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AN ECONOMIC INVESTIGATION OF THE EFFECTS OF FIRE THREATS ON COMMERCIAL FORESTRY IN ZIMBABWE: THE CASE OF BORDER TIMBERS LIMITED'S CHARTER ESTATE COMPANY IN 2008 - 2009

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ABSTRACT

This research project was undertaken to examine the economic effect of fires to commercial exotic forestry in Zimbabwe. Charter Estate of Border Timbers Limited (BTL) was used as a case study, and the area of its plantations damaged by fire between 2008 and 2009 were established together with the cost implications of each of these threats. Secondary data from BTL records and primary data gathered through structured questionnaires and informal interviews were used to determine the relative significance of each of the fires. The results indicate that forest fires were responsible for the largest damage and loss arising from natural factors and their main cause was illegal settlers occupying the estate's plantations, honey harvesting, cigarette butts discarded, and sawmill ash and undetermined causes. Thirty six fires were experienced in these two years. They amounted to a total of over 4232 ha of trees destroyed and a total of over $ 50,326,428 in income lost. The 1-10 year old trees that were damaged caused an income loss of $14,499,804. The 11 – 20 year old trees damaged amounted to $2,352,324, and 21-30 years old trees saw an income loss of $23,474,300 in the two years under study. The cost of labour and equipment to fight these fires cost Charter Estate a total of $65430. Ninety seven per cent of the fires were caused by illegal settlers in the Estate during the harvesting of honey or discarded still smoldering cigarette butts.

INTRODUCTION

Of the 39 million hectares of forest that constitute Zimbabwe, 108 214 ha are under commercial forest plantations which are mainly found in the Eastern Highlands (Mushongahande, 2007). The Eastern Highlands area is suitable for tree growing because it receives a higher rainfall and has a cooler climate. Border Timbers Limited (BTL), Wattle Company and the Forestry Company of Zimbabwe (FCZ) capitalised on these favourable characteristics of the Eastern Highlands and located their forest plantations in that area. Charter Estate of BTL is in Chimanimani District approximately 150km south of the city of Mutare in Manical and Province of Zimbabwe. Falling under farming zone one, Chimanimani receives an average annual rainfall of about 1500mm. The rains are usually orographic owing to the natural barrier between Zimbabwe and Mozambique represented by the Chimanimani Mountains. Pine trees which make up the larger percentage of exotic tree plantations in Zimbabwe and at BTL, usually do not sprout after any serious assault. Instead they die.

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Furthermore trees, particularly pines and gums trees (Eucalyptus), take long to mature (20 to 30 years) and their establishment is so capital intensive that nothing but their full value should accrue to the forestry company when they, or their products, are sold.

Forest resources (both exotic and indigenous) cover sixty-six per cent of Zimbabwe's total land area and they contribute significantly to the economy, accounting for on average three per cent of gross domestic product (GDP) ((Mabugu and Chitiga 2002;.Nkomo, and Sassi, 2009). Forests are such a valuable natural resource that earns the country huge incomes if they are used sustainably. Trees are planted to: hold the soil firmly thus reducing erosion; for providing a suitable habitat for various organisms in the ecosystem, for beautifying an area and sequestrating carbon dioxide emitted into the atmosphere (Chang 1994). Nkomo *et al.* (2009), characterized the exotic forestry industry in Zimbabwe as oligopolistic since there are only three main companies involved. Border Timbers Limited (BTL), a subsidiary of Anglo-American Corporation is one of them. Other significant players on Zimbabwe's forestry scene are the Forestry Company of Zimbabwe (FCZ) and the Wattle Company.

Border Timbers Limited owns and manages five plantations namely Sawerombi, Imbeza, Tilbury, Sheba and Charter. With 48 000 ha of land under its control BTL devoted 28 000 ha to plantations in 2009 while the remaining 20 000 ha was for open area management (which includes conservation, heritage sites, roads and access routes, rivers and streams). Softwood production covers eighty two per cent (82%) of plant able area at BTL. The pine species grown are *Pinus patula, Pinus ellioti, Pinus taeda* and *Pinus kesiya*. The gum species grown are *Eucalyptus grand*is and *Eucalyptus cloziana*, both of which are grown on a sawlog and pole rotation, and occupy the balance of plant able area. Saw logs harvesting takes place on a rotational period of twenty two years for pine and twenty years for eucalyptus. Eucalyptus pole rotation ranges from three to fifteen years (www.bordertimbers/forestry.html,).

