MISSION REPORT, PART I
USDA FOREST SERVICE TECHNICAL ASSISTANCE PROGRAM
In Collaboration with JariAla and Fanalamanga

FANALMANGA PLANTATION
IN
REPUBLIC OF MADAGASCAR

Mission Dates: October 22 – November 13, 2006

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TABLE OF CONTENTS

CHAPTER 1 - INTRODUCTION

The USDA Forest Service, through a partnership with JariAla-USAID and collaboration with Fanalamanga (Madagascar parastatal company) provided technical assistance with a focus on strengthening Fanalamanga's capacity to collect, analyze and manage forest inventory data and information. As elucidated in the *Terms of Reference for Timothy F. Howard* (TOR)[1], the mission was a reflection of the effort to balance the desirability of efficient inventory methods with economic and practical feasibility to enhance Fanalamanga's forest inventory procedures. I visited selected Fanalamanga plantations, eight (8) times during the period of October 25 through November 8, 2006. This mission report summarizes the results and findings of facts of the in-country visit and is intended to satisfy the requirements of the first 3 week mission TOR. A second 5 week mission with a separate TOR is expected to occur in March 2007.

This report is divided in four Chapters: **(1)** Introduction. **(2)** Summary of technical activities and training provided, a proposed action plan for on-going training, investments, and other activities as well as any other relevant recommendations that would contribute to strengthening plantation management at Fanalamanga; **(3)** Description of the findings of the intensive and extensive inventory undertaken in the southern, central, and northern sections of Fanalamanga; and, **(4)** Summary of the results of the satellite imagery ground-truthing provided to the USDA Forest Service Remote Sensing Application Center (RSAC), Salt Lake City, Utah.

To avoid repetition, information presented in this report does not include complete specific details regarding Fanalamanga Plantation vegetation conditions, economic status, market supply and demand issues, or any political issues or business plans. In some instances, information presented is used to highlight possible responses to identified issues; in other instances, the information presented provides specific details concerning actions or activities that are integral aspects of the management actions recommended in this mission report. For complete information concerning historical timber management practices and present activities on Fanalamanga, the reader is referred to the following documents: *Consultation Report*[2] and *Final Report – Technical Assistance Trip – Republic of Madagascar*[3].

My mission itinerary consisted of:

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[1] JariAla-USDAID. 2006. *Terms of Reference for Timothy F. Howard.* Keck, Andy, Chief of Party, JariAla – Member de l'Alliance Ecoregionale USAID, Madagascar.

[2] EC FAO PARTNERSHIP PROGRAMME. 1999. *Consultation Report – Fnalmanaga Plantation.* Ramakavelo, Seth Philippe. Funded in Part by Tropical Forestry Budget Line B7 – 6201, Project GCP/INT/679/EC.

[3] USDA Forest Service. 2004. *Final Report - Technical Assistance Trip – Republic of Madagascar. Mission Dates: July 18 – July 31, 2004.* Johnson, Marlin A., Higgs, Mike, Kretschmann, David E.

- October 22. Departed Sacramento, California, USA for Antananarivo (Tana), Madagascar.

- October 23-24 (Tana). Arrived in-country. Initial contact with Andy Keck, Chief of Party, JariAla Project to discuss the overall objectives of my visit to Fanalamanga and other topics.. Meeting with JariAla team and representatives Jean Claude Rabemanantsoa, Acting Director General Fanalamanga, and Fanalamanga forestry advisor Ramakavelo Seth Philippe to discuss overall strategies, logistics, and objectives of my mission. It was decided a 10-12 person inventory crew hired by Fanalamanga would conduct inventories supervised by Rabearisoa Luc (Fanalamanga Forest Engineer) and Razafindrahanta Hanitrinianina (Forester contracted with JariAla, not present at meeting) to assist me with implementation, language translation and communication).

- October 25 - 26 (Moramanga and Tana). Initiate inventory training (classroom and field) at Fanalamanga Headquarters, Moramanga. Southern Region

- October 27-November 3 (Tana and Moramanga). Review of progress with the JariAla team in Tana and supervision/participation of first full week of field-based training and inventory work. In the Southern and Central Regions.

- November 3-5 (Tana). Briefing meeting with Dr. Joelisoa Ratsirarson, Secretary General of the Ministry of Environment and Forests and President of Fanalamanga Board of Directors. Present at the meeting: Andy, Hanitrinianina, Ramakavelo Seth Philippe, and myself. The briefing meeting lasted approximately 1 hour. Discussions included an update and overall progress of my mission at Fanalamanga. Preparation of inventory program for the north region of Fanalamanga.

- November 5-9 (field). Training and supervision of inventory work in the north region of Fanalamanga.

