MONITORING REPORT FORM (CDM-MR)*

Version 01 - in effect as of: 28/09/2010

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* as contained within the document entitled "Guidelines for completing the monitoring report form (CDM-MR)” (EB 54 meeting report, annex 34).

MONITORING REPORT
Version 04; –September 15, 2012

Improving Rural Livelihoods Through Carbon Sequestration By Adopting Environment Friendly Technology based Agroforestry Practices

Reference number - 4531
Monitoring period (25/06/04 – 31/08/11)

SECTION A. General Description of the project activity

A.1. Brief description of the project activity: >>

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1. Purpose of the project activity and the measures taken to reduce greenhouse gas emissions;

The A/R CDM project activity mobilizes resource-poor farmers to raise tree plantations on farmlands. It links farmers and end users of wood products in order to optimise the land use and to facilitate the co-ordination of wood producers, agronomists, financial institutions and non-governmental organizations to improve the livelihood opportunities of rural households.

The project activity has been implemented on the degraded farmlands or lands used for rainfed subsistence agriculture in the two states of India: Orissa and Andhra Pradesh. The project area includes small landholders spread over a total of six districts: Rayagada, Koraput and Kalahandi districts in Orissa and the districts of Visakhapatnam, Srikakulam, and Vizianagaram in Andhra Pradesh. These districts have a pre-dominance of indigenous population, notified as Scheduled Tribes and Scheduled Castes in India, with the majority of them being poor.

The participation of small and marginal farmers representing indigenous communities and their organization as part of the CDM A/R makes this project unique in contributing to their land use choice, improvement of livelihood opportunities and in promoting their capacity to organize and implement climate change mitigation initiatives.

The specific objectives of the project include:

- To pilot reforestation activities for generating high-quality greenhouse gas removals by sinks that can be measured, monitored and verified;
- To develop plantation and agro forestry models, which can provide multiple benefits to farmers in terms of timber, firewood and non-wood forest products;
- To provide additional income and to promote livelihoods of resource poor farmers through carbon revenues.
- To reforest degraded lands to control soil and water erosion and reclaim lands.
- To reduce the dependence of industry on natural forests thereby conserving biodiversity.
- To build capacity of various stakeholders to benefit from global mechanisms.

The project has implemented reforestation on 1607.72 ha of land belonging to 1590 farmers in the states of Andhra Pradesh and Orissa.

Table A.1.1 - Year-wise area planted in the project area in ha

Year of Plantation	Total Area(Ha)
2004	179.30
2005	350.02
2006	384.51
2007	693.90
TOTAL	1607.72

A Monitoring Committee comprising the representatives of VCCSL and JKPL, as well as provision of audited records, ensures that the share of the benefits from the sale of carbon credits due to the participating farmers will effectively go to them. A joint escrow account between VCCSL and JKPL is the institutional mechanism for channelling carbon revenues to the farmers. Therefore, the carbon sequestration benefits of the project serve the roles of climate change mitigation and as a source of alternate income to farmers to meet the operation and maintenance expenses for reforestation of degraded lands.

2. Brief description of the installed technology and equipment

One of the main technologies employed in this project is reforestation through direct planting with environmental-friendly techniques on less productive and degraded lands and provision of Eucalyptus seedlings raised from clonal technology to the farmers to raise plantations. JK Paper Limited has embarked on a research & development programme to increase productivity of farm forestry. To fulfil the objectives of research and development programme, state of the art technology and infrastructure such as greenhouses, hardening chambers, nurseries and laboratories have been developed. Please refer Section A.4 for further details of the technology and equipment used.

3. Relevant dates for the project activity (e.g. construction, commissioning, continued operation periods, etc.).

Table A.1.2: Chronology of events related to the development of the project

Timeline (date/month/yr)	**Description of Events**
25/06/2004	Project Start date
Nov 2006 onwards	Signing of tri-partite agreements (JKPL, VEDA MACS and Farmers)
10/1/2007	Letter from JKPL to their field staff giving guidelines for identification of farmers.
8/5/2007	Signing of ERPA between VEDA MACS, IBRD as Trustee of BioCarbon Fund, and JKPL
4/4/2009	Letter to DNA, requesting replacement of VEDA MACS with VCCSL and inclusion of JKPL in revised LOA
15/07/2009	Revised LOA issued by India DNA, jointly to VCCSL and JKPL, based on the old PDD submission

4. Total emission reductions achieved in this monitoring period.

Table A.1.3: The total ERs achieved in the monitoring period of 25 June 2004 till 31 August 2011 are tabulated as follows:

Period	Total net anthropogenic GHG removals by sinks	Remarks
25/06/04 to 31/08/11	**79,811.30**	Please refer to Section E for further details

A.2. Project Participants

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Name of Party involved (*) ((host) indicates a host Party)	**Private and/or public entity(ies) project participants (*) (as applicable)**	**Indicate if the Party involved wishes to be considered as a project participant (Yes/No)**
Government of India (host)	• VEDA Climate Change Solutions Ltd. • JK Paper Ltd	No
Government of Canada	International Bank for Reconstruction and Development as trustee of the BioCarbon Fund; Ministry of Foreign Affairs and International Trade	Yes
France	Eco-Carbone S.A.S	No
Italy,	Government of Italy - Ministry for the Environment, Land and Sea	Yes
Japan	Idemitsu Kosan Co.,Ltd. ; The Japan Iron and Steel Federation (JISF) ; Japan Petroleum Exploration Co., Ltd. (JAPEX) ; The Okinawa Electric Power Co., Inc.; Sumitomo Chemical ; Sumitomo Joint Electric Power Co.,Ltd ; Suntory Holdings Limited ; The Tokyo Electric Power Co., Inc.	No
Spain	Kingdom of Spain- Ministry of the Environment and Rural and Marine Affairs & Ministry of Economy and Finance	Yes
Luxembourg	Ministry of Sustainable Development and Infrastructure	Yes

A.3. Location of the project activity:

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The proposed A/R CDM project activity is located in Koraput, Kalahandi and Rayagada districts of Orissa and Visakhapatnam, Vizianagaram and Srikakulam districts of Andhra Pradesh in India.

Table A.3.1: Details of land proposed under the project

District	**Villages**	**Blocks/ Mandals**	**Land under project (in ha)**	**Number of parcels**	**Average land under project per farmer (in ha)**
Vizianagaram	151	30	620.71	444	1.48
Srikakulam	107	20	232.66	473	0.51
Rayagada	78	12	269.30	247	1.24
Koraput	29	06	140.02	107	1.60

Kalahandi	80	10	177.97	279	0.70
Visakhapatnam	56	19	167.07	158	1.07
	501	**97**	**1607.72**	**1708**	**1.01**

The project boundary includes all discrete parcels of land owned by different farmers in the blocks/ mandals (an administrative block) of the six districts. Each of these parcels of land is identified through GPS coordinates. The GPS coordinates reflect the delineation of land parcels on the ground. Additionally, each parcel of land is also identified using official documents and maps of the Land Administration/Revenue Department.

A.4. Technical description of the project

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JK Paper Limited has embarked on a research & development programme to increase productivity of farm forestry. To fulfil the objectives of research and development programme, state of the art technology and infrastructure such as greenhouses, hardening chambers, nurseries and laboratories have been developed. The Agro-Economic Research Centre (AERC) in southern Orissa is involved in disseminating modern agriculture practices to farmers, as is JKPL.

Site preparation

To prevent soil erosion, reduce GHG emissions and protect the existing carbon stocks, site burning and overall tillage was not carried out during the site preparation. The soil profile and physical properties of soils in the region are studied. The land is prepared for planting by minimal site disturbance. For sloping areas ploughing is done across the slope to prevent erosion.

The pits ranging from 0.015 – 0.0283 m^3 were dug along the contour and most of the original vegetation was kept intact. The site preparation was conducted in the winter season. The soil was treated with termicides (in case of Eucalyptus). An integrated pest management plan was incorporated in the Environment Management Framework developed for the project. Weeding operations were carried out manually. The plantations do not require any access roads, as they are located near villages.

Planting stock development and nursery technology

The planting stock used in the project has been developed from candidate trees of Eucalyptus and Casuarina selected from stands (Eucalyptus - Araku valley, Visakhapatnam, Aguru in Rayagada district; Casuarina – selected stands in the districts of Vizianagaram and Visakhapatnam) located around the project area and from clonal material developed from mother plants that grow under similar conditions.

- Clonal Eucalyptus: The clones of Eucalyptus are genetically superior, fast growing, grow uniformly and contribute to increased productivity (i.e.2 to 3 times higher than normal seed route plantations). The clones also ensure improved productivity of coppice crops and compensates for low productivity of soils. The clones are produced following macro-propagation (mist propagation) technique. The method consists of collecting coppice sprouts that are just beginning to harden and keeping them constantly moist while 2-leaf-pair cuttings are prepared and end-dipped in rooting hormone. The cuttings are placed under intermittent mist in individual containers. For successful clonal propagation, JKPL has an R & D centre with 14 mist chambers covering an area of 3700 m^2, hardening area of 1200 m^2 and open nursery area of 10,000 m^2. The clonal technology with root trainers has contributed to the production of quality planting stock. The root development is better in root trainers than in polypots as multiple roots seldom form in the root trainers and root coiling is avoided. The out planting results are high thereby increasing survival and productivity. The quality parameters for saplings are developed and delivery of planting material is made after due quality inspection.

  To sustain production of selected clones, JKPL has established mother orchards from which cuttings are prepared and are treated with fungicide solution (Bavistin) and growth hormone, IBA. The seedlings are transplanted in root trainer blocks containing vermiculite. These are then placed inside the state of art greenhouses where required conditions for conducive growth are

created through automatic temperature and humidity control systems. After about 35-40 days when the shoots and roots emerge from the cuttings they are shifted to the acclimatization chamber and are kept for 10-15 days to harden and subsequently shifted to the sunlight with controlled irrigation for 2 months, during this period they attain a height of about 45 cm and are ready for planting in the fields.

- Seed origin Eucalyptus: For Eucalyptus based on seed propagation, saplings are raised in decentralized nurseries across the districts in different locations for easy delivery of saplings to resource poor farmers. Generally, the nursery capacity ranges from 100,000 to 150,000 seedlings. In the nursery, genetically superior seeds from multiple sources such as Forest Research Institute (FRI) Dehradun, Western India Match Company (WIMCO) and Seed Production Areas (SPA) at Aguru, Jaykaypur in Orissa are used for planting stock production.

- Casuarina seedling production: Casuarina saplings are also raised in decentralized nurseries in the coastal areas of Andhra Pradesh.

Planting Technique and spacing

Planting is done in pits of 30 X 30 X 30 cm. Bag plants are used after removing the polythene cover carefully, without disturbing the soil in the bag. To ensure good growth, weeds are removed manually three times a year during the first year. Survival is checked within three months time and mortality if any is replanted.

In seed route plantations (*Eucalyptus globulus),* the number of seedlings required per ha is 2,500 with spacing of 3 m x 1.33 m. The coppicing cycle of the species is 5 years and the expected fuel wood from the branches and bark per ha is about 10 tonnes.

Casuarina is propagated through seedlings. Spacing of 1 m x 1 m is maintained. The pits are filled with organic manure. About 1/3rd of the plant from the base is pruned during the 2nd year of plantation to stimulate growth and to avoid crowding.

