

**MANAGEMENT COST IN GOVERNMENT AND PRIVATE FOREST
PLANTATIONS IN TANZANIA: CASE STUDY OF SAO HILL AND
MAPANDA PLANTATIONS, MUFINDI DISTRICT, TANZANIA**

By

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**A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE
REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN
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ABSTRACT

A study on management cost in government and private forest plantations in Tanzania was carried out at Sao Hill Forest Plantation and Mapanda Forest Plantation. Specifically, the study identified management costs of Sao Hill and Mapanda forest plantations, examined factors influencing management costs of Sao Hill and Mapanda forest plantations and also assessed cost management strategies used by Sao Hill and Mapanda forest plantation all for the past five years. Socio-economic data were collected through checklists and structured questionnaires. Data were collected from the two projects treasurer's offices of Sao Hill Forest Plantation and Mapanda Forest Plantation head offices in Mafinga. Qualitative data were analysed through content and structural-functional analysis. Quantitative socio-economic data were analysed using descriptive and inferential statistical methods. The results show that average real management costs for Sao Hill Forest Plantation (SHFP) is TAS 520 000/ha/year and TAS 345 000/ha/year for Mapanda Forest Plantation (MFP) and is significantly influenced by salaries and wages (45.5%), soil ingredients (27.6%) and seed purchase (16.4%), fire protection(23.1%), pitting and planting (14%), weeding (5%), pruning (0.9%) and beating up (0.6%). It was further revealed that the main factor contributed to higher management cost in Sao Hill forest plantation is lack of knowledge on cost management strategies. It is recommended that the government should use management costs as the basis for setting or changing royalty fees and also review the cost management strategies so that they can further attain the lowest unit real costs.

DECLARATION

I, Hamisi Iddi Malinga, do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my own original work and that it has not been submitted for a degree award at any other university.

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Date

The above declaration confirmed

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Date

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This work is dedicated to my mother Amina Seking'ufya (Mwimbwa) who laid the foundation of my education with a lot of sacrifice.

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LIST OF ABBREVIATION

CPI	Consumer Price Index
FAO	Food Agriculture Organization
FBD	Forest and Beekeeping Division
FD	Forest division
FSC	Forest Stewardship Council
KVTC	Kilombero Valley Teak Company
MDC	Mufindi District Council
MNRT	Ministry of Natural Resources and Tourism
MPM	Mufindi Paper Mill
NBS	National Bureau of Statistic
OCIO	Office of Chief Information officer
OSI	Office of systems integration
PMBOK	Project Management Body of Knowledge
SFM	Sustainable Forest Management
SPSS	Statistical Products and service Solution
SUA	Sokoine University of Agriculture
TANWAT	Tanganyika Wattle Company Limited
URT	United Republic of Tanzania
VCS	Voluntary of Standards
WBS	Work breakdown Structure

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

The government of Tanzania has 16 government owned industrial forest plantations covering about 83 000 hectares with *Pinus patula* as the major species. Plantation forestry has been widely used as a “quick fix” solution to the problems pertaining to over exploitation of natural forests. According to Mtuy (1996), forest plantations make a big contribution to economic, social, cultural and environmental welfare. Forest plantations are the only source which can plug the growing gap between wood demand and supply by complementing but not substituting the natural forests which are known to be diverse, resilient and stable.

The industrial forest plantations have a good potential to contribute to the national economic and rural development. However, they are found to be poorly managed culminating to having trees of poor form, which do not supply enough quality wood to support the growing forest industries. This state of affairs is due to among others, use of seeds of inferior genetic quality and low budgetary allocations resulting in the skipping of some silvicultural operations (MNRT, 2001a; Nshubemuki *et al.*, 2001). According to Nshubemuki *et al.* (2001), plantation forests can go a long way in augmenting and increasing industrial and non industry wood supply, provided that the right species of trees are planted in the right places and proper management practices are put in place. In most cases plantations, especially those of exotic tree species are preferred due to their fast rate of growth and easy management.

Sao Hill Forest plantation is one of the government’s forest plantation which was established in 1970s. Sao Hill Forest Plantation covers about 41 604 hectares which is

about 50% of the total area covered by all government owned forest plantations. It was established with the aim of supplying raw materials to the Southern Paper Mills (SPM), Mgololo, currently known as Mufindi Paper Mills (MPM) and Sao Hill Sawmills. The remaining area of about 42 000 ha is more or less clustered in the northern part of the country on the lower slopes of Kilimanjaro and Meru mountains, the Usambara mountains and around Lake Victoria while few plantations are clustered in the southern highlands (O’Kting’ati and Monela, 1996).

There are several private forest plantations in Tanzania most of them started in 1990s due to policy and institutional reforms which started since 1980s (MNRT, 2000). Mapanda forest plantation with an area of more than 100 000 ha (8 000 ha planted) is among the private plantation located in Mufindi district and owned by the Green Resources limited (Ngaga *et al.*, 2008).

A forest plantation bears costs from establishment to terminal operations. Any investments made, like forest plantation, aims at maximizing profits hence cost management is one of the key roles of the management in order to maximize returns.

To ensure high productivity and good quality products from forest plantations, proper forest management is required. Forest management is a practical application of scientific, technical and economic principles in forestry (MNRT, 2001a). However forest management is costly and effective use of resources is of paramount importance. Cost management strategies used by different forest plantation practitioners entail making decision on how much money will be spend to accomplish certain operations, and differs considerably between government and private sector (Colin, 2004). According to Hax and Majluf (1982), the management of cost of manufactured products is fundamental to long

term profitability of any firm operating in a competitive market. To a great extent, the strength of business rests on its ability to deliver products at costs lower than its competitors. The costs of a product should not be viewed as simple accumulation of direct and allocated expenses for its manufacture and sale, but also as indicator of the firm's ability to manage its resources.

1.2 Problem Statement and Study Justification

The knowledge on management cost is important in order to produce high wood quality and supporting the government and private efforts to establish more forest plantations at minimal costs and maximum profits. The Forestry and Beekeeping Division (FBD) developed forest plantation cost items (Production coefficients) which are used to compute management costs of forest plantations (FBD, 2001).

However, the extent to which these costs are managed in order to cut down costs and how they differ from one plantation to another especially between government and private owned forest plantation was not known. Government forest plantations are public goods which are governed by certain principles. It is quite common to find an inefficient allocation of resources in public institution according to the theory of public goods/services compared to private ones URT (2001). According to Gregory (1972), the public goods are non rivals in consumption hence resource allocations for its production are not exclusive from the public access as well as in satisfying social wants and merit wants (Gregory, 1972).

The guideline on plantation management cost in public or private investments is useful in order to identify or use least cost combinations of inputs to establish and operate a forest plantation with reasonable profits. It is of interest to find out which and how unit costs for

government plantations differ from those of private plantations and their associated cost management strategies. This could instil cost consciousness and contribute to efficient allocation of resources.

One of the indicators on how the cost management strategy is effective is the derived unit management costs. Therefore, this study aimed at determining, analysing and comparing the plantation management costs in both government and private owned plantations and the strategies used in cost management. Findings from this study will contribute to available knowledge on forest management in Tanzania by generating information which will enable decision makers identify areas of which costs can be reduced and increase profits.

1.3 Study Objectives

1.3.1 Overall objective

The overall objective of this study was to compare management costs between Government and private owned forest plantations in Tanzania.

1.3.2 Specific objectives

The specific objectives for this study were:

- i) To identify management costs of Sao Hill and Mapanda forest plantations for the past five years.
- ii) To examine factors influencing management costs of Sao Hill and Mapanda forest plantations for the past five years.
- iii) To assess cost management strategies used by Sao Hill and Mapanda forest plantation for the past five years.

1.4 Research Questions

The following research questions were used to guide this study:

- i) What are the management costs and trend by Sao hill and Mapanda forest plantations for the past five years?
- ii) What are the factors influencing the management costs at Sao hill and Mapanda forest plantations for the past five years?
- iii) What strategies are used by Sao hill and Mapanda forest plantations to manage costs for the past five years?

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Forest Management

According to Besong (1997), management regime is defined as “the way in which a forest is managed, which group and individuals have access to it, timing, means and degree of management and all considerations”. Management regimes are mechanisms that determine the future of forests. How well the regime is conceived, and how well it is implemented will determine how secure the future of the forest can be. Management regimes vary widely from state ownership and control to communal and private ownership. Irrespective of the type of use and type of forest, the actors are basically the same, the forest inhabitants, government agents, national users, and international users. Securing the future of the forest is of paramount important to each of these user groups and seeking options to guarantee the existence of the forest must involve all of them.

Most Government forests fall under common pool resources, i.e. resources that are costly to or difficult to exclude potential users, but which are subtractable or rival in consumption and can thus disappear or can be poorly managed. The subtractability of consumption means that open access arrangements can lead to quick resource depletion (McKean, 2000). Owning the forest as common property is the current thinking towards sustainable forest management. Common property refers to a particular institutional arrangement in which a group of resource users share rights and duties toward a resource (McKean, 2000). In this arrangement, a particular group of individuals share rights to the resource such as a forest. User rights are common to specified group of individuals, not to all. Thus, common property is not access open to all but access limited to specific group of users who hold their rights in common. The property rights in a common property regime can be very

clearly specified, they are by definition exclusive to co-owners and they are secure if they receive the appropriate legal support from the government (Kihyo, 1998). When governments overrule traditional user rights to forests, local communities and individual households are unable and less willing to prevent destructive encroachment or overexploitation. In effect, these state forests are turned into open access (Leach *et al.*, 1997). In the past, much attention in Tanzania forest management focused on increasing powers and responsibilities to the government. According to Kaoneka and Monela (2000), the biggest constraint was the failure of the government to enforce property rights in its forests and hence indirectly allowing people to use forests under open access regime (Mlowe, 2007).

2.2 State Forest Management

Forest management is defined as a forestry practice that is characterized by a state/centralised, authoritarian structure. It is a top-down approach to management and decision-making that in most cases excludes the local people (Horn, 2002). Additionally, (Wily and Mbaya, 2001) said that the basic instrument of state authority is the forest law.

The common provisions in the forest law include the regulation of timber extraction, preparation of management plans, designation of protected species, and the right to declare protection orders over private estates and to intimidate local participation in fire fighting. The policing functions of forestry departments are central in state forest management regimes. Mgeni and Kajembe (1996) described state forest management as a top down approach characterised by a philosophy of “protection” and “preservation”. Forest management using this approach is usually not sympathetic to the needs of the local people. The preservationist approach requires a militaristic strategy and always heightens conflicts. Outsiders determine the objectives and modes of implementation of forest

management without consulting local communities. Worse still, revenues from the forests are usually directed to the government treasury. Very little tends to be reinvested in these forests or surrounding villages adjacent to the forests. This approach is still used in all plantation forests in Tanzania (Willy, 2000).

Involving stakeholders has recorded big success in forest management. For example, according to Chamshama and Nwonwu (2004), the success of the Southern Africa forest plantation programme is mainly due to significant involvement of the private sector either as private corporate companies, out-growers, private individuals or communities.

2.3 Socio-Economic and Policy Reforms

Since the 1980s, Tanzania, like many other African countries, has been pursuing a number of policy and institutional reforms to improve both social and economic development. These reforms aimed at attaining the nation's vision: sustainable socio-economic development by year 2025. According to URT (1999), the public sector reforms in Tanzania also aim at improving the delivery of services particularly to enhance the role of local communities in decision-making. In natural resources management, these reforms are geared towards devolving common pool resources management from the state to lower levels (Wily and Mbaya, 2001). These policy reforms mainly underlay the need for community participation and empowerment in the management of natural resources in order to achieve sustainable development (Mniwasa and Shauri, 2001).

The national development policies emphasizes on the role of private sector in promoting economic growth and combating poverty laid the foundation for the National Forest Policy of 1998. The National Forest Programme (NFP) emphasises the principles of market-oriented forestry and moving away from the government ownership of the means of

production. The new forest policy of 1998 promotes the involvement of the private sector and local communities in forest management, including industrial forest plantations. It also recognises the importance of reforming the forestry institutions so that they are better equipped to ensure delivery of various products and services (URT, 1998).

2.4 The Concept of Stakeholders' Involvement

There is general agreement that various stakeholders have different roles in the management of forest resources, including plantation forests (Colfer, 1995). According to Grimble and Welland (1997), stakeholders are groups of people, organised or unorganised, who share a common interest or stake in a resource. They could be at any level or position in society, from global, national and regional down to the level of household.

As long as government or the public sector in Tanzania continues to play a dominant role in plantation establishment from land allocation or lease to tree growing and marketing, the forestry sector will continue to encounter supply deficits of wood to both domestic and export markets. The public sector is known to have perennial financial problems, which lead to inefficiency in management, low productivity and above all corruption such that its managerial competence and ability to achieve good results to justify the huge financial investments in plantations become doubtful (Chamshama and Nwonwu, 2004).

Experience shows that sustainable forest management has failed where forest dependent communities were excluded and lacked recognition of their rights to resources. Their involvement in forest management would ensure continued supply of forest products and services. According to Kajembe *et al.* (2003), making the people living adjacent to the forests the guardians of the resource in the neighbourhood appears to be the most viable, effective, cheaper and long-lasting way to manage the resources. Community involvement

in this case acts as a built-in mechanism for sustainability. Involving stakeholders enables the government to delegate some of its functions, which help to spread costs, which would otherwise be born by the government alone (MNRT, 2001a).