- November 10 (Tana). Briefing meeting with Razakamanarina Ndranto, USAID, Specialist of Forestry, Madagascar. Present at the meeting: Andy, Hanitrinianina, Christian Burren (JariAla lead forester), and myself. The briefing meeting lasted approximately 1 hour. Discussions included the status of my mission, an overall update of progress of work, sampling methods, and deliverables (basic manual of inventory methods and procedures)and other details concerning Fanalamanga.

- November 11-13. Consolidation of field results and return to United States.

Note: Data and information collected and analyzed provides a very brief and broad-scale, reconnaissance overview of selected areas in the north, central, and southern regions of Fanalamanga Plantation and has no statistical significance. Descriptive details concerning the plantations are based on observations during my visit. Photographs are used to emphasize vegetation descriptions. Not all sections of each region were visited. A small sample of sections and plantations, primarily older plantations (25+ years old) were inventoried due to the short time in-country, logistics, and inaccessibility of areas of Fanalamanga. However, young plantations (pine and eucalyptus), and other areas were visited to provide information and data for ground-truthing satellite SPOT imagery.

CHAPTER 2

SUMMARY OF TECHNICAL ACTIVITIES AND TRAINING PROVIDED, A PROPOSED ACTION PLAN FOR ON-GOING TRAINING, INVESTMENTS, AND OTHER ACTIVITIES AS WELL AS ANY OTHER RELEVANT RECOMMENDATIONS THAT WOULD CONTRIBUTE TO STRENGTHENING PLANTATION MANAGEMENT AT FANALAMANGA

2.1-Technical Activities and Classroom Training. On October 25, 2006, I arrived at Fanalamanga Headquarters on the outskirts of Moramanga, Madagascar. The purpose was to provide classroom instruction and review of basic inventory measurement techniques, equipment use, and sampling methods to be used in the extensive and intensive inventories. There were (14) fourteen participates, including Hanitriniaina Razafindrahanta (contracted with JariAla to assist me with implementing the TOR and language translation and communication), and Luc Rabearisoa (Fanalamanga Forest Engineer, who provided logistics, locating inventory locations, translation, communication, and general information during my stay at Fanalamanga). Rambeloarisoa Gerard, Forest Programme Officer, WWF Madagascar &West Indian Ocean Programme Office assisted me with my presentation by providing interpretation of classroom and field discussions and instructions to the Malagasy inventory crew. I compressed basically 40 hours normally allowed for classroom instruction into about 3 hours and 2 weeks of hands-on field exercises into 8 hours covering basic forest inventory measurements. Topics of classroom instruction included: fixed plot sampling procedures, systematic sampling design and layout, on-the-ground sampling procedures, equipment use, and data recording. The participants were experienced at collecting and performing inventory duties at Fanalamanga.

Fanalamanga employees who participated: Rabearisoa Luc, Razafindrahanta Hanitriniaina, Randriantsasa Dedy, Rakotomalaca Richard, Razafimpamoa Francois, Randrianandrasana Thisdau, Rijaherijaona Tsirimampiasa, Ramanantsihoarana Tantely, Ramananiary Jean fidile, Ranotonirina Ravelonjara, Rakotonandrasana Dieusonne, Randrianaiisoa, Ratsimbazafy Sylvain Guillamne, Rabemanantroa Jean Eric, and Narisoa Jean de Dieu. These individuals conducted the field inventories during the 9 days of actual data collection in the northern, central, and southern plantations in Fanalamanga.

After field work and training exercises were completed by the individuals listed above, I sincerely appreciated working with them in every aspect of the mission and the professional quality of their work was beyond my expectations in their united performance of their duties, including:

- Workmanship was excellent in every detail in conducting forest inventories.

- They were experienced forestry workers and quick to learn a different inventory method than what was traditional used at Fanalamanga. They were quick to perceive and recognize the efficiency of the fixed plot inventory methods and procedures introduced to them and recognized the benefits of the method introduced to them. Performing the new inventory tasks that was assigned to them did not interfere with the progress of conducting inventories. They were well organized, efficient, and displayed a large capacity for protracted effort, regardless of the difficulty or frustrations of the job.

- Their ability to quickly acquire skills necessary to properly use complex measuring equipment and employing the inventory process from start to finish. This includes: GPS handheld recorders, clinometers, diameter tapes, data recording, and measurement techniques.

2.2-Fanalamanga Proposed Action Plan

The goal of this Proposed Action Plan is to strengthen and support the actions of managers at Fanalamanga to manage plantations and investment strategies at Fanalamanga. The four targeted items below should be the focus of this endeavor:

- Identify on-going forest inventory training needs for Fanalamanga personnel
- Investments and financial requirements to fund forest inventories.
- Identify other activities that would further contribute strengthening plantation management
- Provide relevant recommendations that would contribute to strengthening plantation management at Fanalamanga.

