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BASELINE AND QUANTIFICATION OF SEQUESTRATION OF 2.5–3 BILLION TONNE OF CO_2e BY 2030

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BASELINE AND QUANTIFICATION OF SEQUESTRATION OF 2.5–3 BILLION TONNE OF CO_2E BY 2030

Introduction

Climate change essentially refers to the rise in the average surface temperature on Earth. Historical emissions since 1880 have resulted in 0.85% Celsius rise in global temperature (MoEF&CC 2009). Till 2009, the historical carbon space occupied by India was only 3%. The percentage share of India in the global annual emissions as on 2018 is 7%. India, even though not part of the problem, has been an active and constructive participant in the search for solutions. At the 19th COP in Warsaw in 2013 all the countries were required to prepare Nationally Determined Contributions (NDCs) and present them in COP 21 in Paris. Government of India presented its NDCs as it felt it was balanced and comprehensive. India communicated its NDCs on 2 October 2015 and ratified it on 2 October 2016. By 2030, India has committed to reduce the emissions intensity per GDP by 33–35% from the 2005 level and create an additional carbon sink of 2.5 to 3 billion tonne of CO_2e through additional forest and tree covers. India's NDC has three quantified targets: the first is related to emissions intensity of GDP. The second is related to contribution of renewable energy in the overall installed power and the third is about achieving further carbon sink of 2.5 billion tonne to 3.0 billion tonne through additional forest and tree cover by 2030. The present study focuses on the third target specified in quantity. It is felt that developing additional carbon sequestration sink of 2.5–3 billion tonne of CO_2e through forestry sector will be an exceedingly difficult and ambitious task that will require immediate reforms as well as strong political and financial commitment from the government. In this document we present a brief analysis of the impending challenges in attaining the desired NDC goals through forestry, and summarize the possible recommendations and a road map for achieving the NDC objectives.

Forests in India are primarily treated as social and environmental resources, and only secondarily as commercial resource. Forests are home to 80% of the country's biodiversity (FAO 2010). They provide 40% of energy needs, 30% of fodder supply, and 50% of grazing requirement along with other non-timber forest products (NTFPs). The forest sector provides livelihood support to one-fourth of the population living in 173,000 forest-dependent villages. More than 350 million people derive their full or partial livelihood and sustenance needs from forests, largely on unsustainable basis.

Forest comes under the concurrent list of the Indian Constitution, and the central government is responsible for policy and planning while the state government's responsibility is implementation. The country's forest cover is 71.22 million hectare, which is 21.67% of the geographical area (ISFR 2019). The areas under very dense cover, moderately dense cover, and open forests are 9.92 million hectare (3.02%), 30.84 million hectare (9.38%), and 30.44 million hectare (9.26%), respectively. Natural forests contribute to about 95% to the forest cover of the country. The tree cover is 9.50 million hectare, which is 2.89% of the geographical area of the country. The total forest and tree cover in the country is 80.72 million hectare, which amounts to 24.56% of the

geographical area. The growing stock of India's forests is 4273.47 million m^3 and the growing stock of trees outside the forest (TOF) is 1642.29 million m^3 (ISFR 2019). While open forests increased, there was a reduction of 0.34 million hectare of moderately dense forests, indicating forest degradation (FSI 2019). Unsustainable harvest of fuel wood and minor forest produce is the major driver for forest degradation. In view of the above, it is evident that the anthropogenic pressure endured by the nation's forest is enormous. With rapidly growing population, this pressure is set to rise in the future. This will seriously affect the quality of forests and their sequestration potential.

In the last one and a half decades, forest and tree cover in India has shown a gradual and steady trend of increase (Figure 1). India is among the few countries in the world to achieve this positive trend of forest cover increase. This increase is even more creditable as a large number of tribal people and other villagers living in the forest fringe villages depend on forests for their day-to-day needs of fuel wood, fodder, small timber, and NTFPs. The increase in the forest cover could be possible only because of the high priority accorded to conservation by the national and state governments, which is reflected in a strong framework of policies, acts, and rules and programmes that ensure conservation of forests and biodiversity, enhance green cover and participation of people in the conservation activities while protecting the rights of the forest-dependent communities.

