FRIM NEWS

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Editorial

Welcome dear readers to this issue of FRIM Newsletter. In this Newsletter we present to you pest alerts to ensure that all pest management options including integrated pest management techniques are timely applied for tree and forests protection. After a successful forestry season it is right and proper that we take count of how many trees, out of those millions that were planted in the season, are surviving to date. Sound tree / forest management practices should continue as planned on our planted forests and other forests so that we get the best out of the investment made. Forest protection is central to tree / forest management to enhance tree survival and the pest alerts couldn't come at a better time than now. Let us all take responsibility in tree management to successfully restore the degraded landscapes. Enjoy reading the FRIM Newsletter.

PEST ALERT!

Senna siamea Novel Grub detected in some parts of Malawi

Davie Moyo & Herbart Jenya

Most forest inhabiting insects consistently remain at low levels in terms of population and are of little or no concern because they are not easily detectable. However, others can go through periods of extremely high numbers and alternating low number periods where they are difficult to detect. Insects that undergo periods of high population levels and become damaging are those of greatest concern. Several classes of outbreak cycles have been described by Berryman (1986). Many insects that are pests of forest plantations tend to remain at high levels because of the virtually unlimited host material provided by large areas of single species and even-aged stand characteristics of most plantations. The monocultural system of raising trees in plantations makes it difficult to break the chains of insect transmission. Examples of these insect pests in Malawi include *Thaumastocoris peregrinus* (Bronze bug), *Leptocybe invasa* (Gall wasp) and *Glycaspis brimblecombei* (Red gum lerp psyllid) which specifically attack *Eucalyptus* species. Recently a new stem borer has been observed to be attacking *Senna siamea* planted in a monoculture setting as a live barn in tobacco growing area of Malawi.

S. siamea has proved to be one of the most important plant species in the tobacco growing districts of Malawi as it has been extensively used in live tobacco barns. This has minimized the pressure which could have been exerted on indigenous trees. Traditionally, tobacco barns in Malawi are used by smallholder farmers for curing tobacco. Use of traditional barns has proved to be unsustainable as they require regular maintenance thereby contributing to deforestation in the country. Research has shown that live barn technology if successfully implemented can positively reduce deforestation. *S. siamea* has been earmarked as one of the species that can successfully been used in a live tobacco barn. Regrettably, of late, the species has been attacked by a novel xylophagous stem borer at larva stage. The stem borer bores into the stem and as it grows it tunnels downwards hollowing out the main root. The larva ejects frass through a hole in the stem just above the ground level and the extruded frass accumulates at the stem base.

A roving survey was therefore conducted to assess bio-physical distribution of xylophagous stem borer; evaluating damage levels through incidence and severity; and provide management options against the pest.

Site visitation and spot checks were the methods that were used during the assessment. Assessments targeted the tobacco growing districts of Chitipa, Karonga and Rumphi, in the Northern Region of Malawi; Dowa and Salima in the Central Region of Malawi; Mulanje and Phalombe in the Southern Region of Malawi. These are also areas where *S. siamea* species is being used in a live tobacco barn and households woodlots.

To assess damage of xylophagous stem borer, the extent of severity and incidence of the stem borer attacking *S. siamea* live barns, was evaluated. In each barn, randomly selected *S. siamea* stems were scored according to the levels of damage by the insect. Scoring was done on a 10cm portion above Diameter at Breast Height (DBH) which is measured at 1.3metres from the base of the tree. Damage scores and their criteria were as follows: 0 healthy tree, no damage; 1= < 25% stems and branches infected; 2= 25-50% stems and branches infected; 3= 51-75% stems and branches infected; and 4= >75% stems and branches infected.

Based on the severity level of every plant, average damage index was then calculated according to the following formula:

$$R = \frac{\sum_i n_i v_i}{NV},$$

Where R is the average damage index, ni the number of trees infected at damage index i, vi the damage index at level i, N number of trees assessed, and V the highest damage level (4). Based on the average damage index, a damage severity level was identified as follows; nil (average damage index = 0), low damage (average damage index < 1.0), medium damage (average damage index 1.1–2.0), severe damage (average damage index 2.1–3.0) and very severe damage (average damage index 3.1–4.0) (Thu *et al*. 2009).

