Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

CITES Tree Species Programme (CTSP)

Activity Output 3.2: Ethnobiological information, current harvesting, processing, transport, trade, control and monitoring of *Osyris lanceolata* in Tanzania

Joseph Nicolao Otieno and Samson Hilonga
Muhimbili University of Health and Allied Sciences
Institute of Traditional Medicine
P.O.Box 65001 Dar es Salaam, Tanzania

+255 784 412625

Email: onicolao@yahoo.co.uk

EXECUTIVE SUMMARY

Osyris lanceolata in East Africa is famously traded globally for its fragrance in perfumery industry. Increased harvesting from the natural forests to feed the growing international market is a threat to the species growing in East Africa. In Tanzania, *O. lanceolata* has been exploited freely from natural forests until in 2006 when the government imposed ban on exploitation. Despite the ban, there is insufficient data on trade control from the natural forests of Tanzania. No up-to-date information on the trade chain even for imported raw materials for local factories in various parts of Tanzania. To fill the gape of such a missing information, this study was initiated by the CTSP to determine and record current harvesting and trading trends for local factories and for export. The recorded information will guide current resource control, market chain and traceability of African sandalwood not only in Tanzania but in the whole of East Africa region.

Babati and Kondoa Districts were selected for collection of ethnobiological information, current harvesting, processing, transport, trade, control and monitoring of *Osyris lanceolata* as a small sample of what is happening elsewhere in the country. The study was extended to other regions following the information on trade chain of the resources such as Tanga and Dar es salaam regions. The harbor and Airports were visited as potential exit points for Sandalwood raw materials and semi-finished products.

Both questionnaires and field visits were used to get information from local communities, regulatory authorities, local factories and the import and exit routes mainly harbor and airports

It was found that two *Osyris* spp viz. *O. lanceolata* and *O. compressa* in the study area are used interchangeably locally for fuel wood and medicine. However, for international trade *Osyris lanceolata* with comparatively high oil yield has been dominating the trade in Tanzania for decades up to 2016 when the government officially imposed ban on trade allover the country. The study carried out in the northern corridor of Tanzania mainland did not record any current harvesting from the natural forests implying the effectiveness of the state ban in the past 14

years. Besides local harvesting, there is evidence of importation of raw materials from other East Africa countries to Tanzania where oil is extracted and exported overseas.

Generally there is insufficient tracking and records of the actual trade volumes of the species in the region. The study has however created a threshold for knowing trade trends in Tanzania and the connection with sister states in the region. The trade on Sandalwood defies national boundaries in the region and this requires regional collaboration to ensure sustainability through joint monitoring and control. Growing international demand is an investment opportunity for the regional economic growth if the biomass accrual will be achieved through effective *ex-situ* and *in-situ* conservation programs

ACKNOWLEDGEMENTS

Communities in Babati, Kondoa and Handeni Districts, Forest Service (TFS), and local industries were so collaborative in availing information on trade and conservation of *Osyris lanceolata* in Tanzania. Financial support by CITES Trees Species Programe is appreciated to make this study possible

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LIST OF ABBREVIATIONS/ ACRONOMY

CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CTSP	CITES Tree Species Programme
FBD	Forestry and Beekeeping Division
ITM	Institute of Traditional Medicine
MUHAS	Muhimbili University of Health and Allied Sciences
NAFORMA	National Forest Resources Monitoring and Assessment of Mainland Tanzania
TFS	Tanzania Forest Services

1.0 INTRODUCTION

1.1 Background

Osyris lanceolata in East Africa is harvested mainly from the wild, private farms or communal lands for its fragrance. It is also locally traded as timber and medicine. International trade in *O. lanceolata* is unrecorded and unregulated in the region. Exclusive harvesting from wild sources and the growing international market with attractive prices is a threat to the species growing in the wild/forests in East Africa. High demand for the Sandalwood oil has led to over exploitation of *O. lanceolata*. In Tanzania, *O. lanceolata* has been exploited freely from natural forests and woodlands for export. Later in 2006 Tanzania government reinforced ban on export of logs and suspended tree harvesting in protected natural forests in order to address illegal logging (ICTSD, 2006). Despite the ban on harvesting and trading of the *O. lanceolata* in about the past 2 decades, there is insufficient evidence of trade arrest from the natural forests of Tanzania. No up-to-date information on the status of available stock, regeneration and control mechanism.

To obtain such missing information, this study was initiated by the CITES Species Tree Programme in attempt to determine and record current harvesting and trading trends and the quantities harvested both for local industries and for export.

1.2 Rationale of the assignment

The recorded information will guide current resource control, market chain and traceability of African sandalwood not only in Tanzania but in the whole of East Africa region. It is noted that the sources of African Sandalwood oil that is processed and exported through major exit points in Tanzania originates in the region including DRC, Uganda and Southern Sudan. All states involved can now develop common strategy for trade control and monitoring.

9 United Nations Road; Upanga West; P.O. Box 65001, Dar Es Salaam: Tel. G/Line: +255-22-2150302/6; Ext. 1236; Direct Line:+255-22-2152635;Telefax:+255-22-2150465;E-mail:dvcarc@muhas.ac.tz;Web:https://www.muhas.ac.tz

2.0 METHODOLOGY

2.1. Study area

Selection of a study area was guided by the consultancy report under the Output 2 that described that in Tanzania *O. lanceolata* is widely distributed in both reserved and unreserved forests in Arusha, Manyara, Dodoma, Singida, Iringa, Njombe, Rukwa, Pwani and Mbeya regions; and in Eastern Arc Mountains (i.e. Kilimanjaro, Tanga and Morogoro regions). In addition information was derived from the National Forest Resources Monitoring and Assessment (NAFORMA) of Tanzania Mainland that was carried 2009 – 2014 that revealed a large concentration (78%) of O. lanceolata in the Bush land of Northern and Southern ecozones. *Osyris lanceolata* is also distributed in woodlands of Southern Highlands (9%) and Eastern (2%), forest of Southern Highlands (2%), Bush land of Central (3%) and Grassland (6%) of Southern Highland zones.

Babati and Kondoa Districts in particular was selected to represent other areas in northern region of Tanzania that is reported to be comparatively rich in *O. lanceolata* to other regions. The study was extended to other regions following the information on trade chain of the resource such as Tangga and Dar es salaam. The harbor and Airports were visited as potential exit points for Sandalwood products for export.

2.2. Data collection

- Ethnobotanical surveys was done among the communities adjacent to the selected *O. lanceolata* in Boay, Bonga, Duru and Mombo villages local uses and the impact to the plant community. Communities provided the current information on harvesting, processing, transport, trade, control and monitoring of *O. lanceolata.* Retrospective recording of trade within 2 decades past was recorded for comparison with the current status.

- Interviews was done with regulatory authorities (Tanzania Forest Service) and the guards at the on-road check points.
- Local factories in Babati, Tanga and Dar es Salaam were visited for interview on Sandalwood oil trade.

