3 Description of the Project

3.1 Operation

3.1.1 Nursery Stage

3.1.1.1 Georeferencing

The following table shows the georeferencing of the nursery and the greenhouse which are located in the San Cristóbal Estate. The flat coordinate system is Magna Colombia Este Este.

Table 3.1: Coordinates permanent nursery San Cristobal Estate

Point	Flat coordinates	
	X	Y
1	916138,6944	1172012,087
2	916158,2281	1171910,372
3	916198,8292	1171919,838
4	916179,5838	1172008.65
5	916162,9756	1172005,601
6	916158.6925	1172020,968

Source: FFC , 2017)

Table 3.2: Coordinates greenhouse nursery San Cristobal

Point	Flat coordinates	
	X	Y
1	916201,7366	1172018,756
2	916220,3964	1171950,221
3	916261,6127	1171960,301
4	916244,1879	1172032,521

Source: FFC , 2017)

Table 3.3: Supply nursery coordinates Toro I

Point	Flat coordinates	
	X	Y
1	978124,252	1169970,438
2	978127,0205	1169974,123
3	978133,474	1169966,134
4	978137,1644	1169969,511

Source: Information provided by Forestal de la Orinoquia

3.1.1.2 Type *of Nursery*

The project nursery will be established under the Jiffy plant production system, this system revolves around Jiffy peat pellets or tablets that are pressed peat units wrapped in a biodegradable mesh, which expand vertically once moistened.

Figure 3.1: Jiffy pellets

Source: Technical specifications of (Jiffy Products International BV)

These Jiffy pickups as seen in Figure 3.1 are containers of seedlings, which have soft walls that allow roots to develop laterals and voters in an optimal way and without restrictions. The seedlings will be produced in the permanent nursery of San Cristóbal, registered with the ICA and subsequently transported to Toro 1 farm on Jiffy trays to a temporary nursery that will be established on said farm, whose main purpose will be hydration and russification of seedlings for planting. Orinoquia Forest provides forestry services at Toro 1 farm.

The seeding process is done mechanically with the planter Jiffy nursery, which plants the seeds in the pellets (substrate), with a maximum capacity of 120,000 units per day. Once the seeds are sown, the trays are located in the nursery benches, as seen in Figure 3.2. These benches are covered with poly shadow to maintain a microclimate of moisture in the plant material and thus prevent birds or rains from eroding the seeds.

Figure 3.2: Nursery benches, location of planted pellets

Source: (Environmental Economic Assessment, 2017)

Seedlings should have a uniform size, which varies depending on the succulent plants are sent in the months of greatest rainfall approximately 30 – 45 days old, and in the months of least rainfall rustified plants between 60 – 75 days old.

Figure 3.3: Forest nursery of the Orinoquia- San Cristóbal Seedlings of Acacia Mangium

Source: (Environmental Economic Assessment, 2017)

Figure 3.4: Forest Greenhouse of the Orinoquia-San Cristóbal Estate

Source: (Environmental Economic Assessment, 2017)

Permanent nursery: Is located in the main San Cristóbal estate, that is where the plant material will be produced permanently for 10 months of the year and will supply the requirements for planting in the field and to the nursery of catering in other properties.

Supply nursery: Is located on Toro I, under the model of FMS forest services, has a capacity of 60 thousand seedlings.

Figure 3.5: Supply nursery Toro I site to which Forestal is the Orinoquia Provides Forest Services

Source: FFC , 2017)

It is planned to establish another supply nursery on the site Tierradentro, with an approximate capacity of 100,000 seedlings.

3.1.1.3 Nursery area

- *Areas of distribution of plant material (Access and roads communication):* The lines marked in red are the areas of distribution of material, here the personnel in charge of the activities in the nursery, in the case of the outdoor nursery has a width of 4.5 meters allowing transit in. The greenhouse has a width of 4 meters. Finca San Cristóbal Nursery Area: 4,700m² outdoors (outdoor nursery) and 2,700m² under greenhouse.

Figure 3.6: Permanent nursery area located in San Cristóbal

Source: Satellite images available from the remote sensor Digitalglobe Google Earth. Cartographic edition (Forestry of the Orinoquia, 2017)

For the development of the project an additional nursery will be built in San Cristobal.

- *Access and communication routes (Nursery):* Road access to the nursery corresponds to the national highway (Port Carreño- Puerto López), this is the parallel road to the Meta River, with few kilometers of paved road, and the rest corresponds to track passable in summer time. The distance from the national highway to camp where the outdoor nursery and greenhouse of San Cristóbal is located is approximately 5 km with an unsurfaced road.

- *Soil conditions and fertility:* As mentioned above, Jiffy-7® Pellets will be used as substrate: Jiffy Pellets or tablets are units of pressed and inert peat wrapped in a mesh, which, when moistened, expand vertically.

Jiffy-7® Forest Pellets-Specifications:

Peat: They are made with peat (*sphagnum* –Scale Von Post 2-3) High quality selected. They come wrapped in a fine mesh, respectful with the environment.
pH: They have a standard pH adjusted with dolomitic lime between 4.5 to 5.
Moisture content: Approximately 20%.

Figure 3.7: Jiffy-7® Forest Pellets

Source: Technical specifications of (Jiffy Products International BV)

- *Water supply:* For water supply for the nursery Caño Muco surface shot will be required for operation first in the pellets which are sent dry and compressed to facilitate transport and storage in the nursery, followed in the process of seedling growth for the irrigation and fertigation system (nutritive solution).

  The collection is carried out with a 2.5 HP pump and a 5 pipe inches, which passes through sediment filters and is distributed with micro sprinklers located in each of the nursery banks in the case of the irrigation system and disperse the nutritional mix solution in the nursery with hoses in the case of fertigation.

- *The topography of the area:* The topography of the land is flat and corresponds to the eastern plains of Orinoquia, in the case of the nursery area systems are constituted topographic maps with heights between

75 and 90 meters above sea level, for the San Cristóbal nursery location, which can be seen in the following figure, where it is observed that the project area is at heights not over 100 meters above sea level.

Figure 3.8: Physical map of the department of Vichada IGAC

Source: IGAC

- *The species to propagate:* The species to propagate will be Acacia mangium and Eucalyptus pellita. Local seed (Colombia) will be used for the development of plant material since the suppliers (El seedbed and Refocosta) are producers of certified seed and have historical information on the ability to species adaptation for Colombia. Origin and quality of the seed:

  - Acacia Mangium
    Common N.: Acacia Mangium
    N. Scientist: *Acacia Mangium*
    Family: *Fabaceae*
    Tierra Alta Córdoba, El Semillero supplier 1
    Cabuyaro Meta, El Semillero supplier

Figure 3.9: Acacia Mangíum

Source: (Environmental Economic Assessment, 2017)

  - Eucalyptus Pellita
    N. Common: Eucalyptus
    N. Scientist: *Eucalyptus pellita*
    Family: *Myrtaceae*

Villanueva Casanare, Refocosta supplier.

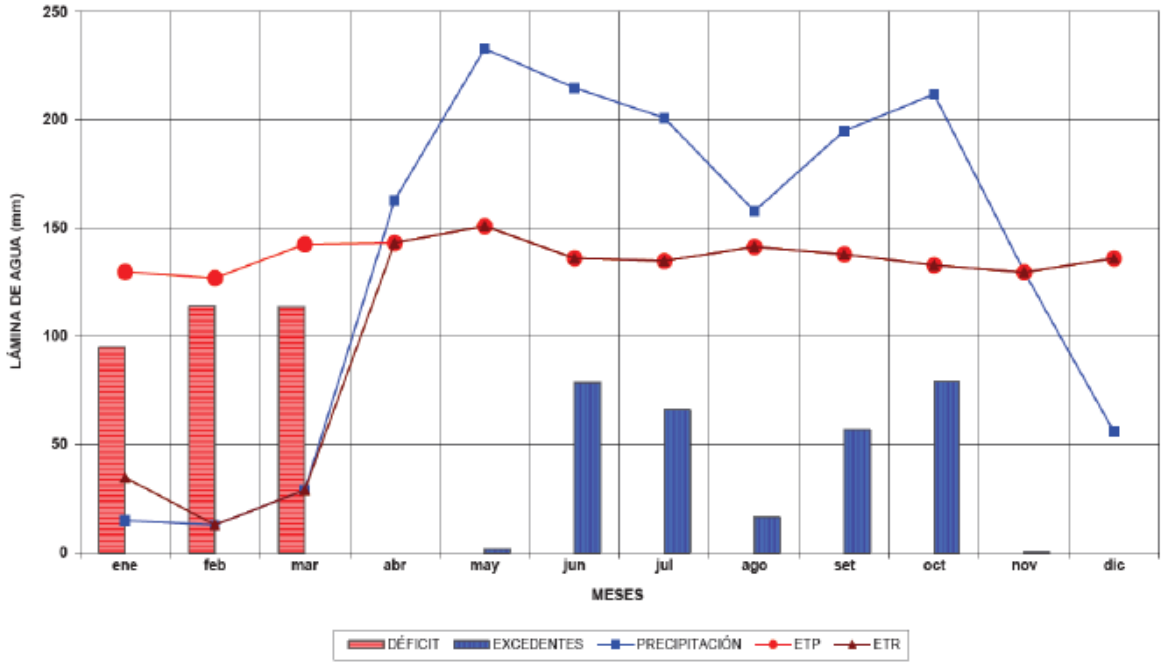
Figure 3.10: Eucalyptus Pellita

Source: (Environmental Economic Assessment, 2017)

- *Climate and ecological conditions:* In general terms the study area is found in the bh-T formation (Holdridge, 1978), the dominant climate in the area covers the Awi and the Ami between 26 – 28°C (Koppen, 1954), with seasonality marked and monomodal type; warm thermal floor, and super wet

  A single mode regime is observed for the area, with a dry season between December and April and a wet season from April to November. The annual rainfall is 2,398mm, with an average monthly rainfall of 199.8 mm (IDEAM, 2010). In addition, FFC performs its own measurements with several stations on farms with operations.

Graph 1: Water Balance Puerto Carreño station



Source: (IGAC, 2014)

As can be seen in the previous graph, there are two well-defined periods, three marked months in deficit and 6 months marked with surpluses of precipitation. Historical records and compiled own measurements by FFC show that this seasonality is stable since there are records (i.e. 1974 – today).

