JATROPHA AGROFORESTRY SENEGAL

Document Prepared By CarbonSinkGroup s.r.l.

Project Title	Jatropha Agroforestry Senegal
Version	Version 05
Date of Issue	11 November 2013
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1 PROJECT DETAILS

1.1 Summary Description of the Project

The Jatropha Agroforestry Senegal project develops Jatropha curcas plantations in the Fatick, Kaolack and Kaffrine regions, in central-western agricultural region of the Senegal. The Jatropha curcas plantations are foreseen cover an area of 1411.34 ha of degraded soils mainly in the surroundings of the cities of Ourour and Kaffrine. The plantations will be located near villages around these cities to limit transport and facilitate the access of inhabitants as the project involves local hand-workers from villages. Local workers will be trained for both sustainable agricultural and forestry practices and hired for all plantation operational activities.

The planned agro-forestry system will assure a proper management of trees in cultivated lands allowing the carbon storage by plants biomass and soils, consequently providing a contribution to the greenhouse effect mitigation and the reversal of soil degradation trend.

African National Oil Corporation s.a.r.l. (ANOC) has concessions for the project lands and will be the owner of Jatropha plants and products. Moreover, ANOC will manage the agricultural operations (e.g., sowing, fertilizing). In addition, contemporary crop activities will be boosted as local farmers will be working only part-time in the Jatropha fields. The unused fallow agricultural land, where Jatropha will be grown, were legally assigned to ANOC for 25% of the available agricultural land, hence ensuring to continue to produce both food and traditional agricultural products (e.g., peanuts) as usual in the baseline scenario.

The aims of this project are:

- The sequestration of carbon dioxide (CO_2) through the nurturing of Jatropha curcas.
- The regeneration of degraded soils, protecting them against erosion processes and saving existing carbon stocks.
- The empowerment of local communities to develop sustainable agro-forestry practices.
- The provision of rotated livelihood potentialities for local communities with the possible access to alternative income for local stakeholders and the promotion of sustainable agricultural practices (e.g., Jatropha farming will harvest fruit whose seeds can be sold by villagers so as to be mechanically pressed to extract oil and generate the biodiesel fuel).
- The local production of biodiesel from Jatropha seeds will replace the scarcely-available diesel fuel, which is currently used to generate electricity; consequently, the biodiesel will provide an alternative source of energy for the sustainable development of this region.

1.2 Sectoral Scope and Project Type

The project will be a Verified Carbon Standard (VCS) project within the sectoral scope of Agriculture, Forestry and Other Land Use (AFOLU) and category Afforestation, Reforestation and Revegetation (ARR). The project will be a grouped project comprising a set of grouped project activity instances. While only one project activity instance is included in this Project Description (PD), the intention is to add more instances over time subsequent to project validation. This VCS project is hereafter referred to as “the project”.

1.3 Project Proponent

African National Oil Corporation s.a.r.l. (ANOC) is the project proponent of the project. ANOC is a Senegalese private company owned by the Italian Bioenergy Production s.r.l. In Senegal its activities started in 2008 with the development of first nurseries in several villages and made first pilot Jatropha plantations near Ourour (Fatick region) and Kaffrine (Kaffrine region). ANOC developed the plantations respecting the environment by using sustainable agricultural practices (e.g., green manure, no mechanization), consistently with national and local laws, and cooperating with the Biofuels Division of the Senegal Ministry of Energy and Biofuels.

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Roles/responsibilities:

ANOC is the project proponent and managing entity. ANOC will manage the project activity (like agricultural operations e.g., sowing, fertilizing) and the monitor activities.

1.4 Other Entities Involved in the Project

Agroils Technologies s.r.l.

Agroils Technologies s.r.l. has been formed to provide technical assistance to Jatropha producers. Today Agroils is the European leader in Jatropha consultancy and it is a promoting partner of the Jatrophabook ONLUS, the most important stakeholders’ platform in the sector. Agroils has developed a strong network with top research institutes (IFEU, Hohenheim, Wageningen) and is an active player in the international debate on sustainability (GBEP, RSB). In

addition, recently Agroils has become operational as a technical consultant in the carbon sector both for voluntary and mandatory initiatives, with special focus on biofuels and AFOLU projects.

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Roles/responsibilities:

The role of Agroils Technologies s.r.l. is to give technical consultation for the project.

CarbonSinkGoup s.r.l

Carbon Sink Group s.r.l. is a specialized consultancy company dealing with the environmental preservation and management. Thanks to the recognition as Academic Spin-Off by the University of Florence and the professional background of its team, Carbon Sink Group is focused on projects aimed to the reduction and offsetting of the greenhouse gas (GHGs) emission in the atmosphere.

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Roles/responsibilities:

The role of CarbonSinkGroup s.r.l is to give technical and scientific consultation in the phase of preparation of the project design document, validation, monitoring and verification as well as on commercializing the produced credits.

1.5 Project Start Date

The starting date of the project is 03 June 2009.

The evidence of the provided starting date is assured by attached documents on land property [see the enclosed Land property acts & land use rights[1]] as well as with the receipts of the seed purchase and labour payments[2].

1.6 Project Crediting Period

The project crediting period will be 24 years and 06 months. The crediting period starting date is 03 June 2009 and the ending date is 31 December 2033.

1.7 Project Scale and Estimated GHG Emission Reductions or Removals

Project	x
Large project	

Years	Estimated GHG emission reductions or removals (tCO_2e)	
	First project instance	Whole grouped project
03/06/2009-02/06/2010	-289	-713
03/06/2010-02/06/2011	26	26
03/06/2011-02/06/2012	73	73
03/06/2012-02/06/2013	222	223
03/06/2013-02/06/2014	865	877
03/06/2014-02/06/2015	2,071	2,086
03/06/2015-02/06/2016	3,726	3,832
03/06/2016-02/06/2017	5,633	5,928
03/06/2017-02/06/2018	6,349	7,004

[1] Land property acts & land use rights, Republic of Senegal 2009.
[2] Receipts_Starting_date

03/06/2018-02/06/2019	5,313	6,578
03/06/2019-02/06/2020	3,175	5,103
03/06/2020-02/06/2021	928	3,463
03/06/2021-02/06/2022	0	2,948
03/06/2022-02/06/2023	0	2,986
03/06/2023-02/06/2024	0	2,843
03/06/2024-02/06/2025	0	2,500
03/06/2025-02/06/2026	0	2,058
03/06/2026-02/06/2027	0	1,889
03/06/2027-02/06/2028	0	1,583
03/06/2028-02/06/2029	0	1,078
03/06/2029-02/06/2030	0	370
03/06/2030-02/06/2031	0	0
03/06/2031-02/06/2032	0	0
03/06/2032-02/06/2033	0	0
03/06/2033-31/12/2033	0	0
Total estimated ERs	28,091	52,735
Total number of crediting years	24.5	24.5
Average annual ERs	1,147	2,152

1.8 Description of the Project Activity

The proposed project activity aims to plant 1411.34 ha of Jatropha curcas in the Fatick, Kaolack and Kaffrine regions within the context of central-western part of the Senegal. The plantations of the first project instance i.e. the areas which are to be validated in this PD were made within the years 2009-2011 (total 574.34 ha) following the work plan [see the enclosed Work Plan 1 and Work Plan 2[3]]. In addition to the first project instance it is foreseen additional 837 hectares to be planted by the year 2020 as presented in the table 1. Plantation establishment and management are described also below. The proposed agro-forestry system will assure a proper management of trees in cultivated lands allowing the carbon storage by plants biomass and soils, consequently providing a contribution to the greenhouse effect mitigation and the reversal of soil degradation trend. The lifetime of the project activity will be 25 years. More precise description of the Jatropha curcas species is presented in a separate document "Description of Jatropha curcas L.[4]

[3] Work Plan 1 and Work Plan 2, ANOC 2012.
[4] Description of Jatropha curcas L, CarbonSinkGroup 2013.

Figure 1. Jatropha saplings in a uncultivated plot in 2009 (Author: A. Madani)

Figure 2. The same plot showed in figure 1 above, photographed in 2011 (Author: A. Madani)

Table 1. Foreseen planting area

Planting year	Area planted
2009	48.16
2010	241.25
2011	284.93
2012	67
2013	80
2014	90
2015	100
2016	100
2017	100
2018	100
2019	100
2020	100
Total	1411.34

Plantation Establishment

Preamble

Jatropha curcas produces seeds that can be processed into non-polluting biodiesel that, if properly exploited, can provide opportunities for fair incomes and rural development.

The production of Jatropha seeds can assist local farmers to diversify their incomes whereas its by-products (i.e., husks and press cake) can be composted and used as fertilizers or can substitute the harvested fuel-wood (i.e., currently used for cooking and charcoal production).

The introduction or mixture of woody perennials with agricultural crops or pastures, will overcome the competition with food crops; on the other hand the proposed innovative system will improve the overall productivity of the cultivated lands in the involved area. For example, by boosting the peanut production between the Jatropha rows ANOC could ensure additional incomes for the locals as well as to enhance the soil fertility in the project area.

The agro-forestry scheme would consist in a mixed-system based on the integration of trees into farms. There will be no disturbances for the plantation area because the proposed system will be based on minimal quantities of fertilizers (i.e., Urea, Manure, 10-10-20 fertilizer and no machinery). The existing non-tree vegetation will be slashed manually along the land form contour while, accordingly to the national laws, all the existing trees will not be removed from the site preparation.

The Jatropha curcas cultivation will occur by pre-growing of seedlings in dedicated nurseries and direct planting. This plant needs little care and relatively low water requirements; moreover, this species is easily adaptable to marginal areas and moderate regimes of rush. The species by-products, such as husks and press-cake, after a preliminary treatment, will be used as organic fertilizers or for biomass energy production. Furthermore, an optimization usage of current food

crops and practices will be pursued in order to enhance soil conservation (e.g., introduction of nitrogen fixing crops).

All the maintenance activities (i.e., weeding, pruning and fruit harvesting) will be conducted manually by local farmers hired, expressly employed by project participants.

Site selection

Project sites are selected according to the basic environmental requirements and local soil properties to achieve an optimal growth of the selected species (Jatropha curcas).

Figure 3. Jatropha curcas site selection and measurement (Author: L. Galbiati)

Nursery preparation

The saplings used during reforestation and enrichment operations are produced in nurseries; in particular, they derive from seeds of local origin. If possible, a part of seeds produced in the nurseries of the first plots will be used to manage the following ones. It will take 3-6 months to have some saplings from the seeds planted in a nursery. The production of Jatropha curcas seeds starts rapidly in 8-10 months and usually reaches maturity after 5 years, after which the production remains stable for 20-30 years.

Basically, nursery practices will produce saplings through a method based on saplings in seedbeds previously prepared in the soil; each local family, inhabiting the villages involved in the project area, can manage approximately 4,000 seeds. These local communities are organized in cooperatives dealing with a nursery each, near villages and water sources. For this reason, in each nursery it was planned the growth of 25% of plants more than the amount necessary to the capacity of related plots; thus, the project participants will be able to replace promptly all the dead trees.

Figure 4. Jatropha curcas nursery (Author: L. Galbiati)

Figure 5. Jatropha curcas saplings in a nursery (Author: L. Galbiati)

Site preparation

A few small shrubs (i.e., Nguer, Kinkeliba) have already been slashed manually due on site preparation. The soil preparation process will use only manual devices and instruments (such as hoes, machetes, spades, shovels, rakes, and pickaxes) by local people whose work will be supervised by staff members of project participants. Any pre-existing tree (with diameter > 12 cm) present in the plantation area will be left in place accordingly to the national law; however, in the selected plots the baseline tree cover is far less than 6 % (i.e., approximately 5 trees/ha) (see for example figure 3 and 19). The planting activity will take place after the first rain, digging a hole for each seedling and then covering it with the soil.

Planting and fertilization

Jatropha trees are planted in rows. The marking activity is done accordingly to the triangle system, in alternating rows, and by using ropes. In the first project years plots had a distance of 2x2 m between saplings (maximum of 2,500 trees/ha), or distance of 3x2 m (maximum of 1,666 trees/ha). Later also distances of 3x3 m 4x3 m and has been applied (maximum of 1,111 trees/ha or 833 trees/ha, respectively). The distances of 3x3 and 3x4 m were found as the optimal space to be maintained between the saplings. On top of that, planting locations are marked through pits to support the rapid establishment of trees.

The survival rate of trees will be taken into account and will be measured six months after planting, during the first three years from the starting date of the planting activity, to replace dead or diseased trees as well as ensure a survival rate around 95%.

Prior to the planting, an inspection of each sapling root system is performed in the nursery. Insufficiently developed plants are removed and others are pruned if necessary. Upon planting, the soil surrounding the base of each sapling is compressed to avoid the root death possibly caused by air pockets. Moreover, the planting activity is carried on, early in the morning or late in the afternoon, to reduce the effects of sun-related stress on the newly planted saplings. For the same reason, when possible, the planting is carried out during cloudy days.

They are three teams working during the above mentioned operations:

First team	They dig a hole and they dispense the specific product against the nematodes, then mix with the original soil
Second team	After one week, women teams set the saplings and then cover them with the soil
Third team	Within one month, they deposit the manure and urea

The fertilization plan is expected to be as presented here below (for each plant):

(a) at the time of relocation, there will be placed both urea and 800 g of pulverized manure;
(b) at the end of the first year, there will be added both urea and 800 g of pulverized manure;
(c) from the third year onward, it will be used a fertilizer following the rule of 10-10-20 ratios (10% Nitrogen - 10% Phosphorus - 20% Potassium) as well as 800 g of pulverized manure, to be given once a year during the raining season.

Provisions will be arranged to protect the plantations against the risk of wild fire. Moreover, there will be implemented occasional initiatives against the grasshoppers, quite widespread in this area. On this purpose, training courses will be provided to villagers in order to enforce these practices effectively on their plantations.

Plantation Maintenance

Weeding

During the first three years, the project participants will weed the plantation twice a year. The weeding will be carried out manually (i.e., using a machete) whereas once a year a 1 m radius circle area will be cleared around seedlings and then will be fertilized. The practice of weeding is very important in the first few years after the plantations establishment in order to reduce the competition from weeds, which are usually better adapted to the local environments than the newly established seedlings; after the first three years the wedding is useless and, consequently, will no longer be performed.

Figure 6. Weeding activity (Author: L. Galbiati)

Pruning

The pruning is practiced once a year from the second year onward. It will be performed differently according to the requirements of the growing stage of each tree. While pruning requires experience and is site-specific, a range of common criteria are analyzed before pruning. These criteria include different features of individual trees such as age, crown size, health, branch diameter, and diameter of the stem where lateral branches are growing out from the trunk. The biomass derived from the pruning will be left on the land in case the fire risk mitigation doesn't require removing. The quantities of wood material deriving from the pruning will be around the following data: 1 kg/tree in the second year, 5 kg/tree in the third year, 10 kg/tree from the fourth year onward.

Fruit harvesting

The fruit harvesting will be carried out manually by the local villagers. The Jatropha curcas plant is a rapidly maturing species which produces seeds from the first year of age. The harvesting will start from the third year. The harvesting plan is presented below in the table 2.

Table 2. The prevision of the harvesting plan.

Intervention year	Harvesting prevision
3rd year	0.5 kg
4th year	1.5 kg
5th year	2.5 kg
6th year and the following years	3.5 kg

Figure 7. Jatropha curcas fruits (Author: L. Galbiati)

Figure 8. Jatropha curcas fruits after harvesting (Author: L. Galbiati)

Forest establishment and management organization

There are 20 villages involved in the proposed project (Table 3), even the plantation plots are actually located in the territory of only six villages. All the 20 villages (with total population of approximately 7,000 people) are providing hand-workers for the management of nurseries and plots. As presented in the graphic below (Figure 9), ANOC is the project supervisor and manager who will hire around 100 people to be directly employed by the project for the entire year (every person will have around 6 ha area). Moreover, in the period between June and September almost all the women of the 20 villages are employed due on planting and fertilizing activities, thus reaching more than 500 hand-workers employed by the project. These local workers have daily employment contracts and are organized in cooperatives. Moreover, there will be a separate “research and development unit”, an Italian entity, who will periodically control the reforestation functions like nurseries and planting sites and who will be called for help also in case of specific situations like plant diseases or invasion of pests.

Table 3. Population and households of the Ourour and Kaffrine rural community

	Villages	Population	Number of households (place where a group of relatives lives together)
1	OUROUR SINTHIE	484	83
2	MAKA SOUMBEL	229	29
3	SOUMBEL GALLO NDIAYE	158	19
4	SOUMBEL MISSION	293	39
5	COLOBANE SOUMBEL	273	30
6	GOWETHE SERERE	723	76
7	GOWETHE WADENE	332	37
8	KEUR MIGNANE	385	30
9	MANDE KEUR DIEGANE THIARE'	413	48
10	KEUR MBISSANE	111	11
11	KEUR DIEGANE DIOP	77	12
12	COLOBANE LAMBAYE	680	68
13	OUROUR NDIODO	105	21
14	OUROUR KADA 1	165	29
15	OUROUR KADA 2	312	47
16	NDIOTE MOR	808	115
17	DIANKE KAW	845	120
18	NDIOTE BIRAME	295	57
19	DELBY	223	28
20	NDIOLOFENE	415	64
	TOTAL POPULATION	7.326	963

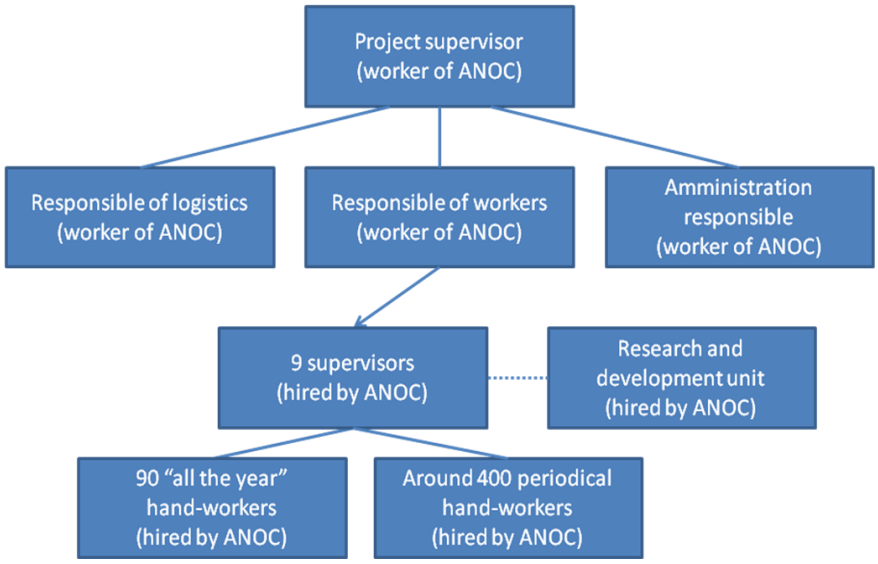

Figure 9. Organization structure of the project management

The project will include specific training courses for local farmers focused on Jatropha curcas cultivation, sustainable agricultural and forest management practices. Furthermore, a comprehensive illustrated guidebook on agricultural and forest management practices will be issued, printed and distributed among local stakeholders (i.e., farmers and representatives in schools and villages).

