Training Manual for Local Indigenous Community on REDD+ Measurement, Reporting and Verification

REDD+ is one of the climate change mitigation actions in developing countries relating to reducing emissions from deforestation and forest degradation, with the '+' signifying conservation of forests, sustainable management of forests, and enhancement of forest carbon stocks.

The success of REDD+ will depend on both accurate and transparent monitoring of carbon emissions and removals by forests and on non-carbon elements such as the safeguards. Local communities are well positioned to collect information on a broader range of parameters beyond carbon that may be needed for REDD+ implementation. These parameters include socio-economic information (e.g., biomass energy use, food production), governance (e.g., benefit sharing processes, mechanisms for participation in decision making), and biodiversity (e.g., species observations, habitat changes). Involving local communities in forest measurement can lead to additional benefits such as transparency, increased ownership of mitigation actions, improved social and environmental safeguards, cultural relevance of monitoring approaches, strengthened capacity of local institutions, access to resources, and employment opportunities. A successful REDD+ programme is ment to give financial incentives to the participating communities. Further, participation of local communities can lead to the long-term sustainability of interventions and of monitoring initiatives.

Measurement, Reporting and Verification (MRV) for REDD+ specifically refers to the measurement, reporting and verification of a country's forest, and associated greenhouse gas emissions and removals, including their changes over time. The range of MRV systems and forest monitoring systems that are being developed for REDD+ will likely require monitoring of forest changes, forest carbon stocks, and 'safeguards' for biodiversity conservation, forest governance and livelihood support.

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NORWEGIAN MINISTRY OF FOREIGN AFFAIRS

MIZORAM ENVIRONMENT FOREST & CLIMATE CHANGE

1. MEASUREMENT

It refers to the direct or indirect measurement of emissions or removals from forest areas as a result of human activities. Direct measurement can include both field measurements and remote sensing, and can be supplemented with modeling. Indirect measurement involves estimation of emissions reductions using equations based on data on land areas and specific emission factors or the use of complex models.

1.1 Forest Carbon Pools and their Measurement: The Forest Survey of India defines forest as "all lands more than one hectare in an area, with a tree canopy density of more than 10%, irrespective of ownership and legal status". Forest absorbs carbon from the atmosphere and store in wood, leaves and soil in the form of biomass because of which they are considered as carbon sinks. This stored carbon in the forest ecosystem can be released into the atmosphere when forests are burned. There are five major carbon pools in which carbon is stored in the forest biomass i.e. above ground biomass, below ground biomass, litter, deadwood, and soil organic carbon.

Aboveground biomass: All living biomass above the soil, including stem, stump, branches, bark, seeds, and foliage. In a forest, aboveground biomass typically emits the most carbon upon conversion to non-forest.

Belowground biomass: All living biomass of live roots upto 2 mm diameter. Belowground biomass is an important carbon pool that may constitute 25.30% or more of the aboveground biomass in many forests.

Dead wood: Includes all non-living woody biomass not contained in the litter, either standing, lying on the ground, or in the soil. Dead wood includes wood lying on the surface, dead roots, and stumps larger than or equal to 10 cm in diameter.

Litter: Includes all non-living biomass with a diameter less than 10 cm, lying dead, in various states of decomposition above the mineral or organic soil. This includes the litter, fumic, and humic layers. Litter can be described as the "forest floor," includes fine woody debris, foliage and twigs that are on the ground and not attached to a plant stem, as well as live fine roots that are above the mineral or organic soil. For some forest types, litter tends to decompose easily, and as a result, may not be worth measuring since the pool is not typically large.

Soil organic matter: Includes organic carbon in mineral and organic soils to a specified depth (30 cm). Live fine roots are included with soil organic matter where they cannot be distinguished from it empirically. Typically, there is no inorganic carbon in soils, except for sites that are so arid that few trees are likely to grow and sites with carbonaceous soils such as limestone. Although there are often measurable amounts of soil organic carbon down to depths of several meters, carbon is generally counted if it is in the top 20 or 30 cm of soil. The density of soil carbon decreases with depth.

1.2 Instrument and Materials Required for Sampling: Quality and accuracy of field work always depends on the type of the field equipments. The equipment used for fieldwork should be accurate, calibrated and durable to use under various adverse conditions during the field surveys.

Compass, Global Positioning System (GPS), clinometer, caliper, core sampler, portable weighing balance with battery, secateurs, saw, *khurpee*, measuring tape, tailor tape, small nails, aluminum tags, paper bags, polythene bags, markers, pens, piece of red cloth/ribbon, ropes 44.72 m (2 nos.), ropes 31.62 m (4 nos.) of different colour, polythene bags for collection of soil and plant samples, bamboo poles of 10 cm diameter with 1.5 m length (5 nos.) and plot description form (Annexure I).

1.3 Sampling Methods: Sampling must be unbiased to ensure that resulting inventories will be reliable. The common methods of sampling are random sampling, systematic sampling and stratified (random or systematic) sampling.

Random Sampling: A random sample approach locates plots within a study area at random. The primary advantage of random sampling is that the calculation of means and uncertainty is simple.

Systematic Sampling: A systematic sample ensures that all geographic areas are equally represented, and is especially useful if little is known about forest conditions or dynamics.

Stratified Sampling: It is accomplished by dividing the sampling area into relatively homogenous sub-areas, and separately sampling each sub area. Stratification increases efficiency of sampling, giving more precise estimates for the same or less effort. Within each stratum, a systematic sample or simple random sample is conducted. Carbon stock (or stock change) is estimated for each stratum, then the stocks of the strata are summed to estimate the stock (or stock change) of the entire area.

