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# A century of forest management research in Uganda: 1898-1998

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## Abstract

**The early people of Uganda derived their livelihood from natural forests by collecting wild fruits for food, fuelwood for domestic heating and metal working, wood for building and making canoes for fishing and warfare, herbs and other plant parts for medicine, and many other social and cultural uses. Subsequently forestry management developed into economic activities to supply both fuelwood and timber for domestic and industrial uses, for export. Forests were also cleared for establishment of plantation crops such as coffee, sugar cane and tea. Early investigations explored the stocking of rubber trees and vines in the natural forests and ecological, studies which culminated in the publication of the book "Indigenous Trees of Uganda" in 1951. This was followed by the development of silvicultural research involving underplanting of residual forest after logging; and the development of polycyclic selection method and a monocyclic shelterwood silvicultural system. Plantation forestry research in Uganda was initiated to identify suitable species for increased and reliable production of timber and other forest products. This was mainly because the natural forests were incapable of supplying the quantities and types of timber demanded by the market. Suitable species and provenances for plantation forestry have been identified including the techniques for raising and managing them. This paper gives information on forest management research in Uganda from 1898-1998. It also gives highlights on future research in both natural and plantation forests.**

**Key words:** *Forest management research, natural, plantation, silviculture.*

## Introduction

Uganda covers an area of 236,000km$^2$ and consists of a variety of landscapes that support several vegetation types including valuable forests, wetlands and grasslands, as well as fresh water lakes and rivers. While all these ecosystems support the country's agro-based economy, forests which constitute about 7% of land area play a particularly important role of providing a wide range of renewable prodocts and services.

Uganda's current forest resources consists of 1,483,920 ha of a variety of natural forests, 39,080 ha of coniferous and eucalyptus plantations, and numerous individual trees and small woodlots interspersed with food and cash crops on farm land (Forest Department 1996). This resource base supplies 96% of domestic energy needs in form of fuelwood to over 90% of the population. It is also vital for processing high value export crops like tea and tobacco. Consequently recent estimates indicate that forestry accounts for 23% of the country's GDP. This has largely been possible due to forest management and conservation efforts during the last 100 years.

This paper describes the evaluation of forest management research and its role in the quest for sustainable management and conservation of Uganda's valuable forest resources. It is particularly focused on research aims, objectives, and activities, giving highlights of significant achievements since the beginning of modern agricultural practice in the country early this century. The paper consists mainly of a synthesis of information derived from Forest Department documents and records, annual reports and Technical Notes of the Forestry Research Institute, and other related forestry literature.

### Historical development of natural and plantation forestry research

Early inhabitants of Uganda derived their livelihood from the natural forests in the form of wild food products, fuelwood for domestic heating and metal working, wood for building canoes for fishing and warfare medicines, and many other social and cultural uses. British colonial rule which started at the turn of the 19$^{th}$ Century brought new forms of economic activities such as establishment of large estates of coffee, rubber, sugar cane and tea which required clearing vast areas of natural forest. This was followed by development of a big market for fuelwood and timber for domestic use, industrial development and for export.

The combined activities of forest clearance for agriculture, timber and human settlement as the population increased rapidly helped to reduce Uganda's natural forests from approximately 20% five hundred years ago to the present day 7% (Langdale-Brown et al., 1964; Hamilton, 1984. At the turn of the last century the British colonial administration came to realise that forests were being

degraded at a fast rate and steps were taken to rescue some of the remaining forests for continued provision of forest products and services.

**Early ecological botanical investigations**

The Forestry and Scientific Department was established in 1898 with research being a major component of forest management activities (Forest Department, 1951). Initial research started in 1906 to explore the stocking of rubber trees and vines in natural forests. This was followed by studies on forest ecology consisting of botanical and timber species investigations. By 1918 a herbarium containing over 1,700 specimens of dried plants had been established at Entebbe. Duplicates of these specimens were sent to Imperial Institute in Britain for identification.

This early ecological research culminated in the publication of the first checklist of forest trees and shrubs in Uganda containing 107 families, 452 genera and 1,146 species and varieties in 1935 (Eggling, 1947 a & b). Five years later, "Indigenous Trees of Uganda" was published with descriptions of all the tree species recorded up to mid-1939 (Eggling and Dale, 1951). Included in the publication were 79 families, 304 genera and 646 species and varieties. A grass collection was added in 1944 and by 1950 the total number of species had increased to 2,533 (Forest Department, 1955).