Figure 10. Explanation of technical methods to the local workers (Author: L. Galbiati)

1.9 Project Location

The grouped project boundary will be the regions of Fatick, Kaolack and Kaffrine (Figure 11). All the project activity instances will be within these regions.

Figure 11. Regions of Senegal (source: Wikipedia, 2013[5])

All the plantation plots of the first project instance are located in the vicinity of the major cities of Ourour and Kaffrine, within regions of Fatick, Kaolack and Kaffrine (figure 12 and table 4). More detailed boundary of the first project instance is presented in separate files in Google Earth KML format[6].

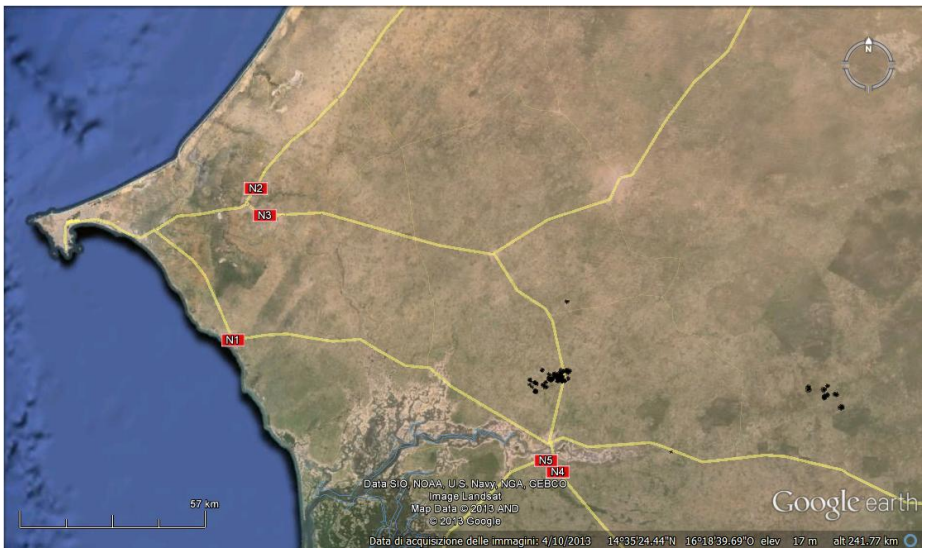

Figure 12. Location of the project site (source: Google Earth 12/09/2013)

[5] Wikipedia, 2013: http://en.wikipedia.org/wiki/File:Regions_of_Senegal.svg. Site visited 17/04/2013.
[6] KML_Plantations_2009_2010_2011.

Table 4. Project area plots of the first project instance

Name	Location (Region)	Area (ha) and planting year		
		2009	2010	2011
OUROUR FORAGE 19	Fatick	9.13		
OUROUR CADA 20	Fatick	3.12		
OUROUR CADA 21	Fatick	8.60		
OUROUR CAMARA 24	Fatick	1.71		
OUROUR CAMARA 25	Fatick	17.33		
KEUR MIGNAN 12	Kaolack	1.35		
KEUR MIGNAN 13	Kaolack	3.03		
KEUR MIGNAN 14	Kaolack	2.65		
NAWEL 1	Kaolack	1.24		
OUROUR 1	Fatick		4.97	
OUROUR 2	Fatick		3.57	
OUROUR 3	Fatick		6.32	
OUROUR 4	Fatick		5.03	
OUROUR 5	Fatick		9.84	
OUROUR 6	Fatick		33.35	
OUROUR 7	Fatick		14.25	
OUROUR 8	Fatick		3.05	
COLOMBANE 2	Fatick		5.75	
SOUMBEL 1	Fatick		13.01	
SOUMBEL 2	Fatick		6.65	
SOUMBEL NUOVO 3	Fatick		3.25	
COLOMBANE 1	Fatick		2.95	
COLOMBANE NUOVO 3	Fatick		3.64	
KEUR DIEGANE 1	Fatick		1.94	
KEUR DIEGANE 2	Fatick		5.90	
KEUR DIEGANE 3	Fatick		4.75	
KEUR MIGNAN 2	Kaolack		1.93	
OUROUR 22	Fatick		2.05	

NDIOTE MOR 1	Kaffirine		33.48	
NDIOTE MOR 2	Kaffirine		12.75	
NDIOLEFENE 1	Kaffirine		19.36	
DELBY 1	Kaffirine		24.80	
DIANKE KAO 1	Kaffirine		17.66	
OUROUR CRISE 10	Fatick			26.36
OUROUR VIRAGE BAC 15	Fatick			1.55
OUROUR ROUTE DE GAGNIK 16	Fatick			4.16
ROUTE DE SOUMBEL 1	Fatick			6.63
ROUTE DE SOUMBEL 2	Fatick			0.43
ROUTE DE SOUMBEL 3	Fatick			16.64
ROUTE DE SOUMBEL 4	Fatick			2.51
ROUTE DE SOUMBEL 5	Fatick			2.71
OUROUR 13	Fatick			28.43
OUROUR 14	Fatick			3.58
MAKA SOUMBEL 1	Fatick			3.24
MAKA SOUMBEL 2	Fatick			6.68
SOUMBEL GALLO 1	Fatick			2.96
SOUMBEL GALLO 2	Fatick			3.88
SOUMBEL GALLO 3	Fatick			2.19
SOUMBEL GALLO NEW 4	Fatick			2.74
GOWETHE SERERE 1	Fatick			1.98
GOWETHE SERERE 3	Fatick			5.64
COLOBANE 4	Fatick			12.00
KEUR MIGNANE DIOP 5	Kaolack			4.80
KEUR DIEGANE NEW 7	Fatick			2.42
KEUR MIGNANE 4	Kaolack			0.95
KEUR MIGNANE 6	Kaolack			1.88
GOWETHE WADENE 1	Fatick			4.84
KEUR MIGNANE 7	Kaolack			2.89
KEUR MIGNANE 8	Kaolack			0.36
KEUR MIGNANE 9	Kaolack			0.46
KEUR MIGNANE 10	Kaolack			0.83

TEOWROUCOSOM 1	Fatick			10.28
DIANKE SOUF 1	Kaffrine			40.01
DELBY 2	Kaffrine			25.17
NDIOTE MOR ENTREE 1	Kaffrine			24.61
NDIOTE MOR ENTREE 3	Kaffrine			10.97
NDIOLOFEME 2	Kaffrine			12.40
NDIAAW NEW 1	Kaffrine			7.75
Total area (ha)		**48.16**	**241.25**	**284.93**

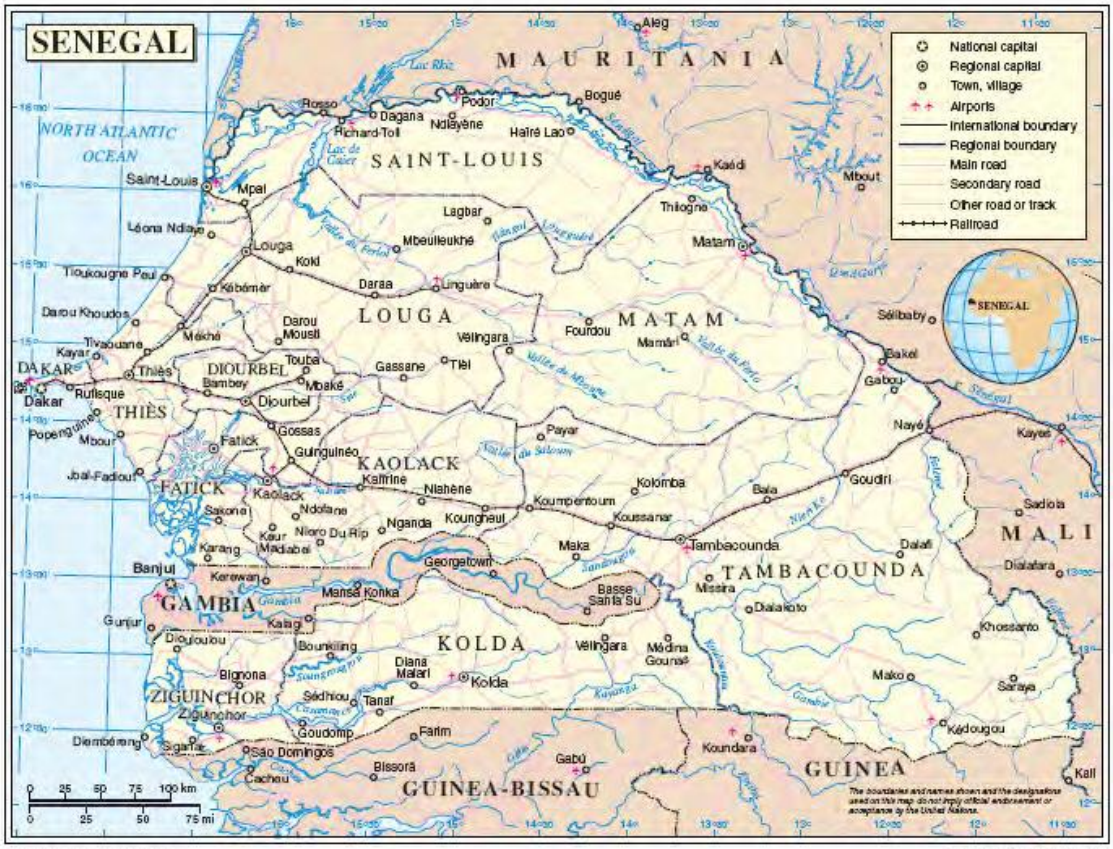

Figure 13. Political map of Senegal (source: UN, 2004[7])

[7] http://www.un.org/Depts/Cartographic/map/profile/senegal.pdf (Site visited 22/04/2013)

1.10 Conditions Prior to Project Initiation

The project area is located in the most degraded zone of the whole country of Senegal. The areas selected to be planted are currently mostly not utilized by the farmers because they are located mostly far away from the villages and are not easily accessible. Anyhow of the isolated location some of areas has been utilized previously for cultivating peanuts, which is a common cultivation type expanded in the Peanut Basin largely already in the 1950s and 1960s. In fact, the Peanut Basin has witnessed a nearly complete transformation of its landscapes during the last 150 years caused by the continuous cultivation activities which have replaced in many parts the vestiges of the natural vegetation. Also the major droughts occurred at the 1970s and 1980s changed significantly the vegetation cover of this area. [8,9] The Peanut Basin was named as one of the areas suffered the most from environmental degradation in Senegal already in the end of the 1980s[10]. Early aerial photographs from the 1930s and 1940s published by Tappan et. al (2004) [11] can provide a glimpse of the original agricultural landscapes found in Peanut Basin that included patches of diverse vegetation cover and traditional bush fallow.

The general landscape transformation described above has occurred also in the project area already 10 year before the project start date[12]. Therefore, it is clear that project areas were not cleared of native ecosystems to create GHG credits as required by the VCS AFOLU Requirements[13]. Moreover, during the site selection it was also confirmed that the project lands did not contain forest at the start of project activities and that the site were either not temporarily unstocked i.e. that the area would have been expected to revert back to a forest. In general, local unused agricultural land (after more than 20 years) is characterized by extremely scarce vegetation. Tree vegetation includes species locally known as Baobab, Kadd, Dimb, Ngui-gis, Sump, Olom, and Loucena. No rare or endangered species were identified in the project site[14].

For the first project instance the baseline tree cover has been estimated to be approximately 5 trees/ha in each plantation plot which it's estimated conservatively to be equal to 1 % crown cover (assuming a mean crown cover of one tree to be 10 m^2). The baseline tree crown cover estimation is based on an ocular estimation made during the site selection procedure[15]. Also the

[8] Tappan G.G., Shall M., Wood E.C. and Cushing M. 2004. Ecoregions and land cover trends in Senegal. Journal of Arid Environments 59, pp. 427-462. http://www.sciencedirect.com/science/article/pii/S0140196304000783#
[9] Tschakert, P. 2001. Human Dimensions of Carbon Sequestration: A Poltical Ecology Approch to soil Fertility Management and Desertification Control in the Old Peanus Basin of Senegal. Aridlands Newsletter, No. 49. May/June 2001. http://ag.arizona.edu/oals/ALN/aln49/tschakert.html (site visited 22/07/2013)
[10] Golan, E.H. 1990. Land Tenure Reform in Senegal: An Economic Study from the Peanut Basin. Land Tenure Center. University of Wisconsin-Madison. January 1990. http://pdf.usaid.gov/pdf_docs/PNABF005.pdf
[11] Tappan G.G., Shall M., Wood E.C. and Cushing M. 2004. Ecoregions and land cover trends in Senegal. Journal of Arid Environments 59, pp. 427-462. http://www.sciencedirect.com/science/article/pii/S0140196304000783#
[12] Landsat_1999
[13] VCS AFOLU Requirements: VCS Version 3. http://v-c-s.org/sites/v-c-s.org/files/AFOLU%20Requirements%20v3.3_0.pdf
[14] Mbow C, Mertz O, Diouf A, Rasmussen K, Reenberg A (2008). The history of environmental change and adaptation in eastern Saloum – Senegal. Driving forces and perceptions. *Global and Planetary Change*, 64: 210-221
[15] This is in accordance with the used tool: "Considering that the biomass in trees/shrubs in the baseline is smaller compared to the biomass in trees in the project, a simplified method of measurement may be used for estimating tree/shrub crown cover. Ocular estimation of tree/shrub crown cover may be carried out or any other method such as the line transect method or the relascope method may be applied."

shrub crown was estimated preliminary during the site selection procedure to be, depending the plantation plot, between zero to 20 %. The biggest shrub crown covers (> 10%) where all observed in the Kaffrine Region. For plantation areas located in the regions of Fatick and Kaolack the maximum observed shrub crown cover was 10 %. Both the tree crown cover and shrub cover were re-confirmed from the Google Earth imagines taken before the project start date. For this matter the satellite imagines mainly taken from 2003-2007 were studied as more resent imagines (for the period before the project start) were not available. The use of the imagines from the years 2003-2007 can be justified as the land use changes in the area has been estimated to be non relevant. The minimal changes in land use during the last years is evident also when comparing the areas outside the plot borders in the attached document "Google_Earth_imagines_ for_baseline_and_ current_situation"[16].

A 20 m x 20 m grid were overlaid on top of the imagines to facilitate the cover estimation process. Below is presented as example few of the imagines with the grid overlay (figures 14-16). All the Google Earth imagines used for the baseline estimations of the project as well as the estimated coverage percentages for each plots are available for the validation[17].

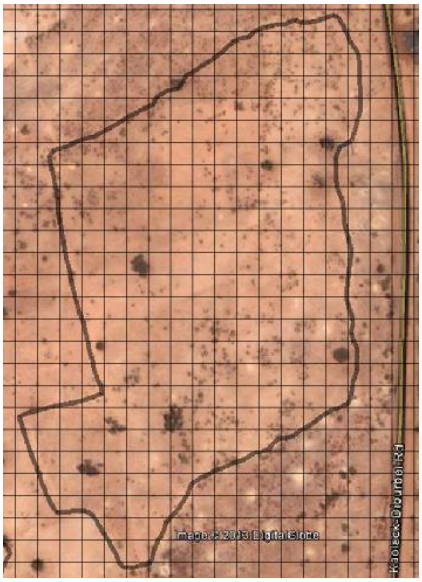

Figure 14. Ourour Forage 19 (9.13 ha):
baseline tree crown cover 1 %, baseline shrub cover 3 %.

[16] Google_Earth_imagines_for_baseline_and_current_situation
[17] See the separate documents "Google_Earth_imagines_for_baseline_and_current_situation" and "Baseline tree and shrub cover_estimates"

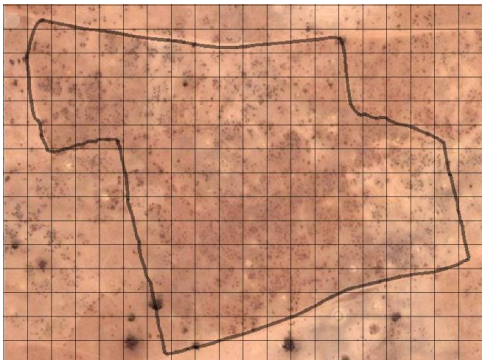

Figure 15. Colombane 2 (5.75 ha):
baseline tree crown cover 0.2 %, baseline shrub cover 7 %.

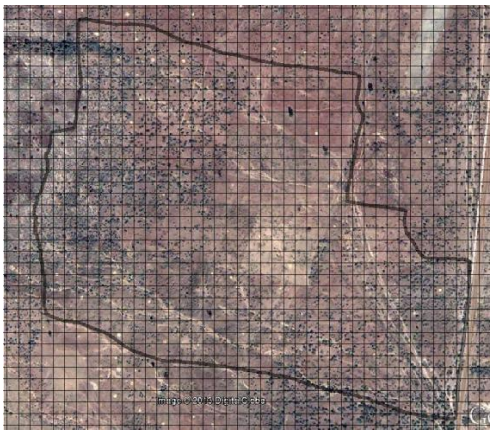

Figure 16. Ndiote Mor 1 (33.48 ha):
baseline tree crown cover 0.2 %, baseline shrub cover 17 %.

As conclusion of the above described estimation procedure the following baseline tree crown and shrub cover stratums has been identified for the first project instance:

	Area (ha)	Baseline cover (%)
Tree crown cover	574.34	1 %
Shrub cover	344.38*	max. 10 %
	229.96**	max. 20 %

*Plantation of the first project instance in Fatick and Kaolack Regions
**Plantations of the first project instance in Kaffrine Region

For the new project instances the tree crown cover and shrub cover will be confirmed before starting the planting. For the *ex ante* calculations it is estimated that all the project area would have the similar baseline cover as the first project instance (i.e. tree crown cover 1 % for all the

area, maximum shrub cover of 10 % for 60.0 % of the area and maximum shrub cover of 20 % for 40.0 % or the area.

At present, shifting cultivation is the only agricultural method used in the geographic area. Plots of land are farmed during the rainy season with food crops (e.g., millet, maize, peanuts) and then abandoned for quite long periods to restore their fertility. At the end of fallow period (called jachère) the vegetation is cleared and then cultivated again. In addition, natural fires may occur.