1.4 Sample Plot Designs and Sample Plot Layout: Plot designs are point, line and area. Normally, we use square plot for national forest inventory as standardized by the Forest Survey of India. Permanent plots, which are re-measured periodically, allow for estimating the stand growth and disturbances with more precision and can therefore quantify small increases or decreases in stocks. Typically, when forest carbon is being measured, it is necessary to detect the magnitude of change in carbon stocks over a short period of time such as five years or less. Temporary plots are often used in timber inventories.

A square plot of 0.1 ha laid out for sampling. The plot centre reached after covering desired distance and bearing from the reference point represents the centre of the plot of 0.1 ha. i.e. the point of inter section of two diagonals i.e. North East to South West and North West to South East of the plot. The length of each diagonal measures 44.72 m. After reaching the plot centre put a bamboo pole about 10 cm in diameter and 1.5 meter in height. After fixing the plot centre fix the North East at 45^0, South East at 135^0, South West at 225^0, North West at 315^0 corners of the plot by measuring 22.36 m. horizontal distance i.e. half of the diagonal by measuring tape in all four directions. These four corners should be marked by bamboo poles (10 cm in diameter and 1.5 metre in height). A red colour cloth may be tied at the top end of these corner poles for getting clear visibility from different points in the plot. Check the dimensions of the plot i.e. all sides should measure 31.62 metres horizontal distance.

Within this 0.1 ha plot, sub plots of 1m x 1m will be laid out at each corner for collecting data on soil, forest floor (humus and litter carbon). To lay out this sub plot mark 1.42 m along the diagonal towards the plot centre of 0.1 ha plot, then mark 1 m on both the sides and join.

The data regarding herbs and shrubs (including regeneration) is to be collected from four square subplots of 1m x 1m and 3m x 3m respectively. These subplots will be laid out at a distance of 30m from the centre of the main plot in all the four directions along the diagonally. The sample plot layout scheme is given in figure 1.

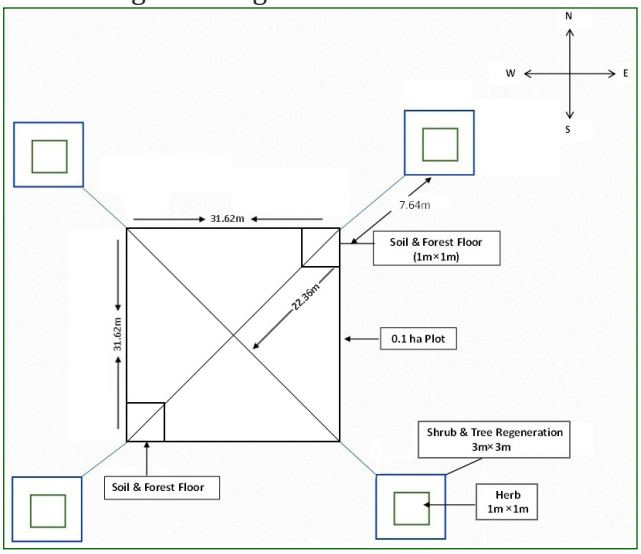

Fig. 1 Sample plot lay out scheme

1.5 Tree Diameter Measurements: Tree diameter at breast height or DBH is measured at 1.37cm above ground. The decision of breast height is based on location and position of tree on the terrain. For slopping ground, this distance measures from the uphill side of the stem. The diameter may be measured by wrapping measuring tape firmly around the stem, perpendicular to axis. The point must be marked for repeated measurements for assessing growth rate to ensure that the same position will be measured in each occasion. The diameter can also be measured through calipers. Caliper are often quicker, however measure stems only across one diameter of their cross-section. This bias may be reduced by taking two measurements, at right angles to each other, and estimates of mean of these two measurements as stem diameter. Diameter measurement at breast height may not be representative in some cases such as deformity, swelling, branches, malformation, wound etc. at that point. In this cases following considerations should be followed.

- Two measurements equidistant above and below the breast height should be recorded. If the difference in measurements is low, arithmetic mean will serve the purpose, otherwise, quadratic mean will be a better option.
- Alternatively, measurement may be recorded from a single point by selecting one position of representative size.

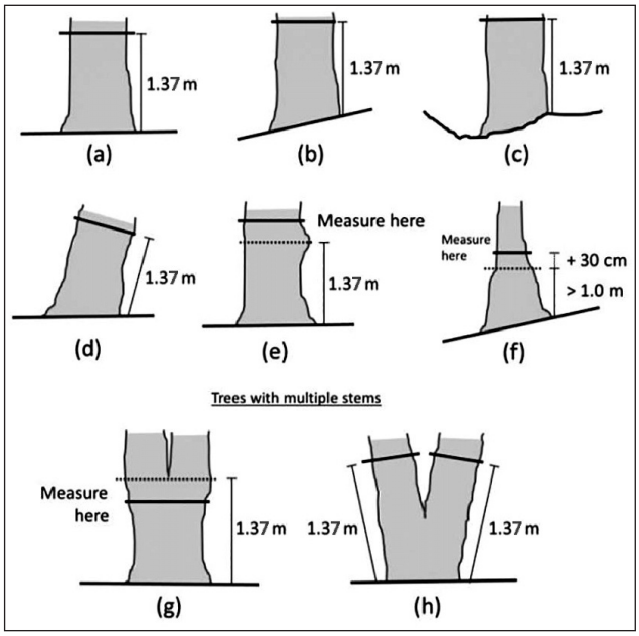

Fig.2 Tree DBH measurements under different situations

Following precautions are to be observed while measuring tree diameter:

- On slopping ground measurements should be taken from the uphill side of the stem.
- For leaning trees (on level ground), the point will be on the under-side of the tree parallel to the axis of the stem.
- Trees forked below breast height should be treated as a double stem *i.e.* two separate tree.