Methodology

The study has undertaken a mixed approach which involves secondary research and stakeholder consultations. The study is based on secondary sources of data from *India State of Forest Report* (ISFR) 2019. Biomass gain and loss method has been adopted to estimate the greenhouse gas (GHG) emissions and removals, and to assess the trends of growing stock and carbon stock as reported in ISFRs. Broadly, the study covers the existing legal and policy framework around forest and interrelated sectors in India, their current status of implementation, challenges and opportunities, and strategies to overcome the challenges.

The methodology used for developing the road map includes:

- Mapping existing policies, plans/programmes, mechanisms and measures related to the NDC target and to assess current status of implementation of these policies, plans/ programmes mechanism, and measures.
- Analyse factors, gaps, and challenges impacting the achievement of the NDC target.
- Target setting to achieve the forest carbon sink by 2030.

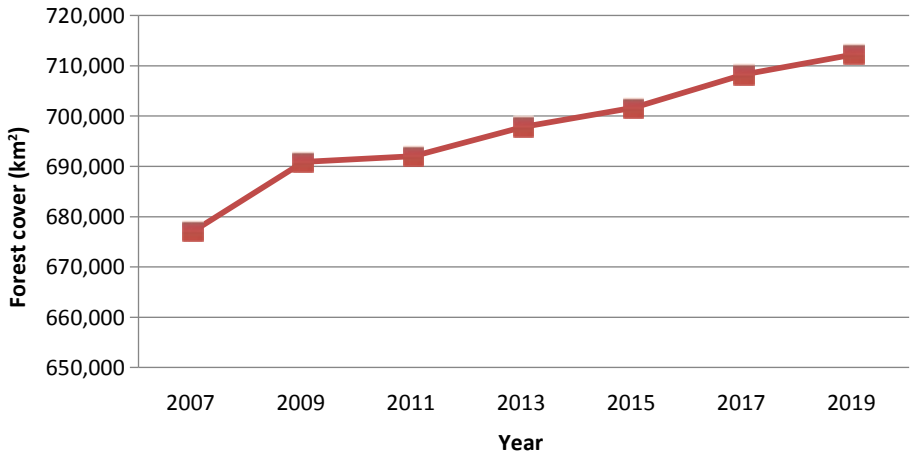

Figure 1: Trend in forest cover from 2007 to 2019

Mapping existing policies and programmes related to the NDC target and to assess their current status of implementation

An overview of policies, legal instruments, and programmes which provide enabling conditions in India for achieving sustained growth of forest and tree cover in the country, has been given here:

Indian Forest Act, 1927

This Act consolidates the law relating to forests, the transit of forest produce, and the duty leviable on timber and other forest produce. Proper implementation of the provisions of this Act is capable of ensuring conservation of biodiversity of the natural forests as also enhancing the quality and extent of the forest and tree cover in the country, which, in turn, contributes to the achievement of NDCs.

Wildlife Protection Act, 1972

This Act provides for the protection of wild animals, birds, and plants and for matters connected therewith or ancillary or incidental there to. It perfectly synergizes with the NDC target of increasing forest and tree cover by conservation of biodiversity and non-conversion of natural forests into plantations.

National Forest Policy, 1988

The principal aim of National Forest Policy (NFP), 1988 is to ensure environmental stability and maintenance of ecological balance. The policy aims for maintaining one-third of the country's geographical area under forest and tree cover and calls for massive afforestation and social forestry programmes with people's participation for increasing the forest and tree cover in the country. The objectives of NFP synergize with India's NDC commitments of climate change mitigation through the forestry sector. The more the area under forest, the more the mitigation it will provide.

Forest Conservation Act, 1980

It is one of the most effective legislations contributing to reduction in diversion of forest lands for non-forestry purposes. This was enacted to reduce indiscriminate diversion of forest lands for non-forestry purposes, and to help regulate and control the land use changes in forests. The Act empowers the Union Government to allow the diversion of forest for non-forestry use in a rational manner after detailed scrutiny and ensuring compensatory afforestation. With the enactment of this Act, the deforestation and conversion of forest lands to non-forest use has been drastically reduced. Being an Act for regulating diversion of forest land for non-forestry purposes, and to strike a balance between conservation and development, it will help to achieve NDC targets in the country by supporting conservation and improving natural forests.