The lands selected for the project activity are legally assigned to ANOC. The selection of the project lands was made in way to guarantee the continuation of the production of food and other traditional agricultural products (e.g., peanuts) as usual in the baseline scenario. In fact, ANOC bought only maximum 25 % of each land owner's lands. Therefore, it could be ensured that for each farmer remained lands for cultivation of food crops. Moreover, the areas chosen for the project activity were the areas least utilized by the locals.

The main events over the project initiation stage, after the land acquisition, have been the site selection for nursery and planting activities as well as the nursery and site preparations. Initial phases have also included communication with different stakeholders and training activities for the local workers.

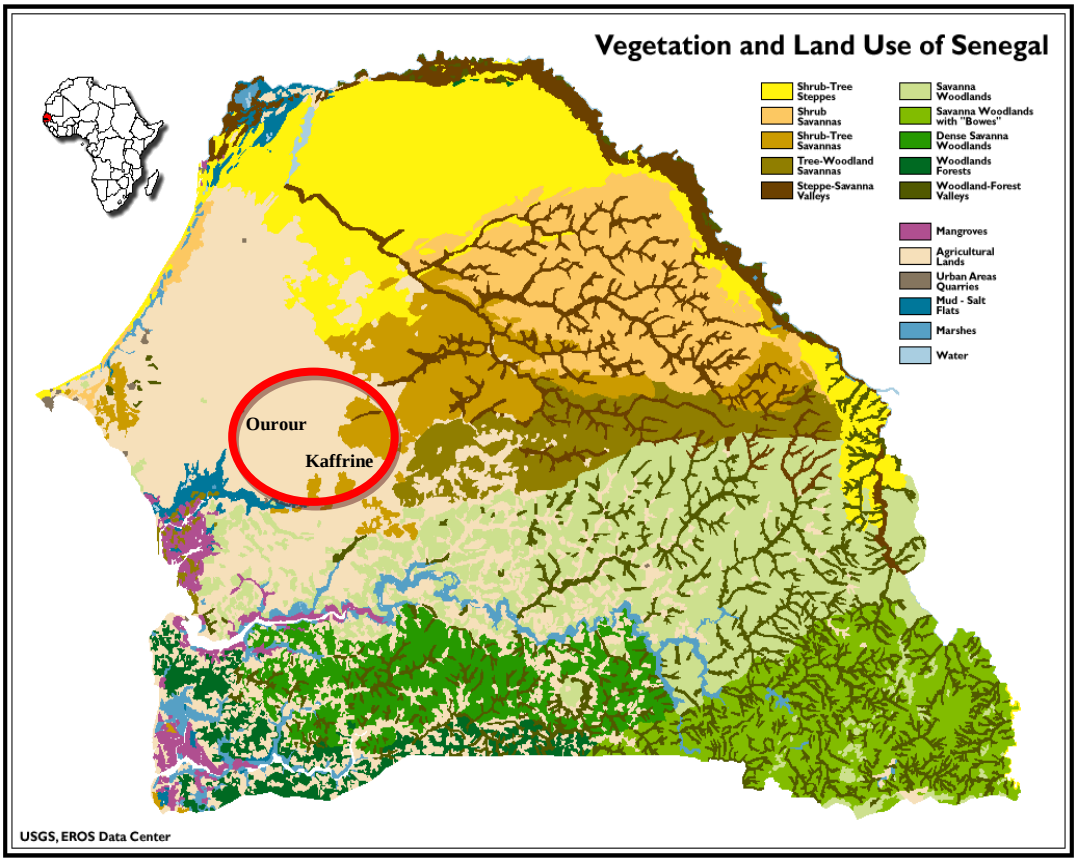

Figure 17. Map of vegetation and land use of Senegal
(source: USGS/EROS 2006; Senegal Biodiversity and Tropical forest assessment, USAID 2008).

Figure 18. Map of main agricultural macro-areas of Senegal
(source: http://www.isra.sn).

Figure 19. Typical landscape of the region (Author: L. Galbiati)

Project was not implemented for subsequent GHG reductions, removal or destruction

The Project Proponent declares this project was not implemented to create GHG emissions for the purpose of their subsequent reduction, removal or destruction. A project identification note was written before the project start, thus clearly demonstrating that GHG revenues (i.e., income due carbon credit marketing) were accounted before the implementation of the initial project plan. The long term funding of the project is totally dependent on the revenue stream provided by a long-term tree growth.

1.11 Compliance with Laws, Statutes and Other Regulatory Frameworks

Currently no laws and regulations prevent or enforce the project activity or baseline land use scenarios. Laws and regulations do not prevent or prescribe either agriculture and cattle breeding in the project area, nor forest conversion. More specifically, in compliance with the Senegal's Forest Policy for the years 2005-2025[18] there are not any laws or regulations which would force the forestation activities to be implemented. Neither the National Biofuel Programme from 2007[19] or the biofuel law from 2010[20] is forcing the biofuel plantations to be implemented.

The aim of the National Biofuel Programme as well as the biofuel law 22-2010 is to promote sustainable production of biofuels, enhance the fuel independency of Senegal and foster rural and agricultural development taking in the consideration anyhow always also the food security and the social and environmental protection. The proposed project activity in consistent with these aims as it produces biofuels for domestic market in sustainable way, creates working possibilities for local people and secures the food security by the site selection and allowing the food crop cultivation between the Jatropha rows.

The proposed project is also in compliance with directions set for the "Peanut Basin" in the National Forest Policy[21] as it introduces agroforestry activities in a degraded land and affects positively to both to the soil restoration as well as to the welfare of the local population.

In relation to Annex I and II of the Government Decree N° 2001 – 282 dated 12 of April 2001 Containing the Application of the Environmental Code and according to the Law Nº 2001 – 01 dated 15 of January 2001 Containing the Environmental Code, there was no need to perform an Environmental Impact Assessment before starting the project. In fact, the regulation concerning the performance of an environmental impact assessment was only introduced in Senegal in 2010, after the project starting date. Moreover, the project has got endorsement from the Ministry of Environment[22].

1.12 Ownership and Other Programs

1.12.1 Right of Use

ANOC has concessions for the project lands and will be the owner of Jatropha plants and products. The unused fallow agricultural land, where Jatropha will be grown, were legally assigned to ANOC for 25% of the available agricultural land, hence ensuring to continue to produce both food and traditional agricultural products (e.g., peanuts) as usual in the baseline scenario.

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[18] Politique Forestiere du Senegal 2005-2025, Rèsumè Exècutif. Ministere de l'environnement et de protection de la nature, Republic du Sengal, 2005.
[19] Ministere du Developpment Rural et de L'Agriculture. 2007. Programme special Biocarburants. http://www.compete-bioafrica.net/policy/070801-Programme%20National%20Biocarburants.pdf
[20] Loi n° 2010-22 du 15 décembre 2010 portant loi d'orientation de la filière des Biocarburants.Available from http://www.jo.gouv.sn/spip.php?article8920 (Site visited 07/08/2013)
[21] Politique Forestiere du Senegal 2005-2025, Rèsumè Exècutif. Ministere de l'environnement et de protection de la nature, Republic du Senegal, 2005.
[22] Letter_of_Endorsement_from_the_Envoronmental_Ministry_of_Senegal

In the project areas located in Fatick and Kaolack regions the lands are owned by single private persons which have given the land in concession for ANOC through the rural council. In these areas there is a possibility to convert the concession in the future to a permanent land property title. Instead in the area of Kaffrine the project lands are owned by the government of Senegal which have given them to concession to ANOC through the rural council in accordance with the local families which were having the use rights of the lands before the concession.

See the enclosed Land Property Acts & Land Use Rights[23] and the clarifications made for the first project instance[24].

1.12.2 Emissions Trading Programs and Other Binding Limits

The Project Proponent declares that net GHG emission reductions or removals generated by the project will not be used for compliance with an emissions trading program, or to meet binding limits on GHG emissions.

1.12.3 Participation under Other GHG Programs

The Project Proponent declares the project has not been registered, nor is seeking registration under any other GHG programs.

1.12.4 Other Forms of Environmental Credit

The Project Proponent declares this project does not create another form of GHG-related environmental credit for GHG emission reductions or removals claimed under the VCS Program, or that any such credit has been, or will be, cancelled from the relevant program.

1.12.5 Projects Rejected by Other GHG Programs

The Project Proponent declares this project has not been rejected by any other GHG programs.

[23] Land property acts & land use rights, Republic of Senegal 2009.
[24] Clarification_for_the_first_project_instance

1.13 Additional Information Relevant to the Project

Eligibility Criteria

The eligibility of the new project activity instances, as part of the grouped project, is demonstrated in accordance with the paragraph 3.4.9 of the VCS Standard. All the new instances needs to:

1) Meet the following applicability conditions set out in the methodology applied to the project:

	Justification for the first project instance
a) The land subject to the project activity does not fall in wetland category.	The first project instance does not include wetlands as evident by the recent satellite imagines[25].
b) Soil disturbance attributable to the afforestation and reforestation (A/R) project activity does not cover more than 10% of area in each of the following types of land, when these lands are included within the project boundary: i. Land containing organic soils; ii. Land which, in the baseline, is subjected to land-use and management practices and receives inputs listed in appendices 1 and 2 of the methodology.	Project activities doesn´t include ploughing, ripping or scarification as described section 1.8. Moreover planting will be made digging only a small hole of some centimeters for each seedling. Therefore soil disturbance attributable to the project activity does not cover more than 10% of the project area.
c) A project activity shall also comply with the applicability conditions of the tools contained within the methodology and applied by the project activity: • The forestation activity is not violating any applicable law • The project activity is applying the AR-	The demonstration related to the applicability conditions are described in section 2.2.

[25] Google_Earth_imagines_for_baseline_and_current_situation

ACM0003 "A/R Large-scale Methodology: Afforestation and reforestation of lands except wetlands" • For the purpose of accounting/not accounting the soil organic carbon (SOC) it is clarified for each new instance if litter is removed or kept on site • Non-CO2 GHG emissions resulting from any occurrence of fire within the project boundary shall be accounted for each incidence of fire which affects an area greater than the minimum threshold area reported by the host Party for the purpose of defining forest, provided that the accumulated area affected by such fires in a given year is ≥5% of the project area • Total area subjected to pre-project crop cultivation activities to be displaced is less than 5% of the area of the entire A/R project activity • Total area subjected to pre-project grazing activities to be displaced is less than 5% of the area of the entire A/R project activity, or less than 50 ha	

2) Use and apply the site preparation, plantation and maintenance technologies as specified in the project description:

- The methodology AR-ACM0003 is followed in full (except than requirements related to the definition of forest) and its application is not negatively impacting the conservativeness of the quantification of GHG emissions reductions or removals (For ensuring that the CDM A/R methodology can be applied for the new instances).

- Both the tree crown cover and shrub cover will be estimated before starting the planting (For ensuring the correct baseline information for estimating carbon stock in baseline trees and shrubs).

- The baseline tree crown cover is less than 6 % i.e. less than 20 % of the threshold crown cover reported by Senegal, 30 % (For ensuring that the "Baseline default method" can be used for estimating the carbon stock change in trees).

- Any pre-existing tree with diameter > 12 cm present in the plantation areas will be left in place (For ensuring that the condition for not accounting for changes in baseline tree carbon stock is fulfilled).

- The plantations will be made with Jatropha curcas (For ensuring the same plantation technology).

- The planting activity will be made manually by digging a small hole of some centimetres for each seedling and then covering it with the soil (For ensuring the same plantation technology).

- The separate plantation areas are greater than 0.05 hectares (For ensuring that the VCS definition of revegetation is fulfilled).

- During the first three years from the starting date of the planting activity the dead or diseased trees we'll be replaced to ensure a survival rate of around 95% (For ensuring the same plantation technology).

- Fire is not used in site preparation and/or to clear the land of harvest residue prior replanting of the land (For ensuring that increase in non-CO_2 GHG emissions within the project boundary as a result of the implementation of the A/R project activity ($GHG_{E,t}$) can be accounted as zero in case there will not be wild fires).

3) Are subject to the baseline scenario "continuation of the pre-project land use" and geographic area of the regions of Fatick, Kaolack and Kaffirine in Senegal.

4) Have characteristics with respect to additionality that are consistent with the initial instances i.e. the new instances face the same investment and technological as the initial instances.

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Moreover, to evaluate each eligible polygon added to the grouped project, the following activities will be carried out:

- Field observation will be made to learn about vegetation existing in project sites.
- All polygons will be geo-referenced to construct a database in GIS (Geographic Information System) format.
- Interviews will be conducted on the historical use with former farm owners as well as with persons who have resided in the zone for a long time.
- Studies of the zone conducted by ANOC at the time of purchase will be reviewed.
- Information on agro-ecological (e.g., soils, fertility, erosion, etc.) variables in sites within the project's boundaries will be collected.
- Crown cover information on pre-existing woody and non-woody vegetation will be reviewed.

Leakage Management

In accordance with the Priority Action Plan 2006-2010[26] the proposed project aims to reduce the vulnerability of agricultural activities (i.e., fighting against soil degradation, parasites and insects), foster land development and productive investments, increase and diversify farming incomes, diversify energy sources and technologies, combat desertification and preserve fauna and flora.

Under applicability conditions of the applied methodology the only leakage emissions that can occur are the GHG emissions due to displacement of pre-project agricultural activities. Each project activity phase will be conducted with a specific attention to limit potential leakage.

Commercially Sensitive Information

There is not any commercially sensitive information excluded from the public version of the project description.

Further Information

Not applicable.

2 APPLICATION OF METHODOLOGY

2.1 Title and Reference of Methodology

The project will use an UNFCCC approved CDM A/R baseline and monitoring methodology, called AR-ACM0003 "A/R Large-scale Methodology: Afforestation and reforestation of lands except wetlands" (Version 01.0.0).

The methodology is available at UNFCCC website:
http://cdm.unfccc.int/methodologies/ARmethodologies/approved

2.2 Applicability of Methodology

VCS revegetation projects may use CDM afforestation/reforestation methodologies, where:

- The methodology is followed in full, other than requirements related to the definition of forest, and its application shall not negatively impact the conservativeness of the quantification of GHG emissions reductions or removals; and
- Project activities meet the VCS definition of revegetation (noting that it is not required for such projects to result in the creation of a forest).

VCS definition of revegetation "A direct human-induced activity to increase carbon stocks of woody biomass on sites through the establishment of vegetation that covers a minimum area of 0.05 hectares and does not meet the definitions of afforestation and reforestation"[27] is fulfilled as all the plantation areas of the proposed project activity are greater than 0.05 hectares (see table 4). Instead, as some of the plantation areas are smaller than 0.5 hectares (see table 4), the definition of forest set by the DNA of Senegal[28] is not fullfilled, and thereafter the definitions of afforestation and reforestation can't be met.

[26] Poverty Reduction Strategy Paper 2006. IMF Country Report No. 07/316. Available at http://www.imf.org/external/pubs/ft/scr/2007/cr07316.pdf (Site visited 15/01/2013)
[27] http://v-c-s.org/sites/v-c s.org/ files/ Program%20Definitions%2C%20v3.4.pdf
[28] Definition of forest: a minimum tree height of 2 meters, a minimum tree crown cover of 30% and a minimum land area of 0.5 hectares. http://cdm.unfccc.int/DNA/index.html

The proposed project activity fulfills all of the applicability conditions of the methodology AR-ACM0003 (Version 01.0.0) an the used tools:

Applicability conditions of the applied methodology	Justification
• The land subject to the project activity does not fall into wetland category	All the areas included in the project boundary are defined as grasslands and thus they don´t fall into wetland category as demonstrated in section 1.10.
• Soil disturbance attributable to the afforestation and reforestation (A/R) project activity does not cover more than 10 per cent of area in each of the following types of land, when these lands are included within the project boundary a) Land containing organic soils b) Land which, in the baseline, is subjected to land-use and management practices and receives inputs listed in appendices 1 and 2 to this methodology.	Site preparation or other project activities doesn´t include ploughing/ ripping/ scarification as demonstrated in section 1.8 and thus soil disturbance attributable to the project activity does not cover more than 10% of the project area.

Applicability conditions of the applied tools	Justification
"Combined tool to identify the baseline scenario and demonstrate additionality in A/R CDM project activities" [29] • Forestation of the land within the proposed project boundary performed with or without being registered as the A/R project activity shall not lead to violation of any applicable law even if the law is not enforced. • This tool is not applicable to small-scale afforestation and reforestation project activities.	The forestation activity within the project boundary is not violating any applicable law as described in section 1.11. The project activity is a grouped project applying the AR-ACM0003 "A/R Large-scale Methodology: Afforestation and reforestation of lands except wetlands".
"Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities" [30]	N/A. This tool has no internal applicability conditions.
"Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities"[31]	N/A. This tool is not applied as carbon pools in dead wood and litter has not been selected. Moreover, the tool does not have internal applicability conditions.
"Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities" [32]	This tool will be applied for the project plots where all the applicability conditions of the tool are fulfilled. The justification of the

[29] EB 35, Annex 19. http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-02-v1.pdf
[30] AR-TOOL14. http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-14-v3.0.0.pdf
[31] EB 67, Annex 23. http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-12-v2.0.0.pdf

This tool is applicable when the areas of land, the baseline scenario, and the project activity meet the following conditions: a. The areas of land to which this tool is applied: i. Do not fall into wetland category; or ii. Do not contain organic soils as defined in "Annex A: glossary" of the IPCC GPG LULUCF 2003; iii. Are not subject to any of the land management practices and application of inputs as listed in the Tables 1 and 2; b. The A/R project activity meets the following conditions: i. Litter remains on site and is not removed in the A/R project activity; and ii. Soil disturbance attributable to the A/R project activity, if any, is: • In accordance with appropriate soil conservation practices, e.g. follows the land contours; • Limited to soil disturbance for site preparation before planting and such disturbance is not repeated in less than twenty years.	fulfilment of the applicability conditions for the new project instances is given during each verification. For the first project instance the applicability condition b. i. is not fulfilled as litter has been removed from the project site during the first project years.
"Estimation of non-CO_2 greenhouse gas (GHG) emissions resulting from burning of biomass attributable to an A/R CDM project activity" [33] • The tool is applicable to all occurrence of fire within the project boundary. • Non-CO_2 GHG emissions resulting from any occurrence of fire within the project boundary shall be accounted for each incidence of fire which affects an area greater than the minimum threshold area reported by the host Party for the purpose of defining forest, provided that the accumulated area affected by such fires in a given year is ≥5% of the project area	The applicability of the tool will be justified separately for each year when the fire has occurred within the project boundary. DNA of Senegal has defined that the single minimum land area which can be defined as forest is 0.5 ha.[34]
"Estimation of the increase in GHG emissions attributable to displacement of pre-project	This tool is not applicable as the increase of GHG emissions attributable to the

[32] EB 60, Annex 12. http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-16-v1.1.0.pdf
[33] EB 65, Annex 31. http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-08-v4.0.0.pdf
[34] http://cdm.unfccc.int/DNA/index.html

agricultural activities in A/R CDM project activity"[35] • This tool is applicable for estimating the increase of GHG emissions attributable to the displacement of pre-project agricultural activities due to implementation of an A/R project activity, which can not be considered insignificant according to the most recent: (i) "Guidelines on conditions under which increase in GHG emissions attributable to displacement of pre-project crop cultivation activities in A/R CDM project activity is insignificant, (ii) "Guidelines on conditions under which increase in GHG emissions related to displacement of pre-project grazing activities in A/R CDM project activity is insignificant". • This tool is not applicable if the displacement of agricultural activities attributable to the A/R project activity is expected to cause any drainage of wetlands or peatlands.	displacement of pre-project agricultural activities can be considered insignificant. The detailed demonstration of this is made in section 3.3.
"Calculation of the number of sample plots for measurements within A/R CDM project activities" [36]	N/A. This tool has no internal applicability conditions.