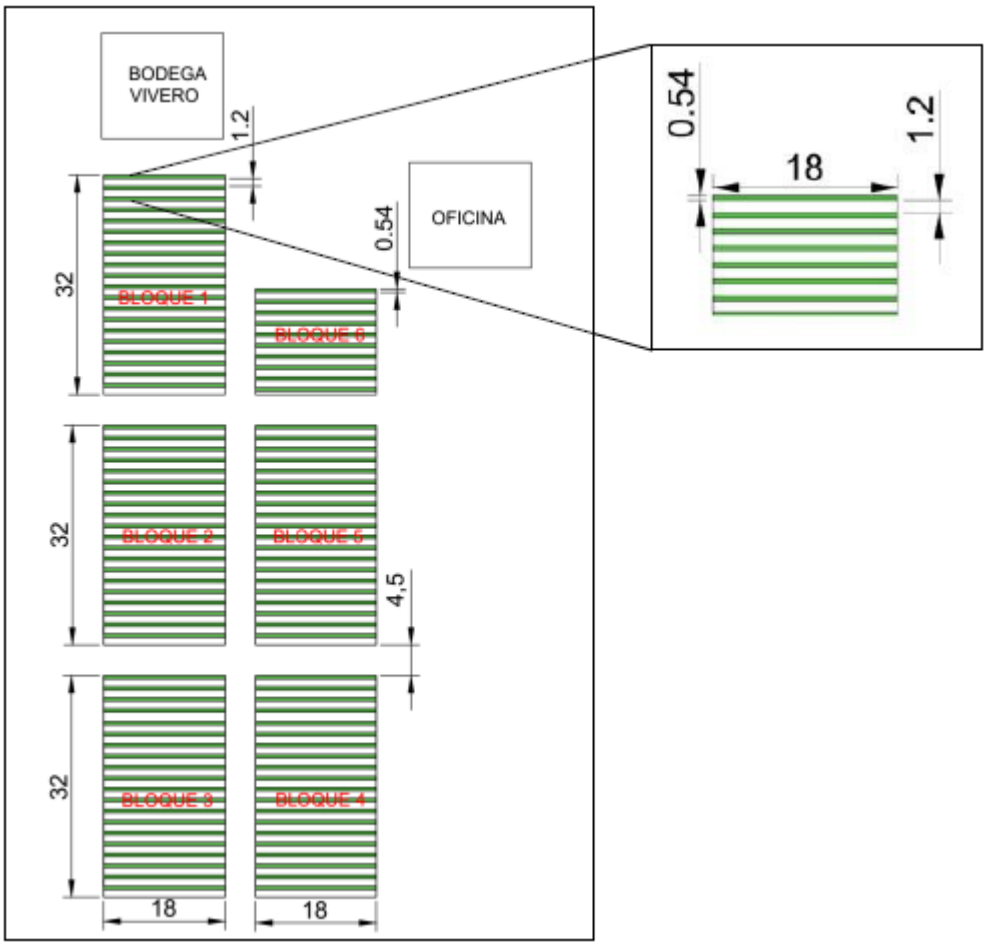
Based on the Orinoquia Forest precipitation distribution establishes the annual planting cycle between mid-March until end of November at the beginning of the cycle as at the end of the cycle, Forestry of the Orinoquia includes the use of hydro retainer within the practices foresters.

3.1.1.4 Growth Areas

San Cristobal Outdoor Nursery - Acacia

The dimensions of the seedling development sites in the outdoor nursery of San Cristobal, are designed of 0.54 meters of bank width and 18 meters of length (see Figure 3.11). The distance between growth areas is 1.2 meters, which allows the transit of operations.

Figure 3.11: Dimensions and distribution of the outdoor nursery



Source: VEA based on information from FFC

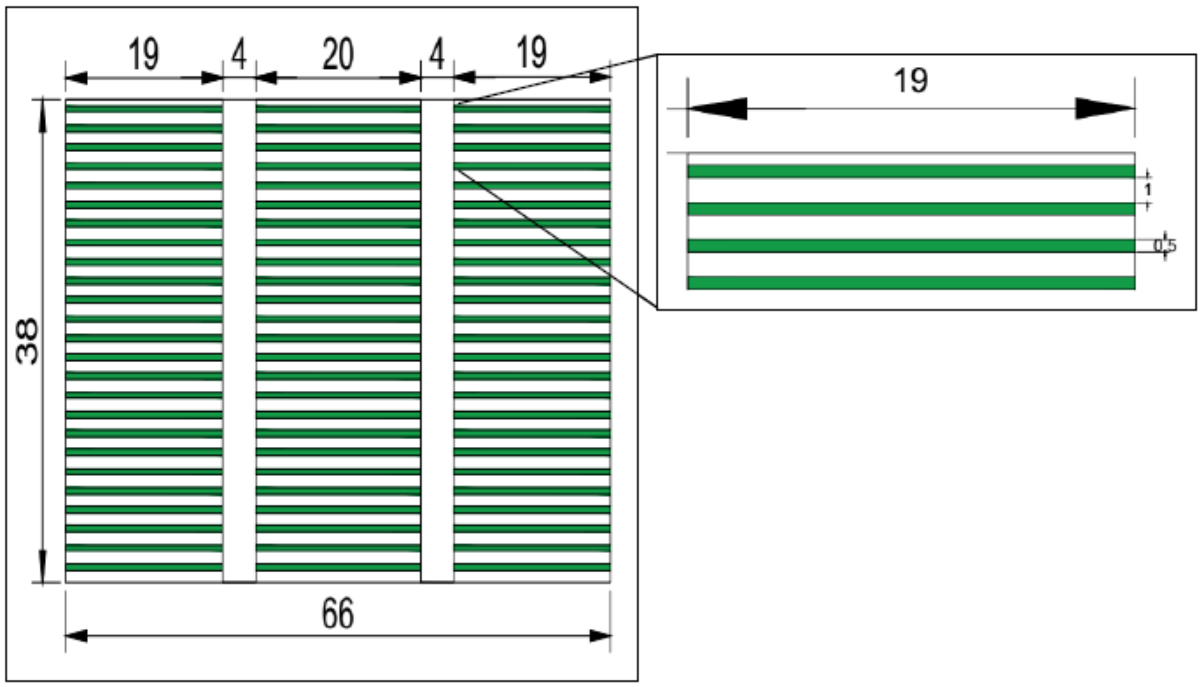
The outside nursery of San Cristóbal comprises 6 blocks, of which the first five are made up of 20 banks while the last block (6) has only 10 banks, for a total of 110 banks for the outside nursery outside, which stores 48 trays of Jiffy® for each bank.

Roofed Nursery San Cristobal - Eucalyptus

The dimensions of the seedling development sites for the roofed nursery are from 0.45 to 0.50 meters in bank width, and between 19 and 20 meters in length. The distance between growth areas is 0.9 to 1 meters, which allows transit of operations inside the nursery.

This nursery is distributed in three Blocks which contain 25 banks each, for a total of 75 banks for the greenhouse, which store 50 trays of Jiffy® for the banks of 19 meters in length and 53 Jiffy® trays for banks 20 meters long.

Figure 3.12: Dimensions and distribution of the greenhouse



Source: VEA based on information from FFC

The banks described above are shown in the following illustrations both in the roofed nursery and in the outside nursery, which are constructed with posts of immunized wood approximately 0.83 meters in height.

Figure 3.13: Example of outdoor nursery banks

Source: VEA, 2017

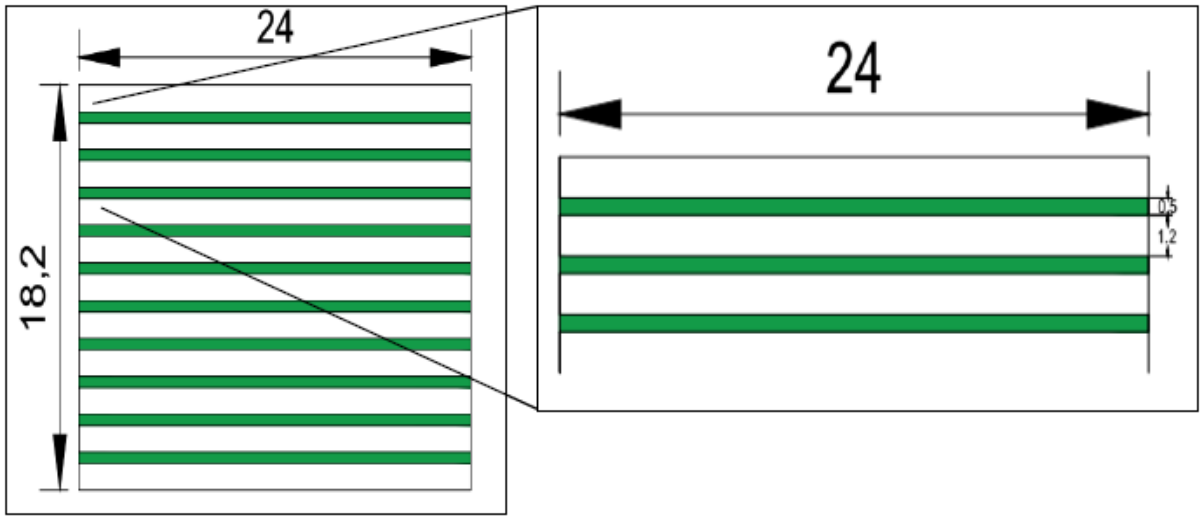
Figure 3.14: Example of roofed nursery banks

Source: VEA, 2017

Toro I transitional nursery

The dimensions for the Toro I transitional nursery are 0.50 meters wide, and 24 meters long. Bank space is 1.2 meters, which allows the transit of operations inside the nursery. In this nursery are 10 banks, which store 66 Jiffy® trays each.

Figure 3.15: Dimensions and distribution of the transitional nursery located at Toro I



Source: VEA based on information from FFC

The following figure shows the banks located at the transitional nursery at Toro I.

Figure 3.16: Example of the Toro I transitional nursery banks

Source: FFC , 2017)

3.1.1.5 *Annual* nursery *capacity*

The annual capacity of the San Cristóbal nursery is presented in the following table, where for 2017 the total production plan is for 12,517,857 seedlings, and for 2018 the total production is 23,223,214 seedlings.