Identify on-going forest inventory training needs for Fanalamanga personnel.

Develop, implement, and maintain a technical training program. Emphasis would be on cost effective inventory planning and implementation. This could be an accredited 2 day short-course in Forest Inventories. Course content would include but not limited to: inventory design, techniques, methods, and procedures; statistical data analysis; GPS, field exercises; aerial photo interpretation; different inventory methods (large scale overviews, small scale products areas), defect deductions methods; equipment use; inventory information analysis; inventory report interpretation; measurement techniques in plantations and natural forests; etc. Having the knowledge, skills, and ability to perform forest inventories is key. Information about the exiting condition of plantation attributes derived from forest inventories is required to sound resource management plans.

- Need 10 individuals with the necessary knowledge and skills to perform inventory duties working full or part-time depending on inventory needs for timber cruises (intensive inventories) and large-scale inventories needed for management planning. Recommendations for the development, planning, and implementation of management plans have been submitted by previous technical assistance teams and are therefore will not be included here.
- On-going refresher training is needed to update knowledge and skill levels of the inventory technicians.
- Development and implementation of the training program could be initially designed and implemented by USDA Forest Service in collaboration with USAID – Jari Ala.
- Provide training relating to silvicultural treatments to achieve management objectives in terms of desired species composition, structure, and age based on direction in Fanalamanga land management planning. The goal of my mission is to assist Fanalamanga to put in place a rigorous inventory database system and procedures for managing plantations. The first step is to know the existing condition of the plantations and this is accomplished through precise forest inventories at the large scale (All Regions) and small scale (individual permits). This initial technical assistance mission had led me to the observation that plantations suffer from no/little silvicultural maintenance and that the inventory team had little knowledge of how to analyze and manage plantations. Providing the necessary training in the use of computers and plantation databases, silvicultural systems, and forest

inventories is a basic foundation needed for the establishment of sound plantation management at Fanalamanga.

- Monitoring. Develop, implement, and maintain a monitoring program of all inventory activities. This includes GIS and tabular database management, record keeping, inventory scheduling, and checking field work perform by inventory crews. Monitoring would be conducted by the Regional District Manager, Silviculturist or Forest Engineer. Annual reports submitted to Director General Fanalamanga.

Investments and financial requirements to fund forest inventories.

Fixed costs related to an efficient inventory program could be cost prohibitive for Fanalamanga. Taking this into account, the following suggestion and list of supplies and equipment are prioritized by short-term needs from 1 to 3, 1 being the highest priority. To sustain a program of work, annual budgets will dictate the extent and scope of conducting inventories on Fanalamanga. In developing annual program of work and budgets, take into account fixed costs of supplied to carryout inventory work. This list contains estimates of costs, actual costs at time of purchase will vary. An alternative to purchasing new equipment would be donations of used or excess equipment from organizations, foreign governments or institutions. Equipment purchases could be phased over a 1-3 year period depending on budget allowance to purchase and priorities of management planning.

(1) Computers. 3 computers with the latest software (ArcGIS, MS programs, GPS. US $3,000 each.

(3) Plotter. 1 plotter, located at Fanalamanga Headquarters in Moramanga. US $5,000

(1) Color Printers. 3 printers. US $500 each

(1) Computer Software. Network licenses for GIS and GPS programs, including miscellaneous programs (MSWORD, Access, and Excel) . $5,000.

(2)Aerial Photography. Color laminated, 1/10,000 aerial photographs of Fanalamanga Plantation proper. US $5,000

(1) Satellite Spot Imagery. South and North Regions. US $5,000. Imagery of the Central Region has already been purchased.

(1) Inventory Equipment. Basic equipment to carryout field and office duties. Not an inclusive list, but could include: cruiser's vest, rain gear, compasses, diameter tapes, binoculars, backpacks, clinometers, miscellaneous office and field supplies, etc. Enough to outfit 10 individuals. US $5,000

(1) 2-way hand-held radios. 12 each. 1 supplied to each person. Cost dependent on desirable range of radios, make and models, etc. US $1,000

(2) Vehicles. 3 vehicles. Designate 3 individuals of the inventory crews to be drivers as a collateral duty. US $75,000.

(3) Generator. 3 generators of sufficient output to supply electricity to power equipment at remote Regional Headquarters. US $4,000

(1) Camping Equipment. Enough camping equipment (tents, sleeping bags, cooking equipment, miscellaneous supplies) to support inventory crews when camping out away when housing is not available. Assume enough for 12 individuals. US $3,000.