2.3 Project Boundary

Project boundary

According the applied methodology the "project boundary" geographically delineates the afforestation or reforestation project activity under the control of the PPs. The project activity may contain more than one discrete area of land. Each discrete area of land shall have a unique geographical identification. The project boundary is described in section 1.9.

GHG sources

Based on the applied methodology the only possible sources of GHG emissions from the project implementation is caused by burning of woody biomass. GHG emissions generated by the project (i.e. GHG sources) and associated GHGs selected for accounting of GHG emissions are shown in Table 5.

Table 5. Emission sources and GHGs selected for accounting of GHG emissions

[35] EB 51, Annex 15. http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-15-v1.pdf
[36] EB 58, Annex 15. http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-03-v2.1.0.pdf

Source	Gas	Included?	Justification/Explanation
Burning of woody biomass	CO_2	No	CO_2 emissions due to burning of biomass are accounted as a change in carbon stock
	CH_4	Yes	CH_4 emissions due to burning of biomass can be significant
	N_2O	Yes	N_2O emissions due to burning of biomass can be significant

GHG sinks and reservoirs:

According to the applied methodology carbon pools for consideration are above- and below-ground biomass, dead wood, litter and soil organic carbon (SOC). Table 6 shows the carbon pools selected for the project.

Table 6. Carbon pools selected for accounting of carbon stock changes

Source		Gas	Included?	Justification/Explanation
Baseline	Above- and below ground biomass	CO_2	Yes	Carbon stock in this pool is expected to increase due to the implementation of the project activity
		CH_4	No	Not required by the methodology
		N_2O	No	Not required by the methodology
		Other	N/A	
	Soil organic carbon (SOC)	CO_2	Yes	Carbon stock in this pools may increase due to implementation of the project activity.
		CH_4	No	Not required by the methodology
		N_2O	No	Not required by the methodology
		Other	N/A	
	Dead wood and Litter	CO_2	No	Carbon stock in these pools may increase due to implementation of the project activity. The applied methodology also provides anyhow a conservative choice of not accounting for carbon stock changes in any of these pools if such choice is identical for both the baseline and the project scenarios.
		CH_4	No	Not required by the methodology
		N_2O	No	Not required by the methodology
		Other	N/A	
Project	Above- and below ground biomass	CO_2	Yes	Carbon stock in this pool is expected to increase due to the implementation of the project activity
		CH_4	No	Not required by the methodology
		N_2O	No	Not required by the methodology
		Other	N/A	

Source		Gas	Included?	Justification/Explanation
	Soil organic carbon (SOC)	CO_2	Yes	Carbon stock in this pools may increase due to implementation of the project activity.
		CH_4	No	Not required by the methodology
		N_2O	No	Not required by the methodology
		Other	N/A	
	Dead wood and Litter	CO_2	No	The applied methodology provides the conservative choice of not accounting for carbon stock changes in dead wood, litter and soil organic carbon if such choice is identical for both the baseline and the project scenarios
		CH_4	No	Not required by the methodology
		N_2O	No	Not required by the methodology
		Other	N/A	
	Leakage	CO_2	No	Leakage is considered to be insignificant and is accounted for as zero as described more detailed in section 3.3 “Leakage”.
		CH_4	No	
		N_2O	No	
		Other	N/A	

Above described carbon pools are in line with VCS AFOLU provisions which identifies aboveground woody biomass, aboveground non-woody biomass, belowground biomass, litter, dead wood, soil and wood products as relevant pools for ARR projects[37]. In accordance with the VCS AFOLU requirements the pools in litter, dead wood and soil can be anyhow excluded when the project activities doesn’t reduce the pool significantly. Carbon pool of wood products is optional and has been excluded from the project boundary.

2.4 Baseline Scenario

The baseline scenario of the project activity implemented under the applied methodology is continuation of the pre-project land use. The identification of this baseline scenario is demonstrated later in section 2.5 following the procedure described in the tool “Combined tool to identify the baseline scenario and demonstrate additionality in A/R CDM project activities”[38].

At present, shifting cultivation is the only agricultural method used in the project area. Plots of land are farmed during the rainy season with food crops (e.g., millet, maize, peanuts) and then abandoned for quite long periods to restore their fertility. At the end of fallow period (called jachère) the vegetation is cleared and then cultivated again. In addition, natural fires occur frequently in unmanaged fallow areas. The baseline situation can be thus described as

[37] VCS AFOLU Requirements: VCS Version 3. http://v-c-s.org/sites/v-c-s.org/files/AFOLU%20Requirements%20v3.3_0.pdf
[38] EB 35, Annex 19. http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-02-v1.pdf

"unmanaged grassland with wildfire-dominated ecological conditions and natural re-growth dynamics".

The project activity is implementing a voluntary coordinated action and not a mandatory policy/regulation; it would not be implemented in the absence of the carbon revenues. A project identification note was written before the project start, thus clearly demonstrating that GHG revenues (i.e., income due on carbon credit marketing) were accounted before the implementation of the initial project plan. Moreover, there are either no alternative land uses that can be reasonably expected as described in section 2.5. Thus the baseline scenario "continuation of the current situation i.e. continuation of the pre-project land use" can be justified. Below is summarized the current problems occurring generally in the area of "Peanut Basin".

- density of the rising population;
- fragile and endangered natural environment and, in some areas, also a severe degradation already underway;
- extension of cultivated lands to the detriment of grazing and forested terrains;
- low-income from productions;
- declining fertility of soils;
- low-income from animal husbandry;
- lack of valorization of rural production and absence of diversification of rural activities;
- weakness of agricultural revenue hastening the exodus from rural areas (nowadays not just seasonal but lasting to extended periods);
- slow modernization of indigenous crafts and weak development of local factories, which could, if developed, increase local employment and produce both equipment and material needed to improve the life quality in rural areas;
- established approach of technical development, dictated by people outsider to these rural areas, oriented towards a single-cash-crop production predominantly for export (e.g., peanuts) rather than a healthy-for-the land diversification, and mainly focused on men whilst ignoring any possible involvement of women.

2.5 Additionality

The demonstration and assessment of the additionality of the project is made in accordance with the applied methodology (AR-ACM0003, Version 01.0.0) following the steps of the "Combined tool to identify the baseline scenario and demonstrate additionality in A/R CDM project activities" (Version 01)[39]

Step 0: Preliminary screening based on the starting date of the A/R project activity

As the proposed A/R project activity has a starting date after 31 December 1999 but before the date of project's registration, evidences needs to be provided for following two points:

1) Provide evidence that the starting date of the A/R project activity was after 31 December 1999

The starting date of the project is 3rd of June 2009 as demonstrated with evidences in Section1.5.

[39] EB 35, Annex 19. http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-02-v1.pdf

2) Provide evidence that the incentive from the planned sale of carbon credits was seriously considered in the decision to proceed with the project activity. This evidence shall be based on (preferably official, legal and/or other corporate) documentation that was available to third parties at, or prior to, the start of the project activity.

A project identification note was written before the project start, thus clearly demonstrating that GHG revenues (i.e., income due carbon credit marketing) were accounted before the implementation of the initial project plan. The long term funding of the project is totally dependent on the revenue stream provided by a long-term tree growth.

Step 1: Identification of alternative scenarios to the proposed A/R project activity

Sub-step 1a: Identify credible alternative land use scenarios to the proposed project activity

Below is presented a list of alternative scenarios identified in accordance with the applied tool:

Scenario 1. Continuation of the pre-project land use

Of all of Senegal's ecological regions, the Peanut Basin has been the most fundamentally altered by centuries of human activity and during the last 150 years the zone have witnessed a nearly complete transformation of its landscapes. In the mid 1800s, small farming communities were scattered throughout a mosaic of wooded savannas and open woodlands. Today, continuous cultivation has replaced in many parts vestiges of the natural vegetation. The cultivated area of the Peanut Basin is presumed to have peaked sometime in the mid-1980s (being approximately around 80%) when farmers still benefited from agricultural subsidies. From that period the cultivated area has declined to be less than 70% in 2000. Not cultivated areas of the Peanut Basin are mostly grassy fallow areas or grazing lands.[40] As described above in Section 2.4. shifting cultivation is the only agricultural method used in the project and also the only land-use type found currently within the project area. The continuation of the pre-project land use is a realistic and credible alternative scenario.

Scenario 2. Forestation of the land within the project boundary performed without being registered as the Verified Carbon Standard project activity

In this scenario the forestation activities would be performed without GHG revenues (i.e., income due carbon credit marketing). Anyhow, there is no tradition of establishing plantations or re-vegetation with Jatropha curcas. In fact, the local people living within the project area are not used to cultivate any plants which doesn't produce fruits or other parts for nourishment purposes. In addition, the project area is degraded and not easily accessible because it's remote location, therefore, it's not interesting for commercial forestry.

Scenario 3. Forestation of at least a part of the land within the project boundary of the proposed A/R project at a rate resulting from 1) Legal requirements; or 2) Extrapolation of observed forestation activities in the geographical area with similar, socio-economic and ecological conditions to the proposed A/R project activity occurring in a period since 31 December 1989 as selected by the PPs.

In this scenario the forestation activities would be performed resulting from 1) Legal requirements or from 2) Extrapolation of observed forestation activities. This scenario is not realistic alternative scenario as there is either no legal requirements for forest establishment (See section 1.11) nor observed Jatropha curcas plantations in nearby

[40] Tappan G.G., Shall M., Wood E.C. and Cushing M. 2004. Ecoregions and land cover trends in Senegal. Journal of Arid Environments 59, pp. 427-462. http://www.sciencedirect.com/science/article/pii/S0140196304000783#

areas which could be extrapolated to cover the lands or the parts of the lands within the project boundary (See Step 4 "Common practice analysis).

Outcome of Sub-step 1a: Scenario 1 and Scenario 2 are the identified credible alternative land use scenarios.

Sub-step 1b: Consistency of credible alternative land use scenarios with enforced mandatory applicable laws and regulations

The alternative scenarios to the project activity presented above as the outcome of Sub-step 1a are all in compliance with mandatory legislation and regulations taking into account the enforcement in the region or country and Board decisions on national and/or sectoral policies and regulations. The legal and regulatory requirements are identified in section 1.11.

Outcome of Sub-step 1b: Scenario 1 and Scenario 2 are plausible alternative land use scenarios.

Step 2: Barrier analysis

Sub-step 2a: Identify barriers that would prevent the implementation of alternative scenarios

Below is presented a list of barriers that may prevent alternative scenarios to occur.

a) Investment barriers, other than insufficient financial returns

No private capital is available from domestic or international capital markets due to risks associated with investments in Senegal[41]. Moreover, specially the domestic investments are hindered by an under-developed financial sector. In Senegal there are nineteen commercial banks from France, Nigeria, Morocco and Togo which all have conservative lending guidelines and high interest rates. Collateral requirements dominate bank lending. Few domestic firms are eligible for long-term loans, and small and medium sized enterprises have little access to credit.[42] The financial benefits obtainable through the carbon finance, could represent a way to overpass these obstacles.

b) Technological barriers

Lack of access to planting materials, constraining in using fertilizers, breakdown of the agricultural economy (including lack of seeds, agricultural credits, and agricultural equipment) are among the major technological barriers. These barriers has been identified, for example by Tappan et al. (2004)[43], to be among the main reasons for decrease of the agricultural land-use in the Peanut Basin. The result of these constraints is to reduce the productivity (increase the farm gate cost of fertilizers) and declines the soil organic carbon content with a resultant declines in soil fertility.

[41] For example the Moody's rating for Senegal is B1 and S&P rating is B+. http://www.tradingeconomics.com/senegal/rating (Site visited 15/07/2013)
[42] Bureau of Economic and Business Affrairs, U.S. Department of State. 2013. Report: 2013 Investement Climate Statement - Senegal. http://www.state.gov/e/eb/rls/othr/ics/2013/204727.htm (Site visited 15/07/2013)
[43] Tappan G.G., Shall M., Wood E.C. and Cushing M. 2004. Ecoregions and land cover trends in Senegal. Journal of Arid Environments 59, pp. 427-462. http://www.sciencedirect.com/science/article/pii/S0140196304000783#

Local communities are committed to plant Jatropha, but without the carbon component they do not have adequate access to technical and organizational assistance. Villagers need the support of ANOC to implement and maintain the project as they are not used to cultivate plants which doesn't produce fruits or other parts for nourishment purposes. In fact, in the beginning of the project it was difficult to receive the support and collaboration from the local people. The proposed project activity has anyhow been able to surpass the initial difficulties working together with the local communities and offering local people knowhow and training.

Sub-step 2b: Elimination of land use scenarios that are prevented by the identified barriers

The alternative scenario "Scenario 2" is prevented by the barriers listed in Sub-step 2a, and thus Scenario 2 is eliminated from further consideration.

Outcome of Step 2b: The only alternative scenario not prevented by any barrier is the Scenario 1 "Continuation of the pre-project land use"

Sub-step 2c: Determination of baseline scenario

In accordance with the decision tree of the used tool, the Scenario 1 "Continuation of the pre-project land use" is the baseline scenario and the additionality demonstration needs to be continued with Step 4 "Common practice test".

Step 4. Common practice test

A global market report on Jatropha published in 2008 states that Jatropha plantation found in Senegal were, in that time, mainly pilot plantations[44]. According to the European Comission's more recent report (published in 2013) there were nine biofuel projects registered[45] during the years 2007-2010 in Senegal. Most of these projects have been anyhow discontinued and specially the big projects has encountered difficulties[46]. Currently there is active just one other Jatropha project is Senegal: project of Sopreef Sarl in southern part of Fatick Region. Soprereef sarl has not anyhow made any plantations with Jatropha but has only organised the locals to collect seeds from already exiting hedgerows of Jatropha from an area which covers around 60 ha. [47] In summary, in the Peanut Basin, or more generally in Senegal, there isn't any other active Jatorpha plantation project with similar scale as the proposed project activity and, therefore, the proposed project activity is not the baseline scenario.

[44] GEXSI LLP. 2008. Global Market Study on Jatropha. Final Report. Prepared for WWF. London/Berlin, May 8th 2008. http://www.jatropha-alliance.org/fileadmin/documents/GEXSI_Global-Jatropha-Study_FULL-REPORT.pdf
[45] Project registered at the APIX (National agency for the promotion of investment and exports)
[46] AETS. 2013. Assessing the impact of biofuels production on developing countries from the point of view of Policy Coherence for Development. Contract N° 2012/299193 FWC COM 2011 - Lot 1 – Studies and Technical Assistance in all Sectors. Final report, February 2013. http://ec.europa.eu/europeaid/what/development-policies/documents/biofuels_final_report_assessing_impact_of_eu_biofuel_policy_pcd_22022013_en.pdf
[47] Personal communication from Alessandro Milani/ANOC October 2013.

Outcome of Step 4: The proposed project activity is not the baseline scenario and, hence, it is additional.

2.6 Methodology Deviations

The project and project monitoring plan meet all of the requirements of the applied methodology and does not deviate from the baseline scenario, additionality determination, or inclusion of project GHG sources, sinks and reservoirs.

3 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

3.1 Baseline Emissions

Procedures to be used for calculation of *ex ante* baseline net GHG removals by sinks are detailed in the AR-ACM0003 methodology (Version 01.0.0) under the section 5.4 "Baseline net GHG removals by sinks". According the methodology baseline net GHG removals by sinks are calculated with the following equation:

$$\Delta C_{BSL,t} = \Delta C_{TREE\_BSL,t} + \Delta C_{SHRUB\_BSL,t} + \Delta C_{DW\_BSL,t} + \Delta C_{LI\_BSL,t} \qquad \text{(equation 1)}$$

Where:

$\Delta C_{BSL,t}$ Baseline net GHG removals by sinks in year t; tCO_2-e

$\Delta C_{TREE\_BSL,t}$ Change in carbon stock in baseline tree biomass within the project boundary in year t, as estimated in the tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities[48]"; tCO_2-e

$\Delta C_{SHRUB\_BSL,t}$ Change in carbon stock in baseline shrub biomass within the project boundary, in year t, as estimated in the tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities[49]"; tCO_2-e

$\Delta C_{DW\_BSL,t}$ Change in carbon stock in baseline dead-wood biomass within the project boundary, in year t, as estimated in the tool "Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities[50]"; tCO_2-e

$\Delta C_{LI\_BSL,t}$ Change in carbon stock in baseline litter biomass within the project boundary, in year t, as estimated in the tool "Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities[51]"; tCO_2-e

[48] AR-TOOL14. http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-14-v3.0.0.pdf
[49] AR-TOOL14. http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-14-v3.0.0.pdf
[50] EB 67, Annex 23. http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-12-v2.0.0.pdf
[51] EB 67, Annex 23. http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-12-v2.0.0.pdf

Carbon stock in trees

a) According the tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities[52] change in carbon stock in trees in the baseline is estimated using the following stepwise procedure: Select the technique and use the appropriate equation for estimating the carbon stock in trees.

Here is chosen "Baseline default technique"

$$C_{TREE,BSL,i} = \frac{44}{12} * CF_{TREE\_BSL} * B_{FOREST} * (1 + R_{TREE\_BSL}) * CC_{TREE\_BSL,i} * A_{BSL,i} \quad \text{(equation 2)}$$

$$C_{TREE,BSL} = \sum_{i=1}^{M} C_{TREE\_BSL,i} \quad \text{(equation 3)}$$

Where:

$C_{TREE,BSL}$ Carbon stock in living trees in the baseline, in the project boundary, at the start of the A/R project activity; t CO2-e

$C_{TREE,BSL,i}$ Carbon stock in living trees in the baseline, in baseline stratum i, at the start of the A/R project activity; t CO2-e. Baseline strata are delineated on the basis of tree crown cover

CF_{TREE_BSL} Carbon fraction of tree biomass in the baseline; t C (t.d.m.)$^{-1}$ A default value of 0.47 t C (t.d.m.)$^{-1}$ is used

B_{FOREST} Default above-ground biomass content in forest in the region/country where the A/R project is located; t d.m. ha^{-1}

R_{TREE_BSL} Root-shoot ratio for the trees in the baseline; dimensionless. A default value of 0.25 is used unless transparent and verifiable information can be provided to justify a different value

$CC_{TREE\_BSL,i}$ Crown cover of trees in the baseline, in baseline stratum i, at the start of the A/R project activity, expressed as a fraction (e.g. 10% crown cover implies $CC_{TREE\_BSL,i}$ = 0.10); dimensionless

$A_{BSL,i}$ Area of stratum i in the baseline, delineated on the basis of tree crown cover at the start of the A/R project activity; ha

i 1, 2, 3, … tree biomass estimation strata within the project boundary

b) Select the method and use the appropriate equation for estimating the carbon stock change in trees.