Like any business, forestry has its inherent threats. Fires, droughts, pests and diseases, baboons and cyclones/storms are regarded as natural threats to sustainable tree growing (Mushongahande 2007). Border Timbers Limited states categorically in its website (www.bordertimbers.com /forestry.html) that fire constitutes the major threat to the company's plantations. On the same website the company claims that baboon damage has been on the increase in the past fifteen years. High tree mortality and significantly reduced log recoveries per hectare are the chief undesirable effects of both these threats.

Exotic timber plantations in Zimbabwe, were established to increase the commercial timber resource base (Chamshama and Nwonwu, 2004). Increasing industrial activity and population in the then Rhodesia in the 1930s stimulated greater demand for timber and timber products that the indigenous forests could not satisfy. The excess demand triggered research on fast-growing exotic tree species for plantation development (Shumba 2001). This spurt of research culminated in the establishment of a series of forest research stations in the eastern part of the country and the sourcing, evaluation and subsequent improvement of pine and eucalyptus germplasm for production under Zimbabwean climatic and edaphic conditions. Out of all these efforts a vibrant exotic timber plantation industry which produces for both the domestic and export market came into being (Mushongahande 2007). Since then significant exotic plantation forests have been established in the country with *Pinus patula*, Eucalyptus species(particularly *E grandis*) and *Acacia mernsi* as the most common species (FAO, 2000). Zimbabwe's sawmills and wood and pulp industries depend on these exotic timber plantations for logs (Chamshama *et al* 2004). The major product from exotic forestry plantations is industrial roundwood. About seventy percent are managed for sawlogs, fourteen percent for pulpwood, seven percent for woodboard raw material and nine percent for poles (AFDB, EC and FAO, 2003).

Mabugu *et al*. (2002) reported that commercial forestry, both from exotic plantations and indigenous timber, accounted for three percent of Zimbabwe's Gross Domestic Product (GDP). This implies that for every $100 the Zimbabwean aggregate economy generates in output, the forestry sub-sector contributes $3.00. The formal forestry sector in Zimbabwe employed a total of 14 253 people between 2004 and 2005 (Mushongahande 2007). Labour is to commercial forestry just one of the three determinants of output: the others are technology and capital (Dornbusch 2001). Processing of trees, is carried out to add value to the timber product, and to this end many sawmills of varying sizes have been established in Southern Africa (Britton 2006). Forest products that result from forestry are, pine needles for landscaping, while pine bark is used as a medium in growing tree and crop seedlings in nurseries. Wood-based chemicals are extracted to be used in laundry detergents, toothpaste, adhesives, animal feed pellets, artificial vanilla, synthetic plastic, rayon fibre, printing ink and among others.

The economic value of forestry is normally undermined by natural disasters like, fires, baboons, pests and diseases and droughts or cyclons. The occurrence of any of these disasters could result in huge economic loses to the forest companies and to a country like Zimbabwe as a whole. Very little has been done to examine the natural threat profile of exotic tree plantations in the Eastern Highlands of Zimbabwe where the majority of the country's exotic forests are located. So intense was the problem of tree losses that in March 2006 the Timber Producers Federation (TPF) predicted that the forestry companies would continue to face shortages of mature trees for logging.

The Media had earlier on in 2008, written that two fires had destroyed 930 ha at two of BTL's plantations four years before. Any factor that damages trees is detrimental to the forestry companies because it reduces the revenue receivable from forestry products such as logs and timber. To arrest the problem of plantation damage due to natural threats or factors, it is imperative to construct a body of accurate knowledge that will be used to devise effective forestry protection programmes. This study looks at only the effects of one major threat – fire. It being the main threat in Zimbabwe's forestry and specifically at the BTL's Charter Estate areas under the pine and eucalyptus plantations only.

