Eucalyptus Hybrid Clones in East Africa

Meeting the Demand for Wood through Clonal Forestry Technology

Occasional Paper No.1
Foreword

This Paper argues that clonal forestry technology offers a sustainable and environmentally sound approach to meeting the growing demand for fuel-wood and other wood products for home, industry and construction in East Africa. Over the past 10 years, Kilimo Trust and Gatsby Charitable Foundation (UK) have invested US$3.6 million in the Tree Biotechnology Programme (TBP) to bring the benefits of clonal forest technology to smallholder farmers and small and medium scale commercial tree planters in Kenya, Tanzania, and Uganda. This flagship programme has supported not only the introduction of Eucalyptus hybrid clone planting material and techniques to the region but also the development of private, smallholder tree nurseries to produce and market the plantlets. Some 21 million Eucalyptus plantlets have been planted to date with an estimated market value of US$300 million. Over 80 nursery businesses have been established and they have supplied planting material to about 20,000 growers across the region.

To achieve this, a comprehensive programme of adaptive research was undertaken to assess the most suitable Eucalyptus hybrid clones to grow in the different agro-climate zones across East Africa. This was led by the three national forestry research institutes – Kenya Forestry Research Institute (KEFRI), Tanzania Forestry Research Institute (TAFORI), and Uganda’s National Forestry Resources Research Institute (NaFORRI) – with technical support from Mondi Forests Ltd and the Council for Scientific and Industrial Research (CSIR) of South Africa.

This Paper describes the challenges facing the forest industry in East Africa, the increasing demand for wood and wood products, the decline in the region’s natural forests and woodlands, and discusses the environmental concerns about Eucalyptus planting. It is based on papers published in 2010 in the Journal of East African Natural Resources Management Vol 3 No1.

We believe that the TBP has made an important contribution to the potential for improving the prosperity of smallholder farmers, contributing to national economies, and sustaining productive ecosystem services across East Africa.
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Disclaimer

The content of this publication does not reflect the views of Gatsby Charitable Foundation, Kilimo Trust, and Uganda Gatsby Trust. Any error in presentation and misinterpretation of the data and scientific information presented are the responsibilities of the authors of the Tree Biotechnology Project Evaluation Report, Tree Value Chain Study Report, and the scientific papers published in the Journal of East African Natural Resources Management whose materials have been used to prepare this Occasional Paper with minimum change of content.

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1 East Africa’s challenge

East Africa’s population continues to grow and so too does the demand for fuel-wood and wood products for construction and fencing. Natural forests and woodlands across the region cannot keep pace with demand and the resulting deforestation is degrading the environment. Agriculture too is expanding into natural woodlands and forests.

Wood is an essential and vital part of the lives of most people in East Africa. Poor rural and urban communities, in particular, rely wholly on wood for energy and for construction. In 2007 the demand for wood in Kenya, Tanzania, and Uganda was over 94 million cubic metres. About 90% of this was fuel-wood for cooking and heating and this represents more than 90% of the countries’ energy requirements.

Increasing populations and economic growth has meant that in many areas the demand for wood is beginning to outstrip the supply. Indigenous trees are slow-growing and cannot keep up with demand and estimates suggest that the region as a whole will become a net importer of fuel-wood in the 2020s. National governments are most concerned about the decline in natural forest resources and the need to increase wood production. But they are equally concerned about the potential impact on the environment of growing more wood, particularly with the dark cloud of climate change on the horizon.

Policy-makers across the region are increasingly accepting that future increases in demand for wood and wood products will need to be met from planted forests rather than natural woodlands and that the private sector, both smallholder farmers and industrial plantation companies, have a major role to play in this. But commercial growers want returns on their investment and this means high quality planting materials with desired properties such as fast growth and resistance to pests and diseases. The key question – how can this be achieved?

One promising option is to grow Eucalyptus hybrids using clonal forestry technology. Eucalyptus is not new to East Africa. It has been grown extensively in Kenya, Uganda, and Tanzania for decades, particularly by smallholder farmers, and is proven to be one of the best tropical tree species for bio-energy production. It is hybrid clonal technology that can add a new dimension to Eucalyptus production. This is a natural plant breeding process that enables genetic material to be moved or exchanged between plants to achieve some desired characteristics. It is widely used in plant breeding programmes to produce plant varieties with intended features such as increased yield, productivity and resistance to pests, diseases, and environmental stress.

Box 1: About hybrid clones

Clones are genetically identical plants which are not reproduced from seed but by some other means such as rooted cuttings or tissue culture. Hybrid clones are plants which combine the desirable properties from several different plants and are produced through natural tree breeding programmes. For Eucalyptus, hybrid clones bring together such properties as fast and uniform growth, high productivity, small crowns, resistance to pests and diseases, and straight stems which lead to a good quality, highly marketable product.

Hybrid cloning is not genetic modification (GM) which is the direct human manipulation of genetic material in a way that does not occur under natural conditions.

Hybrid clonal technology can radically change the way in which Eucalyptus plants are selected and grown and it offers a means of producing planting materials with highly desirable growth characteristics that result in superior timber with high calorific value (Figure 1).

Over the past 10 years, Kilimo Trust and Gatsby Charitable Foundation (UK) have invested US$3.6 million in the Tree Biotechnology Programme (TBP) to bring the benefits of Eucalyptus hybrid clonal technology to smallholder farmers and small and medium scale tree planters in Kenya, Tanzania, and Uganda.
This flagship programme also recognized the importance of the tree value chain as the means of successfully introducing this technology on a commercial basis to smallholder farmers. So in addition to introducing the hybrid clonal technology, over 80 commercial nursery businesses were established to produce and market the clonal planting materials. To date some 21 million trees with an estimated value of US$300 million have been supplied to about 20,000 growers across the region.

The TBP has demonstrated that Eucalyptus hybrid clones offer a commercially viable product that can make a substantial contribution to the prosperity of smallholder farmers and to national economies. But Eucalyptus planting is not without its critics. There are concerns that widespread planting of Eucalyptus can damage the natural environment and seriously impact eco-system services.

This Paper describes the work of the TBP and presents the case for growing Eucalyptus hybrid clones in East Africa. It also addresses the criticisms and concerns that people have about widespread Eucalyptus planting in the natural environment.

Figure 1  Eucalyptus plantlets and a stand of eucalyptus being screened for site suitability
2 A growing demand for wood

The demand for wood and wood products in East Africa is strong and shows no sign of diminishing (Table 1).