Table 3.4: Nursery Plan – capacity

Existing Capacity – Plan			
Description	**Cycle**	**Days**	**Capacity (Seedlings)**
Nursery – Greenhouse	1	42	650,000
Nursery – Exterior	1	42	600,000
Total capacity per cycle			**1,250,000**
Trays per cycle (Each tray 198)			6,313
Production Period – Months			7
Production Period – Days		30	210
Production cycles per year			5
Existing capacity	**5**	**210**	**6,250,000**
2017 – Plan			
Description	**Cycle**	**Days**	**Capacity (Seedlings)**
Existing capacity			6,250,000
Extended capacity with 2 new units in the Nursery - Greenhouse			
Nursery - Greenhouse	1	28*	1,300,000
Production Period – Months			4.5
Production Period – Days		30	135

Production cycles per year			4.82
Production Capacity per year			**6,267,857**
Total, Production 2017			**12,517,857**
Seedling Requirements	**Has**	**Sdlg nursery**	
FFC	4,000	1,400	5,600,000
Total, of Seedlings required			**5,600,000**
Excess / deficit			**6,917,857**
% Nursery capacity			**90%**
2018 – Plan			
Description	**Cycle**	**Days**	**Capacity (Seedlings)**
Nursery – Greenhouse (x3)	1	28	**1,950,000**
Nursery – Exterior	1	28	**600,000**
Total capacity per cycle			**2,550,000**
Production Period – Months			8.5
Production Period – Days		30	255
Production cycles per year			9.11
Production Capacity per year			**23,223,214**
Optimum nursery capacity with 85% efficiency			**19,739,732**
Maximum plantation has with a 85% efficiency			**14,000**
Seedling Requirements	**Has**	**Sdlg nursery**	
FFC	6,000	1,400	8,400,000
FMS	6,000	1,400	8,400,000
Total, of Seedlings required			**16,800,000**
Excess / deficit			**6,423,214**
% Nursery capacity			**72%**
***** Note: Production days in the nursery are reduced from 42 days to 28 days.			

Source: Orinoquia Forest

3.1.1.6 *Origin and seed* certification

The origin of the seeds is from El semillero, a specialized company within the forestry sector, with products and services for primary seed production, nurseries and forest plantations. With Nit number: 830.055.528 Producer of Selected Seed, is registered as importer of seeds for forest, fruit, ornamental, aromatic, decorative grass, plants fodder (grasses and legumes) and vegetables- Resolution 01745 of July 5 of 2000 which was modified in Resolution 001940 of June 8, 2010. (Annex 1 and 2).

Forestry of the Orinoquia identified with Nit: 900.371.224 is Registered as a producer of selected seed of Eucalyptus Pellite and Acacia mangium - Resolution No. 000734 of March 11, 2015. (Annex 3), and is also registered as importer of Selected Seed of Forest Species - Resolution No. 000736 of March 11, 2015. (Annex 4)

Origin and quality of the seed:

- Acacia Mangium:
- Tierra high cordoba (seed type F)
- Cabuyaro - goal (seed type F)

- Eucalyptus Pellita:
- Villanueva Casanare, Refocosta supplier.

3.1.1.7 Pre-germinative *treatment*

Pre-germinative treatments include processes that favor the permeability of the seed cover to the entrance of water and oxygen. For the case of Acacia mangium, the pre-germinative treatment that is applied to the seed includes:

- *Mechanical or physical:* Scarification will be used for acacia mangium mechanics (sandpaper) to weaken the seed testa and improve the Germination percentage of this.
- *Water treatment:* It is used for acacia mangium after mechanical scarification, the seeds are left in imbibition for 24 hours). For Eucalyptus Pellita, we do not use any pre-germinative treatment.

3.1.1.8 Substrates

The type of substrate used in the forestry project is from Turba called Jiffy-7® Forest Pellets. The manufacturing company Jiffy delivers them packed in sheets configured with different densities. These pellets are produced with a preformed hole in the center to facilitate placement of the seeds and provide optimal germination conditions. The sowing of the seeds is performed with the Jiffy seeder machine. Jiffy pellets perform well for vegetative propagation purposes. Due to the high quality of the fibers peat sphagnum may expand when they get wet. In this case it is designed with a deeper hollow, which facilitates the installation of cuttings.

Fully expanded pellets absorb about 7 times their weight in water. Hence the name Jiffy-7®. This medium provides excellent conditions so that the seeds germinate without problems of pathogens or weeds and roots develop freely.[1]

[1] Jiffy Products International BV. (sf). *Technical Specifications - Jiffy.* Jiffy Group

Figure 3.17: Pellet size during the plantation development process

Source: (Environmental Economic Assessment, 2017)

Figure 3.18: Roots expand freely with the Pellets

Source: (Environmental Economic Assessment, 2017)

The Jiffy system is used to make easy water management under a scheme Mofino, must be supplied to keep them at their field capacity (between 5 and 7 times its weight in water), range in which the best results are obtained of plant development.[2]

3.1.1.9 Irrigation systems *to be used only in the nursery*

The type of irrigation to be implemented in the nursery is sprinkler irrigation, it is done by middle of a 2.5 hp motorcycle pump which captures water from a superficial source and is distributed by a pipe to the sediment filters (see Figure 3.19) which act as a screen to remove these particles and thus distribute the water collected between the different banks located in the nursery. Nebulizer nozzles are located in the banks, as seen in Figure 3.20, on the other hand, fertilization is carried out by an independent irrigation system, called fertiriego which is driven by a motor pump and pipes independent which are distributed on the banks with hose and pistols.

Figure 3.19: Sediment filter for the irrigation system

Source: (Environmental Economic Assessment, 2017)

This nebulization system is suitable for seedling irrigation, which requires a fine droplet size, due to the fragility of the same plant, or because of the low volume of substrate they have. Uniformity in these cases is usually less than 90%.[3]

[2] Jiffy Products International BV. (sf). *Technical Specifications - Jiffy.* Jiffy Group

[3] Monstserrat, J. (2005). Irrigation system for use in nurseries. *Extra*, 82.

Figure 3.20: Irrigation System (left) and Fertigation (Right)


Source: (Environmental Economic Assessment, 2017)

3.1.1.10 Irrigation flow

The following table shows the flow required for the irrigation and fertigation activities that are required permanently in the nursery:

Table 3.5: Volume needed for irrigation and fertigation activities - Vivero San Cristobal

Activity	Volume (m^3)	Frequency	Demand of Water (Flow (l/s))
Fertility	1.5	Day in between (every 2 days)	0.0087
Irrigation	75	Daily	0.8681

Source: Information provided by Forestal de la Orinoquia

It should be noted that for the supply nursery located on the Toro 1 farm, no fertigation is done, but only irrigation, this is because the seedlings will stay in this location for approximately 2 days, under the service model forest FMS.

Table 3.6: Volume needed for irrigation activities - Vivero Toro I

Activity	Volume (m^3)	Frequency	Flow rate (l/s))
Watering in the nursery	0.3	Daily	0.00347

Source: Information provided by Forestal de la Orinoquia

3.1.1.11 Identification of the main water sources

The water source is Caño Muco, which belongs to the hydrographic basin of the *Meta* and to the hydrographic subzone Direct Low Meta between rivers Casanare and Orinoco. In the San Cristóbal farm the surface water collection would have a use for human consumption and work in the forest nursery.

A second water source the Bita River is available which belongs to the *Meta* River Basin and the Direct Meta Sub River Area between Casanare and Orinoco rivers, on the land within the water collection would have a use for human consumption and operation of the Project plantations.

3.1.1.12 Characteristics *and volumes of inputs in operation stage*

Seedlings are subjected to different fertilization and prevention processes for pathogens, supplying their physiological needs to obtain a high-quality plant material that arrives in a rustic and healthy field. The fertilization is done through an independent fertigation system, the solutions are prepared at 0.5 concentration (100gr / 200Lt), the following elements are applied:

Table 3.7: Inputs applied in fertilization

Elements applied in fertilization		
N	Nitrogen	urea
P	Phosphorus	MAP, Monoammonium Phosphates
K	Potassium	KCL, Potassium Chloride
Ca	Calcium	$CaNO_3$

Source: FFC , 2017)

Fertilization schedule: It should be noted that it is not a recipe, there are variations depending on the requirements, times and behavior of the seedlings.

Per seedling after planting:

Table 3.8: Fertilization Schedule

Application No.	**No. of days**	**Quantity**
1	At 12 days	0.006 gr (P) + 0.006gr (K)
2	16 days	0.006 gr (P) + 0.006gr (K)
3	19 days	0.006gr (P) + 0.006gr (K) + 0.004gr (N)
4	22 days	0.006gr (P) + 0.006gr (K) + 0.004gr (N)
5	25 days	0.006 (K) + 0.006gr (N) + 0.004gr (P) + Ca
6	28 days	0.006 (K) + 0.006gr (N) + 0.004gr (P) + Ca
7	32 days	0.006 (K) + 0.006gr (N)
8	35 days	0.006 (K) + 0.006gr (N)
9		Nutrifoliar (NPK).
10		Field Dispatch

Source: FFC , 2017)

Preventive and curative fungicidal products (if necessary) are used to avoid infection of plant material, and contact insecticides to avoid insect infestation

3.1.1.13 Requirements *for use, exploitation and affectation of Natural resources*

During the operation of the project, use will be made of surface water sources, underground, forest use and water discharges will be carried out domestic.

The surface source will be used for human consumption, for the nursery, washing of machinery and reserve to fight fires, if presented. On the other hand, for forest plantations the permit of logging on the grounds where there is natural forest (trees isolated), and in this way make the plantations. In Chapter 4 Demand, use, exploitation and / or impact of natural resources, this information through an inventory of natural resources to be used in the project development.

3.1.1.14 Labor Required

Below is the projection of the labor required for the project operation

Table 3.9: Projection of required personnel

Projections of personal	Year							
	2017	2018	2019	2020	2021	2022	2023	2024
Establishment	108	279	372	518	518	518	518	518
Maintenance	11	65	168	224	312	312	312	312
Harvest and transport	-	-	8	8	36	61	96	122
Total Operations	119	344	548	750	867	892	926	952
FFC Ops. and Admon.	42	163	174	183	183	183	183	183
Total FFC FTE s	161	480	722	933	1050	1075	1109	1135

Source: Information collected by (Forestal de la Orinoquia, 2017)

3.2 Forest Component

3.2.1 Object of the Plantation

The objective of the plantation is the use of wood for the market of biomass and / or cellulose production. The selected rotation regime responds to this objective that for the harvest of Eucalyptus Pellite and Acacia Mangium is:

Table 3.10: Planting regime chosen for planting

Species	Criterion	Description
E. pellita & A. mangium	Rotation	7 years
	Planting Density	1360
	Spacing	3.2m x 2.3m

Source: FFC , 2017)

This means that all the wood to be harvested will be chipped in a mobile chipper (initially), and then distributed to the international or domestic markets.in a processor of chips.