Trees forked above breast height should be treated as a single stem and measured according to the position of tree on ground or hills.

- Trees forking at breast height or slightly above are measured at the point of minimum diameter below the fork.
- Coppice crops should be measured from ground level, not from level.

Besides above, following precautions should also be ensured for proper and accurate measurements:

- The loose mounds of soil and litter should be displaced and cleared.
- The vines, moss, loose bark and other loose material at breast height should be removed.
- The breast height should be fixed by using a fixed height (bh) stick.
- Measure at right angles to the stem axis. Keep tapes taut.
- Special attention should be placed for buttressing and fluting situations to ensure standardization and comparability of records. Normally, measurement is made above the buttress/fluting. Where this extends well up the bole, an arbitrary height is specified, e.g. 3 m above ground.

1.6 Tree Height Measurement: The height of tree is important characteristics for measuring the total amount of wood contained in live tree. It is the vertical distance from ground level to the highest given point on the tree known as tip of the tree. Height can be measured through ocular estimate, non instrumental, (shadow method, single pole method). The specifically the tree-height measurements can be done with the help of clinometers, altimeters etc.

Measuring tree height:

- Walk around the tree and find the best location to view the top of the tree.
- Stand far enough away from the tree so that the top of the tree is less than 90 degrees above the line of sight.
- Always stand up-slope of the tree. Standing down-slope of the tree should only take place when no other option exists.
- Measure height of dominant canopy trees.
- Follow the instructions provided by the manufacturer of the instruments.
- Place chalk mark on the tree to indicate that the tree has been measured.
- All trees should be tagged with the placement of an aluminum numbered tag and nail.
- Record species name with the local name and the associated DBH and height.

When all of the trees in the plot have been measured, there should be double-checking to see that all of the trees have been measured.

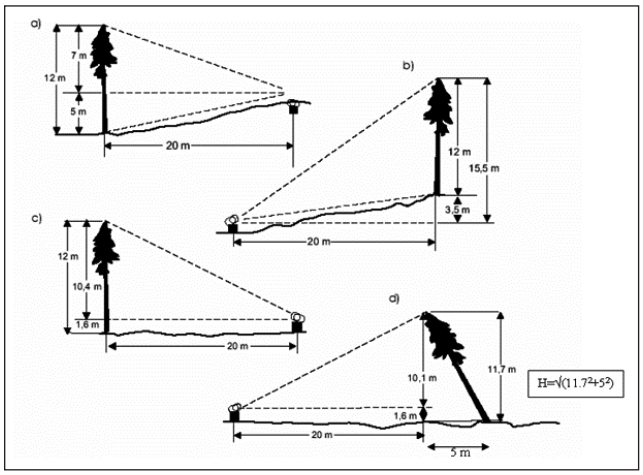

Fig.3 Tree height measurements at different locations

1.7 Shrub Biomass: Plots of 3 × 3 m will be laid for the shrub biomass estimation as per the sample plot layout scheme. Species name and number of each shrub should be recorded. Harvest all the shrubs in the plot and weigh. Sample of known quantity should be brought to the laboratory for the further estimation of the biomass. Sample should be dried to constant weight in the oven and the values are extrapolated to per hectare stock.

1.8 Herb Biomass: Sampling of the herbs is done by lying 1×1 m plots as per the sample plot layout scheme. The following steps could be followed for the herbs biomass estimation:

- Species name and number of each herb should be recorded in the prescribed format
- Harvest all the herbs in the plot
- Fresh weight of the each species should be taken through portable weighing machine and recorded in the prescribed format
- Sample should be properly packed, labeled and brought to the laboratory for further estimation
- Estimate the dry weight of the sample by drying it in an oven till constent weight
- Extrapolate the sample plot value of dry herbs to per hectare stock

The steps for measuring the litter biomass are as follows:

- Collect the litter completely present in the sample plot by laying out the quadrat of 1 m x 1m at all the four corners lying inside the plot boundary
- Record the fresh weight of the total litter collected
- Take the 200 gm sample of the litter
- Sample should be properly marked and

packed. Brought the sample to the laboratory for further estimation

- Oven dry the litter sample till constant weight
- Extrapolate the sample plot value of dry litter to per hectare stock

1.9 Collection of Soil Samples

(i) For Organic Carbon Estimation: Forest floor and litter from an area of 1 m × 1 m, at sampling point is removed and a pit of 30 cm wide, 30 cm deep and 50 cm in length is dug out. Soil from three sides of the pit of 0 to 30 cm depth was scraped with the help of a *khurpee* and bulked. This soil is mixed thoroughly, and about 500 g soil is collected. The soil sample is kept in a polythene bag and tightly closed with thread. A label showing sample details is kept inside the bag before closing the bag.

(ii) For Bulk Density Estimation: Insert the bulk density core (core sampler of known volume) in between 0–15cm depth with the help of hammer, up to the top of the core. Remove the core carefully so that the soil inside the core may not drop down. Collect the entire soil in a polythene bag, and bring it to laboratory. Repeat this exercise again in the soil 15–30 cm depth.

Finally, average of both the above densities will be taken for final calculation of the soil weight of that particular site.