Table 1 Forest products forecast demand in East Africa in m³ (2015-2020)

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Population (Million People)</td>
<td>46.2</td>
<td>51.7</td>
<td>40.0</td>
<td>46.7</td>
<td>49</td>
<td>54.5</td>
</tr>
<tr>
<td>Firewood (000 m³)</td>
<td>23,380</td>
<td>26,180</td>
<td>20,160</td>
<td>23,520</td>
<td>24,780</td>
<td>27,580</td>
</tr>
<tr>
<td>Charcoal (000 m³)</td>
<td>14,280</td>
<td>15,960</td>
<td>11,760</td>
<td>14,280</td>
<td>15,120</td>
<td>16,800</td>
</tr>
<tr>
<td>Construction poles (000 m³)</td>
<td>1,896</td>
<td>2,146</td>
<td>1,641</td>
<td>1,938</td>
<td>2,010</td>
<td>2,262</td>
</tr>
<tr>
<td>Transmission poles (000 m³)</td>
<td>438</td>
<td>590</td>
<td>379</td>
<td>532</td>
<td>464</td>
<td>622</td>
</tr>
<tr>
<td>Sawn Softwood (000 m³)</td>
<td>408</td>
<td>491</td>
<td>333</td>
<td>443</td>
<td>432</td>
<td>517</td>
</tr>
<tr>
<td>Sawn Hardwood (000 m³)</td>
<td>39.0</td>
<td>47.0</td>
<td>33.8</td>
<td>42.5</td>
<td>41.4</td>
<td>49.5</td>
</tr>
<tr>
<td>Plywood (000 m³)</td>
<td>75.0</td>
<td>91.0</td>
<td>64.9</td>
<td>82.2</td>
<td>79.5</td>
<td>95.9</td>
</tr>
<tr>
<td>Fibre board (000 m³)</td>
<td>17.0</td>
<td>21.0</td>
<td>14.7</td>
<td>19.0</td>
<td>18.0</td>
<td>22.1</td>
</tr>
<tr>
<td>Particle board (000 m³)</td>
<td>17.0</td>
<td>21.0</td>
<td>14.7</td>
<td>19.0</td>
<td>18.0</td>
<td>22.1</td>
</tr>
<tr>
<td>Paper and paper board (000 m³)</td>
<td>219.7</td>
<td>273.9</td>
<td>190.2</td>
<td>247.4</td>
<td>233.0</td>
<td>288.7</td>
</tr>
<tr>
<td>Total (000 m³)</td>
<td>40,769</td>
<td>45,820</td>
<td>34,612</td>
<td>41,125</td>
<td>43,198</td>
<td>48,260</td>
</tr>
</tbody>
</table>

Source: Computed by Author based on Kenya data (Mbugua, 2002 and UN Data, 2008) and extrapolated to Tanzania and Uganda

Energy is by far the largest consumer of wood in the form of firewood and charcoal. Woody biomass provides more than 90% of the region’s energy needs. In Kenya charcoal use is increasing because there is a lack of affordable alternative energy sources for domestic and industrial use (Figure 2). Consumers also prefer charcoal made from hardwood and this is partly responsible for the rapid depletion of forests and woodlands. In 2004, Kenya used 2.5 million MT of charcoal valued at US$400 million. Given that it can take up to 10 MT of freshly cut wood to produce 1-2 MT of charcoal, some 12-25 million MT of wood is needed to meet the market demands – in volume terms this is about 27 million m³ (FAO, 2001). In Box 2, a case study of Olerai charcoal market is presented.

Tanzania also relies heavily on charcoal for cooking and heating. Fuel-wood (firewood and charcoal) consumption in 2002 was 46 million m³. Almost half of this was used to produce charcoal worth US$4.8 million – the equivalent of 624,000 ha of woodland.

In Uganda, fuel-wood use in 2005/06 was about 38 million m³ and valued at US$19.3 million (Nalwadda, 2008). At the present rate of wood consumption it is predicted that Uganda will become an importer of fuel-wood by 2020.
Box 2: Charcoal production threatens the natural environment in Olerai, Kenya

Olerai is the main charcoal supply centre for markets in Nairobi, Mombasa, Tanzania, and countries in the Middle East such as Yemen and Qatar. Kenya alone consumes 4,000-7,000 MT of charcoal each day. Hundreds of charcoal bags are brought daily from the heartland of Narok, Mau forest, and Mara to this trading centre and transported to outside markets.

According to the Kenya Forest Service, annual charcoal business at Olerai is worth US$ 33-46 million which is equivalent to Kenya’s tourism earnings in the first nine months in 2008. Traders buy one bag of charcoal for US$6 in Olerai and sell it for US$17 in Nairobi. Charcoal trading is good business and Olerai charcoal commands about three times the price of charcoal made from other sources (Opala, 2008). But the forests surrounding Olerai cannot sustain this level of production and the environmental damage is significant. Charcoal supplies from managed on-farm trees and plantations would help to sustain a more favourable environment in Olerai.

Sawn timber (Figure 3) is one of the most commonly traded forest products in East Africa. In Uganda, demand outstrips supply due to the rapid growth in the construction industry. The deficit is met from timber that enters the market illegally from Sudan and the Democratic Republic of Congo. In Kenya, in addition to the demand for construction, over 770,000m³ of the timber is used for furniture making. It is similarly used in Uganda and Tanzania but data on the volumes used are not readily available.
The market for transmission poles from the power and telecommunications sector is also strong. In Kenya about 212,000 semi-processed poles are required each year with a value of US$2.5 million. Uganda cannot meet its demand from locally grown trees and so poles are imported from Tanzania and South Africa.
3  East Africa’s forests

National forests and woodlands currently supply all the wood and wood product needs in the region, they make significant contributions to national economies, and they are also important to sustaining a favourable natural environment. In Kenya, for example, more than 300,000 people are employed directly and indirectly in forestry, and forest cover provides an estimated US$32 million/ha in benefits to water catchments. Forests also have the capacity to absorb large amounts of atmospheric carbon. In spite of this, forests across the region are in decline and are poorly funded. In 2009 the sector was allocated less than 1% of national budgets.

Forest cover varies considerably across the region (Table 2). In Kenya, forest cover is only 6% of the total land area, which is well below the global average (21.4%) and the average for Africa (9.3%). The government is putting measures in place to significantly increase the forest area such as promoting farm forestry and the intensification of dry land forest management, and encouraging community participation in forest management and conservation.

<table>
<thead>
<tr>
<th>Country</th>
<th>Forest area (000 ha)</th>
<th>% of land area</th>
<th>Forest area/person (ha)</th>
<th>Rate of degradation (%)</th>
<th>Forest contribution to GDP (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kenya</td>
<td>3,467</td>
<td>6</td>
<td>0.1</td>
<td>-0.34</td>
<td></td>
</tr>
<tr>
<td>Uganda</td>
<td>2,988</td>
<td>15</td>
<td>0.1</td>
<td>-2.39</td>
<td>6.1</td>
</tr>
<tr>
<td>Tanzania</td>
<td>33,428</td>
<td>38</td>
<td>0.8</td>
<td>-1.10</td>
<td>13.3</td>
</tr>
<tr>
<td>Africa</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>9.3</td>
</tr>
<tr>
<td>The world</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>21.4</td>
</tr>
</tbody>
</table>

\textit{Source: Commonwealth Forestry Association (2010)}

In Uganda, forests and woodlands cover is a much greater percentage of land area. Over 70% of Uganda’s forests are privately owned while 15% are managed by National Forestry Authority as central forest reserves. The construction industry is growing annually at a rate of 10% and is expected to consume 32 million m$^3$ per annum by 2015. About 4% of this is expected to come from plantation forests.