3.2.2 Planted species

Acacia Mangium: The taxonomic classification of Acacia mangium is:
Family: Mimosaceae
Sub-Genus: Heterophylium
Genus: Acacia Species: Mangium

Acacia mangium is native to Australia, Papua, New Guinea and Indonesia, including the Moluccan Islands. It has been introduced in countries like Sri Lanka, China Popular, Thailand, Philippines, Costa Rica, Panama and Venezuela. (Clavero 1998)

In America it is known as "Mangium" or "Acacia". It is a kind of rapid growth associated with low-lying agroecological conditions of humid forest and very humid tropical forest. Areas characterized by a very short dry period and an annual rainfall between 1,400 and 3,000mm tolerating a minimum rainfall of 1,000mm. Mangium can tolerate a range of temperature from a minimum of 1°C to a maximum of 36°C. The range of altitude is from sea level to 800 meters above sea level.

Acacia mangium normally develops in acidic soils (4.5 - 6.0) well drained, tolerates soils with pH as low as 3.8 and 70 aluminum saturation %. It does not tolerate saline soils, low temperature and dense shade. It is also very susceptible to wind damage. (Clavero 1998)

Acacia mangium wood is light brown with dark bands, it stands out for its great beauty that enables good and fine finishes. As Advantages have that air drying is easy - no problems in your anatomy– and that when sawing, turning, sanding, drilling, brushing and nailing or in machining operations it is easy to work, with good results. It is characterized by being a hard, resistant and dense wood, frequently compared to Teak wood (Tectona grandis) - of high quality and that of Walnut (Cordia Alliodora). These qualities have made it attractive in the markets national and international to manufacture fine furniture, for high cabinetmaking quality and for the construction area in the manufacture of cabinets, frames for doors, windows and moldings. It is also used in the production of particle board, handles for sports elements, agricultural utensils, chipboard, jabas, fence posts, woodchips, running boxes and guacales One of its potential uses is the production of paper pulp Fine, cardboard, bags and wrapping papers. Other uses include production of Honey, adhesives and its firewood is used as fuel and coal. Its leaves are they can use as foliage, offering shade to the cattle.

Eucalyptus Pellite: The taxonomic classification of Eucalyptus Pellite is:
Family: Myrtaceae
Genus: Eucalyptus Species: Pellite
Straight and cylindrical trunk
Leafy cup
Light brown outer bark with skin appearance and strips off leaving gray or brownish spots on the inner bark, smoother.
Sésiles, simple, alternate, without stipula and without exudate, oval and greyish leaves, lengthening and becoming leathery and of a bright bluish green color of adults, has:
Lonely white flowers
Fruit capsule
Small seeds

Originally from Australia and Tasmania, it is a fast growing group, in which there are about 700 species of eucalyptus, distributed in regions, especially from Mediterranean, tropical or subtropical climates.

Climatic requirements:

Table 3.11: Climate requirements of Eucalyptus

Altitude:	0 – 2,000 masl
Precipitation:	800 – 1,200 mm
Temperature:	24°C
Requirements edaphic:	Requires loam soils - clay, no compacted, deep, that keep good sewer system.

Source: FFC , 2017)

The properties of eucalyptus wood are organoleptic, yellow pale, slightly differentiated veined, with medium texture, straight grain has crosslinked, non-distinctive smell, something similar to tannin, non-distinctive taste, shine Medium durability.

WOOD USES
Cellulose, chips, lighting poles, logs for sawing, props for civil construction, manufacture of posts, parquet floors, supports in mines, fiber boards

3.2.3 Forest Establishment

To ensure the potential for wood production and sustained yields, it is necessary to integrate, along with the research programs, all the disciplines within our forestry (see Figure 3.21). This is achieved through the identification of two main components namely: classification and characterization of the site added the best operating practices of each of the activities within each of these components, they will have at your disposal the data so that decisions can be made in order to ensure that the technology and management considered is appropriate. Further, will be able to provide accurate information regarding all its levels planning, which include:

- Operational planning
- Stand planning
- Annual planification
- Forecast planning
- Budget planning

Figure 3.21: Silvicultural Disciplines

Source: FFC , 2017)

A plantation is designed and planned taking into account the environmental environment (contour forestry), transportation and harvest objectives. Said design respects sensitive environmental areas such as low and / or wetlands, areas of drainage and natural forest areas which are of great ecosystem value and areas stipulated in Resolution 500.41-15-1753 of December 3, 2015 of the Regional Autonomous Corporation of the Orinoquia CORPORINOQUIA.

- PLANTATION DESIGN

The stands are measured and taken to a database by using GIS geographic information systems to finally produce a map Thematic of the plantation. These stands are planned with an average size approximately 40-60 Ha, based on topography, hydrographic conditions and slopes of the areas.

The coding of the stands is an arbitrary identification code, the specific environmental and physical characteristics per site are entered into the base of geographic information system data and are filtered by its attribute table.

Firewalls are planned based on the risk category that each zone presents; which are clearly defined in an operating procedure of Forestry of the Orinoquia, which is used to train all the personnel of countryside. The main factors that served to define risk categories they are the social, physical, and natural aspect since depending on the terrain and the neighborhood anthropic activity causes us to have greater or lesser involvement in the risk and danger of fire. The risks of highest probability are the burning neighborhoods by extensive livestock, therefore, it has established a Ranger protocol, who in the dry season are monitoring constantly plantations and any smoke signal triggers alarms on field.

Roads are established according to the characteristics of the terrain, and choosing the areas that optimize maintenance costs and do not contravene the conservation assets FFC has software Microforest that is integrated into the GIS geographic information system which Quantify the kilometers of roads.

3.2.3.1 Land preparation and adaptation

Two fundamental preparations will be made: 1st and 2nd pass of implement with hydraulic and mechanical eccentrics respectively, this Preparation is not 100%, for each hectare approximately 34% is prepared. Strips or rows are opened with discs that generate the place of placement of the seedlings we call ridges to improve drainage conditions ground. It is necessary to make a high ridge for various purposes; the first is help trees gain height, as there are precipitation events with very high intensity that temporarily stand the stands, but thanks to the Camellon do not drown seedlings. In addition, it is necessary to fragment a slight hardened layer on the ground of all stands to be planted, in Vichada it they burn to develop livestock activities extensively, hardening the soil, creating erosion and waterlogging when they occur rainfall

These two activities will be between 2 - 4 weeks apart between the 1st and 2nd Lastly, this is a technical criterion because during those 2 - 4 weeks after the 1st pass, climatic aspects such as: wind, precipitation, solar radiation contribute to the weathering of the soil masses and then the second pass disintegrates said masses of soil into masses of Smaller size suitable for better root development and high individuals physiological quality the orientation of the lines will be done with a GPS system guaranteeing the reliability of spacing.

These lines should be approximately 1,200 meters (this measure can vary once the harvest is planned) by lifting the implement every 400 meters approximately, in order to generate access roads 4 meters wide and protect stands against erosion. Low or wetland areas, areas of drainage and sensitive areas will not be prepared for planting.

Figure 3.22: First implement pass, hydraulic eccentric

Source: FFC , 2017)

As part of the land preparation, the herbicide application is carried out and 100% fertilization with herbicide. The application of glyphosate will be carried out conveniently after the second pass (100% of the area) and almost that immediately before planting, as this allows us to eliminate competition of the seedling by light, water and nutrients by weeds for a greater period of time, this also depends on the climatic supply and other factors natural as the state of weed development. All herbicide application it will be done in the most suitable conditions such as low wind and dry environment to the extent possible (the day will be planned optimal schedule without rain). If necessary we would apply a brand adjuvant *Cosmoflux* commercial in maximum 40% of the plantation area, in a dosage between 1.5 - 2.5 cm3 / lt.

The operator who performs the herbicide application is properly trained and trained, know the product, its handling, its storage and the final disposal of the packages. The decision to carry out weed control of a stand is made based on the schedule of activities and its subsequent weed characterization in the field, where according to the type of weed, predominant species and development status, the dose of the products is decided and / or additives to apply.

3.2.3.2 Sowing

I. Manual planting

It is carried out by qualified operators, at an average yield of 1 hectare / wage. This activity does not include fertilization which must be carried out. later.

II. Mechanized Plantation

A mechanized plantation will be carried out, which requires a tractor with a planted machine mounted and calibrated. At the same time of planting it fertilize the seedling. It is important to consider the planting depth, the which in this case will be 2-4 cm; the seedling will be rustified and tall adequate depending on the species, the month to be planted and the distance between Seedlings will be 2.3 m.

This planting machine has a dosing system of gel retainer by pressurized tank, thus allowing to extend the planting range until the months of least rainfall.

The spacing between plants is previously calibrated as is the dose of fertilizer per individual. Depending on the climate offer, the dose of fertilizer of the first and second fertilization may vary, without affecting the total Fertilizer used in tree life.

3.2.4 Forest Maintenance

3.2.4.1 Fertilization

Types of fertilizers:

The fertilizers used are granular, which are found in merchant brands such as advance, abotek and rafos, of the Yara Colombia company. Below is the description and chemical composition of them.

Chemical composition of fertilizers:

a) Abotek: is a NPK chemical complex granular fertilizer, with a high content of potassium (23%) so it is especially suitable for the stages of production. It is also recommended in other situations that require greater potassium demand as prevention against damage from cold temperatures and water deficit, among others.