[52] AR-TOOL14. http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-14-v3.0.0.pdf

Here is chosen "Baseline default method" which is acceptable method in accordance of the used tool as the mean tree crown cover in the baseline is less than 6 % (i.e. less than 20 per cent of the threshold crown cover reported by Senegal, 30 %).

$$\Delta C_{TREE,BSL,i} = \frac{44}{12} * CF_{TREE\_BSL} * \Delta B_{FOREST} * (1 + R_{TREE\_BSL}) * CC_{TREE\_BSL,i} * A_{BSL,i}$$

(equation 4)

$$\Delta C_{TREE,BSL} = \sum_{i=1}^{M} \Delta C_{TREE\_BSL,i} \qquad \text{(equation 5)}$$

Where:

$\Delta C_{TREE,BSL}$ Average annual change in carbon stock in tree biomass in the baseline; t CO2-e yr^{-1}

$\Delta C_{TREE,BSL,i}$ Average annual change in carbon stock in tree biomass in the baseline in baseline stratum i; t CO2-e yr-1

CF_{TREE_BSL} Carbon fraction of tree biomass in the baseline; t C $(t.d.m.)^{-1}$ A default value of 0.47 t C $(t.d.m.)^{-1}$ is used

ΔB_{FOREST} Default average annual increment of above-ground biomass in forest in the region/country where the A/R project is located; t d.m. ha^{-1} yr^{-1}

R_{TREE_BSL} Root-shoot ratio for the trees in the baseline; dimensionless. A default value of 0.25 is used unless transparent and verifiable information can be provided to justify a different value

$CC_{TREE\_BSL,i}$ Crown cover of trees in the baseline, in baseline stratum i, at the start of the A/R project activity, expressed as a fraction (e.g. 10% crown cover implies $CC_{TREE\_BSL,i}$ = 0.10); dimensionless

$A_{BSL,i}$ Area of stratum i in the baseline, delineated on the basis of tree crown cover at the start of the A/R project activity; ha

i 1, 2, 3, … tree biomass estimation strata within the project boundary

Carbon stock in shrubs

According the tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities[53] change in carbon stock in shrubs in the baseline is estimated:

[53] AR-TOOL14. http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-14-v3.0.0.pdf

$$C_{SHRUB,t} = \frac{44}{12} * CF_s * (1 - R_s) * \sum_i A_{SHRUB,i,t} * B_{SHRUB,i,t} \qquad \text{(equation 6)}$$

For those areas where the shrub crown cover is less than 5 %, the shrub biomass per hectare is considered negligible and hence accounted as zero. Instead, for those areas where the shrub crown cover is 5 % or more, shrub biomass per hectare is estimated as follows:

$$B_{SHRUB,i,t} = BDR_{SF} \times B_{FOREST} \times CC_{SHRUB,i,t} \qquad \text{(equation 7)}$$

$$dC_{SHRUB,(t_1 t_2)} = \frac{C_{SHRUB,t_2} - C_{SHRUB,t_1}}{T} \qquad \text{(equation 8)}$$

$$\Delta C_{SHRUB,t} = dC_{SHRUB,(t_1,t_2)} \times 1 year \quad \text{for } t_1 \leq t_2 \qquad \text{(equation 9)}$$

Where:

$C_{SHRUB,t}$	Carbon stock in shrub biomass within the project boundary at a given point of time in year t; t CO2-e
CF_s	Carbon fraction of shrub biomass; t C (t.d.m.)$^{-1}$ IPCC default value of 0.47 t C (t.d.m.)$^{-1}$ is used
R_s	Root-shoot ratio for shrubs; dimensionless
$A_{SHRUB,i,t}$	Area of shrub biomass stratum i at a given point of time in year t; ha
$B_{SHRUB,i,t}$	Shrub biomass per hectare in shrub biomass stratum i at a given point of time in year t; t d.m. ha^{-1}
BDR_{SF}	Ratio of shrub biomass per hectare in land having a shrub crown cover of 1.0 and default above-ground biomass content per hectare in forest in the region/country where the A/R project is located; dimensionless
B_{FOREST}	Default above-ground biomass content in forest in the region/country where the A/R project is located; t d.m. ha^{-1}
$CC_{SHRUB,i,t}$	Crown cover of shrubs in shrub biomass stratum i at a given point of time in year t expressed as a fraction (e.g. 10% crown cover implies $CC_{SHRUB,i,t}$ = 0.10); dimensionless

$dC_{SHRUB,(t1,t2)}$	Rate of change in carbon stock in shrub biomass within the project boundary during the period between a point of time in year t_1 and a point of time in year t_2; t CO_2-e yr^{-1}
$C_{SHRUB,t2}$	Carbon stock in shrub biomass within the project boundary at a point of time in year t_2; t CO_2-e
$C_{SHRUB,t1}$	Carbon stock in shrub biomass within the project boundary at a point of time in year t_1; t CO_2-e
$\Delta C_{SHRUB,t}$	Change in carbon stock in shrub biomass within the project boundary in year t; t CO_2-e
T	Time elapsed between two successive estimations ($T=t_2 – t_1$); yr
i	1, 2, 3, … shrub biomass strata delineated on the basis of shrub crown cover
t	1, 2, 3, … years counted from the start of the A/R project activity

Carbon stocks in dead wood and litter

The carbon stock in dead wood and litter are not selected (See table 6) and thus in accordance with the applied methodology these pools are set to zero.

3.2 Project Emissions

Procedure to be used for calculation of *ex ante* actual net GHG removals by sinks are detailed in the AR-ACM0003 methodology (Version 01.0.0) under the section 5.5 “Actual net GHG removals by sinks”. According the methodology the actual net GHG removals by sinks is calculated as follows:

$$\Delta C_{ACTUAL,t} = \Delta C_{P,t} - GHG_{E,t} \qquad \text{(equation 10)}$$

Where:

$\Delta C_{ACTUAL,t}$	Actual net GHG removals by sinks, in year t; tCO_2-e
$\Delta C_{P,t}$	Change in the carbon stocks in project, occurring in the selected carbon pools, in year t; tCO_2-e
$GHG_{E,t}$	Increase in non-CO_2 GHG emissions within the project boundary as a result of the implementation of the A/R project activity, in year t, as calculated in the tool “Estimation of non-CO_2 GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity[54]”; tCO_2-e

[54]EB 65, Annex 31. http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-08-v4.0.0.pdf

For *ex ante* situation the increase in non-CO_2 GHG emissions within the project boundary as a result of the implementation of the A/R project activity ($GHG_{E,t}$) is accounted as zero as the project implementation plan is not including 1) fire used in site preparation, 2) fire used to clear the land of harvest residue prior replanting of the land and 3) impact of wild fires is estimated to be insignificant.

The non CO2-e GHG emission caused from wild fires are estimated *ex ante* to be insignificant as the project is implemented paying a particular attention to the fire risk mitigation: The fire risk is mitigated by removing the litter and shrubs from the plantation areas. Each family working on the project area is aware of the fire mitigation and extinguishment procedures. Moreover, in general level, the fires occurring in Peanut Basin have been reported to be mostly small and scattered[55] which endorses the above assumption of the insignificance of the wild fires possibly occurring in the project area. In case significant fires will occur during the *ex post* situation, the equation 1 of the tool "Estimation of non-CO_2 GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity" [56] will be used for determine the increase in non-CO_2 GHG emissions ($GHG_{E,t}$).

Change in the carbon stocks in project, occurring in the selected carbon pools, in year *t* is calculated as follows:

$$\Delta C_{P,t} = \Delta C_{TREE\_PROJ,t} + \Delta C_{SHRUB\_PROJ,t} + \Delta C_{DW\_PROJ,t} + \Delta C_{LI\_PROJ,t} + \Delta SOC_{AL,t} \quad \text{(equation 11)}$$

Where:

$\Delta C_{P,t}$	Change in the carbon stocks in project, occurring in the selected carbon pools, in year t; tCO_2-e
$\Delta C_{TREE\_PROJL,t}$	Change in carbon stock in tree biomass in project in year t, as estimated in the tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities[57]"; tCO_2-e
$\Delta C_{SHRUB\_PROJL,t}$	Change in carbon stock in shrub biomass in project in year t, as estimated in the tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities[58]"; tCO_2-e
$\Delta C_{DW\_PROJL,t}$	Change in carbon stock in dead-wood biomass in project in year t, as estimated in the tool "Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities[59]"; tCO_2-e

[55] Nielsen T., Rasmussen K., Mbow C. & Touré A. 2003. The fire regime of Senegal and its determinants. Geografisk Tidsskrift, Danish Journal of Geography 103(1): 43-53. http://rdgs.dk/djg_article_details.asp?site=djg&art_id=77&pid=11
[56] EB 65, Annex 31. http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-08-v4.0.0.pdf
[57] AR-TOOL14. http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-14-v3.0.0.pdf
[58] AR-TOOL14. http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-14-v3.0.0.pdf
[59] EB 67, Annex 23. http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-12-v2.0.0.pdf

$\Delta C_{LI\_PROJL,t}$	Change in carbon stock in litter biomass in project in year t, as estimated in the tool "Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities[60]"; tCO_2-e
$\Delta SOC_{AL,t}$	Change in carbon stock in SOC in project, in year t, in areas of land meeting the applicability conditions of the tool "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities[61]", as estimated in the same tool; tCO_2-e

Change in carbon stock in tree biomass in project

Carbon stock in tree biomass is estimated on the basis of the tree biomass strata described in the table 7. Carbon stock in trees is estimated by applying Allometric equation technique and change in carbon in trees is estimated by applying Stock change method (equations 12-21 below).

$$B_{TREE,j,p,i,t} = f_{j(x1p,i,t,x2p,i,t,x3p,i,t)} * (1 + R_j) \quad \text{(equation 12)}$$

$$B_{TREE,p,i,t} = \sum_j B_{TREE,j,p,i,t} \quad \text{(equation 13)}$$

$$b_{TREE,p,i,t} = \frac{B_{TREE,p,i,t}}{A_{p,i}} \quad \text{(equation 14)}$$

$$b_{TREE,i,t} = \frac{\sum_{p=1}^{n_i} b_{TREE,p,i,t}}{n_i} \quad \text{(equation 15)}$$

$$s_i^2 = \frac{n_i * \sum_{p=1}^{n_i} b_{TREE,p,i,t}^2 - \left(\sum_{p=1}^{n_1} b_{TREE,p,i,t} \right)^2}{n_i * (n_i - 1)} \quad \text{(equation 16)}$$

$$b_{TREE,t} = \sum_{i=1}^{M} w_i * b_{TREE,i,t} \quad \text{(equation 17)}$$

$$s_{b_{TREE,t}}^2 = \sum_{i=1}^{M} w_i^2 * \frac{s_i^2}{n_i} \quad \text{(equation 18)}$$

$$u_{b_{TREE,t}} = \frac{t_{VAL} * s_{bTREE,t}}{b_{TREE,t}} \quad \text{(equation 19)}$$

[60] EB 67, Annex 23. http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-12-v2.0.0.pdf
[61] EB 60, Annex 12. http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-16-v1.1.0.pdf

$$C_{TREE,t} = \frac{44}{12} \times B_{TREE,t} * CF_{TREE}$$ (equation 20)

$$dC_{TREE(t1,t2)} = \frac{C_{TREE,t2} - C_{TREE,t1}}{T}$$ (equation 21)

$$\Delta C_{TREE,t} = \Delta C_{TREE,(t1,t2)} * 1year$$ for $t_1 \leq t \leq t_2$ (equation 22)

Where:

$B_{TREE,i,p,i,t}$	Biomass of trees of species j in sample plot p of stratum i at a given point of time in year t; t d.m.
$f_{j(x1p,i,t,x2p,i,t,x3p,i,t)}$	Function relating measured tree dimensions (x1, x2, x3, …) to above-ground biomass. Tree dimensions are measured in sample plot p of stratum i at a given point of time in year t. Tree dimensions x1, x2, x3, … could be, for example DBH, height of tree, etc.
R_j	Root-shoot ratio for tree species j; dimensionless
$B_{TREE,p,i,t}$	Tree biomass in sample plot p in stratum i at a given point of time in year t; t d.m.
$b_{TREE,p,i,t}$	Tree biomass per hectare in sample plot p in stratum i at a given point of time in year t; t d.m. ha
$A_{p,i}$	Area of sample plot p in stratum i; ha
$b_{TREE,i,t}$	Mean tree biomass per hectare in stratum i at a given point of time in year t; t d.m. ha-1
n_i	Number of sample plots in stratum i
s_i^2	Variance of tree biomass per hectare in stratum i at a given point of time in year t; (t d.m. ha-1)^2
$b_{TREE,t}$	Mean tree biomass per hectare within the project boundary at a given point of time in year t; t d.m. ha^{-1}
w_i	Ratio of the area of stratum i to the sum of areas of biomass estimation strata; dimensionless
$s^2_{bTREE,t}$	Variance of mean tree biomass per hectare within the project boundary at a given point of time in year t; (t d.m. ha-1)^2
M	Number of tree biomass estimation strata within the project boundary

$u_{bTREE,t}$	Uncertainty of tree biomass per hectare within the project boundary at a given point of time in year t; %
t_{VAL}	Two-sided Student's t-value for: (i) Degrees of freedom equal to n – M, where n is total number of sample plots within the project boundary, and M is the total number of tree biomass estimation strata; and (ii) a confidence level of 90%.
$s_{bTREE,t}$	Square root of the variance of mean tree biomass per hectare within project boundary at a given point of time in year t (i.e. the standard error of the mean); t d.m. ha^{-1}
$C_{TREE,t}$	Carbon stock in tree biomass within the project boundary at a given point of time in year t; t CO_2-e
$B_{TREE,t}$	Total tree biomass within the project boundary at a given point of time in year t; t d.m.
CF_{TREE}	Carbon fraction of tree biomass; t C t $d.m.^{-1}$. A default value of 0.47 is used unless transparent and verifiable information can be provided to justify a different value.
$dC_{TREE,(t1,t2)}$	Rate of change in carbon stock in tree biomass within the project boundary during the period between a point of time in year t1 and a point of time in year t 2; t CO_2-e yr^{-1}
$C_{TREE,t2}$	Carbon stock in tree biomass within the project boundary at a point of time in year t_2; t CO2-e
$C_{TREE,t1}$	Carbon stock in tree biomass within the project boundary at a point of time in year t_1; t CO2-e
T	Time elapsed between two successive estimations ($T=t_2 – t_1$); yr
$\Delta C_{TREE,t}$	Change in carbon stock in tree biomass within the project boundary in year t; t CO_2
j	1, 2, 3, … tree species in plot p
p	1, 2, 3, … sample plots in stratum i
i	1, 2, 3, … tree biomass estimation strata within the project boundary
t	1, 2, 3, … years counted from the start of the A/R project activity

Change in carbon stock in shrub biomass in project

Carbon stock in shrub biomass within the project boundary at a given point of time in year t is calculated in accordance with the tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities[62] using the equations 6-9 described before in the section 3.1.

According the applied tool for the first verification, the variable $C_{SHRUB,t1}$ in equation 8 is assigned the value of carbon stock in the shrub biomass at the start of the A/R project activity.

Change in carbon stocks in soil organic carbon in project

Soil organic carbon is set to zero conservatively for all the grouped project area in *ex ante* estimations as the applicability conditions of the tool "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities" [63] are not fulfilled for the first project instance (see the section 2.2). For the *ex post* situation the soil organic carbon will be accounted for all the plots where the applicability conditions of the tool are fulfilled (i.e. for all the plots where litter is not removed from the project site) with the following equations:

The initial SOC stock at the start of the project is estimated as follows:

$$SOC_{INITIAL,i} = SOC_{REF,i} * f_{LU,i} * f_{MG,i} * f_{IN,i} \quad \text{(equation 23)}$$

For each stratum of the areas of land which is subjected to soil disturbance attributable to project activity and for which the total area disturbed, over and above the area disturbed in the baseline (if any), is greater than 10% of the area of the stratum, the following carbon loss is accounted:

$$SOC_{LOSS,i} = SOC_{INITIAL,i} * 0.1 \quad \text{(equation 24)}$$

For all other strata:

$$SOC_{LOSS,i} = 0 \quad \text{(equation 25)}$$

The rate of change in SOC stock in project scenario until the steady-state SOC content is reached is estimated as follows:

$$dSOC_{t,i} = 0 \quad \text{for } t < t_{PREP,i} \quad \text{(equation 26)}$$

$$dSOC_{t,i} = \frac{SOC_{LOSS,i}}{1 year} \quad \text{for } t = t_{PREP,i} \quad \text{(equation 27)}$$

$$dSOC_{t,i} = \frac{SOC_{REF,i} - (SOC_{INITAIL,i} - SOC_{LOSS,i})}{20 year} \quad \text{for } t_{PREP,t} < t < t_{PREP,t} + 20 \quad \text{(equation 28)}$$

[62] AR-TOOL14. http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-14-v3.0.0.pdf
[63] EB 60, Annex 12. http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-16-v1.1.0.pdf

Considering uncertainties and inherent limitation of the precision of a factor-based estimation used in this tool, value of the rate of change of SOC stock is not accounted as more than 0.8 t C ha-1 yr-1, that is:

$dSOC_{t,i}$ < 0.8 t C ha-1 yr-1 the $dSOC_{t,i}$ = 0.8 t C ha-1 yr-1 (equation 29)

The change in SOC stock for all the strata of the areas of land, in year t, is calculated as:

$$\Delta SOC_{AL,t} = \frac{44}{12} * \sum_i A_i * dSOC_{t,i} * 1year \quad \text{(equation 30)}$$

Where:

$SOC_{INITIAL,i}$	SOC stock at the beginning of the A/R project activity in stratum i of the areas of land; t C ha-1
$SOC_{REF,i}$	Reference SOC stock corresponding to the reference condition in native lands (i.e. non-degraded, unimproved lands under native vegetation – normally forest) by climate region and soil type applicable to stratum i of the areas of land; t C ha-1
$f_{LU,i}$	Relative stock change factor for baseline land-use in stratum i of the areas of land; dimensionless
$f_{MG,i}$	Relative stock change factor for baseline management regime in stratum i of the areas of land; dimensionless
$f_{IN,i}$	Relative stock change factor for baseline input regime (e.g. crop residue returns, manure) in stratum i of the areas of land; dimensionless
$SOC_{LOSS,i}$	Loss of SOC caused by soil disturbance attributable the A/R project activity, in stratum i of the areas of land; t C ha-1
0.1	The approximate proportion of SOC lost within the first five years from the year of site preparation
$dSOC_{t,i}$	The rate of change in SOC stock in stratum i of the areas of land, in year t; t C ha-1 yr-1
$t_{PREP,i}$	The year in which first soil disturbance takes place in stratum i of the areas of land
$\Delta SOC_{AL,i}$	Change in SOC stock in areas of land meeting the applicability conditions of this tool, in year t; t CO2-e
A_i	The area of stratum i of the areas of land; ha
i	1, 2, 3, … strata of areas of land; dimensionless

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

Change in carbon stocks in dead woodand litter in project

The carbon stock in dead wood and litter are not selected (See table 6) and thus, in accordance with the applied methodology, these pools are set to zero.