In Tanzania, forests and woodlands cover a substantial part of the land area and employs over 1 million people in rural areas. Some 70% of the forest area is suitable for plantation development. About 80,000 ha of forest plantations are owned by the state while 70,000 ha are privately owned. Tanzania exports 10-15% of forest products, mainly as low-value round wood. In 2009 about 80% of this went to China. Tanzania’s forests are now declining at over 90,000 ha a year. By 2020 estimates suggest that this will result in a loss of water catchment functions equivalent to US$300 million.

Overall, it is clear that the demand for wood is presently met from local supplies but these are rapidly diminishing and in places where they are already degrading the natural environment. This situation will only worsen as the demand for wood grows if action is not taken to produce more wood and to bring supply and demand into a more sustainable balance.
4  Eucalyptus in East Africa

Eucalyptus is not new to East Africa. It is a multipurpose fast-growing tree that has adapted well in the tropics and can provide wood for energy and construction within 6-10 years. It is a popular tree and is easy to grow. It has over 600 different species and is found in a wide variety of ecological zones. Although a native of Australia, Eucalyptus is now widely and successfully planted in India, South Africa, Zimbabwe, Kenya, Uganda, and Tanzania. Historical records show that Eucalyptus was established in Kenya in the 19th century to supply wood for the Kenya-Uganda railway. In 1996 about 17,000 ha of government forests and 9,000 ha of private forest plantations of Eucalyptus were established in Kenya.

Eucalyptus has more uses than is often perceived by tree growers. In South Africa, Eucalyptus is grown for industrial purposes to provide wood chip for export to Japan for paper manufacture. On farms and in plantations across eastern and southern Africa, Eucalyptus is grown for firewood, poles (for building, construction and fencing), timber, and charcoal. A study in Uganda showed that Eucalyptus was used to support climbing beans with as many as 50,000 Eucalyptus bean stakes being grown per hectare.

Many different species are grown but East Africa’s plantations are dominated by Eucalyptus grandis, which is suited to cooler and wetter areas, and Eucalyptus camaldulensis, which grows well in hotter and drier climates (Figure 4). But it is of concern that few growers pay attention to these particular species preferences. The result is that Eucalyptus is often grown in inappropriate agro-climatic conditions and this impacts not only on yield and quality, it also contributes to the negative perceptions about the tree’s suitability for some locations.

Many efforts have been made over the years to improve Eucalyptus wood quality. About 52 Eucalyptus varieties were tested in Uganda but only a few were selected for forest plantation development. Eucalyptus grandis and Eucalyptus saligna were planted in southern Uganda and Eucalyptus camaldulensis and Eucalyptus tereticornis were planted in the relatively drier eastern and northern regions. In Tanzania, Eucalyptus was assessed for growing transmission and building poles.

4.1  Environmental concerns

Of all the trees species planted in the tropics, Eucalyptus has by far attracted the most criticism and a great deal of negative publicity. Some suggest that Eucalyptus removes too much water from the soil and streams, inhibits the growth of other vegetation, and its leaf litter has adverse effects on soil humus. Tree growers argue that some of these arguments are based more on popular perception than on rigorous scientific evidence. So what are these criticisms and are they justified? What does the science say? Like most aspects of life, there is no simple answer.
4.1.1 Using too much water?

All trees consume water as they grow but the criticism that Eucalyptus uses excessive amounts of water causes the most concern because of its potential to reduce water resources in regions that are already water-short. Indeed in some areas, Eucalyptus plantings have been cut down in the hope of improving stream flows. But stripping out vegetation may not be the answer. On steep slopes it can lead to serious soil erosion, landslides and increased flooding downstream.

The reputation for high water use appears to come from the fact that Eucalyptus is often planted in wet and water-logged areas to dry them out. An example is the planting of *Eucalyptus robusta* to help drain wetlands in Uganda. But whatever the source of the criticism, the amount of water used to grow Eucalyptus will depend on the variety, the climate (rainfall and solar radiation), soil type and depth, vegetative cover, tree growth stage, wood density, and tree rooting depth.

Fast growing trees consume more water than slow growing trees. But like all other plants Eucalyptus will also adjust the amount of water it consumes in line with the water available. When the soil is wet and the water table is near the surface then the trees will take more water. When the soil dries the trees take less water. Clay soils retain more moisture and so trees in clays may use more water than those grown on sandy soils. Organic matter can also improve water retention. Clearly this is a complex picture from which it is difficult to generalize about just how much water is being used. Each catchment has its own unique physical and agro-climatic characteristics and so rather than making sweeping generalizations it is important to judge each separately on its own merits. In Box 3, a case study of Eucalyptus controversy in Kenya is presented.

Box 3: Eucalyptus controversy in Kenya – but what are the alternatives?

In 2003 the Kenyan government promoted the planting of Eucalyptus hybrid clones to help alleviate the shortage of fuel-wood and wood for construction, relieve pressure on natural forests and woodlands, and also generate alternative income for smallholder farmers. Farmers were told that improved Eucalyptus hybrid clones had superior qualities such as fast and uniform growth, straight stems, and high quality wood that does not split during sawing. They could also harvest fuel-wood within two years.

However, following the production of a video documentary by World Agroforestry Centre (ICRAF) in August 2006 titled “Thirsty trees: A search for Better Alternatives”, Prof. Wangari Mathai, – the Nobel Peace Prize winner and renowned Kenyan environment advocate – called for a total ban of Eucalyptus planting because it was perceived to be using too much water. In response to this the Kenyan Government ordered Eucalyptus trees to be uprooted from wetlands and banned tree planting along river banks and in watersheds for fear they will dry up the streams and rivers. This has become a major bottleneck to investment in Eucalyptus plantation forests in Kenya.

But the reality is that Kenya has a growing fuel-wood and timber shortage as natural forests are in decline and cannot be replaced fast enough to meet the demand. Tree growers argue that Eucalyptus is still a good tree to plant but they know it is essential to do this in a responsible manner that carefully matches appropriate varieties and planting densities to suitable sites and agro-climatic conditions.

The public and decision-makers may be uncomfortable about planting Eucalyptus but without viable alternatives they may have little choice but to strike a balance between the environment and the need for more wood.