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3.0 FINDINGS

3.1. The ethnobotanical information *Osyris* spp

The species is used for fire wood and medicine against gastrointestinal ailments whereas both the stem and the root are used. The curved bole shape and height do not favor uses for poles and timber. The local uses have not had negative effects to the species until in the 1980-2000s when a species entered the international market. This came about after introduction of the processing industries in Babati and Mombo-Tanga. Commercial exploitation involved uprooting of whole tree, in that effect there was no any management initiative introduced as communities were oblivious of the ongoing business. The species is locally known as 'Msandali. Communities identified two categories of Msandali namely 'Msandali Dume' (*Osyris lanceolata* Hochst. & Steud. ex A. DC) and "Msandali dume" (*Osyris compressa* (P.J.Bergius) A.DC). *O. compressa* is named male Msandali because it has less oil compared to *Osyris lanceolata*. Both species grows in similar/same habitats and in most cases non experienced can not distinguish them. Phenotypically the two species differs in terms of size and shape of leaves and fruits. Leaves in *O. lanceolata* are lanceolate while in *O. compress*a are elliptical. Fruits of *O. lanceolata* are larger in size than that of *O. compressa*, but differ in size and shape (plate 1&2)

Plate 1: Osyris lcompressa branches, Male (left) with flowers and Female (right) O. laanceolata with fruit

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3.2. Trade chain of *Osyris lanceolata*

3.2.1. Local trade

Before 2006, harvesting of *Osyris lanceolata* was free. Harvesting was done by agents from outside the villages. These would employ casual laborers who uprooted plants indiscriminately at a modest payment. Villagers were not informed on the market value of the products. Some villagers harvested and sold logs to the agents of local factories in Babati. Most materials were collected from areas around Duru and Dareda as well as neighboring districts of Hanang, Kondoa, Monduli, Kiteto and Karatu. The main consumer of these materials were Sierra Ltd Factory in Babati and the rest were exported to Dar es Salaam. Currently there is no local harvest in the neighborhood. Report from Mombo village in Tanga echoed a report obtained in Babati District, however unlike Babati where harvesting was done around, raw materials for a local factory (Afro Aromatics) in Mombo were transported from other districts such as Lushoto and Same. Harvesting was not done in Mombo for less supply in the wild, however the factory was strategically located in that area for accessibility convenience with reference to the main road.

From the ethnobotanical questioning, the districts that supplied raw materials for local factories and for export are Babati, Hanang, Kiteto and Karatu in Manyara region; Kondoa in Dodoma region; Same in Kilimanjaro region; Lushoto and Handeni in Tanga region and Monduli in Arusha region. Total of 9 districts in northern corridor of Tanzania.

Plate 2: Villagers in Boay Village in Babati District with CTSP team during ethnobotanical and sensitization meetings on *Osyris lanceolata*

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3.2.2. International trade

Interview with the factory owners

Three factories namely Siera Limited located in Babati-Manyara, Afro-Aromatics in Mombo-Tanga and Natural Aromatics LTD in Dar es Salaam were visited to get the insights on the current supply of raw materials, processing and markets. According to factories management there is no local purchase of raw materials. Four sandalwood processing factories were licensed and established in 2004. However, due to shortage of raw materials, only three are operating to date.

Natural Aromatics LTD Factory

Natural Aromatics LTD Factory in Dar es Salaam imports sandalwood (*Osyris lanceolata*) raw materials from Uganda through Mutukula, Congo through Tunduma and South Sudan through Uganda (*Osyris lanceolata*), this factory exports sandalwood oil and spent dust to India , Saudi Arabia and China through Julius Nyerere international Airport and Dar es Salaam Port as in Table 1.

Table 1. Snapshot of the import and export of sandalwood oil by Natural Aromatic CO. LTD in Dar es salaam

DATE	KG	VALUE (USD)	DESTINATION	EXPORT FEES	source
3/8/2016	550	40,246	INDIA	302,200	
12/8/2016	200	80,000	INDIA	302,200	
5/9/2016	450		INDIA	302,200	
15/9/2016	400	25,378	INDIA	302,200	
29/9/2016	550		INDIA	302,200	
20/10/2016	350		India	302,200	Uganda
2/11/2016	500	200,000	INDIA	302,200	Uganda
2/11/2016	50	10,000	INDIA	302,200	Uganda
30/11/2016	600	240,000	INDIA	302,200	
15/12/2016	450		INDIA	302,200	
21/12/2016	250	10,000	INDIA	302,200	Uganda

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11/1/2017	300	120	INDIA	302,200	
24/1/2017	650	32,648	INDIA	302,200	
6/2/2017	450		INDIA	302,200	
20/2/2017	550		INDIA	302,200	
2/3/2017	600	240,000	INDIA	302,200	UGANDA
23/3/2017	600		INDIA	302,200	UGANDA
3/4/2017	400	60,000	INDIA	302,200	
17/4/2017	550	220,000	INDIA	302,200	
16/5/2017	450	120,342	INDIA	302,200	
31/5/2017	150		DUBAI	302,200	
8/6/2017	700		INDIA	302,200	UGANDA
20/7/2017	600	270,000	INDIA	302,200	
25/8/2017	540	31,413	INDIA	308,900	
4/9/2017	350	157,000	INDIA	308,900	
18/12/2017	500	225,000	INDIA	308,900	
20/12/2017	450	202,500	INDIA	308,900	
25/1/2018	500		INDIA	308,900	
12/2/2018	500	225,000	INDIA	308,900	
13/2/2018	500	225000	INDIA	308,900	
12/3/2018	500	225000	INDIA	308,900	
20/4/2018	400		INDIA	308,900	
19/6/2018	450		INDIA	308,900	
18/10/2018	150		INDIA	308,900	
19/11/2018	150		INDIA	308,900	
12/12/2018	250	68750	INDIA	308,900	
9/1/2019	200	55,000	INDIA	308,900	

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23/1/2019	150	41,250	INDIA	308,900	
15/2/2019	200	55,000	INDIA	308,900	
4/3/2019	250	68,750	INDIA	308,900	
13/3/2019	250		INDIA	308,900	
29/3/2019	150		INDIA	308900	
30/4/2019	250	68750	INDIA	308,900	
9/5/2019	250	68750	INDIA	308,900	
27/6/2019	255	61,875	INDIA	308,900	
30/7/2019	400	110,000	INDIA	308,900	
23/8/2019	250	68,750	INDIA	308,900	
10/9/2019	300	68,750	INDIA	308,900	
26/9/2019	300		INDIA	308,900	
27/11/2019	200		INDIA	308900	
24/12/2019	325		INDIA	308900	
16/1/2020	150	14250	INDIA	308900	
5/2/2020	250	68750	INDIA	308900	
17/2/2020	150		INDIA	308900	
9/3/2020	300	82500	INDIA	308,900	
19/3/2020	150	41250	INDIA	308,900	

Siera Limited factory

Siera Limited factory (Table 2) sources for its raw materials mostly from Australia (Australian sandalwood) and to the little extent from India (Indian Sandalwood) and from Uganda, South Sudan, (African sandalwood), Dubai and China (pers. Comm. manager, Sierra Ltd, June 2022). This factory exports sandalwood oils and spent dust mainly to India, United Arab Emirates, Taiwan, China, Australia, Singapore and Sudan as well as Dubai through Kilimanjaro International Airport, Julius Nyerere international Airport and Dar es Salaam Port.

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Table 2: Snapshot of import and export of sandalwood oil by Siera ltd in Babati Manyara				
Importer Name	**Consignment Value**	**Origin Country**	**Import Port**	**Quantity**
SIERRA LIMITED	212906.4 USD	Australia	Dar es salaam Port	24.472 Tons
SIERRA LIMITED	300000 TZS	Australia	Dar es salaam Port	24.472 Tons
SIERRA LIMITED	300000 TZS	Australia	Dar es salaam Port	24.472 Tons
SIERRA LIMITED	300000 TZS	Australia	Dar es salaam Port	24.472 Tons
SIERRA LIMITED	150000 TZS	United Arab Emirates	Dar es salaam Port	12624 Kg
SIERRA LIMITED	212906.4 USD	Australia	Dar es salaam Port	24.472 Tons
SIERRA LIMITED	225515 USD	United Arab Emirates	Dar es salaam Port	8510 Kg

Plate 3: Mr. Samson Hilonga from MUHAS left and Mr. Ashish Upadhyay, Managing Director of the Sierra Sandalwood Factory Ltd-Babati,

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Afro-Aromatics Factory

On the other hand Afro-Aromatics Factory in Mombo-Tanga Imports sandalwood raw materials from East Africa (*Osyris lanceolata*), they import *Osyris* from Congo through Tunduma border and Kigoma; another import is from Uganda through Mutukula border and they also import *Osyris* from South Sudan through Uganda via Mutukula to Tanzania).