In addition to its high potassium content, it provides nitric nitrogen, phosphorus assimilable, magnesium, sulfur, zinc and boron, necessary elements for plant growth and that in the balance presented by Abotek, promote the formation, growth and development of fruits, grains and other organs of storage that are harvested.[4]

Below are the percentages of fertilizer nutrients, together to the composition of the ingredients and their physical and chemical properties:

Table 3.12: ABOTEK Nutrient Table

Nutrients			
N	15%	P_2O_5	4%
Nitric	6.7%	K_2O	23%
Ammoniacal	8.3%	MgO	4%
S	2%	Zn	0.1%
Presentation: Granular			

Source: (Yara Colombia, nd)

Table 3.13: Composition and information on ingredients

Substance / Preparation	**Mixture**	
Product or ingredient name	**Identifiers**	**%**
Ammonium nitrate	CAS: 6484-52-2	> = 35 - <45
Potassium chloride	CAS: 7447-40-7	> = 35 - <45
Langbeinite	CAS: 14977-37-8	> = 5 - <7
Calcium Bis (dihydrogen orthophosphate)	CAS: 7758-23-8	> = 2 - <3
Disodium tetraborate, pentahydrate	CAS: 12179-04-3	> = 0.3 - <1

[4] 4 Yara Colombia. (sf). *Yara Colombia*. Retrieved on 08 of 04 of 2017, from Nutrition vegetable -Abotek: http://www.yara.com.co/crop-nutrition / products / other / 13a6-abotek /

Zinc Oxide	CAS: 1314-13-2	> = 0.1 - <0.2

Source: Safety data sheet (Yara Colombia, 2015)

Physical and chemical properties:

Table 3.14: Physical and chemical properties

Physical state	Solid
Colour	Brown
Odor	Weak smell
pH	5 - 7.5 [Conc: 100g / l]
Inflammability	Non-flammable
Bulk density	1,000 - 1,150 kg/m³
Solubility	Insoluble in water

Source: Safety data sheet (Yara Colombia, 2015)

b) Rafos: it is a granular fertilizer with a high phosphorus content especially necessary in early stages of cultivation to promote Root development and plant growth. It also provides nitrogen, potassium, magnesium, sulfur, boron and zinc in an optimal relationship for development in the early stages of cultivation.

The phosphorus provided by Rafos comes in the form of high monocalcium phosphates solubility immediately available to the plant and dicalcium phosphates for A more progressive availability. The contribution of other elements together with high phosphorus levels make it a unique fertilizer that ensures the establishment of plantations in the countryside.[5]

Below are the percentages of fertilizer nutrients, together to the composition of the ingredients and their physical and chemical properties:

Table 3.15: RAFOS Nutrient Table

Nutrients			
N	12%	P_2O_5	24%
Nitric	3.2%	K_2O	12%
Ammoniacal	8.88%	MgO	2%
S	1%	Zn	0.02%
Presentation: Granular			

Source: (Yara Colombia, nd)

Table 3.16: Composition and information on ingredients

Substance / Preparation	**Mixture**	
Product or ingredient name	**Identifiers**	**%**
Ammonium nitrate	CAS: 6484-52-2	> = 20 - <25
Potassium chloride	CAS: 7447-40-7	> = 20 - <25
Langbeinite	CAS: 14977-37-8	> = 7 - <10
Calcium Bis (dihydrogen orthophosphate)	CAS: 7758-23-8	> = 2 - <3

[5] Yara Colombia. (sf). Yara Colombia . Retrieved on 08 of 04 of 2017, from RAFOS 12-24-12: http://www.yara.com.co/crop-nutrition / products / other / 13a2-rafos-12-24-12 /

Disodium tetraborate, pentahydrate	CAS: 12179-04-3	> = 0.1 - <0.2

Source: Safety data sheet (Yara Colombia, 2015)

Table 3.17: Physical and chemical properties

Physical state	Solid (granular solid)
Colour	Brown
Odor	Weak smell
Inflammability	Non-flammable
Bulk density	1,120 kg/m³
Solubility	Insoluble in water

Source: Safety data sheet (Yara Colombia, 2015)

Dose and period of application of fertilizers:

Manual Fertilization

Climate offer: We call climate offer, the precipitation curve single mode present in the area, which provides us with a calendar of months and ideal times to perform fertilization operations on stands desired, thus ensuring that the plants will take advantage of in a way Efficient fertilizer. (April to December).

The application of fertilizers allows adequate growth and development of the trees Fertilizer applications are intended to meet the nutritional demands of the plantations during the different stages of their increase.

It is important to identify if the fertilization process is establishment or maintenance, which are also called, colon fertilization and fertilization at one point respectively.

Fertilization in two points: The meter is 50 gr, applying a measure on the row on each side of the plant (10 - 20 cm) for 100 gr in total of the fertilizer per tree.

Second fertilization (before twelve months)

Fertilization at one point: The meter is 100gr applying a measure between each tree on the row, in the "leak" of the cup. This activity is from maintenance.

The second fertilizer application will be done after weed control in the entrefila, and is manually fertilized at one point, applying a measure between each tree on the row, in the "leak" of the cup.

Depending on the climate offer, the dose of fertilizer between the first and second Fertilization may vary, without affecting the total fertilizer used in the life of the tree.

These fertilizers are acquired in Yara Colombia.

3.2.4.2 Weed Control

This activity ensures eliminating competition for resources between weeds and the trees and also that the fertilizer is used efficiently in the plant. It must be done before the second fertilization; at approximately six months for wet savanna vegetation and maximum 8 months, however, constant monitoring makes the first green weed indicator the stands must

be fumigated, because a determining relationship of reduction of forest growth in areas where weeds exist. This operation It is done with a tractor and a 600lt sprayer. The active component is Glyphosate

- **Weed control between rows**

It is an activity that takes place on stands where weeds are found aggressive who are colonizing the ridge. This herbicide application and Fertilization is done by an operator and a back pump.

The Product to be used for weed control is called *ROUNDUP 747 (Herbicide),* this product is in the toxicological category IV (Slightly Toxic), its composition is:

Table 3.18: Composition / information ROUNDUP 747

Component	**CAS No.**	**% by weight (Approximately)**
Glyphosate: Monoammonium salt of N- (phosphonomethyl) -glycine	114370-14-8	74.7%
Other additive and inert ingredients: Moisturizer, carrier and impurities		25.3%

Source: ROUNDUP 747 Monsanto Company safety data sheet

The physical and chemical properties of the product and ecotoxicological information are presented below:

Table 3.19: Physical and chemical properties

Colour	Pale yellow
Physical state	Solid (Granules)
Odor	Old, mouldy
Flash point	Not applicable, non-volatile solid material
Density	0.5606 g / mL
pH	4.3 (1% solution)
Solubility	Very soluble in water, insoluble in solvents, organic

Source: ROUNDUP 747 Monsanto Company safety data sheet

Environmental toxicity:

Table 3.20: Ecotoxicological Information

Dog DL_{50} oral	> 5.0 mg / kg, very low toxicity
Goat DL_{50} oral	4,860 mg / kg
Bee 48 hours DL_{50}	> 100 µg / bee
48 hour dermal bee DL_{50}	> 100 µg / bee
48 hours, Daphnia magna (with aeration) EC50	37 mg / l (slightly toxic)
48 hours, Daphnia magna (without aeration) EC50	24 mg / l (slightly toxic)
48 hours, Gammarus pseudolimnaeus EC50	42 mg / l (slightly toxic)
96 hours, tent TL50	19.7 ppm (slightly toxic)
96 hours, Blue gill (in stagnant water) LC50	14 mg / l (slightly toxic)
96 hours, Blue gill (in current) LC50	5.8 mg / l (moderately toxic)
96 hours, Trout (in standing water), LC50	15-26 mg / l (slightly toxic)
96 hours, Trout (in current), LC50	8.2 mg / l (moderately toxic)
96 hours, Catfish LC50	16 mg / l (slightly toxic)

96 hours, Carpita CL50	9.4 mg / l (slightly toxic)
96 hours, Crab CL50	> 1,000 ppm (very low toxicity)
96 hours, Coho Salmon CL50	22 mg / l (slightly toxic)
96 hours, Chinook CL50 Salmon	20 mg / l (slightly toxic)

Source: ROUNDUP 747 Monsanto Company safety data sheet

3.2.4.3 Pruning

Pruning training in *Acacia Mangium*

The plantations of the project in question will be destined for the market of biomass and / or cellulose (woodchips), we must obtain a single shaft from the tree in the pruning of formation, to avoid cost overruns in the harvest.

Training pruning will take place between the 10-13 month of the individual's life, in average at 12 months of planting established and up to 65% of the height to favor the growth of the tree. If more than the due sheets are removed, this one reduces the growth of this one, since the function of the leaves is to optimize photosynthesis and harness the sun's rays, air, water and nutrients from soil, and improves access to young plantations, and also reduces the risk of Plantation fires. Pruning is only done in *A. Mangíum.*

Figure 3.23: Scissors performing training pruning

Source: FFC , 2017)

Branch Cutting Method

The branches will be cut flush with the shaft, without damaging the bark of the tree and will be carried out in the dry season since the season offers as advantages a rapid drying of the cuts, low risk of disease and rapid healing of the same. However, if required in winter time it would be done Depending on the need.

The cutting of the branches will be done with pruning shears, it can also be done with handsaw or arc saws, depending on the diameter of the branch, taking care of hold the branches well so that the bark does not crack.

Forest protection

3.2.4.4 Prevention and mitigation of forest fires

FFC within its forestry operations, has designed a Fire Protection Plan, which is a guide that is part of the Forest management system is also accompanied by a calculator Fire designed in order to serve as a fire risk meter.

Additionally, a system is used for control, fire prevention global information management on fires, "AFIS: Information System Advanced Fire" this advanced fire information system (AFIS) is the first operational satellite fire monitoring system in almost real time, in southern Africa, using MODIS and MS data, which makes part of the FAO global fire information management system.

The following describes the prevention and mitigation procedures for fires that FFC has established within the "*Plan of Fire Protection*"prepared by Forestal de la Orinoquia.[6]

Prevention includes two levels of activities:

1. The prevention of man-made fires through the population education, specific legislation and corrective measures.
2. Use of techniques to control the combustible material and thus prevent or hinder the spread of fires that may not be avoided.

For this, certain activities to prevent and mitigate such as:

- **Forest guards system** that carry out land routes with motorcycles and / or vans, in order to save and prevent actions that could be done by some people who enter without authorization to hunt or fish and perform wildfires. To try to minimize the fire risk works with neighbors and the community to raise awareness and work together in the field fire control.
- **Fire Plan:** Firewalls are part of the design and forest planning, they are located on the perimeters of the plantations or separating some areas of others and surrounding the low (by accessible places). The width of the firewalls will be a minimum of 10 to 50 meters where the grass will be kept as short and green as possible.