2. REPORTING

It refers to the presentation of measured information in a transparent and standardized manner. Reporting for REDD+ can be defined as the process used to translate information resulting from measurements or monitoring (for example, information generated by a forest carbon inventory and a land-use change analysis) into an agreed format, such as the UNFCCC reporting framework. It encompasses the amount of greenhouse gas emissions avoided as a result of reduced deforestation and forest degradation, as well as the amount of greenhouse gas removals as a result of forest conservation and enhancement activities. Depending on the specific activity, other reported information may include data on forest areas affected, methodologies employed, emission factors used, impact on deforestation drivers, effectiveness of measures put in place, financial resources needed or used, or application of quality assurance/quality control (QA/QC) procedures. The reported information is often used to help improve the transparency of actions and verify emissions and removals claimed for different activities.

3. VERIFICATION

It refers to the assessment of the completeness, consistency, and reliability of the reported information through an independent process. Verification provides inputs to improve data (including green house gas emissions and removals as well as all measured data or derived parameters). Verification can be performed to check the accuracy of the report by independent means. Verification can be done through internal check or through external agencies as desired.

Annexure-1

Plot Description Form

Name of Forest Division with Range: ..... Date: .....

S.No.	Description						
1	Plot No. (31.62 X 31.62 m)						
2	Tree - DBH and Height Measurements						
	S.No.	Species Name				DBH (cm)	Height (m)
		Common Name		Botanical Name			
	1						
	2						
3	Shrub and Regeneration (3m X 3m)						
	S.No.	Species Name		Collar dia at base (cm)	DBH (cm) if any	Height (m)	Remarks, if any
		Botanical Name	Local Name				
	Sub Plot No.:						
	1						
	2						
	Sub Plot No.:						
	1						
	2						

	Sub Plot No.:						
	1						
	2						
	Sub Plot No.:						
	1						
	2						
4	Herbs and Seedlings (1m X 1m Plot)						
	S.No.	Species Name		Height (m)	Remarks, if any, about the condition of herbal vegetation		
		Botanical Name	Local Name				
	Sub Plot No.:						
	1						
	2						
	Sub Plot No.:						
	1						
	2						
	Sub Plot No.:						
	1						
	2						
	Sub Plot No.:						
	1						
	2						
5	Litter Sample Collection						
	Sample No.: ..... Fresh Weight: ..... Sample No.: ..... Fresh Weight:						
6	Soil Sample Collection						
Soil Sample No. for Carbon Estimation:		Soil Sample No. for Bulk Density 0-10 cm :		Soil Sample No. for Bulk Density 10-20 cm :		Soil Sample No. for Bulk Density 20-30 cm :	

Sample Collected By : .....

Date : .....

Note: This training manual has been prepared for the capacity buildings of the local indigenous communities on MRV aspect of REDD+ under the project 'REDD+ Himalayas: Developing and using experience in implementing REDD+ in the Himalayas'.

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"REDD+ Himalaya: Himalaya-a REDD+ hmanna tura tawnhriat awmsa hman tangkai leh tih changtlun"

Khawtlang mipui tana REDD+ hmalakna chhutchhuah, inhrilhhriat leh finfiah dan tura inkaihhruaina

REDD+ hmalakna pakhat chu ram thang meka ramngaw tih chhiat leh chereu nasat lutuk avanga boruak chhia in siam nasa lutuk tih kiam emaw ven hi ani a, '+' ina a entir chu ramngaw humhalh, ramngaw enkawl leh boruak chhia (Carbon) a tam thei ang ber thing leh maua chhekkhawl hi ani.

REDD+ hlawhtlinna bul chu dik leh rintlak taka boruakchhia ramngaw kan tihchhiat ina a pek chhuah zat chhut chhuah hi ani. Hemi kawngah hian khawtlang mipuite pawhin he REDD+ hmalakna a hlawhtlin theihna atan tih tur tur kan nei awm e, chungtechu: socio-economic information atangin (entirnan: thing tuah tur ramhnuaia tanga lakzat, kan thlai thar chhuah zat), khawtlang inawp dan atangin (entirna: hlawkna in sem tawn, khawtlang anga tanrual), biodiversity (thing leh mau kan humhalh dan, kan leilung danglam zel dan). Hetianga teh fung leh record fel tak nena kan ramngaw kan enkawl chuan hlawkna tam tak kan neih phah thei dawn ani, entirna: boruakchhia pung tur kan veng thei anga, kan khawtlang boruak a lo thianghlim phah anga, khawtlangin hma a sawn phah anga, kan ram leilung hausakna a pun belh bawk ang. REDD+ hmalakna kan tih puitlin hian, khawtlang mipuiten sum leh paia tanpuina tam tak kan dawng thei bawk ani.

Measurement, Reporting leh Verification (MRV) in a tum bulpui chu kan ramgawin boruak chhia (Greenhouse gas) a pek chhuah zat dik tak chhut chhuah, report leh finfiah zel hi ani. MRV system hmang hian kan ramngaw danglam dante, carbon awm zatte, kan humhalh dante, kan enkawl dan leh ramhnuai atanga hlawkna kan hmuh dante tha taka kan chhinchhiah chuan REDD+ hmalakna leh thiltum tih hlawhtlinna kawngah nasa takin kan pui thei dawn ani.

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1. MEASUREMENT

Mihringin ramngaw kan tih chhiat avanga boruak chhia lo in siam hi chi hnih a teh theih a ni a: direct leh indirect measurement hmangin. Direct measurement-ah chuan ramhnuaia kal a va teh leh Remote Sensing hmangin a ni a, indirect measurement-ah chuan mithiam ten tehfung (Equation) an siamsa hmangaihte hi ani.