The factory exports Sandalwood oil to Dubai, USA and India through Port of Tanga and sometimes through Julius Nyerere international Airport

Plate 4: From Left Mr. Samson Hilonga (MUHAS), Mr. Abdul Samad-Managing Director Afro Aromatic Limited and Mr. Shan from Afro Aromatic Limited Mombo

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Plate 5: Facility for sandalwood essential oil extraction at Afro Aromatic Limited Factory Mombo

Plate 6: Sandalwood dust ready for export

Visit at the Tanga port recorded various companies involved in export of Sandalwood oil and other products such as Cielmac (T) LTD, Coastal Consortium LTD, Liverpool LTD (Table 3) however the sources fo their products is not indicated. The researchers could not have access to detailed information due to access limitations to the information.

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Table3: Export of forest product -sandalwood (2006-2021,) Tanga port

S/N	NAME OF EXPORTER	TYPE OF FOREST PRODUCTS	SPECIES	TONS	REVENUE COLLECTED	COUNTRY OF DESTIN
1	CIELMAC (T) LTD	OIL	SANDAL WOOD	0.3	285,000.00	USA
2	COASTAL CONSORTIUM LTD	OIL	SANDAL WOOD	0.15	140,000.00	NIL
3	LIVERPOOL LTD	OIL	SANDAL WOOD	0.2	145,000.00	DUBAI
4	LIVERPOOL LTD	OIL	SANDAL WOOD	15	50,000.00	MOMBO
5	COASTAL CONSORTIUM LTD	OIL	SANDAL WOOD	0.004	255,780.00	NIL
6	AFRO AROMATIC LIMITED	SANDAL WOOD	INCENSE POWDER	80	762,000.00	INDIA
TOTAL COLLECTION				95.654	1,637,780.00	

3.3. Trade control and monitoring

3.3.1. Control at the Checkpoints

There was no separate record of *Osyris lanceolata* products through the checkpoints in Babati, Kondoa and Handeni districts. Responsible officers at the checkpoints are not instructed to point out Sandalwood and other restricted species that are shipped across the checkpoints. The attention is on timber and logs as these are conspicuous. Sandalwood are transported in equivalency with other firewood that are allowed through with minimum checkup. Sandalwood are often harvested from public forests. According to the governing laws, traders have permits to harvest/trade logs for firewood or timber if harvested from the certified sources or public forests.

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Plate 7: Mr. Samson Hilonga from MUHAS left and Forest Conservators at the TFS Checkpoint in Babati

3.3.2. Control at the national level

According to TFS, Tanzania has banned trade on Osyris lanceolata. This government decision was officially announced in 1993 to serve the species from overexploitation. Various conservation concerns on *Osyris lanceolata* are reported as deliberations of official meetings.. The need of conducting detailed research on the *Osyris lanceolata* (East African sandalwood) was first mentioned in the workshop on "Setting Forestry Research Need and Priorities" held in Moshi Tanzania in 1997. Through the workshop, stakeholders were informed on a threat facing the species over the past five decades in Tanzania. The matter re-emerged in the "Eastern Arc Biodiversity Conference" held in Morogoro in 1997. In both sessions, it was agreed to conduct research on: 1) resource availability in the country, and 2) development of suitable techniques for propagation and cultivation of the species (Mwang'ingo, and Mwihomeke, 1997).

Since then, researches on sandalwood have been conducted in Tanzania. In the first phase (2000 - 2010) studies were focused on resource assessment and reproductive biology (techniques for propagation and cultivation). Annex 1 (a copy and paste table from a consultant report for Output 2 in this project) that presents previous researches in Tanzania from the 2000s to the present.
Currently, the harvesting licensing system involves the villages located near the forest and the district harvesting committee, which is under the District Commissioner. A person who wish to harvest forest produce from natural forests must be discussed at village government level. The applicant must pay costs of convening the meetings to sustain the village committees. After approval by the village committee, his/her application is submitted to District Harvesting Committee to be discussed. Once he/she is approved, the applicant gets a license from forest owners (TFS for NFRs, District Council for LAFRs and Village Council for VFR) (Forest Act No. 4 of 2002).

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However, before the trade of *O. lanceolata* was banned or even a period when illegal harvesting of the tree dominated, the tree was harvested in both reserved and unreserved. The most preferred harvesting regime was uprooting the whole tree. A reason for this was a fact that the most preferred part of the tree is the root and a small proportion of the root collar. This has resulted in adopting uprooting as a harvesting method. Uprooting has wiped out the tree in other areas of the country. The fact that roots are more preferred for the high content of essential oils is a threat to the existence of the tree (FBD, 2007).

Tanzania has up to date rules and guidelines governing transportation of forest produce within the country. For instance, in 2019 the Tanzanian government through the MNRT issued a new Government Notice (GN 417 published on 24/5/2019) which among other things deals with transportation of forest produce. According to the regulation, a person who needs to move forest produce should have the followings: (a) a Forest Produce Allocation Certificate; (b) a transit pass; (c) a license to fell and collect forest produce; (d) a certificate of registration as a forest produce dealer; and (e) a government receipt. The regulation also stated time of transporting forest produce, which is from 6.00 am to 6.00 pm on the routes and means of transport stipulated in the transit pass (URT, 2019b).

Plate 8: Mr. Samson Hilonga from MUHAS and Forest Conservators from Tanzania Forest Services Agency (TFS) Babati

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4. CONCLUSION

Trade on *Osyris lanceolata* has been active in Tanzania for sometime up to 2006 when the government officially imposed ban on export of *O. lanceolata* logs allover the country. The study carried out in the northern corridor of Tanzania mainland did not record any current harvesting from the natural forests implying the effectiveness of the state decree to stop harvesting of the species in the past 14 years. The ban has allowed fast regeneration of the species thus giving bright future prospects on the standing stock in Tanzania. Besides local harvesting, there is import of raw materials of the same species from Southern Sudan, Uganda and Democratic Republic of Congo to the local factories in Tanzania that extract and export Sandalwood oil overseas mainly to India, China, Saudi Arabia, Dubai, Singapore, Australia and USA through the major Airports. Raw materials are imported from South Sudan and Uganda through Mutukula border while those from DRC are imported through Kigoma and Tunduma border. More imports of Australian and Asian Sandalwood are imported to Tanzania through the Dar es Salaam, Tanga harbors.

Generally there is insufficient tracking and records of the actual trade volumes of the species in the region. The claim that local harvesting in Tanzania is totally checked can not be substantiated due to lack of data. There are more dealers in Sandalwood oil trade but the sources of their products for export is not fairly recorded.

The study has however created a threshold for knowing trade trends in Tanzania. The regulatory authorities have a pending task of following up and record the actual trade volumes along the trade chain in Tanzania. The notion that the trade is banned in Tanzania can not replace the urgency of strengthening monitoring, control and recording. The trade requires regional collaboration as the trade chain transcend individual country borders within the East Africa region. While Tanzania is enjoying importation of raw materials from the sister states in the region, there is a need of collaborative surveillance to ensure this import doesn't harm diversities of the species in the source countries.

The economic contribution of the species to the regional economy is outstanding. Therefore, there is an avenue for expanded sell and export of Sandalwood in the future by supporting stock buildup through *ex-situ* planting in public and private lands. *In-situ* enrichment planting in the forests is a potential strategy to ensure fast regeneration of the available stock. For the meantime

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the importation of raw materials from other regions outside East Africa help to buffer the shortage by keeping the local factories running thus creating employment while the local stock is building-up.