(1) Digital Database of Spatial and Tabular Information. Transferring Fanalamanga paper plantation maps into a GIS digital format. $1,000. Linking the tabular existing plantation database to the digital plantation spatial data of Fanalamanga. $1,000. **Maintaining and Updating the Fanalamanga Geodatabase are a recurrent basis. ($5,000/year). Capitalize on knowledge of field personnel to assist with the digitizing work by having them assist and review spatial and tabular data.**

(2) Employees. Employ an individual to oversee the computerized database and spatial data. This individual would also supervise and perform workforce planning the 10 person inventory crew. $40,000/year. Inventory crew salaries range from $10,000 to 25,000/year.

Initial Fixed Cost. Priority (1). Approximately $37,000

Priority Item (2). Approximately $120,000

Priority Item (3). Approximately $10,000

Total Cost. Approximate estimate: **US $170,000**

Identify other activities that would further contribute strengthening plantation management

The purpose of this intervention is to continue efforts begun with USFS assistance in November 2006 in support of Fanalamanga's goal to strengthen its systems for managing plantation data. Specifically, the USFS would mobilize an expert in inventory design and management, Tim Howard, for a 5-week mission to begin on March 20, 2007 to lead the implementation of these plantation data management strengthening activities. Mr. Howard will work directly with Fanalamanga and Jariala personal during this mission to accomplish specific duties stated below:

1. Review Fanalamanga's system for timber valuation and timber appraisal methodology
2. Review Fanalamanga's internal organization to identify options for managing data and to define lines of responsibility for management of inventory data and other descriptive information on plantation stands
3. Identify personnel to be trained in data entry and analysis to ensure proper capacity is built
4. Prepare three stands of pine trees of approximately 30 ha at Fanalamanga for a timber sale, potentially via existing competitive bidding processes in place for natural forests in Madagascar
5. Complete compilation and analysis of inventory data
6. Install computers and software at Fanalamanga and initiate basic training on GIS and other programs as necessary
7. Undertake ground-truthing of recent USFS work to "interpret" Fanalamanga's plantations using SPOT 10 m resolution satellite imagery.
8. Review the digitizing and georeferencing work of the Fanalamanga field maps and, if possible, establish the link between this and the Fanalamanga existing databases on the stand descriptions
9. Develop a 12-month plan for all on-going work to be done with emphasis on cruising and development of tenders/timber sales, updating the databases, etc.

Roles and Responsibilities

To aid and assist Tim with this work, Fanalamanga and JariAla have the following responsibilities:

Fanalamanga will be responsible for mobilizing employees to work full time or part-time with Tim. Employees selected would be the original individuals who were trained and worked with Tim during his first mission. Luc Rabearisoa would be the preferred crew supervisor because of his English speaking skills and understanding of forest management at Fanalamanga. Provide all necessary logistics, aided by JariAla, while in the field and office at Fanalamanga (Moramanga and Analabe) for the crew.

JariAla will recruit a Malagasy forester with English language skills to collaborate with Tim on all aspects of the scope of work, preferably Hanitriniaina Razafindrahanta or Mamy Rakotondralambo, if available. JariAla will also coordinate in-country logistics for the duration of Tim's visit; including camping equipment, 4x4 vehicles, drivers, etc. Jariala will also be responsible for installing computers / software at Jariala, as well as initiating a contract to do the digitizing of the original paper maps and georeferencing of the Central region

JariAla will also mobilize additional full-time personnel or consultants, as needed to undertake the following tasks in collaboration with Tim:

- review of Fanalamanga's timber valuation system
- organizational review to determine where to assign responsibilities for data input, analysis, and storage (data bases) as well as mapping and work with a GIS
- introduction and installation of a data input interface
- installation of computers and software
- training on GIS and use of the data input interface
- digitization of Fanalamanaga field maps

Specific requirements and timing for these inputs will be determined either prior to the start of the mission or during the first week from March 20-23.

Deliverables

Mr. Howard will prepare a preliminary report with the following elements:

- Detailed account of the results of the timber cruising and inventory work
- Detailed account of the results of the timber appraisal and valuation work
- A compilation and analysis of inventory data from all sites
- A short note for each of the three timber sale sites summarizing the pertinent details of the stand's inventory and appraisal work to serve as the basis for a more complete timber sale document
- A 12-month plan for all on-going work to be done with emphasis on cruising and development of tenders/timber sales, updating the databases
- A summary of the results of the satellite imagery ground-truthing exercise to be shared with the USFS Remote Sensing Applications Center, with a focus on next steps to complete the mapping and plantation stratification work

This report will be completed prior to departing Madagascar. The final report would be completed at a later date after RSAC completes the processing of the ground-truthing data. This final report will be submitted to

Oliver Pierson, USDA Forest Service, International Programs for distribution to the Malagasy government, USAID – JariAla, and Fanalamanga Management.