Central and state-sponsored schemes

Afforestation is a cross-sectoral activity taken up under various central and state government schemes, viz. National Afforestation Programme, Green India Mission and CAMPA (Ministry of Environment, Forest and Climate Change), National Bamboo Mission and Integrated Development of Horticulture (Ministry of Agriculture and Farmers' Welfare), Mahatma Gandhi National Rural Employment Guarantee Scheme and Integrated Water Management Programme (Ministry of Rural Development), Catchment Area Rehabilitation under Namame Ganga Scheme (Ministry of Water Resources), etc. States also have externally aided projects operational in the forestry sector. Apart from central assistance, states allocate funds for afforestation activities from their annual budget. National Afforestation Programme of MoEF&CC which targets degraded lands contributed about 20% of this total afforestation with an investment of about ₹1665 crore. An account of various recent initiatives and policy measures such as Green India Mission, National Afforestation Programme, CAMPA, MNREGA, Green Highway Policy, 2015, Policy for Enhancement of Urban Greens, National Agro-forestry Policy and Sub-

Mission on Agroforestry, National Bamboo Mission, and National Mission for Sustainable Agriculture, etc., having significant activity of afforestation and reforestation, has been taken into account

- ***State-funded schemes***

  In addition to the above, state and UT governments have their own afforestation and reforestation programmes. State-specific schemes are formulated according to the states' circumstances for which financial resources are provided from the respective state's budget. Almost every state has activities under social forestry, which largely focuses on tree planting in areas outside forests.

Factors, gaps, and challenges impacting the achievement of NDC target

Various factors can hinder forest and tree cover increase. This could be forest and tree cover loss or degradation in the quality of the forests. These factors are categorized as biotic and abiotic. Abiotic factors include natural forest fires, spread of invasive species, natural calamities. Biotic factors involve interaction of living organisms that prevent increases in forest/tree cover and include deforestation, overgrazing, land use change (e.g. conversion of forest land for urbanization), human-made forest fires, disease/pest attack on forests among others.

In India, about 68% of the country's total population is rural and a significant part of it depends on forests for meeting their needs of fuel wood, fodder, small timber, bamboo, and NTFPs. The livestock population in the country is one of the largest in the world (ISFR 2019). As per Census 2011, of 650,000 villages in the country, nearly 170,000 are located in the proximity of forest areas and termed as forest fringe villages. Forests play an important role in the socio-economic and cultural lives of the people inhabiting these villages. Since ages they have been dependent on the forests for fuel wood, fodder, timber, and bamboo. However, with the manifold increase in their population in the last 60 to 70 years, the pressure on forests has also increased in likewise manner.

Globally, India accounts for the highest annual wood removal of 434,766 thousand m^3, 88.6% which is fuel wood (FAO 2015). In 2019, 274.36 million tonne of fuel wood was being used to meet the energy requirement annually, out of which 85.29 million tonne of fuel wood was collected from natural forests (ISFR 2019). Unsustainable harvest of forest produce and NTFPs degrade the ground and middle flora of the forests. Grazing affects 81% of the country's forest area of which heavy and excessive grazing and lopping for fodder affects vegetation. Around 6% of the forest area is prone to injuries from lopping (FSI 2015). Efforts have been made for fulfilling the increasing demand of fuel wood and timber from TOF or farm forestry. The demand for timber required by various industries (construction, real state, production of agricultural equipment, pulpwood) is primarily fulfilled from farm forestry in the country. Still the intense pressure on natural forests for fuel wood, fodder, timber, and NTFP for fulfilling the domestic and industrial needs is a major cause of forest degradation in India. Unsustainable harvest is a major driver for forest degradation in the country owing to livelihood dependence of people living in and around forests. The use of fuel wood in future will keep on increasing considering population growth, demand of rural energy, energy requirement of brick kilns due to more urbanization. With about 5 crore connections across several states, many of which are forest-rich, the 2016 Ujjwala scheme reached a large population. But refilling the cylinders still remains a challenge for the households. As per a survey done by CRISIL in 2015, 86% of the people who received LPG cylinders as part of the Ujjwala scheme said they had not switched from biomass to LPG because the price of refilling the cylinder was too high (CRISIL 2015). While official figures state that 80% of Pradhan Mantri Ujjwala Yojana beneficiaries opt for at least one refill, field-based media reports suggest that the number of refills is far from sufficient to meet the cooking needs of the households.