According to MNRT (2000), the main benefits that are likely to be accrued from increased stakeholders' participation in the management and ownership of forest plantations include:

- i) Eased budgetary pressure on government;
- ii) Improved management of plantation forests;
- iii) Better recognition of the needs and aspirations of local communities as stakeholders and future joint forest owners;
- iv) Liberalizations of trade in forest products through the elimination of state subsidies and market price distortions through opening them up to greater competitions;
- v) Reduced pressure on indigenous forests for supply of timber products;
- vi) Attraction of foreign investment and technology to the sector;
- vii) Greater certainty and new career options for staff currently employed by FBD;
- viii) Certainty of tenure and wood supply to encourage both new processing investments in new plantation forests.

2.5 Private Forestry in Tanzania

Most of the forests in Tanzania are natural forests; plantations cover only a fraction of the total forest area of 38.8 million hectares. The total gross area of forest plantations is estimated to be 160 000 – 200 000 ha comprising 83 000 ha of state owned industrial plantations, some 6 000 - 7 000 ha of private industrial plantations, and about 80 000 – 100 000 ha of village and farm plantations (MNRT, 2001b). Until in the early 1990s, the past

economic policies reflected state domination in the industrial round wood production and processing, and did not encourage private plantation sector to develop.

Until a decade ago, forest plantation development by private sector was not very common in Tanzania except for Tanganyika Wattle Co Ltd (TANWAT) that started a long time back. Two plantations that are funded by the Commonwealth Development Corporation exemplify the recent private sector involvement in forest management. The first one is the Kilombero Valley Teak Company (KVTC) that started its operation since 1992 in Kilombero and Ulanga districts. The second example of private sector involvement in plantation forestry is the Green Resources Limited owning the Mapanda Forest plantation in Mufindi and Kilombero districts that started in 1996, which is a venture, financed by private Norwegian investors. These plantation forests represent an entirely new kind of plantation development in Tanzania. First, they are financed from private sources. Second they have been established with an objective to sequester CO₂ and generate revenue from trading carbon credits under the Kyoto Protocol Clean Development Mechanism. Therefore, the role of private sector in plantation forestry development does not rely solely on revenue generation, but also to embrace one of the objectives of the Kyoto Protocol of reducing the effects of green house gases (Ngaga, 2006).

However, the total area established by the private sector is still marginal in relation to the potential that Tanzania has in terms of political stability, good land availability, inexpensive labour force, and good growing conditions in terms of soils and rainfall. Tree planting by farmers and communities has taken place throughout the country. But this is more evident in Southern highlands of Tanzania for instance in Njombe and Mufindi districts in Iringa region. In some areas such as Mufindi, log and timber supply from farmers is large enough to compete with industrial plantations in the local wood market.

Privately owned industrial forest plantations are also common in South Africa, Swaziland and Zimbabwe. These plantations are very successful and have achieved high productivity due to careful site selection, intensive cultural practices, selection of best species/provenances and genetic improvement through research (Chamshama and Nwonwu, 2004).

Further, many public sector managed plantations are not profit-oriented. They have other environmental and social services and benefits as objectives. These target watershed protection, conservation of land and biodiversity, and creation of employment. Many benefits from such activities are not easily quantifiable in monetary terms and, therefore, cannot be used to determine the profitability of the plantations. Thus, in financial analysis, the public sector owned and managed plantations are unprofitable and not economically viable because these important benefits are excluded in the calculations (Zobel *et al.*, 1987; Evans, 1992).

2.6 The Theories of Cost Management

The cost management strategy is the project management processes for costs reduction on the project as tailored from the Project Management Body of Knowledge (PMBOK) which according to Drurry (2004) falls under five steps namely:

- Step 1 - Cost Planning
- Step 2 - Cost Tracking
- Step 3 - Cost Reporting and Metrics
- Step 4 - Cost Control and Changes
- Step 5 - Cost Closeout

It has been noted that most of these theories are practised by Mapanda Forest plantation directly and some with little changes. Sao Hill forest plantation and other national forest plantations don't follow these steps but they do plan as a general management plan and within it there are components of cost planning, monitoring and evaluation and then implementation (URT, 2001). The application of theories of cost management is key to successful cost management (Keith, 1980).

Communication is a key part of the cost management process and occurs at every step of the process among the project team, project stakeholders and consultant team. The Financial Manager is responsible for leading the cost management effort, sponsoring cost budgeting and tracking activities, facilitating communication on fiscal status, and ensuring the project cost tool is maintained (FAO, 1987).

The Financial Manager is responsible for providing the Project Manager with recommendations and status on the project budget and expenditures. The Financial Analysts are responsible for coordinating and developing project funding and approval documents and expenditure tracking and reconciliation in accordance with state processes. The analysts also work with the Financial Manager to reconcile the cost management and accounting data (Lucey, 1996). The Functional Managers are responsible for identifying funding needs and for assisting with the tracking of expenditures including tracking of staff effort and costs. Once the Budget Act is signed, the Project Manager and Project Financial Analyst review the cost allocation against the approved budget, and adjust the allocations, if necessary, to reflect the approved funding for the year. Upon approval by the Project Manager, the cost allocations are baselined (Drury, 2004).

2.6.1 Cost Planning

2.6.1.1 Resource planning

The planning processes of Cost (Resource Planning, Cost Estimating, and Cost Budgeting) have been consolidated into a section called Cost Planning. Cost estimation begins upon completion of the project Work Breakdown Structure (WBS). Resource skills are determined based on the needs of the project and the products being produced (Lucey, 1992). The project uses and tailors the personnel resource information from the Staff Management Plan and project responsibility assignment matrix for determining needed resource skills (Lucey, 1992).

2.6.1.2 Cost estimating

Hour estimates are created for each WBS item. The necessary skill sets and staff labour categories are identified for each WBS element. Approximate costs are estimated based on the anticipated classification of staff assigned to the work. The anticipated costs are allocated to each WBS item and totalled. Resource/labour costs are allocated by resource category and total (O’Kting’ati, 1996). The estimates are then used to request funding or funding adjustments for the project. Risks associated with the cost estimates are documented and included in the risk management database.

2.6.1.3 Establishing the cost baseline

Once the Budget Act is signed, the Project Manager and Project Financial Analyst review the cost allocation (of funding per WBS item) against the approved budget, and adjust the

allocations, if necessary, to reflect the approved funding for the year. Upon approval by the Project Manager, the cost allocations are baselined.

2.6.2 Cost tracking

Actual hours expended are recorded and validated against attendance records and contractor monthly reports. The hours are converted to costs for tracking the cost of current progress to determine if the project is staying within and expected to complete within budget. Office of Chief Information Officer (OCIO) requires:

- Actual costs to be recorded by cost category
- Comparison of actual costs to budgeted costs on a regular basis
- Supporting data for actual costs to be retained

Overall costs are compared to the budgeted project costs on a monthly basis by the Project Financial Manager. The overall costs are comprised of the actual labour hours (state and private) and project expenditures for the month (received from the project financial staff). Variances are reviewed and analyzed to determine the cause and possible mitigations or corrections.

2.6.3 Cost reporting and metrics

To assist with tracking actual costs against the baseline, the following reports are used:

- Spending Plan, (by fiscal year) – a report showing the actual costs against the baseline by month for the fiscal year and the cumulative total to date for the fiscal year. The reports accounts for what was planned to the actual costs spend during each month and finally at the end of fiscal year.
- Cost by WBS Item - a report showing the labor costs by level of each WBS items by month for the fiscal year and the cumulative total to the end of the fiscal year.

- Cost Variance by WBS Item – a report showing the actual costs against the baseline to date. Through this report will reveal that the baseline cost sufficed all planned activities or was not enough to have all planned activities accomplished (Collin, 2004).
- Labor Hours by WBS' Deliverable Item – a report showing the amount of effort expended towards the Level 1 WBS items by month for the fiscal year and the cumulative total (to date) for the fiscal year.

2.6.4 Cost control and changes

2.6.4.1 Cost variances

For variances against the baseline of more than ten percent at the Level 1 WBS deliverable items, the rationale for the variance is documented in the associated report and discussed at the management staff meeting. If the variance does not affect the overall project cost baseline, no other actions are required. If the overall cost baseline is affected, the variance is documented and reported to the Project Director and, subsequently, the Executive Steering Committee. The Project Director and the Executive Steering Committee review the rationale and discuss the options and mitigations for dealing with the variance, and determine if a re-plan, is necessary. If so, the issue and recommendation is presented to the Executive Committee for review and approval. The Executive Steering Committee makes the policy decision to amend the projects' cost, scope, schedule, or quality.

2.6.4.2 Cost re-planning

If a re-plan is deemed necessary by the Executive Steering Committee, the project prepares documents to address the re-plan. The state funding documents are included in the next budget cycle and are subject to the normal review and approval processes.

2.6.4.3 Cost re-baselining

Once the re-plan is approved, the Project Manager works with the Project Financial Manager to re-baseline the cost data and estimates based on the approved funding. The project works with the Office of Systems Integration, (OSI) Accounting Office to adjust their encumbrances and accounting tools to reflect the re-plan.

2.6.4.4 Cost closeout

At the end of the project, the cost historical information is completed by the Project Financial Manager, reviewed by the Project Manager, submitted to OSI Budget Office for review and then forwarded to Department of Finance of the Donor.

2.6.4.5 Annual cost summary

At the end of the fiscal year, the Project Manager and Project Financial Manager summarize the actual hours and costs expended against the baseline for the fiscal year. The annual summary is archived for historical purposes.

2.6.5 Reconciling the state process to the project process

As discussed previously, the State budgeting and accounting processes operate separately from the project cost management processes, though they are related. This section discusses the relationships and where these processes must interact and synchronize.

2.7 Sustainable Forest Management

There are many definitions of SFM though essentially the core concept is promotion of conservation and management practices which are environmentally, socially and economically sustainable, and which generate and maintain benefits for both present and future generations. Sustainable Forest Management (SFM) is a subset of sustainable development. Higmans *et al.* (1999) defined sustainable development as development that is economically viable, environmentally harmless and socially beneficial and which balances present and future needs. According to Lands Act 2002, land is worth and cost of it also seemingly high. The communities around Mapanda through SFM offered land to the investor by expecting to get supports to their community development projects and employment in return which eventually reduced the management costs to Mapanda Forest plantation. According to FAO (1999a), SFM is defined as the stewardship and use of forests and forestlands in a way, and at a rate, that maintains their biodiversity, productivity, and regeneration capacity, vitality and their potential to fulfil, current and future, relevant ecological, economic and social functions, at local, national, and global levels, and that does not cause damage to other ecosystems. SFM is also defined by ITTO (1998), as the process of managing forests to achieve one or more clearly specified objectives of management with regard to the production of a continuous flow of desired forest products and services, without undue reduction of its inherent values and social environment. Banana and Gombya-Ssembajjwe (1999), assert that sustainable forest management is more likely to result when:

- i) Local communities can make rules and enforce them,
- ii) Local institutions involved in forest management exist and local forest users participate in making decisions,
- iii) Expected net financial benefits to the community are highly and equitably shared among members and,

- iv) Local forest users can effectively control harvesting levels of forest produce at sustainable levels.

Through Sustainable forest management the management costs of forest plantation will be reduced due to availability of local community to participate in plantation activities as labour as well as helping the plantation in forest protection against fires. Also, if the local community around the forest plantation will plant trees in their land, there will be availability of alternative wood sources outside the private or public forest plantation hence maintaining forest normality will be possible.

2.8 Management Cost

Sao Hill Forest Plantation management is the main custodian of the forest plantation on behalf of the Ministry of Natural Resources and Tourism (Table 5). They have the mandate to incur cost for management of the plantation in a sustainable manner. Their interests include to provide employment to the local communities, provide raw material (round wood) for Mufindi Paper Mills Ltd, Sao Hill Timber Ltd and other small sawmills, collect revenues from forest royalties, guiding the implementation of policy and legislation, forest protection, educating local communities on the importance of the forest, and delegation of activities to other stakeholders in the management of the plantations. Interests of Sao Hill forest plantation management originate from institutional mandate.

Likewise, Mapanda Forest Plantation has the mandate to incur cost from her own source to manage its forest. Their interests and roles among others include to participate in forest ownership and Management, income from carbon and timber sales, provision of employment, revenue collection, provide raw material for the sawmills, electric poles and paper mills, regulate and facilitate resource use by other stakeholders, protect the

plantations and educate people on importance of plantations (Mlowe, 2007). Other stakeholders in the management of forests and who in their form of participations incurs cost of management are summarised in the table below.

Table 1: Interests/roles of stakeholders in Forest plantation management in Mufindi District

Main stakeholders	Stakeholders interest(s) and roles	Originality
1. Sao Hill Forest Plantation management	<ul style="list-style-type: none"> • Sustainable forest management of the plantations • Provision of employment • Revenue collection • Provide raw material for the sawmills and paper mills • Regulate and facilitate resource use by other stakeholders • Guide policy and legislation • Protect the plantations • Educate people on importance of plantations 	Institutional mandate
2. Mapanda Forest Plantation	<ul style="list-style-type: none"> • Participate in Forest ownership and Management • Income from Carbon and timber sales. • Provision of employment • Revenue collection • Provide raw material for the sawmills, Electric poles and paper mills • Regulate and facilitate resource use by other stakeholders • Protect the plantations • Educate people on importance of plantations 	Economic and Environmental care interests
2. Saw millers	<ul style="list-style-type: none"> • Raw material procurement • Participate in forest ownership and management • Income from timber sales 	Economic interests
3. Forest adjacent communities	<ul style="list-style-type: none"> • Participate in forest management especially on forest protection <ul style="list-style-type: none"> • Benefit sharing • Access to forest products e.g. firewood • Employment • Social services • Farming plots • Own part of forest 	Dependency for livelihoods and geographical proximity
4. Business community	<ul style="list-style-type: none"> • Income generation 	Economic interest
5. Sao Hill Plantation employees	<ul style="list-style-type: none"> • Employment • Social services • Farming plots 	Dependency for livelihoods
6. Timber traders	<ul style="list-style-type: none"> • Purchase timber 	Economic interest
7. Timber transporters	<ul style="list-style-type: none"> • Transportation of Timbers 	Economic interest
8. Mufindi Paper Mill Ltd	<ul style="list-style-type: none"> • Raw material for the mill 	Economic interest

Main stakeholders	Stakeholders interest(s) and roles	Originality
9.Mufindi District Council	<ul style="list-style-type: none"> • Own part of the forest • Provide employment • Income generation through collection of levy from Sao Hill Forest Plantation and Mapanda Forest Plantation • Employment 	Institutional mandate and economic interests
10.Tanzania Revenue Authority	<ul style="list-style-type: none"> • Tax revenue collection 	Institutional mandate

Source: MDC (2008)

According to this study, a management cost is the amalgamation of establishment costs and that of operation costs.