Results and Discussion

The pest was first spotted in Phalombe and Mulanje districts in the Southern part of Malawi during a routine insects' survey. Qualitative observations were made that defined the gravity of the insects' damage. Upon observing the magnitude of the problem, a detailed survey was conducted in the seven (7) selected tobacco growing districts of Malawi to quantify the level of infestation. Basing on the assessment method provided above, average damage index (ADI) was computed that was defined by damage severity scale (magnitude of infestation). The results showed that, statistically, Karonga and Chitipa scored high in terms of damage levels seconded by Rumphi, and Salima was the least (F=21.94, P<0.05) as illustrated in Table 1. The variation in damage intensity among districts is attributed to differences in age of the trees and climatic conditions/biophysical factors.

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Table 1: Average damage indices of *S. siamea* stem borer

District	Site	Average Damage Index*	Damage Severity Scale.
Salima	Siyasiya	0.73±0.26[a]	Low Damage
Phalombe	Phalombe	1.47±0.26[ab]	Medium Damage
Dowa	Dowa	1.99±0.15[bc]	Medium Damage
Rumphi	Bwengu	2.41±0.15[c]	Severe Damage
Karonga	Ipyana	3.32±0.18[d]	Very Severe Damage
Chitipa	Mposya	3.62±0.26[d]	Very Severe Damage

*Average damage indices followed by the same letters are not significantly different at P=0.05.

Preliminary field observations revealed that the borer (Figure 1A) is big enough to inflict a big injury to the affected tree stems. The stem borer bores into the stem (Figure 1B) and as it grows it tunnels downwards hollowing out the main root. The larva ejects the frass through a hole in the stem just above the ground level and the frass accumulates at the base of the stem (Figure 1C).

A **B** **C**

Fig 1: (A) Grub of the borer (B) Gallery (Tuneling) (C) Bore frass at the base of the stem
(Pic: Herbart Jenya)

The stem borer attack results in tunnels in the tap-root and the stem immediately above ground. The tunnel may reach about 40-60 cm in length and in worst cases, the tree stops growing and eventually dies (Figure 2D). Vigorous and strong growing trees may survive the attack with some serious deformations and girdling on the stem (Fig 2E).

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D E

Figure 2: (D) Dead tree after heavy infestation (E) Deformation/ Girdling on the stem (Pic: Davie Moyo)

As the pest pupates to adult, it burrows a very big exit hole (Figure 3F) that is also injurious to the plant. Additionally, during the exit time the pest leaves its shell (Figure 3G) on the exit hole as the adult goes elsewhere to seek another host for further reproduction. Many shells (Figure 3H) have been collected in the sites that have been visited and the number of shells define the rate at which the insect is multiplying.