MATERIALS AND METHODS

Primary data was collected from a survey on a randomly selected sample. The sample contained one hundred employees (100), and it was selected by first selecting randomly, 25 workers from each of existing divisions of BTL Charter namely: the silvicultural; planning; harvesting and loss control. This involved stratifying the workers into the different tasks performed and then conducting a systematic random sampling exercise from each of the four strata that represented the workers. The entire sampling method thus fitted the designation stratified simple random sampling. This method was suitable since there was marked heterogeneity. Each selected respondent was then interviewed using structured questionnaires. Data was also collected from key informants, mainly the company's management through the use of a separate open questionnaire. Secondary data was also collected from BTL records which complimented the raw data from the survey. Data collected was then analyzed to provide inferences. Microsoft Excel was the mainly used data analysis tool.

RESULTS AND DISCUSSION

Five pine species are were found to be grown at Charter with *Pinus patula* being the major one, grown on 2000 ha, followed by *P taeda* (2200 ha), *P ellioti* ((2000 ha), *P kesiya* (1500 ha) and lastly *P oocarpa* (500 ha).

Effects of fire on the trees grown

Table 1 shows that during January to June in the two years under study (2008- 2009) no fires took place because these are the rainy seasons during the time when the undergrowth is green and does not burn easily. All forest fires in the study period occurred between July and December. This period is characteristically dry and very little or no rain is received up to mid-October with the result that the undergrowth in the tree plantations dries up and becomes highly flammable. Thus fires start easily and spread rapidly especially under the windy conditions in August. The second half of the year has been aptly dubbed the 'fire season' by planners at Charter. Hence 26 and 12 fires occurred during this period in the year 2008 and 2009 respectively. The area destroyed and the financial loss are shown in Table 1. The Table also reveals the cost of the tree loss.

The two-year period covered by this study registered a total of 38 fires but the year 2008 saw a greater number of fires at Charter than the year 2009. In 2008 two major fires caused extensive damage to trees at Charter. The first one occurred in September and affected 1 026 ha of pine plantation worth USD 7 371 081.60. Then in October of the same year, an even more destructive fire occurred affecting 3 008 ha of plantation valued at USD 18 360 000.00. These two fires accounted for 97.73% of the area affected by fires and 94.25% of the financial worth of the area destroyed by fire in 2008.

Table 2 on the other hand shows the number of employees engaged in fighting these fires and the monetary cost that was incurred by the company on the labour engaged in firefighting. In 2008 alone, Charter Estate incurred an incredible sum of money ($65,431) from employing labour to fight the high number of fires (26) and larger sizes fires that occurred then. This is against a backdrop of only 12 smaller fires that occurred in 2009 that resulted in only $544 as the cost of labour that was employed to fight the fires.

However, a small part of the financial losses was recovered by the recovery scheme operated by the Company where mildly burnt trees were felled and taken to the sawmill. At the sawmill the recovered logs were continuously watered in a process called wet milling prior to sawing. This made the burnt logs softer and easier to work on later in the processing chain. This process saw seventy percent (70%) of the value affected by fire recovered in 2008 where the burnt recovered logs were processed into other tree products. The recovery rate for 2009 was slightly lower than that for 2008 since the plantation compartments affected in 2009 were generally younger than those affected in 2008. The recovery rate was 65% in 2009 since most of the relatively young affected trees were burnt beyond the wet milling-redeemable extent.

The effect of fires on the age of the trees

The ages of the trees that were affected by fires can reliably be taken to fit into three distinct categories. The 1 to 10 years age group consisted largely of trees that are too young for harvesting and processing. Some trees in this age group can be felled for milling in a process termed thinning which is meant to reduce competition for light and nutrients in the plantation. But after a fire assault some burnt trees with ages up to ten years can be recovered.

Table 1. Number of fires, area damaged and costs incurred at Charter Estate between 2008 and 2009

	January to June, 2008	July to December, 2008	January to June, 2009	July to December, 2009
Total number of fires	0	26	0	12
Total forest area affected (ha)	0	4 127.44	0	5.51
Financial worth of plantation area affected (USD)	0	27 300 300.00	0	36 128.25

Table 2. Labour employed to fight fires and their coast at Charters Estate

	January to June 2008	July to December 2008	January to June 2009	July to December 2009
Supervisory labour used to control/fight fires	0	38	0	35
Total supervisory labour costs incurred in fire fighting (USD)	0	13 376.08	0	419.60
Number of general workers who participated in fire fighting	0	386	0	237
Total labour costs for general workers involved in fire fighting (USD)	0	65 306.75	0	124.47

Table 3. The area financial value s of plantation damaged by fire at Charter Estate between 2008 and 2009