Plantation management - Eucalyptus

The plantations have been raised by resource poor farmers in rainfed conditions. The organizers enumerated the plantations every year during the months of January and February. A third party carried out a sample check to verify the authenticity of this enumeration. The plantations are kept weed free by manual weeding. Fire line tracing was done during the summer months all across the plots.

In order to impart the technical know-how of the clonal technology, the farmers were provided with training/awareness on clonal propagation, planting, and plantation management through by JK Field Staff who are well qualified in forestry, agriculture and allied science and also supported by M/s Veda Climate Change Solutions Staff. Such programmes were conducted periodically to upgrade the knowledge of the beneficiaries.

Eucalyptus is managed with a 5-year rotation period. The plantations are felled and debarked manually. The cutting was done using a manual saw. The branches and twigs are retained by farmer for firewood. The main stem is debarked and cut to smaller lengths for transporting by truck, tractors, tucks or carts depending upon the distance.

Coppicing: Eucalyptus spp. regenerates naturally by coppicing, thus avoiding site preparation and soil disturbance in the second rotation. After harvesting, Eucalyptus is regenerated through coppicing. As many shoots regenerate through natural means, only two or three strong shoots are allowed to grow by cutting the remaining shoots.

Plantation management – Casuarina

Casuarina is a large fast growing evergreen tree. It grows well in both southwest and northeast monsoon and grows well in loose fine coastal sands. It is a good pulpwood species and its major uses are fuel wood, timber and some medicinal purposes.

Ploughing: The land was ploughed with traditional plough or mould board plough. Generally ploughing was done manually and in very few cases farmers adopted mechanical ploughs.

Fertilization: A dose of super phosphate and murate of potash at 8 kg per hectare was applied two months after the planting.

Pruning: In the 2nd year branches were pruned flush to the stem up to 1/3rd of the stem height. This will induce 1/3rd of height, growth and clean stems.

Harvesting: The Eucalyptus and Casuarina plantations are felled, debarked and loaded on to the truck manually and transported by tractors or trucks. The harvested sites are kept intact for further regeneration for next coppice crop. Thus by using this technology the degraded /subsistence agriculture lands could be converted to carbon sinks over multiple rotations.

In order to impart the technical know-how felling & transportation, the farmers were provided with training/awareness on size & length of billets and relevant procedures by JK paper Mills Plantation Officers. Such programmes are conducted periodically to upgrade the knowledge of the beneficiaries. The company also maintains a robust management system supported by manuals and procedures by detailing the critical operations, training requirements and competency needs

A.5. Title, reference and version of the baseline and monitoring methodology applied to the project activity:

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Title: Reforestation or Afforestation of Land Currently under Agricultural Use

Reference: AR-AM0004; Version-03

A.6. Registration date of the project activity:

The registration date of the project was 28 February 2011

A.7. Crediting period of the project activity and related information (start date and choice of crediting period):

The project activity has a fixed crediting period of 30 years from the project start date i.e. 25 June 2004

A.8. Name of responsible person(s)/entity(ies):

Veda Climate Change Solutions Limited and JK Paper Mills Limited are jointly responsible for completing the monitoring report form (CDM-MR).

SECTION B. Implementation of the project activity

B.1. Implementation status of the project activity

1. The starting date of operation of the project activity.

Plantation activities started on 25/06/2004. The year wise details of plantation are provided in Tables B.1.1 and B.1.2

Table B.1.1: Year wise plantation schedule by strata

Year Of Plantation	Districts of Andhra Pradesh			Districts of Orissa		Total
	AEC	AES	ACA	OEC	OES	
2004	17.32	9.24	48.63	76.84	27.28	179.30
2005	132.01	7.57	108.76	72.35	29.32	350.02
2006	209.42	8.46	94.93	32.09	39.61	384.51
2007	228.31	26.65	129.14	199.33	110.46	693.90
TOTAL	**587.06**	**51.92**	**381.46**	**380.60**	**206.68**	1607.72

Table B.1.2. Year wise unharvested project area by strata

Strata	Year-2007	2008	2009	2010	2011-upto July
AEC	587.06	586.18	526.30	342.97	266.15
AES	51.92	49.88	35.83	30.80	15.38
ACA	381.46	341.12	247.28	52.31	15.03
OEC	380.60	363.21	326.27	231.44	200.13
OES	206.68	205.49	192.87	175.45	173.53
Total	**1607.72**	**1545.88**	**1328.55**	**832.97**	**670.22**

2. The information regarding the actual operation of the project activity during this monitoring period, including information on special events.

Measurements were carried out by JKPL in all the sample plots selected. Special events such as death of plants are recorded in the measurement register. Harvesting is carried out after completion of 5 year felling cycle and details of harvesting is also monitored for all the sample plots.

3. Events or situations that occurred during the monitoring period, which may impact the applicability of the methodology and how the issues resulting from these events or situations are being addressed.

There has been no event or situation during the monitoring period which may impact the applicability of the methodology.

B.2. Revision of the monitoring plan

The Monitoring Plan has not been revised since registration of the project activity.

The project implementation is in line with the provisions of the paragraph 6 of the "Procedures for notifying and requesting approval of changes from the project activity as described in the registered project design document (EB 48, annex 66). As per the "Guidelines on accounting of specified types of changes in A/R CDM project activities from the description in registered project design documents" (Version 02.0) (Annex 24, EB 66), the types of changes from the project description of the A/R CDM project activity in the PDD as listed below are identified as minor in nature. The changes have not impacted the baseline scenario and additionality of the project. The changes applicable to the project are to be confirmed by the designated operational entity at the verification stage without the need for submitting a notification of changes to the PDD or a request for revision to the monitoring plan.

Table B.2.1 Types of changes from the description in the registered PDD as outlined in the guidelines (Annex 24, EB66) and their applicability to the implemented project

No.	Types of changes from the project description	Applicability to the project

	in the PDD of an A/R CDM project activity	
a)	Changes in year-wise areas planted, possibly resulting in a part of the project area not being planted;	No
b)	Changes in species composition, if the changes are demonstrated at verification to be consistent with the baseline identification and additionality demonstration made at the validation stage;	No. The species composition of the project are consistent with the baseline identification and additionality demonstration made at the validation stage
c)	Changes in stocking density, if the changes are demonstrated at verification to be consistent with the baseline identification and additionality demonstration made at the validation stage;	No. The standing density is consistent with the baseline identification and additionality demonstration made at the validation stage.
d)	Changes in timing and choice of silvicultural operations;	Yes, farmers conducted silvilculatural operations as per their convenience
e)	Changes in timing of harvest occurring before the third verification;	Yes, farmers harvested plots as per their harvest schedule.
f)	Changes related to collection of non-timber forest products;	No
g)	Changes in tree/shrubs propagation method;	No
h)	Changes in post-harvest re-planting/regeneration methods;	Yes, changes in the post harvest replanting/regeneration methods are observed
i)	Changes in technology employed;	No
j)	Changes in inputs (e.g. fertilizers, certified seeds, watering);	No
k)	Changes in stratification for sampling;	Yes, *ex post* stratification has been implemented taking into account the changes to *ex-ante* strata.
l)	Changes in type of sample plots (e.g. temporary, permanent, point-sampling);	No
m)	Changes in number of sample plots and their allocation to strata;	Yes, as a follow up to *ex post* stratification, the calculation of number sample plots and their allocation has been revised.
n)	Changes in the project boundary (limited to reduction in project area), if the changes are demonstrated at verification to be consistent with the baseline identification and additionality demonstration made at the validation stage;	No.
o)	Changes in quality assurance/quality control (QA/QC) procedures, where it can be demonstrated that the changed QA/QC procedures are used by the National Forest Inventory or were applied in another registered A/R CDM project activity;	Yes, Changes in quality assurance/quality control procedures are consistent with procedures used by the national forest inventory and other registered A/R project activities.

p)	Changes in parameters, equations, or methods used in tree biomass estimation, if the applicability of the changed parameters, equations, or methods is demonstrated at verification using the .Tool for demonstration of applicability of allometric equations and volume equations in A/R CDM project activities" when available, or if the changed parameters, equations, or methods do not result in a decrease in precision of the estimate of tree biomass;	Yes, Changes in parameters, equations, or methods used in tree biomass estimation are consistent with A/R Tool – "Tool for demonstration of applicability of allometric equations and volume equations in A/R CDM project activities"
q)	Changes from provisions regarding shifting of pre-project activities, if the related emissions are estimated at verification using the tool "Changes from provisions regarding shifting of pre-project activities, if the related emissions are estimated at verification using the tool "Estimation of the increase in greenhouse gas (GHG) emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity". and are accounted for as leakage;	Yes, monitoring is done to assess leakage
r)	Changes in use of fire in site preparation, if the related emissions are estimated at verification using the tool "Estimation of non-CO2 GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity" and are accounted for as project emissions;	Not Applicable
s)	Changes in extent of soil disturbance in site preparation, if the related emissions are estimated at verification using Equation (2) of the "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities" and are accounted for as project emissions;	Not applicable
t)	Changes in methods of estimation of changes in any carbon pool, if the method applied at verification uses the latest version of the relevant approved tool and the applicability conditions of the methodology applied are consistent with the applicability conditions of the tool.	Yes.

As per the "Guidelines on application of specified versions of A/R CDM methodologies in verification of registered A/R CDM project activities" (Version 01.0), early versions of methodologies applied in the registered A/R CDM project activities contain requirements that were withdrawn during revisions/improvements of these methodologies. The guidelines allow a registered A/R CDM project activity to apply, at the time of verification, the revisions/improvements that occurred in the methodology after the date of registration of the project activity. The applicability of these guidelines to the project is presented in Table B.3 below.

Table B.2.2 Applicability of guidelines to the implemented project

Requirement	Methodology	Guidelines	Applicability to the project
Monitoring of data and parameters	AR-AM0004 v.03	(i) Only data and parameters obtained from field measurement are required to be monitored; (ii) Monitoring is not required for data, parameters, or variables appearing as intermediate values in calculation steps and those	Yes, only data and parameters obtained from field measurement are monitored

		taken from existing sources (e.g. published literature)	
Sampling design, sample plot lay-out, and marking of permanent sample plots	AR-AM0004 v.03	(i) Use of temporary sample plots; (ii) Random lay-out of sample plots; (iii) A maximum allowable relative margin of error of the mean, for estimation of aboveground tree biomass, of ± 10% at 90% confidence level shall be allowed.	Yes, maximum allowable margin of error of 10% of the mean and 90% confidence level was applied
Accounting for uncertainty	AR-AM0004 v.03	Requirements related to uncertainty assessment, uncertainty analysis, methods of combining uncertainties and uncertainty in expert judgment are superfluous and compliance with these requirements shall not be enforced.	Yes, uncertainty analysis is not conducted as sampling approach implemented in the addresses these issues.
Field measurement of soil organic carbon		(i) Instead of field measurement of soil organic carbon, the "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities" shall be used for areas which meet the applicability conditions of the tool; or (ii) The value of change in soil organic carbon shall be set to zero. Consequently, monitoring of data and parameters related to estimation of changes in soil organic carbon shall not be required.	Not applicable
Clearance or burning of herbaceous vegetation	AR-AM0004 v.03	(i) Changes in carbon stocks resulting from clearance of herbaceous vegetation shall be set to zero; (ii) Emissions resulting from clearance or burning of herbaceous vegetation shall be set to zero. Consequently, monitoring of data and parameters related to (i) and (ii) above shall not be required.	Yes, loss of carbon in living herbaceous vegetation has not been accounted.
Estimation of emissions of nitrous oxide from use of fertilizers		Estimation and accounting of emissions of nitrous oxide from use of fertilizers shall not be required. Consequently, monitoring of data and parameters related to the above-mentioned emissions shall not be required.	Not applicable, as fertilizers are not used in the project.
Burning of	AR-AM0004 v.03	Estimation and accounting of	Yes, emissions from burning

fossil fuel		emissions from burning of fossil fuel, both within and outside the project boundary, shall not be required. Consequently, monitoring of data and parameters related to the above mentioned emissions shall not be required.	of fossil fuel, both within and outside the project boundary were not monitored and accounted.