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Annex 1: Research reports for various studies conducted on Osyris laneolata in Tanzania from 2000s

SN:	#1
Year:	2016
Researchers:	Emmanuel Japhet
Research topic:	Preserving the Endangered Tree Species *Osyris Lanceolata* through Ex-Situ Conservation in the Eastern Arc Mountain (Case Study – Chome Nature Reserve (CNR), Tanzania
Focus area:	Biology and Economy
Objectives:	1. Identifying and assessing the composition, the constraints and interventions for increasing the productivity of the Homegarden around CNR; 2. Identifying and assessing potential components (wood perennial livestock) for integrating in the Homegarden; 3. Building capacity (train) farmers on production of desired woody perennials and *O. lanceolata* and integrating them in their Homegarden; and 4. Applying air laying, cuttings and wildling to produce *O. lanceolata* seedling and seed for production of desired woody perennials
Study sites:	Chome Nature Reserve in South pare Mountain Block, Same District, Kilimanjaro Region
Methodology:	1. Socio-economic survey – households surveys (60 households; 30 in each village), Focus Groups Discussion and Key informant interviews in two purposively sampled villages (Mhero and Ndolwa). 2. Biological survey (inventory) in Chome Nature Forest Reserve – two transects. 3. Capacity enhancement - six on farm training workshops, three in each village.
Key findings:	1. The potential components for integrating *O. lanceolata* in the Homegarden are wood perennial (e.g. Albizia schimperiana), livestock (e.g cattle, goats and poultry) while agricultural crops (e.g. maize, bananas and coffee spp). Constraints identified were many, include lack of germplasm. 2. 120 villagers were trained on production of *O. lanceolata* through Air layering and cutting method. Along with, a total of over 1000 seedlings of a desired woody perennial and over 500 *O. lanceolata* were produced.
Source:	Japhet (2016).

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Research status:	Finished
Financier:	Not available
SN:	#2
Year:	2015
Researchers:	Victoria Rementone Shayo
Research topic:	Conservation status of *Osyris lanceolata* in northern Tanzania a case study of Ngorongoro conservation area and Karatu forests in Arusha
Focus area:	Ecology and Economy
Objectives:	1. Assess regeneration of the species 2. Determining utilization patterns of *O. lanceolata* by adjacent communities
Study area:	Karatu and Ngorongoro Districts, Arusha, Tanzania
Methodology:	1. Forest assessment (inventory) – to regeneration of the species 2. Socio- economic surveys - 98 structured questionnaires; two focus group discussions and four key informant interviews
Key findings:	1. Stems density in both protected and unprotected forests were 442stems/ha and 263stems/ha and the mean volume of standing wood was 853.2cm3/ha and 577.1cm3/ha, respectively. 2. Densities of saplings, seedlings and coppices were 28/ha, 246/ha and 68/ha in the protected but were 6/ha, 154/ha and 14/ha in unprotected area. 3. Uses of *O. lanceolata* reported include: for medicinal purposes (3% of respondents), and for selling (6% of respondents).
Source:	Shayo, 2015
Research status:	Finished
Financier:	Not available
SN:	#3
Year	2015
Researchers:	Dickson Kalabamu Xavery and Tilaye Feyissa
Research topic:	Prospects of Biotechnological Approaches for propagation and improvement of threatened African Sandalwood (*Osyris lanceolata* Hochst & Steud)
Focus area:	Biology
Objectives:	To present on the prospects of biotechnological approaches for propagation and improvement of threatened African Sandalwood (*Osyris lanceolata* Hochst & Steud)
Study area:	-
Methodology:	Review of articles
Key findings:	1. Commercial success of *Osyris lanceolata* is hindered by the slow conventional propagation through root suckers or seeds

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	In vitro regeneration method is required for the large scale production of African sandalwood to exploit its potential as commercial plant.
Source:	Xavery and Feyissa, 2015
Research status:	Finished
Financier:	Not available
SN	#4
Year:	2010
Researchers:	PL Mwang'ingo, G Kibodya and AR Mng'ong'o
Research topic:	Oil yield and quality variation between sexes in *Osyris lanceolata* (African sandalwood) and its value as a fodder plant in Tanzania
Focus area:	
Objectives:	1. To determine oil yield and quality variation between sexes in *Osyris lanceolata* 2. To determine of nutritive value and suitability of species as a fodder plant in order to add value and encourage farmers to raise the species due to its multiple uses for optimum profit.
Study area:	Four forests namely Image, Nundu, Sao Hill and Lushoto in, Tanzania.
Methodology:	1. Laboratory analysis - distillation to extract the oil using the standard procedures of Association of Official Analytical Chemist (AOAC 1990). This was done to determine oil yield and quality 2. Laboratory analysis - nutritive value (dry matter -DM, Crude Protein, crude fibre, ash, and nitrogen-free extract [NFE]) of the leaves and fruits/berries as per standard procedures outlined by AOAC (1990).
Key findings:	1. The highest oil yield was 9.32 ± 0.611%, and there was no significant variation ($p = 0.856$) in oil yield between sexes. The result also showed that sexes did not differ significantly ($P = 0.655$) in oil quality 2. Results on nutritive showed that the plant have 15.9–19.7% crude protein, 15.9–24.0% crude fibre,0.77–0.81% fat/oil, 97.5–97.8% dry matter, 8.5–10.3% ash content, 72.2–72.4% digestibility.
Source:	Mwang'ingo et al., 2010
Research status:	Finished
Financier:	Not available
SN:	#5
Year:	2007
Researchers:	Mwang'ingo, P.L. 2 Teklehaimanot, Z., Hall, J.B., and Zilihona, J.E.I
Research topic:	Sex distribution, reproductive biology and regeneration in the dioecious species Osyris lanceolata (African sandalwood) in Tanzania

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Focus area:	Reproductive biology - phenological (flowering and fruiting), plant-pollinator interactions and sexual systems of the species
Objectives:	1. Assessing the spatial distribution of tree sexes in *O. lanceolata* populations and whether this has any significance in influencing the reproductive success and regeneration; 2. Documenting the phenological events that occur between flowering and fruiting and their respective intervals; 3. Examining the reproductive success of the species through pollination experiments and determine whether agamospemy behaviour exist in *O. lanceolata*; and 4. Assess the potential and mode of natural regeneration in the species and recommend the necessary procedures and protocols for its successful recruitment.
Study area:	Forests of Bereko in Babati District, Gubali in Kondoa District, Image in Iringa District, Mgwashi in Lushoto District, Nundu in Njombe District and Sao hill in Mufindi District for assessing sex distribution and regeneration in *Osyris lanceolata* and Sao Hill for assessing reproductive sequence and success
Methodology:	1. Assessment of sex distribution – the use of a sample plot by adapting the nearest tree neighbor distance method as described by Krebs (1998). 2. Field experiment – 10 trees, 5 from each sex were randomly selected in Sao Hill, observed and recorded at two days intervals.
Key findings:	1. Image forest had the longest distance between plants of opposite sex (male and female), which was 23.48 ± 1.41 m followed by Nundu, Sao Hill, Bereko, Mgwashi and Gubali forests. 2. Half of female flowers withered within 29-31 days while male flowers withered within 31 to 38 days. 25% of the mature unripe fruits became ripe within 27.7± 8.8 days since bud initiation and more than 75% were ripe in 162.6 ± 17.0 days. The time taken from flower initiation until when ripe fruits are formed is about 104 days. 3. Assisted pollination had a greater proportion of fruits formed with a mean of 79.3 ± 1.5% while natural pollination had 72.9 ± 1.2%. 4. The plant can regenerate from both seeds and coppice/rootstock but rootstock/coppice source had more regeneration (19.4 individuals/ha) compared with seeds source that had a mean regeneration of 12.2 individuals/ha. 5. There is difference in time of flowering between males and females. Females had their flowers opened almost two days