What is often not well understood is that although Eucalyptus may consume more water than other trees over a given time period, they grow much faster and convert water into wood more efficiently than other species. One well quoted research report (Davidson, 1989) showed that for the same amount of water, *Eucalyptus saligna* and *Eucalyptus grandis* could produce 46 m³ of wood/ha/year whereas conifers only produced 16.4 m³ of wood/ha/year.
Most Eucalyptus species need on average 785 litres of water per kilogram biomass produced. This is in contrast to other crops which use much greater amounts of water to produce the same biomass. Cotton, coffee, and bananas for example, require 3,200 litres per kilogram of biomass and maize which requires 1000 liters per kilogram (Davidson, 1989). The point to consider here is that if Eucalyptus is removed from a catchment, unless the ground is left bare which is not a good idea in the tropics, it will need to be replaced by some other ground cover crop which will also need water – even pasture for grazing will require substantial quantities of water. So it is the net saving that would need to be considered and not just the amount that is taken by the Eucalyptus. When water is scarce, reducing planting densities would be one way of controlling excess water uptake.

Some Eucalyptus species such as *Eucalyptus camaldulensis* and *Eucalyptus tereticornis*, are well adapted to grow in relatively dry conditions. Unlike many other tree species which fail to survive when there is a drought, Eucalyptus can survive by closing its stomata and shedding leaves which reduces the amount of water it uses. Drought tolerant varieties of Eucalyptus are also capable of developing deep root systems to access underground water that may not be available to other tree species. Indeed, in relatively dry areas, where annual rainfall is less than 800 mm, there is evidence that plantations of *Eucalyptus camaldulensis* and *Eucalyptus tereticornis* do not use any more water than indigenous trees in adjacent natural forests. These unique characteristics make Eucalyptus a robust tree that can adapt to a variety of soil moisture conditions and intuitively cope with the effects of a changing climate.

So the answer to the question – does Eucalyptus use more water than other tree species? – is yes and no. Yes, in some circumstances, Eucalyptus uses more water than other tree species but it also produces more wood. Eucalyptus is probably the most efficient tree species available for converting water into wood. Evidence in dry conditions suggests that Eucalyptus uses no more water than other tree species. In wet swampy conditions, it can use more water, but in such situations water use may not be such a critical environmental issue – it all depends on the location.

### 4.1.2 Controlling soil erosion

Effective soil erosion control requires good ground cover vegetation and litter. Although some Eucalyptus varieties can add to the problems of controlling soil erosion, others can help to reduce the problem. *Eucalyptus pellita, Eucalyptus urophylla, Eucalyptus grandis, Eucalyptus citriodora* and *Eucalyptus tereticornis* have crowns that spread horizontally and cast dense shades that hinder the growth of ground vegetation. But *Eucalyptus camaldulensis* has a less dense canopy which allows in light so that groundcover vegetation can grow. It is one of the few Eucalyptus species that can benefit agroforestry and soil erosion control.

### 4.1.3 Supporting wildlife

Eucalyptus planting does not have a good reputation as a wildlife habitat. The small, hard fruits and tiny seeds from Eucalyptus are poor food for birds and the leaves are unpalatable to most animals. But in their defence, they do produce lots of flowers that are rich sources of nectar and pollen that attract many insects, including honey bees. Eucalyptus trees also shed stringy bark which provides nesting materials for birds. Leaf litter also breaks down rapidly under Eucalyptus which assists nutrient cycling, despite it being an exotic tree.

### 4.2 Balancing the arguments

Whatever the arguments for and against Eucalyptus planting, in the absence of other viable fuel-wood sources, it is argued that there is a need to strike a balance between these environmental concerns and the growing need for more wood and wood products.

A sensible, evidence-based approach is needed which recognizes that Eucalyptus impacts and responses can be very different at different sites and that they are complex and not always well understood. In such
circumstances broad generalizations do not help either the case for or against them. Rather each case needs to be fully assessed on its own merits. Some facts are presented in Box 4.

When Eucalyptus planting is properly planned and managed in catchments suited to growing tree crops, it can make a most positive contribution to sustainable and productive ecosystem services across East Africa. Forests already play, and will continue to play, an invaluable role in protecting water catchments, and the rivers and lakes which supply municipalities and industry with water.

Box 4: Some facts about Eucalyptus and water

There is no ‘one variety fits all’. Each catchment has its own unique physical and agro-climatic characteristics which require careful matching with appropriate Eucalyptus varieties.

Eucalyptus is an efficient consumer of water. It produces more wood per cubic meter of water used than any other tree species.

In dry areas some Eucalyptus varieties do not use any more water than indigenous species.

All catchments in the tropics need ground cover, such as grass, crops, and trees, to avoid erosion problems. But they all use a lot of water. So replacing Eucalyptus with other crops does not necessarily save much water.
5 The Tree Biotechnology Programme

The main objective of the Tree Biotechnology Programme (TBP), which began in 1997, was to transfer Eucalyptus hybrid clones, suitable for a range of wood products and for planting by smallholder farmers, from Mondi Forests Ltd, in South Africa, to East Africa.

Hybrid clonal technology, using conventional plant breeding methods, is a means of bringing together the desirable characteristics of different varieties and multiplying the planting material to produce reliable, consistent, and commercially viable trees (Figure 5). The aim is to produce trees that grow faster and have more desirable characteristics than ordinary Eucalyptus land races (locally grown trees) found on most farms in East Africa.

Figure 5 A stand of Eucalyptus (left) and straight nature of the stem (right)

Mondi Forests Ltd scientists visited East Africa to familiarise themselves with the different agro-climatic zones across the region and to learn more about the local plantation forestry industry (Figure 6). They selected suitable hybrids for cloning by cross-breeding local East African Eucalyptus varieties. This produced three main hybrid clone groups. GC clones (grandis-camaldulensis) are products of cross breeding between Eucalyptus grandis and Eucalyptus camaldulensis; GU clones (grandis-uroplylla) are cross breeds of Eucalyptus grandis and Eucalyptus uroplylla; and GT clones (grandis-tereticornis) are cross breeds of Eucalyptus grandis and Eucalyptus tereticornis.

Figure 6 Scientists from Mondi Forests Ltd, Kilimo Trust, and the TBP visiting a Eucalyptus hybrid clone trial plot
Cuttings of superior quality where then transferred and screened for their suitability in specially designed long-term research trials set up across the region in different agro-ecological zones by the East African national forestry research institutes – Kenya Forestry Research Institute (KEFRI), Tanzania Forestry Research Institute (TAFORI) and Uganda’s National Forestry Resources Research Institute (NaFORRI). Over a period of 10 years, the trees were monitored for growth performance and appropriateness for planting by farmers in specific agro-ecological zones. Large-scale multiplication of the hybrid clones is now in progress in central tree nurseries by the national forestry research institutes, and plantlets distributed and propagated by local commercial nurseries for sale to farmers.

5.1 Producing plantlets

TBP followed a standard procedure for producing the hybrid clones. First the hybrid clones were imported from Mondi Forests Ltd as rooted cuttings obtained from 5-year old ‘mother’ plants and then planted in ‘mother’ gardens or nurseries (Figure 7). These cuttings became parent plants from which further cuttings were prepared. The leaves of these cuttings were trimmed and dipped in rooting hormones to stimulate and speed up root development. A mixture of river sand and clay sub-soil in different proportions was used to assess root formation in the cuttings.