Timber cruise reports summarizing the results of intensive inventories of a minimum of two parcels in the Southern Region. The cruise reports will be completed with the aid of Fanalamanga data processing programs and personnel. All data collection will be done by Fanalamanga technicians.

A final and complete report of Mission 1 and Mission 2 will be prepared. This report will provide conclusions of the 1st and 2nd mission inventories as well as other recommendations for future inventory and forest management activities at Fanalamanga.

Other Recommendations that would contribute to strengthening plantation management at Fanalamanga.

- Capitalize and follow through on previous USDA Forest Service Technical Assistance Missions. Implement their recommendations to the extent practicable.
- Increase budget allowances and annual operating expenditures for the operating Fanalamanga.
- Design, develop, and implement a 5 year Resource and Business Operating Plan for Fanalamanga.

CHAPTER 3

DESCRIPTION OF THE FINDINGS OF THE INTENSIVE AND EXTENSIVE INVENTORIES COMPLETED IN THE NORTHERN, CENTRAL, AND SOUTHERN REGIONS OF FANALAMANGA

Background. Fanalamanga plantations have traditionally been the land units of forest management. That is, management prescriptions are formulated on a plantation basis for achieving the plantation management objectives, which are defined in terms of a desired species composition and structure at some time in the future based on direction in Fanalamanga management policies. Here a framework is provided for relating the selection of silvicultural treatments to the achievement of plantation management objectives. Plantations are normally considered the smallest management unit for prescription writing, record keeping, mapping, and recognition depends upon plantation management objectives (many criteria are possible) from a silvicultural viewpoint. Since plantations are considered the smallest plantation management unit for prescription writing, record keeping, mapping, database updates of proposed treatments will apply on a plantation-by-plantation basis. However, small areas (groups) of plantations are also considered at the local level for sale for specific purposes, including sawtimber, fuelwood, or other locally desired products.

My understanding of the hierarchy of vegetation classification units for Fanalamanga plantation management under management policies includes Regions, Sections, Parcels, Plantations, and Groups. Table 1 displays the hierarchy of vegetation classification on Fanalamanga from Regions to Groups.

Table 1. Hierarchy of Vegetation Classification for Plantations on Fanalamanga, Madagascar

Scale	Key Characteristics
Region (North, Central, South)	Largest and most heterogeneous unit. Recognized by life form and/or species composition of dominant plants. Size usually extensive. Mapping Unit. Database record keeping unit. Minimum size depends upon administrative boundaries and/or composition of dominant plant species. 18,000 hectares Management direction provided in Fanalamanga Regional Guidelines and Policies.
Section (Designation- A through Z)	Less heterogeneous unit than Region Recognized by life form and/or species composition of dominant plants Size usually extensive. Mapping Unit Database record keeping unit Used to establish priorities for silvicultural treatments within a Region. Minimum size approximately 10,000 hectares
Parcel (Designated by sequential numbers)	Less heterogeneous unit than Section. Composed of somewhat similar in overstory and understory densities, sizes, and species composition Silvicultural treatment unit. Mapping Unit Database record keeping unit Minimum size approximately 2,000 hectares Recognition depends upon Section management objectives - many criteria are possible. Land units of plantation management. Includes non-plantation areas, such as natural forests, grasslands, rice fields, villages, and private lands.
Plantation (Designated by sequential numbers assigned to Parcels)	Homogeneous unit. Recognition depends upon management objectives – many criteria are possible. Minimum size is one (1) hectare Smallest silvicultural treatment unit. Smallest database record keeping unit. Smallest Mapping unit (presently not mapped in GIS). Smallest land unit of plantation management Not the same hectares assigned to Parcels. Plantation are generally less hectares than Parcels.
Group (Designed by Permit Number)	Homogeneous unit. Located within Plantation boundary proper. Recognized on basis that different management is required than management for any of the surrounding vegetation (natural vegetation, grasslands, rice fields, etc.) Database record-keeping unit. Mapping unit. Similar appearing groups belong to the same group type. Size depends upon treatment practicality at the local level.

Objectives. The primary objectives of the reconnaissance level inventories were to determine, through timber surveys of the south, central, and northern regions, existing conditions of selected plantations and to provide ground-truthing information to type satellite 10 meter SPOT imagery. Another objective was to provide instruction in conducting timber inventories to employees of Fanalamanga.

Inventory Design, Sampling Method, and Selection of Plantations.

Inventory Design. At each parcel, the following general information was collected: GPS of plot center; Canopy Cover (Low-0-30%, Moderate-30-70%, and High- 70-100%); Slope (Low-0-10%, Moderate – 10-35%, and High- Greater than 35%); Aspect (Flat, North, East, South, and West); Understory Vegetation (Percentage of the total understory covered by trees, grasses, or nothing. Low-0-30%, Moderate-30-70%, High-70-100%); Parcel elevation; Parcel age; Parcel Hectare; Photo (if available); and Inventory Crew Initials.