B.3. Request for deviation applied to this monitoring period

There has been no request for a deviation for this monitoring period.

B.4. Notification or request of approval of changes

There has been no request of changes to the registered CDM PDD for this project.

SECTION C. Description of the monitoring system

Stratification

Taking into account the species planted and technology proposed for implementation, the project was organized into five ex ante strata. The details of *ex ante* stratification outlined in the PDD are noted below.

***Ex ante* stratification**

The five *ex ante* strata adopted at the start of the project implementation.

- i. AP – Eu (clonal) [AEC]
- ii. AP – Eu (seed) [AES]
- iii. AP – Casuarina [ACA]
- iv. Orissa – Eu (clonal) [OEC]
- v. Orissa – Eu (seed) [OES]

Table C1: Strata under *ex ante* stratification of the project (area by strata in ha)

	AEC	AES	ACA	OEC	OES	Total
Area	587.06	51.92	381.46	380.60	206.68	1607.72

As part of the project implementation, areas of the strata that are harvested are expected to be regenerated through coppice or replanting methods in case of Eucalyptus and through replanting method in Casuarina.

Considering the differences in the carbon stock status of areas with standing stock of trees and of areas proposed for regeneration on the project strata, the ex post stratification of the project is undertaken to ensure carbon stock measurement reflects the project implemented on the ground.

During the first monitoring period, the area of project observed in standing stock and regeneration categories is represented in Table C2 below.

Table C.2: Ex post stratification showing strata with standing stock strata and strata with proposed regeneration.

Category	**AEC**	**AES**	**ACA**	**OEC**	**OES**	**Total**
a). Area with standing trees	266.15	15.38	15.03	200.13	173.53	670.22
b). Area regenerated (coppice/replanting) measurable (>2.5 cm dia)						
i) 2008 coppice/replanting	0	0.76	12.2	16.2	1.2	30.36
ii) 2009 coppice/replanting	43.53	7.09	7.61	36.95	12.62	107.8
Regeneration stock measurable -(i + ii)	43.53	7.85	19.81	53.15	13.82	138.16
I. Area of standing stock (a + b)	**309.68**	**23.23**	**34.84**	**253.28**	**187.35**	**808.38**
c). Area not regenerated/growth not-measurable i) 2010 coppice/replanting	94.02	5.04	5.34	93.73	17.43	215.56
ii) 2011 coppice/replanting	65.01	1.92	0	29.87	1.9	98.7
Regeneration stock not-measurable-(i +ii)	159.03	6.96	5.34	123.6	19.33	314.26
d). Area harvested and not replanted	118.35	21.73	341.28	3.72	0	485.08
II. Area of proposed regeneration (c+d)	**277.38**	**28.69**	**346.62**	**127.32**	**19.33**	**799.34**
Total project area	**587.06**	**51.92**	**381.46**	**380.6**	**206.68**	**1607.72**

***Ex post* stratification**

As part of the *ex post* stratification, area of each *ex ante* stratum is divided into two strata representing the following categories.

I. Area with **standing stock** (i.e., includes trees of above 2.5 cm DBH eligible for measurement). It includes area with standing trees and area of regeneration through coppice or replanting in 2008 and 2009.
II. Area of **regeneration** after harvest through coppice or replanting (including the coppice area that have standing stock below 2.5 cm DBH and therefore not measurable). It includes area that is harvested but not replanted; and area of regeneration through coppice or replanting in 2010 and 2011.

The strata resulting from the ex post stratification are presented in the table C3 below.

Table C.3: Strata under ex post stratification of the project

Ex ante strata	**Ex post strata**	
	Standing stock (ss)	**Regeneration (rg)**
AEC	**AECss**	**AECrg**
AES	**AECss**	**AECrg**
ACA	**ACAss**	**ACArg**
OEC	**OECss**	**OECrg**
OES	**OESss**	**OESrg**

It is anticipated that the areas harvested as part of the project implementation will be replanted during the project period. As a consequence, project area with standing stock and regeneration is expected to vary between monitoring/verification periods. The *ex post* stratification is intended to account for the bi-

directional transition in the area of standing stock and area proposed for regeneration between the monitoring/verification periods of the project.

Based on the criteria of the *ex post* stratification, 10 strata have been identified in the first monitoring/verification period. The strata and their area is noted in the Table C4 below.

Table C.4: Strata as per the ex post stratification

S.No	**Ex post strata**	**Area**
	Strata with standing stock	
1	**AECss**	**309.68**
2	**AESss**	**23.23**
3	**ACAss**	**34.84**
4	**OECss**	**253.28**
5	**OESss**	**187.35**
	Strata with regeneration	
6	**AECrg**	**277.38**
7	**AESrg**	**28.69**
8	**ACArg**	**346.62**
9	**OECrg**	**127.32**
10	**OESrg**	**19.33**
	Total project area	**1607.72**

Procedure for calculation of number of sample plots:

The methodology AR AM0004 version 3 presents equations to assess the number of sample plots required for monitoring to keep a maximum permissible error of ±10% of the mean, at a 95% confidence level. The "Guidelines on application of specified versions of A/R CDM methodologies in verification of registered A/R CDM project activities" (Version 01.0), revised the sampling requirements to meet the required permissible error of ±10% of the mean and a 90% confidence level, which are adopted for the calculation of the number of sample plots required for monitoring of the project. The following equations of the methodology were used to calculate the number of sample plots required under *ex post* stratification.

Equation 67 of AR AM0004, Version 3

$$n = \frac{\left[\sum_{h=1}^{L} N_i \cdot st_i\right]^2}{\left(N \cdot \frac{E_1}{z_{\alpha/2}}\right)^2 + \sum_{i=1}^{L} N_i \cdot (st_i)^2}$$

Equation 68 of AR AM0004, Version 3

$$n_i = \frac{\sum_{i=1}^{L} N_i \cdot st_i}{\left(N \cdot \frac{E_1}{z_{\alpha/2}}\right)^2 + \sum_{i=1}^{L} N_i \cdot (st_i)^2} \cdot N_i \cdot st_i$$

Where

L = total number of strata
z = z value for a confidence level (95%)
E = allowable error (±10% of the mean), E = Q * DLP;

st_i = standard deviation of stratum i
n_i= number of samples per stratum allocated
N = number of total sample units (all stratum), $N = \sum N_i$
N_i= number of sample units for stratum i, calculated by dividing the area of stratum i by the area of the sample plot of 256 m^2 (16 x 16 meter).
Q = Approximate average value of the estimated quantity *Q,* (e.g. wood volume); e.g. m^3ha^{-1}
DLP = Desired level of precision (e.g. 10%); dimensionless

The parameters of the strata in terms of their area, mean carbon stock, and standard deviation under the ex post stratification are used for calculation of the number of sample plots.

Area of strata: The area of the strata reflects the area with **standing stock** and **regeneration** at the end of the monitoring period.

Mean carbon stock of strata (Qi): Mean carbon stock of a stratum reflects the quantity of biomass present on the land parcels of the strata. Because of the changes in area of standing stock and area of regeneration subsequent to harvests, the mean carbon stock of strata could vary between monitoring periods.

Standard deviation of the carbon stock of strata (sti): Standard deviation in the carbon stock of strata is expected to vary because of the differences in the growth rates of stands on different lands parcels, and harvest and regeneration decisions of farmers.

Coefficient of variation (CV): Coefficient of variation as the ratio of standard deviation and mean carbon stock of a stratum expressed in percent reflects the variability of carbon stock of different strata of the project.

Table C.5 presents the parameters in the calculation of number sample plots required for calculation of carbon stock change during the first monitoring period. The area of strata indicates the area of standing stock and regeneration during this period. The mean carbon stock and standard deviation are based on the measurements conducted on the sample plots laid out on the project land parcels.

The mean carbon stock and standard deviation of the carbon stock of the strata under **regeneration** are considered zero as these strata have land parcels/stands that have been harvested but not planted or replanted/regenerated through coppice but have tree vegetation below the measurable threshold of 2.5 cm DBH. Therefore, mean stock and standard deviation of the mean carbon stock of these strata are zero.

Table C.5: Parameters supporting calculation of number of sample plots

(a) Strata with standing stock

Strata	Units	AECss	AESss	ACAss	OECss	OESss
Stratum i	Ha	309.68	23.23	34.84	253.28	187.35
Mean Qi	t C/ha	29.18	17.45	36.58	26.58	23.05
Sti	t C/ha	10.29	4.25	8.75	15.89	13.33
Coef.var	%	35.25	24.36	23,91	59.79	56.98
N	62,802	62,802	62,802	62,802	62,802	62,802
Ni	integer	12,178	907	1,014	10,127	7,414
Z α/2	integer	1.645	1.645	1.645	1.645	1.645

(b) Strata with regeneration

Strata	Units	AECrg	AESrg	ACArg	OECrg	OESrg
Stratum i	Ha	277.38	28.69	346.62	127.32	19.33
Mean Qi	t C/ha	0	0	0	0	0
Sti	t C/ha	0	0	0	0	0
Coef.var	%	0	0	0	0	0
N	62,802	62,802	62,802	62,802	62,802	62,802
Ni	integer	10,719	1,121	13,908	4.720	694
Z α/2	integer	1.645	1.645	1.645	1.645	1.645

The number of sample plots by strata calculated based on mean carbon stock and standard deviation of the carbon stock based on the sample plot measurements to meet the permissible error limit of 10% of the mean and a confidence interval of 90% is presented in Table C6. The sample plot calculation sheet is attached as Annex 2 (separate file).

Table C.6: Sample plots in project area by strata.

Strata	Sample plots required to meet 90% confidence interval and 10% precision	Sample plots established in the project strata
AECss	18	23
AESss	1	2
ACAss	2	3
OECss	23	30
OESss	14	14
AESrg	**0**	**0**
AESrg	**0**	**0**
ACArg	**0**	**0**
OECrg	**0**	**0**
OESrg	**0**	**0**
Total	**58**	**72**

Location of sample plots

To avoid subjective choice of plot locations, the permanent sample plots are located following simple random sampling. For the purpose all discrete land parcels/stands within the project's boundary are listed in Annex 1[1]. From the land parcels/stands of strata, the sample plots are randomly picked and sample plot IDs were assigned to them. This has been repeated for each strata to get the required number of sample plots.