Valuable tree species such as *Podocarpus milanjianus, Entandrophragma spp., Khaya anthotheca, Melicia excelsa, Lovoa trichilioides, Alstonia boonei* and *Parinari holstii* identified during the botanical and timber investigations were tested for various properties at the Forest Products Laboratory in England during the 1930s. This research formed the basis for the growth of the sawmilling industry which had started earlier at Minziro in 1912 to process a single species, *Podocarpus milanjianus* in Sango Bay forest on the shores of Lake Victoria.

**Development of silvicultural research**

During the initial years of timber exploitation there was no regulation of yield due to lack of information on the extent of forests, timber stocks, and growth rates. However, as mentioned earlier, the Forest Department was anxious to replace valuable timber species harvested and in 1916 seedlings of *P.milanjianus* were raised and planted at Sango Bay forest although with limited success due to flooding. This heralded the development of silvicultural research involving underplanting of residual forest, after logging, with indigenous timber species.

Prior to the first World War, only a few forests had been demarcated and separated from private and public land. It was not until the 1930s that most of the major forests such as Budongo, Bugoma, Bwindi, Kalinzu, Kibale and Maramagambo were demarcated. This survey work led to research into photo-interpretation, plotting of maps from aerial photographs, and development of diagnostic sampling methods. This permitted modern forest management activities such as preparation of management plans, with the first one prepared in 1935 for Budongo forest. Diagnostic sampling was carried out in order to get general information on the prospects of successful natural regeneration and possibility of producing economic timber stocks (Dawkins, 1958). The samples provided useful data for planning sawmilling activities, regulation of yield, and design to appropriate silvicultural technologies for regenerating exploited forests.

While underplanting of exploited areas was initially cousidered expensive, research in this field continued and trials started about 40 years ago have demonstrated a number of both indigenous and exotic tree species with outstanding growth performance. Research results also revealed conditions necessary for successful underplanting (Dawkins, 1958).

Prior to the 1950s, timber yield regulation was by a selection (polycyclic) harvesting method of working with 30-40 year intervals between fellings. However the method, subsequently could not yield enough volume of exploitable timber sizes and was replaced by a monocyclic method of yield regulation. The latter method involved drastic opening of the forest canopy to permit rapid development of regeneration, and adopting the tropical shelterwood silvicultural system of forest regeneration with intervals of 40-80 years between fellings.

Under the shelterwood system, various experiments were carried out involving removal of weedy shrubs competing with regeneration of desirable species, opening up of the forest canopy by poisoning unwanted trees or converting them into charcoal so as to encourage development of seedlings and saplings of valuable species (Dawkins, 1955, Earl, 1968). Such stand improvement methods referred to as "refining" ceased in 1970s when the Forest Department could not secure funds to import chemicals or to continue with charcoal production due to the economic decline in the country.

Due to political instability and the resulting economic decline between early 1970s and mid 1980s, forestry research was severely disrupted leading to a shift to forest management methods based on socio-economic and political pressures rather than research findings. This led to extensive degradation of forest resources that caused a serious threat to the socio-economic and environmental health of the country. In order to reverse this problem, the government decided to strengthen Forestry Research and Development by transferring forestry research mandate from the Forestry Department to the Forestry Research Institute (FORI) of the National Agricultural Research Organisation (NARO) established in 1992 as part of agricultural modernisation and poverty eradication policy.

**Plantation forestry**

Plantation forests in Uganda were first established in 1908 and aimed at the search for both increased and reliable production of trees and forest products. The objectives of developing plantation forestry varied from production of industrial raw materials such as fuelwood and timber, through rehabilitation of degraded sites, to growing trees for amenity.

As indicated earlier, large scale exploitation of timber from the tropical high forests in Uganda mainly began during the colonial period. This led to attempts in developing management systems based on the concepts of sustainable yields. The natural forests, however, were incapable of supplying the quantities and types of the timber demanded

by the market. This led to the development of the concept of "compensatory plantations" in 1908 to plant prime timber species indigenous to Uganda, which mainly included: *Milicia excelsa* the mahoganies, *Entandrophragma utile, E.cylindricum, E.angolense* and *Khaya anthotheca; Markhamia lutea* (Nsambya); and *Maesopsis eminii.*

The compensatory plantations had to compensate for a number of constraints on timber production imposed by the nature of the natural forests in Uganda. These included:

- The low number of commercially desired timber species;
- The species available were not suitable for the desired industrial development;
- The rates of growth of the desired species such as *Podocarpus* and *Meliacea* was slow, and their regeneration and silviculture posed managerial problems;
- The area of natural forest was too small to meet projected demand for forest and tree products and services.

