# SILVICULTURE MODERNIZATION IN THE SOUTH AFRICAN FORESTRY INDUSTRY

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Silviculture in the South African forestry industry has in the past been characterized by manually intensive operations. Studies have shown that many of these operations are ergonomically inferior and pose unacceptably high safety risks. Additional factors have resulted in reduced manual labour availability and productivity. These include rural to urban migration of labour, increased social welfare payments by government, the low social status of manual labour, the improved secondary school education system, increased absenteeism and turnover, and the effects of HIV and AIDS. Studies have been commissioned at both industry level and within companies to try and address the identified problems.
Modernization should also ensure that the quality of silvicultural activities is not compromised, and that the new or modified activity contributes to improved value chain efficiencies. The modernization focus was placed on residue management, site preparation, establishment, coppice management, weed control and fire protection activities. The specific activities that posed a high ergonomic or safety risk were identified in each of these silvicultural categories. Where existing science and technology was missing for specific activities, or not entirely suitable, the industry partnered with suppliers to develop novel and innovative solutions. Current results show that silvicultural operations in South Africa can be modernized to supply decent work to labour. The industry is currently in an implementation phase whereby high risk operations are being modernized using appropriate technologies.

*Keywords*: Silviculture, modernization, South Africa, ergonomics, safety.
*Parole chiave*: Selvicoltura, modernizzazione, Sud Africa, ergonomia, sicurezza.

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## 1. Introduction and background

Silviculture in the South African forestry industry has in the past been characterized by manually intensive operations. Studies have shown that many of these operations are ergonomically inferior and pose unacceptably high safety risks (Scott *et al.*, 2004). Additional factors have resulted in reduced manual labour availability and productivity. These include rural to urban migration of labour, increased social welfare payments by government, the low social status of manual labour, the improved secondary school education system, increased absenteeism and turnover, and the effects of HIV and AIDS. Studies have been commissioned at both industry level and within companies to try and address the identified problems. These studies mostly conclude that a modernization of silvicultural operations is necessary in order to make the existing labour safer, more productive and not suffer from poor health.
The objective of this paper is to document the silvicultural modernization process followed in South Africa. It is a common perception that South Africa has an oversupply of labour. This perception comes from the unemployment figure of 25.4 per cent (fourth quarter 2014) and an average unemployment figure for the period 2000 to 2014 of 25.27 per cent (Statistics South Africa, 2014).
However, research done by Steenkamp (2008) revealed productivity decreases and difficulty to source suitable labour for tedious hard forestry work like manual pitting, fertilizing, hoeing and planting. The difficulty of finding suitable labour for these forestry activities that are considered to be of low social status was aggravated by the average incidence of HIV measured at forestry contractors to be 43 per cent in 2005 (Steenkamp, 2008).
The result of this under supply of labour was an increased cost to labour due to scarcity, aggravated by increased labour absenteeism and turnover. The increased market cost was superseded by a sectoral wage determination for forestry. Steenkamp (2008) predicted that the conversion point from labour to capital would be reached in the near future and it materialized since 2012, when the first timber grower company embarked on a modernization strategy to do silviculture forestry activities.
Ergonomics and safety were also cited as major drivers

for modernization. The ageing population of forestry workers and employment competition from especially the mining sector were also cited as drivers of modernization (Da Costa, personal communication, 2014). As can be viewed in Figure 1, in South Africa there is also a trend that labour is migrating from rural to urban areas to look for decent job opportunities and the prospects of better social circumstances (United Nations Department of Economic and Social Affairs, 2014). A significant increase in social welfare payments, especially in rural areas, has also eroded the number of people actively looking for employment. The number of people receiving a government grant at 31 August 2014 numbered 16 368 403. (South African Social Security Agency, 2014).

The result of the socio-economic environmental changes, the difficulty to source suitable labour for silviculture activities and the expectations from labour unions prompted modernization, and grower companies had to revise their strategies to remain competitive in international markets for timber derived product (Godsmark, personal communication, 2014). To enable grower companies to stay competitive on world markets, it was critical to research what equipment was available and how the process of modernization should be conducted in South Africa to ascertain economic sustainability. The cost of labour versus the cost of the employment of capital is critical in the decision making process of modernization. Increased capital investment causes higher fixed costs for a business and this implies higher financial risk (Brink, personal communication, 2014). Brink (personal communication, 2014) and Da Costa (personal communication, 2014) emphasize the importance of training of users and operators of equipment to ensure the safe, appropriate and productive use of modern equipment and systems to optimize financial viability and reach the goals of modernization.