F G H

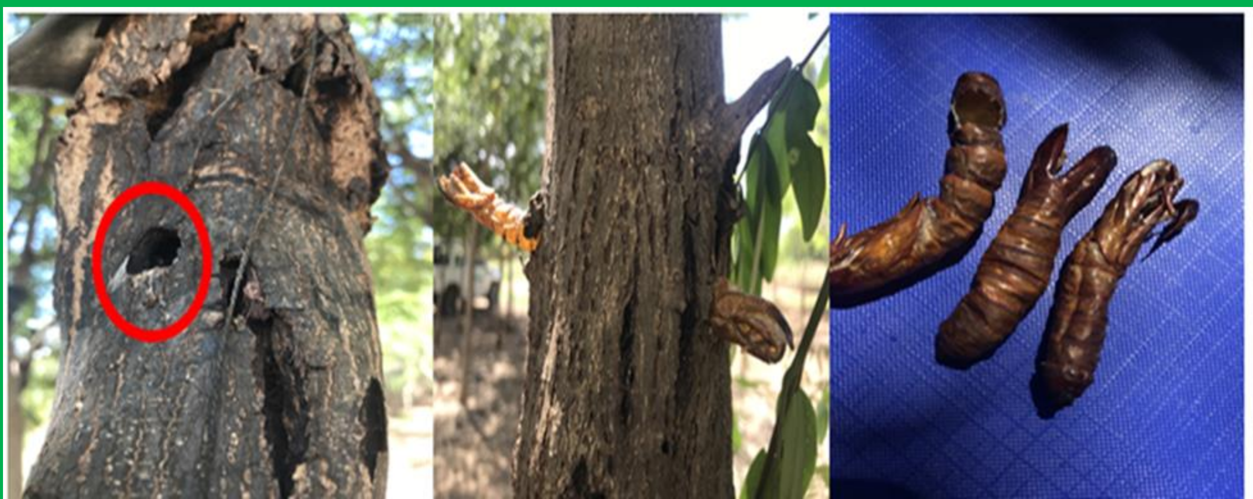

Fig 3: (F) Big exit hole (G) Shells left on a tree stem after ecdysis (H) Collection of shells left after molting (Pic: Davie Moyo)

In worse circumstances, the exit holes might enlarge to the extent of exposing the inner cambium of the tree stem (Figure 4I). The enlarged exit holes might attract other opportunistic beetles that might turn it into their habitat (Figure 4J) and further damage that part of the tree where they are residing. In some cases, stem borers are easier to assess not by the actual damage they cause to stems but by resin exudations (Jactel *et al*. 2002) which is as a result of their activities inside the infested stem (Figure 4K).

I J K

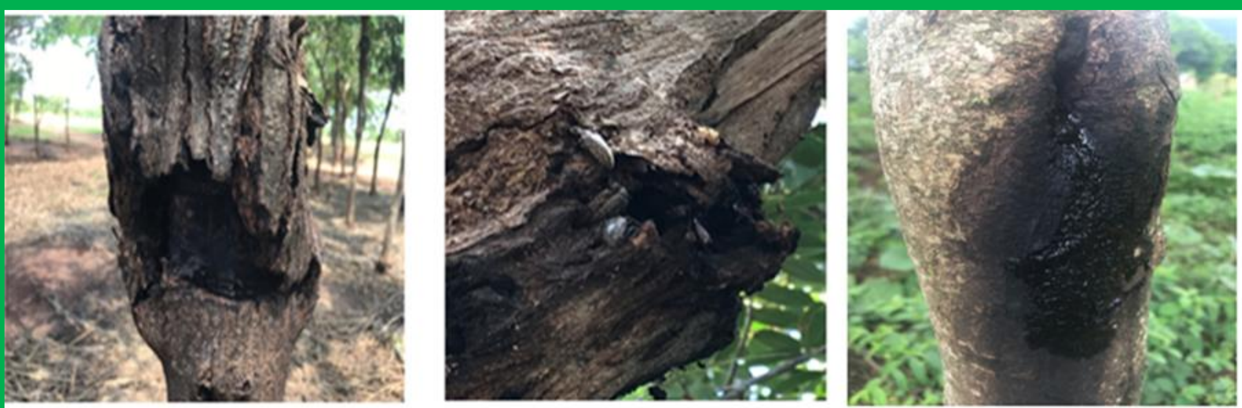

Fig 4: (I)Inner cambium of the heavily affected tree; (J) Opportunistic beetles habitating in the enlarged exit holes; (K) Exudation of resin in one of the infected stems. (Pic: Davie Moyo)

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PEST ALERT!

Conclusion and Recommendation

The larva has not yet been identified in terms of species name because the process requires some molecular techniques and no adult beetle has been observed, but it is suspected to be the larvae of a long-horned beetle (*Coleoptera: Cerambycidae*). Larvae of most *Cerambycidae* bore in the cambium and wood of living trees, logs or wood in use. Others bore in stems and roots of herbaceous plants. They are known as round headed wood borers because they produce rounded or slightly oval exit holes when emerging from infested trees or logs. Some infest weakened or recently dead trees and others can infest living trees. Many are considered pests because they weaken the structural integrity of living trees or wood in use, reduce the quality of lumber, or function as vectors of tree diseases. Some are known to kill trees. Some species spend long period in the larval stage in wood and can be transported long distances via logs, wooden crating, pallets, dunnage or fuel wood (Bybee *et al.* 2004). As a result, several insect species have been established in new locations and become pests.