1.1 1.1 Ramhnuaia Carbon inchhek khawl teh dan: Ramhnuai awmzia Forest Survey of India in a sawifiah dan chu "Ramhnuai (forest) kan tih chu ram leilung hectare khat a zauah 10% tal thingkungin a luah khat tur a ni, sorkar emaw mimal ram thliar hrang lovin". Ramhnuaia thingkung te hian boruaka carbon awm hi an hip luta, akungah, a hnahah leh leilungah te a chhekkhawla, hei vang hian thing leh mau tamna hmunah chuan carbon tam tak a in chhekkhawm tihna ani. Ram kan hal thin avang hian chu carbon in chhekkhawm chu boruakah a lo chhuak thina, khawvel sik leh sa a lo danglam phah thin ani. Carbon in chhekkhawlna pawimawh tak tak panga a awma, chungte chu: Aboveground biomass (thingkung lei chunglam zawng), belowground biomass (a zung), litter (thing hnah leh a tang tla), deadwood (thingkung thi) leh soil (leilung).

Aboveground biomass: Thingkung lei chung lam zawng (entirnan: a kung, a hnah, a zar, a kawr, a chi) hi an pawimawh hle a, ramngaw kan tih chhiat avanga boruak chhia lo chhuahna bulpui ber pawh an ni.

Belowground biomass: Hei hian a zung (2mm diameter) aia lian zawng a huama, Carbon inchhekkhawlna pawimawh tak ani a, a kungin a Carbon a khawl zat atanga 25-30% emaw a aia tam pawh a zungah hian a khawl ve thei ani.

Deadwood (Thingkung thi): Hei hian thingkung thi tawh, dingin emaw a tlu emaw lei chhunga in phum a huam a. Hei mai bakah hian thingkihna hnu bul (stump) 10cm diameter emaw a aia lian a huam tel bawk ani.

Litter: Litter kan tih hian thingkung thi tawh, 10cm diameter aia lian lo te, a hnah leh a tang tla zawng zawng te, a zung te reuh te te a huam vek ani. Ramngaw thenkhatah chuan heng a hnah leh a tang tla te hi an tawih hma em em a, carbon an pek chhuah a tlem em avangin teh kher pawh a ngai lo.

Soil organic matter: Soil organic matter hi leilunga thil tawih thei engpawh sawina a ni a. Heng hian lei chung lang (30cm) thlenga carbon pe chhuak tu ber ani a. Dan pangaiah chuan inorganic carbon hi kan leiah a awm mang meuh lova, hmun ro (ruahtui tlemna) tak thing leh mau tlemna hmun leh limestone tamna hmunah chauh hian a tam thin ani. A tlangpui thu chuan organic carbon kan tih hi lei chung lang a tanga meter engemaw zat thleng hi chuan an awma, a tam na hmun ber chu lei chunglang a tanga 20-30cm vel chauh hi ani. Lei a thuk poh leh carbon hi a tlem ve tial tial ani.

1.2 Field work tihna hmanrua leh a tih dan phung: Field work tha leh dik taka ti thei tur chuan kan hmanrua a pawimawh hle, kan hmanruate chu rintlak, dik leh tha, eng hun leh hmun pawha hman tlak an ni tur ani.

Compass, Global Positioning System (GPS), Clinometer, caliper, core sampler (lei lakna), portable weighing balance with battery (bukna), secateurs (thing tang cut na), saw (ara), khurpee (tuthulh), measuring tape, tailor tape, perek, aluminium tag, paper bag, polythene bag, marker, pen, puanthem/red ribbon, hruihrual (44.72m) pahnih, hrui (31.62m) pali rawng chi hrang hrang, lei leh hnimhnah lakna polythene bag, mautlawn (10cm diameter-a lian leh 1.5m a sei) leh plot siam dan Annexure 1 ah dah khah tur ani.

1.3 1.3 Sampling tih dan tur: Ramhnuaia thing leh mau awm dan kan zir dawn chuan dik leh tha taka sampling tih tur ani. Sampling tih dan chi hrang hrang te chu:

Random Sampling: Random sampling hi hman tlanglawn ber ani a, ramhnuaia kan duhna laiah tak kil li neiin hrui kan pawt anga, kan hrui pawh chhunga thing leh mau awm te chu kan zir chiang dawn ani, entirna: a thing hming, a san zawng, a len zawng leh adangte. Random sampling hman nawmna chhan ber chu chawh chhuah a awl hi ani.

Systematic Sampling: Systematic sampling-ah chuan ramngaw kan zir bing tur kha a tam thei ang berah in ang theuhin square plot kan siam ang, chu chuan a ramngaw awm dan a paw chhuak zo bawk tur ani. Kan ramngaw hriat ngai lem loh pawh fel fai takin a thing awmte, thing tam bik te, a len leh san zawng te kan hre thei mai dawn ani.

Stratified Sampling: Stratified sampling-ah chuan ramngaw kan zir chian tur chu ang khat theuhin kan thensawm (sub-area) ang. Sub-area chhungah chuan a chunga kan tarlan tak sampling method hmang khian ramngaw chanchin chu kan zir chiang tawh mai dawn ani. Stratified sampling-hi a buaithlakin a hahthlak deuha, amaherawhchu a result a dikin a rintlak ber thung. Sub-area chhunga carbon inchhekkhawl zat kan chhut chhuak anga, a result chu belhkhawmin ramngaw chhunga carbon awmzat kan hre tawh mai dawn ani.