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	before males.
Source:	Mwang'ingo, *et al.,* 2007
Research status:	Finished
Financier:	Finnish International Development Agency (FINNIDA) through Finnish Support to Forestry Research in Tanzania (FORST Project) in collaboration with Tanzania Forestry Research Institute (TAFORI)
SN:	#6
Year:	2006
Researchers:	P.L. Mwang'ingo, Z. Teklehaimanot, L.L. Lulandala & S.M. Maliondo
Research topic:	Propagating *Osyris lanceolata* (African sandalwood) through air layering: Its potential and limitation in Tanzania
Focus area:	Reproductive biology
Objectives:	1. Assessing the effect of time at which air layers are initiated (i.e. February, June, September and December); and 2. Examining the influence of IBA as rooting promoter at three concentrations (50, 100 and 150 ppm).
Study area:	Sao Hill, Mufindi District, Iringa Region, Tanzania
Methodology:	Experiment - Air layers were initiated on the young shoots (1 – 2 years old) of mature *O. lanceolata* trees, rooted layers were detached, potted in polyethylene tubes and reared at the nursery for a further three months.
Key findings:	1. Rooting success of up to 80% can be achieved from air layers, thus the propagation technique a viable alternative to seedlings or cutting propagation. 2. Rooting success was influenced by both the season and application of rooting hormone with optimal rooting being achieved during June and September with the addition of IBA at a rate of 50 ppm.
Source:	Mwang'ingo, et al., 2006 (Abstract)
Research status:	Finished
Financier:	Finnish International Development Agency (FINNIDA) through Finnish Support to Forestry Research in Tanzania (FORST Project) in collaboration with Tanzania Forestry Research Institute (TAFORI)
SN:	#7
Year:	2005
Researchers:	P.L. Mwang'ingo, Z. Teklehaimanot, L.L. Lulandala and S.T. Mwihomeke
Research topic:	Host plants of *Osyris lanceolata* (African Sandalwood) and their influence on its early growth performance in Tanzania

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Focus area:	Ecology and reproductive biology
Objectives:	1. Investigating the potential host species of *O. lanceolata* in Tanzania through soil excavation in natural populations; and 2. Assessing influence of different host plants in its early growth.
Study area:	1. Three natural forests namely Image, Nundu and Sao Hill for identification of host plants. 2. Iringa Zonal Tree Seed Centre for assessing influence of host plants on the early performance of *O. lanceolata*
Methodology:	1. Field study that involved excavation of the soils up to a distance of 3 m in radius from the base of each tree – for identification of host species 2. On station experiment - six treatments of 12 containers each and replicated three times, making a total of 216 containers, which were laid out in a randomised complete block design.
Key findings:	1. Forty nine plant species were identified as hosts of *O. lanceolata*. 2. Male and female plants of *O. lanceolata* had no preference with both sexes occurring in more than 80% of hosts. 3. Experiment results show that plant height, root collar diameter, and root & shoot biomasses in *O. lanceolata* were all significantly affected by host species. 4. By the age of 12 months, *O. lanceolata* grown with *B. speciformis* were the tallest (62.6 cm) while large plants in terms of diameter were those grown with *C. equisetifolia* (10.3 mm). *O. lanceolata* grown with *R. natalensis* had the highest root biomass (8.84 g) while shoot biomass was more in *O. lanceolata* grown with *C. equisetifolia* (10.67 g).
Source:	Mwang'ingo, et al., 2005
Research status:	Finished
Financier:	FINNIDA through Finnish Support to Forestry Research in Tanzania (FORST) in collaboration with Tanzania Forestry Research Institute (TAFORI)
SN:	#8
Year:	2004
Researchers:	P.L. Mwang'ingo, Z Teklehaimanot, Maliondo, S.M., Msanga H.P
Research topic:	Storage and pre-sowing treatment of recalcitrant seeds of Africa sandalwood (Osyris lanceolata)
Focus area:	
Objectives:	1. To evaluate how seeds of *O. lanceolata* could be stored at least for short-term supply by manipulating the seed moisture content and storage temperatures during storage, and 2. To assess the influence of various pre-sowing treatments on

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	germination and early growth of seedlings in the nursery as the first step towards successful domestication of the species.
Study sites:	Iringa Zonal Tree Seed Centre, Tanzania, using seed material collected from the Sao Hill Forest in Mufindi, Tanzania. Sao Hill forest is a small forest located within a large forest plantation project, which was left purposely to serve as a catchment forest.
Methodology:	1. Fruits were collected from 15 mature trees, stored in plastic bags and transported to Iringa Zonal Tree Seed Centre for further process, including removal of the pulp, drying in the shade to the desired moisture content (15, 20, 25 and 30%). The storage temperatures assessed were –1 to 1 ºC, 3 to 5 ºC, 8 to 10 ºC and 13 to 15 ºC. Seed viability was assessed through a simple cut and inspection test (a topographic tetrazolium test). 2. Germination and early growth of *O. lanceolata* was tested by subjecting seeds in the following treatments: (1) soaking seeds in tap water in the ratio of 1:2 (seed volume: water volume) for 12 hours; (2) soaking seeds in ready boiled water (100 ºC) in the ratio of 1:2 and left to cool for 12 hours; (3) seed nicking by red hot wire (1 mm) to break the testa; (4) total removal of seed coat; and (5) a control (untreated). Treated seeds were then sown in the nursery bed using sand as a growth medium.
Key findings:	1. Seeds stored at 3-5 ºC, after being dried to moisture content of 20% retained viability longer than those stored at other conditions. Rate of viability loss per week was 0.5%, thus by the end of the 36th week, the viability was 60%. Temperatures below 3 ºC and over 13 ºC decreased rapidly the life span of seeds. Moisture content below 15% and over 25% were also noted to be lethal. 2. Complete removal of the seed coat and soaking in hot water enhanced seed germination (66.5% and 57.5%, respectively), shortened the time of seed to commence germination and promoted early seedling growth.
Source:	Mwang'ingo et al., 2004 (Paper)
Research status:	Finished
Financier:	Funding from Finnish Support to Forestry Research Project in Tanzania (FORST) in collaboration with Tanzania Forestry Research Institute (TAFORI)
SN:	#9
Year:	2004
Researchers:	Z. Teklehaimanot, P.L. Mwang'ingo, A.G. Mugasha & C.K. Ruffo
Research topic:	Influence of the origin of stem cutting, season of collection and auxin

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	application on the vegetative propagation af African Sandalwood (*Osyris lanceolata*) in Tanzania
Focus area:	
Objectives:	1. Examining the effect of season at which cuttings are collected i.e. December, February, June and September; 2. Examining the effect of origin of stem cutting in a shoot, i.e. basal and terminal portions; and 3. Assessing the effect of different levels of IBA as root promoters, i.e. 0, 50, 100 and 150 ppm.
Study area:	Tanzania Tree Seed Agency, Iringa Zone, Tanzania
Methodology:	Experiment at a tree nursery – three treatments: 1) season of cuttings collection, 2) origin of stem cutting in a shoot, and 3) different levels of IBA as root promoters
Key findings:	1. Stem cuttings collected from the sprouting stumps have a potential to be used in propagating *O. lanceolata.* 2. Season at which cuttings are collected; origin of the stem cuttings in a shoot and application of auxins influenced the rooting success. 3. Stem cuttings collected in September, originating from the basal portion had the best rooting (43.8 ± 3.9%). 4. Auxin application in interaction with the season at which cuttings were collected enhanced the number of cuttings that rooted, the number of roots formed (13 ± 0.4), the length (14 ± 0.3 em) and biomass of roots (6.95 ± 3.9 g) produced. 5. Basal portions had better rooting than the terminal portion.
Source:	Teklehaimanot, *et al.,* 2004 (Abstract)
Research status:	Finished
Financier:	Not available
SN	#10
Year:	2003
Researchers:	P.L. Mwang'ingo, Z.Teklehaimanot, J.B Hall and L.L.L. Lulandala
Research topic:	African sandalwood (*Osyris lanceolata*): Resource assessment and quality variation among populations in Tanzania
Focus area:	Ecology and biology
Objectives:	1. Assessing current resource status of African sandalwood, 2. Assessing variation in quantity and quality of oil produced among populations, and 3. Investigating the overall composition of the oil in the plant
Study area:	Six forests in Tanzania namely: 1) Mgwashi in Lushoto District, 2) Bereko in Babati District, 3) Gubali in Kondoa District, 4) Nundu in Njombe District, 5) Mufindi in Iringa, and 6) Image in Iringa