Plans are underway to collect as many pests samples as possible across Malawi that shall be sent to RSA for molecular verification and identification by experts. Research on the biology, ecology and management of this borer is a critical activity needed to develop appropriate management strategies and tactics to effectively reduce losses. New approaches for management of insects are needed to develop environmentally friendly pest management tools. Currently, survey of the pest is underway across the country to establish its distribution, severity, incidence and the underlying bio-physical environment in which they survive. Once that information is gathered then we will be proposing mitigation options to curb the problem of the pest. New pests are incessantly appearing and provide additional challenges for forest management, therefore, FRIM is appealing to the general public to report immediately any tree pest detection to the institute or to any nearest Forestry office. Early detection and reporting are critical as it ensures rapid response to avert serious pest damage through timely interventions.

Wilting and Dying of *Eucalyptus Dunnii* in Mbalachanda, Mzimba

Davie Moyo & Michael Likoswe

In Malawi out of 23, 577 km^2 forest cover, 22, 857 km^2 is Miombo woodlands and 820 km^2 is plantation forest (GoM, 2018). All pointers show declining forest and tree cover globally due to a numerous factors. Considerable effort is therefore needed to increase the productivity of the existing forests and to afforest suitable areas. Despite many determinants, insect pests and diseases constitute major biological determinants of forest productivity, particularly in forest plantations. Pests and disease, therefore, are potentially capable of offsetting the efforts to increase wood production to meet the growing needs of the increasing population. In Malawi, there have been several recent epidemics of exotic pests that include Bronze bug (2008), Gall wasp (2013) and Red gum lerp psyllid (2015), which have damaged forest plantations and caused severe economic losses to farmers and the nation at large. Pests prevalence are expected to increase with climate change and hence pest monitoring need to be considered as one of core activity under sustainable forest management. It is therefore important that tree farmers, plantation owners and government are able to detect and control such pests early enough.

Forestry Research Institute of Malawi (FRIM) through Pyxus Malawi learnt that some of *Eucalyptus dunnii* trees species were wilting and dying in Mbalachanda in Mzimba. FRIM organized a trip to visit the tree stand of 10 hectares, growing on an elevation of 1142m planted in 2020.

The specific objectives of the trip were to: assess severity levels of the insect pests; collect samples for pest identification; and propose control and management approaches for the pest.

The methodology used was physical visitation to appreciate the gravity of the problem. The area was surveyed to establish the extent and distribution of the infestation. Live and dead wood samples of infected trees were collected for further laboratory analysis. The wood samples were further processed right in the field (to 30cm length) for laboratory incubation. After two weeks the incubated wood pieces were checked for possible presence of adult insects and were subsequently split to check the presence of any biological stages of insect pest.

Results: Adult insect

After a period of two weeks an adult insect emerged from the 30 cm piece of wood and it was identified as Eucalyptus long horned borer *Phoracantha semipunctata* (Figure 1). *P. semipunctata* is a serious borer pest of Eucalyptus species. In their native Australia, they are considered minor pests attacking damaged, stressed or newly felled trees but they have become established in many temperate and tropical regions worldwide where they have been known to kill even healthy trees. Female beetles are attracted to stressed trees or freshly cut wood where they lay eggs in groups under loose bark. Adults are approximately 14-30 mm long and have shiny, dark brown and yellow to cream-colored areas on their wing covers. Antennae are as long as or longer than the body and the antennae of males have prominent spines (Fig 1).