All sample plots, their GPS coordinates, location of stand, name of farmer, village name, district name and the state recorded and archived in the project database. Each plot is given a sample plot ID and this has also been plotted on a map and the project documents.

<u>Procedure for data collection on sample plots</u>

Carbon stock changes over time are calculated as per the steps below.

[1] Attached as separate file.

i) Procedure for measurement of tree biomass
Tree diameter: Measurements for diameter at breast height (1.37 m) were conducted. The minimum diameter measured was 2.5 cm. The trees with DBH greater than 2.5 cm on sample plots were measured.

Tree height - Height of all trees on a sample plots were measured with altimeter. Calibration of altimeter was conducted prior to conducting tree height measurements on each sample plot.

Measurements and data recording and processing were carried out in accordance with QA/QC procedures.

ii) Calculation of volume, carbon stock and carbon stock change

Data to assess the change in aboveground carbon stock is based on the measurements of sample plots. Carbon stock change over time is calculated following the stock change approach.

For strata with Eucalyptus, the volume per tree of the aboveground biomass corresponding to the measured diameters is assessed from the volume equations. The volume is then multiplied by number of trees on the sample plot to obtain volume per sample plot. Volume per plot is calculated as a product of volume per hectare and sample plot area. From the volume of trees, carbon stock in CO_2 is calculated using the parameters on wood density, biomass expansion factor (BEF), and carbon fraction (CF).

For stratum with Casuarina, allometric equation method is used to calculate the carbon stock change. The biomass estimated from allometric equation is then multiplied by number of trees on the sample plot to obtain above ground biomass per sample plot and hectare. From the aboveground biomass of trees, carbon stock in CO_2 is calculated using the parameters on root shoot ratio, biomass expansion factor (BEF), and carbon fraction (CF).

iii) Monitoring of project emissions by sources

There were no GHG emissions associated with the implementation of the project as there was no biomass burning involved in the site preparation and site preparation and planting activities were carried out using manual methods. Therefore, project emissions are considered zero. The monitoring activity covers natural fires. No fire has occurred during the current monitoring period. Records evidencing the non-occurrence of fire are maintained at the JKPL office and shared at the time of verification.

iv) Monitoring leakage

- Displacement of grazing - The ex ante assessment indicated that the displacement of grazing is not expected to occur as a result of the project as additional fodder is produced in the project area. During project implementation number of animals in the project area were estimated using household survey and converted to number of animal equivalent units supported by the project ($Na_{AR,t}$). Random sample of animal owner households whose land parcels are the discrete areas of the project was used to conduct survey. The survey of the 120 households out of 1590 project households was conducted on sample basis (20 farmers from each district. The results of the surveys showed that no animals were displaced out of the project area. Therefore, leakage associated with the displacement of grazing is zero

- Displacement of fuel-wood collection - Lands under the project do not contain any tree growth in the baseline scenario. As mentioned in the PDD (Section 5.1.3), FGBL $<$FGAR,t holds throughout the project crediting period. As the project produces more fuel-wood in comparison to the baseline, there has been no fuel-wood leakage. Hence as stated in the PDD, no monitoring of the leakage from displacement of fuel-wood collection outside the project is required in the project.

Organisational Structure:

A Project Management Unit (PMU) has been formed and it comprises of an Executive Body and an Advisory Board. Members belong to both JKPL and VCCSL. The Advisory Board consists ofMr.M.C.Goel (EVP (Works) JKPL) and Mr.C.A.Rao (MD, VCCSL).

The Executive Body is consisting of Mr.Dharmendra Daukia (GM RMP,JKPL), Mr.Biswajeet Deb (GM Accts JKPM,JKPL), Mr. N. Sai Kishore (Executive Director, VCCSL) Ms. Pragya Gupta (Carbon Finance Specialist, VCCSL), Ashutosh Mahana (Asst Manager Pl JKPM,JKPL), Mr.Sushanta Behuria(Dy Manager Accounts, JKPM, JKPL), and Mr.V.Shanmukha Rao (CDM Project Manager VCCSL), Mr. Ch. Suresh Babu, (Business Development Executive, VCCSL), Mr.D.Madhav Krishna (Manager Accounts, VCCSL) & Ms.Chinnamamba (Statistician, VCCSL).

The PMU is supported by two Project Implementation Units (PIUs) at Visakhapatnam and Rayagada which are under the charge of Mr.V.Shanmukha Rao and Mr.Asutosh Mahana respectively.

Roles and Responsibilities:

Management

1. Mr.Sai Kishore (Executive Director, VCCSL): He is the Project Director. He holds the overall responsibility of the PMU and coordinates with the World Bank, VCCSL and JKPL.
2. Mr.Dharmendra Daukia (GM (RMP) JKPL): He is the advisor for the project implementation at the ground level. He provides inputs for management of the PMU.
3. Ms. Pragya Gupta (Carbon Finance Specialist, (VCCSL)): She is responsible for co-ordinating the project monitoring and financial reporting.
4. Mr.B.P.Ratho (GM(Forest) JKPL): He is responsible for overall co-ordination with field staff and provides guidance for implementation of the monitoring process.

Account Keeping

1. Mr.Biswajit Deb (GM (Accounts) JKPM, JKPL): He is responsible for and oversees project account keeping and regular audit of statements.
2. Ms.Pragya Gupta, Carbon Finance Specialist (VCCSL): She is responsible for and oversees financial reporting to the World Bank.
3. Mr.SushanataKu.Behura (Dy Manger (Accounts) JKPM, JKPL): He maintains information on project expenses related to PIU, Rayagada. He is responsible for proper account keepings of the PIU at Rayagada.
4. Mr.Ch.Suresh Babu (VCCSL): He is responsible for proper account keeping of the PIU and PMU at Visakhapatnam
5. Mr.D.Madhav Krishna (Manager (Accounts), VCCSL): He maintains information on project expenses related to PIU and PMU at Visakhapatnam.

Operations & MRV

1. Mr.V. Shanmukha Rao (Project Manager (VCCSL)): He is the Project Manager for the PIU at Visakhapatnam. He is responsible for coordinating with the PIU situated at Rayagada. He is responsible Quality Assurance / Quality control measures like cross checking of field data.

2. Mr.Ashutosh Mahana (Asst. Manager (Pl) JKPM, JKPL): He is the Project Manager for PIU at Rayagada. He is responsible for all the documentation aspects including monitoring records, which are to be maintained at PIU level at Rayagada. He is also responsible for administration of staff and community training for the monitoring systems and data management and storage of data collected during field work. He assists the Project Director for operations of the PMU.

3. Ms.B.Chinnamamba (Statistician, VCCSL): She assists the PMU / PIUs in monitoring, verification and data management and will also be responsible for Quality Assurance / Quality control measures like verifying field data collected.

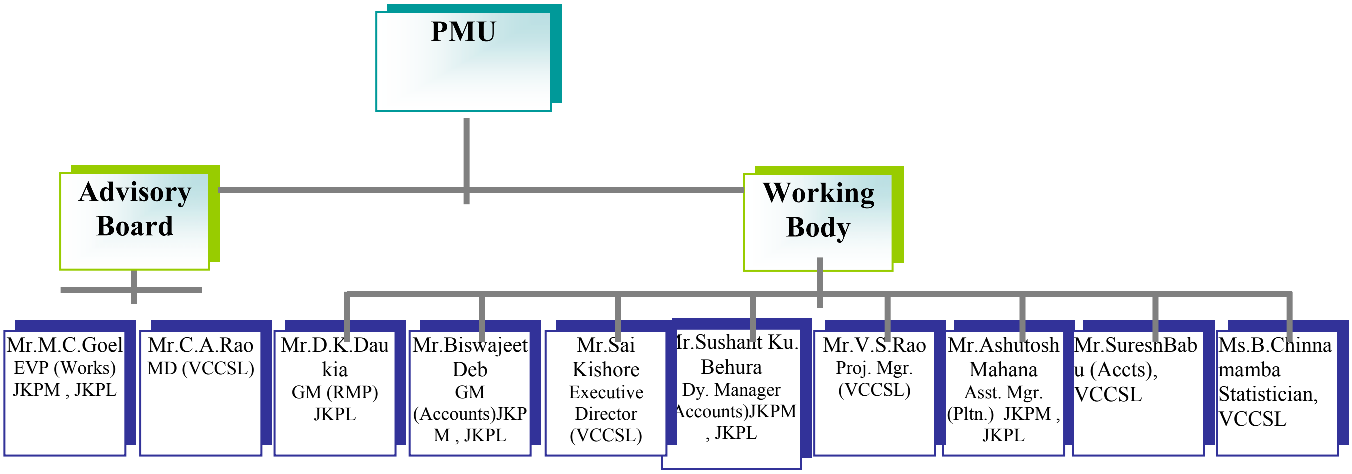

Table C.7: Role and responsibilities of project team.

Task and Responsibility	Method Used	Frequency	Responsible Role	Contact details
Staff training for monitoring systems		Annually and as new staff and community members are recruited	JKPL Manager	Mr.Ashutosh Mahana (Asst. Manager (Pl) JKPM, JKPL) ashutosh@jkpm.jkmail.com
Operation of monitoring equipment	As per equipment instructions	Review annually	JKPL Manager	Mr.Ashutosh Mahana (Asst. Manager (Pl) JKPM, JKPL) ashutosh@jkpm.jkmail.com
Quality control of monitoring equipment	Manual of monitoring	Annual	JKPL Manager	Mr.Ashutosh Mahana (Asst. Manager (Pl) JKPM, JKPL) ashutosh@jkpm.jkmail.com
Coordination of field data collection	Manual of monitoring	Annual	JKPL Manager	Mr.Ashutosh Mahana (Asst. Manager (Pl) JKPM, JKPL) ashutosh@jkpm.jkmail.com
Data cross-check of field measurements	Manual of monitoring	Annual	VCCSL Project Manager	Mr.Shanmukha Rao (Project Manager (VCCSL) vsrao_vedamacs@yahoo.co.in
Calculation of emissions reductions and deviations from projections	SMART forms	Annual	VCCSL Statistician	Mrs.Chinnamamba (Statistician – VCCSL) chinna@vccslindia.org
Coordination of Quality Assurance / control		Annual	VCCSL Project Manager	Mr.Shanmukha Rao (Project Manager (VCCSL) vsrao_vedamacs@yahoo.co.in

Sign off of monitoring reports and ER calculations		Annual	VCCSL and JKPL Project Manager	Mr.Ashutosh Mahana (Asst. Manager (Pl) JKPM, JKPL) ashutosh@jkpm.jkmail.com and Mr.Shanmukha Rao (Project Manager (VCCSL) vsrao_vedamacs@yahoo.co.in
Verifying and comparing the ERs with the projections made in PDD		Annual	VCCSL Carbon Finance Specialist	Ms. Pragya Gupta (Carbon Finance Specalist, VCCSL) pragya1.gupta@gmail.com

Emergency Procedures:

• Procedures to assess the GHG emissions due to fire in the boundary

The project depends on local communities for implementing the fire management plan. The fire prevention measures such as establishment of fire lines, reduction of fuel load, clearance of brushwood and dry vegetation close to the project parcels have been implemented.

In case of accidental fires, the area and carbon stock affected would be assessed using field surveys and measurement. No fire has occurred during the current monitoring period. Records evidencing the non-occurrence of fire are maintained at the JKPL office and shared at the time of verification.