3.3 Leakage

According the applied methodology the only leakage emissions that can occur are the GHG emissions due to displacement of pre-project agricultural activities. Procedure to be used for calculation of *ex ante* leakage is described in AR-ACM0003 methodology (Version 01.0.0) under the section 5.6 "Leakage". Leakage emissions are estimated as follows:

$$LK_t = LK_{AGRIC,t} \qquad \text{(equation 31)}$$

Where:

LK_t	GHG emissions due to leakage, in year t; tCO_2-e
LK_{AGRICt}	Leakage due to the displacement of agricultural activities in year t, as estimated in the tool "Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity[64]"; tCO_2-e

If the application of the "Guidelines on conditions under which increase in GHG emissions attributable to displacement of pre-project crop cultivation activities in A/R CDM project activity is insignificant[65]" and the "Guidelines on conditions under which increase in GHG emissions related to displacement of pre-project grazing activities in A/R CDM project activity is insignificant[66]" leads both to the conclusion that the applicable increase in GHG emissions is insignificant, then leakage from displacement of agricultural activities is estimated to be zero.

At the baseline situation, shifting cultivation is the only agricultural method used in the project area. Plots of land are farmed during the rainy season with food crops (e.g., millet, maize, peanuts) and then abandoned for quite long periods to restore their fertility. At the end of fallow period (called jachère) the vegetation is cleared and then cultivated again. In addition, contemporary crop activities will be boosted as local farmers will be working only part-time in the Jatropha fields. The unused fallow agricultural land, where Jatropha will be grown, were legally assigned to ANOC for 25% of the available agricultural land, hence ensuring to continue to produce both food and traditional agricultural products (e.g., peanuts) as usual in the baseline scenario. The satellite imagines taken before the project start date[67] can confirm that the project area did not contain any significant crop cultivation or grazing activities before the project start. The project area fulfils the condition (a) "Total area subjected to pre-project crop cultivation activities to be displaced is less than 5% of the area of the entire A/R project activity" of the

[64] EB 51, Annex 15. http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-15-v1.pdf
[65] EB 51, Annex 14. http://cdm.unfccc.int/Reference/Guidclarif/ar/methAR_guid29.pdf
[66] EB 51, Annex 13. http://cdm.unfccc.int/Reference/Guidclarif/ar/methAR_guid28.pdf
[67] See the attached document "Google_Earth_imagines_for_baseline_and_current_situation"

"Guidelines on conditions under which increase in GHG emissions attributable to displacement of pre-project crop cultivation activities in A/R CDM project activity is insignificant"[68] as well as the condition (a) "Total area subjected to pre-project grazing activities to be displaced is less than 5% of the area of the entire A/R project activity, or less than 50 ha" of the "Guidelines on conditions under which increase in GHG emissions related to displacement of pre-project grazing activities in A/R CDM project activity is insignificant[69]". Therefore, the increase in GHG emissions due to displacement of pre-project crop cultivation and grazing activities attributable to the A/R project activity can be considered insignificant. The leakage from displacement of agricultural activities can be thus estimated to be zero.

3.4 Summary of GHG Emission Reductions and Removals

According the applied methodology the net anthropogenic GHG removals by sinks are calculated as follows:

$$\Delta C_{AR-CDM,t} = \Delta C_{ACTUAL,t} - \Delta C_{BSL,t} - LK_t \qquad \text{(equation 32)}$$

Where:

$\Delta C_{AR-CDM,t}$ Net anthropogenic GHG removals by sinks, in year t; tCO_2-e

$\Delta C_{ACTUAL,t}$ Actual net GHG removals by sinks, in year t; tCO_2-e

$\Delta C_{BSL,t}$ Baseline net GHG removals by sinks, in year t; tCO_2-e

LK_t GHG emissions due to leakage, in year t; tCO_2-e

Years	Estimated baseline emissions or removals (tCO_2e)		Estimated project emissions or removals (tCO_2e)		Estimated leakage emissions (tCO_2e)		Estimated net GHG emission reductions or removals (tCO_2e)	
	First instance	Grouped area	First instance	Grouped area	First instance	Grouped area	First instance	Grouped area
03/06/2009-02/06/2010	0	0	-289	-713	0	0	-289	-713
03/06/2010-02/06/2011	0	0	26	26	0	0	26	26
03/06/2011-02/06/2012	0	0	73	73	0	0	73	73

[68] EB 51, Annex 14. http://cdm.unfccc.int/Reference/Guidclarif/ar/methAR_guid29.pdf
[69] EB 51, Annex 13. http://cdm.unfccc.int/Reference/Guidclarif/ar/methAR_guid28.pdf

03/06/2012-02/06/2013	0	0	222	223	0	0	222	223
03/06/2013-02/06/2014	0	0	865	877	0	0	865	877
03/06/2014-02/06/2015	0	0	2,071	2,086	0	0	2,071	2,086
03/06/2015-02/06/2016	0	0	3,726	3,832	0	0	3,726	3,832
03/06/2016-02/06/2017	0	0	5,633	5,928	0	0	5,633	5,928
03/06/2017-02/06/2018	0	0	6,349	7,004	0	0	6,349	7,004
03/06/2018-02/06/2019	0	0	5,313	6,578	0	0	5,313	6,578
03/06/2019-02/06/2020	0	0	3,175	5,103	0	0	3,175	5,103
03/06/2020-02/06/2021	0	0	928	3,463	0	0	928	3,463
03/06/2021-02/06/2022	0	0	0	2,948	0	0	0	2,948
03/06/2022-02/06/2023	0	0	0	2,986	0	0	0	2,986
03/06/2023-02/06/2024	0	0	0	2,843	0	0	0	2,843
03/06/2024-02/06/2025	0	0	0	2,500	0	0	0	2,500
03/06/2025-02/06/2026	0	0	0	2,058	0	0	0	2,058
03/06/2026-02/06/2027	0	0	0	1,889	0	0	0	1,889
03/06/2027-02/06/2028	0	0	0	1,583	0	0	0	1,583
03/06/2028-02/06/2029	0	0	0	1,078	0	0	0	1,078
03/06/2029-	0	0	0	370	0	0	0	370

02/06/2030								
03/06/2030-02/06/2031	0	0	0	0	0	0	0	0
03/06/2031-02/06/2032	0	0	0	0	0	0	0	0
03/06/2032-02/06/2033	0	0	0	0	0	0	0	0
03/06/2033-31/12/2033	0	0	0	0	0	0	0	0
Total	0	0	28,091	52,735	0	0	28,091	52,735

4 MONITORING

4.1 Data and Parameters Available at Validation

Data Unit / Parameter:	CF_{TREE_BSL}
Data unit:	t C (t.d.m.)$^{-1}$
Description:	Carbon fraction of tree biomass in the baseline
Source of data:	Default value
Value applied:	0.47
Justification of choice of data or description of measurement methods and procedures applied:	According to the applied tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities"[70] a default value of 0.47 is used
Any comment:	N/A

Data Unit / Parameter:	B_{FOREST}
Data unit:	t d.m. ha^{-1}
Description:	Default above-ground biomass content in forest in the region/country where the A/R project is located

[70] AR-TOOL14. http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-14-v3.0.0.pdf

Source of data:	Table 3A.1.4 of IPCC GPG-LULUCF 2003 (value for Senegal)
Value applied:	30
Justification of choice of data or description of measurement methods and procedures applied:	According the tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities"[71] values from Table 3A.1.4 of IPCC GPG-LULUCF 2003 are used unless transparent and verifiable information can be provided to justify different values
Any comment:	N/A

Data Unit / Parameter:	R_{TREE_BSL}
Data unit:	Dimensionless
Description:	Root-shoot ratio for the trees in baseline
Source of data:	Default value
Value applied:	0.25
Justification of choice of data or description of measurement methods and procedures applied:	According the tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities"[72] a default value of 0.25 is used unless transparent and verifiable information can be provided to justify different value
Any comment:	N/A

Data Unit / Parameter:	ΔB_{FOREST}
Data unit:	t d.m. ha^{-1} yr^{-1}
Description:	Default average annual increment in above-ground biomass in forest in the region/country where the A/R project is located
Source of data:	Table 3A.1.5 of IPCC GPG-LULUCF 2003
Value applied:	For the years 1-20: 1.2

[71] AR-TOOL14. http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-14-v3.0.0.pdf
[72] AR-TOOL14. http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-14-v3.0.0.pdf

	For the years 21-25: 0
Justification of choice of data or description of measurement methods and procedures applied:	Mean value from Table 3A.1.5 of IPCC GPG-LULUCF 2003 for Africa (dry climate) has been chosen for the project years 1-20. After that year, in accordance with the used tool, it is assumed that the biomass in baseline reaches steady-state and thus the parameter is taken to be zero.
Any comment:	(a) Tree biomass may reach a steady state when biomass growth becomes zero or insignificant – either because of biological maturity of trees or because the rate of anthropogenic biomass extraction from the area is equal to the rate of biomass growth. Therefore, this parameter should be taken to be zero after the year in which tree biomass in baseline reaches a steady state. The year in which tree biomass in baseline reaches steady-state is taken to be the 20th year from the start of the project activity, unless transparent and verifiable information can be provided to justify a different year; (b) When land is subjected to periodic slash-and-burn practices in the baseline, the average tree biomass is constant, and hence value of this parameter is set equal to zero.

Data Unit / Parameter:	**CF_S**
Data unit:	t C (t.d.m.)$^{-1}$
Description:	Carbon fraction of shrub biomass
Source of data:	IPCC default value
Value applied:	0.47
Justification of choice of data or description of measurement methods and procedures applied:	According to the applied tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities"[73] IPCC default value of 0.47 is used
Any comment:	N/A

Data Unit / Parameter:	**R_s**

[73] AR-TOOL14. http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-14-v3.0.0.pdf

Data unit:	Dimensionless
Description:	Root-shoot ratio for shrubs
Source of data:	Tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities"[74]
Value applied:	0.40
Justification of choice of data or description of measurement methods and procedures applied:	The value of R_S shall be 0.40 [Table 4.4 of 2006 IPCC Guidelines for National Greenhouse Gas Inventories] unless transparent and verifiable information can be provided to justify different values
Any comment:	N/A

Data Unit / Parameter:	**BDR_{SF}**
Data unit:	Dimensionless
Description:	Ratio of biomass per hectare in land having a shrub crown cover of 1.0 (i.e. 100%) and the default above-ground biomass content in forest in the region/country where the A/R project is located
Source of data:	A default value of the tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities"[75]
Value applied:	0.10
Justification of choice of data or description of measurement methods and procedures applied:	A default value of 0.10 should be used unless transparent and verifiable information can be provided to justify a different value
Any comment:	N/A

Data Unit / Parameter:	**R_j**
Data unit:	Dimensionless
Description:	Root-shoot ratio for tree species j
Source of data:	Calculated
Value applied:	For the *ex ante* values see the Excel-file "Calculations_ex_ante_First_instance" and

[74] AR-TOOL14. http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-14-v3.0.0.pdf
[75] AR-TOOL14. http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-14-v3.0.0.pdf

	"Calculations_ex_ante Grouped_project".
Justification of choice of data or description of measurement methods and procedures applied:	The value of Rj is calculated as R = exp[-1.085+0.9256*ln(A)]/A, where A is above-ground biomass content (t d.m. ha-1) [Table 4.A.4 of IPCC GPGLULUCF 2003] unless transparent and verifiable information can be provided to justify different values.
Any comment:	N/A

Data Unit / Parameter:	CF_{TREE}
Data unit:	t C (t d.m)$^{-1}$
Description:	Carbon fraction of tree biomass
Source of data:	Default value
Value applied:	0.47
Justification of choice of data or description of measurement methods and procedures applied:	According to the applied tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities"[76] a default value of 0.47 is used as there is not available transparent and verifiable information to justify a different value.
Any comment:	N/A

Data Unit / Parameter:	$f_j(x1_{p,i,t}, x2_{p,i,t}, x3_{p,i,t}, \ldots)$
Data unit:	t d.m.
Description:	Function relating measured tree dimensions (x1, x2, x3, …) to above-ground tree biomass
Source of data:	For the *ex ante*: Ghezehei et al. (2009)[77] For the *ex post*: The equation will be chosen and demonstrated to be appropriate later.
Value applied:	For *ex ante* $$fj(B_D) = \frac{a \cdot B_D^{\ b}}{10^6}$$

[76] AR-TOOL14. http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-14-v3.0.0.pdf
[77] Ghezehei B, Annandale JG and Everson CD (2009), Shoot allometry of Jatropha curcas, Southern Forests, 2009.

	a = $2.83*10^{-4}$ b = 3.529 Where: $fj(B_D)$ Above ground biomass per tree (t d.m.) B_D Basal diameter at stem base (mm)
Justification of choice of data or description of measurement methods and procedures applied:	For *ex ante* estimation the allometric equation applicable to a tree species is selected from the following sources (the most preferred source being listed first): (a) Existing data applicable to local situation (e.g. represented by similar ecological conditions); (i) National data (e.g. from national forest inventory or national GHG inventory); (ii) Data from neighbouring countries with similar conditions; (iii) Globally applicable data. For *ex post* estimation, the allometric equation used must be demonstrated to be appropriate for the purpose of estimation of tree biomass by applying the tool "Demonstrating appropriateness of allometric equations for estimation of aboveground tree biomass in A/R CDM project activities"
Any comment:	N/A

Data Unit / Parameter:	t_{VAL}
Data unit:	dimensionless
Description:	Two-sided Student's t-value, at infinite degrees of freedom in the first iteration and at degrees of freedom equal to (n-1) in subsequent iterations, for the required confidence level; dimensionless
Source of data:	Student's t-distribution table available in the tool "Calculation of the number of sample plots for measurements within A/R CDM project activities"[78]
Value applied:	1.96
Justification of choice of data or description	The selected t_{VAL} 1.96 is equal for the confidence

[78] EB 58, Annex 15. http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-03-v2.1.0.pdf

of measurement methods and procedures applied:	level 95 % and degree of freedom "infinite".
Any comment:	This parameter is used for calculating the number of sample plots. See Excel-file “Sample plot size_ex_ante”.

Data Unit / Parameter:	**E**
Data unit:	t d.m. ha^{-1}
Description:	Acceptable margin of error (i.e. one-half the confidence interval) in estimation of biomass stock within the project boundary; in units used for s_i.
Source of data:	Calculated
Value applied:	7.30
Justification of choice of data or description of measurement methods and procedures applied:	The selected value is calculated as 15% of the mean biomass stock within the project boundary.
Any comment:	This parameter is used for calculating the number of sample plots. See Excel-file “Sample plot size_ex_ante”.

Data Unit / Parameter:	$\mathbf{SOC_{REF,i}}$
Data unit:	t C ha^{-1}
Description:	Reference SOC stock corresponding to the reference condition in native lands (i.e. non-degraded, unimproved lands under native vegetation – normally forest) by climate region and soil type applicable to stratum i of the areas of land
Source of data:	Default value
Value applied:	31
Justification of choice of data or description of measurement methods and procedures applied:	According to the applied tool “Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities” [79] a default value of 31 for tropical dry climate with sandy soils.
Any comment:	N/A

[79] EB 60, Annex 12. http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-16-v1.1.0.pdf

Data Unit / Parameter:	$f_{LU,i}$
Data unit:	dimensionless
Description:	Relative stock change factor for baseline land-use in stratum i of the areas of land
Source of data:	Default value
Value applied:	1.00
Justification of choice of data or description of measurement methods and procedures applied:	Table 6 of the applied tool "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities" [80] gives 1.00 as a relative stock change factor for grassland management.
Any comment:	N/A

Data Unit / Parameter:	$f_{MG,i}$
Data unit:	dimensionless
Description:	Relative stock change factor for baseline management regime in stratum i of the areas of land
Source of data:	Default value
Value applied:	0.97
Justification of choice of data or description of measurement methods and procedures applied:	Table 6 of the applied tool "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities" [81] gives a default value of 0.97 for moderately degraded grassland in tropical climate regime.
Any comment:	N/A

Data Unit / Parameter:	$f_{IN,i}$
Data unit:	dimensionless
Description:	Relative stock change factor for baseline input

[80] EB 60, Annex 12. http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-16-v1.1.0.pdf
[81] EB 60, Annex 12. http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-16-v1.1.0.pdf

	regime (e.g. crop residue returns, manure) in stratum i of the areas of land
Source of data:	Default value
Value applied:	1.00
Justification of choice of data or description of measurement methods and procedures applied:	According the Table 6 of the applied tool "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities" [82] an input factor of 1 is used for all grassland without input of fertilizers.
Any comment:	N/A

4.2 Data and Parameters Monitored

Data Unit / Parameter:	$A_{BSL,i}$
Data unit:	Ha
Description:	Area of stratum i in the baseline, delineated on the basis of tree crown cover at the start of the A/R project activity; ha
Source of data:	Field measurement
Description of measurement methods and procedures to be applied:	Standard operating procedures (SOPs) prescribed under national forest inventory are applied. In the absence of these, SOPs from published handbooks, or from the IPCC GPG LULUCF 2003, are applied
Frequency of monitoring/recording:	Every five years since the year of the initial verification
Value applied:	For the baseline situation:

	Area (ha)	
Shrub stratum	First instance	Grouped area
Stratum 1	574.34	1411.34

Monitoring equipment:	N/A
QA/QC procedures to be applied:	Quality control/quality assurance (QA/QC) procedures prescribed under national forest inventory are applied. In the absence of these, QA/QC procedures from published handbooks, or

[82] EB 60, Annex 12. http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-16-v1.1.0.pdf

	from the IPCC GPG LULUCF 2003, are applied
Calculation method:	N/A
Any comment:	N/A

Data Unit / Parameter:	$A_{SHRUB,i,t}$
Data unit:	Ha
Description:	Area of shrub biomass stratum i at a given point of time in year t
Source of data:	Field measurement
Description of measurement methods and procedures to be applied:	Standard operating procedures (SOPs) prescribed under national forest inventory are applied. In the absence of these, SOPs from published handbooks, or from the IPCC GPG LULUCF 2003, are applied
Frequency of monitoring/recording:	Every five years since the year of the initial verification
Value applied:	For the baseline situation:

	Area (ha)	
Shrub stratum	First instance	Grouped area
Stratum 1	344,38	846.80
Stratum 2	229,96	564.54

For the project situation, *ex ante* estimations:

	Area (ha)	
Shrub stratum	First instance	Grouped area
Stratum 1	574.34	1411.34

Monitoring equipment:	N/A
QA/QC procedures to be applied:	Quality control/quality assurance (QA/QC) procedures prescribed under national forest inventory are applied. In the absence of these, QA/QC procedures from published handbooks, or from the IPCC GPG LULUCF 2003, are applied
Calculation method:	N/A
Any comment:	N/A

Data Unit / Parameter:	**$CC_{TREE\_BSL,i}$**
Data unit:	Dimensionless
Description:	Crown cover of trees in the baseline, in baseline stratum i, expressed as a fraction (e.g. 10% crown cover implies $CC_{TREE\_BSL,i}$ =0.10)
Source of data:	Field observation
Description of measurement methods and procedures to be applied:	Considering that the biomass in trees in the baseline is smaller compared to the biomass in trees in the project, a simplified method of measurement may be used for estimating tree crown cover. Ocular estimation of tree crown cover may be carried out or any other method such as the line transect method or the relascope method may be applied
Frequency of monitoring/recording:	Every five years since the year of the initial verification and as well at the time of planting of new project instances
Value applied:	For *ex ante* estimations: 0.01
Monitoring equipment:	N/A
QA/QC procedures to be applied:	Quality control/quality assurance (QA/QC) procedures prescribed under national forest inventory are applied. In the absence of these, QA/QC procedures from published handbooks, or from the IPCC GPG LULUCF 2003, are applied
Calculation method:	
Any comment:	Only one baseline tree crown cover stratum has been identified *ex ante*.