Mist propagation technology is often used to propagate planting material but it can be very expensive and there were concerns that nursery operators in Kenya, Tanzania, and Uganda would not adopt it because of the requirements for electricity and a piped water supply. The alternative was a ‘non-mist’ propagator which comprises a simple dome-shaped tunnel made of local plant materials and covered with a polythene sheet so that rainwater could easily run off (Figure 8). This type of propagator is commonly used in the tea industry but had not been used before for Eucalyptus propagation.

The non-mist propagation system eliminates the need for electricity and a piped water supply. The propagators were opened every two weeks for watering and for chemical spraying to control fungus. Using locally available construction materials coupled with quick-root formation in cuttings makes the non-mist propagator a cost effective and farmer-friendly method of producing plantlets. It is simple and cheap and is a most practical method especially in rural areas.

Once the roots have developed the hybrid clones are transferred to raised platforms and given more time to fully develop.
5.2 Matching tree varieties to sites

Tree breeders usually look for trees that are healthy, grow vigorously, are tall and have big stems and hence produce plenty of quality wood and wood products. Trees should also be capable of growing well in different locations (referred to as agro-ecological or agro-climatic zones). Such trees are said to be ‘stable’. Selecting appropriate trees depends on the way its growth is affected or influenced by environmental factors such as soils, climate (rainfall, temperature and humidity) and management practices such as weeding, protection from animal damage, fire and vandalism.

Selecting suitable trees for producing planting materials is usually based on the results of field trials. Trees which are locally grown are often referred to as ‘land races’. They may be introduced species that have become ‘local’ because they have been grown for a long time and adapted to local environmental conditions. Over time, cross-pollination and environmental conditions can modify the genetic and morphological characteristics of trees to the extent that they appear to be like indigenous species. Trees which are imported are referred to as ‘exotic’.

Selecting clones for forest plantation development presents a formidable challenge for tree breeders, usually because of the wide range of selection criteria. Selection would normally be based on any or a combination of height, diameter, volume of wood and/or survivability. But selection also needs to take into account that hybrid clones are bred from single trees and this makes them vulnerable to being wiped out by pest and disease attack. The standard practice therefore is to use planting materials from many different clones to minimize the risk of pest and disease damage – a technique referred to as ‘expanding the genetic base’.

Following visits by scientists from Mondi Forest Ltd, strategic trial sites, which also served as demonstration plots for the public to see the superior qualities of the Eucalyptus hybrid clones, were established in different agro-ecological zones across the region (Table 3 & 4).
Table 3 Hybrid clones introduced to East Africa from South Africa

<table>
<thead>
<tr>
<th>Country</th>
<th>Clones introduced from South Africa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kenya</td>
<td>15 Eucalyptus hybrids <em>E. grandis</em> x <em>E. camaldulensis</em> GCs – EGC3, GC10, GC12, GC14, GC15, GC167, GC522, GC581, GC584, GC642, GC785, GC796, GC514, GC784, GC540 (The last 3 GC are under material transfer agreement)</td>
</tr>
<tr>
<td></td>
<td>3 Eucalyptus hybrids <em>E. grandis</em> x <em>E. urophylla</em> abbrev. GUs – GU7, GU8, GU21 (Under material transfer agreement)</td>
</tr>
<tr>
<td></td>
<td>TAG5 (under material transfer agreement)</td>
</tr>
<tr>
<td>Tanzania</td>
<td>12 Eucalyptus hybrids <em>E. grandis</em> x <em>E. camaldulensis</em> GCs – GC10, GC14, GC15, GC167, GC522, GC581, GC584, GC514, GC746, GC786, GC940, GC962</td>
</tr>
<tr>
<td></td>
<td>3 Eucalyptus hybrids <em>E. grandis</em> x <em>E. urophylla</em> GUs – GU21, GU26, GU608</td>
</tr>
<tr>
<td></td>
<td>Eucalyptus hybrids <em>E. grandis</em> x <em>E. teretinornis</em> GT – GT529</td>
</tr>
<tr>
<td>Uganda</td>
<td>4 Eucalyptus hybrids <em>E. grandis</em> x <em>E. urophylla</em> GUs – (GU7, GU8, GU21, GU607 and GU609)</td>
</tr>
<tr>
<td></td>
<td>6 Eucalyptus hybrids <em>E. grandis</em> x <em>E. camaldulensis</em> GCs – (GC514, GC540, GC550, GC578, GC784 and GC796) and TAG5 which is pure grandis</td>
</tr>
</tbody>
</table>

Table 4 Research trial/demonstration sites for hybrid clones in East Africa

<table>
<thead>
<tr>
<th>Country</th>
<th>Demonstration sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kenya</td>
<td>Karura, Hombe, Embu, Machakos, Timborora, Gede, Msambweni, Sokoke, Marigat, Kabage</td>
</tr>
<tr>
<td></td>
<td>Highlands: Lushoto - Tanga, Mufindi - Iringa, Ikurot - Arusha</td>
</tr>
<tr>
<td></td>
<td>Lowlands: Mombro – Korogwe Tanga, Kwamarrukanga - Korogwe Tanga,</td>
</tr>
<tr>
<td></td>
<td>Coastal: Kibaha - Pwani, Chaani &amp; Kibele Forest - Zanzibar, Maswiangombe - Pemba</td>
</tr>
<tr>
<td></td>
<td>Semi arid: Kigwe-Dodoma, Kisangiro - Mwanga, Lubaga - Shinyanga</td>
</tr>
<tr>
<td></td>
<td>Miombo: Kingolwira - Morogoro, Tabora, Mangua Primary School near Peramiho - Songea</td>
</tr>
<tr>
<td></td>
<td>Lake zone: Kanyinya - Muleba</td>
</tr>
<tr>
<td>Tanzania</td>
<td>Abi, Apala, Akol, Ngeta, Serere, Katakwi, Mukongoro, Ikulwe, Kifin, Kigumba, Kyembogo, Sambabule, Bugongi, Katooma, Nyabushabi</td>
</tr>
</tbody>
</table>

These extensive trials have shown that hybrid clones generally perform well in the different agro-climatic zones of Kenya, Tanzania and Uganda. But the research has also shown that no one hybrid clone fits all situations. Some clones are better suited to different agro-climatic zones than others. The following taken from research reports demonstrate this point.

**In Kenya**

The trials at Embu, Karura, Machakos and Timborora to monitor the growth, height, and diameter of hybrid clones showed that GC hybrid clones performed well in the field. Their growth performance was similar and sometimes better than those planted using materials obtained from locally growing Eucalyptus (land races). GC hybrid clones also grew well along the Kenyan coast in Gede, Msambweni and Sokoke. However, trials of GU hybrids at Gede and Msambweni did not perform well.