We will use dredges from time to time, to keep the area in optimum conditions, so that they effectively fulfill their function of stopping the fire, and also facilitate the rapid access of crews and equipment fire control and thus ensure that they can move without risk of getting caught in the fire. There will also be a passed with the harrow in a width of 3 meters in the firewalls, to Use this width as a taxiway. The ROTOSPEED, or cut weeds, to keep firewalls with grass very short, easy to control contributing to the reduction of erosion and bare floors in the firewalls.

The firewalls will be guaranteed to be in optimal conditions so that help fire control and facilitate access and combat fire. As a guide to the firewall width we use the following:

Table 3.21: Firewall width specifications

Fire type according to location	Fire width (m)
Cut fires, north and east limits	50
Cut fires limits south and east	25 – 35

[6] Orinoquia Forest. (2016). Forest Operations-Protection Plan fire protection

Source: FFC , 2016)

- **Sensitization to workers and the community:** In Forestry of the Orinoquia trees are our main asset. Fire many times it is more harmful than a disease or pest that can affect the plantations, for this reason within the project a rule is taken into account of gold: **"ALWAYS PREVENT FIRE"**. The goal is to involve all workers and neighbors educating and training to combat fire.

Responsibilities, stages and communication:

Responsibilities:

- Contractor: Will be in charge of the implementation of the Protection System of the Patrimony, and purchase of the necessary equipment for the control and fire prevention
- Contractors: Will be responsible for equipment control, and maintenance of roads and fireworks. It will ensure that audits of the equipment, cut fires, etc.
- Supervisor of Forestry of the Orinoquia and the contractor in the "Focal Point" operational district in the field for fire control.
- Ranger: Responsible for the detection of fire sources, providing information on the exact place, dimensions and access roads faster and safer for the gang and firefighting equipment.

The stages to develop the fire protection plan consist of:

a) Detection: There is a fire watch tower that is located in the San Cristóbal field on the edge of the nursery, surveillance in the Paraíso field area and at the base of Garza Morena with which they can see practically all the columns of smoke that could arise on the project grounds; with this you can detect and give a location approximate column of smoke. Parallel to this, it also performs ground surveillance with motorcycles, guards travel all Field locations and alert immediately.

b) Communication: Forestry of the Orinoquia has fields located in the suburbs of La Venturosa in the district of Puerto Carreño. In these Fields there are three operations centers that we call:

Paradise Supply Center
San Cristóbal Supply Center
Mono supply center

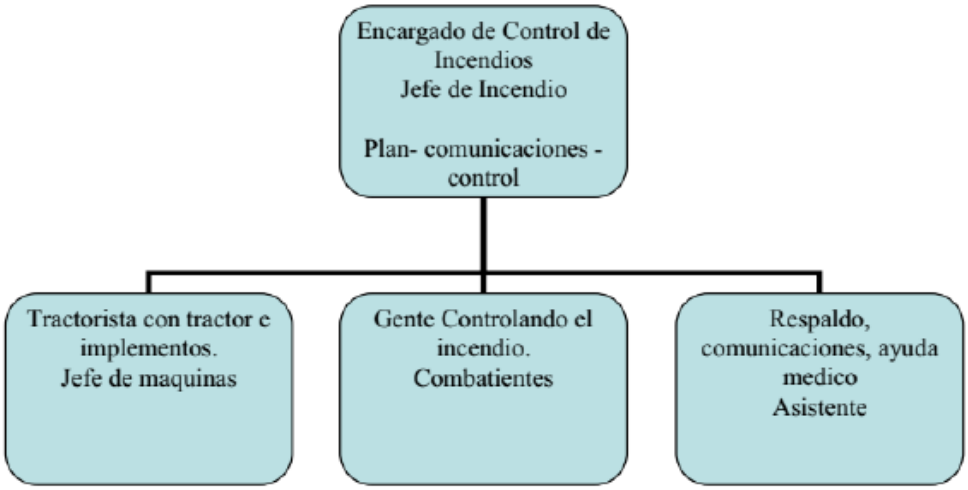
To which must be added two camps of contractors that fit Permanent have staff.

In the centers we have base radios, telephones and internet only in San Cristobal. In this place you will find two people from the staff of the Contractor company that are permanently under surveillance. In the days at higher risk of fire there are more personnel at the base, who are Attentive to act quickly in case of any fire start. Additionally there is a guard and a sprayer ready to fight water.

In the project camps, there are also Bakkie Sakkies teams available.[7] Also as a forest reinforcement of the Orinoquia has a tank truck with 2,000 liters of water, and personnel of the La Venturosa town to help in extreme cases.

[7] Definition of Bakkie Sakkies: It is a device used to irrigate / distribute water, which serves to fight fires. This equipment consists of a tank, a suction pump and hose.

Figure 3.24: Fire control plan organogram



Source: FFC , 2016)

a) Combat: Includes all fire fighting actions, which they are oriented fundamentally to extinguish the fire by means of weakening and / or separation of the fire triangle components (fuel, oxygen, heat).

Fuel: On the Orinoquia Forest fuel acts executing the following actions:

- Cutting the continuity of the fuel in the path of the fire by building a fuel-free strip (e.g. Sheets of grasses, trees, trunks, among others), with enough width so that prevent the passage of this. This will be done with hand tools, harrows or tractors with shovels, depending on the type of material and characteristics of the fire
- Increasing the moisture content of the fuel by throwing water on the combustible material. This can be done on both sides of the firewall to ensure that the fire does not cross the firewall. For this Forest of the Orinoquia has Bakkie Sakkies and the sprayers equipped to throw water which will be supported by a Water tank or tank truck.
- Remove combustible material using controlled fire, in the form of against fire. For this purpose, Orinoquia Forest has the gang of burners that will always be in each Center of catering.

Oxygen:

- Covering the combustible material with soil or with a choker to that in this way the oxygen surrounding the body is eliminated switched on. This is what is called SOFOCAR. To do this in each Supply center will meet at least 6 people.
- Decrease the proportion of oxygen in the surrounding air by increasing the proportion of water vapor, this is done by throwing water to the base of you call them

Hot:

- Reduce the temperature of the burning fuel by applying water, with this heat is consumed trying to evaporate the water, if not have water, it is recommended to cover with soil so that it absorbs part of the heat

Fire Hazard Index

To calculate the fire hazard index, a system that will called FDR (Fire Danger Rating), this system calculates the danger every day, taking consider:

- Temperature
- Relative Humidity
- Days without rain
- Amount of previous rains
- Wind speed

Table 3.22: Fire irrigation classification

Classification	Classification Description
Low	The fire hazard is so low that no caution.
Moderate	Fires that include prescribed burning can be allowed outdoors with the condition that people who make fires take reasonable precautions against fire spread
Tall	The danger of fire is such that there is no fire allowed in the air free, except those authorized by the Official Chief of contractor crew.
Very high	The danger of fire is such that under no circumstances are there fire allowed outdoors except those that are authorized by the staff of Forestry of the Orinoquia.
Extreme	The danger of fire is such that under no circumstances are there permitted outdoor fires, and the preparation of measures Specials for fire emergencies should be involved

Source: FFC , 2016)

Fire Risk Meter -MRI- (Fire Calculator)

Forestry of the Orinoquia contemplates as a prevention measure a meter of fire risk or fire calculator.

The meter is a hazard and fire classification calculator based on the South African Rating system.

This calculator works on the basis of the current standard calculations for the South African MRI system, the required fields are completed and subsequently the hazard rating (MRI) for the given weather conditions is calculated. It also provides the index of discomfort and a description of the classification to take actions for the calculated MRI.

The program requires five variables to calculate the fire hazard; one. Dry bulb temperature °C current temperature), 2. Relative humidity%, 3 Wind speed Km / h, 4. Number of days without rain and 5. Precipitation of the last month. The data is filled in a window as shown in the following figure:

Figure 3.25: Variables to consider in the fire calculator

Source: FFC , 2014)

Once the MRI is calculated, it is placed on the needles of the boards in field, indicating the corresponding color as seen below:

Figure 3.26: Board located in the field- Fire calculator

Source: FFC , 2014)

Below is an example of the boards located in the field within of the project, FFC has 2 boards within the premises of the project.

Figure 3.27: Example of field fire calculator

Source: Orinoquia Forest 2017

A record and record will be kept with the data obtained from the fire calculator of the calculated indices, each time the MDI is calculated, the captured variables and thus keep track of the reported data.

Field equipment available to fight forest fires

Equipment that is always present in the field or areas, are the following:

- Staff: 5 people located 24 hours a day between the El Paraíso and La Garza Morena and 5 people in San Cristóbal.
- Tractor: 1 tractor with eccentric at each station.
- Burners: 1 in Paradise and Garza Morena and 2 in San Cristóbal.
- Botafuegos and backpacks with water: 5 in total in each field.
- Bakkie Sakkies: 1 in each field ready and full of water. Plus 2 at the base of San Cristóbal for the use of company technicians.
- Trucks: 1 in each field.

3.2.4.5 Control and management of pests and diseases

Heritage Protection

Firewall

The use of fire and controlled burning will be used to reduce the accumulation of plant material in the perimeters of the property and in high areas risk of fire during the summer season. Firewalls are designed based on the risk category, where the highest risk is 1 and the lowest is 3. These categories are established with based on internal company procedures.

Phytosanitary control

During the first month, monitoring and control activities will be carried out in the stands in order to identify and quantify species of insects, fungi and pathogens in general. Together with the growth and monitoring inventories, they will carry out

a phytosanitary evaluation in 1-3-7 years to continue identifying and quantifying pathogens that can reach the threshold of economic damage (mortality greater than 5%). Currently FFC is aware of the species reported as a pest by the ICA and are building a base of data with insects found in plantations, but none has represented a problem in the currently forested fields.