1.4 Sample plot siam leh ruahman dan: Plot siam dawna pawimawh tak chu a point, line leh a zau zawng hi ani. Forest Survey of India-in ramngaw a zir chian dawn reng rengin square plot (kil li nei) zel a hmang thin ani. Plot nghet (permanent plot) tam tak a siam a, kum tinin plot nghet sa chu a zir chiang thin ani. Thing leh mau chereu dan te, a pun dan te, fel fai takin a chhinchhiah thlap thlap

thin ani. Ramngawa carbon awmzat kan chhut hian, hun rei lo te (kum 5 emaw a aia tlem) chhunga carbon in lum let dan kan zir chian hi a pawimawh hle ani. Plot nghet lo (temporary plot) hi chu thing zir chian nan a tawk lek ani.

Sampling tih nan chuan 0.5ha plot hi a tawk maia, a plot lai tak chu kan hrui pawh na (plot kan siam tanna) Hmar Chhak atanga Chhim Thlang leh Hmar thlang atanga Chhim Chhak a khaw kham zawnga hrui pawhin tawhna lai tak ani tur ani. Kan hrui pawh chu 44.72m sei a ni tur ani. Plot lai tak chu kan chhinchhiah anga, mau 10cm a lian leh 1.5m sei kan phun tur ani. Plot lai tak kan chhinchhiah hnu chuan Hmar Chhakah 45°, Chhim Chhakah 135°, Chhim Thlang 225° leh Chhim Chhak 315° in a kil tin kan chhinchhiah tur ani. A kil tin ah mau (10cm a lian leh 1.5m a sei) kan phun vek tur ani a, puan sen nena chhinchhiah bawk tur ani. Kan plot siam kil tin sei zawng chu 31.62m a ni tur ani.

Kan plot (0.5ha) zau chhungah chuan sub-plot 1m×1m a zau kan siam leh tur ani a, hemi chhung a tang hian lei leh litter atangin carbon awm zat kan chhut chhuak tur ani. Sub-plot siam tur hian a kil tanga a khaw khawm zawnga kan hrui pawh 1.42m ah kan chhin chhiah anga, a kil leh lam ve ve ah chuan 1m kan chhin chhiah ang, heta tang hian a khaw kham kan hrui pawh 1.42m ah chiah khan kan va zawm tur ani.

Herbs (hnim) leh shrubs (hnim buk) kanteh duh a nih chuan square plot 1m×1m leh 3m×3m kan hmang ngei ngei tur ani. Sampling lak dan chu a hnuaia lem ang hi a ni e.

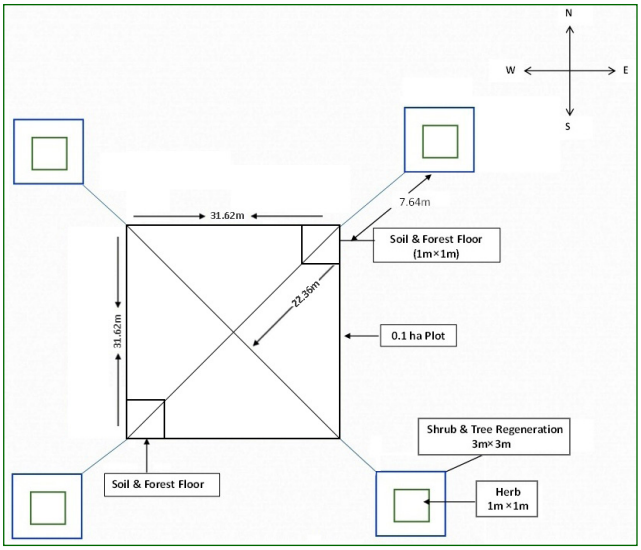

Fig. 1 Sampling lak dan design

1.5 Thingkung diameter teh dan: Thingkung kan teh dawn anih chuan a bul atanga kan awm zawn (1.37m) a sangah kan teh tur ani. Amaherawhchu, a thingkung awmna hmun a zirin a teh dan hi a danglam thin. Kham/awih ami thingkung len zawng kan teh dawn anih chuan a chung lam atang teh tur ani. Measuring tape nen uluk tak a teh tur ani a. Kan teh nalai tak (1.37m) kha chhinchhiah tur ani, a than chak dan zir nan pawh a tangkai hle ani. Caliper hmang pawhin a diameter hi kan teh thei bawk. Caliper hi hman a nuama, a rang bawk. Amaherawhchu, caliper hmanga kan teh dawn anih chuan hmun hnih atanga kan teh a ngai dawn ani. Thingkung diameter hi 1.37m ah chiah chiah kher a teh theih loh thin, a chhan chu thingkung kha a to dan a dik lo thei entirnan: 1.37m lai tak kha a te emaw a lian bik a ni thei, hetiang thingkungah chuan1.37m aia sang emaw hniamah emaw teh mai tur ani.