In Machakos, Hombe, and Kabage local Eucalyptus performed better in height and diameter than hybrid clones. However, when hybrid clones were planted on fertile land, they grew faster in height and diameter. Hybrid clones planted on virgin forest land in Sokoke, on the Kenyan coast, grew rapidly in the first nine

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months and height and diameter exceeded those of hybrid clones planted on land that had grass fallows in Gede and Msambweni. But the Sokoke clones were choked by fast growing weeds and needed more regular weeding than those planted in Gede. This finding supports the argument that forest land, while it may initially support faster tree growth due to abundant nutrients released by humus, may not sustain productivity in the long-run when nutrients are depleted. Farmers use this argument to justify forest encroachment and deforestation when forest land is converted to farmland to grow agricultural crops. But they soon realise that the productivity of the land rapidly declines if nutrients are not replaced.

Although Eucalyptus hybrid clones thrive in rich and fertile soils, given the scarcity of fertile land for farming in East Africa, even if fertile forest land was available, it is unlikely that farmers would plant trees on it. An exception is in Uganda where degraded, but fertile forest land was allocated by the National Forestry Authority to individuals or organizations for tree planting. Growing agricultural crops on this land is forbidden.

**In Tanzania**
The trials in Kwamurukanga in the north-eastern lowlands, GC14, 581 and 940 grew much better than GC167, 584, 608 and 796. In Ilkurot in the northern dry highland, GC15, 514, 785, 940 and GT529 grew well.

In Sao Hill in the southern highlands, the presence of couch grass reduced the growth of hybrid clones. Couch grass is an aggressive weed with an extensive root system that smothers the growth of other plants and so must be kept under control. GC514 and 785 require weed free growth conditions. In the wet mountain zone of Lushoto, GC167, 581, 584 and 796 performed very well.

**In Uganda**
In general GC hybrid clones survived better than GU clones throughout the country. However, the exception was sites in the south and west. GU hybrid clones did not grow well in eastern and mid-northern regions because of the drier conditions.

Most hybrid clones were susceptible to drought and died in large numbers during prolonged drought of 2004. GU hybrids were unsuited to the eastern and northern regions because of their shallow roots that made them susceptible to water stress.

GC578 and 796 and GU7 and 8 grew straight stems suitable for the production of poles for building, fencing, and transmission. GC540, 550, 578 and GU7 and 8 had small branches and clean poles suitable for inter-planting with agricultural crops. Generally, GC hybrids grew taller in the east than in the north.

**In General**
Tree height and diameter are good indicators of wood volume. In the trials GC540, 550 and GU 21 yielded larger volumes of wood than the thin-straight stemmed GC578 and 579 and GU7 and 8. GC540 and 550 were capable of producing more than 0.5 cubic metres of wood per tree within four years.

**5.3 Insect pests and diseases**
Farmers who grow hybrid clones are often concerned about pest and disease problems because clones are much more susceptible to damage and crop loss than locally grown varieties. For this reason there was close monitoring of pest attack and disease occurrence during the field trials. In all field trials, the clones were observed for presence or absence of pests and diseases in the first six months and thereafter on an annual basis. The mother gardens (nurseries), cuttings, and seedlings were also monitored for any incidence of pest and disease.

**Pests**
In Kenya, the main reported insect pests were Blue gum chalcid (BGC), Eucalyptus snout beetles, Chrysomelid beetles, Eucalyptus psyllid, and termites. Some of these are shown in Figure 9.
Blue gum chalcid (Figure 9b) is a small wasp, originally from Australia, which is transmitted via rooted cuttings. It was first recorded in Kenya in 2002 on young Eucalyptus trees. The adults and nymphs (young ones) feed by sucking juices from Eucalyptus and cause leaves to distort and wilt, mostly at the tips, followed by leaf drop. When heavily infested, leaves and twigs die backwards from the tip and the growth of young plants is retarded due to loss of leaves. The nymphs hide under a white wax which they secrete. It forms a large bump-shaped swelling, known as gall, on leaf midribs, petioles (leaf stem), and the stems of young Eucalyptus.

Blue gum chalcid attacks were recorded in Embu and Machakos districts in Kenya on *Eucalyptus grandis* and *Eucalyptus tereticornis*. It was also reported as widespread in Uganda. The wasps can be controlled by biological means – when other insects eat the wasps – and by spraying with insecticides, although this is neither environmentally friendly nor economically viable. Imidachlorpid, Methomyl, Chloropyrifos and Fipronil are effective insecticides. When there is heavy infestation, it is recommended that the affected plants are uprooted and burnt.

Snout beetle (Figure 9c), which attacks *Eucalyptus saligna*, *Eucalyptus tereticornis* as well as GC14, 514, 581, 784, 785, GU 8 and TAG 5, was reported in Gede, Kabage, Karura, Meru, and Msambweni in Kenya. Snout beetle is also widespread in the Kenya Highlands where Eucalyptus is generally grown. Both the adults and the larvae damage Eucalyptus trees. The adults feed and damage the edges of leaves while the larvae eat and damage the entire leaf blade. In 1945, an egg-eating parasite, known as *Anaphes nitens*, was introduced into Kenya from South Africa to control the beetles. Since then only minimal sporadic outbreaks have been reported.

Termites, which attack *Eucalyptus grandis*, *Eucalyptus saligna*, *Eucalyptus uropylla* and GC3, 581 and 796 were reported in Karura, Meru, and Timbora in Kenya. Termite damage includes ‘bark-ringing’ – removal of a ring of bark – and death of seedlings. Termites can be controlled using insecticides such as Chloropyrifos, Imidachloprid, and Fipronil in the soil at the base of seedlings at the time of planting.

Chrysomelid beetles cause the Eucalyptus trees to defoliate. It was reported on GC514, 540, 581, and GU 8 in Gede, Kenya and on GC 14, 540, 581, and GU 7 in Sokoke, Kenya along the coast. Records show that the insect was first reported in Tanzania in 1959 but no damage was recorded at that time.

**Diseases**

The diseases reported were Botryosphaeria canker, Mycosphaerella leaf spot, Powdery mildew, Phytophthora root disease, and Cylindriocladium.

Botryosphaeria canker (Figure 10a) is the most common Eucalyptus disease. It was reported at elevations of 2,000 metres in Kabage and Timbora in Kenya but with no apparent stress on the trees. It causes canker (wound) on the stem, produces brownish gum and stunts growth. In some cases a brown ring appears in the outer (sap) wood layer in the stem.
This disease mostly affects *Eucalyptus camaldulensis*, *Eucalyptus grandis*, *Eucalyptus urophylla*, GC514 and GC581. Table 5 shows the Eucalyptus hybrid clones that have been attacked by this disease in different parts of Kenya.

Table 5 shows the Eucalyptus hybrid clones that have been attacked by this disease in different parts of Kenya.