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Methodology:	1. Forest inventory to assess current status, and 2. Laboratory analysis sandalwood oil quality by determining the percentage of odoriferous sesquiterpenic alcohol compound known as santalol
Key findings:	1. Higher tree density was found in northern ecozone (i.e. in Mgwashi, Bereko, and Gubali forests than in southern ecozone (Nundu, Mufindi, and 6) Image forests. 2. Tree from Gubali Forest was relatively rich in oil followed Nundu, Bereko, Sao hill, Lushoto, and Image. 3. Best oil was found in tree from Bereko because of containing more santalol percentage (content) followed Lushoto, Gubali, Nundu, Image and Sao hill.
Source:	Mwang'ingo, *et al.,* 2003.
Research status:	Finished
Financier:	Finnish International Development Agency (FINNIDA) through Finnish Support to Forestry Research in Tanzania (FORST Project) in collaboration with Tanzania Forestry Research Institute (TAFORI)
SN:	#11
Year:	2002
Researchers:	Patrick L.P. Mwang'ingo
Research topic:	Ecology and Silviculture of Osyris Lanceolata (African Sandalwood): An Aromatic Tree of Tanzania
Focus area:	Ecology and Biology
Objectives:	1. To characterize the current status of *O. lanceolata* in Tanzania with a view of: a) assessing the current status of the populations of *O. lanceolata* in Tanzania in terms of size class and gender distribution of the species, b) characterizing the ecological aspects of these populations in terms of associated species, climate and soil characteristics, and c) assessing the status of natural regeneration in these populations. 2. To assess the reproductive biology of the species by examining: a) the phonological events that occur between flowering and fruiting, and b) the reproductive success of the species through pollination and experiments 3. To assess the chemical composition and quantity of sandalwood oil from different populations of *O. Lanceolata* in Tanzania 4. To identify possible hosts of *O. lanceolata* in Tanzania 5. To evaluate how possible seeds of *O. lanceolata* can be stored at least for short term supply by manipulating moisture content and storage temperature 6. To assess the influence pf various pre-sowing treatments that can enhance germination and early growth of seedlings in the nursery as the first step towards successful domestication of the species.

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	7. To investigate the possibility of raising *O. lanceolata* through vegetative means to supplement and provide an alternative to the use of seeds
Study sites:	Six forest in Tanzania namely: 1) Mgwashi forest in Lushoto District, 2) Bereko (a part of Bereko Forest Reserve) in Babati District, 3) Gubali forest in Kondoa District, 4) Nundu forest reserve in Njombe District, 5) Sao Hill forest (part of Sao Hill Forest Plantation) in Mufindi District , and 6) Image forest reserve in Iringa District; and Iringa Zone Tree Seed Centre
Methodology:	1. Laying out sample plots to assess population of *O. lanceolata*, status of natural regeneration and assessment of associated plant species – this was conducted in six sampled forests 2. Experiment to assess reproductive biology (reproductive process, and reproductive success - this was conducted in Sao Hill 3. Laboratory analysis for oil content between root and shoot of the same tree. Tree samples were collected from all six forests, dried and taken to the University of Wales Bangor for oil extraction and analysis. 4. Soil excavation in the field and nursery assessment to asses host plants 5. Experiment – involved collection of ripe fruits from Sao Hill forest, extraction of seeds, and analysis of moisture contents, which was carried in Iringa Zonal Tree Seed Center. 6. Vegetative propagation experiment – involved collection of matured and healthy trees at Sao Hill Forest and planted at Iringa Zonal Tree Seed Centre
Key findings:	1. Soil – slightly acidic in southern ecozone (nundu, image and Sao hill) and slightly alkaline in northen ecozone (Bereko, Gubali and Mgwashi). 2. Climate (rainfall) – Nundu (1500 mm) and Sao hill (950 mm) forests receive relatively high rainfall compared with all other four populations (forests). Other forests receive less than 800 mm. 3. Neighbor distance – the distance ranged from as close as 11.48 ± 0.61 m in Bereko to as far as 16.18 ± 0.94 m. 4. Tree density ranged from as little as 38 individuals per hectare in Sao Hill forest to as many as to 76 individuals per hectare in the Bereko forest. 5. Mean tree height - The mean total tree height ranged between 2.06 ± 0.05 m Mgwashi and 6.49 ± 0.17 m in Nundu forest reserve 6. Mean tree diameter – bigger trees were found in Nundu forest (mean DBH 8.6 ± 0.32 cm) while smallest trees were found Mgwashi (mean DBH 3.61 ± 0.05 cm). 7. Number of stems per tree – it ranged from as little as 1.5 ± 0.06 in Image to as many as 5.6 ± 0.49 in Sao Hill. 8. Natural regeneration – both seedlings and samplings were

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	observed. Seedlings were more abundant (51.96 ± 2.51 individuals per hectare) and formed 62% of total regeneration compared with saplings that were 32.43 ± 1.8, which contributed 38% to the total regeneration. 9. Associated plant species – 179 associated plant species were identified of which Image forest the most diverse with a total of 89 species and a mean density of 933 individuals and basal area of 53370 cm^2 per hectare. 10. Reproductive success - Assisted pollination had a greater proportion of fruits formed with a mean of 79.3 ± 1.5% while natural pollination had 72.9 ± 1.2%. 11. Sandalwood oil content – Wood from Gubali was relatively rich in oil (8.45 ± 0.54% out of wood materials) while wood from Image produced had least oil content (3.42 ± 0.29%) 12. Santalol variation as a measure of oil quality – Santalol content ranged from as low as 1.6 ± 0.2% in Sao Hill forest to 32.2 ± 1.2% in Bereko forest. 13. Sandalwood host plants – number of host plants differ between forests: Image (29 plants dominated by *Brachystegia spiciformis*), Sao Hill (16 plants dominated by *Rhus natalensis*), Nundu (18 plants dominated by *Aphloea theiformis*). 14. Storage of *O. lanceolata* seeds – At the end of 36 weeks, seeds with 20% moisture content were able to maintain significantly higher viability than those with other moisture contents (i.e. 25%, and 30%). 15. The best storage method of *O. lanceolata* seeds was 20% moisture content of seeds stored at 3 – 5º C. 16. The best pre sowing treatment technique was complete removal of the seed coat before sowing. This technique gave a germination of up to 66.5% as compared to 57.5% of soaking seeds in hot water. 17. Vegetative propagation involved stem cuttings and marcotts. The results shows that the species can be propagated through both stem cutting and marcotting. The use of auxins proved in promoting rooting in both stem cuttings and marcotting with IBA at 50 ppm.
Source:	Mwang'ingo, 2002 (PhD thesis)
Research status:	Finished
Financier:	Finnish International Development Agency (FINNIDA) through Finnish Support to Forestry Research in Tanzania (FORST Project) in collaboration with Tanzania Forestry Research Institute (TAFORI)

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Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

CITES Tree Species Programme (CTSP)

Project Title: Conservation and Sustainable Management of *Osyris lanceolata*, for Economic Development in East Africa

NON-DETRIMENT FINDING OF *OSYRIS LANCEOLATA* FOR TANZANIA

AUTHORS:

Dr. Joseph Nicolao Otieno and Samson Slaa Hilonga

Institute of Traditional Medicine, Muhimbili University of Health and Allied Sciences, Tanzania.