The challenges and opportunities, categorized as forecasting financial resources, analysing the institutional framework, strengthening agroforestry, policy interventions and sustainable forest management policy, technology, financial, capacity building, institutional arrangement, etc. have been further analysed and discussed.

Target setting to achieve the forest carbon sink by 2030

FSI has assessed carbon stock in India's forests four times in 2004 and then biennially since 2011, i.e. 2011, 2013, and 2015. The estimates of the carbon stock corresponds to forest cover assessed by FSI and reported in ISFRs in different years, which includes all tree patches of size 1 hectare or more within the recorded forest areas and outside. The estimate on carbon stock does not include carbon stock in 'tree cover' which is also assessed by FSI regularly and reported in ISFRs. Since the NDC target mentions 'forest and tree cover', it is desirable to generate an estimate for the carbon stock in forest and tree cover of the country and its trend. Table 1 gives the estimates for carbon stock of India over the years.

Table 1: Carbon in Forest and Tree Cover of India

Year	Forest Cover (km^2)	Carbon in Forest Cover (million tonne)	Tree Cover (km^2)	Carbon in Tree Cover (million tonne)	Carbon in Forest and Tree Cover (million tonne)	Carbon in Forest and Tree Cover CO_2e (billion tonne)
2004	677,088	6,663	91,663	958	7,621	27.97
2011	697,898	6,941	91,266	953	7,894	28.97
2013	701,495	7,044	92,572	967	8,011	29.40
2015	708,273	7,083	93,815	980	8,063	29.59

Using the above values, NDC targets have been estimated in different years. Table 2 gives the projected values of carbon in India's forest and tree cover in different (possible) baseline years and the corresponding NDC targets.

Table 2: Projection of NDC targets in different (indicative) baseline years

Year	Projection of Carbon in Forest and Tree Cover in BAU Scenario (billion tonne CO_2e)	Plus 2.5 billion tonne	Plus 3.0 billion tonne	Difference from the Projected Value in 2030	
				2.5 billion tonne	3.0 billion tonne
2005	28.12	30.62	31.12	–1.25	–0.75
2015	29.62	32.12	32.62	0.25	0.75
2020	30.53	33.03	33.53	1.16	1.66
2030	31.87				

There could be two scenarios of the NDC target:

- **Scenario I:** Achieving additional carbon sink of 2.5 to 3.0 billion tonne CO_2e from the level of baseline year, in BAU, and meeting only the shortfall by additional forest and tree cover.
- **Scenario II:** Achieving additional carbon sink of 2.5 to 3.0 billion tonne CO_2e above the level, which is projected for 2030 in BAU from the level of baseline year.

Over the years, several technological and methodological advances have taken place in mapping forest cover in terms of better satellite data, higher scale maps, and improved mode of interpretation. Therefore, it is suggested that 2015 be taken as the baseline year instead of 2005. Presuming the baseline year as 2015, the NDC target in respect of additional carbon sink through additional forest and tree cover has been estimated as given in Table 3.

Table 3: NDC target taking 2015 as baseline year

Year	Projection of Carbon in Forest andTree Cover in BAU Scenario (billion tonne CO_2e)	Projected Value in 2030 as per BAU (billion tonne CO_2e)	Difference from the Projected Value in 2030 above the Usual BAU (billion tonne CO_2e)	
			2.5 billion tonne	3.0 billion tonne
2015	29.62	31.87	34.37	34.87

Therefore according to Scenario I, the target would be between 30.62 and 31.12 billion tonne, whereas according to Scenario II it would be between 34.37 and 34.87 billion tonne. As per the policy statement given in NDC, the target should be over and above BAU.