• Procedures to assess the impact of pest infestation on the carbon stock of the project

In case of pest damage, monitoring team assesses the area affected and the carbon stock of the pest affected area and implement pest management measures to minimize negative impacts on the remaining carbon stock in the project boundary and to prevent the spread of infestation to areas outside project boundary. There have been no major instances of pest infestation under the project.

• Impact of weather related disturbances on carbon stocks in the project boundary

Procedures have been implemented to assess the weather related disturbances events such as droughts and floods in the project area and survival of plantations in the affected areas. The data from field surveys of the affected areas is used to assess the impact of droughts and floods on the carbon stock of the project. No weather related disturbances have been noticed in the project boundary.

Quality Assurance and Quality Control (QAQC) Measures:

To reduce uncertainty while monitoring the carbon stock changes in the project context and to ensure that the net anthropogenic GHG removals by sinks are measured and monitored precisely, credibly, verifiably and transparently, a quality assurance and quality control (QA/QC) procedure has been implemented:

a) Reliable field measurements
To ensure reliable field measurements,

- Standard Operating Procedures (SOPs) for each step of the field measurements, including all detail phases of the field measurements and provisions for documentation for verification purposes have been prepared.
- Training courses on the field data collection and data analyses have been held for persons involved in the field measurements. The training courses ensure that each field-team member is fully aware of all procedures and the importance of collecting data as accurately as possible.

Table C.8: List of trainings held for project team members.

Sl. No.	Date	Training Programme	Persons attended
1	5/2/2007	GPS Use for boundary demarcation of plantation field	10 persons 8 from JKPL & 2 from VCCSL
2	16/03/2008	GPS Use for boundary demarcation of plantation field	5 persons from JKPL.
3	15/05/2009	Monitoring & Evaluation along with roles & responsibility	10 persons 8 from JKPL & 2 from VCCSL
4	10/1/2009	Leakage concept & monitoring of sample plots	5 persons from JKPL.
5	12/8/2010	Monitoring & Evaluation along with roles & responsibility	10 persons 8 from JKPL & 2 from VCCSL
6	25/08/2010	Leakage concept & monitoring of sample plots	10 persons 8 from JKPL & 2 from VCCSL

- 15 Project staffs both of JKPL & VCCSL were given training on using the GPS meters for taking the coordinates of the project boundaries.
- 20 project staff both of VCCSL & JKPL were trained in monitoring and evaluation, with the goal of clarifying monitoring requirements of the project, and assigning clear roles and responsibilities for all stakeholders.
- 15 project staff including both of JKPL & VCCSL was trained in leakage concept, monitoring and management of sample plot.

b) Verification of field data

Sample plots have been established and the measurements were taken periodically. Randomly selected plots were re-measured by teams other than those that were involved in measurements in the previous round of data collection and measurements. - The selected sample plots were monitored throughout the year. After the schedule was finalized, the inventory teams were able to go into the field and start the measurement process. In the measurement process, four key items were checked and recorded (1) sample plot geographical position (using a GPS); (2) area of the sample plot; (3) tree height of all trees; and (4) the diameter at breast height (DBH). Where a deviation of more than ± 5% was found the field team has to re-measure once again to correct the mistake. The non-conformities procedures, depending on the seriousness, can vary from a report to the re-training of the inventory team.

c) Verification of data entry and analysis

To minimize the possible errors in the process of data entry, the entry of both field data were reviewed by an independent project team. The data entered was checked by VCCSL representative and the same was further verified by the project manager to cross- check the validity of data entry. 10% of the data is rechecked by VCCSL representative on a sample basis. Signed copies of the same are available with the PMU for verification.

d) Data maintenance and archiving

Data has been archived in both electronic and paper forms, and copies of data have been provided to all participating farmers. All electronic data and reports are also copied on durable media such as CDs and copies of the CDs are stored in multiple locations. The archives include:

- Copies of all original field measurement data, laboratory data, data analysis spreadsheet;
- GPS coordinates and other spatial data;
- Estimates of the carbon stock changes in all pools and non-CO2 GHG and corresponding calculation spreadsheets;
- Copies of the measuring and monitoring reports.

SECTION D. Data and parameters

D.1. Data and parameters determined at registration and not monitored during the

monitoring period, including default values and factors	
(Copy this table for each data and parameter. To report multiple values, a table may be used)	
Data / Parameter:	$BEF_{2,j}$
Data unit:	Dimensionless
Description:	Biomass expansion factor for conversion of stem biomass to above-ground biomass for tree species j
Source of data used:	IPCC GPG LULUCF (2003)
	Eucalyptus clone 2.00 *Eucalyptus seed* 2.00
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Carbon stock in living biomass of trees under the project scenario
Additional comment:	

Data / Parameter:	D_j
Data unit:	t d.m. m^{-3}
Description:	Basic wood density for tree species *j*
Source of data used:	IPCC GPG LULUCF (2003)
	Eucalyptus clone 0.34 *Eucalyptus seed* 0.34
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Carbon stock in living biomass of trees under the project scenario

Data / Parameter:	R_j
Data unit:	Dimensionless
Description:	Root-shoot ratio for tree species *j*
Source of data used:	IPCC GPG LULUCF (2003)
	Eucalyptus clone 0.35 *Eucalyptus seed* 0.35 *Casuarina equisetifolia* 0.32
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Carbon stock in living biomass of trees under the project scenario

Data / Parameter:	V_{ijt}
Data unit:	m^3/tree
Description:	Stem volume of trees of species *j* in sample plot *p* of stratum *i* at a point of time in year *t*, estimated by using the tree dimension(s) as entry data into a volume table or volume equation
Source of data used:	1. Chaturvedi, A.N. (1995): Volume tables and the regression equation for clonal plants, Tata Energy Research Institute, New Delhi. 2. Chaturvedi,, A.N (1974): Tree quality volume tables for Eucalyptus Hybrid, Indian Forester, Vol. 100, No. 10, pages 595-600.
Value(s) :	Tree species — V_{ijt} *Eucalyptus clone* — V = 0.00258 + 0.0281*((π*D)^2) * H *Eucalyptus seed* — V = -0.0001+0.31145*(D^2)*H

Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Carbon stock in living biomass of trees under the project scenario.

Data / Parameter:	*fj(DBH,H)*
Data unit:	*kg tree*$^{-1}$
Description:	Allometric equation for species *j* linking aboveground tree biomass (kg tree-1) to diameter at breast height (DBH) and tree height (H) measured on plots for stratum *i*, species *j*, time *t* , *kg tree*$^{-1}$
Source of data used:	B. Mohan Kumar, Suman Jacob George, V. Jamaludeen and T.K. Suresh (1998). Comparison of biomass production, tree allometry and nutrient use efficiency of multipurpose trees grown in woodlot and silvopastoral experiments in Kerela, India. *Forest Ecology and Management* (112) pp. 145-163.
Value(s) :	B= -0.37767 + 0.032996*(D^2) *H
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Carbon stock in living biomass of trees under the project scenario.

Data / Parameter:	CF_j
Data unit:	**Dimensionless**
Description:	Carbon fraction of tree biomass
Source of data used:	IPCC Default
Value(s) :	0.5
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Carbon stock in living biomass of trees under the project scenario.

Data / Parameter:	$\mathbf{Na_{BL}}$
Data unit:	Number of animal equivalent units; Dimensionless
Description:	Ex *ante* estimated pre-project number of animals from the different livestock groups that would be grazing in the project area under the baseline scenario.
Source of data used:	AR-CDM-PDD
Value(s) :	1943
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	The data on livestock are used to assess the occurrence of leakage

D.2. Data and parameters monitored

(Copy this table for each data and parameter. To report multiple values, a table may be used)	
Data / Parameter:	PL_{ID}
Data unit:	alpha numeric
Description:	Sample plot ID
Measured /Calculated /Default:	Default
Source of data:	Project and plot map, GIS
Value(s) of monitored parameter:	Sample plot IDs listed in the project database to be checked and confirmed with the sample plots laid out in the project strata.
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Not Applicable
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Not Applicable
Measuring/ Reading/ Recording frequency:	At the end of first monitoring period, and thereafter at 5 years
Calculation method (if applicable):	Not Applicable
QA/QC procedures applied:	Sample plot IDs were checked prior to conducting aboveground biomass measurements

Data / Parameter:	PLik
Data unit:	Dimensionless
Description:	Total number of plots in stratum i, stand model k
Measured /Calculated /Default:	Calculated
Source of data:	Sample size calculation
Value(s) of monitored parameter:	Number of sample plots in stratum *i*
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Number of sample plots in stratum *i* is used to calculate the actual GHG removals from sinks
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Not Applicable
Measuring/ Reading/ Recording frequency:	At the end of first monitoring period, and thereafter at 5 years
Calculation method (if applicable):	Calculation of sample size
QA/QC procedures applied:	Total number of sample plots recorded in each stratum prior to conducting measurement of aboveground biomass.

Data / Parameter:	A
Data unit:	ha
Description:	Total area of all strata (A) in the project

Measured /Calculated /Default:	Calculated
Source of data:	Records of project monitoring
Value(s) of monitored parameter:	1607.72ha
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Total area of all strata of the project is used to calculate the actual GHG removals by sinks from the project.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Not Applicable
Measuring/ Reading/ Recording frequency:	Prior to start of project and at the end of each monitoring period
Calculation method (if applicable):	Sum of area of all project strata
QA/QC procedures applied:	Total area of all strata under *ex ante* and *ex post* stratifications is checked for consistency

Data / Parameter:	*Ai*
Data unit:	ha
Description:	Area of stratum *i*
Measured /Calculated /Default:	Calculated
Source of data:	Records of project monitoring
Value(s) of monitored parameter:	Area of stratum *i* as per the records of project monitoring
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Area of stratum *i* used to calculate the actual GHG removals for stratum *i*
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Not Applicable
Measuring/ Reading/ Recording frequency:	Prior to start of project and at the end of each monitoring period
Calculation method (if applicable):	Sum of areas of all project land parcels of stratum *i*
QA/QC procedures applied:	*Ex post* stratification during the monitoring period

Data / Parameter:	AP
Data unit:	ha
Description:	Sample plot area
Measured /Calculated /Default:	Measured
Source of data:	Sample plot measurement
Value(s) of monitored parameter:	0.0256 ha
Indicate what the data are	Sample plot area is used to calculate the carbon stock of the sample

used for (Baseline/ Project/ Leakage emission calculations)	plot in the project
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	GPS, compass, tape, rope, calculator, field map
Measuring/ Reading/ Recording frequency:	At the end of first monitoring period; and thereafter at 5-year intervals
Calculation method (if applicable):	Not Applicable
QA/QC procedures applied:	Plot location and area checked and verified as per the monitoring plan

Data / Parameter:	*DBH*
Data unit:	cm
Description:	Diameter at breast height of living trees
Measured /Calculated /Default:	Measured
Source of data:	Measurement of trees with DBH > 2.5cm on sample plots
Value(s) of monitored parameter:	Diameter at breast height of trees measured on sample plots
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Diameter at breast height of trees is used to calculate the carbon stock of trees on a sample plot of the project.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Diameter tape, wooden stake Accuracy class: 1 mm Calibration frequency: Prior to conducting diameter measurement.
Measuring/ Reading/ Recording frequency:	At the end of the first monitoring period & thereafter at five year intervals
Calculation method (if applicable):	Not Applicable
QA/QC procedures applied:	Diameter measurements are randomly checked during measurement.