## 2. The drivers of silviculture modernization

Even though there are many drivers of silvicultural modernization, only the main drivers are discussed. These are health and safety; social status and education; migration patterns in the South African labour market; HIV and AIDS, productivity, labour turnover and absenteeism; and sectoral wage determination, labour legislation and social grants.

### *2.1 Health and safety*

According to Scott (2009), from an ergonomic point of view, it is not good for the human muscle-skeletal system to do hard work where bending of the back is required. Many activities, such as pitting and planting, require bending over to an extent. These activities also require substantial energy, with Scott *et al.* (2004) indicating that many labourers do not have an adequate nutritional intake for the activity performed. Linked to nutrition, Steenkamp (2008) found that nutrient supplementation improved the productivity of such activities.

The safety of workers is of paramount importance and injuries and fatalities are viewed in a very serious light and as unacceptable. Although the effect of HIV and AIDS on safety was not studied in particular, it is assumed, especially combined with malnutrition that the risk of injury is increased. The number of people employed correlates to the risk attached to the operation. Modernization of silviculture activities reduces the number of people in-field and hence the probability of injury.

### *2.2 Social status (esteem) and education*

Social status is a very important contributing factor to the un-willingness of people to be involved in the strenuous silviculture activities (Steenkamp, 2008). Job level and type of job (activity) is narrowly linked to social status and the empowerment of the person. People with a Grade 12 qualification are in most instances not prepared to do hard manual labour, but would seek employment in lower level management jobs and will migrate from rural areas to urban areas in the hope to be employed in a position with higher social status.

### *2.3 Migration patterns in the South African labour market*

According to the United Nations Department of Economic and Social Affairs (2014), the rate of urbanization is increasing. This increase in urbanization is caused by the perception of employment seekers that they will find employment in urban areas and in the mining sector (Da Costa, personal communication, 2014).

### *2.4 HIV and AIDS, productivity, labour turnover and absenteeism*

Steenkamp (2008) correlated HIV and AIDS narrowly with reduced productivity, increased labour turnover and increased absenteeism. The combined effect of these factors leads to decreased safety, increased labour scarcity and increased costs. Improved nutrition was offered as a mitigant, but a more important mitigant that was suggested was an increased level of the employment of capital.

### *2.5 Sectoral wage determination, labour legislation and social grants*

Due to the high levels of unemployment the South African Government established social grants to alleviate poverty and improve the social circumstances of disadvantaged people. The number of grants paid during August 2014 numbered 16 386 403 (South African Social Security Agency, 2014). Some people that are discouraged are not looking actively for employment. It is deducted that these people are satisfied with receiving a grant. People not looking for work are excluded from the unemployment figures.

The minimum forestry wage was R1,428.70 per month during 2012 and increased to R2,229.32 per month in 2013 and to R2,420.41 per month in 2014 (Godsmark, personal communication, 2014a). The current proposal

by Government is a national minimum wage of approximately R5,400 per month (Godsmark, personal communication, 2014b). Forestry South Africa stated in a communique to members that it is expected that such an increase in wages will further increase the differential cost between labour and capital and will hence accelerate the employment of capital (Godsmark, personal communication, 2014b).

## 3. Silviculture modernization and equipment

Modernization should also ensure that the quality of silvicultural activities is not compromised, and that the new or modified activity contributes to improved value chain efficiencies. Due to high unemployment in South Africa, modernization does not necessarily refer to mechanisation, although mechanisation was not excluded as an option. The specific activities that posed a high ergonomic or safety risk were identified in each of these silvicultural categories. As a result, the modernization focus was placed on residue management, site preparation, establishment, coppice management, weed control and fire protection activities. An international benchmarking of plantation silviculture operations, and agricultural operations, took place to identify existing and/or innovative science and technology that could be used within the industry to mitigate the identified high risk activities. Where existing science and technology was missing for specific activities, or not entirely suitable, the industry partnered with suppliers to develop novel and innovative solutions. Much of the information sourced for this article is derived from personal communication with those experts currently involved in the modernization processes in various companies. Little published information is currently available.