**Species and provenance evaluation research**

Research on species performance in Uganda is practically as old as tree planting and was generally executed by the District Forest Officers and local Authority staff (Kriek, 1970). The evaluation of tree species expanded greatly after 1953, when methods of research planning and recording were established in the first written Silvicultural Research Plan (Philip, 1964).

Trials to evaluate the species performance were needed to obtain adequate information on the requirements of the species, or on the characteristics of the site, or both. The choice of species and provenances to use for afforestation involved the extrapolation of information from the original habitat. Climatic and ecological matching of a new site and the original habitat of a species was rarely enough, since it could not reveal the adaptability of the species to new conditions or its ability to grow satisfactorily on a range of sites. In Uganda, trials to evaluate the performance of species and provenances followed the conventional phases of: species evaluation, testing, proving and provenance testing as described below.

**The species elimination phase**

This involved the mass screening of a large number of possible species in over 6,500 research plots. These were small plots maintained for a short period (0.1-0.2) of the expected rotation. This was mainly to determine survival and promise of the tree species to reasonable growth. The plots were small, usually 5 tree row plots or a maximum of 25 trees in 5x5 trees arrangement.

**Species testing phase**

These were designed for critical testing and comparison of a reduced number of promising species in larger plots. The plots usually consisted of 16-25 trees in 4x4 or 5x5 trees arrangement with one or two rows surrounding the plots. These trials were grown for about 0.25-0.5 of the expected rotation.

**The species proving phase**

These trials were designed to confirm the superiority of few probable species in large plots. Under normal plantation conditions the plots consisted of 100 trees in a 10x10 trees arrangement with two rows of trees surrounding the plots. They provided data on growth and yield for the full rotation including the investigation of various management techniques. The wood quality was also determined.

**Provenance testing**

The steps followed in species evaluation also applied to provenance testing for species with a wide natural distribution: These namely are: a range-wide provenance sampling phase, a restricted provenance sampling phase, and a provenance proving phase. Since these phases usually apply to species considered promising, plot size and time scale exceeded those for the comparable phases of species trials.

**Research sites, reports and achievements**

All research plots in Uganda were classified by phytogeographic zones in the Silvicultural Research Plan (Philip 1964). The classification of species and provenances research plots were described by Stuart-Smith (1967). The results of species and provenance trials established prior to 1966 were summarised as Technical Notes of the Forest Department (Kriek 1967 a-k, 1968 a-k).

The Technical Notes outlined the climatic and endaphic conditions of the research sites together with growth data of the species and provenance, and recommendations for afforestation potentials. Further, underplanting trials, spacing, stand development and productivity of *Eucalyptus* species in Uganda were reported.

The major achievements of the past plantation forestry research in Uganda include:

- Recommendations of suitable species and provenances for various sites in the country
- Nursery techniques for raising seedlings of major
- plantation species to ensure establishment Spacing, establishment and pruning regimes to produce desired crops of plantation species
- Stand development and productivity of the *Eucalyptus* species

**Current research**

Since the establishment of NARO, the Forest Management Research Program of FORI has initiated research activities geared towards addressing the national agricultural policy objectives of poverty alleviation and sustainable development through agricultural modernisation (NARO, 1996). This has been pursued by emphasising a research-extension-client participation approach in the process of priority setting, planning, on-farm/forest estate research and technology transfer. Research projects are

implemented and managed by interdisciplinary teams of scientists with a focus on components that foster creativity and better services to clients through adaptive and applied research.

It is important to note that forests provide critical support to agricultural production through maintaining suitable conditions for crop and animal production, and provision of material goods and services. Forests have environmental, production and socio-economic links to food security. Forests influence buth immediate surroundings and stabilise the buffer environment. Forests produce food items such as fruits, nuts, leaves, roots and gums and they are habitats for many animals, birds, insects and other forms of wildlife. On the socio-economics the products and services of forests are linked to the people who depend on them. The Forest Management Research Program was established to carry out research in both natural and plantation forests aimed at developing appropriate technologies to increase the productivity of the forests in terms of material goods, conservation of biodiversity, and protection of the environment on a sustainable basis. Sustainability in this context implies maintenance of ecological, economic, and social functions of the forests for the benefit of both present and future generations.