2.8.1 Establishment costs

Sao Hill Forest plantation has two major permanent nurseries at Irundi and Ihalimba Villages in Division one and three respectively. Other flying nurseries are situated in all divisions that is Division two and Four in Mgololo. The Mapanda Forest Plantation have one big permanent nursery in Mapanda village and several flying nurseries in Chogo, Makungu (Mechanical Nursery), Kidete and Uchindile Villages. The establishment costs are those costs incurred to raise seedling from the seed to the seedlings of the plantable size.



Figure 1: Mapanda permanent Nursery

Raising of seedlings is done in the nurseries and the following activities are done; pots filling, pricking, and loading of soil, loading of seedlings, supplying soil to pot fillers, general cleanliness and tilling. Other activities performed are pegs cutting, nursery security, preparation of transplanting beds and seed sowing. On the other hand, security of water tanks, repair of water pipes and cleanliness of water drainage system from intake source. Common activities done in nurseries of both plantations were identified and hence costs centres were developed in order to calculate the costs for each activity.

The study excludes costs of land acquisition assuming that the land is available or already acquired. To calculate the establishment costs we need to know the costs attributes or costs centres. For the sake of the study the following are the cost centres which were found to be common to Sao Hill Forest Plantation and Mapanda Forest plantation.

2.8.2 Operation costs

Operation costs are all costs incurred in the silvicultural or tending operations of transplants from the date of planting to the fields to harvesting time. These activities are weeding, pruning, thinning, forest protections and road constructions.

2.9 Factors Affecting Forest Plantation Cost Management in Tanzania

The costs evolved in forest management are influenced by several factors including: procurement procedures, cost management strategies, salary wage rates, survival percentage, thinning techniques, planting site distances, fuel price fluctuations, price of

logs and other sellable products, labour availability, equipments servicing periods, fire incidents, climate , diseases and calamities and topography (FBD, 1998).

2.9.1 Procurement procedures

The procurement of several items in the Government forest plantations are supposed to follow the Procurement Act. In order to follow it effectively one must follow a long route (Bureaucratic) which leads to delay in purchases. When items are required to be bought and used example in January, especially for planting, if delays are made due to bureaucracy to fulfill the procurement Act requirements and cause to buy such items in March. These items will not be used in January in the same year but for the next planting season/time in which the price will be much higher than the planned. Instead of purchasing certain Kilograms of seeds or polythene tubes in January 2004 then less Kilograms will be used to purchase in January 2005 due to higher prices than 2004 hence causing re-budgeting and increase in management costs.

2.9.2 Cost management strategies

Strategies used by several institutions in cost reduction dictates how much costs are to be used in certain activity of the project. Cost management if done properly will ensure quality, productivity and profit of the forest plantation owner. The private institutions/company tends to have an effective management strategy hence ensures high profits from their endeavors. If cost reduction strategies are good then management costs will be reduced/small and vice versa.

2.9.3 Salary/wages rates

Salaries and wage scales are all set by the government to safeguard her people's welfares. Reviewing the salary and wage scales are done every year. The salary and wage scale

fluctuation always affects project/plantation costs. The higher the Salary/wage scale the higher will be the management costs and vice versa.

2.9.4 Survival percentage

Determination of survival percentage are done at the end of planting season to assess how much trees are surviving out of how many planted trees. The higher the survival percentages the less is the cost for beating up and vice versa. Therefore the survival percentage has direct effects to costs of management of the plantation.

2.9.5 Thinning techniques

Thinning is the act of reducing the number of stems per given area. The type of thinning techniques used will entails how much costs are vested in the given activity. Thinning using two man cross cut saw will be cheaper than mechanical thinning but time consuming.

2.9.6 Planting site distances

Distances where planting is done also affects costs of operations. The higher the distance will cause more fuel, ware and tear of equipments and eventually higher operation costs. In order to reduce costs, the projects management do plans establishment of flying nurseries close to planting sites.

2.9.7 Fuel price fluctuations

Machines and equipments need fuel in order to work. The price fluctuations of fuels do affects the establishment and operations costs of the plantation. If the planning will be done when price of fuels are down than during implementation periods it forces, re-planning to accommodate the changes leading to increase of management costs.

2.9.8 Price of logs and other sellable products

Price determination of logs is based on production costs which again are caused by several factors. The higher the production costs/ Management costs the higher is the price of the logs and vice versa (Chamuya, 2007).

2.9.9 Labour availability

Human labour is the key input required by the forest plantation management for several activities like nursery activities, silvicultural activities, planting activities and many more plantation activities. Sao Hill are not having any problem with labour availability but Green Resources faces some problems with labour availability, because people expects high pay from private than Government.

2.9.10 Equipments servicing periods

Machines and equipment with long periods of service means ware and tear is higher and needs more money for maintenance and hence management costs tend to be higher than shorter periods of equipments serving periods.

2.9.11 Fire incidents

Fire has traditionally been viewed as a destructive force in forest ecosystems often causing the loss of a large portion of the living biomass and drastically changing the landscape structure and species composition (Asbjørnsen *et al.*, 1999). Conservationists observe that fire is an increasing risk to many forests, which have previously been largely unaffected. Fire has become a serious problem in Tanzanian forestry as well. While fire is part of miombo woodlands, it has become a common phenomenon also in plantations and even in catchment forests (MNRT, 2001a). It is estimated that forest fires destroy about 65 000 ha

of forests and other wooded areas annually (FBD, 2002). Most of these fires occur in woodlands (75%), followed by forest plantations (20%) and least in high forests (5%). Most of fires are caused by human activities particularly farm preparation, hunting, charcoal making, mining, pit sawing, grazing, controlled burning, arson and smoking (FBD, 2002 and Lulandala *et al.*, 1995). Between 1990 and 2000 forest fires in Tanzania plantations (excluding Sao Hill) caused a financial loss of Tshs 8.8 billion (MNRT, 2001 a). The average forest plantation area burnt annually is 2466 ha and 40% of which is from Sao Hill where the fires are frequent. According to Lulandala *et al.* (1995), between 1985 and 1987 at Sao Hill Forest Plantations, there were 105 incidences of forest fires destroying 5 665 ha. Between 1999 and 2001, MNRT (2001b) reported that a total of 7 644 ha of forest plantations were destroyed by forest fires at Sao Hill alone. Like in other places, fires at SHFP are caused by human activities.

2.9.12 Climate

The time of the year with worse climates increases number of seedling causalities and death. As the survival percentages increase this means the less is the management costs and vice versa.

2.9.13 Diseases and calamities

Diseases and calamities increases a number of seedlings and big trees to die or be deformed. The costs of treating them might be higher according to what kind of diseases are attacking the trees (Madoffe and Day 1996 and Madoffe (1989) in Iddi 1996).

2.9.14 Topography

The hilly and undulated topography needs powerful machines to carry seedlings and other operations in the field. The powerful machines means highly or costly machines with high costs of purchases and running (Tarimo, 1996).

2.10 Management Cost Analysis

Management cost focuses on cost used by forest plantation as establishment costs and operation costs (Appendix 6). Management cost analysis again focuses on how the management cost differs and contributed to the whole plantation costs together with cost reduction and continuous improvement and change rather than cost containment. Indeed, the term cost reduction could be used instead of cost management but the former is an emotive term. Therefore cost management is more preferred (Collin, 2004). Cost accounting provides information about the costs of individual operation like establishment cost and tending operations costs. Management costs analysis reveals that costs are divided into direct costs, fixed and overhead costs (Keith, 1980). The costs management strategies is a tool to control the management cost and set by public service includes provision of permanent employment and low salary/ wages pay per month (Whether they work or not will be paid monthly), equipments bought for the public forest plantations not necessarily work for the specified tasks i.e. can perform other public services hence increasing management costs (Lucey, 1992). The costs management strategies set by private sectors ensures value for money hence contracts, daily pay, piece work payments are done hence minimizing unit management costs (Keith, 1980). Therefore management costs is a summation of establishment costs and operations costs (Appendix 6).

2.11 Consumer Price Index (CPI)

According to Mettrick (1993), Consumer Price Index is defined as a measure of the average change over time in the prices paid by the consumers for a market of consumer

goods and services. Normally the CPI measures only the change in prices of a basket of goods consumed by a typical household over time and is calculated based on a series of interrelated samples of base year quantities (Miscellaneous products-<http://www.politonomist.com/gdp-deflator> as visited on 1/7/2010). CPI is an important parameter in the process of getting real costs of a given item in a particular year. To calculate a current year CPI, the following formula is used:

$$\text{CPI} = \frac{\text{Base year basket quantities} \times \text{Current year cost}}{\text{Base year basket quantities} \times \text{Base year cost}}$$

Source: Cliffs Notes (2010).

During Calculations of the real costs of the management costs of forest plantations, CPI data from NBS was used. The calculations involved the use of the real or constant prices which were obtained by dividing CPI over given years, by base year to get deflators (a conversion factor that transformed current costs into real costs).

CHAPTER THREE

3.0 METHODOLOGY

3.1 Study Area Description

3.1.1 Location and climate

Mufindi district has an area of 7 122 km² and lies between 8° 00' 9° 15' S and 34° 35'–35° 55' E. It is one of the seven districts in Iringa region, in southern highland of Tanzania with average rainfall of 600 – 1 500 mm and temperature ranging between 10° c to 28° C per annum (MDC, 2006). The Sao Hill Forest plantation headquarters are 17 km from Mafinga Township, which is the district headquarters. The area is a rolling plateau with low hills and wide flat- bottomed valleys. It is within Ihalimba, Luhunga, Makungu, and Mafinga Wards (Mlowe, 2007).

The Mapanda Forest Plantation is owned by The Green Resources Company Limited. The plantation is located in Kibengu division, Mapanda ward and Mapanda and Chogo villages, Mufindi District.

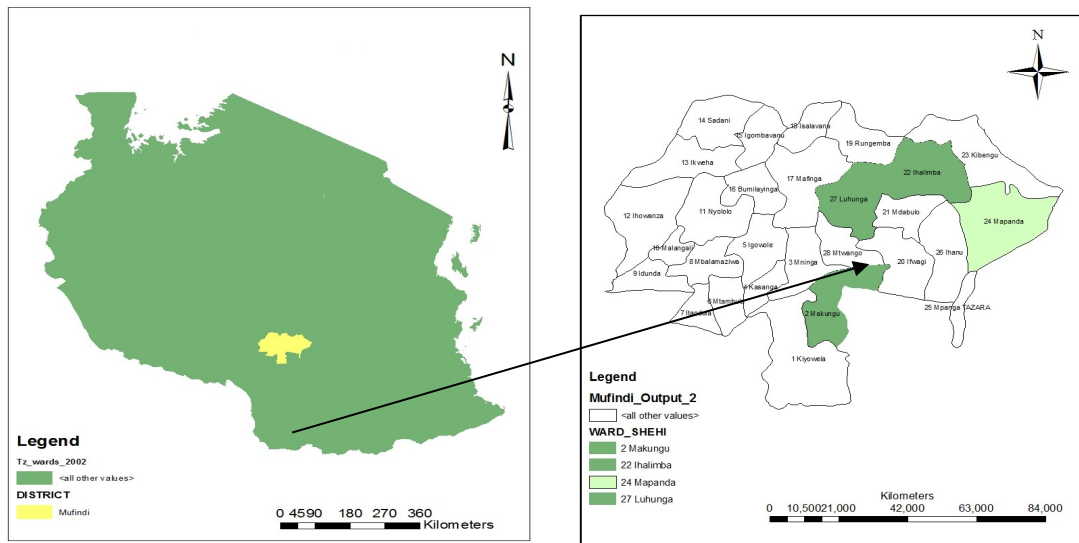


Figure 2: A map of Mufindi showing study area

It is 130 km to the main tarmac road at Mafinga and 750 km from Dar es Salaam. The land lies at an altitude of 1 400 m – 1 760 m with the mean temperature 14⁰ C. Average annual rainfall is 1 050 mm with the rainy season from December to April (GRL, 2008). The aim of Mapanda Forest Plantation is to grow trees for carbon sequestration as well as to harvest wood for sawn timber, transmission poles and renewable energy. The forest Stewardship Council (FSC) Certificate for the project was attained on 8 August 2008 and voluntary carbon standard (VCS) certification was achieved on 17 July 2009.