This drive to increase silviculture modernization and mechanization has resulted in existing techniques (both national and international) and new innovative techniques for operations being identified, tested and implemented. Examples of these are discussed below.

### *3.1 Fire management*

Modern methods to employ for fire management include discing with an agriculture tractor where site conditions allow. This makes combustible materials mix with soil and hence reduces combustible fuel load. Another method is sweeping away of combustible materials with skid-steer attachments to create temporary fire belts, mainly in emergency situations. Stump cutting attachments allow for access to compartments. A further development is extreme off-road carriers for firefighting purposes on steep terrain. (Da Costa, personal communication, 2014).

### *3.2 De-stumping*

De-stumping is required for access to compartments. This process is enhanced if mulching is used, as the fuel load is modified to a less combustible composition and stumps are cut to be level with the ground, allowing access to vehicles and equipment for silviculture and protection operations. The current experience is that mulching is costly due to the very high energy input required. The cost is aggravated when the soil contains rock and damages the mulching tips (Da Costa, personal communication, 2014). Mulchers require highly skilled operators to be productive with high utilization and cost effectiveness.

According to McMaster (personal communication, 2014), it is preferred to cut *Eucalyptus* stumps below ground level to reduce their coppicing ability. A stump cutter that cuts stumps of up to 600mm in diameter is currently being tested. From observing the activity, the process seems to be slow and it may take up to one minute to cut a single stump. The slow functioning of the stump cutter results in high costs for stump cutting. A Marshall Tree Saw is being employed by a grower company and test results are promising for cutting stumps at ground level or just below ground level (Da Costa, personal communication, 2014).

### *3.3 Pitting and planting*

Various pitting equipment was tested from 2010 onwards. The equipment varied from chainsaw engine driven augers to compact excavator based rotating pitting heads. The motor-manual machines like the small engine driven hand held augers, seen in Figure 2, and tractor driven, person controlled machines, still pose significant safety risk, even if improvements are made, such as the ergonomic improvements to the hand held auger shown in Figure 3. There is also little or no control regarding the quality of pits and the number of pits completed per time period.

The compact excavator based units, shown in Figure 4, are fitted with a Process Logic Control computer system. The system counts completed pits (350mm diameter and 350mm deep), records the entire shift performance and GPS position of every pit. This information is sent automatically via e-mail to designated e-mail addresses at pre-set intervals. The recording of the management information serves as a management control over the activity and it enables the compiling of three dimensional maps of the completed area. (Steenkamp, personal communication, 2014). The consistent quality of the pits is viewed as an advantage to achieve more uniform stands and earlier canopy closure. The compact excavator pits are suitable for semi-mechanized planting as opposed to the motor-manual pits that are invariably not suitable for semi-mechanized planting due to variations in pit size, as there is no control over the quality of the planting pit (Viero, personal communication, 2014).

Semi-mechanized planting equipment comprises a trailer drawn by an agriculture tractor. The typical configuration on a planting trailer includes two water or hydro-gel tanks with pneumatic activation, feeding a boom carrying up to six manual or pneumatically operated planting tubes. The person at each planting tube is responsible for spading the planting tube into the prepared pit, putting the seedling into the tube and activating the water or gel depositing. The depth of planting cannot be controlled well and hence seedlings of 350mm long are recommended for planting when

using a semi-mechanized planting unit (Viero, personal communication, 2014).

*3.4 Fertilizer application*

It is common practice in South Africa to fertilize *Eucalyptus* at the time of planting or within a few weeks after planting. Fertilizing is a labour intensive practice, but important for yield enhancement, and therefore it is important to execute the activity with precision. The pre-modernization process entailed the use of a stick to prod a hole on opposite sides of the seedling, approximately 150mm from the seedling, and to fill these holes with a specific quantity of fertilizer by cutting a tin or plastic container to the size for the required amount of fertilizer. The changes through the process of modernization were to a back-pack, carried by a person, but with a depositor with a scissors action to discharge a fixed quantity of fertilizer. The back pack applicators lack the ability to discharge the desired quantity of fertilizer and also can result in the operators not being accurate in the application of fertilizer.