Data Unit / Parameter:	$CC_{SHRUB,i,t}$
Data unit:	Dimensionless
Description:	Crown cover of shrubs in shrub biomass stratum i at a given point of time in year t
Source of data:	Field measurement
Description of measurement methods and procedures to be applied:	Considering that the biomass in shrubs is smaller than the biomass in trees, a simplified method of measurement may be used for estimating shrub crown cover. Ocular estimation of crown cover may be carried out or any other method such as

<table>
<tr><td></td><td>the line transect method or the relascope method may be applied</td></tr>
<tr><td>Frequency of monitoring/recording:</td><td>Every five years since the year of the initial verification and as well at the time of planting of new project instances</td></tr>
<tr><td>Value applied:</td><td>For the baseline situation:
<table>
<tr><td>Shrub stratum</td><td>$CC_{SHRUB,t}$</td></tr>
<tr><td>Stratum 1</td><td>0.05*</td></tr>
<tr><td>Stratum 2</td><td>0.10*</td></tr>
</table>
*one half of observed maximum shrub crown cover

For the project situation, ex ante estimations:
<table>
<tr><td>Shrub stratum</td><td>$CC_{SHRUB,t}$</td></tr>
<tr><td>Stratum 1</td><td>0</td></tr>
</table></td></tr>
<tr><td>Monitoring equipment:</td><td>N/A</td></tr>
<tr><td>QA/QC procedures to be applied:</td><td>Quality control/quality assurance (QA/QC) procedures prescribed under national forest inventory are applied. In the absence of these, QA/QC procedures from published handbooks, or from the IPCC GPG LULUCF 2003, are applied</td></tr>
<tr><td>Calculation method:</td><td>N/A</td></tr>
<tr><td>Any comment:</td><td>(a) When land is subjected to periodic slash-and-burn practices in the baseline, an average shrub crown cover equal to default value of 0.5 is used in Equation (35) unless transparent and verifiable information can be provided to justify a different value;

The baseline shrub cover was confirmed from the satellite imagines as described in section 1.10 and two different stratums were observed: For the region of Kaffrine maximum estimated shrub crown cover was 20 % (Stratum 2) and for the other areas the maximum shrub crown cover was 10 % (Stratum 1). As the project area is subjected to periodic slash-and-burn practices, a crown cover, $CC_{SHRUB,i,t}$, equal to a one half of the observed maximum shrub crown covers is applied for each stratum.

(b) Ex ante estimation of shrub crown cover at a time other than at the start of the project is carried out with the following considerations in view:

(i) Shrub crown cover is assumed to remain at the preproject level unless transparent and</td></tr>
</table>

	verifiable information can be provided to justify a different rate of change; (ii) When land is abandoned, shrubs may encroach such land and shrub crown cover may reach the maximum value of 1.0 over a period of 20 years from the year in which the land is abandoned. If the year in which the land is abandoned is not known, then an average crown cover of 0.50 is assumed at the start of the project.

Data Unit / Parameter:	T
Data unit:	Year
Description:	Time period elapsed between two successive estimations of carbon stock in trees and shrubs
Source of data:	Recorded time
Description of measurement methods and procedures to be applied:	N/A
Frequency of monitoring/recording:	-
Value applied:	N/A
Monitoring equipment:	N/A
QA/QC procedures to be applied:	-
Calculation method:	N/A
Any comment:	If the two successive estimations of carbon stock in trees are carried out at different points of time in year t_2 and t_1, (e.g. in the month of April in year t_1 and in the month of September in year t_2), then a fractional value is assigned to T.

Data Unit / Parameter:	$A_{BURN,i,t}$
Data unit:	Ha
Description:	Area burnt in stratum i in year t; ha
Source of data:	Field measurement or remote sensing measurement
Description of measurement methods and procedures to be applied:	The area shall be delineated either on the ground using GPS or from georeferenced remote sensing data
Frequency of monitoring/recording:	This area is measured whenever forest fire has occurred

Value applied:	N/A
Monitoring equipment:	GPS
QA/QC procedures to be applied:	Quality control/quality assurance (QA/QC) procedures prescribed under national forest inventory are applied. In the absence of these, QA/QC procedures from published handbooks, or from the IPCC GPG LULUCF 2003, may be applied
Calculation method:	N/A
Any comment:	Used in equation 7 of the tool "Estimation of non-CO_2 GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity[83] in case the wild fires occurs.

Data Unit / Parameter:	$A_{p,i}$
Data unit:	ha
Description:	Area of sample p in stratum i
Source of data:	The area of each sample plot is 0.01 ha (50m * 2m). The total number of sample plots in each stratum is calculated with "Calculation of the number of sample plots for measurements within A/R CDM project activities" (version 02.1.0)[84]
Description of measurement methods and procedures to be applied:	Standard operating procedures (SOPs) prescribed under national forest inventory are applied. In the absence of these, SOPs from published handbooks, or from the IPCC GPG LULUCF 2003, are applied
Frequency of monitoring/recording:	Every five years since the year of the initial verification
Value applied:	For *ex ante* situation the following values are estimated for the first project instance:

Stratum	$A_{p,i}$ (ha)
Stratum 1	0.05
Stratum 2	0.02
Stratum 3	0

[83] EB 65, Annex 31. http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-08-v4.0.0.pdf
[84] EB 58, Annex 15. http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-03-v2.1.0.pdf

	Stratum 4	0.15
	Stratum 5	0.07
	Stratum 6	0.10
	Stratum 7	0.06
Monitoring equipment:	GPS	
QA/QC procedures to be applied:	Quality control/quality assurance (QA/QC) procedures prescribed under national forest inventory are applied. In the absence of these, QA/QC procedures from published handbooks, or from the IPCC GPG LULUCF 2003, are applied	
Calculation method:	N/A	
Any comment:	Sample plot location is registered with a GPS and marked on the project map.	

Data Unit / Parameter:	n_i	
Data unit:	Dimensionless	
Description:	Number of sample plots in stratum i	
Source of data:	Calculated	
Description of measurement methods and procedures to be applied:	N/A	
Frequency of monitoring/recording:	n_i is calculated every for each monitoring event, at least every five years	
Value applied:	For *ex ante* situation the following values are estimated for the first project instance:	
	Stratum	**n_i**
	Stratum 1	5
	Stratum 2	2
	Stratum 3	0
	Stratum 4	15
	Stratum 5	7
	Stratum 6	10
	Stratum 7	6
Monitoring equipment:	N/A	
QA/QC procedures to be applied:	N/A	
Calculation method:	The calculation method is described in the tool “Calculation of the number of sample plots for measurements within A/R CDM project activities”	

	(version 02.1.0)[85]
Any comment:	N/A

Data Unit / Parameter:	w_i
Data unit:	Dimensionless
Description:	Ratio of the area of stratum i to the sum of areas of biomass estimation strata
Source of data:	Calculated
Description of measurement methods and procedures to be applied:	N/A
Frequency of monitoring/recording:	w_i is calculated every for each monitoring event, at least every five years
Value applied:	For *ex ante* situation the following values are estimated for the first project instance:

Stratum	**w_i**
Stratum 1	0.051
Stratum 2	0.031
Stratum 3	0.002
Stratum 4	0.252
Stratum 5	0.168
Stratum 6	0.268
Stratum 7	0.228

Monitoring equipment:	N/A
QA/QC procedures to be applied:	N/A
Calculation method:	w_i is equal to the area of the stratum i divided by the project area
Any comment:	N/A

Data Unit / Parameter:	B_D
Data unit:	mm
Description:	Diameter at stem base
Source of data:	Physical measurements
Description of measurement methods and	Physical measurement of the trees in the sample

[85] EB 58, Annex 15. http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-03-v2.1.0.pdf

procedures to be applied:	plots, measurement taken at stem base.
Frequency of monitoring/recording:	B_D of trees in sample plots is measured and recorded every five years by ANOC
Value applied:	For *ex post*: field measurements in sample plots. For *ex ante*: the following estimates are used[86] Age of the plant: B_D (mm) 1: 18 2: 36 3: 37 4: 67 5: 89 6: 111 7: 133 8: 148 9: 158 10: 162
Monitoring equipment:	Computer and database
QA/QC procedures to be applied:	Part of overall QA/QC procedures discussed in Section 4.3.
Calculation method:	Basal diameter will be calculated out the measured perimeter which can be considered as a circle
Any comment:	N/A

Data Unit / Parameter:	N
Data unit:	Dimensionless
Description:	Total number of possible sample plots within the project boundary (the sampling space or the population)
Source of data:	Calculated
Description of measurement methods and procedures to be applied:	N/A
Frequency of monitoring/recording:	N is calculated every for each monitoring event, at least every five years.

[86] Diameter range estimations are based on on the field measurements made summer 2013 on the first project instance. Conservatively as maximum diameter is used the maximum value measured (162 mm) even though it is supposed the plants will grow bigger.

Value applied:	For *ex ante* situation the following value is estimated for the first project instance: 57,434
Monitoring equipment:	N/A
QA/QC procedures to be applied:	N/A
Calculation method:	N is equal to project area divided by the size of the sample plot (574.34 ha/0.01 ha = 57,434)
Any comment:	N/A

Data Unit / Parameter:	s_i
Data unit:	t d.m. ha^{-1}
Description:	Estimated standard deviation of biomass stock in stratum i. Standard deviation of biomass stock per unit area (in t d.m. ha^{-1}) may also be used for this purpose.
Source of data:	Calculated
Description of measurement methods and procedures to be applied:	Approximate value of the standard deviation of biomass stock in each stratum is either known from existing data related to the project area or existing data related to a similar area, or is estimated from a preliminary sample
Frequency of monitoring/recording:	s_i is calculated every for each monitoring event, at least every five years.
Value applied:	For *ex ante* situation the following values are estimated for the first project instance:

Stratum	**s_i**
Stratum 1	50.70
Stratum 2	33.79
Stratum 3	22.53
Stratum 4	32.19
Stratum 5	21.47
Stratum 6	20.40
Stratum 7	15.30

Monitoring equipment:	N/A
QA/QC procedures to be applied:	N/A
Calculation method:	50 % of the mean biomass stock

Any comment:	N/A

Data Unit / Parameter:	A_i
Data unit:	ha
Description:	The area of stratum i of the areas of land; ha
Source of data:	Field measurement
Description of measurement methods and procedures to be applied:	The area shall be delineated either on the ground using GPS or from georeferenced remote sensing data
Frequency of monitoring/recording:	Every five years since the year of the initial verification
Value applied:	N/A
Monitoring equipment:	GPS
QA/QC procedures to be applied:	Quality control/quality assurance (QA/QC) procedures prescribed under national forest inventory are applied. In the absence of these, QA/QC procedures from published handbooks, or from the IPCC GPG LULUCF 2003, are applied
Calculation method:	N/A
Any comment:	A_i is used for calculating the change in SOC stock.

4.3 Description of the Monitoring Plan

The monitoring plan of the project activity meets the requirements established by the applied methodology AR-ACM0003 (Version 01.0.0). In accordance with the applied methodology the monitoring plan shall provide for collection of all relevant data necessary for

(a) Verification that the applicability conditions listed under paragraphs 3 and 4 have been met;

(b) Verification of changes in carbon stocks in the pools selected; and

(c) Verification of project emissions and leakage emissions.

The data collected shall be archived for a period of at least two years after the end of the last crediting period of the project activity. The precision requirements are those listed in the Verified Carbon Standard and in the in the tool “Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities”[87].

[87] AR-TOOL14. http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-14-v3.0.0.pdf

Moreover, Information shall be provided, and recorded in the project design document (PDD), to establish that the commonly accepted principles and practices of forest inventory and forest management in the host country are implemented. If such principles and practices are not known or available, standard operating procedures (SOPs) and quality control/quality assurance (QA/QC) procedures for inventory operations, including field data collection and data management, shall be identified, recorded and applied. Use or adaptation of SOPs available from published handbooks, or from the "IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry 2003", is recommended.

The organizational structure of monitoring is presented before in figure 9.

a) Verification that the applicability conditions listed under paragraphs 3 and 4 have been met

The verification of the applicability conditions is done through the project boundary monitoring and through forest establishment monitoring.

Monitoring of project boundary will be conducted with field surveys concerning the project boundary within which the project activity has occurred, site by site, measuring geographical positions using GPS and checking that the afforested/reforested areas are in coherence with the eligibility criteria. Project boundaries, as well as any stratification inside the boundary, of all the discrete areas forming each project instance will be defined at the start of the project and every five years from the date of the initial verifications. Geographic coordinates of the measurements will be recorded in a database and archived.

The periodically monitoring of the boundary is done to demonstrate that the actual area afforested conforms to the afforestation area outlined in the project plan. If the forest area changes during the crediting period, for instance, because deforestation occurs on the project area, the specific location and area of the deforested land will be identified. Similarly, if the planting on certain lands within the project boundary fails these lands will be documented. Personnel involved in the monitoring will be trained to identify the changes in the boundary and to record changes in the project database for reporting of project verification.

The forest planting and management plan of each project instances will be provided together with a record of the plan as actually implemented during the project for validation and verification. The record of the plan as actually implemented will be used to ensure that the assumptions made in the *ex ante* assessment still holds in the *ex post* situation

Monitoring of forest establishment and forest management will be done to ensure that it is compliant with this VCS-PD during the complete establishment period, including all major activities that can affect carbon stocks or generate GHG emissions. The inventory operations, including field data collection and data management, will be done following standard operating procedures (SOPs) and quality control/quality assurance (QA/QC) procedures. Established stands will be also monitored with respect to the species and strata pre-defined in the VCS-PD. Any deviation from the planned forest establishment will be documented and justified.

The survival of the sampling will be quantified in the field approximately six months after the planting of each plot. The survival check will repeated every 6th month during the first three years after the planting. If the survival is below 95% of the initial quantity planted, the stand will be replanted with the same species, seeking to maintain the lots homogeneous in terms of age and development. The estimate is made through a simple count of the individuals within each plot, taking on account their vitality state, determining the density of live individuals and finally comparing it to the initial quantity. In case of extensive outbreaks caused by pests, diseases or fire, trees will be replanted.

b) Verification of changes in carbon stocks in the pools selected

Forest management activities (e.g., planting, re-planting, pruning and fruit harvesting) as well as unexpected natural disturbances occurring during the crediting period (e.g., due to fire, pests or disease outbreaks) will be monitored to guarantee that the correct practices are applied in accordance with the management plan and to ensure the health of the stands. In case of the wild fires the area subjected to the fire will be monitored in accordance with the tool "Estimation of non-CO_2 GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity[88].

The growth of individual trees on sample plots will be measured at each monitoring event for the estimation of above-ground tree biomass using allometric model based on stem base diameter. The below ground biomass will be extrapolated from above-ground biomass. In the monitoring plots, diameters at stem base (D) of each tree will be measured.

Pre-existing (baseline) trees and non-tree vegetation will not be measured and accounted for, making the monitoring conservative. Anyhow, the monitoring includes verifying that the baseline trees are not removed i.e monitoring the parameter $CC_{TREE\_BSL,i}$. Pre-existing and planted trees can be differentiated because pre-existing species are different to the planted (Jatropha curcas L.).

If after measuring all permanent plots it is found that the targeted precision level (95/15) is not met, then additional permanent plots will established and measured until the targeted precision level is achieved.

Plots establishment and trees measurements will be done with the following equipment:

- diametric tape or caliper;
- GPS;
- compass;
- measuring tape;
- PVC rods.

Carbon stock changes in living planted trees can be estimated through biomass expansion factors or allometric equations. In this case, for the *ex ante* estimations, the biomass will be estimated using species specific allometric equation observed by Ghezehei et al. (2009)[89].

[88] EB 65, Annex 31. http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-08-v4.0.0.pdf
[89] B Ghezehei, JG Annandale and CD Everson (2009), Shoot allometry of Jatropha curcas, Southern Forests, 2009.

This allometric equation is wildly site independent[90] and it has been demonstrated, for example, to be site-adapted for the conditions of Mali[91]. Before the *ex ante* verification the appropriateness of the selected or other chosen equation will be demonstrated in accordance with the tool "Demonstrating appropriateness of allometric equations for estimation of aboveground tree biomass in A/R CDM project activities".

$$fj(B_D) = \frac{a \cdot B_D^{\ b}}{10^6} \qquad \text{(equation 33)}$$

a ≈ $2.83*10^{-4}$
b ≈ 3.529

Where:

$fj(B_D)$	Above ground biomass per tree (t d.m.)
B_D	Basal diameter at stem base (mm)

c) Verification of project emissions and leakage emissions

According the applied methodology the only increase in GHG emissions within the project boundary which needs to be accounted for is the non-CO_2 GHG emissions from burning of woody biomass for site preparation and/or forest management. The monitoring of emissions is required only if the emissions are considered significant; if insignificant, evidence should be provided (e.g., in the relative part of the monitoring plan of each project instances that the assumption for the exclusion made in the *ex ante* assessment still hold in the *ex post* situation.