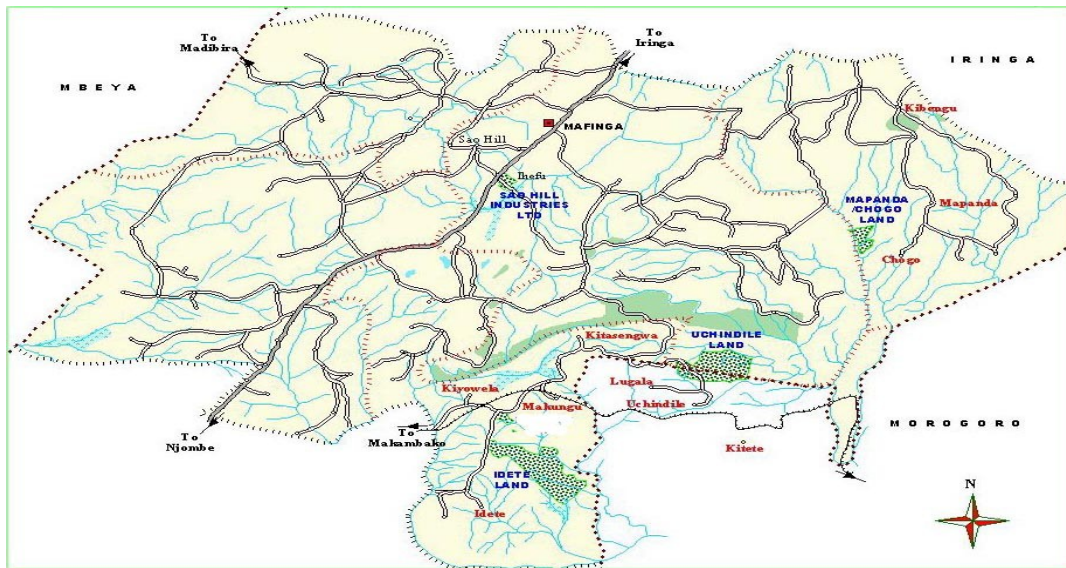


Figure 3: Map showing Mapanda Forest plantation's area

3.1.2 Vegetation

The natural vegetation is characterized by mosaic of open grassland with scattered trees and shrubs dominated by *Brachystegia* and *Julbernardia*. Other species include *Erythrina*, *Parinari*, *Cussonia*, *Apodytes* and *Albizia*. Common grass species are *Themeda triandra*, *Pennisetum schimperi* and *Exotheca abyssinica* (Mhando *et al.*, 1993). The exotic species include *Pinus patula*, *Pinus elliottii*, *Pinus caribea*, *Cuppressus lustanica*, *Eucalyptus saligna* (MNRT, 2001a).

3.1.3 Socio economic activities

The economy of the surveyed area, like in many parts of Africa and particularly East Africa depend mainly on subsistence and cash crops. The major household economic activities in the villages surrounding the Sao Hill and Mapanda Forest plantations are diverse ranging from agriculture, to small or petty business, to forest products harvesting and selling (logging and non-timber forest products) to casual employment .

In general, the large proportion of the Mufindi people were engaged in crop production such as maize, green peas, Irish and sweet potatoes, vegetables, wheat and pyrethrum.

While the livestock production engaged only 18 percent of the people, and the commonly kept animals were cattle, goats, sheep, pigs and poultry. The rest who were engaged in both petty or small business and casual employment accounted for 3.3 percent respectively (MDC, 2008). The local communities who were engaged both in farming and livestock production accounted for about 10 percent. All these economic activities have been and remain the major economic activities of the people around the forest plantation providing them all the basic human necessities. The only problem is how these activities are exercised since they may lead to the over-exploitation of resources.

3.2 Data Collection

3.2.1 Primary data collection

Primary data was collected from treasurers, planning officers and project managers of Sao Hill and Mapanda Forest plantation by using the developed cost centres (Appendix 1). The establishment and operations costs were obtained from unit task forms for Mapanda forest plantation and productivity coefficients (Job cards) provided to supervisors for Sao Hill Forest plantation. The unit tasks and Job cards explains how much resources are needed to accomplish a certain tasks for the whole year such as labour costs per activities and fuels per ha/trip. These productivity coefficients are developed through project planning national wise based on the high quality productivity and profit maximization.

3.2.2 Key informants

The key informants were interviewed using checklist to solicit information which was not possible to be collected through other means. The key informants included project managers, Forest operation managers/Supervisors and Nursery supervisors from Sao Hill Forest Plantation and Mapanda forest plantation. The key issues discussed with them

focused on the establishment and operation costs, strategies used to cut down costs for each sub unit/activity within the compartment and factors affecting cost management.

3.2.3. Secondary data collection

Other sources of secondary data were collected from the publications and reports from SUA library and Forestry and Beekeeping Division.

3.3 Data Analysis

Data was analyzed using both qualitative and quantitative analysis techniques.

3.3.1 Quantitative data analysis

Descriptive and inferential statistical analysis was carried out using Statistical Product and Service solution (SPSS). Descriptive statistical analysis was then used in exploring central tendencies and dispersion. Testing the hypothesis, the Student t-test was done to test whether there is a significant difference between management costs of Sao Hill and Mapanda Forest plantation.

$$t = \frac{\bar{d}}{s/\sqrt{n}}$$

$$s/\sqrt{n}$$

$$Sd = \sqrt{\frac{\sum di^2 - (\sum di)^2/n}{n-1}}$$

$$n-1$$

where,

t = Student t- value

s = Variance

\bar{d} = average change between management costs of Sao hill and Mapanda

sd = standard deviation between management costs of Sao hill and Mapanda

n = number of observation

$\sum d^2$ = sum square of the difference

3.3.2 Qualitative data analysis

Content Analysis technique was applied to qualitative data. It was used to analyze the components of information which was collected through verbal discussions with key informants and was analysed using Content analysis. As suggested by Kajembe (1994), the information collected through verbal discussions from key informants should be broken down into smallest meaningful units of information or themes and tendencies

3.4 Limitations of the Study

3.4.1 Inadequate cooperation from respondents

Some respondents were not willing to give information because they thought this study would reveal the secrets of cost management and productivity. The private forests plantation management assumed that cost management strategies are secrets and should not be exposed anywhere. However, the researcher was quite familiar to Mapanda top management leaders and resolved their doubts and provided all required data for the study.

3.4.2 Poor cost data storage

Both plantations had some problems with data storage. Sao Hill forest plantations don't have well stored data particularly cost data for the past decade. Accordingly, cost data for 2004 and 2005 were missing in both plantations. The researcher used job cards and productivity coefficients to calculate all needed costs of Establishment and Operation costs.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSIONS

This chapter present and discusses results from the study, including identification of management costs, factors affecting management costs and cost management strategies used by Sao hill and Mapanda forest plantations.

4.1 Management costs

According the study, a management cost is obtained from the summations of establishment and operation costs.

4.1.1 Establishment costs

The study exclude costs of land acquisition assuming that the land is available or already acquired. To calculate the establishment costs one needs to know the cost attributes or costs centres. The following are the findings on cost centres common to both Sao Hill Forest Plantation and Mapanda Forest plantation.

4.1.1.1 Land Preparation

Findings from this study revealed that the average unit land preparation cost for Sao hill for five years was 35.60 Tshs/m²/year and Mapanda Forest plantation was 34.42 Tshs/m²/year (Table 2a and b).

It was found also that there is a difference in the contribution of land preparation costs to the total Establishment costs from the two plantations. The Sao Hill plantations highest cost contribution in 2008 amounted to 0.38 % and the lowest being 0.25 % in 2007.

During 2007 and 2008 Sao Hill hired labourers from Kilombero, Morogoro which caused high labour costs for land preparation. The same activity contributed almost 0.0 % to the total costs for Mapanda with the reason that labourers were found from the same villages where the nurseries are situated and effective use of machine lowered the land preparation costs for the whole period.

Their unit costs per year again differs, Sao Hill units costs ranges from 22.70 TShs/m²/year in 2005 as lowest unit costs to 58.5 Tshs/m²/year in 2008 as the highest unit costs while Mapanda the lowest land preparation unit costs in 2008 amounted 6.9 TShs/m²/year and its highest unit costs was 48.8 TShs/m²/year in 2007. The unit costs of Mapanda increased every year from 2004 to 2007 due to several factors such as locally available labourers preferred to work with Sao Hill forest plantation due to daily pay. In order to revamp the situation Mapanda had to increase the daily pay with high supervision and use of machineries in land preparations. These factors latter in 2008 lowered the unit costs. From 2009 onwards, the unit costs for Mapanda will possibly be lower than 6.6 Tshs/m²/year due to the new technology of mechanized nursery installed in Makungu Ward, Mufindi District.

**Table 2(a): Contribution in % as per establishment unit costs for Sao Hill Forest
Plantation**

S/N	Cost Centres	2004	%	2005	%	2006	%	2007	%	2008	%
		Unit Cost		Unit Cost		Unit Cost		Unit Cost		Unit Cost	
1	Land Preparations (Sq. M)	23.87	0.0	22.70	0.0	45.9	0.0	26.8	0.25	58.5	0.38
2	Seed Purchase (Kg)	47235.17	28.2	46509.55	23.1	46500.8	21.4	47022.0	17.58	48018.9	12.26
3	Soil Ingredients (Trips)	67639.96	40.4	75014.25	37.2	75076.6	34.6	80060.8	16.50	79043.0	13.79
4	Labour (Mandays)	1846.01	1.1	1846.00	0.9	2640.0	1.2	2639.0	30.95	3810.0	44.01
5	Lorry/ Tractor Fuel	1008.01	0.6	1008.00	0.5	1015.0	0.5	1120.0	20.74	1250.0	15.72
6	Potting (Mandays)	1845.27	1.1	1846.60	0.9	2635.7	1.2	2642.0	2.54	3821.0	4.26
7	Watering (Mandays)	1860.00	1.1	1846.65	0.9	2636.8	1.2	2645.0	0.30	3800.0	0.38
8	Root Pruning (Mandays)	1853.00	1.1	1845.65	0.9	2600.0	1.2	2644.0	0.81	0.0	0.00
9	Loading/ Unloading Seedlings (Mandays)	1854.00	1.1	1846.83	0.9	2645.0	1.2	2639.0	1.86	3817.0	2.06
10	Purchase polythene (Kg)	2106.00	1.3	2103.41	1.0	2010.7	0.9	2008.4	0.66	2101.2	0.67
11	Salaries	39850.12	23.8	67348.96	33.4	78969.2	36.4	90574.	7.49	98888.7	5.38
12	Water (Units)	211.25	0.1	200.00	0.1	200.0	0.1	200.0	0.30	220.0	1.08
		167332.6	100.0	201438.6	100.0	216975.6	100.0	234221.5	100.00	244828.3	100.0

**Table 2(b): Contribution in % as per establishment unit costs for Mapanda Forest
Plantation**

S/N	Cost Centres	2004		2005		2006		2007		2008	
		Unit Cost	%	Unit Cost	%	Unit Cost	%	Unit Cost	%	Unit Cost	%
1	Land Preparations (Sq. M)	28.2	0.0	42.7	0.0	45.5	0.0	48.8	0.0	6.9	0.0
2	Seed Purchase (Kg)	40,021.4	23.4	40150.0	19.6	40479.5	17.1	45573.9	13.9	44964.0	8.2
3	Soil Ingredients (Trips)	67,694.1	39.6	68076.9	33.2	71424.6	30.1	74908.2	22.8	68089.9	12.4
4	Labour (Mandays)	1,845.9	1.1	2898.8	1.4	1845.9	0.8	1846.1	0.6	3500.0	0.6
5	Lorry/Tractor Fuel (Mandays)	1,100.0	0.6	1806.9	0.9	1200.0	0.5	1250.0	0.4	3820.0	0.7
6	Potting (Mandays)	1,846.0	1.1	2084.1	1.0	1846.1	0.8	1845.8	0.6	3680.0	0.7
7	Watering (Mandays)	1,846.8	1.1	2575.8	1.3	1846.1	0.8	1846.0	0.6	3752.0	0.7
8	Root Pruning (Mandays)	1,841.4	1.1	1962.0	1.0	1846.4	0.8	1846.1	0.6	3800.0	0.7
9	Loading/ Unloading of Seedlings (Mandays)	1,847.8	1.1	1826.5	0.9	1843.0	0.8	1846.1	0.6	3782.0	0.7
10	Purchase polythene (Kg)	2,101.2	1.2	2101.0	1.0	2109.5	0.9	2111.2	0.6	2100.9	0.4
11	Salaries	50,522.6	29.6	81333.3	39.7	112287.2	47.4	194581.4	59.3	411034.7	74.9
12	Water (Units)	200.1	0.1	205.2	0.1	200.1	0.1	220.0	0.1	250.0	0.0
		170,895.7	100.0	205063.2	100.0	236974.0	100.0	327923.5	100.0	548780.3	100.0

4.1.1.2 Seed purchase

The results shows that Sao Hill had 28.2% seed purchase cost contribution to the total establishment costs as the highest in 2004 while 23.1% was found in 2005 and the least unit cost contribution of 12.26% in the year 2008 (Table 2a and Fig. 4). The trend showed that the unit costs decreased from 2004 to 2008. Results from Mapanda also followed the same trend of decreasing unit costs from 23.4% in 2004, 19.6% in 2005 and the least being 8.2%, in 2008 (Table 2a and b).