P. O.BOX 65001 Dar es Salaam Tanzania

onicolao@yahoo.co.uk

Tel: +255 784 412 625

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Tanzania Forest Service (TFS), communities in Babati and Kondoa Districts and local industries were so collaborative in availing information on trade and conservation of *Osyris lanceolata* in Tanzania. CITES Trees Species Programe kindly supported the project by 100% financially and as such CTSP is one of the central core of this NDF establishment in Tanzania

ABBREVIATIONS

CFR	Community Forest Reserces
CTSP	CITES Tree Species Programme
FBD	Forest and Bee keeping Division
ITM	Institute of Traditional Medicine
MUHAS	Muhimbili University of Health and Allied Sciences
NARFOMA	National Forest Resources Monitoring and Assessment of Mainland Tanzania
NDF	Non-Detriment Finding
URT	United Republic of Tanzania

RESUME

BACKGROUND INFORMATION ON THE TAXA

Osyris lanceolata Hochst. & Steud. ex A. DC. (Msandali in Swahili) provides high-value essential aromatic oil used as a fragrance and cosmetic ingredient. Due to this value, it has entered the international market as a substitute for traditional Asian sandalwoods (*Santalum spp*.). East African Sandalwood (*Osyris lanceolata*) is among the species known for producing fragrant-scented wood from which sandalwood essential oil used in perfumery, fragrance and medicinal industry is extracted.

Exclusive harvesting from wild sources and the growing international market with attractive prices is a threat to the species growing in the wild/forests in East Africa. Although the ban was made over harvesting and trading of the *O. lanceolata*, but there is no sufficient evidence of resource status and its future prospects. This is because of lack of current information on status of the plant species generated from national forest inventory. It is against this background that this proposed study is aiming to assess the NDF of current resource status of African sandalwood in Tanzania that is helpful prior to any export of a product listed in Appendix II of the CITES Convention. Despite the value of the species as a source of its aroma, it could also been a candidate for agri-business and one source income for rural populations if sustainable conservation is realized. .

I. MATERIAL AND METHOD

The information used to develop NDF in this study is based on the biological and trade chain data from Babati and Kondoa Districts. Market surveys involved local communities, regulatory authorities and markets outlets and borders.

Systematic sampling along the transect lines in sampling units were used as data sources for determination of annual quota including number of stems, basal area, volume and biomass per ha. Other parameter such as regeneration potential, associated tree species and distribution of the species was determined.

II. BIOLOGICAL DATA

Two Osyris species i.e. *Osyris lanceolata* Hochst. & Steud. ex A. DC and *Osyris compressa* (P.J.Bergius) A.DC) were recorded along each other in all sampling units. These are widely distributed with a concentration of (78%) of *O. lanceolata* in the Bush land of Northern and Southern ecozones. *Osyris lanceolata* is also distributed in woodlands of Southern Highlands (9%) and Eastern (2%), forest of Southern Highlands (2%), Bush land of Central (3%) and Grassland (6%) of Southern Highland zones.

Stand level parameters in term of number of trees (N), basal area (G), and biomass (B) are presented whereas the stem density ranged from 6 to 94 stems/ha (highest in Haisamu and lowest in Gedagerere village forests) and from 7 to 103 stems/ha(highest in Gidagewong and lowest in Sebas village forests). Forests in Kondoa were found to have relatively lower stem density compared to the former districts ranging from 1 stems/ha in Hachwito 12 stems/ha in Gubali village forests. Basal area and the AGB followed the same trend as the number of stems per ha ranging from 0.0001 to 0.096 m^2/ha and from 0.001 to 0.231 tones/ha, respectively. The total standing AGB is estimated to be 110.1, 183.38 and 45.9 tons respectively. It seems the ban on harvesting the species has helped stock build up significantly. The maximum DBH attained in the studies forests was 11.6 cm. The distribution of number of trees, volume and biomass per ha over diameter classes is presented. This implies that the species is in the regrowth phase after the harvest restriction. Associate tree species are also recorded

III. MANAGEMENT MEASURES OF OSYRIS LANCEOLATA IN TANZANIA

Following listing of *Osyris lanceolata* under CITES Appendix II, the government of Tanzania imposed harvesting ban in 2006. There are number of legislation regulating conservation of national diversity depending on the category of resource ownership from Central government, Game reserves, National Parks, Local government Authority and Village government. Community Based Forest Management has also proven potency to manage natural flora both in-situ and ex-situ

Despite the availability of all acts and regulation, and beside the ban to harvest the species that was instituted in 2016, the implementation and enforcement is weak in some districts to the

extent of creating avenues for sustained illegal harvesting. The estimated total biomass of sandal wood currently growing in Babati, Hanang and Kondoa districts is 339 tons including small tree down to 1 cm Dbh. It is clear that this amount is inadequate to feed the factory even for 1 year. It is therefore premature to think of any industrial harvesting of the species currently.

IV. UTILIZATION, TRADE, MONITORING, CONTROL, CONSERVATION AND PRECOUTIONARY PRINCIPALS

Tanzania has three factories that extract and export sandalwood oil oversees. Raw material for the factories are imported from Australia, Asia, Uganda, South Sudan and DRC. There is no evidence of local harvesting from Tanzania forests. Lack of information on local harvesting could be attributed to weak surveillance by the regulatory authorities. This destruct confidence in the use of monitoring schemes and effective implementation of available Acts and regulations

CONCLUSIONS AND RECOMMENDATIONS

Although *Osyris lanceolata* is widely distributed in Tanzania, there is no enough quantitative documentation that can justify legalization of harvesting in their range states. Meanwhile the available biomass in the study is inadequate to feed the local factories, it is therefore premature to think of legalizing harvesting of the species currently. Instead, there is urgent need to determine current status of the species country wide for a complete picture for establishment of NDF and for determining status for smooth local and international trade on the species. Relevant stakeholders should be sensitized to invest in this lucrative economic wing by engaging in ex-situ production of raw material

1. **BACKGROUND INFORMATION ON THE TAXA**

Osyris lanceolata Hochst. & Steud. ex A. DC. (Msandali in Swahili) provides high-value essential aromatic oil used as a fragrance and cosmetic ingredient. Due to this value, it has entered the international market as a substitute for traditional Asian sandalwoods (*Santalum spp*.). East African Sandalwood (*Osyris lanceolata*) is among the species known for producing fragrant-scented wood from which sandalwood essential oil used in perfumery, fragrance and medicinal industry is extracted. Apart from its use in the fragrance industry, sandalwood oil finds its use in medicine, and is considered to have narcoleptic effect. On the other hand, sandalwood tree also yields edible berries (fruits), used extensively as a dietary supplement in dry lands areas of Tanzania where it is mostly found.

The species provides high value essential aromatic oil used as fragrance, herbal and cosmetic ingredient (Thshisikhawe, 2012). Harvesting of *O. lanceolata* for use in the perfumery and fragrance industry has been concentrated in Tanzania as there are four sandalwood processing factories that were established and licensed in 2004. However, due to shortage of raw materials, two were closed down and only two factories are in operational in Babati, Manyara Region and another in Dar es Salaam. This factory sources its raw materials from outside Tanzania mainly from other African countries, Asia and Australia.

Exclusive harvesting from wild sources and the growing international market with attractive prices is a threat to the species growing in the wild/forests in East Africa. Along with, the high demand for the Sandalwood oil and restricted access to traditional sources due to diminishing populations has led to overexploitation of *O. lanceolata*. In Tanzania, *O. lanceolata* is exploited through unsustainable smuggling and poaching from natural forests and woodlands. Tanzania have Decreed trade control from the wild harvesting whereas in 2006, the Tanzanian government reinforced the ban exports of logs and sandalwood and suspended tree harvesting in protected natural forests in order to address illegal logging (ICTSD, 2006).