Inventory plot size was chosen on the basis of number of trees of the primary vegetation, such that, on average, each plot would have 7 to 10 trees recorded. Once the size of plot was established for an individual parcel, the same plot size was used on all plots within the parcel if 2 or more plots were established. Fixed plot sizes used: $1/10^{th}$, $1/20^{th}$, $1/50^{th}$, $1/100^{th}$, $1/500^{th}$, and $1/1000^{th}$ hectare plots. Inventory crews determined the size of plot to use depending on existing vegetation.

At each plot, the following data was collected for each tree: species, diameters, total tree height, merchantable height (up to 14 cm diameter), tree status (live, dead, defective), and notes (extent of defect).

Location of Plots. Plots was systematically located by pacing between plots on a cardinal direction. The larger the parcel, the greater the distance between plots.

Selection of Plantations. The plantations surveyed were selected on the basis of accessibility by vehicle and time allowed for the mission. **A total of 247 survey plots were inventoried**. Surveys were restricted to the Sections and Parcels for each of the three Regions as displayed in Appendix A.

Sections R and S of the Northern Region are not in GIS digital form. Refer to the attached maps of the north, central and south regions for locations of sampled parcels and sections.

Results: Field Data Collection Forms. The original data was transcribed in MS Excel by Hanitriniaina Razafindrahanta and is located in Appendix B).

Intensive Inventory Results and Conclusions.

Intensive inventories were conducted on two parcels located with the South Region of Fanalamanga: Section Z, Parcel 12 and Section X, Parcel 6.

Section X, Parcel 6. 26 Hectares, *Pinus cariibeae,* 24 year old plantation A total of 4, $1/100^{th}$ hectare plots were systematically located within the 26 ha plantation area. The following is a summary of the inventory:

Section X, Parcel 6						
Trees Per Hectare	Average Diameter	Average Height	Gross Volume Per Hectare	Net Volume Per Hectare	Total Gross Volume	Total Net Volume
900	21.5 cm	16 m	94.5 cubic M/Ha	88.8 cubic M/Ha	2,457 Cubic Meters	2,308 Cubic Meters

The nominal cruising percentage is computed as: (Plot Size in Hectare/Hectares Represented) X 100 = (0.01/6.5) x 100 = 0.15%.

Section Z, Parcel 12. 60 Hectares, *Pinus kesiya,* 20 year old plantation A total of 12, $1/500^{th}$ hectare plots were systematically located within the 60 ha plantation area. The following is a summary of the inventory:

Section X, Parcel 6						
Trees Per Hectare	Average Diameter	Average Height	Gross Volume Per Hectare	Net Volume Per Hectare	Total Gross Volume	Total Net Volume
1,460	17.7 cm	15 m	102 cubic M/Ha	90 cubic M/Ha	6,120 Cubic Meters	5,400 Cubic Meters

The nominal cruising percentage is computed as: (Plot Size in Hectare/Hectares Represented) X 100 = (0.002/5) x 100 = 0.04%.

Conclusions: Both cruises are had very low sampling intensities and sampling statistics were not calculated, but the sampling error is approximately 20%, i.e., In Section X, Parcel 6, the total gross volume is expected to be within 4,896 and 7,344 cubic meters. If the purpose of the inventory is to sell the wood products based on timber cruises, a 10% sampling error would be recommended as a acceptable standard used by Fanalamanga on future product sales, when design timber cruises, which means increasing the number of plots and/or increasing plot size systematically located within the tract of land to be sold. The number of plots is dependent on tract size, products to be sold, stand density, species composition, and silvicultural prescription.

Extensive Inventory Results and Conclusions.

Central Region, Fanalamanga. Eighteen Parcels were inventoried. A total of 52 plots were randomly located within the 1,542 total hectares represented by the 18 parcels. This represents approximately 7.2% of the Central Region was sampled in about 3 days! The average plantation age is 21 years old. All plantations sampled comprised of *Pinus kesiya* with the exception 2 parcels of *Pinus elliottii*, and 1 parcel of *Pinus caribeae.* All areas visited exhibit over dense conditions with density-dependant mortality beginning to onset. Live crown ratios are low, about 10%. Spacing between live trees average about 2.5-3 meters between trees. Canopy cover ranges from 70-100%.