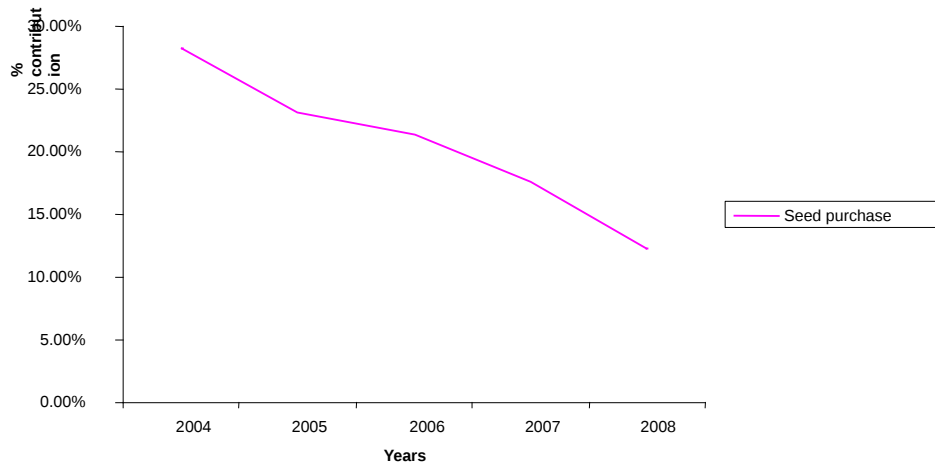


Figure 4: Graph showing the seed purchase cost contribution to the total unit costs for Sao Hill Forest Plantation.

4.1.1.3 Soil ingredients

In this study, about 39.6% was found to be the soil ingredient unit cost contribution in 2004 by Mapanda as the highest and the least being 12.4% in 2008. Likewise, Sao hill had 40.4% unit cost as per Soil ingredients in 2004 and 13.8% in 2008 showing a decreasing trend annually (Table 2a and b).

The decreasing trend is due to the fact that in the beginning, the cost of collecting soil ingredients is higher and tends to decrease due to the fact that some soils are not collected regularly as can be used for two to three years.

4.1.1.4 Labour

It was found that the Mapanda unit contribution of labour to the total unit cost tended to increase from 1.1% in 2004 to 1.4 % in 2005 but latter dropped drastically from 1.4% in 2005 to 0.6% in 2008 (Table 2b). The trend was the opposite of Sao Hill forest plantation because it increased with the increase in years.

The major factor is that Sao Hill follows Government rates for salaries and day pay rates for labourers. Every year the Government tend to increase the pay rates which in turn affect Sao Hill plantation establishment costs as well as operation costs. The highest per unit contribution was found in the year 2008 which was about 44.0 % and the least being 1.1% in 2004 (Table 2a). According to Monela (1989), the cost centres, combines together all wages for casual labour, national provident fund contributions, motivation for various activities in the Government and private forest project in Tanzania.

4.1.1.5 Lorry/tractor fuel

The study revealed that the average Lorry/tractor fuel unit cost is 1 080.20 Tshs/Litre/year for Sao hill and 1 835.40 Tshs/litre/year for Mapanda. The big difference in unit costs depends on sources of where fuels are purchased and use of machineries. The study revealed that Sao Hill forest plantation uses less machinery while Mapanda uses more machinery in their activities that is why Mapanda was found to have higher fuel consumption than Sao Hill.

Table 3: Lorry/ Tractor fuel unit costs and %age contribution

Year	Sao	Hill	Mapanda	%
	Unit cost	contribution	Unit Cost	
2004	1,008	0.6	1100.0	0.6
2005	1,008	0.5	1806.9	0.9
2006	1,015	0.5	1200.0	0.5
2007	1,120	20.8	1250.0	0.4
2008	1,250	15.7	3820.0	0.7
Total	5,401	38.1	9,176.90	3.1
Average	1,080.20	0.1	1,835.40	0.62

4.1.1.6 Potting

The study revealed that potting contributed a maximum of 4.3% to the total unit cost in year 2008 and the minimum contribution being 0.9% for Sao Hill forest plantation.

Mapanda forest showed that the potting maximum contribution was 1.1 % in 2004 and the least was 0.6% in 2006.

The main factor causing differences in percentage contribution between Sao Hill and Mapanda was due to availability of labour and the rates for labour daily pay between the two projects.

After soil mixing, the soil mixture must be watered and turned for 3- 4 days before it is filled in polythene tubes and beds. It is not advisable to fill the pots if the mixture has been soaked with rain. The Standard Soil Mixture must be moist for pot filling. If it is too wet or too dry its structure will be ruined and a plant in it will develop very slowly, all these activities, means costs (Holmes, 1995).

4.1.1.7 Watering

The results indicate that the average unit cost contribution to the total establishment costs for five years was 0.8% for Sao Hill compared to 0.9% for Mapanda Forest plantation. With reference to table 2a, Sao Hill's highest contribution of watering unit costs to total establishment costs was 1.2% in 2006 and 0.3 % as minimum in 2008. Mapanda watering unit costs contributed 1.3% in 2005 and 0.6 % in 2008 as maximum and minimum respectively (Table 2b).

The Mapanda forest plantation had a relatively higher per unit cost contribution than Sao Hill forest plantation, because Sao hill had permanent water sources established since 1970s while Mapanda is newly established nurseries, and water sources are sometimes

found far from the nursery sites especially in dry spell periods of December before rains. The watering activity in some long drier years is labour intensive and costly (GRL, 2007).

The soil in beds and polythene tubes must all the time be wet or moist to ensure survival and good rate of growth. The standard soil mixtures must not be left dry or too wet as this will cause plants to check or to rot and die. The wet soil is colder than a moist soil, and the drop of temperature does not benefit young plants. A moist, warm soil provides the best condition for plant growth (Holmes, 1995).

4.1.1.8 Root pruning

The root pruning activity contributed about 1.2% to the total unit cost for Sao hill in 2006 and 0.0 % in 2008 while, the same activity contributed 1.1 % in 2004 and 0.6% in 2007. The study showed again that the average unit cost for Sao Hill for root pruning was 2 235.50 Tshs/mandays/year and 2 219 Tshs/mandays/year for Mapanda. Based on these data it can be concluded that the costs in two plantations are more or less the same. However, there were relatively more intensive cost management in Mapanda as a private company which helped to reduce costs further.

4.1.1.9 Loading and unloading of seedlings

It was observed that Sao Hill had 2.1% contribution to the total unit costs of loading and unloading in 2008 and 0.9% as the minimum in 2005 (Table 2a). Data from Sao Hill also revealed that the unit costs for loading and Unloading of seedlings increased from year 2004 to 2008. Likewise, Mapanda had about 1.1% as the highest contribution in 2004 and 0.6% as the minimum unit contribution in 2007 (Table 2 b). These activities are labour intensive and also use Government labour wages rates and daily pay set by the

Government. From the results it can be concluded that there is slight differences in costs because both plantations uses the same Government rates to pay labourers but with different cost management strategies. The slight differences come from use of relatively more machineries at Mapanda than Sao Hill.

4.1.1.10 Purchase polythene tubes

The study results showed that Sao hill had 2.1% as contribution to the total establishment unit costs in 2008 and 0.9% in 2005. The unit cost for Sao hill was found to be 2 065.90 Tshs/kg/year (Table 2a) and that of Mapanda was 2 104.70 Tshs/kg/year (Table 2b). Mapanda's contribution on polythene purchase was 1.2% in 2004 and 0.4% in 2008 respectively. It was revealed that the percentage contribution to the total establishment costs in Mapanda decreased from 2004 to 2008 (Table 2b). It was found that some polythene tubes were re-used by Mapanda Forest plantations in order to reduce costs of establishment.

Sao Hill had the lowest unit cost because it ordered a lump sum of Kilograms of polythene tubes due to a big area of planting per year.

4.1.1.11 Salaries

It was established that Sao Hill had 336 permanent staffs and 45 staffs under contract (mainly security guard and drivers) while Mapanda had 216 Permanent employees.

According to the findings, the contribution of salaries to total establishment costs was 36.4% in 2006 and 5.4% in 2008 for Sao Hill forest plantation. Mapanda had about 75% in 2008 and 29.6% in 2004 (Table 2a and b). The study showed that the Mapanda increased

of salaries every year with its effects to the total unit costs. Mapanda had fewer staff than Sao Hill but had higher Salaries than Sao Hill. The average salary for Sao Hill for five years under study was 75 126.20 Tshs/person/Month while Mapanda had 260 892.60 Tshs/person/ month.

Sao Hill had many permanent staff receiving less than 74 000 Tshs/month with fewer staff receiving above 300 000 Tshs/month. Mathematically this pull down the average salary to about 70 000's Tshs/month. At Mapanda forest plantation fewer staff was below 150 000 Tshs/month while most staff were above 300 000 Tshs/month hence its average being relatively higher.

4.1.1.12 Water

Water is one of the key factor for existence and good growth of trees in the nursery as well as in the field. The findings show that 1.1% and 0.1% was the contribution of water to total costs for Sao hill forest plantation. The same was observed at Mapanda nursery where water contributed about 0.1% as the highest and 0.0% as the minimum in 2004, 2007 and 2008 respectively. It can be concluded that water is cheaply available and its contribution to the total establishment cost is minimal compared to other cost centres.

4.1.2 Operation costs

Operation costs are all costs which are incurred during field development and tending operations of forest plantations. It includes all activities done to raise seedlings from transplant to harvestable tree after rotation age. Accordingly, in this study operation costs are costs which are used in land preparations, pitting and planting, beating up, weeding, pruning, thinning, and forest fire protections. Each activity is treated separately as cost

centre which in turn contributes in percentage wise to the total unit costs of the whole operation costs.

4.1.2.1 Land Preparation

Land preparation is done to ensure the performance of seedlings/transplant in the field. The cost of land preparation for Sao Hill Forest Plantation contributed an average of 2% while the highest contribution to total unit costs of operation costs was 3.7% in 2008 and the lowest being 0.8% in 2004 (Table 4 a). Land preparation unit costs for Sao hill was 957.10 Tshs/ha/year in 2004 as the minimum and 14 887.20 Tshs/ha/year in 2008 as maximum (Table 4a and b). The trend showed that the unit costs increased gradually each year (Table 4a). The Mapanda forest plantation had the minimum unit costs of 9 601.30 Tshs/ha/year in 2006 and 53 098.30 Tshs/ha/year in 2008 as the highest cost for Land preparation (Table 4b).

The land preparation for Mapanda forest plantation contributed 9.3% on average. The percentage contribution to total unit costs was 14% in 2004 and 2008 but the lowest being 4.3% in 2006 (Table 4b). Therefore, the major reason for the big differences between Sao Hill and Mapanda land preparation costs include the following. Firstly, the land set for tree planting in Mapanda was in undulated landforms which required more mandays of casual labourers. Secondly, the lower costs for Sao Hill was due to the fact that some of the areas allocated for tree planting were clear felled before and plots were given to farmers to carry out Taungya practice, (Holmes, 1995, Kalaghe & Manssy 1989 and Maliondo & Chamshama 1996).The casual labourers are used in areas which are not practising the Taungya System like Mapanda Forest Plantation. Studies in Tanzania and elsewhere have shown that more rigorous land preparation such as complete cultivation (deep ploughing

and harrowing) where appropriate, results in improved survival (Turner 1983, Will & Manley 1983, Evans 1983, Chamshama & Hall 1987).

4.1.2.2 Pitting and Planting

The results show that Sao Hill pitting and planting activity contributed 15.2 and 6.3% to the operational cost as highest and lowest in 2005 and 2007 respectively (Table 4a). Contrary to Mapanda, the percentage contribution of pitting and planting costs was 32.5% as highest and the lowest being 5% in 2008 (Table 4b). The Sao Hill pitting and planting unit costs were found to be 11 642.20 Tshs/ha/year as the minimum in 2004 and 28 287.60 Tshs/ha/year as the maximum in 2008. Mapanda forest plantation again had 18 363.80 Tshs/ha/year as the minimum in 2008 and the highest unit costs in 2004 was 64 331.40 Tshs/ha/year (Table 4b).

The Mapanda's pitting and planting activity has shown to be more than two times higher than Sao Hill. This is attributed by the fact that the land required for Mapanda Forest plantation was new/virgin with a lot of tall grasses and hard top soils which required more work (GRL, 2007).

Other studies reveal that planting spacing plays an important role in tree growth, influences cost of various operations and the quality of and quantity of the wood produced (Iddi, 1996). The initial spacing may therefore influence the distribution of tree size (Diameter and Height), health, mortality, width rows, taper, malformation, branch size and angle (Incoll *et al.*, 1979, Evans 1982, Forest Division 1982). Canopy closures, which sets in early in closer spacing, contributes to higher and longer period of competition resulting in greater number of tree death (Sibomana *et al.*, 1994 and Malimbwi, 1992a).