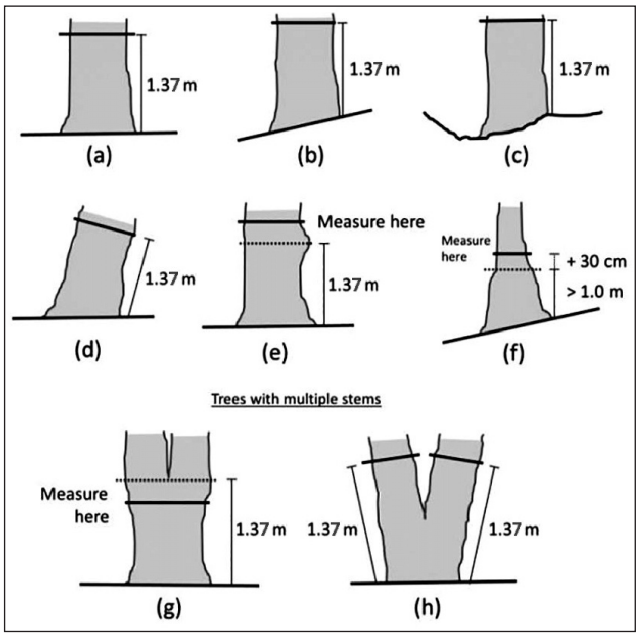

Fig.2 Thingkung diameter (len zawng) teh dan

Thingkung diameter teh dawna inven tulna te:

- Kan thingkung teh tur chu tlang awiha awm a nih chuan a chung lam atanga teh tur ani.
- Thingkung awn (zawla ami) a nih chuan a awnna lam atanga teh tur ani.
- Thingkung chu 1.37m aia hniam atanga a kak chuan thingkung pahnih anga chhiar tur ani.

Thingkung chu 1.37m aia sang atanga a kak chuan thingkung pahnih anga ngaih tur a ni a, a teh dan turah pawh a to dan leh awmna hmun a zirin a danglam thei ani, entirna: thingkung awn leh khampang ami.

- Thingkung chu 1.37m ah tak a kak emaw a aia sang hret atanga a kak chuan a kakna hnuai chiah atanga a diameter teh tur ani.
- A bul atanga chawr thingkung chu lei hrul atanga a diameter teh tur ani.

A chunga kan sawi bak thil pawimawh dang te chu:

- Thingkung diameter kan teh hmain a bul vela hmawmhnawk kan tifai hmasa thin tur ani.
- Kan tehna hmun tur (1.37m a sang) taka hruizam leh thil dang to reng reng chu kan

thian fai tur ani.

- Kan tehna hmun tur 1.37m a sang chu tha takin kan chhinchhiah tur ani.
- A kung atanga right angle chiaha measuring tape mar taka pawta teh tur ani.
- Thingkung bul chu a pawng vak anih chuan, a pawng chung chiah atanga teh tan tur ani.

1.6 Thingkung san zawng teh dan tur: Lei atanga a ler thleng hi thingkung san zawng chu ani mai a, heng hmangte hian thingkung san zawng a teh theih ani: mita en mai atangin (teh than chu angai), hmanraw tel lovin entirna: hlimthla tangin, mautlawn hmangin. Heng hmanrua clinometer, altimeter leh adangte hmang hian thingkung san zawng chu kan teh thei bawk ani.

Thingkung san zawng teh dan:

- Thingkung chu a ler a hmuh theihna atangin teh ang chu
- Thingkung ler chu 90° aia tlema i hmuh theihna hmunah ding ang chu.
- Thingkung awmna chu a awih a nih chuan a chunglam atang zelin teh ang chu, teh dan dang a awm thlawt lo a nih chuan a hnuai lam atanga tehmai tur ani.
- Thingkung i teh tur chu a sang ber pawl an ni tur ani.
- I thingkung teh tawh apiang chu chhinchhiah zel ang chu.
- Aluminum tag-ah i thingkung teh tawh apiang chu number pe la
- Thing hming, local hming, diameter leh a san zawng record thlap thin ang chu.

Plot zawng zawng atanga thingkung i teh tawh zawng zawng chu en dik leh vek thin ang chu.

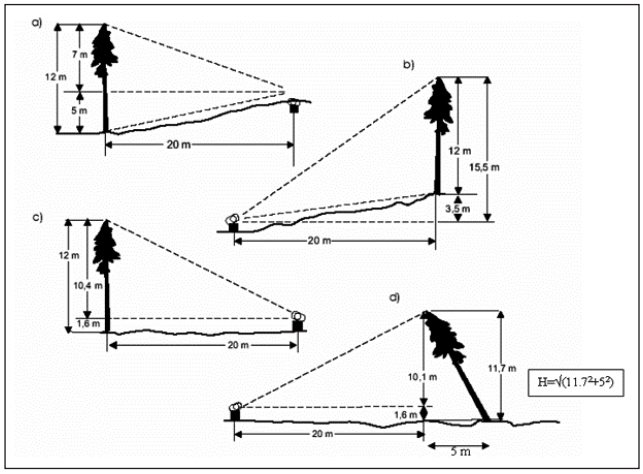

Fig.3 Thingkung san zawng teh dan

1.7 Hnim buk biomass: Hnim buk biomass teh nan chuan 3×3m plot kan siam anga, hemi plot chhunga hnim buk awm zawng zawng, an hming leh a awm zat fel takin kan chhinchhiah tur ani. Hnim buk awm zawng zawng chu kan la khawm anga, a rih zawng kan buk ang. Hnim hring rih zawng kan buk hnu chuan oven-ah kan ti ro ang a, chu mi hnuah a rih zawng kan buk leh tur ani. Kan result chu hectare khat hisapin kan chawk chhuak leh tur ani ang.

1.8 Hnim biomass: Hnim biomass chu 1×1 m plot atanga teh tur a ni a, fel fai takin a hnuaia tarlan ang hian record tur ani:

- Hnim hming leh plot chhunga awm zat kan chhinchhiah ang
- Hnim awm zawng zawng chu ka la anga
- A hrin laiin kan buk ngei ngei tur ani.
- Kan hnim lak chu sarangah (polythene bag) kan dah tha anga, kan chhinchhiah thlap bawk tur ani.
- Oven-ah ti ro in kan buk leh thlap tur ani.
- Kan result chu hectare khat hisapin kan chhut leh tur ani.