Data / Parameter:	*H*
Data unit:	meters
Description:	Tree height in meters
Measured /Calculated /Default:	Measured
Source of data:	
Value(s) of monitored parameter:	Height of tree measured on sample plots
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Height of trees is used to calculate the carbon stock of trees on a sample plot of the project.
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Type: Ravi altimeter Accuracy class: 0.2 m Calibration frequency: When in usage, every half yearly when not in usage, immediately before using it. Dates of last calibration: Aug 2011

	Validity: 6 months, if in use
Measuring/ Reading/ Recording frequency:	Measurement at the end of first monitoring period and thereafter at 5 years
Calculation method (if applicable):	Not Applicable
QA/QC procedures applied:	Height measurements are randomly checked during measurement

Data / Parameter:	*nTRPLikt*
Data unit:	Dimensionless
Description:	Number of trees in the sample plot
Measured /Calculated /Default:	Count
Source of data:	Sample plot measurement
Value(s) of monitored parameter:	Total number of trees > 2.5 cm
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Number of trees is used to calculate the carbon stock on a sample plot of the project
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Not Applicable
Measuring/ Reading/ Recording frequency:	At the end of first monitoring period & thereafter at five year intervals
Calculation method (if applicable):	Not Applicable
QA/QC procedures applied:	Count of the trees measured on sample plots is checked

Data / Parameter:	*NaAR,t*
Data unit:	Dimensionless
Description:	Monitored number of animals present in the project area at year *t*
Measured /Calculated /Default:	Measured through survey
Source of data:	Survey of farmer households participating in the project
Value(s) of monitored parameter:	Value assessed based on survey of farmer households
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Data on fodder production capacity of project lands was assessed from 20 households from each strata for a total of 100 households
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	Survey questionnaire to collect data on fodder production and grazing in the project area
Measuring/ Reading/ Recording frequency:	At the end of the first monitoring period
Calculation method (if applicable):	Not Applicable
QA/QC procedures applied:	Survey questionnaires are checked to ensure collection of relevant data

SECTION E. Emission reductions calculation

E.1. Baseline emissions calculation

The lands under the project are all discrete parcels owned by individual farmers. Dry land agriculture has been practiced on these lands for a long period. The subsistence agriculture on laterite and sandy soils in semi-arid climate with short rainy and prolonged dry seasons contributed to steep decline in the productivity of lands. Such degraded lands are expected to remain under subsistence agriculture or as fallow lands in the absence of the project. Considering the use of lands for agriculture, the pre-existing vegetation is also either absent or insignificant.

According to the methodology, the baseline carbon stock changes do not need to be monitored because the accepted baseline approach assumes continuation of existing changes in carbon stock resulting in its further loss of regeneration ability. Baseline emissions are conservatively estimated at zero in the PDD.

Verification Period	Baseline Emissions
25/06/04 to 31/08/11	0

E.2. Project emissions calculation

>> The project is not expected to result in emissions for the following reasons.

Most of the lands under the project are barren and do not contain any tree growth. The grass and herbaceous vegetation (present in insignificant quantities as the lands are under subsistence agriculture or short-term fallow lands) is cleared through manual ploughing to prepare land for planting activity. The farmers do not practice biomass burning in site preparation; as a consequence, emissions from biomass burning are zero. The project also does not use machinery in site preparation, thinning and harvesting. Therefore, there are no emissions associated with the use of machinery in site preparation and logging. Additionally, as per the decision of paragraph 37 of EB44, the GHG emissions associated with fertilizers, removal of herbaceous vegetation and transportation are insignificant and can be ignored.

Considering that no project GHG emissions were observed, the project emissions are considered **zero**. The only GHG emissions relevant for the project are the GHG emissions associated with the natural fires, which were monitored and no natural fires were observed during the monitoring period.

The project emissions are therefore identified to be zero.

$GHG_E = 0$

Verification Period	Project Emissions
25/06/04 to 31/08/11	0

E.3. Leakage calculation

>>

Leakage due to fencing: The fencing is done by using thin branches and twigs. The activity displacement due to use of this fuel wood for fencing is negligible. As per the paragraph 37 of the EB44, the GHG emissions from the fencing material are insignificant and are therefore not monitored.

Leakage due to fuel wood collection: Lands under the project do not contain any tree growth in the baseline scenario. Only grass and herbaceous vegetation is present in insignificant quantities. As a consequence, the pre-project annual fuel-wood gathering in the project area is **zero**.

$FG_{BL} = 0$

Leakage due to displacement for fuel-wood collection is set as zero ($LK_{fuel\text{-}wood} = 0$) as the information gathered from the actual material harvested from the plantation and is monitored regularly by field staffs. The harvesting data of the project indicate that the fuel-wood production is increased significantly as result of the project. Consequently, $FG_{BL} < FG_{AR,t}$ will hold throughout the project crediting period. Therefore, **no** monitoring of the leakage from displacement of fuel-wood collection outside the project is required in the project as also stated in section 5.1.3 of the PDD.

Leakage due to vehicle emission: As per the paragraph 35, EB 42 report, emissions associated with transportation are considered insignificant and can be neglected. Therefore, emissions from the transport of personnel to areas outside the project boundary and products to the market are not required to be monitored.

Leakage due to animal displacement: The number of livestock in animal equivalent units (AEU) under the baseline prior to the project implementation was assessed and reported on the page 61 of the registered PDD.

The pre-project number of animals under the baseline scenario (Na_{BL}) is:

$$Na_{BL} = 1943$$

The following steps are used to assess leakage associated with the displacement of grazing activities.

As per the Step 1 of section III. 7.1.1of the AR AM0004, version 03 methodology, monitoring of leakage due to the conversion of land to grazing land is necessary up to the fifth year after the last measure taken to reduce animal populations in the project area.

As per the step 2 of section III. 7.1.1 of the methodology, the estimate of average animal population present in the project area (NaAR,t) is done through sample survey by interviewing animal owners. As part of the project monitoring, the survey of sample farmer households was conducted using the following procedure.

1. Data collection through surveys from 120 farmer households (20 farmer households from each district) out of the 1590 farmer households participating in the project.

2. The results of the sample data are extrapolated to the district level based on the number of farmers of the districts participating in the project.

3. Year wise compilation of animal equivalent for 1590 farmers.

The livestock population in the region includes cow, bullocks, sheep, and goat considering the differences in the biomass intake of different categories of livestock, they are expressed in animal equivalent units (AEU) to assess the fodder requirements during the pre- project period.

The units of conversion for estimating the animal equivalent units (AEU) are as below.
Cow, bullock, and buffalo = 1 AEU
Goat = 0.2 AEU
Sheep = 0.2 AEU

The table E.3.1 shows the number of livestock in animal equivalent units (AEU) assessed through survey.

Table E.3.1: Number of livestock in animal equivalent units assessed in the project area

Animal type	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**Average for 2005 to 2010**
Cow	139	139	143	141	141	142	140.8
Buffalo	106	106	109	110	114	115	110.0
Bullock	136	138	138	140	140	140	138.7
Goat	141	153	168	172	180	183	166.2
Sheep	19	19	31	37	38	39	30.5
Total AEU for sample	413	417.4	429.8	432.8	438.6	441.4	428.8
Total AEU for project (1590 farmer households)	**4533.1**	**4567.9**	**4700.7**	**4703.2**	**4773.1**	**4800.9**	**4679.8**

The average number of animals in animal equivalent units (AEU) ($Na_{AR,,t}$) supported by the project during the monitoring period

$Na_{AR,,t} = 4679.8$

As per the methodology, leakage is expected to occur in situations:

$$Na_{outside,t} = Na_{BL} - Na_{AR,t}$$ **(Equation 103 of AR AM0004, Version 03)**

$Na_{outside,\ t}$ = Number of animals displaced outside the project area at year *t*; dimensionless
Na_{BL} = *Ex ante* estimated pre-project number of animals from the different livestock groups that would be grazing in the project area under the baseline scenario; dimensionless. This estimate is fixed for the entire crediting period and is specified in the AR-CDM-PDD
$Na_{AR,t}$ = Monitored number of animals present in the project area at year *t*; dimensionless

If $Na_{BL} < Na_{AR,t}$ then, it can be assumed that the AR-CDM project activity has not displaced grazing animal populations. Leakage due to conversion of land to grazing land can be set as zero ($LK_{conversion} = 0$);

Considering that NaBL = 1943 < NaAR,t = 4679.8, there is no leakage associated with the project as the fodder production on the farms is more than adequate to meet the fodder requirement of the livestock. The project was supporting significantly more livestock during the monitoring period of 2005 to 2010 than was observed in the baseline.

therefore, $LK_{conversion} = 0$;

Thus we conclude that there is no animal displacement out of the project area and leakage due to animal displacement is considered as zero.

Summing of all these above points, leakage from fuel wood collection, fencing and vehicle emissions and animal displacement is identified as zero.

E.4. Emission reductions calculation / table

>>

The emission reductions are calculated applying the equations of the methodology to the data collected from the measurement of trees on the sample plots located on the discrete areas of the project.

The verifiable changes in carbon stock represent the carbon stock changes in above-ground biomass and below-ground biomass within the project boundary are estimated using the equations of the methodology, AR AM0004 version 3.

$$\Delta C_{P,LB_T} = \sum_{t=1}^{t*} \sum_{i=1}^{S_{ps}} \sum_{k=1}^{K} \Delta C_{P,ikt}$$ **(Equation 72 of AR AM0004, Version 3)**

where:

$\Delta C_{P,LB}$ Sum of the changes in living biomass carbon stocks (above- and below-ground); t CO_2-e

$\Delta C_{P,ikt}$ Annual carbon stock change in living biomass for stratum *i,* stand model *k*, time *t;* t CO_2-e yr^{-1}

i 1, 2, 3, ... S_{ps} strata of the project activity

k 1, 2, 3, … *K* stand models

t 1, 2, 3, ...*t** years elapsed since the start of the A/R project activity

$$\Delta C_{P,ikt} = (\Delta C_{AB,ikt} + \Delta C_{BB,ikt}) \cdot \frac{44}{12}$$ **(Equation 73 of AR AM0004, Version 3)**

where:

$\Delta C_{P,ikt}$ Annual carbon stock change in living biomass for stratum *i,* stand model *k*, time *t;* t CO_2-e. yr^{-1}

$\Delta C_{AB,ikt}$ Annual carbon stock change in above-ground biomass for stratum *i,* stand model *k*, time *t;* t C yr^{-1}

$\Delta C_{BB,ikt}$ Annual carbon stock change in below-ground biomass for stratum *i,* stand model *k*, time *t;* t C yr^{-1}

The mean change in carbon stocks in above-ground biomass and below-ground biomass per unit area are based on the measurements on permanent plots.

Two methods available for the estimation of carbon stock are used to calculate the biomass growth: Biomass Expansion Factors (BEF) method and Allometric Equations method.

As per the Annex 27, EB63, paragraph 3(p), BEF method is used to calculate the carbon stock change of Eucalyptus clone and Eucalyptus seed strata; and allometric equation method is used for calculate the carbon stock change of Casuarina.