Figure 2 shows the projections of carbon sink till 2030.

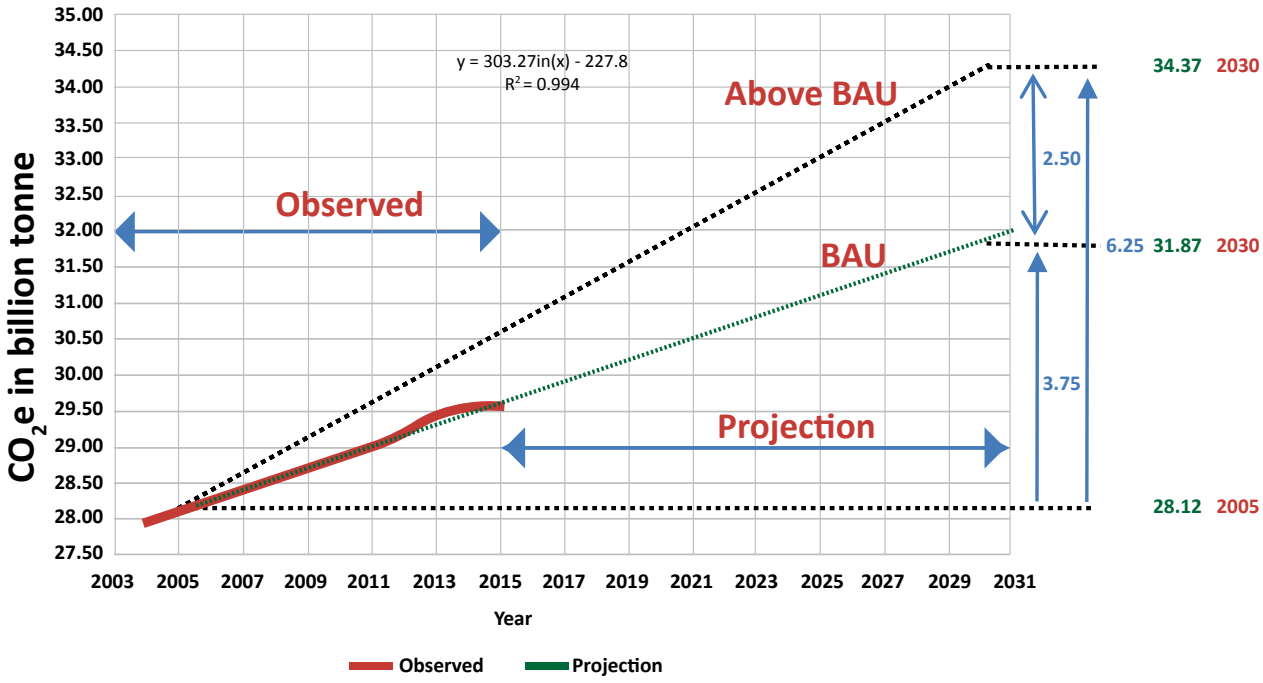

Figure 2: Projection of carbon sink by 2030

Source: *FSI (2019)*

It is seen from the above table that with baseline year 2015, a comparison between the NDC target and the projection for 2030 in BAU shows a short fall of 0.25 billion tonne and 0.75 billion tonne of CO_2e against the target of 2.5–3.0 billion tonne respectively, which can be achieved by activities such as restoration of open forests and afforestation on different kinds of available lands such as wastelands, area under agroforestry, along national and state highways, railway siding, urban landscapes. The study further shows that restoration of open forests is the most cost-effective strategy in achieving the NDC target and, at the same time, holds large potential of creating additional carbon sink.

It is important to understand the latest status of forests and tree resource in India before preparing a road map to achieve the 3 billion tonne of CO_2e sequestration targets. We have a scope of converting around one-third of the 30 million hectare of open forests into moderately dense forests and part of the moderately dense forests into dense forests through conservation approach and assisting natural regeneration. We will be able to achieve around one-third of the target with conservation approach. The remaining two-third targets could be met through afforestation on non-forest land. As already mentioned, forest is a concurrent subject. Hence, while the responsibility of the central government is policy and planning, the state government oversees the management, development, and conservation of forests. So the target has been distributed and further rationalized among the states based on the area under forest cover and the potential area under agroforestry (Table 4).