Ant control

The arriera ant is the main plague that threatens the plantations and the objective of this activity is to detect in a timely manner the presence of ants ant that It can have a negative effect on forest plantations. Necessary identify, quantify and categorize the anthill based on their size, following internally established procedures for quantification and categorization

The management and control of the arriera ant, must have several components, the which are complementary and their effectiveness will depend on the genus of ant and your species the genera of arriera ant that are most abundant in Colombia are *Atta spp*. And *Acromyrmex spp.*

You tighten and harvest

The project is not carried out. The total harvest by stand is done at the end of rotation (7 years) which is indifferent between Acacia Mangium and Eucalyptus pinch

Volume of wood to offer

The projected volumes for the coming years are:

Table 3.23: Volumes to harvest

	2019	2020	2021	2022	2023	2024
Volumes to harvest - 000 m³						
Own plantation	151	162	234	254	365	871
FMS services	-	-	-	113	1.021	1.418
harvest volumes Vol. m³	151	162	234	367	1.386	2.289
Volumes to harvest - 000 ton						
Own plantation	126	135	195	212	304	725
FMS services	-	-	-	94	851	1.182
Harvest Vol. Ton	126	135	195	306	1.155	1.907

Source: Information collected by (Forestal de la Orinoquia, 2017)

3.2.4.6 Planting plan

In the following tables are the properties and species currently planted and projected for the Orinoquia Forestry project:

Table 3.24: Farms and species currently planted

Property	E. pellita	TO. mangium	Total
Cuernavaca	24.00		24
El Paraíso I		233	233
El Paraíso II	182.4	272.6	455
Hato Nuevo	658.9	471.7	1,130.6
La Cordobeza	1,886	500.7	2,386.7

La Garza Morena	534.1	163.3	697.4
La Josa	510.80	35.5	546.3
Llano lindo	75.50	0	75.5
Los palmares	235.00	505.1	740
Paraíso (PR)	303.60	118.4	422
Paraíso Tierradentro	-	75.9	75.90
San Cristobal	105.9	301.7	407.6
Tierradentro	-	47.2	47.20
El paraíso PC	161.30	618	779.30
Total (Ha)			**8,020.60**

Site Name	Area total (Ha)	Areas planted (Ha)
Toro I FMS	2,089.50	516.35
Total	**2,089.50**	**516.35**

Source: Information collected by (Forestal de la Orinoquia, 2017)

Table 3.25: Projected planted hectares

Planted areas (Ha's)	Year							
	2017	2018	2019	2020	2021	2022	2023	2024
Own plantation	3,948	6,000	10,000	16,286	16,286	16,286	16,286	16,286
Plantation of services forest FMS	703	6,000	6,000	6,000	6,000	6,000	6,000	6,000
Total area	4,651	12,000	16,000	22,286	22,286	22,286	22,286	22,286
Total, Planted Areas - Ha's								
Own plantation	8,741	14,741	23,841	39,227	54,413	69,599	84,385	97,671
FMS	1,223	7,223	13,223	19,223	23,223	25,223	25,223	25,223
Total area planted	9,964	21,964	37,064	37,064	77,636	94,822	109,608	122,894

Source: Information collected by (Forestal de la Orinoquia, 2017)

3.2.4.7 Complementary works

The Orinoquia Forestry project will begin its planting process of Acacia Mangium and Eucalyptus Pellite species (Forest Operation) between the years 2019-2020. The required works include the following infrastructure:

A camp located in the San Cristóbal Estate, where all will be developed the main field activities of the project, and accommodation for staff that works in the field, in addition to support, the following bases are used:

Table 3.26: Number of people per camp

Camp	Property	No. of people	Activity
San Cristóbal	San Cristóbal	225	Main field activities of the project: camp, irrigation and nursery fertigation, application of herbicide and fertilization, firewalls, controlled burning and combat of fires.
Base Mono	La Cordobeza	20	Forest ranger, (Fight Fire) firewall, burn Controlled and fire fighting, fertilization and herbicide application.
Paraíso PC	Paraíso PC (Puerto Carreño)	75	Camp, fertilization Y herbicide application. (Fight fires) firewall, burning controlled and fire fighting.

Malvinas	Malvinas	10	Ranger (It contemplates future this location for the location of a charging terminal, for the project development). (Fight fires) firewall, burning controlled and fire fighting, fertilization and herbicide application.
Tierradentro	Tierradentro 6	150	Camp, fertilization Y herbicide application. (Fight fires) firewall, burn controlled and fire fighting.
Toro I	Toro I	60	Camp, on this site They provide forestry services. (Fight fire) firewall, controlled burning and combat of fires. Herbicide application and fertilization.

Source: Orinoquia Forest

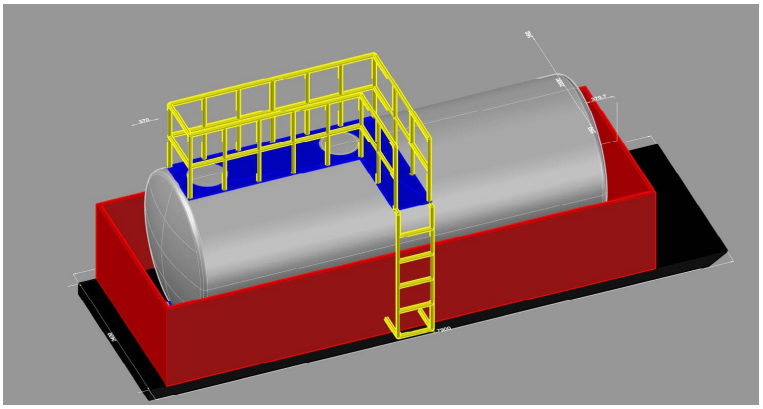
These six bases would consist of a basic infrastructure (bedrooms, bathrooms and kitchen). The function of these bases is to serve as support in the field work, the surveillance of both the properties and the plantations and the accommodation at Project staff

Additionally, two tanks of the project include tanks of Fuel storage required for the project, then Describe some characteristics of them.

- **Fuel storage tanks**

FFC acquires its fuel from Brisas del Orinoco in Puerto Carreño, this company supplies and transports the fuel with a monthly frequency In the San Cristóbal and Tierradentro properties are located in each property a tank with a capacity of 4,000 gallons, 500 gallons for ordinary gasoline and 3,500 gallons of diesel. It is presented in Annex 22 on respective contingency plan for fuel management.

Figure 3.28: Fuel storage tank of the Forestry project of the Orinoquia



Source: Orinoquia Forest

Table 3.27: Geographical coordinates fuel tanks of San Cristobal and Earth inside

Point	Coordinates System flat coordinates Magna Colombia - Origin THIS EAST	
	North	West
Fuel tank Earth inside	990406.84	1157208.45
Fuel tank San Cristobal	916010.432	1171773.82

Source: (Environmental Economic Assessment, 2017)

The aforementioned works are part of the necessary infrastructure for the forestry operation, the location of a chipper plant is planned in the future for the project, a cargo terminal on the Las Malvinas property and one the construction of an additional nursery in San Cristóbal.

3.2.4.8 Forest Research

The project does not have any forestry research established.

3.2.4.9 Measures for forest monitoring and dynamics

Below are the dynamics monitoring measures and Plantation growth. The information presented here is part of a planning document (*Technical Specifications - Inventory and Enumeration of growing actions, carried out by Forest de la Orinoquia*). Source: FFC , 2013)

1. Inventory and sampling methods
2. The sampling strategy
3. Field procedures
4. Data capture

a) Inventory and sampling methods

Types of inventory

Two basic types of planting inventories are the common practice in direction of the growth action of a company. Both types of inventory should be used extensively and form the structure of growth, prediction and projection in the plantation database.

- Management inventories, with the main objective of determining tidal volume and media quality, and a secondary objective of using this information to Predict your future growth and production with growth models. An additional advantage is the gathering of support information (weeds, parasites, etc.)

- Slimming control inventories, which can be used for same purposes as the previous management inventories, but they have the advantage additional quality control of the marking operation.

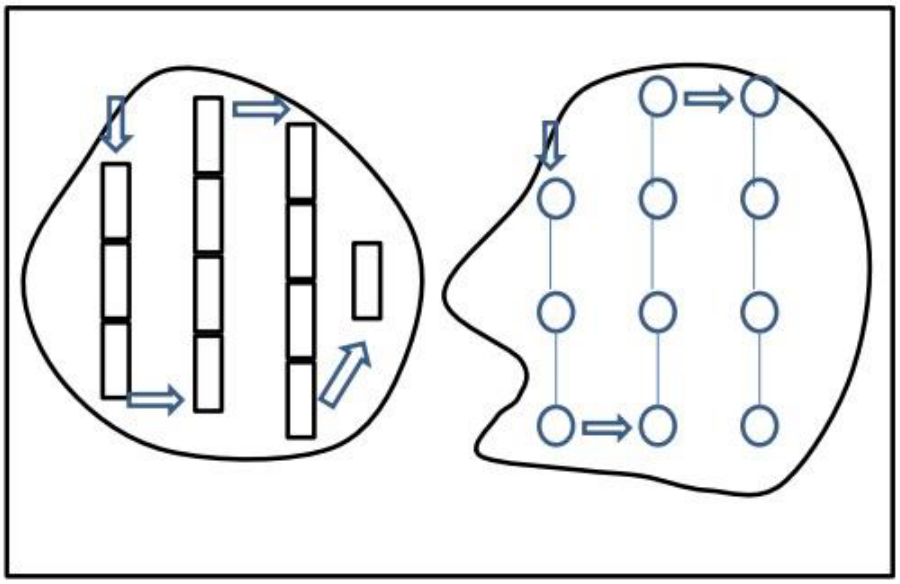
Sampling and inventory methods

- Background: The crucial problem in sampling is to obtain a sample that is representative of the entire population (stand). From a relatively sample small, it is possible to represent, obtain, evaluate and use features and exact statistics of a stand to predict volume, estimates of products, etc. Full sampling is usually too slow and expensive.

The sampling design (that is, the method of selecting the location of the field measurement plots) must be systematic (for example, a grid, equidistant and parallel strips). Systematic sampling is widely used in forestry practice because it simplifies considerably the location of field plots. Statistical analyzes they are based on the assumption of randomness, so care must be taken to ensure that the systematic design does not match any natural pattern in countryside. If this precautionary measure has been taken, the sampling results Systematic and random can be considered equivalent.

- String method: The traditional inventory method used is the plot of the cruise line, method sampling or chain strip. Figure 3.29 shows observe the uneven relative distribution of the plots within a stand with this method in relation to the circular plot method. A marked disadvantage, especially if the strips follow the natural strata, which They exhibit growth patterns. Other disadvantages are the size of great equipment required to carry out the inventory, the large number of trees in the boundary and sampling diameters. One of the advantages of the method of The chain is reduced time and simplicity.