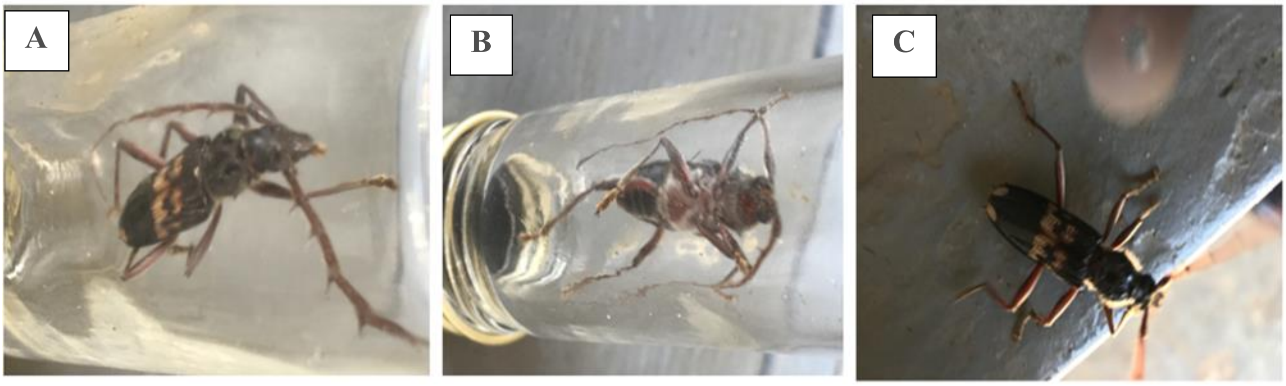

Figure 1: A male adult *P. semipunctata* in a collecting bottle (A&B) extracted from an infected *E.dunnii* piece of wood. (Pic: Davie Moyo)

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Larvae stage

The larvae (Figure 2) tunnel under the bark and into the cambium layer and effectively ring bark the host trees. The larval feeding can rapidly kill the trees or cause significant damage to the timber of affected trees. Mature larvae are cream-colored, legless and may be more than an inch in length. Eggs are ovoid and pale yellow in color.

Figure 2: White grub, a larvae of *P. semipunctata* on a split piece of *E.dunnii* (Pic: Davie Moyo)

Symptoms and Damage

Presence of holes in the bark, stains or oozing liquid on limbs or trunks are common symptoms of long-horned borer attack. Tree girdling often resulting in a thin canopy with wilted or dry leaves and cracked bark (Figure 3) packed with frass (insect excreta and chewed wood particles). Infested trees are often killed in a matter of a few weeks and re-sprouting may occur from the tree base.

Figure 3: A cracked *E. dunnii* bark (A) and a standing dead tree (B) (Pic: Davie Moyo)

Discussion

P. semipunctata is one example of **s**tem and bark boring insects that attack living trees and often kill their host, but mostly attack weakened trees. They feed on the outer surface of the bark and tunnel into the inner bark penetrating into the sapwood and heartwood. The severity and incidence of attack by *P. semipunctata* on *E. dunnii* at Mbalachanda was high and localized. The spread of the infection was from one tree to another depending on proximity. This is not the first time that FRIM has reported the incidence of this pest in Malawi because it was also recorded in the past.

Recommendations

Control methods for *P. semipunctata* are based on good cultural practices and biological control. Such practices involve reducing tree stress through timely silvicultural practices such as weeding, irrigation and protection against injury, planting resistant or tolerant eucalypt species and avoiding activities that disrupt biological control. Cut and split wood in infested sites to hasten drying of wood as moist wood is most suitable for ovipositing. Remove bark from felled logs or wood and place them in sunny environments to prevent resident *P. semipunctata* from emerging and spreading to standing host trees nearby. Infested Eucalyptus trees, branches and wood should be treated or destroyed by burying or burning. Biological control with natural enemies such as parasitic wasps is possibly the best solution of controlling long horned borer populations. There is a need to establish permanent sample plots for monitoring pests to ease pest detection and identification at an early stage.

Identification of the mating systems of *Adansonia digitata* L. (baobab) in Malawi

Herbert Jenya

Mating systems in plants directly influence patterns of pollen movement between individuals, and has a major effect on the genetic composition of the progeny produced (Fuchs and Hamrick 2010). The main functions of mating system on plants are gene flow, genetic structuring of populations and potential evolution of plant population (Ge *et al*. 2003). Plant breeding systems may be obligate selfing, obligate out-crossing or facultative, with various levels of self-incompatibility. Theoretically, species will be predominately out-crossing or selfing to avoid inbreeding and out breeding depression, respectively (Rymer *et al*. 2002).

African baobabs (*Adansonia digitata* L.) are hermaphrodite trees (Baum 1995). Several hermaphroditic plants are known to produce plentiful flowers but the fruit set is said to be poor (Stephenson 1981). Low fruit set is attributed to sparse distribution in the population (Årgren 1996) and pollen limitation (Burd *et al.* 2009) during fertilization. In baobab, reports indicate that about 50 % of adult trees hardly produced any fruit despite apparent normal flowering (Venter and Witkowski 2011). Flowers of baobab have large diameter that can reach up to 20 cm (Orwa *et al*. 2009). The flowers are white in colour, pendulous with stigma, anthers and nectar spatially separated in the same flower. Anthesis usually occurs in the evening, with 10 – 15 flowers per tree opening synchronously each night. This takes place rapidly when the calyx, which completely encloses the flower bud, splits open and flexes back. Flowers abscise within 24 hours (Baum 1995). Stigma receptivity commences at the time of anthesis and remains receptive until morning (Baum 1995) which means that the flowers have a 24 hour life and a functional pollination life of 16–20 hours (Wickens and Lowe 2008).