Table 4: Proposed state-wise distribution of NDC target and financial outlay

State	Area Under Forest Cover (km^2)	Potential Area Under Agroforestry (km^2)	Target (in million tonne of CO_2e)	Total Grant (in crore/y)	Total Grant (in crore) till 2030 (taking 2015 as baseline year)
Andhra Pradesh	28,147	16,730	183.22	3,664.49	54,967.35
Arunachal Pradesh	66,964	180	197.79	3,955.86	59,337.84
Assam	28,105	2,670	98.61	1,972.12	29,581.78
Bihar	7,299	7,950	69.22	1,384.35	20,765.32
Chhattisgarh	55,547	6,990	205.18	4,103.60	61,554.03
Goa	2,229	110	7.21	144.18	2,162.67
Gujarat	14,757	10,890	108.79	2,175.89	32,638.31
Haryana	1,588	3,520	25.82	516.37	7,745.61
Himachal Pradesh	15,100	0	44.36	887.14	13,307.17
Jammu and Kashmir	23,241	940	73.92	1,478.42	22,176.29
Jharkhand	23,553	5,340	101.28	2,025.60	30,383.94
Karnataka	37,550	12,930	188.01	3,760.20	56,402.96
Kerala	20,321	940	65.34	1,306.87	19,602.99
Madhya Pradesh	77,414	13,450	308.24	6,164.76	92,471.39

Contd...

State	Area Under Forest Cover (km^2)	Potential Area Under Agroforestry (km^2)	Target (in million tonne of CO_2e)	Total Grant (in crore/y)	Total Grant (in crore) till 2030 (taking 2015 as baseline year)
Maharashtra	50,682	19,160	264.03	5,280.52	79,207.76
Manipur	17,346	0	50.95	1,019.10	15,286.50
Meghalaya	17,146	0	50.37	1,007.35	15,110.25
Mizoram	18,186	0	53.42	1,068.45	16,026.77
Nagaland	12,489	50	36.99	739.75	11,096.32
Odisha	51,345	8,040	199.15	3,982.93	59,743.97
Punjab	1837	4,200	30.64	612.73	9,191.01
Rajasthan	16,572	20,510	171.94	3438.77	51,581.56
Sikkim	3,344	80	10.30	206.08	3,091.20
Tamil Nadu	26,281	6,880	118.55	2370.97	35,564.49
Tripura	7,726	260	24.26	485.16	7,277.44
Uttar Pradesh	14,679	19,710	161.57	3231.40	48,471.01
Uttarakhand	24,295	740	75.82	1516.30	22,744.57
West Bengal	16,847	4,050	73.83	1476.56	22,148.43
Puducherry	53.67	20	0.28	5.56	83.36
Delhi	192.41	60	0.93	18.52	277.74
Total	680,836.08	166,400	3,000	60,000	900,000

Sources: *ISFR (2017) and Rizvi, Dhyani, Newaj,* et al. *(2014)*

Result and Discussion

The activities which may be included in the strategy for creating additional carbon sink of 2.5 to 3.0 billion tonne through additional forest and tree cover by 2030 can be broadly outlined as follows:

- Improvement/restoration of natural forests
  - Improving forests which have lost canopy density in the last few years
  - Improving open forests of longer vintage
- Tree planting on culturable wastelands and other available lands in villages
- Tree planting along
  - Roads (national highways, state highways, and other roads)
  - Railway lines including railway siding
  - Rivers and canals
- Greening of urban spaces
- Agroforestry

To achieve India's NDC goals, a mix of conservation and afforestation approach is needed. The conservation approach will involve protection and conservation of open forests so that one-third of the 30 million hectare of open forests (i.e. 10 million hectare) can be converted into moderately dense forests, and partly moderately dense forests can be converted into dense forests through assisting natural regeneration and reducing dependence on forests. This amounts to treating 2 million hectare of open forests per year. On average, 25 tonne to 30 tonne of CO_2 per hectare will be sequestered when livelihood is provided to people and thus their dependence on forests gets reduced, and also by assisting natural regeneration. This would require a budgetary allocation of approximately ₹40,000 crore per annum for assisting natural regeneration, by providing quality planting material, LPG, income-generating activities for the forest-dependent communities, and support for stall feeding to the livestock.