	Age of trees affected by fire (years)	1-10	11-20	21-30
Year 2008	Affected area (ha)	540	460	3 127.44
	Value of affected area (USD)	1 498 500	2 346 000	23 455 800
Year 2009	Affected area (ha)	0.47	1.24	3.80
	Value of affected area (USD)	1 304.25	6 324	28 500

At the Estate a mean value of USD 2 775 was attached to each hectare of trees in the 1-10 age group. A hectare of pine trees in the 11-20 year age had an approximate mean worth of USD 5 100 whilst for trees in the 21-30 year interval (mature trees) the value per hectare was USD 7 500. Table 2 below shows the areas affected by fire and their values in 2008 and 2009. The areas and cost of trees affected by fire are shown in Table 3 below.

Causes of Fire at Charter Estate

The study found out that in 2008, fires were caused by a number of factors. Illegal settlers appeared to be responsible for the largest fire damage that befell the Estate both in terms of cost and area destroyed. Discarded cigarette butts; honey harvesting; electric faults and saw mill discarded ash were found to be the causes of fire destruction in the Estate.

Illegal settlers, in Zimbabwe, are all those people who unlawfully established settlements on properties and/or premises they are not entitled to occupy. The fast track land reform programme in Zimbabwe set in motion a wave of farm and estate invasions that Charter Estate was not spared from. These settlers chose the most fertile portions of the estate they could find, cleared land for cultivation and built shelters right in the middle of pine plantations.

They start forest fires when they burn stalks and crop debris from the previous season without taking proper precautionary measures to ensure that the fire does not spread to the neighbouring plantations. This resulted in the most damage affecting the largest area of plantation (97.82% of the total) and a total of 4027 ha from 4 major fires in 2008 alone. Discarded cigarettes butts, were also found to cause serious fires at this plantation and also in others as found by Nkomo and Sassi (2009). In this Estate it is estimated that this cause destroyed 5 ha from 3 smaller fires in 2008. Since in many plantations eucalyptus and pine plantations are used for honey farming, some parts of Charter Estate (mostly those that are adjacent to communities) are used for this purpose.

Since practically all of the honey farmers operating in the estate's territory do so in a non-commercial way, they do not use any chemical substances to make the bees unconscious during harvesting but instead burn a mixture of collected bunches of green and dry grass and tree leaves to smoke the bees during honey harvesting. The harvesting is often done at night and the smoking bunches are sometimes carelessly dropped in the plantation once the honey has been collected. If the undergrowth in the plantation is dry, a small breeze certainly kindles a fire that destroys trees. This problem affected 30% of the area under plantation. This problem caused 8 small fires and destroyed 17 ha of trees in 2008. Sawmill boiler ashes were found to be another causes of forest fires here. The fires resulted from the incomplete combustion of wood used to heat water at the saw mill. Since the ashes when removed from the kiln contain small glowing pieces of wood and get deposited close to dry grass at the edge of a plantation, any mild wind caused the wood in the ashes to ignite and cause a fire in the neighbouring plantation. This caused a damage of 2.5 ha from one single small fire. Coupled with the sawmill ash fires, an electric fault was also found to cause one small fire in 2008 from lightning during storms. However in 2008 unknown causes of 6 fires also occurred. These caused the second biggest destruction in 2008 of 56 ha of planted trees. The percentage causes of fire in the Charter Estate in 2008 is shown by Figure 1 below.

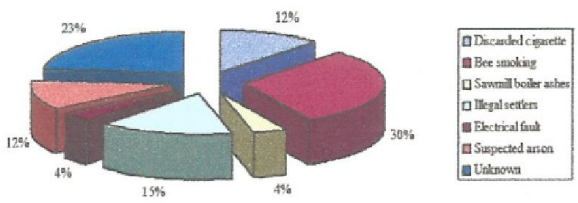
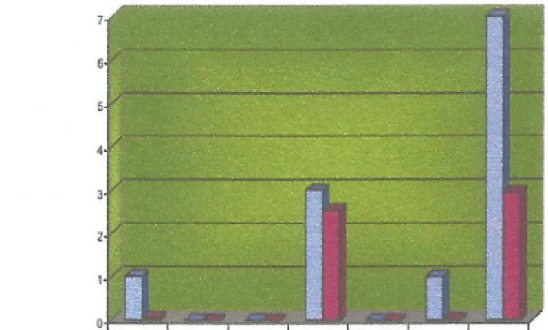