As stated in section 1.8 of this document there will be no burning of biomass for site preparation or for forest management. Thus the emissions by sources are considered insignificant and the monitoring of emissions is not needed. Anyway, while monitoring the forest management activities evidences will be provided that the assumption made in the *ex ante* assessment still hold in the *ex post* situation. If needed, for example in the case of wild fires occurs in the project area, the monitoring and estimation of GHG emissions will be done in accordance with the latest version of the tool "Estimation of non-CO_2 GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity[92]".

Under applicability conditions of the applied methodology the only leakage emissions that can occur are the GHG emissions due to displacement of pre-project activities. As described in section 2.4 of this document for the *ex ante* situation the leakage emissions has been

[90] B Ghezehei, JG Annandale and CD Everson (2009), Shoot allometry of Jatropha curcas, Southern Forests, 2009, p.284: "While the inclusion of data from additional sites may make the equations developed here more generalised, the fact that widely differing tree spacing management and growing conditions had no significant effect on allometry indicates that these equations show a potential relevance to other sites."
[91] Jatropha Curcas grouped project in Mali. https://vcsprojectdatabase2.apx.com/myModule/Interactive.asp?Tab=Projects&a=2&i=829&lat=13.1828259998737&lon=-9.32054409999992&bp=1 (site visited 09/04/2013)
[92] EB 65, Annex 31. http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-08-v4.0.0.pdf

estimated to be insignificant. Monitoring activities will ensure that this assumption still hold in the *ex post* situation.

d) Stratification

According the applied methodology if biomass distribution over the project area is not homogeneous, stratification should be carried out to improve the precision of biomass estimation. Different stratifications may be required for the baseline and the project scenarios. In particular:

- For baseline net GHG removals by sinks, it is usually sufficient to stratify the area according to major vegetation types and their crown cover and/or land-use types;
- For actual net GHG removals by sinks the stratification for *ex ante* estimations is based on the project planting/management plan and the stratification for *ex post* estimations is based on the actual implementation of the project planting/management plan. If natural or anthropogenic impacts (e.g. local fires) or other factors (e.g. soil type) significantly alter the pattern of biomass distribution in the project area, then the *ex post* stratification is revised accordingly.

Stratification of project area is done *ex ante* based on the project planting/management plan and updated *ex post* as necessary subsequent to project implementation. The stratification for *ex post* estimations will be based on the actual implementation of the project planting/management plan and thus the number and boundaries of strata defined *ex ante* may change during the crediting period. If natural or anthropogenic impacts or other factors add variability to the growth pattern of the biomass in the project area, then the *ex post* stratification will be revised accordingly. Established strata may be merged if reasons for their establishing have disappeared.

The changes to project strata during the crediting period will be monitored adjusting the sampling frame to the changes in the number and extension of strata. Table 7 shows the seven *ex ante* strata defined for first project instance based on the plantation age and the planting density.

Table 7. *Ex ante* stratification of the first project instance

***Ex ante* strata**	**Planting year**	**Planting density (trees/ha)**	**Area (ha)**
Stratum 1	2009	2,500	29.11
Stratum 2	2009	1,666	17.81
Stratum 3	2009	1,111	1.24
Stratum 4	2010	1,666	144.95
Stratum 5	2010	1,111	96.30
Stratum 6	2011	1,111	153.74
Stratum 7	2011	833	131.19

The *ex post* stratification will be updated periodically because the following events are likely to affect current strata:

- Unexpected disturbances occurring during the crediting period (e.g., due to fire, pests or disease outbreaks), affecting differing impacts on various parts of an originally homogenous stratum;

- Forest management activities (e.g., planting, pruning, re-planting) that are implemented in different intensities, dates and spatial locations differing from the original plan;

- Two or more different strata may be similar enough to allow their merging into one stratum.

Monitoring of strata and stand boundaries will be done using a Geographic Information System (GIS), which allows data from different sources to be integrated (including field data, GPS coordinates and possible remote sensing data).

e) Sampling framework

Sample size

Permanent sampling plots will be used for sampling over time to measure and monitor changes in carbon stocks. Each sampling plot will be 50 meter long and 2 meter wide row (0.01 ha). This size and shape is chosen to guarantee that there will be approximately at least 10 trees within the plot boundaries at the end of the crediting period; The smallest initial density of plantation will be 3x4 m (see table 7) and as the recovery rate of plantations is assumed to be around 95%.

The total number of permanent sampling pots is estimated the tool "Calculation of the number of sample plots for measurements within A/R CDM project activities" (version 02.1.0)[93]. Sample plots will be located randomly inside each stratum and measured at least every five years, for verification purposes.

Number of sample plots is calculated with the following equation:

$$n = \frac{N \cdot t_{VAL}^{2} \cdot \left(\sum_i w_i \cdot s_i \right)^2}{N \cdot E^2 + t_{VAL}^{2} \cdot \sum_i w_i \cdot s_i^{2}} \qquad \text{(equation 34)}$$

Where:

Parameter	Description	Comment
n	Number of sample plots required for estimation of biomass stocks within the project the project	Calculated with equation 34

[93] EB 58, Annex 15. Calculation of the number of sample plots for measurement within A/R CDM project activities (Version 02.1.0). http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-03-v2.1.0.pdf

	boundary; dimensionless	
N	Total number of possible sample plots within the project the project boundary (i.e., the sampling space or the population); dimensionless	In case of the first project instance: 57,434 which is equal to the project area (574.34 ha) divided by the size of the sample plot (0.01 ha)
t_{VAL}	Two-sided Student´s t-value, at infinite degrees of freedom, for the required confidence level; dimensionless	1.960 as presented in the used tool (Confidence level of 95%, degree of freedom of "infinite")
w_i	Relative weight of the area of stratum *i* (i.e., the area of the stratum *i* divided by the project area); dimensionless	The relative weight of the area of stratum *i* is equal to the area of the stratum *i* divided by the project area
s_i	Estimated standard deviation of biomass stock in stratum *i*; t.d. (t d.m. ha^{-1})	A standard deviation of 50% of the mean biomass stock within the stratum is used [94]
E	Acceptable margin of error (i.e., one-half the confidence interval) in estimation of biomass stock within the project boundary (i.e., in the units used for s_i); t d.m. (or t d.m. ha^{-1})	A default value equal to 15% of the mean biomass stock within the project is used
i	*1,2,3*... Biomass stock estimation strata within the project boundary	See the table 7

The total number of sample plots will be 45 (Table 8). The number is calculated with the equation 34 presented above and then added 5% more plots as additional quality guarantee. The number of sample plots will be recalculated before the first verification using the actual data from the measurements.[95]

Plots location

The allocation of sample plots among the strata is estimated by following the tool "Calculation of the number of sample plots for measurements within A/R CDM project activities" (version 02.1.0)[96] using the following equation (equation 35):

$$n_i = n \cdot \frac{w_i \cdot s_i}{\sum_i w_i \cdot s_i} \qquad \text{(equation 35)}$$

Where:

Parameter	Description	Comment

[94] Paragraph 6 of "Guidelines on conservative choice and application of default data in estimation of the net anthropogenic GHG removals by sinks" (version 02): http://cdm.unfccc.int/Reference/Guidclarif/ar/methAR_guid26.pdf

[95] See the Excel-file "Sample_plot_size"

[96] EB 58, Annex 15. Calculation of the number of sample plots for measurement within A/R CDM project activities (Version 02.1.0). http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-03-v2.1.0.pdf

n_i	Number of sample plots allocated to stratum *i*, dimensionless	Calculated with equation 35
n	Number of sample plots required for estimation of biomass stocks within the project boundary; dimensionless	Calculated with equation 34
w_i	Relative weight of the area of stratum *i* (i.e., the area of the stratum *i* divided by the project area); dimensionless	The relative weight of the area of stratum *i* is equal to the area of the stratum *i* divided by the project area
s_i	Estimated standard deviation of biomass stock in stratum *i*; t.d. (t d.m. ha^{-1})	A standard deviation of 50% of the mean biomass stock within the stratum is used [97]
i	*1,2,3*... Biomass stock estimation strata within the project boundary	See the table 7

Table 8. Number and allocation of the sample plots for the *ex ante* stratums

Stratum	Number of sample plots allocated to stratum *i* (n_i)
Stratum 1	5
Stratum 2	2
Stratum 3	0
Stratum 4	15
Stratum 5	7
Stratum 6	10
Stratum 7	6
Total number of sample plots (n)	**n = 45**

Permanent sample plots will be located randomly inside each stratum. The random location will be determined with a step wise procedure: First, the allocation inside the different districts of each stratum will be identified randomly. After the random districts has been selected, the random geographical coordinates inside the selected districts will be created [98]. The coordinates will be used as a reference for the starting point of each individual permanent sample plot. The concrete sampling procedure is described more detailed in separate document "Rilevamento parametri biometrici" [99] and the calculation procedures in the file "Sample_plot_size". [100]

Selected sample plots will be identified using GPS and marked on maps to facilitate their location during field work. For each monitoring period, maps will be updated and the data on new planted areas and eventual new sampling plots will be included. Plots will not be marked on site to ensure that they do not receive differential treatment. The geographical position (GPS coordinates), stratum and identification code of each sample plot will be recorded and archived.

[97] Paragraph 6 of "Guidelines on conservative choice and application of default data in estimation of the net anthropogenic GHG removals by sinks" (version 02). http://cdm.unfccc.int/Reference/Guidclarif/ar/methAR_guid26.pdf
[98] Random Point Generator of Geo Midpoint is used for creating the coordinates. http://www.geomidpoint.com/random/
[99] Rilevamento parametri biometrici, CarbonSinkGroup 2013.
[100] See the Excel-file "Sample_plot_size"

f) Monitoring frequency

Although the verification and certification will be carried out every five years after the first verification until the end of the crediting period, the monitoring interval can be less than five years so that enough information can be collected for management purposes. However, it is possible that only the data to be used for verification will be recorded in the database structure used for verifications. Additional data may be kept in a separate bookkeeping system.

g) Quality Assurance/Quality Control plan

Quality assurance

A quality assurance/quality control (QA/QC) plan will be implemented to ensure the net anthropogenic GHG removals by sinks are measured and monitored precisely, credibly, verifiably and transparently. QA/QC control includes steps to control the errors in project boundary, stratification, sampling, measurement, data entry, data analysis, and data maintenance and archiving. This plan will be implemented in two phases, as follows:

First phase: The objective of this phase is to train the measurement groups assigned in each area. The groups will consist of local people whose work will be supervised by the ANOC workers (see Figure 9). The training includes teaching the group leaders to manage and calibrate the various measuring instruments (caliper, diametric tape, compass, GPS, etc.) and to understand and analyze their use. The models and parameters needed for calculating are also explained and analyzed in the first phase.

The first phase will include also specifics trainings for local farmers in Jatropha cultivation, sustainable agricultural and forest management practices. A comprehensive illustrated book on agricultural and forest management practices will be produced, printed and distributed among farmers and representatives in schools and villages.

Second phase: All the theoretical knowledge acquired in the first phase is put into practice in this phase. This will include a practice of the use the instruments. The following activities will be conducted to confirm the proper use of the instruments:

- With the compass and GPS, the groups assigned to each area will establish and measure permanent plots, and calculate their area.
- Once plots are established, information on the trees found inside them will be collected, using appropriated instruments and the forms designed for this purpose. To check the accuracy of the information, the specialist from ANOC will conduct separate measurement and the results will be compared with those obtained by the trained groups.
- Using the information collected, data will be processed to calculate the biomass in plots using the corresponding equations.

Quality control

ANOC will be responsible for planning and for designing a system to control the quality of growth measurements. ANOC will develop formats that will be used to collect random samples which will be used to make comparisons with the information collected by the teams assigned to each area.

This quality control activity will be conducted with the same frequency as that of the measurements (i.e., during the first five years of tree stand growth). Meetings will be held with the persons responsible for processing information in order to review formats, the screening system for information collected, and the databases and calculations.

Survey data are entered into a computer-based information system especially designed for the project. This makes it possible to record, calculate and analyze all inventory information, including calculations of the biomass of permanent parcels. To minimize the possible errors in the process of data entry, the entered data will be reviewed by an independent expert and, where necessary, compared with independent data to ensure that the data are realistic. Communication between all personnel involved in measuring and analyzing of data will be used to resolve any apparent anomalies before the final analysis of the monitoring data. If there are any problems with the monitoring plot data that cannot be resolved, the plot is not used in the analysis. All the electronic data and reports will be copied on durable media, such as compact discs (CDs), and copies of them will be stored in multiple locations.

Conservative approach and uncertainties

The guidelines provided in the document "Guidelines on conservative choice and application of default data in estimation of the net anthropogenic GHG removals by sinks" (Version 02)[101] will be used to ensure that application of default data in estimation of the net anthropogenic GHG removals by sinks results in conservative, but not overly conservative, estimates.

h) Record system

A database will include all information related to the monitoring of project activities: identification codes and coordinates for each sampling plot, dates when sampling has been made, persons involved in the sampling and the sampling results. Database will include also scanned original field notes. The database ensures that all afforested and/or reforested areas within a specific project instance are uniquely defined and are included exclusively in one project, thereby avoiding double accounting of emission removals. The project participant (ANOC) belonging to this grouped project activity and all of its project instances will has concessions for all the lands where the project activities are implemented. The procedure to ensure that double accounting does not occur is the confirmation that a new project instances are not included in the above mentioned project database or in the CDM's project activities database (UNFCCC).

[101] EB 50, Annex 23. Guidelines on conservative choice and application of default data in estimation of the net anthropogenic GHG removals by sinks. http://cdm.unfccc.int/Reference/Guidclarif/ar/methAR_guid26.pdf

5 ENVIRONMENTAL IMPACT

No significant negative environmental impact is foreseen. In relation to Annex I and II of the Government Decree N° 2001 – 282 dated 12 of April 2001 Containing the Application of the Environmental Code and according to the Law Nº 2001 – 01 dated 15 of January 2001 Containing the Environmental Code, there is no need to perform an Environmental Impact Assessment.

Here below is anyhow listed the synthesis of environmental benefits of the project:

- Reduction of soil erosion. Jatropha curcas has proven effective in reducing the erosion of soil by rainwater and wind. The taproot anchors the plant in the ground while the profusion of lateral and adventitious roots near the surface both binds the soil and keeps it from being washed out by heavy rains. Moreover, by lessing wind velocity it also reduce the wind erosion. It improves rainwater seepage especially when planted in lines to form contour bunds. However, these anti-erosion effects are limited by dry season leaf drop. This can be ameliorated by growing drought-resistant ground cover in the agro-forestry system.

- Degraded land rehabilitation. Jatropha curcas acts as a nutrient pump, the taproots are able to extract minerals that have leached down through the soil profile and then return them to the surface through leaf fall, fruit debris and other organic remains.

- Increase of soil organic matter. Thanks to leaves senescence, pruning, fruit coats and press-cake the organic matter is expected to increase. This will lead to an improvement of soil aggregation and soil stability increasing the overall resilience of the ecosystem. The inter-cropped food crops will benefit of a natural protection against grazing, natural phyto-protective action against pests and pathogens.

- Introduction and adoption of agricultural sustainable practices.

- Decreased occurrence of natural fires due to improved land management.

- Fight against Climate Change and Global Warming. The sustainable development of bio-energy crops and the upcoming production of vegetable oil to be used as substitute of fossil fuel will have a positive impact on GHGs emissions. This fully responds to environmental and energy priorities of Senegal, EU and UNFCCC' Convention of Parties (CoPs).

The description of socio-economic benefits of the project is described in a separate document "Socio economic impact analysis"[102].

6 STAKEHOLDER COMMENTS

Recently it has been developed a dedicated web-page (http://www.carbonsink.it/ar-jatropha-agroforestry-senegal-project/) in order to disseminate the results of the initiative, give the opportunity of check the state of the project in real time, and interact directly with project

[102] Socio economic impact analysis, CarbonSinkGroup 2013.

participants through the feeds on social networks (e.g., facebook, twitter) as well as updated tools (e.g. project blog).

A coherent series of discussion groups/seminars aimed at specific targeted public were organized. In total, approximately 600 people participated providing different levels of information and reflection. Thanks to concise presentations, the objective was to inform people about the implementation of the proposed project activity as well as show expected impacts and benefits. A great deal of time was dedicated to the listening of local participants and answering their queries.

In particular, discussion groups took place with male and female hand-workers[103] in the following dates and places:

- 15/12/2011 in the Ourour rural community;
- 05/01/2012 in the Colobane Grand Place;
- 10/01/2012 in the Ourour village centre.

Figure 20. Meeting with local stakeholders (Author: L. Galbiati)

The main comments provided by local stakeholders during the above mentioned discussion groups were:

- The vast majority of the population knows and approves the proposed reforestation project.

[103] Local stakeholders meeting (1), Local stakeholders meeting (2) and Local stakeholders meeting (3)

- Local people requires particular attention to be given to the issues related to the land use.
- The water lack is a fundamental problem in this region; in the center of Ourour village the drinkable water is slightly salty due on limited deepness of the present sources (Figure 21)
- Some worries have been expressed regarding the risk of fires.
- The most important expectation concern the job creation and infrastructures maintenance.
- Several villages wish to benefit from reforestation project activities.

Figure 21. People who are procuring water from a well (Author: L. Galbiati)

The answers given by project participants were as follows:

- Concerning issues related to land use and possible population flows, the meetings have defined that the project implementation would allow an improved control of these two factors (thanks to the permanent presence on site of staff members in charge of management).
- A key-objective is the building of some wells in the area, to improve the drinking water quality and to irrigate the nurseries dedicated to provide saplings for the Jatropha curcas plots.
- Regarding the risk of fires, the proposed project will improve the management of the land around the villages and the surroundings territory, besides of reforestation that will improve the trees cover of the land as well as the deletion of the herbs responsible in the fire events during the dry season.
- The project will create both permanent and temporary jobs. In the beginning, the priority will be given to local recruitment but, generally speaking, the policy will be “recruitment, training, and selection” so as to set up a team of expert specialists (e.g., highly skilled, qualified, etc.) in all involved disciplines.

- In response to these expectations, the research and development unit planned in the flow chart (Figure 9) will be able to develop proper forestry techniques and a adequate working methodology, for example through the system of local cooperatives.