<table>
<thead>
<tr>
<th>Area</th>
<th>Eucalyptus species attacked</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kabage</td>
<td>GC*540, 584, TAG 5</td>
</tr>
<tr>
<td>Gede</td>
<td>GC581</td>
</tr>
<tr>
<td>Marigat</td>
<td><em>Eucalyptus tereticornis</em></td>
</tr>
<tr>
<td>Meru</td>
<td>GC10, 12, 522, 784</td>
</tr>
<tr>
<td>Msambweni</td>
<td>GC581</td>
</tr>
</tbody>
</table>

*50% were infected, became stunted and died after two years

Figure 10 Main recorded Eucalyptus diseases

Table 5 Eucalyptus hybrid clones attacked by Botryosphaeria canker disease in Kenya

Powdery mildew (Figure 10b) is a fungal disease that forms a whitish coating and causes young leaves to curl. It was found in the Eucalyptus hybrid clone nursery in Karura in Kenya. GC12 and GC785 are also susceptible to the disease. It can be controlled by spraying the clones with Ridomil (Benlate) and Milraz.

Mycosphaerella leaf spots (Figure 10c) are found on older leaves of most Eucalyptus hybrid clones and local species. This was reported in all three countries, the most affected were GC clones, *Eucalyptus camaldulensis*, *Eucalyptus tereticornis* and *Eucalyptus urophylla*.

Phytophthora root rot disease was also reported in Karura in hybrid clones planted as hedges (mother trees) to produce cuttings. The disease is caused by a fungus called Phytophthora. It rots the roots and after wilting, the leaves, stems, and roots all die.

Cylindrocladium is a disease that prevails in humid climates and was reported in Kenya. It attacked cuttings of GC clones during rooting and also caused cankers (wounds) on young seedlings of *Eucalyptus grandis*.

Studies undertaken during the TBP trials indicate that these pests and diseases can be controlled without much difficulty.

5.4 Wood properties

Wood properties of hybrid clones are evaluated in order to provide information to farmers, tree growers, and potential users of hybrid clones about the most appropriate end uses. Although detailed data are not yet available, the following provide some guidance on the properties of hybrid clones in comparison to locally grown Eucalyptus.
The suitability of wood for various uses depends on its properties. These include moisture content, wood density, strength, and calorific value. Wood properties are likely to vary between hybrid clones and the same clones grown in different agro-climatic zones. Understanding these variations in wood properties is important for tree improvement and enhancing wood processing and utilization.

In general hybrid clones are expected to be suitable for fuel-wood and building poles at 3-4 years (Fig 11), transmission poles at 6-8 years, and timber at 10 years and above.

**Moisture content**
This is the amount of moisture in the wood. It is important when wood is sold on a weight rather than a volume basis. It varies among and within varieties depending on tree location, size, age, and harvest season. GC3, 12, and 642 had the highest moisture content while GC10, 14, and 15 had the lowest. GC3, 581, and 642 had higher moisture content than the local land races such as *Eucalyptus camaldulensis* and *Eucalyptus tereticornis*.

**Density**
This is a measure of the weight of a cubic metre of wood in kilograms per cubic metre. Wood density increases as trees grow. It also varies with growth rate and so wood from fast growing trees such as Eucalyptus is less dense than wood from slow growing trees like Mahogany.

In Kenya, hybrid clones generally had a greater density than local land races. The exception was *Eucalyptus grandis* which had a greater density than GC15. All the other hybrid clones, *Eucalyptus camaldulensis*, *Eucalyptus saligna*, and *Eucalyptus tereticornis* had greater wood density than *Eucalyptus grandis*.

In Machakos and Timboroa the density of *Eucalyptus grandis* wood was greater than that of GC15. All the others, including *Eucalyptus camaldulensis* and *Eucalyptus tereticornis* had greater wood density than *Eucalyptus grandis* and *Eucalyptus saligna*. This is because *Eucalyptus grandis* and *Eucalyptus saligna* grow faster than other land races.

As the wood density of hybrid clones is generally greater than those of local land races they are well suited for use in construction, for transmission poles, and beams.

In contrast to the faster growing Eucalyptus clones, slow-growing trees also produce good quality, high density timber for construction, furniture, and finishing work. But many small farmers are reluctant to plant such trees as Mahogany, Mvule (*Milicia excelsa*). They are even reluctant to grow because they can take more than 10 years to mature and this delays the return on investments.

**Shrinkage**
This is the reduction in size as the wood loses moisture during drying. Volumetric shrinkage can distort wood shape and create difficulties in wood working thus rendering it less valuable. Wood of *Eucalyptus camaldulensis*, *Eucalyptus saligna* and *Eucalyptus tereticornis* shrinks more than the hybrid clones GC3, 10, 522 and 582 clones. Hence the wood of hybrid clones can be used for making doors, door frames, furniture and external structures that are exposed to rain and solar radiation.

Careful wood drying can minimize excess loss of water and shrinkage that affects the quality of wood products. High shrinkage can be reduced by removing bark from 80% of a tree’s stem about 24 months before felling.
**Strength**
Strength properties refer to the ability of wood to withstand load or forces. These are most important when wood is used for structural building applications such as floor joists, rafters in wooden frame housing, power line transmission poles, plywood roof sheathing, sub-flooring and glue laminated beams in commercial buildings.

GC hybrid clones have the same or higher stiffness (modulus of elasticity), bending strength (modulus of rupture), shear strength, compression strength, and surface hardness than local Eucalyptus species. Both GC hybrid clones and local Eucalyptus species can be used for construction and fencing post when they are 5-6 years old. The relatively high wood strength of hybrid clones is most likely inherited from the parent land races.

**Calorific value**
The calorific value of wood is the amount of heat energy generated when a unit quantity of wood is totally burnt. It is directly related to wood density. The calorific value of hybrid clones is generally greater than that of mature local Eucalyptus varieties such as *Eucalyptus globulus*, *Eucalyptus grandis* and *Eucalyptus saligna*. This implies that hybrid clones provide better quality firewood and charcoal.

This quality can reduce pressure on natural forests and woodlands which are the main sources of firewood and charcoal in East Africa.

### 5.5 Planting recommendations
Eucalyptus hybrid clones imported from South Africa have performed well in different parts of Kenya, Tanzania and Uganda. But all the findings from the TBP demonstrate the importance and complexity of selecting the right hybrid clones for the right agro-climatic and site conditions.

On the basis of the trials, the recommended hybrid clones in each country and each agro-climatic zone are listed in Table 6.