Figure 3.29: Schematic illustration of plot distribution in methods Chain and circular weft



Source: FFC , 2013)

As seen in the previous image, the chain method comprises the strips equidistant from the interrupted sequences of rectangular arguments. The prescribed arguments are 30m (one chain / cable) long and 10m wide, although they also allow the argument lengths of 20m and 40m in young and mature stands respectively. The width of the argument is controlled using 5m on the light bar. The distance between the cruise lines It is determined by the sampling intensity and using the following formula:

$$Distancia\ (m) = {}^{Ancho\ de\ la\ tira} / {}_{\%\ Intensidad\ de\ muestreo}$$

- Method of the circular diagram: Figure 3.29 shows the advantages of a more balanced distribution of the plots on the stand. Other advantages are a Smaller inventory equipment, less border trees and no sampling excessive diameters Field studies have shown that it Production can be maintained with the circular plot method and a team of two men (with electronic equipment) Vs the chain method that uses a Team of five men of standard equipment.

Figure 3.29 shows the arrangement of circular plots in the form of grid (or parallel, equidistant lines). The prescribed size of the plot is 500 m² (circle radius 12.62 m) for medium to low density populations (800 spha or less) and 300 m² (circle radius 9.77 m) for supports with a density greater than 800 spha. The grid size is calculated based on the Plot size and sample size required.

b) The sampling strategy

Taking into account the previous inventory methods, the strategy of Sampling on any stand will depend on several factors:

Table 3.28: Sample size according to the area of the stand

Area stand (Ha)	% Sample (Area)	Number of plots per hectare required	
		500 m² Plot	300 m² Plot
1 – 3	10%	2	4
3 – 5	7.5%	2	3
5 – 10	5%	1	2
> 10	3 – 5%	1	1 – 2

Source: FFC , 2013)

- **INTENSITY**

The sampling intensity (sample size) will depend mainly on the size of stands and variability (species, site differences) of the stock growing in terms of DAP and spha. The experience of the past has demonstrated that the percentage of sample size (by area), which is shows in the

Table 3.29 above, can be used as an approximate guide for inventories of the chain and circular plots.

Table 3.29: Sampling of the enumeration chart

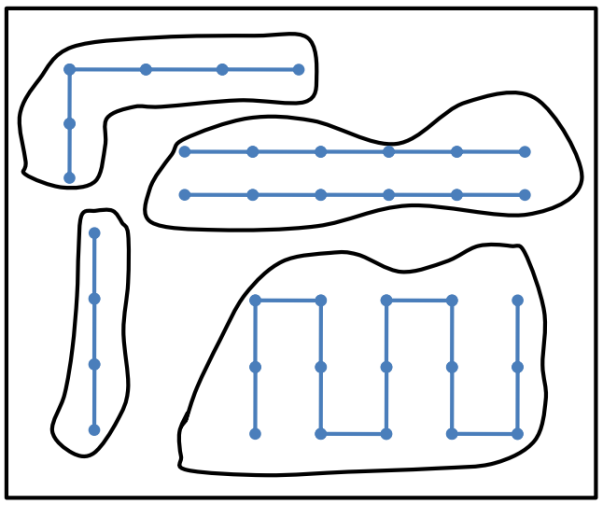
Radio of plot (m)	Size of the plot (m²)	Intensity of the sample	Number of Trees
5.65	100	1%	14
7.99	201	2%	27
9.77	300	3%	41
12.62	500	5%	68

Source: FFC , 2013)

- RODAL FORM

Figure 3.30 shows an indication of the importance of planning adequate sampling strategy before starting a stand inventory specific. The previous study of the planning of the planting map of the point input can save time and improve inventory accuracy.

Figure 3.30: Influence of the stand shape on the sample distribution



Source: FFC , 2013)

- TIPE AND FREQUENCY OF INVENTORY

The type of inventory and the interval between inventories in any stand depends on the species and the object of management (work circle). In the following Table 3.30, indicate the types of inventory required for the different work circles.

Table 3.30: Type of inventory and frequency by management objective

Management objective	Inventory Type	
	Control of slimming	Maturation measure
Acacia and Eucalyptus Bioenergy	N/A	- At 6 months old. - At the age of 1 year. - In the average rotation – 3 years. - In the year before the harvest.
Transmission posts eucalyptus	Before the control of size	- At the age of 1 year. - 3 years. - At the age of 6. - In the year before the harvest.

Source: FFC , 2013)

c) Field procedures

Inventory preplanning

The importance of planning and preparation before going to the field is necessary and should be emphasized. The following are the minimum requirements:

- Complete measurement system, which must be in good condition.
- Plantation or site maps / Aerial photos.
- Correct stand information.
- Sample size and planning of the entry point.

Plot measurements

- The importance of measurement and counting must be underlined precisely. Determining the correct boundaries of the plot and border trees is important.
- The diameter at chest height (DAP) at 1.37 m from all the trees in the plot is measured and recorded to the nearest cm. A minimum of 150 is required DAP measurements by shared inventory.
- DAP / Height of the pairs of at least 30 trees spread throughout the DAP range It must be measured by stand. DAP is measured to the nearest millimeter while the Height is recorded to the nearest 10 cm.
- Estimates of stem count (spha) usually take into account the highest source of error in an inventory. Therefore, it is important to ensure that the sampling intensity in this regard is high enough, especially in small and uneven stands.
- Record details about defects, weeds, insects, fungi and damage Climate according to the prescribed methods is very important. Evaluation of spaces, gaps and recommendations for the adjustment of the area of the

stand (area effective) at the end of the cruise must be done as specified. If not observed None of the above in the stand, a "clean" record must be registered. All unusual observations of insects and pest damage should be reported to the General Manager of Forestry.

d) Management Inventory

Purpose

Management inventories may vary from an inventory in a young stand for determine its growth potential, up to a pre-harvest inventory, for product and volume advice purposes.

The main purpose of these inventories is to determine the current quality of the volume and a stand, with a secondary objective of predicting growth future and performance through growth models, as well as get information on weeds and insects, their presence and spread.

Description

The inventory procedure for this type of inventory can be summarized as follow:

- The sampling strategy and field procedures are how to specify previously.
- Inventory data is processed and analyzed using the software Microforest approved (MF) to ensure that the total sample taken in the Inventory is statistically acceptable.
- Depending on the previous result, the inventory is approved / not approved. Of being approved, detailed inventory data is stored in the database of Microforest plantations (MF).

e) Density control inventories

Purpose

- Thinning[8] is probably the silvicultural operation that has the greatest impact on a plot of trees from a growth point of view and performance. Consequently, it is important to control these events of thinning during the life cycle for the treatment of correct slimming and for obtaining valuable information about changes of volume status for current volume estimates and predictions of future volume At the same time, information on pests can be obtained from insects and fungi (especially Fusarium circinatum) registered and informed to the General Manager of the company.
- Slimming control provides a methodical way of monitoring and capture the slimming process before the actual slimming occurs and provides a detailed analysis on the quality of the brand and its effects on the Future support development.
- Prediction of the available volumes of slimming operation.

Description

The slimming control procedure can be summarized as follows way:

[8] Definition of thinning: Elimination of suppressed and poor trees.

- The support is marked (and controlled) for thinning, preferably a year before operation. These results must be analyzed and approved by the Forest manager before weight loss.
- Slimming control inventory, use the prescribed sampling number and measurement procedures described above, which makes a distinction between the trees to be removed and the trees to remain after weight loss

Inventory data is processed and analyzed using the approved software Microforest (MF) to ensure that:

- The global sample taken in the inventories is statistically acceptable.
- The poor trees are eliminated and suppressed with thinning.
- The spacing of the trees throughout the stand will be fairly uniform after of weight loss.
- The intensity of weight loss is as established by the policy of reduction or prescription.
- Depending on the result of (iii) above, the decision to lose weight is made, measure again or comment on the support, or yes, in the light of previous treatments incorrect or damaged, the prescribed clarification should be adapted or even canceled.
- The decision is documented and approved in MF and the results obtained they will be available to the forester in question for further attention.
- Depending on the previous approval, inventory data is stored detailed in the plantation database (MF) as part of the stand register.

FOLLOW-UP AND CORRECTIVE ACTION

- The general responsibility for the slimming control processes that carried out is the responsibility of the forest planner. Forest manager approve the analyzes and give the final decisions on weight loss (or observation) by registering inventory in MF, which then becomes a permanent record in the database for future reference.
- The forestry manager in question is responsible for the effective and timely execution of marking and slimming operations.
- The forest planner is responsible for the inventory process, which includes the planning, execution and presentation of inventory reports by your team, the analysis of the data and the results, with recommendations, to the manager of planting for final approval and incorporation of inventory data in the plantation database.
- With the inventory and data analysis, the forest planner will provide special follow-up attention:
  - The correct execution of the inventory and data collection by the team.
  - Statistical validation of the inventory, that is:
    - Sample size (3% -10% per area depending on size and the variability of the stand)
    - Maintain the standard error of the individual components (DAP, Height and SPH) as much as possible up to 5% or less and the error combined standard (DAP + Height + SPH + Volume Regression) up to 10% or less.
    - DAP regression / acceptable height.
- The analysis of the marking process. The following must be verified in detail at The Analysis Sheets:
  - Increase in the average DAP of the remaining support (thinning from down).
  - Improvement (narrowing) of the distribution of DAP after slimming
  - Distribution of spha more uniform in foot after weight loss.
  - spha after weight loss should be as prescribed in the policy slimming

- The volume of the analysis must be available to the Planting Manager.
- Adjust the requirements of the slimming regime when appropriate, using the inventories.
- Capture additional information (comments on weeds and pests) that It has been collected by inventories in the stand register (MF).

- The Forest Manager is responsible for an annual audit of the equipment Inventory.

Figure 3.31: Quality list format

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QUALITY CHECKLIST

OPERATION	Enumeration	

Month: Week No :	Comp No's:	
Supervisor:	Name:	Sign:
Operator:	Name:	Sign:
Shift:		

	Plan	Actual
Date:		
What is the general appearance of the enumeration equipment		
Has the equipment been calibrated?		
No signs of damage		
Have the compartments been planned?		
Have the compartments been provisionally inspected for access?		
Are there sufficient recording pages?		
Has the map been printed and plots planned?		
Are there spare pencils?		
Has the data been checked?		
Has the data been captured into Microforest?		
Has the analysis been checked		
Has the Planner checked the data?		
Has the Planner uploaded the data into the system		
Has the Planner discussed the results with the forester?		

Source: FFC , 2013)

3.2.4.10 Products and by-products

The expected initial product: woodchips, for the bioenergy market and for paper pulp, differentiated by species (acacia and eucalyptus), and in the future Poles and sawn wood.