Pollination in baobab flowers is known to be by fruit-bat (Baum 1995). However, Venter (2012) explained that pollination by fruit-bat has not been observed in southern Africa and that field observations suggest that insects (Hymenoptera species) may be playing an important role as pollinators in this area. It is further suggested that baobab flowers may not be adapted to insect pollination and therefore many trees may be receiving a large amount of self pollen or pollen from closely related trees. The facts brought forward by Venter (2012) restrain generalization of the mating system of baobab in its entire geographical distribution (Munthali 2012) before a thorough study is done. However, controlled hand pollination experiments on *Adansonia gregorii* (one of the eight members in the genus *Adansonia*) showed that it is self-incompatible (Baum 1995) which may also apply to *A. digitata*. In Malawi, a study by Munthali (2012), observed that autogamy led to fruit development which aborted within the first month showing strong self-incompatibility. Aguilar *et al*. (2006) and Lobo *et al*. (2013) have reported that trees of the Bombacoideae subfamily, where the African baobab belong, are predominantly self-incompatible and thus depend on pollinators to reproduce sexually. Trees in this subfamily (Bombacoideae) are said to be mainly pollinated by bats but can have alternative pollinators (Baum 1995; Fleming *et al*. 2009).

Studies on the mating system of baobab in Malawi are scanty. Therefore, in this study focus was on the mating systems of *A. digitata* in Karonga District and the study addressed specific issues regarding mating.

Materials and methods

The study site was in Karonga District. The site has mean annual maximum temperature ranging from 28° C to 30° C with mean annual minimum temperature of 22° C to 25° C and mean annual rainfall ranging from 500 mm to 1200 mm. The climate is Tropical and has a wet and dry season. The wet season starts in November and ends in April or May while dry season occurs from May to October with occasional rains during the month of June in some parts of the District. The lake shore plain zone where baobab thrives covers an area from the lake at an altitude of between 500 m to 600 m above sea level. Baobab mostly exists in depositional sites comprising of alluvial soils, often calcimorphic (Hardcastle 1978). The lakeshore plain is largely cultivated with isolated trees and small patches or relict woodland of baobab and palm (*Hyphanene ventricosa)* being dominant vegetation (Hardcastle 1978).

Five trees were randomly selected at a minimum distance of 50 m to 100 m. Treatments were: (i) Selfing and apomixes: where six green buds per tree irrespective of size were covered by cotton cloth to deter any pollination agents (insects, bats and wind); (ii) Wind pollination: where six green buds were covered with green mosquito net to inhibit access by insects, bats and other animals; (iii) Insect pollination: where six green buds were covered with a chicken wire to deter bats and other mammals; and (iv) Natural pollination: labels were tied to six buds per tree to act as a control. In one baobab tree, 24 buds were selected and a total of 120 buds were used for the whole experiment from five baobab trees.

Flowering process and fruit development were observed and recorded initially every month up to fruiting stage using a scale of 0 to 8 as described by Ngulube *et al*. (1998) and Munthali (2012). Where, (0) represents small buds, inflorescence sepals closed (bud stage closed); (1) Large buds, inflorescence sepals cracked (opening); (2) Sepals and petals fully open; (3) Inflorescence petals, anthers, stigma, turned brown; (4) Inflorescence petals, anthers, stigma wilting; (5) Inflorescence petals, anthers, stigma fallen off; (6) Bud fallen before sepals open; (7) Fruit forming; and (8) Fruit aborted. Floral activities were observed using a Bushnell wildlife camera with night vision on a flower bud which was about to start anthesis from 25-11-2016 (15:35:01) to 26-11-2016 (07:52:15) for the period of about 17 hours.

Data were subjected to descriptive analysis using MINITAB 16.0 statistical package.

.....Results of the study to be presented in the next issue

Our Mission

To conduct operational forestry research to generate usable technologies and provide information for sustainable management,

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