BEF method

The volume of the commercial component of trees into carbon stock in above-ground biomass and below-ground biomass via basic wood density, BEF root-shoot ratio and carbon fraction, given by:

$$MC_{AB,ijt} = MV_{ijt} \cdot D_j \cdot BEF_j \cdot CF_j$$ **(Equation 74 of AR AM0004, Version 3)**

$$MC_{BB,ijt} = MC_{AB,ijt} \cdot R_j$$ **(Equation 75 of AR AM0004, Version 3)**

where:

$MC_{AB,ijt}$ Mean carbon stock in above-ground biomass per unit area for stratum *i,* species *j*, time *t;* t C ha^{-1}

$MC_{BB,ijt}$ Mean carbon stock in below-ground biomass per unit area for stratum *i,* species *j*, time *t;* t C ha^{-1}

MV_{ijt} Mean merchantable volume per unit area for stratum *i,* species *j*, time *t;* m^3 ha^{-1}

D_j Volume-weighted average wood density; t d.m. m^{-3} merchantable volume

BEF_j Biomass expansion factor for conversion of biomass of merchantable volume to above-ground biomass; dimensionless

CF_j Carbon fraction; IPCC default value = 0.5; t C (t d.m.)$^{-1}$

R_j Root-shoot ratio; dimensionless

The total carbon stock in living biomass for stratum *i,* species *j*, time *t* is calculated from the area for stratum *i,* species *j*, time *t* and the mean carbon stocks in above-ground biomass and below-ground biomass per unit area, as follows:

$$C_{AB,ikt} = A_{ikt} \cdot MC_{AB,ikt}$$ **(Equation 76 of AR AM0004, Version 3)**

$$C_{BB,ikt} = A_{ikt} \cdot MC_{BB,ikt}$$ **(Equation 77 of AR AM0004, Version 3)**

where:

$\Delta C_{AB,ijt}$ Annual carbon stock change in above-ground biomass for stratum *i,* species *j*, time *t;* t C yr^{-1}

$\Delta C_{BB,ijt}$ Annual carbon stock change in below-ground biomass for stratum *i,* species *j*, time *t;* t C yr^{-1}

A_{ijt} Area of stratum *i,* species *j*, at time *t*; hectare (ha)

Note: The area of a stratum *i* planted with species *j* in stand model *k* has a time notation because stands with species *j* will be established (planted) at different dates.

$MC_{AB,ijt}$ Mean carbon stock in above-ground biomass per unit area for stratum *i,* species *j*, time *t;* t C ha^{-1}

$MC_{BB,ijt}$ Mean carbon stock in below-ground biomass per unit area for stratum *i,* species *j*, time *t;* t C ha^{-1}

The change in carbon stock in living biomass over time is given by:

$$\Delta C_{AB,ikt} = \frac{\sum_{j=1}^{J}(C_{AB,ikt_2} - C_{AB,ikt_1})}{T}$$ **(Equation 78 of AR AM0004, Version 3)**

$$\Delta C_{BB,ikt} = \frac{\sum_{j=1}^{J}(C_{BB,ikt_2} - C_{BB,ikt_1})}{T}$$ **(Equation 79 AR AM0004, Version 3)**

where:

$\Delta C_{AB,ikt}$ Annual carbon stock change in above-ground biomass for stratum *i,* stand model *k*, time *t;* t C yr^{-1}

$\Delta C_{BB,ikt}$ Annual carbon stock change in below-ground biomass for stratum *i,* stand model *k*, time *t;* t C yr^{-1}

$C_{AB,ijt2}$ Carbon stock in above-ground biomass for stratum *i,* species *j*, calculated at time $t = t_2$; t C

$C_{AB,ijt1}$ Carbon stock in above-ground biomass for stratum *i,* species *j*, calculated at time $t = t_1$; t C

$C_{BB,ijt2}$ Carbon stock in below-ground biomass for stratum *i,* species *j*, calculated at time $t = t_2$; t C

$C_{BB,ijt1}$ Carbon stock in below-ground biomass for stratum *i,* species *j*, calculated at time $t = t_1$; t C

T Number of years between monitoring time t_2 and t_1 ($T = t_2 – t_1$); years

j Species *j* (J = total number of species)

Allometric equation method

The allometric equation adopted for Casuarina confirms to the A/R Methodological Tool: Demonstrating appropriateness of allometric equations for estimation of aboveground tree biomass in A/R CDM project activities (Version 01.0.0). The steps of the methodology with allometric equation method are applied to calculate the carbon stock change in the stratum ACA that has areas growing Casuarina.

$$TB_{ABj} = f_j(DBH, H)$$ **(Equation 80 of AR AM0004, Version 3)**

where:

TB_{ABj} Above-ground biomass of a tree; kg $tree^{-1}$

$f_j(DBH,H)$ An allometric equation for species *j* linking above-ground tree biomass (kg $tree^{-1}$) to diameter at breast height (*DBH*) and possibly tree height (*H*) measured in plots for stratum *i,* species *j*, time *t*

The carbon stock in above-ground biomass per tree is calculated by applying the allometric equation to the tree measurements.

$$TC_{ABj} = TB_{ABj} \cdot CF_j$$ **(Equation 81 of AR AM0004, Version 3)**

where:

TC_{AB} Carbon stock in above-ground biomass per tree; kg C $tree^{-1}$

TB_{ABj} Above-ground biomass of a tree of species *j*; kg $tree^{-1}$

CF Carbon fraction (IPCC default value = 0.5); t C (t d.m.)$^{-1}$

The increment of above-ground biomass carbon accumulation is done by subtracting the biomass carbon at time 2 from the biomass carbon at time 1.

$$\Delta TC_{ABjT} = TC_{ABj,t2} - TC_{ABj,t1}$$ **(Equation 82 of AR AM0004, Version 3)**

where:

ΔTC_{ABjT} Carbon stock change in above-ground biomass per tree of species *j* between two monitoring events; kg C $tree^{-1}$

$\Delta TC_{ABj,t2}$ Carbon stock change in above-ground biomass per tree of species *j* at monitoring event t_2; kg C $tree^{-1}$

$\Delta TC_{ABj,t1}$ Carbon stock change in above-ground biomass per tree of species *j* at monitoring event t_1; kg C $tree^{-1}$

The change in biomass carbon per tree within each plot is calculated by multiplying with plot expansion factor which is proportional to the area of the measurement plot.

$$\Delta PC_{ABikT} = \frac{XF \cdot \sum_{tr=1}^{TR} \Delta TC_{ABjT,tr}}{1000}$$ **(Equation 83 of AR AM0004, Version 3)**

$$XF = \frac{10{,}000}{AP}$$ **(Equation 84 of AR AM0004, Version 3)**

where:

$\Delta PC_{AB,ijT}$ Plot level carbon stock change in above ground biomass in stratum *i*, species *j*, between two

monitoring events; t C ha^{-1}

ΔTC_{ABjT} Carbon stock change in above-ground biomass per tree of species j between two monitoring events; kg C tree^{-1}

XF Plot expansion factor from per plot values to per hectare values

AP Plot area; m^2

tr Tree (TR = total number of trees in the plot)

The mean carbon stock change within each stratum is calculated by averaging across plots in a stratum.

$$\Delta MC_{ABikT} = \frac{\sum_{pl=1}^{PL_{ik}} \sum_{j}^{J} \Delta PC_{ABikT,pl}}{PL_{ik}}$$ **(Equation 85 of AR AM0004, Version 3)**

where:

ΔMC_{ABikT} Mean carbon stock change in above-ground biomass in stratum i, stand model k, between two monitoring events; t C ha^{-1}.

ΔPC_{ABijT} Plot level mean carbon stock change in above-ground biomass in stratum i, species j, between two monitoring events; t C ha^{-1}.

pl Plot number in stratum i, species j; dimensionless

PL_{ik} Total number of plots in stratum i, stand model k; dimensionless

j Species j (J = total number of species)

The carbon stock in below-ground biomass is estimated by applying the root-shoot ratio to the above-ground carbon stock.

$$TC_{BBj} = TC_{ABj} \cdot R_j$$ **(Equation 86 of AR AM0004, Version 3)**

$$\Delta TC_{BBjT} = TC_{BBj,t2} - TC_{BBj,t1}$$ **(Equation 87 of AR AM0004, Version 3)**

$$\Delta PC_{BB,ikT} = \frac{XF \cdot \sum_{tr=1}^{TR} \Delta TC_{BBjT}}{1000}$$ **(Equation 88 of AR AM0004, Version 3)**

$$\Delta MC_{BB,ikT} = \frac{\sum_{pl=1}^{PL_{ik}} \Delta PC_{BBikT,pl}}{PL_{ik}}$$ **(Equation 89 of AR AM0004, Version 3)**

where:

TC_{BBj} Carbon stock in below-ground biomass per tree of species j; kg C tree^{-1}

TC_{ABj} Carbon stock in above-ground biomass per tree of species j as calculated in Step 1; kg C tree^{-1}

R_j Root-shoot ratio appropriate to increments for species j; dimensionless

ΔTC_{BBjT} Carbon stock change in below-ground biomass per tree of species j between two monitoring events; kg C tree^{-1}

$\Delta PC_{BB,\,ijT}$ Plot level carbon stock change in below-ground biomass of species j between two monitoring events; t C ha^{-1}

XF Plot expansion factor from per plot values to per hectare values (see equation 80); dimensionless

tr Tree (*TR* = total number of trees in the plot)

ΔMC_{BBikT} Mean carbon stock change in below-ground biomass for stratum *i*, stand model *k*, between two monitoring events; t C ha^{-1}

ΔPC_{BBikT} Plot level carbon stock change in below-ground biomass for stratum *i*, stand model *k*, between two monitoring events; t C ha^{-1} *pl* = plot number in stratum *i*, stand model *k*; dimensionless

PL_{ik} Total number of plots in stratum *i*, stand model *k*; dimensionless

The annual carbon stock change is calculated by dividing the carbon changes between two monitoring events by the number of years between monitoring events.

$$\Delta MC_{ABikt} = \frac{\Delta MC_{ABikT}}{T}$$ **(Equation 90 of AR AM0004, Version 3)**

$$\Delta MC_{BBikt} = \frac{\Delta MC_{BBikT}}{T}$$ **(Equation 91 of AR AM0004, Version 3)**

where:

$\Delta MC_{AB,ikt}$ Annual mean carbon stock change in above-ground biomass for stratum *i*, stand model *k,* at year *t*; t C ha^{-1} yr^{-1}

$\Delta MC_{BB,ikt}$ Annual mean carbon stock change in below-ground biomass for stratum *i*, stand model *k,* at year *t*; t C ha^{-1} yr^{-1}

ΔMC_{ABikT} Mean carbon stock change in above-ground biomass for stratum *i*, stand model *k,* between two monitoring events; t C ha^{-1} yr^{-1}

ΔMC_{BBikT} Mean carbon stock change in below-ground biomass for stratum *i*, stand model *k,* between two monitoring events; t C ha^{-1} yr^{-1}

T Number of years between two monitoring events which in this methodology is 5 years

The annual carbon stock change in living biomass for each stratum *i*, species *j*, stand model *k*, at time *t* is calculated from the area of each stratum *i*, species *j*, stand model *k*, at time *t* and the annual mean carbon stock change in above-ground biomass and below-ground biomass per unit area.

$$\Delta C_{AB,ikt} = A_{ikt} \cdot \Delta MC_{AB,ikt}$$ **(Equation 92 of AR AM0004, Version 3)**

$$\Delta C_{BB,ikt} = A_{ikt} \cdot \Delta MC_{BB,ikt}$$ **(Equation 93 of AR AM0004, Version 3)**

where:

A_{ikt} Area of stratum *i*, stand model *k,* at time *t*; hectare (ha)

$\Delta C_{AB,ikt}$ Changes in carbon stock in above-ground biomass for stratum *i*, stand model *k,* at time *t*; t C yr^{-1}

$\Delta C_{BB,ikt}$ Changes in carbon stock in below-ground biomass for stratum *i*, stand model *k,* at time *t*; t C yr^{-1}

$\Delta MC_{AB,ikt}$ Annual mean carbon stock change in above-ground biomass for stratum *i*, stand model *k,* at year *t*; t C ha^{-1} yr^{-1}

$\Delta MC_{BB,ikt}$ Annual mean carbon stock change in below-ground biomass for stratum *i*, stand model *k,* at year *t*; t C ha^{-1} yr^{-1}

Note that stand models will most often be one of the strata, and therefore will be included as such rather than as a separate consideration.