Table 4 (a): Contribution in % as per operation unit costs for Sao Hill Forest Plantation

S/N	Cost Centres	2004		2005		2006		2007		2008	
		Unit Cost	%	Unit Cost	%	Unit Cost	%	Unit Cost	%	Unit Cost	%
1	Land preparation (Ha)	957.10	0.8	2345.20	1.6	2095.90	1.1	6821.8	2.7	14887.2	3.7
2	Pitting and Planting (Ha)	11642.00	9.8	22893.80	15.2	24607.60	12.8	16076.8	6.3	28287.6	7.1
3	Labour (Mandays)	1846.00	1.5	1846.00	1.2	2646.00	1.4	2700.0	1.0	2897.0	0.7
4	Lorry/ Tractor Fuel (Ltrs)	1007.00	0.8	1007.00	0.7	1007.00	0.5	1007.0	0.4	1007.0	0.3
5	Beating up (Ha)	3801.10	3.2	422.10	0.3	722.20	0.4	1718.4	0.7	21531.1	5.4
6	Weeding (Ha)	16487.00	13.8	30586.50	20.3	51481.00	26.9	60781.0	23.6	114670.2	28.8
7	Pruning (Ha)	14577.60	12.2	19574.90	13.0	33450.70	17.5	55961.5	21.8	42357.6	10.6
8	Thinning (Ha)	0.00	0.0	0.00	0.0	0.00	0.0	0.0	0.0	0.0	0.0
9	Fire protection costs (Km)	12476.00	10.5	17956.80	11.9	21327.00	11.1	57947.4	22.5	18237.1	4.6
10	Salaries	54000.00	45.3	54000.00	35.8	54000.00	28.2	54000.0	21.0	154000.0	38.7
11	Electricity (Units)	2100.00	1.8	0.00	0.0	0.00	0.0	0.0	0.0	0.0	0.0
12	Water (Units)	209.00	0.2	208.00	0.1	208.00	0.1	202.0	0.1	0.0	0.0
		119102.7	100.0	150840.3	100.0	191545.5	100.0	257216.0	100.0	397874.9	100.0

Table 4 (b): Contribution in % as per operation unit costs for Mapanda Forest Plantation

S/N	Cost Centres	2004		2005		2006		2007		2008	
		Unit Cost	%	Unit Cost	%	Unit Cost	%	Unit Cost	%	Unit Cost	%
1	Land preparation (Ha)	28216.0	14.2	13763.5	6.0	9601.3	4.3	20005.6	7.6	53098.3	14.4
2	Pitting and Planting (Ha)	64331.4	32.5	31414.6	13.7	21914.5	9.9	24397.0	9.3	18363.8	5.0
3	Labour (Mandays)	1846.5	0.9	1846.0	0.8	1846.0	0.8	1846.0	0.7	1846.0	0.5
4	Lorry/ Tractor Fuel (Ltrs)	1007.1	0.5	1020.0	0.4	1020.0	0.5	1020.0	0.4	1020.0	0.3
5	Beating up (Ha)	243.3	0.1	1250.1	0.5	2006.0	0.9	1845.9	0.7	2319.0	0.6
6	Weeding (Ha)	4080.7	2.1	3005.0	1.3	3750.0	1.7	29119.0	11.1	34921.0	9.5
7	Pruning (Ha)	0.0	0.0	0.0	0.0	8427.0	3.8	0.0	0.0	1846.9	0.5
8	Thinning (Ha)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	Fire protection costs (Km)	2826.4	1.4	74567.0	32.4	69332.0	31.4	81005.0	30.9	72502.0	19.6
10	Salaries	100200.0	50.6	100790.0	43.8	100790.0	45.6	100790.0	38.4	180790.0	49.0
11	Electricity (Units)	2101.0	1.1	2101.0	0.9	2101.0	1.0	2101.0	0.8	2101.0	0.6
12	Water (Units)	203.0	0.1	206.0	0.1	209.0	0.1	213.0	0.1	223.0	0.1
		198148.40	100.0	229963.10	100.0	220996.80	100.0	262342.60	100.0	369031.10	100.0

A study by Malimbwi (1992) on the effects of spacing concluded that survival percentage increases significantly with spacing, at a spacing of 1.13 m² the survival percentage was 62, at 1.88 m² the survival was 82% and when it reached 3.14 m² survivals was 88%. It can therefore be argued that mean survival, branch diameter, Dbh, Height, Basal area increased with the increase in spacing except for standing volume, branch diameter at merchantable which increased with increase in spacing to a certain limit and then dropped (Chamshama, 2001)

4.1.2.3 Labour

Labour is used in almost every activity from Silvicultural practise to terminal operations of the forest (Fig. 4). Labour cost contributions to total operations costs were noted as 1.5% in 2004 and 0.8% in 2008 for Sao Hill. The labour unit cost was 1 846 Tshs/manday/year in 2004 and 2 897 Tshs/manday/year in 2008 (Table 4a). Likewise, Mapanda forest plantations had labour cost contribution of 0.9% in 2004 and 0.5 % in 2008 with uniform labour unit cost of 1 864 Tshs/manday/year for all five years (Table 4b).

According to the results, the contribution of labour to the total operation costs tended to increase with the years for Sao Hill Forest Plantation (Table 4a). Payment systems for production workers are frequently complex and difficult to administer. Although there are innumerable variations, they are essentially of two types, those whose payments/wages are not related to production levels, and those where payment is related directly or indirectly to production levels (Lucey, 1996). The payments made for labour according to the study focused on payments/wages directly to production levels.



Figure 5: Sao Hill Irundi permanent nursery with labourers.

4.1.2.4 Lorry/tractor fuel

Lorries and tractors which always use fuels and lubricants are useful transportation means from forest nursery establishment to terminal operations. Findings revealed that the contribution of fuels costs to total operation's unit costs was 0.8% in 2004 as the maximum contribution and 0.3% as minimum in 2008 in Sao Hill while in Mapanda it was 0.5% in year 2004 and 0.3% in year 2008 (Table 4a and b). The Saohill unit costs were relatively higher than those of Mapanda. The reason for the difference was the stiff or bureaucratic procurement procedures in Government institutions in purchasing fuels and lubricants which caused Sao Hill to have higher percentage contributions while Mapanda don't use the same procurement procedures but rather have been purchasing fuels in large quantity and used from their stocks hence lowering the unit costs.

4.1.2.5 Beating up

Beating up is defined as the activity of replanting or replacing the dead seedlings after survival assessment. Two up to four weeks after planting the crew goes back to assess the percentage survival and replace the dead seedlings (Fig. 6). The process repeated early in the next planting season if the survival is more than 50%. Otherwise total planting is done if survival is less than 50% (Isango, 1994).

The beating up unit cost for Sao Hill was found to be higher in 2008 which was 21,531.10 Tshs/ha/year and the minimum being 422.10 Tshs/ha/year in 2005. The beating up unit cost contribution to the total operation cost of Sao Hill was noted to be 5.4% in 2008 and its least contribution being 0.3% in 2005 (Table 4 a). Mapanda unit beating cost was observed to be 0.9% in 2006 as the highest and 0.1% in 2004 as the lowest. The results show that the beating up costs was relatively higher in Sao Hill than Mapanda. The introduction of Taungya and poor seed sources was the main factor of seedling death after planting which eventually cause higher cost of beating up to Saohill than Mapanda.



Figure 6: Assessing survival percentage in the Taungya system planted with *Pinus patula*.

4.1.2.6 Weeding

Weeding is always done in different ways like spot weeding, slash weeding, screefing, and strip weeding. The weeding unit cost percentage contribution to the total operation cost was found to be 28.8% in 2008 as the maximum and 13.8% in 2004 as minimum for Sao Hill Forest plantation (Table 4a). Mapanda forest plantation weeding costs contributed 11.1% in 2007 and 1.3% in 2005. The results shows, that the Sao hill weeding unit cost was higher in 2008 at about 114,670 Tshs/ha/year and 16 487 Tshs/ha/year in 2004 (Table 4a). Mapanda Forest Plantation's weeding unit cost was found to be 32 921 Tshs/ha/year as the highest in 2008 and 3 005 Tshs/ha/year as lowest in 2004. It was found that in the two projects, there was a difference in percentage contributions to total operation unit costs. The Mapanda forest had lower percentage contribution as well as weeding unit cost due to the use of weed killers while Sao hill only casual labourers were used in weeding activities.

Juvenile trees when newly planted in the field's face some competitions for food, water and light and if not well tended will eventually die. The weeding activity tries to help the seedlings from competitions Holmes, (1995) explained that for the initial three years weeding is necessary to ensure good stocking and good growth rate.

4.1.2.7 Pruning

The highest percentage contribution of pruning cost were found in the year 2007 when about 21 % was recorded while the minimum contribution was found to be 10.6% in 2008 (Table 4a) for Saohill and Mapanda had a range of 0.0 % and 3.8% (Table 4a). The big differences between Sao Hill and Mapanda arose from the fact that in 2008 Sao Hill hired some labourers from the Kilombero district for pruning which increased costs.

Pruning is practised in the project with two main objectives. First, to produce trees free of dead knots and second, to give an easy access to the forest (Figure 7) for fire protection Monela, (1989). Pruning is carried out at the age of 4, 6, and 8 years that is 1st, 2nd, and third pruning respectively. The summary of pruning schedule of *Pinus patula* in Tanzania is provided in technical order No. 22 of 1968 and No. 24 of 1970 of Forest Division (Table 5).

Table 5: Summary of Pruning Schedules

Top height	Pruning top Height	Number of Stems
meters	meters	
5.50	2.75	All
5.75	5.75	1,000
8.25	8.25	750



Figure 7: Well pruned Pinus patula at (Itimbo range) Sao Hill Forest plantation.

4.1.2.8 Thinning

Thinning is defined as an activity of reducing a number of trees in a given compartment. No thinning was done yet at Mapanda Forest Plantation and therefore its contribution to total unit operation costs was 0% (Table 4a and b). The same situation was found at Sao Hill Forest Plantation and activity hence contributing 0.0% to the total unit cost of operation costs.

4.1.2.9 Forest fire protection

The results show that the forest fire protection (e.g. Figure 8) unit cost contribution to the total unit costs of operations was 22.5% as the maximum in 2007 and 4.6% as minimum in 2008 for Sao Hill Forest Plantation (Table 4a).

It was revealed that the unit cost for Sao Hill in 2007 was 57 947.40 Tshs/km/year as a maximum and in 2008 it was found to be 18 237 Tshs/km/year as the minimum. In the same case, Mapanda forest plantation had unit cost contribution of 32.4% in 2005 as maximum and 1.4% as minimum in 2004 (Table 4b). The main cause of Mapanda forest plantation having higher fire control costs was that, they had to prepare fire lines in very steep and undulated plateaus which had high grasses than Sao Hill who had been maintaining the existing fire lines. The major emphasis in Sao Hill was not maintaining fire lines but rather fire campaigns using cinema and Video shows using the Forest Publicity crews from Forestry and Beekeeping Division based in Mbeya. Again, Sao Hill recorded the highest unit cost in 2007 because it was the period when fire occurred and caused a loss of more than 200 Ha (FBD, 2007).

4.1.2.10 Salaries

Salaries are the main contributing costs in the establishment and Operation of forest plantations in the Government and privates companies. This is so important since it includes payments of skilled labour and administrators of the project. It was revealed from the results that the Sao Hill's salary costs contribution to the operations costs was 45.3% as maximum in the year 2004 and the minimum being 21% in 2007 (Table 4a).The salary contribution for Mapanda forest plantation had the range of 50.6% to 38.4% which was higher than that of Sao Hill. According to Hax and Majluf (1982), the main reason for higher unit cost contribution is that even though skilled workers at Mapanda forest plantation were few than those at Sao Hill they were paid relatively higher.

4.1.2.11 Electricity

The study showed that electricity unit costs contribution to total unit costs of operations at Sao hill were 1.8% in 2004 and almost 0.0% in 2005 to 2008 (Table 4b). For Mapanda forest plantation it was found to be ranging from 1.1 to 0.6% (Table 3 b). The electricity was used for lighting, heating/warming in offices, but also is used for security purposes.

4.1.2.12 Water

It was found that the Sao Hill unit contribution of water to the total unit cost was 0.2% in 2004 and the minimum contribution was 0.0% in 2008. Mapanda forest had uniform level of unit cost contribution of 0.1% in all five years from 2004 to 2008 (Table 4a and b).The water used for nursery and office work are billed by the water Authority in the District and charged per unit (MDC, 2008).

Table 6d: Mapanda forest plantation percentage contribution as per operation unit costs

S/N	Cost Centres	Contribution in %					Average
		2004	2005	2006	2007	2008	
1	Land preparation (ha)	14.2	6.0	4.3	7.6	14.4	9.3
3	Pitting and Planting (ha)	32.5	13.7	9.9	9.3	5.0	14.1
4	Labour (mandays)	0.9	0.8	0.8	0.7	0.5	0.8
5	Lorry/ Tractor Fuel (ltrs)	0.5	0.4	0.5	0.4	0.3	0.4
6	Beating up (ha)	0.1	0.5	0.9	0.7	0.6	0.6
7	Weeding (ha)	2.1	1.3	1.7	11.1	9.5	5.1
8	Pruning (ha)	0.0	0.0	3.8	0.0	0.5	0.9
9	Thinning (mandays)	0.0	0.0	0.0	0.0	0.0	0.0
10	Forest fire protection costs (km)	1.4	32.4	31.4	30.9	19.6	23.1
11	Salaries	50.6	43.8	45.6	38.4	49.0	45.5
13	Electricity (Units)	1.1	0.9	1.0	0.8	0.6	0.9
14	Water (Units)	0.1	0.1	0.1	0.1	0.1	0.1
		100.0	100.0	100.0	100.0	100.0	100.0

Source: Field data

Table 7: Real costs of establishment cost for Sao hill Forest Plantation

Year	CPI	Deflator	Current cost/ha	Real cost/ha
2004	115.1	1.00	192 817.50	192 817.50
2005	120.9	1.05	279 611.10	266 197.17
2006	129.6	1.13	244 708.70	217 330.03
2007	138.7	1.21	345 913.40	287 055.75
2008	153	1.33	400 849.10	301 553.80

Source: Field data

Table 8: Real costs of establishment cost for Mapanda Forest Plantation

Year	CPI	Deflator	Current costs/ha	Real costs/ha
2004	115.1	1.00	93 913.10	93 913.10
205	120.9	1.05	101 998.70	97 105.50
2006	129.6	1.13	114 113.10	101 345.80
2007	138.7	1.21	186 273.70	154 579.00
2008	153	1.33	269 059.80	202 410.40

Source: Field data

4.3 Comparison of Real Operation Costs

The comparison of operation real costs per hectare between Sao Hill and Mapanda show that Sao Hill had higher real costs almost two times than that of Mapanda Forest

Plantation in all five years (2005- 2007) with exception of 2004 and 2008 where Mapanda forest plantation had real costs greater than Sao Hill (Table 11 and Fig. 9). The big differences are brought by differences in cost management strategies. The higher the cost management strategies the lower the real costs (NBS, 2005). The cost management in the government is weakly practised due to the fact that it neglects some of the basic theories of cost management that causes higher operation costs.