The result of this is a loss in growth and yield. The latest trend is to combine fertilizer with the pitting process, but then planting needs to be within a very short time period after pitting to ensure good utilization of the fertilizer.

According to Viero (personal communication, 2014) the ideal is to fertilize the seedlings after their roots have colonized the soil around the seedling. At any earlier stage, a significant quantity of the fertilizer cannot be utilized by the seedling as the root distribution is limited.

## 4. Conclusion

Current results show that silvicultural operations in South Africa can be modernized to supply decent work to labour.

The industry is currently in an implementation phase whereby high risk operations are being modernized using appropriate technologies. Coupled with the implementation process are the requirements of continual training, multi-skilling of operators, the improvement of supervisors, and a continual focus on new practices to promote the well-being and productivity of silvicultural labour and operators.

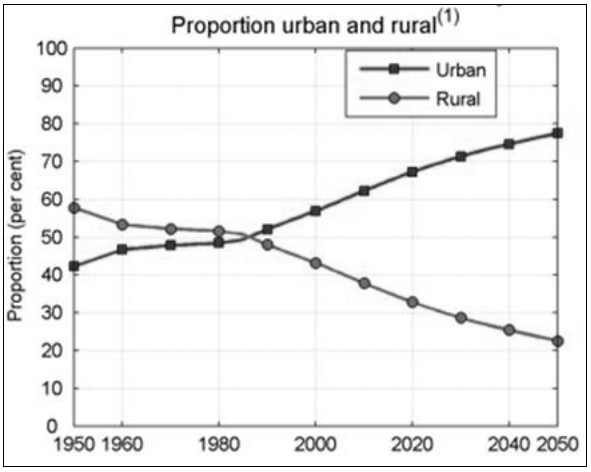


Figure 1. Urbanisation in South Africa (United Nations Department of Economic and Social Affairs, 2014).

Figure 2. Hand held motorised auger.

Figure 3. Hand held motorised auger with improved ergonomic design.

Figure 4. Modern mechanised pitting with mini excavator.

## RIASSUNTO

**Modernizzazione della selvicoltura nell'industria forestale sudafricana**

La selvicoltura nel settore forestale sudafricano è stata caratterizzata in passato da operazioni svolte con un alta incidenza del lavoro manuale.
Diversi studi hanno dimostrato che molte di queste operazioni sono ergonomicamente insostenibili e comportano ad inaccettabili alti rischi per la sicurezza. Altri fattori hanno portato a una ridotta disponibilità e produttività del lavoro manuale. Tra questi si possono indicare i flussi demografici della forza lavoro dalle aree rurali a quelle urbane, l'aumento dei contributi sociali da parte del governo, il basso status sociale del lavoro manuale, il miglioramento del sistema di istruzione della scuola secondaria, il maggiore assenteismo e il turnover, e gli effetti di HIV e AIDS.
Studi sono stati commissionati, sia a livello di settore industriale, sia all'interno delle imprese per cercare di identificare e affrontare i problemi correlati al lavoro manuale. La modernizzazione, oltre a risolvere i problemi della forza lavoro, dovrebbe anche assicurare che la qualità delle attività selvicolturali non sia compromessa, e che le nuove o modificate attività contribuiscano a una migliore efficienza della filiera forestale. La modernizzazione in sud africa si è concentrata sulla gestione dei residui di utilizzazione, sulla preparazione del terreno e l'impianto, sulla gestione del ceduo, il controllo delle infestanti e l'attività di prevenzione e protezione contro gli incendi. Le attività specifiche che comportano un alto rischio ergonomico e di sicurezza sono state individuate in ciascuna di queste categorie selvicolturali.
Dove la scienza e la tecnologia esistente non dava risposte o non era del tutto idonea allo svolgimento di attività specifiche, l'industria ha collaborato con gli operatori per sviluppare soluzioni originali e innovative. I risultati attuali mostrano che le operazioni selvicolturali in Sudafrica possono essere modernizzate consentendo condizioni di lavoro dignitoso.
L'industria forestale è attualmente in una fase di applicazione dei processi di modernizzazione per mezzo dei quali le operazioni ad alto rischio sono in corso di modernizzazione con tecnologie appropriate.

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