The afforestation approach, on the other hand, will involve large-scale plantation on non-forest land. Agroforestry has the potential to achieve the target. The area under agroforestry is estimated to be 166,400 km^2 (Rizvi, Dhyani, Newaj, *et al*. 2014). At present, more than 80% demand of wood and wood products is met from agroforestry sector, 6% from natural forest, and 12% from import. Agroforestry can contribute more than 2 billion tonne of CO_2e by 2030 if the government provides them the minimum support price (MSP) of timber produced by farmer. Agroforestry can supplement farm income, enable risk reduction, and contribute towards climate resilience. Plantation activities can also be done outside forests along the roadside, canals, railway lines, wastelands, and highways. Additional efforts have been put by National Highways Authority of India (NHAI) to increase the tree cover by plantations but it is getting difficult to achieve the target of 1.25 crore plantation. If NHAI achieves 100% of its target to create green highways, then by 2020 it will contribute 3–4% of the NDC targets. The target can be achieved by promoting sustainable livelihoods and employing around 1 lakh people through the greening of highways. Through green highways 2.13–2.46 million tonne of CO_2 can be sequestered, which will contribute towards NDC goals. This would require a budgetary allocation of approximately ₹20,000 crore per annum.

Substantial financial allocation to the tune of around ₹60,000 crore per annum to the forestry sector is needed to achieve the NDC targets. In addition to the requirement of financial resource, there is a need to have institutional strengthening, capacity building, innovative financial mechanism, and policy interventions.

The NDC target of creating additional carbon sink through additional forest and tree cover may be seen as an opportunity to enhance the forestry sector in the country. Targeted approach of improving natural forests and creating tree plantations in a widespread manner along with a strong framework of monitoring, reporting, and verification (MRV) may go a long way in strengthening ecosystems for greater flow of ecosystem services. Improved silvicultural practices and soil and water conservation measures in restoration of natural forests deserve important place in the strategy. The study also reveals the scale of activities and cost implications for formulating an effective and practical strategy. Capacity building of forest department personnel and other stakeholders in MRV and forest carbon measurement are necessary requirements for ensuring the success of implementation.

Recommendations

A stakeholder consultation was conducted in the presence of Director General, Forest Survey of India. Other speakers from Forest Survey of India were also present during the consultation. The following suggestive actions were recommended during the discussion:

- The baseline year should be decided as 2015 in order to quantify India's forestry target to be achieved by 2030.

- The concept behind the usage of 'additional' word twice in the target has been explained. The panellists were of the view that the target should be increased in carbon sink over the business as usual finance mechanism through carbon market.
- NDC targets must be distributed to the states/UTs on the basis of culturable non-forestry area (CNFA) and forest and tree cover.
- The carbon neutrality policy should be promoted at national and state levels, which will help in improving the quality and health of the forest and provide fair compensation to the forest-dwelling communities.
- There is a need to build capacity of frontline staff of the forest department for detailed skills and techniques on biomass and carbon stock assessment, and also prepare projects for obtaining carbon finance.
- Innovative finance mechanism through carbon market should be established at MoEF&CC level or agency recognized by Government of India to regulate the transaction at national level, and also at international level later considering the success of the mechanism.
- Agroforestry has a huge potential to contribute towards achieving India's forestry NDC target, hence it should be promoted. The MSP and institutional strengthening are also important factors to focus on to avoid market failure in agroforestry.
- The practice of monoculture plantations should be disregarded while undertaking activities of afforestation. Instead a mix of native species present in each area is recommended for this purpose.
- Third party monitoring is very important for the maintenance of the plantations done during afforestation activities and any mid-term corrections required in this process of achieving the target.
- A framework should be developed which allows accounting of forest carbon addition as well as loss due to forestry activities undertaken anywhere in the country so that the status of forest carbon sink in the country is known at any given time.

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