Table 9: Real costs of operation costs for Mapanda Forest Plantation

Year	CPI	Deflator	Current cost per ha	Real cost per ha
2004	115	1.00	270 944.00	270 944.00
2005	121	1.05	136 588.00	130 035.10
2006	130	1.13	159 502.00	141 656.50
2007	139	1.21	246 733.00	204 751.00
2008	153	1.33	433 026.00	325 760.12

Table 10: Real costs of operation costs for Sao hill Forest Plantation

Year	CPI	Deflator	Current cost per ha	Real cost per ha
2004	115	1.00	208 986.30	208 986.30
2005	121	1.05	351 923.35	335 040.34
2006	130	1.13	266 099.00	236 327.24
2007	139	1.21	309 852.00	257 130.41
2008	153	1.33	395 739.30	297 709.76

4.4 Comparison of Management Real Costs per Hectare Between Sao Hill and Mapanda Forest Plantations

The study shows that the actual comparison is done for unit real cost regardless of how big is the forest plantation in question. The results showed that in 2004 and 2008, Mapanda had slight bigger unit real costs than Sao Hill because it had 270 944.00 and 325 760.10 Tshs/year respectively while Sao Hill was found to have 208 986.30 and 297 709.80 Tshs/year (Table 11 and Fig. 10).

Table 11: Comparison of operation real costs per hectare of Sao Hill and Mapanda Forest Plantation

	2004	2005	2006	2007	2008
Mapanda Tshs/ha/year	270 944.00	130 035.10	141 656.50	204 751.00	325 760.10
Sao Hill Tshs/ha/year	208 986.30	335 040.30	236 327.20	257 130.40	297 709.80

Source: Field data

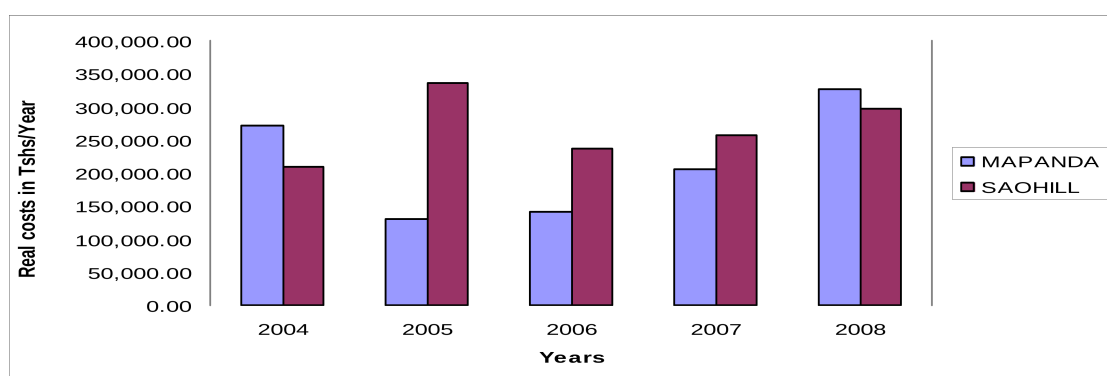


Figure 8: The graphical representation of comparison of operation real costs between Sao Hill and Mapanda Forest Plantation.

It was revealed that the establishment real cost per hectare for Mapanda is lower than that of Sao Hill for almost all five years (Table 12).

Table 12: Comparison of establishment real costs per hectare of Sao Hill and Mapanda Forest Plantation

	2004	2005	2006	2007	2008
Mapanda Tshs/ha/year	93 913.10	97 105.50	101 345.80	154 579.00	202 410.40
Sao Hill Tshs/ha/year	192 817.50	266 197.17	217 330.03	287 055.75	301 553.80

The results show that management cost is the summation of establishment and operation real costs. It was found that there is difference between Sao Hill and Mapanda forest plantation. It was found that the management cost for Sao Hill forest plantation is greater than Mapanda forest plantation for all five years (Table 13).

Table 13: Comparison of management real costs per hectare of Sao Hill and Mapanda Forest Plantation

	2004	2005	2006	2007	2008
Mapanda Tshs/ha/year	364 857.10	227 140.60	243 002.30	359 330.00	528 170.50
Sao Hill Tshs/ha/year	401 803.80	601 237.47	453 657.23	544 186.15	599 263.60

4.5 Factors Affecting Costs in the Management of Forests in Sao Hill and Mapanda Forest Plantations

4.5.1 Price fluctuations of fuels and lubricants

The results from interviews and field findings with Sao Hill and Mapanda forest plantation management show that the major cost factor influencing nursery and general operations is fuel and lubricants. The fuel is used for all vehicles and machines for nursery work and all plantation work. The prices of fuels and lubricants if changes affect the total costs

exorbitantly. It was revealed that prices for fuels rose up from Tshs 1 100 in 2004 to 2 600 Tshs/ litre in 2007 (GRL, 2008).

4.5.2 Labour

The results from interviews with project management of both Sao Hill and Mapanda forest plantation revealed that, labour is a key to any project work or activity. Every activity is done by casual labourers. It was found that Mapanda forest plantation uses the annual labour costs data which provide information about a selection of labour cost survey core variables: average monthly labour costs and average hourly labour costs as well as the breakdown of labour costs by main categories (gross wages and salaries; direct remuneration and bonuses; employers' social security contributions; other labour costs). This data collection is based on gentlemen's agreements and data become available approximately 12 months after the end of the reference period (URT, 2002). Finally, it was explained that shortage of labourers affects establishment and operation costs of both Sao Hill and Mapanda forest plantation.

4.5.3 Duplication of similar projects

The results show that duplication of similar forest plantations near Mapanda or Sao Hill forest plantation affects forest plantations establishment and operation costs. It was pointed out that similar projects would have to compete for the limited human and other resources found in the same catchment area like labour, land, implements and building materials. In order to acquire such resources, project must increase some costs or motivation which eventually raises the management costs of the project. Mapanda which is a private company anticipated to work under pure competitive market rather than Sao Hill forest plantation. This is contrary to Sao Hill Forest Plantation which aimed at mobilizing forest out growers and other private companies to plant trees to create more employments

and provide more wood products to industries as well as environmental conservation. Gregory (1987) said, the number of firms and the number of buyers within the same market area concerned must be large enough so that no one firm can significantly influence the product price by changing the quantity produced or purchased. Therefore, the more investors of the same or similar projects affects establishment and operation costs of each project.

4.5.4 High costs of building materials

It was found that the two projects are engaged in construction of workers and office buildings as well as bridges. Most of the materials used for construction of buildings and bridges have unstable prices/costs. It was revealed from the interviews that continuous rising of prices of building materials affects the total management costs of the project.

4.5.5 Higher costs of fire protection equipments

The results show that purchases of fire protective gears are very costly to an extent that affordability becomes difficulty, even though prevention is better than cure. It was found that Sao Hill has a good number of fire protective gears more than Mapanda but was bought in 1980's when World Bank financed the project. It was further revealed that some equipment are running wear and tear and replacement or buying new equipment is becoming difficult due to high prices.

4.6 Cost Management Strategies

According to the interview with Sao Hill and Mapanda forest plantation managers and treasurers it was found that, Mapanda experienced shortage of skilled staff who expected to be paid highly, the strategy used by Mapanda in order to reduce costs they recruited SUA fresh graduates to work for a low salary and short time and latter on when are

competent in the field work had to decide about whether to remain and work with Mapanda.

Sao Hill had no problems with labour availability with exception of 2007 and 2008 when a deliberate attempt was made to reduce costs by drawing some unskilled labour from Kilombero. This approach reduced costs but created conflicts with communities around project area.

It was found that in order to reduce costs for nursery/ establishment, Mapanda forest plantation developed a mechanical nursery which started to be used as from 2008 and reduced a number of labourers for nursery work and maximised production.

Other strategies developed by Mapanda forest plantation to cut costs for the management of forest plantations was to increase working hours in the field and office as from 7.30 am up to 4.30 pm.

It was also found that Mapanda developed a mechanism for cost reduction of providing full boarding (Dormitories) for labourers who came from far villages where by their rentals were deducted from their salaries for the period of high labour intensive activities. This raised working morale of labourers and maximised production.

The Mapanda forest plantation also employed experienced retired officers from the government with high reputations to work in top management post for high payments but for higher productivity as well to offset profit margin.

The cost management strategies which are efficient are those which can prove to reduce cost of management, and from the results, it shows that the Mapanda forest plantation had the lowest management cost compared to Sao Hill forest plantation (Table 11, 12 and 13).

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

From this study it can be concluded that there is difference in management costs between Government (Sao Hill) and Private (Mapanda) forest plantations in Tanzania.

The management cost for Sao Hill forest plantation is greater than Mapanda forest plantation for all five years. The Sao Hill and Mapanda forest plantation establishment unit real costs increased gradually with years from 2004 to 2008. The establishment real costs for Sao Hill found were to be almost two times greater than Mapanda in 2004.

It can be concluded that the differences are brought by the fact that Sao Hill had poor cost management strategies compared to Mapanda forest plantation. The higher the cost management strategies the lower the real costs (NBS, 2005).

The soil ingredients costs contributed the highest to total establishment costs for Sao Hill forest plantation followed by salaries and seed purchases costs while land preparations and water contributed the least.

The salaries costs contributed the highest in total establishment costs for Mapanda forest plantation followed by soil ingredients and seed purchases costs while land preparations and water contributed the least.

It was revealed further that Saohill forest plantation had a few cost management strategies compared to Mapanda forest plantation hence found to have higher management cost than

Mapanda. The major strategies used by Mapanda was an introduction of internship to fresh forest university graduates, using retired forest officers with high reputation under contract basis, introduce mechanical nursery technology to reduce labour force and maximize per unit productivity, to establish dormitories using cheap building materials to host labourers in labour intensive activity period (Planting) and increase working hours and avoiding business as usual.

5.2 Recommendations

Basing on the results of this study, it is recommended that:

- i) The government should review the cost management strategies so that they can further attain the lowest unit real costs. Also the government should set well defined strategies to reduce costs of management of forest plantation.
- ii) The analysis of cost items for establishment and operation costs shows clearly that salaries and wages, soil ingredients, seed purchase and fire protection have significant impact on management costs. Salaries increase every year and prices of purchased materials for example seeds, fuel and lubricants increases every year. Therefore, the government should use management costs as the basis for setting or changing royalty fees.
- iii) Nursery site selection should be done correctly by the government forest plantation so that availability of soil ingredients will be found close and cheaply transported to the nursery to minimize soil ingredients costs.
- iv) Based on inefficient cost management strategies which caused Sao Hill forest plantation to have higher management costs than Mapanda Forest plantation, the Forest and Beekeeping Division should review its syllabus for Certificates and Diploma courses to incorporate the application of cost management strategies for better management of plantation forests in Tanzania.

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APPENDICES

Appendix 1: Table to show Sao hill forest plantation current and real establishment unit costs

S/N	Cost Centres	2004			2005			2006			2007			2008		
		Unit Cost	Def	Real costs	Unit Cost	Def	Real costs	Unit Cost	Def	Real costs	Unit Cost	Def	Real costs	Unit Cost	Def	Real costs
1	Land Preparations (Sq. M)	23.87	1.00	23.87	22.70	1.05	21.62	45.90	1.13	40.62	26.80	1.21	22.15	58.50	1.33	43.98
2	Seed Purchase (Kg)	47 235.17	1.00	47 235.17	46 509.55	1.05	44 294.81	46 500.80	1.13	41 151.15	47 022.00	1.21	38 861.16	4 8018.90	1.33	36 104.44
3	Soil Ingredients (Trips)	67 639.96	1.00	67 639.96	75 014.25	1.05	71 442.14	75 076.60	1.13	66 439.47	8 0060.80	1.21	66 165.95	7 9043.00	1.33	59 430.83
4	Labour(Mandays)	1 846.01	1.00	18 46.01	1 846.00	1.05	1 758.10	2 640.00	1.13	2 336.28	2 639.00	1.21	2 180.99	3 810.00	1.33	2 864.66
5	Lorry/ Tractor Fuel	1 008.01	1.00	1 008.01	1 008.00	1.05	960.00	1 015.00	1.13	898.23	1 120.00	1.21	925.62	1 250.00	1.33	939.85
6	Potting (Mandays)	1 845.27	1.00	1 845.27	1 846.60	1.05	1 758.67	2 635.70	1.13	2 332.48	2 642.00	1.21	2 183.47	3 821.00	1.33	2 872.93
7	Watering (Mandays)	1 860.00	1.00	18 60.00	1 846.65	1.05	1 758.71	2 636.80	1.13	2 333.45	2 645.00	1.21	2 185.95	3 800.00	1.33	2 857.14
8	Root Pruning(Mandays)	1 853.00	1.00	1 853.00	1 845.65	1.05	1 757.76	2 600.00	1.13	2 300.88	2 644.00	1.21	2 185.12	0.00	1.33	0.00
9	Loading/Unloading Seedlings (Mandays)	1 854.00	1.00	1 854.00	1 846.83	1.05	1 758.89	2 645.00	1.13	2 340.71	2 639.00	1.21	2 180.99	3 817.00	1.33	2 869.92
10	Purchase polythene (Kg)	2 106.00	1.00	2 106.00	2 103.41	1.05	2 003.25	2 010.70	1.13	1 779.38	2 008.40	1.21	1 659.83	2 101.20	1.33	1 579.85
11	Salaries	39 850.12	1.00	39 850.12	67 348.96	1.05	6 4141.87	78 969.20	1.13	69 884.25	90 574.00	1.21	74 854.55	98 888.70	1.33	74 352.41
12	Water (Units)	211.25	1.00	211.25	200.00	1.05	190.48	200.00	1.13	176.99	200.00	1.21	165.29	220.00	1.33	165.41
		167 332.6		167 332.6	2 01438.6		191 846.2	216 975.7		192 013.8	234 221.0		193 571.0	244 828.3		184 081.4

Appendix 2: Table to show Mapanda forest plantation current and real establishment unit costs.