**Natural forest research**

The Forest Department has since 1988 embarked on an ambitious forestry sector rehabilitation program, initially with financial support from the World Bank and the European Union. Two major achievements of the program in regard to uatural forests have been the eviction of farmers who had encroached on the forests since the 1970s and a revision of the forestry policy in order to meet the increasing demand for economic, social and environmental benefits of natural forests. Implementation of this policy has prompted the zoning of natural forests according to the degree of usage, with 20% set aside as a nature reserve, 30% as a buffer area and remaining 50% to be fully utilised for timber management. Unfortunately, of the initial $38 million secured for forestry rehabilitation in 1988, no funds were allocated to forestry research although it is mentioned as a major policy objective and considered vital to sustainable forest management (Karani, 1993).

As indicated earlier, with the transfer of forestry research mandate from the Forest Department to NARO, natural forest management research which had largely been dormant since early 1970s was re-initiated, starting with verification and assessment of the value of past research efforts and to address current forest management problems. Specific research objectives of the natural forest management sub-progam are:

- to assess the status of species diversity of Uganda's forests and prescribe appropriate conservation techniques;
- to analyse the effects of past forest management and resource utilisation practices;
- to develop technologies for forest rehabilitation after logging, encroachment and other forms of forest degradation;
- to assess the prospects for collaborative forest management with local commuoities.

So far, four projects have been formulated under which 12 experiments have been designed to address the above research objectives. Major research results achieved by the sub-program during the last 5 years under NARO include verification of the previous research plots and permanent sample plots, and identification of suitable species for rehabilitation of degraded forests, assessment of the silvicultural impacts of timber harvesting, and prospects and constraints of collaborative natural forest management.

**Plantation forest research**

Plantation forestry research has mainly undertaken the verification and assessment of previously established research plots. This is mainly to link up the past research objectives with the current plantation forestry requirements. It is currently envisaged that more wood production should be emphasized in plantation forests, while conservation and environment benefits accrue from the natural forests. The species identified for plantation development for industrial timber were few and mainly exotic. They comprised of:*Pinus patula, P.kesiya and P.caribaea var bahemansis* for the medium and high elevation areas above 1,200m (asl), and *P.oocarpa and P.caribaea var hondurensis* for the savanna and dry secondary forest between 800 - 1,200m (asl). Similarly, the species of Eucalyptus were identified for pole and fuelwood production. There is therefore, need to widen the species range used in plantation forestry to particularly include the evaluation of indigenous species.

In order to evaluate many of the indigenous species it is essential to first determine the priority species, then develop their appropriate propagation techniques. This will be followed by systematically collecting germplasm for evaluation trials. Subsequently the priority species evaluated together with studying the plantation stand development for production of desired wood products. Concurrently there is need to utilise genetic variation exhibited by both exotic and indigenous species for the genetic improvement of the most priority species.

**Future plans**

Uganda's forests are expected to continue playing an important role in economic development and maintenance of the environment. Forests are renewable resources which provide economic, social and environmental benefits in perpetuity when managed well. Effective forest management requires a good understanding of the composition and ecological dynamics of the constituent ecosystems and development of appropriate technologies for meeting the demand for the variety of forest goods and services.

The forest management research program will therefore continue to collaborate with the Forest Department, farmers and other clients and stakeholders in the generation and transfer of appropriate technologies for sustainable

management and conservation of forest resources in the country. In order to achieve the above objective, future research and extension will be geared towards improvement of seed sources, development of appropriate silvicultural and protection methods for enhancing forest regeneration, growth and yield. Research effort will also be initiated in the fields of ecotourism and non-timber forest products, as well as in the conservation of forest biodiversity.

There has been lack of regular financing of forestry research and management activities. This has been a persistent constraint since the 1970s. However, there is currently a good cause for optimism due to recent developments in the country. Uganda's economy has been growing at over 5% GDP for the last decade and an increase in revenue collection has been reported (Ministry of Planning and Economic Development, 1998). Given these developments and the continued good will of bilateral and multilateral donors, it is hoped that it will be possible for the government to adequately finance forestry research and development in the near future in fulfilment of the current policy objectives of modernisation of agriculture and poverty eradication.

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