Northern Region, Fanalamanga. Sixty-two Parcel were inventoried. A toal of 167 plots were randomly located within the 4,178 total hectares represented by the 62 parcels. This represents about 21% of the Northern Region was sampled in 3 days! The average plantation age is 27 years old. All plantations sampled were a plurality of *Pinus kesiya*, 18 parcels and *Pinus caribeae* 44 parcels, with the exception of 1 parcel was *Pinus elliottii.* As mentioned about in the central region, all plantations visited exhibited over dense conditions (from my perspective). The plantation conditions are the same as the plantations in the Central Region.

Based on a few samples, volume and growth estimates vary little from previous inventory estimates made by other consultants and Fanalamanga inventories. Therefore, I don't see a need to "reinvent the wheel" in terms of completing an entirely new inventory. I do see a need to adjust volume estimates and update the existing database, mainly because of the large catastrophic wildfire that occur throughout Fanalamanga plantation boundary proper.

Concerns. Below, is a list of concerns I have with respect to the management of Fanalamanga. This list is not an all inclusive list but highlights some of the major concerns I have observed:

1. Reduce the risk of stand-replacing fires – To be effective, a sufficiently large area needs to be treated to reduce the likelihood of a stand-replacing fire. Treatment of small, isolated areas to reduce stocking and ladder fuels tends to be ineffective in altering fire in a large catastrophic fire situation.

2. Maintain or enhance natural forests habitat conditions located within Fanalamanga - Disturbance by vegetative treatment operations, prevention of snag development, removal of snags and downed logs,

reduction in overall stand density, and timber theft may negatively affect some wildlife and vegetation species. By implementing appropriate stand prescriptions it is possible to protect or enhance those stand characteristics that are most valuable to late seral wildlife species. By initiating stocking control, it is possible to increase the growth rates of selected residual trees, thereby attaining old growth sized trees more quickly. The natural areas are important to overall ecosystem health and development and I feel it important to protect these areas from exploitation and wild fires.

3. Promote rural economic vitality – The sale of forest products from Fanalamanga is key to sustaining local villages located in and around Fanalamanga. Opportunities exist at Fanalamanga to improve and protect forest health while simultaneously producing timber products that will meet a portion of the continuous demand for timber for the use and necessities of the general public. Mill closures, localized direct and indirect timber related unemployment, and substantial decreases in national receipts because of the depressed sale program have been identified as substantial and inter-related issues.

4. Silvicultural Prescriptions and Precommercial Thinning – The vast majority of the plantations I visited are overstocked and not growing to their potential. In most instances, if the plantations had been precommercially thinned 10-15 years ago, average tree size (diameter) would be over double the current diameters, which equates into increased cubic volumes. For instance. If there are 12-16 rings per 2.54 centimeters, the diameter increase in the next five years will be only 0.2 to 0.38 centimeters. Whereas if there are 2-3 rings per 2.54 centimeters, the diameter increase in the next five years will be about 1.4-2.0 centimeters. If this example is taken out to 10 years, the results approximately double! Silvicultural prescriptions could be a combination of precommercial thinning, clearcuts, and group selection depending upon management constraints and objectives, desired products to be sold, and desired quantity of volume sold each year.

Background Information. There is a relationship of volume growth to stand density. It is generally agreed that for even-aged stands net cubic meter growth is strongly related to stand density up to a given stocking or basal area. After that point, there is a range over which density and growth are not related until a point of very high density or stagnation is reached. Fanalamanga should develop thinning guidelines as an attempt to estimate critical basal area at which point precommercial thinning would be appropriate. This critical basal area is the point on the cubic meter/ha vs density (basal area/ha) curve where basal area above which growth will be at least 90% of the maximum. If the goal of Fanalamanga is to grow large trees in the shortest amount of time, stocking much be kept below this critical basal area and a total loss of total production will result. The relationship will vary with site quality, and for a given species. Plantations can be grown at higher densities on good sites than on poor sites. This relationship depends on plantation history. For plantations which have been grown at a high density (most of the plantations I visited), the critical basal area will occur at a higher basal area than for those which have grown at lower density. In plantations grown at high densities, trees have smaller crowns and they will not be able to fully use the site after thinning if plantation density is reduced too much. Trees grown at wide spacing are better able to use the site after thinning to low stand basal areas. Young plantations can be thinned to lower basal areas than can older plantations. This is because young plantations have the ability to develop crowns since they are still actively growing in height. The critical basal area may be depend upon insect and pathogen complexes in the plantation. It is possible that on certain sites it may be necessary to keep the plantation trees at lower densities to keep trees free from "stress" in order to reduce the impact of diseases and insects epidemics or outbreaks. For plantations in the rapid period of height growth, the critical basal area may be at a higher basal area than for older plantations. During this period a considerable proportion of volume is added by height growth which is usually independent of stocking, except at very high density. This consideration is of little practical importance. A lot of the growth would not be used since carrying young plantations at high densities would result in non-merchantable material, because stem diameter would be too small.