Growth data and equations used in the calculation of carbon stock changes

The growth equations used for calculating net GHG removals by sinks in the project area are:

The volume equations of Eucalyptus grown in states of India with similar edapho-climatic conditions as those of the project region have been adapted to the project. The equations selected conform to the criteria of A/R Methodological Tool: *Demonstrating appropriateness of volume equations for estimation of aboveground tree biomass in A/R CDM project activities, version 01.0.0 (Annex 24, EB 67).*

Volume equations of *Eucalyptus* clone and *Eucalyptus* seed are noted below.

1. Volume equation for Eucalyptus clone[2]

$V = 0.00258 + 0.0281\ G^2 * H$ or
$V = 0.00258 + 0.0281\ (\pi *D)^2 * H$

2. Volume equation for Eucalyptus seed[3]

V = -0.0001+0.31145*(D^2)*H

Where:
V=Volume per unit area (m^3/ha).
D = diameter at breast height (DBH, at 1.37 m above-ground) for all trees in the permanent sample plots.
H= Height of the tree in permanent the sample plots.
G = Girth, π*D

The volume equations of Eucalyptus clone and Eucalyptus seed complies with the AR Methodological Tool: *Demonstrating appropriateness of volume equations for estimation of aboveground tree biomass in A/R CDM project activities, version 01.0.1 (Annex 24, EB 67).*

As per the paragraph 5 of the tool, The Eucalyptus clone and Eucalyptus seed volume equations are derived from trees growing in edapho-climatic conditions of India as those of the project area and are considered appropriate, and therefore are used for ex post estimation of tree stem volume.

As per the paragraph 5 (c) of the tool, the Eucalyptus clone and Eucalyptus seed are based on 30 or more trees and have R^2 value greater than 0.85 as noted below. Therefore, the volume equations are applicable to the project.

Table E.4.1: Details of volume equations of Eucalyptus clone and Eucalyptus seed

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[2] Chaturvedi, A.N. (1995): Volume **tables and the regression equation for clonal plants, Tata Energy Research Institute, New Delhi,**

[3] Chaturvedi,, A.N (1974): Tree quality volume tables for Eucalyptus Hybrid, *Indian Forester*, Vol. 100, No. 10, pages 595-600; and is based on Chaturvedi (1973): General Standard Volume Tables for Eucalyptus Hybrid, *Indian Forest Records*, Vol. 12, No.14, pages 1-9

Species	Volume equation	Equation based on # trees	R^2
Eucalyptus clone	$V = 0.00258 + 0.0281 (\pi D)^2 * H$	30 trees	0.97
Eucalyptus seed	$V = -0.0001 + 0.31145 * D^2 * H$	579 trees	0.9855

3. Allometric equation[4] used for Casuarina equisetifolia is:

B = -0.37767 + 0.032996*(D^2)*H

Where:
B = Aboveground biomass in kg/tree
DBH=Diameter at breast height in cm
H=Height of the tree from permanent the sample plots in meters.

The allometric equation of *Casuarina equisetiflolia* complies with the AR Methodological Tool: Demonstrating appropriateness of allometric equations for estimation of aboveground tree biomass in A/R CDM project activities, volume 01.0.0 (Annex 28, EB 65)

As per the paragraph 6 of the tool, The Casuarina volume equations in India are derived from trees growing in edapho-climatic conditions of India that are similar to those of the project area and are considered appropriate, and therefore are used for ex post estimation of tree biomass.

As per the paragraph 6 (c) of the tool, the allometric equation of Casuarina equisetifolia is based on more than 30 trees and has R^2 value greater than 0.85 as noted below. Therefore, the allometric equation is applicable to the project.

Table E.4.2: Details of allometric equation of Casuarina

Species	Volume equation	Equation based on # trees	R^2
Casuarina equisetiflioa	$B = -0.37767 + 0.032996 D^2 * H$	127 trees	0.95

Root to shoot Ratio (Rj)

The root shoot ratios have been adopted from Table 3A.1.8 of IPCC GPG LULUCF as follows:

Eucalyptus=0.35 (Mean value for eucalyptus plantation) and,
Casuarina=0.32(Mean values for conifer plantation)

.
Total project area is 1607.72 ha. The distribution of area in standing, harvested and replanted/under coppice; and harvested and not replanted/coppiced uprooted is shown in Table E.1 as follows:

[4] B. Mohan Kumar, Suman Jacob George, V. Jamaludeen and T.K. Suresh (1998). Comparison of biomass production, tree allometry and nutrient use efficiency of multipurpose trees grown in woodlot and silvopastoral experiments in Kerela, India. Forest Ecology and Management (112) pp. 145-163.

Table E.4.3: Distribution of project area in standing, and proposed for regeneration categories.

Strata with standing stock	Strata of proposed regeneration	Total Project Area
(a)	(b)	(c)
808.38	799.34	**1607.72**

Calculation of margin of error in the carbon stock change

As per Annex 26, EB63, uncertainty assessment/ uncertainty analysis in the calculation of carbon stock change is not mandatory as part of accounting for uncertainty.

However, as shown in Table E.E.4.4 below (included in Annex 3), the margin of error calculated in the measurement of carbon stock change at the first verification is 9.28%, which is below 10% precision.

Therefore, the net GHG removals by sinks calculated in the project are within 10% precision and 90% confidence interval.

Table E.4.4: Margin of error in the calculation of carbon stock change

Strata	Area of Stratum (ha)	Mean carbon of Stratum (t/ha)	Standard deviation (σ) (t/ha)	S_i^2	Ratio of stratum *i* area to project area (wi)	wi* Mean carbon of Stratum	Number of sample plots	Variance of mean change in carbon per ha	t-value @ 10%, 72 sample plots & 10 strata	Error	Margin of Error (%)
A	B	C	D	$E=(D)^2$	F=(B/B-total)	G = (F*C)	H	$I=(F^2*(E/H))$	J	K=(J -total* SQRT(I - total)	L= K total/ G total
AECss	309.68	29.18	10.29	105.81	0.19	5.6202	23	0.1707			
AESss	23.23	17.45	4.25	18.07	0.01	0.2521	2	0.0019			
ACAss	34.84	36.58	8.75	76.50	0.02	0.7928	3	0.0120			
OECss	253.28	26.58	15.89	252.57	0.16	4.1876	30	0.2090			
OESss	187.35	23.05	13.34	177.84	0.12	2.6862	14	0.1725			
AECrg	277.38	0.00	0.00	0.00	0.17	0					
AESrg	28.69	0.00	0.00	0.00	0.02	0					
ACArg	346.62	0.00	0.00	0.00	0.22	0					
OECrg	127.32	0.00	0.00	0.00	0.08	0					
OESrg	19.33	0.00	0.00	0.00	0.01	0					
Total	**1607.72**					**13.5389**	**72**	**0.5660**	**1.6698**	**1.2563**	**9.28%**

Table E.4.5 represents the actual net GHG removals by sinks from 809.38 ha that were measurable at time of monitoring (area in columns (b) in Table E.4.5). An area of 491.44 ha was planted and subsequently harvested and uprooted.

The actual standing carbon sink is represented in the column (e) of Table E.4.4 for the monitoring period at the end of August'2011 and the same was verified during the verification. Net GHG removals were calculated using the equations of the AR AM0004 version 03 methodology. The calculation sheet is attached as Annex 3 (separate file).

Table E.4.4: Actual net GHG removals by sinks from project area

Strata	Area by stratum	Carbon stock change in living	Accumulated GHG emissions	Actual net GHG removals

	(Ha)	biomass of trees (Above ground and below ground) *t CO2-e* per year	*t CO2-e*	by sinks *t CO2-e*
(a)	**(b)**	**(c)**	**(d)**	**(e) = (c)*7.167 (monitoring period)**
Andhra Casuarina (ACAss)	34.84	652.08	nil	46,73.44
Andhra Eucalyptus Clonal (AECss)	309.68	4622.73	nil	33,131.13
Andhra Eucalyptus Seed (AESss)	23.23	207.37	nil	1,486.24
Orissa Eucalyptus Clonal (OECss)	253.28	3444.35	nil	24,685.67
Orissa Eucalyptus Seed (OESss)	187.35	2209.41	nil	15,834.82
Grand Total	**808.38**			**79, 811.30**

The net anthropogenic GHG removals by sinks are calculated by subtracting the baseline net GHG removals by sinks and leakage emissions from the actual net GHG removals by sinks minus as per the methodology.

$$C_{AR-CDM} = C_{ACTUAL} - C_{BSL} - LK$$ **(Equation 121 of AR AM0004, Version 3)**

where:

C_{AR-CDM} = Net anthropogenic greenhouse gas removals by sinks; t CO_2-e
C_{ACTUAL} = Actual net greenhouse gas removals by sinks; t CO_2-e
C_{BSL} = Baseline net greenhouse gas removals by sinks (as pre-determined in the PDD); t CO_2-e
LK = Leakage; t CO_2-e
Considering that the the baseline net GHG removals by sinks and leakage emissions are zero, the net anthropogenic GHG removals by sinks of the project are same as the actual net GHG removals by sinks.

Net anthropogenic greenhouse gas removals by sinks = 79,811.30 – 0 – 0

= 79,811.30

E.5. Comparison of actual emission reductions with estimates in the CDM-PDD

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Item	Values applied in ex-ante calculation of the registered CDM-PDD	Actual values reached during the monitoring period
Emission reductions (tCO_2e)	**175,011**	**79,811.30**

E.6. Remarks on difference from estimated value in the PDD

The ex-ante emission reduction values presented in the PDD are based on estimates of the forest growth while the actual values are based on the measurements conducted on the sample plots. Moreover, the low value of actual net GHG removals by sinks relative to the *ex ante* calculations presented in the registered project is due to the harvests conducted by some farmers during the monitoring process.

History of the document

Version	Date	Nature of revision
01	EB 54, Annex 34 28 May 2010	Initial adoption.
Decision Class: Regulatory **Document Type**: Guideline, Form **Business Function**: Issuance		