<table>
<thead>
<tr>
<th>Country</th>
<th>Recommended Eucalyptus hybrid clones</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kenya</td>
<td>GC14, 15, 167, 540, 581, 584 GU7, 8, 21</td>
</tr>
<tr>
<td>Tanzania</td>
<td>GC167, 584, 940 and GT 529 in lowlands GC15, 514, 785, 940 and *GT 529 in dry-montane areas GC514, 581, 584 and GT 529 in wet-montane areas GC14, 15, 167, 522, 581 and 585 in semi-arid areas</td>
</tr>
<tr>
<td>Uganda</td>
<td>GC514, 540, 550, 784 GU7, 8, 607, 609</td>
</tr>
</tbody>
</table>

*Although Eucalyptus hybrid clone GT529 was recommended for planting in the lowlands and wet and dry montane areas, it has a poor survival rate.*

Some general observations made during the TBP include:

- Tree growth rate slows down when there is competition for natural resources such as space, light, water, and nutrients. Trees can grow faster under good conditions but growth is proportional to the needs and size of roots, stem, and crown.
- Adequate rainfall speeds up tree growth of varieties well suited to wet areas.
- Weeding young trees, particularly in the first 15 months of growth, reduces competition for natural resources.
- Applying organic or inorganic fertilizers enhances tree growth.
Tree management practices such as thinning and pruning may not be required for hybrid clones because they produce uniform trees which are self-pruning.

It is advisable to wait for at least four years to observe growth performance and adaptation to a site before selecting suitable clones for large-scale planting.

The TBP has covered a wide range of agro-climatic and site conditions, but not all. Additional research will be needed to comprehensively cover the region. So too will continued research to minimize risk of pest or disease attack to which hybrid clones are susceptible.

5.6 The role of the tree value chain

Although the TBP focused on reproducing and testing hybrid clones, it was fully recognised that producing hybrid clones in field trials and providing demonstrations does not take good research into practice. Indeed it is just one link, an important one, in the tree value chain (Figure 12). The tree value chain supports and provides many products and services and many thousands of jobs from the smallholders who grow the trees to the consumers who buy wood and wood products. They include transporters, processors, wholesalers and retailers, input suppliers, finance and information services, and regulators. If the links are not in place and are not well connected then the chain does not function well.

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The success and sustainability of the tree/wood industry in East Africa will depend on the effectiveness and efficiency of activities undertaken by many different people in the value chain (Box 5). Profitability, consumer demand, and environmental and social costs are crucial in the tree sector for optimizing production, maintaining adequate inventory levels, and sustainable and profitable investments.

At present, tree value chains are weak and lack competent and capable capacity to function effectively. There is also a dearth of financial institutions willing to invest in tree planting and provide credit for those wishing to develop the value chain. A Ugandan tree grower’s experience is presented in Box 6.
A value chain comprises a full range of activities required to bring a product or service from conception through production, and final delivery to consumers – and possible disposal after use. This series of interconnecting activities creates and builds value. The essence of a value chain is to understand production-consumption inter-linkages that assist in making decisions about investment in tree growing.

Strengthening the tree value chain is a major undertaking which goes well beyond the scope of the TBP. But the programme did take the important step of linking the science of clonal technology with farmers by supporting the establishment of commercial tree nurseries. Innovative credit products were developed to enable local entrepreneurs to develop small nursery businesses. As a result over 80 commercial nurseries were established to propagate and supply planting material to farmers. To date some 21 million trees, with an estimated value of US$300 million, have been supplied to about 20,000 growers across the region.

Mr. Ponsiano Besesa is a businessman who sold a hotel in Kampala, Uganda to invest in forestry. His interest in tree growing stems from his father’s business in tree sawing in the 1940s and the timber business he has run over the last 32 years. He has planted pine and eucalyptus in different parts of the country and by 2010 he owned 915 hectares of forest, including about 175 hectares leased from the National Forestry Authority in Mubende district. Mr. Basesa expects to gain financially from his investment but he is also a passionate tree grower who aims to help protect the environment and to leave a sustainable legacy.

When the trees mature, Mr. Basesa will earn about US$40,000 from the sale of his trees. He has travelled on sponsored study visits to Australia, Brazil, and South Africa and he won the Sawlog Production Grant Scheme (SPGS) Award in 2008 as the best small and medium-scale tree planter in Uganda. He admits that tree growing demands patience and determination since it is a long-term investment. However, he is also concerned that Banks in Uganda do not give loans for tree growing because of the long maturity period. In spite of this, he advises potential tree growers to seek financial assistance from SPGS.
6 A way forward

The TBP has demonstrated that Eucalyptus hybrid clones can grow well in East Africa if planted on sites with suitable growth conditions. They can help to meet the increasing demand for wood and wood products across the region, reverse deforestation and forest degradation, and contribute to the mitigation of climate change. They can also increase the prosperity of many millions of impoverished rural smallholder farmers which in turn contributes to national GDP.

Economic development of this kind may well have environmental consequences and so care and caution is essential. But whatever the arguments for and against Eucalyptus planting, in the absence of other viable fuel-wood sources, it is argued that there is a need to strike a balance between those environmental concerns and the growing demand for more wood and wood products.

A sensible, evidence-based approach is needed which recognizes that Eucalyptus impacts and responses can be very different at different sites. They are complex and not always well understood. In such circumstances broad generalizations do not help either the case for or against them. Rather each case needs to be fully assessed on its own merits.

Forests already play, and will continue to play, an invaluable role in protecting water catchments, and the rivers and lakes which supply municipalities and industry with water across East Africa. When Eucalyptus planting is properly planned and managed in catchments suited to growing tree crops, it can make a most positive contribution to sustaining these productive ecosystem services.

Introducing Eucalyptus hybrid clones into the economic life of East Africa is not just about farmers planting more trees. Interest in tree growing and the need to invest in carbon credits is attracting direct foreign investment into the region’s forest sector. But these investments need to be matched with a robust tree value chain with clearly defined market structure and marketing systems in which market information is available and accessible to tree growers and others in the chain.

Finance institutions will also play a crucial role in funding investments for both smallholder and medium and large scale tree planting. Currently, commercial banks do not have facilities for funding investments in tree growing despite the recognized benefits and potential returns. In Uganda this vacuum has been partly filled by initiatives such the Sawlog Production Grant Scheme (SPGS) www.sawlog.ug/ – a project financed by the European Union – which offers support to medium, large-scale and community tree growers by financing forest plantation establishment costs. SPGS currently operates as a project with financial support from the European Union. Uganda Gatsby Trust has also assisted members of the Gatsby Clubs to access small-scale, short-term financial support for tree growing at club level. But much more is needed to financially support tree growing and plantation forestry.

The planting of hybrid clones will also require support of policy and decision makers at the highest levels in government. Such support requires that the various stakeholders are adequately sensitized to the socio-economic and environmental importance of matching hybrid clones to the different agro-climate zones across the region. Moreover, it will also help to prevent inaccurate negative publicity about Eucalyptus that tends to discourage farmers and other tree growers from adopting fast growing, early maturing and high yielding clones.

The future of forestry in East Africa will also depend on a strong tree research and breeding programme to continue the work of TBP, broaden the genetic base of tree growing, and extend the knowledge and skills gained to include other indigenous tree species that have high socio-economic and environmental value. This will require an increase in human capacity which is both competent and capable of undertaking such programmes. At present capacity across the region is weak and is a major bottleneck to development.
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