Plantation growth varies with plantation density; however, there is usually a ranges of plantation densities at which a plantation can be left after thinning with little effect on total growth. The most important silvicultural considerations when planning a thinning and deciding what stocking (basal area/ha) to leave are: 1) The condition of the trees to be left. Do they have full crowns with good live crown ratios (30-40%). 2) The age of the trees to be left, or even better, the amount of height growth they can be expected to produce. Future height grown is an index of potential crown development. If a tree currently has a low live crown ratio, but it can be expected to grow in height, the live crown ratio may improve. 3) The probable effects of insects, pathogens, wind exposure (high air temperature and evaporative capacity), understory vegetation, and fire after thinning. 4) The frequency of entry and cost of commercial thinning. If logging is expensive then it may be best to thin heavily and less frequently. If access is easy, light and frequent thinning may be possible. In plantations with low basal area only a light thinning or cleaning may be done and then a long wait to the next entry may be necessary. 5) Effect of logging on the residual crop trees – projection of damage to the planned leave trees.

Given these considerations in thinning plantations it is very difficult to determine any one basal area to leave after thinning which would apply to all plantations of a species on a particular site regardless of past plantation history, possibilities of insects and diseases, management constraints, and wildfire.

CHAPTER 4

SUMMARY OF THE RESULTS OF THE SATELLITE IMAGERY GROUND-TRUTHING PROVIDED TO THE USDA FOREST SERVICE REMOTE SENSING APPLICATION CENTER, SALT LAKE CITY, UTAH

Ground-Truthing[4] satellite 10 meter SPOT imagery of the central region of Fanalamanga Plantation was another component of this mission. The ground truthing consisted of collecting vegetation attributes that will be used to prepare a reconnaissance level map for the Fanalamanga Plantations. Preparation of the reconnaissance level map will be prepared by USDA Forest Service, Remote Sensing Applications Center (RSAC), Salt Lake City, Utah, USA. Field sampling work was limited to the central region of Fanalamanga, due to the limits of the 10m SPOT image.

A total of seventeen (17) parcels in the central region were visited and a quick inventory was conducted to collect stand attributes. The following parcels were sampled: C1, E10, K7, M3, M4, Q1, Q2, Q3, Q4, Q9, R5, S9, T1, T8, U10, Z7 and Z8. Complete inventory information pertaining to these parcels is located in Appendix B.

At each sample plot, the following general information was collected:

- GPS (Laborde Projection, unless otherwise noted) coordinate of plot center.
- Canopy Cover (Low-0-30%, Moderate-30-70%, and High- 70-100%)
- Slope (Low-0-10%, Moderate – 10-35%, and High- Greater than 35%)
- Aspect (Flat, North, East, South, and West)
- Understory Vegetation (Percentage of the total understory covered by trees, grasses, or nothing. Low-0-30%, Moderate-30-70%, High-70-100%)

- Parcel elevation; Parcel age; Parcel Hectare; Photo (if available); and Inventory Crew Initials

- At each plot within the parcel, the following data was collected for each tree: species, DBH, Total Height, Merchantable Height (up to 14 cm diameter), tree status (live, dead, defective), and notes (extent of defect).

An additional thirty-six (36) sample points were also located within or outside parcel boundaries. Sample points were located on roads, grasslands, and drainages. At each sample point the following details were collected: Photograph, Located (GPS using NAD27 CONUS), and a general description of the vegetation. This information is located in Appendix C. Photographs are attached in Appendix D. These point features are included in the GIS coverage (Mad_wpts.shp). Point features of selected roads are also included in the shape file and attributed as such.

The 10 meter spot image map with waypoints and Fanalamanga Regional maps are located in Appendix E.

The Ground Truthing data (maps, photographs, GIS/GPS, vegetation information, etc.) has been mailed to RSAC for analysis and compilation. It is expected after the completion of Mission 2 ground-truthing field work, the maps developed by RSAC should be delivered around May 2007.

USDA Forest Service. 2001. *A Primer on Mapping Vegetation Using Remote Sensing – Vegetation Mapping - Remote Sensing Tips.* Tom Bobbe, Henry Lachowski, Paul Maus, and Jerry Greer. Remote Sensing Applications Center, Salt Lake City, Utah and Chuck Dull. Assistant Director of Engineering, USDA Forest Service, Washington DC.

USDA Forest Service. 2001. *A Primer on Mapping Vegetation Using Remote Sensing – Vegetation Mapping - Remote Sensing Tips.* Tom Bobbe, Henry Lachowski, Paul Maus, and Jerry Greer. Remote Sensing Applications Center, Salt Lake City, Utah and Chuck Dull. Assistant Director of Engineering, USDA Forest Service, Washington DC.