Figure 1. Percentage area of trees destroyed by fire in 2008

The year 2009 had a markedly lower fire incidence than 2008 at Charter, as sawmill boiler ashes, bee smoking and electrical faults resulted in no forest fires at all. Unknown causes climbed ahead of illegal settlers to result in the largest number of fires and the largest area affected. Moreover illegal settlers caused three fires in 2009 whose aggregate area affected was only 2.51 ha as the District Administrator and police evicted some of the illegal settlers from the areas where they could potentially start devastating fires. Intensive fire awareness campaigns to educate those who remained was done that helped. Moreover the estate intensified its fire alertness so that it could quickly deal with any fire in its nascent stage. The 3 fires caused by illegal settlers were subdued before they had done much damage because in each case fire tenders and the skidder were used in fire fighting from the outset unlike in the previous year where they were used only after finding that

other means had failed. Figure 2 shows the number of fires and area affected by each of the causes in 2009.



	Discarded cigarette	Bee smoking	Sawmill boiler ashes	Illegal settlers	Electrical fault	Suspected arson	Unknown
Number of fires	1	0	0	3	0	1	7
Area affected (ha)	0.04	0	0	2.51	0	0.02	2.94

Fig. 2. Causes of fire at BTL Charter Estate in 2009

direction of spread of the fire as well as its magnitude, if possible. The Silvicultural Forester informed the researchers that all fires that occurred at the estate between 2008 and 2009 were detected by fire tower workers. To retard the spread of fires between compartments, fireguards were used. These are five-metre wide strips of land at the margins of the compartments in which no trees are planted and the grass is removed. Fire fighting at the estate used much capital equipment. The firefighting equipment during the period under study and their costs are shown in Table 4. The capital stock used for firefighting during the study period was worth a total of USD 260, 320. This was equivalent in value to 34.709 ha of mature pine trees. The use of machinery in fire fighting exercises gives rise to economic costs**.**

Economic costs of extinguishing fire

Economic costs are incurred on labour and capital goods. The total economic cost is the sum of labour costs and equipment

Table 4. The equipment used to fight fires at Charter and their coast in 2008 and 2009

Name of equipment or machinery	Number or units	Value of each unit (USD)
Fire tenders	3	40 000
Skidders	1	130 000
Tractor-drawn tanks	3	950
Fire beaters	336	15
Hoes	60	12
Rake hoes	30	15
Knapsacks	28	45

Table 5. The economic coast incurred in fire extinguishing fires at Charter Estate in 2008 and 2009

	2008	2009
Labour costs	USD 78 682.83	USD 544.07
Equipment costs	USD 7 237	USD 1 419.22
Total economic costs	USD 86 009.83	USD 1 963.29
Average economic costs per ha	USD 20.84	USD 356.31

Control of forest fires at Charter Estate

Fire control at the estate encompasses prevention, early detection and extinguishing. Three fire towers each equipped with radio communication are located on the peaks of mountains from where virtually all compartments of the estate's plantations can be seen. Designated workers whose task was to constantly scan the pine plantations and areas within their vicinity for any signs of fire were on duty at the towers 24 hours a day during the period under study. Upon detecting a fire or imminent fire in the plantation, they immediately sent a message to the estate headquarters specifying the compartment(s) already affected and the

costs as shown in the equation below. The average economic cost of fighting fire on 1 ha of plantation was higher in 2009 than in 2008 because much of the fire fighting machinery including fire tenders was used in the early stages of the fires, which resulted in a lower area being affected but the equipment and labour costs per unit area were high. Table 5 below shows the breakdown of the economic costs incurred in extinguishing fire during the study period.

Conclusion

Fires started by illegal settlers were responsible for the largest losses incurred by the Estate in 2008 and 2009, implying that the haphazard manner in which land reform was conducted

impacted negatively on the forestry sub-sector. The other causes of forest fire were sawmill boiler ashes, bee smoking, electrical faults, discarded cigarettes, suspected arson and unknown causes. Fire alone cause a destruction of over 4127 ha of forestry in 2008 alone and 6 ha in 2009 at the cost of $225?ha on average that includes the cost of damage to trees and the firefighting cost.

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