Ramhnuaia thing hnah leh a tang tla atanga biomass chhut dan:

- Square plot 1×1m chhunga tla thinghnah zawng zawng chu la khawm la
- A rih zawng buk nghal ang chu, tha takin chhinchhiah bawk ang chu
- Thinghnah 200g chu la in oven ah ti ro ang chu
- Plot zawng zawng atanga thinghnah i lak khawm te chu hectare khat hisap zelin chhut ang chu

1.9 Leilung zir chian tur lak dan

(i) Organic carbon teh dan: I lei lakna tur hmuna hmawnhnawk awm ang ang ti fai la, i lei lak tur chu a thuk zawng 30cm, a vang 30cm leh a dung 50cm a ni tur ani. Lei chu tuthulh nena lak tur a ni a,hmun hran hran atanga i lei lak chu i chawhpawlh (composite) anga, i chawhpawlh atang chuan a tlem berah 500g tal test tur a tan i la tur ani. I lei lak chu polythene bag ah i dah anga, phui taka dah tur ani. I Lakna hmun leh ni tha taka chhinchhiah bawk tur ani.

(ii) Bulk density teh dan: Thir mum tlawn (5cm diameter) nen lei chunglang 0-10cm, 10-20cm leh 20-30cm atanga lak tur ani. Thir mum chhunga lei chu fai takin kan la chhuak anga polythene bag-ah kan dah tur ani. Kan lei lak chu laboratory-a test leh tur ani.

2. REPORT ZIAH DAN

Kan result neih zawng zawng chu rintlak leh dik takin report kan ziak tur ani. REDD+ project hnuaia hna kan thawh zawng zawng (entirnan: thingkung san zawng leh len zawng, carbon awmzat, leia car-

bon inchhekkhawm zat te) chu UNFCCC format awmsa anga result ziah thlap tur ani ang. Kan report-in ramngaw kan tih chhiat leh chereu avanga boruak chhia (Greenhouse gas) lo pun dan emaw ramngaw kan humhalh leh enkawl that avanga boruak chhia kiam chak dante a huam vek tur ani. Kan thil zir piah lamah hengte hi ngaipawimawh bawk tur ani: ramngawin boruak a nghawng dan, kan zir dan phung (methodogy), ramngaw ti chhetu ber, ramngaw kan humhalh kawnga kan pawisa sen zat emaw quality assurance/quality control (QS/QA). Heng thing leh mau chanchin kan zir atang hian REDD+ hmalaknain hma a sawn anga; leilung kan hman dan, kan tih chereu leh humhalh dan atanga boruak chhia lo pung emaw kiam chu kan hre thei dawn ani.

3. FINFIAH DAN

Kan result chu a dik, fel famkim leh rintlak em tih uluk takin kan finfiah tur ani a. Hetianga kan finfiah nawn leh vek hian kan result (entirna: boruak chhia inpek chhuah dan leh kiam dan, lei leh thil dang kan test zawng zawng) chu a hma aia rintlak leh dik zawkin kan siam thei dawn ani. Kan thil zir atanga a chhanna kan neih zawng zawng chu a mal te te a ennawn leh vek a tha khawp mai. Tin, kan result dik zia leh rintlakzia finfiah nan pawn lam mi (mi thiam) te kan ennawn tir bawk thin tur ani.

Annexure-1

Plot Description Form

Forest Division leh Range Hming: ..... Date: .....

S.No.	Description						
1	Plot No. (31.62 X 31.62 m)						
2	Thingkung (Len leh san zawng)						
	S.No.	Thing hming				DBH (cm)	Height (m)
		Local Hming		Botanical hming			
	1						
	2						
3	Hnimbuk leh chawr thar (3m X 3m)						
	S.No.	Hnimbuk Hming		A bul len zawng (cm)	A len zawng (cm)	San zawng (m)	Pawimawh dang
		Local Hming	Botanical Hming				
	Sub Plot No.:						
	1						
	2						
	Sub Plot No.:						
	1						
	2						
	Sub Plot No.:						
	1						
	2						
	Sub Plot No.:						
	1						
	2						
4	Hnim leh a tiak (1m X 1m Plot)						
	S.No.	Hnim Hming		San Zawng (m)	Thil pawimawh dang		
		Local Hming	Botanical Hming				
	Sub Plot No.:						
	1						
	2						

	Sub Plot No.:				
	1				
	2				
	Sub Plot No.:				
	1				
	2				
	Sub Plot No.:				
	1				
	2				
5	Hnah leh thing tang tla lak khawm				
	Sample No.: ..... A rih Zawng: ..... Sample No.: ..... A rih Zawng:				
6	Lei lak khawm				
Sample No. carbon teh na atan:		Sample No. Bulk Density the na atan 0-10 cm :		Sample No. Bulk Density the na atan 10-20 cm :	Sample No. Bulk Density teh na atan 20-30 cm : .....

Sample la tu Hming : .....

Date : .....

Note: He inkaihhruainaa kan tarlante hi REDD+ project 'REDD+ Himalaya: Himalaya-a REDD+ hmanna tura tawnhriat awmsa hman tangkai leh tih changtlun' hnuaia khawtlang mipui te tana tangkai tur leh chhenfakawm thei ang ber tura duan ani.

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