S/N	Cost Centres	2004			2005			2006			2007			2008		
		Unit Cost	Def	Real cost	Unit Cost	Def	Real cost	Unit Cost	Def	Real cost	Unit Cost	Def	Real cost	Unit Cost	Def	Real cost
1	Land Preparations (Sq. M)	28.20	1.00	28.2	42.70	1.05	40.67	45.50	1.13	40.27	48.80	1.210	40.33	6.90	1.33	5.19
2	Seed Purchase (Kg)	40021.40	1.00	40,021.40	40 150.00	1.05	38 238.10	40 479.50	1.13	35 822.57	45 573.90	1.210	37 664.38	44 964.00	1.33	33 807.52
3	Soil Ingredients (Trips)	67 694.10	1.00	67,694.10	68 076.90	1.05	64 835.14	71 424.60	1.13	63 207.61	74 908.20	1.210	61 907.60	68 089.90	1.33	51 195.41
4	Labour (Mandays)	18 45.90	1.00	1,845.90	2 898.80	1.05	2 760.76	1 845.90	1.13	1 633.54	1 846.10	1.210	1 525.70	3 500.00	1.33	2 631.58
5	Lorry/Tractor Fuel (Mandays)	1 100.00	1.00	1,100.00	1806.90	1.05	1 720.86	1 200.00	1.13	1 061.95	1 250.00	1.210	1 033.06	3 820.00	1.33	2 872.18
6	Potting (Mandays)	1 846.00	1.00	1,846.00	2084.10	1.05	1 984.86	1 846.10	1.13	1 633.72	1 845.80	1.210	1 525.45	3 680.00	1.33	2 766.92
7	Watering (Mandays)	1 846.80	1.00	1,846.80	2 575.80	1.05	2 453.14	1 846.10	1.13	1 633.72	1 846.00	1.210	1 525.62	3 752.00	1.33	2 821.05
8	Root Pruning (Mandays)	1 841.40	1.00	1,841.40	1 962.00	1.05	1 868.57	1 846.40	1.13	1 633.98	1 846.10	1.210	1 525.70	3 800.00	1.33	2 857.14
9	Loading/Unloading of Seedlings (Mandays)	1 847.80	1.00	1,847.80	1 826.50	1.05	1 739.52	1 843.00	1.13	1 630.97	1 846.10	1.210	1 525.70	3 782.00	1.33	2 843.61
10	Purchase polythene (Kg)	2 101.20	1.00	2,101.20	2 101.00	1.05	2 000.95	2 109.50	1.13	1 866.81	2 111.20	1.210	1 744.79	2 100.90	1.33	1 579.62
11	Salaries	50 522.60	1.00	50,522.60	81 333.30	1.05	77 460.29	112 287.20	1.13	99 369.20	19 4581.40	1.210	160 811.07	411 034.70	1.33	309 048.65
12	Water (Units)	200.10	1.00	200.10	205.20	1.05	195.43	200.10	1.13	177.08	220.00	1.210	181.82	250.00	1.33	187.97
		170 895.50		170895.5			195 298.29	236 973.90		209 711.42	327 923.6		271 011.2	548 780.40		412 616.8

Source: Researcher

Appendix 3: Table to show Sao hill forest plantation current and real operation unit costs

S/N	Cost Centres	2004			2005			2006			2007			2008		
		Current Unit Cost	Def	Real Unit cost	Current Unit Cost	Def	Real unit cost	Current Unit Cost	Def	Real unit cost	Current Unit Cost	Def	Real unit cost	Current Unit Cost	Def	Real unit cost
1	Land preparation (Ha)	957.10	1.00	957.10	2 345.20	1.05	2 233.52	2 095.90	1.13	1 854.78	6 821.80	1.21	5 637.85	14 887.20	1.33	11 193.38
2	Pitting and Planting (Ha)	11 642.00	1.00	1 1642.00	22 893.80	1.05	21 803.62	2 4607.60	1.13	21 776.64	16 076.80	1.21	13 286.61	28 287.60	1.33	21 268.87
3	Labour (Mandays)	1 846.00	1.00	1 846.00	1 846.00	1.05	1 758.10	2 646.00	1.13	2 341.59	2 700.00	1.21	2 231.40	2 897.00	1.33	2 178.20
4	Lorry/ Tractor Fuel (Ltrs)	1 007.00	1.00	1 007.00	1 007.00	1.05	959.05	1 007.00	1.13	891.15	1 007.00	1.21	832.23	1 007.00	1.33	757.14
5	Beating up (Ha)	3 801.10	1.00	3 801.10	422.10	1.05	402.00	722.20	1.13	639.12	1718.40	1.21	1 420.17	2 1531.10	1.33	16 188.80
6	Weeding (Ha)	16 487.00	1.00	16 487.00	30 586.50	1.05	29 130.00	51 481.00	1.13	45 558.41	60 781.00	1.21	50 232.23	114 670.20	1.33	86 218.20
7	Pruning (Ha)	14 577.60	1.00	14 577.60	19 574.90	1.05	18 642.76	33 450.70	1.13	29 602.39	55 961.50	1.21	46 249.17	42 357.60	1.33	3 1847.82
8	Thinning (Ha)	0.00	1.00	0.00	0.00	1.05	0.00	0.00	1.13	0.00	0.00	1.21	0.00	0.00	1.33	0.00
9	Fire protection costs. (Km)	12 476.00	1.00	12 476.00	17 956.80	1.05	17 101.71	21 327.00	1.13	18 873.45	57 947.40	1.21	47 890.41	18 237.10	1.33	13 712.11
10	Salaries	54 000.00	1.00	54 000.00	54 000.00	1.05	4 897 959.18	54 000.00	1.13	47 787.61	54 000.00	1.21	44 628.10	154 000.00	1.33	115 789.47
11	Electricity (Units)	2 100.00	1.00	2 100.00	0.00	1.05	0.00	0.00	1.13	0.00	0.00	1.21	0.00	0.00	1.33	0.00
12	Water (Units)	209.00	1.00	209.00	208.00	1.05	198.10	208	1.13	184.07	202	1.21	166.94	0.00	1.33	0.00
		119 102.70			150 840.30			19 1545.5			257 216			397 874.9		

Source: Research

Appendix 4: Table to show Mapanda forest plantation current and real operation unit costs

S/N	Cost Centres	2004			2005			2006			2007			2008		
		Unit Cost	Def	Real unit cost	Unit Cost	Def	Real unit cost	Unit Cost	Def	Real unit cost	Unit Cost	Def	Real unit cost	Unit Cost	Def	Real unit cost.
1	Land preparation (Ha)	28 216.00	1.00	28 216.00	13 763.50	1.05	131.08	9 601.30	1.13	84.97	20 005.60	1.21	16 533.55	53 098.30	1.33	39 923.53
2	Pitting and Planting (Ha)	64 331.40	1.00	64 331.40	31 414.60	1.05	299.19	2 1914.50	1.13	193.93	24 397.00	1.21	20 162.81	18 363.80	1.33	1 3807.37
3	Labour (Mandays)	1 846.50	1.00	1 846.50	1 846.00	1.05	17.58	1 846.00	1.13	16.34	1 846.00	1.21	1 525.62	1 846.00	1.33	1 387.97
4	Lorry/ Tractor Fuel (Ltrs)	1 007.10	1.00	1 007.10	1 020.00	1.05	9.71	1 020.00	1.13	9.03	1 020.00	1.21	842.98	1 020.00	1.33	766.92
5	Beating up (Ha)	243.30	1.00	243.30	1250.10	1.05	11.91	2 006.00	1.13	17.75	1 845.90	1.21	1 525.54	2 319.00	1.33	1743.61
6	Weeding (Ha)	4 080.70	1.00	4 080.70	3005.00	1.05	28.62	3 750.00	1.13	33.19	29 119.00	1.21	24 065.29	34 921.00	1.33	26 256.39
7	Pruning (Ha)	0.00	1.00	0.00	0.00	1.05	0.00	8 427.00	1.13	74.58	0.00	1.21	0.00	1 846.90	1.33	1 388.65
8	Thinning (Ha)	0.00	1.00	0.00	0.00	1.05	0.00	0.00	1.13	0.00	0.00	1.21	0.00	0.00	1.33	0.00
9	Fire protection costs. (Km)	2 826.40	1.00	2 826.40	74 567.00	1.05	710.16	69 332.00	1.13	613.56	81 005.00	1.21	66 946.28	72 502.00	1.33	5 4512.78
10	Salaries	100 200.00	1.00	100 200.00	100 790.00	1.05	959.90	100 790.00	1.13	891.95	100 790.00	1.21	83 297.52	180 790.00	1.33	135 932.33
11	Electricity (Units)	2 101.00	1.00	2 101.00	2 101.00	1.05	20.01	2 101.00	1.13	18.59	2 101.00	1.21	1 736.36	2 101.00	1.33	1579.70
12	Water (Units)	203.00	1.00	203.00	206.00	1.05	1.96	209.00	1.13	1.85	213.00	1.21	176.03	223.00	1.33	167.67
		198 148.40		205 055.40	229 963.10		2 188.16	220 996.80		1953.87	262 342.60		216635.95	36 9031.10		277 299.25

Source: Researcher

Appendix 5: CHECKLIST ON COST CENTRES

a) Establishment costs centres which was collected.

No	Cost centres	Tshs 2004	Tshs 2005	Tshs 2006	Tshs 2007	Tshs 2008
1	Land Preparations					
2	Seed Purchase					
3	Soil Ingredients					
4	Labour					
5	Lorry/ Tractor Fuel					
6	Lorry/ Tractor Hiring					
7	Potting					
8	Watering					
9	Root Pruning					
10	Loading of Seedlings					
11	Unloading of Seedlings					
12	Salaries					
13	Electricity					
14	Water					

Source: Researcher

b) Operation Costs centres which was collected

No	Cost centres	Tshs 2004	Tshs 2005	Tshs 2006	Tshs 2007	Tshs 2008
1	Land preparation					
2	Pitting					
3	Planting					
4	Labour					
5	Lorry/ Tractor Fuel					
6	Lorry/ Tractor Hiring					
7	Beating up					
8	Weeding					
9	Pruning					
10	Thinning					
11	Forest fire protection costs.					
12	Salaries					
13	Machineries					
14	Electricity					
15	Water					

Source: Researcher

Appendix 6: Management costs analysis

Management cost /yr/ha = Establishment cost/yr/ha +Operation cost/ yr/ha.

But;

$$\begin{aligned} \text{Establishment cost/yr/ha} &= X_1\text{Shs/yr/ha} + X_2\text{Shs/yr/ha} + X_3\text{Shs/yr/ha} \\ \text{Operation cost/yr/ha} &= X_a\text{Shs/yr/ha} + X_b\text{Shs/yr/ha} + X_c\text{Shs/yr/ha} + X_d\text{Shs/yr/ha} \\ &\quad + X_e\text{Shs/yr/ha} + X_f\text{Shs/yr/ha} \end{aligned}$$

Therefore,

Management Cost/yr/ha =

$$[X_1\text{Shs/yr/ha} + X_2\text{Shs/yr/ha} + X_3\text{Shs/yr/ha}] + [X_a\text{Shs/yr/ha} + X_b\text{Shs/yr/ha} + X_c\text{Shs/yr/ha} + X_d\text{Shs/yr/ha} + X_e\text{Shs/yr/ha} + X_f\text{Shs/yr/ha}]$$

Where:

- $X_1\text{Shs/yr/ha}$ = Seed procurements costs
- $X_2\text{Shs/yr/ha}$ = Site preparation costs (Nursery site)
- $X_3\text{Shs/yr/ha}$ = Nursery tending costs (Fence/Hedge/Windbreaks, Soil ingredients, Potting costs, Watering, Transplanting costs, Root pruning costs, Weeding in Nursery)
- $X_a\text{Shs/yr/ha}$ = Planting costs (Site preparation, Loading and unloading of seedlings, Transportation of seedlings)
- $X_b\text{Shs/yr/ha}$ = Beating up costs (Replacement of dead seedlings)
- $X_c\text{Shs/yr/ha}$ = Pruning costs (Rodent /climber cutting ,Access pruning, High pruning)
- $X_d\text{Shs/yr/ha}$ = Weeding costs (Clean weeding, Line weeding, Spot weeding, Slashing, Cover crops, Mulching, Climber cutting)
- $X_e\text{Shs/yr/ha}$ = Thinning costs (First thinning, second thinning).
- $X_f\text{Shs/yr/ha}$ = Protection costs (Fire, diseases)

Appendix 7: Student's t-test

To test whether there is significant differences between management costs of Sao Hill and Mapanda Forest plantation.

$$t = \frac{\bar{d}}{s/\sqrt{n}}$$

$$Sd = \sqrt{\frac{\sum di^2 - (\sum di)^2/n}{n-1}}$$

where,

\bar{d} = average change between management costs of Sao hill and Mapanda

sd = standard deviation between management costs of Sao hill and Mapanda

n = number of observation

$\sum d^2$ = sum square of the difference