Although the ban was made over harvesting and trading of the *O. lanceolata*, but there is no sufficient evidence of resource status and its future prospects. This is because of lack of current information on status of the plant species generated from national forest inventory. Previous

studies that have reported the resource status of the plant species are site specific (e.g. Mwang'ingo *et al.,* 2003; URT, 2018), therefore, do not provide useful information for the country to be able to plan sustainable harvesting, conservation and improvement programmes. It is against this background that this proposed study is aiming to assess the current resource status of African sandalwood in Tanzania. The study will focus on research activities, biology and ecology of *O. lanceolate* and its control and traceability. The study intends to come up with a strategy to improve management of the plant species.

On the other hand, the listing of *O. lanceolata* in CITES Appendix II is a major contribution to the conservation of this species in East African countries. This act has drawn the attention of the national and international communities to the dangers of uncontrolled exploitation and export of *O. lanceolata*. A fundamental obligation of CITES member countries, prior to any export of a product listed in Appendix II of the Convention, is a non-detriment finding-NDF. To obtain such information, there is need to know the location, distribution, stock, growth, ecology and the volumes exported of the said species. The study intended to come up with some basic information on the status that will help other activities in the project to be under taken as will guide for sustainable harvesting, utilization and for targeting some populations for conservation and improvement programmes.

Sandalwood resource in Tanzania has ever been declining since its identification in 1900s as an important source of the oil. Pressure to overexploit the resource increased further in 1990s following a serious decline in the resource base of Indian sandalwood (*Santalum album*), a species known to yield the best sandalwood oil in the world. For example, a study done in 17 districts of Tanzania in 2006 revealed that there was hardly enough sandalwood in Tanzania to support industrial investment as a result, harvesting of the species was banned to date.

Excessive harvesting from wild sources and the growing international market with attractive prices was a threat to the species growing in the wild/forests in East Africa leading to overexploitation. Tanzania developed guidelines for controlling trade in wild-harvested specimens of the species, especially for the threatened ones. Thus, in 2006, the Tanzanian

government reinforced the ban on exports of logs and sandalwood and suspended tree harvesting in protected natural forests to address illegal logging and increase its natural regeneration.

Despite the value of the species as a source of its aroma, it could also been a candidate for agri-business and one source income for rural populations. However, domestication is handicapped by a lack of knowledge on appropriate sylvicultural practices and sustainability. Domestication of Sandalwood can be an alternative and quick option of increasing its population by being planted in woodlots and plantations. In meeting this task, a study on developing a propagation protocol and facilitating the adoption of appropriate silviculture practices for domestication and sustainable management of Sandalwood by public and private actors was initiated through the sponsorship of the CTSP for 2020/2021 in Kenya, Uganda and Tanzania.

I. MATERIAL AND METHOD

1.1. **Study area**

The information used to develop NDF in this study is based on the biological and trade chain data. Biological information was derived from the inventory done in Babati and Kondoa Districts.These districts were selected because they support the growth of the best quality *O. lanceolate* in terms of santalol content (32 %) in Tanzania (Mwangingoet al 2003). The quality of this species is based on santalol content. Locations and forests with high concentration of *O. lanceolata* outside protected areas was selected since harvesting in these areas is likely to be allowed. Most of these areas were Village Land Forests.

1.2. Method

1.2.1. Background information on Non detriment findings *(Background information in this section 1.2.1 is copy and pest of a report by NDF report on Bubinga tree species in Cameroon by Jean Lagarde 2018 as it is a cutting across and common fact)*

Ensuring trade is within sustainable limits is at the core of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). According to the Convention, Parties shall allow trade in specimens of species included in Appendices II only if the Scientific Authority of the State of export has: (a) Advised that “such export will not be detrimental to the survival of that species" (Article IV); and (b) Determined that the export of specimens of any

such species should be limited in order to maintain that species throughout its range at a level consistent with its role in the ecosystems in which it occurs and well above the level at which that species might become eligible for inclusion in Appendix I (Article IV).

There is a notable variety of approaches and methodologies for formulating Non-detriment findings (NDF) that, should be considered and respected, given that they respond to available instruments and capacities. The key schemes used todate include: (1) the International Expert Workshop on Non detriment findings" held in Cancùn/Mexico, 17-22 November 2008 which developped the first guidelines for making NDF, (2) the Expert meeting on development of guidance and training for CITES non-detriment findings (NDF) for plants" hosted by TRAFFIC in Mexico City, Mexico, 1-3 February 2012 which made the first test of the Mexico 2008 guidelines and developped the second draft of guidelines, (3) NDF schemes developed during the first phase of the ITTO-CITES programme (2008-2011), (4) the training workshop on NDFs organised in Hanoi, Viet Nam, in October 2012, hosted by the CITES Management Authority for Viet Nam which tested the second draft and yielded the third draft of guidelines, (5) Resolution Conf. 16.7 on Non-detriment findings1 [http://www.cites.org/eng/res/16/16-07.php] as a result of the precedent steps, (6) the NDF guidance for perennial plants proposed by the Federal Agency for Nature Conservation (BFN) of the Germany (Leeman and Oldfield 2014), (7) the document (PC21 Inf. 4) on "Non-detriment findings for timber imports from Central Africa: stepwise approach of collecting documentation on carrying capacity of *Pericopsis* populations" proposed by the Belgium's CITES Scientific Authority, (8) and the expert meeting on practical guidance on NDF organised in Guatemala city, Guatemala, from 16th to 19th September 2015 within the ITTO-CITES programme/Phase 2/project "Non-detriment findings: practical guidance for trees included in CITES" supported by the management authorities of Guatemala and Spain.

Following what precedes, it is clear that there is no single, hard-and-fast guideline for making NDF, and the Parties had already expressed their concern about this issue. Rather than providing a rigid methodological framework, a Manual containing a flexible methodological framework should be adopted from which the Parties might find the best option to use. We report here after the three main schemes developped for making NDF, including the Cancùn/Mexico expert workshop, the Resolution Conf. 16.7, and the BFN guidance.

The Cancùn/Mexico expert workshop held in 2008 proposed guidelines with five elements including: (1) Distribution area, (2) population information, (3) management measures and harvesting systems, (4) contrôle and monitoring, and (5) conservation and precautionnary principle.

The Resolution Conf. 16.7 adopted by the CoP in 2013 proposed 8 elements for making NDF including (1) species biology and life history characteristics, (2) species range (historical and current), (3) population structure, status, and trends (in the hervest area, nationally, and internatiollay), (4) threats, (5) historical and current species speific levels and patterns of harvest and mortality (eg. Age) from all sources combined, (6) management measures currently in place and proposed, including adaptive management strategies and consideration of levels of compliance, (7) population monitoring, and (8) conservation status.

The EU-guidelines for making NDF developped by the BFN propose 9 elements including : (1) review specimen identification, (2) review origin and source of specimen, (3) review relevant exclusions and previously made NDF, (4) evaluate conservation concerns, (5) evaluate intrinsic biological risk, (6) evaluate harvest impacts, (7) evaluate trade impacts, (8) evaluate if management rigourous is appropriate to severity of concerns, risand impacts (appropriate and precautionnary management), (9) make a non-detrient finding or provide related advice (positive advice or negative advice).

In this document, we use the guidelines proposed by the Cancùn/Mexico workshop, considered as the most effiscient for two reasons: (1) it summarizes the core areas proposed by the BFN, and (2) data can easily be available at the Cameroon level.

1.2.2. Occurrence, distribution area, and population information of Osyris lanceolata in Tanzania

Area of extent occurrence and area of occupancy of *O. lanceolata* were estimated based on the consultant report by Dr Consolatha Kapinga of Tanzania Forest Research Institute (part of Output 2.1 of this CTSP supported project and the results of the forest management inventories conducted by the Tanzania Forest Service Authority in Tanzania. Also data from the major national wide inventory (NARFOMA) was used to supplement the inventory data.

1.2.3. General use and trade information

Trade information and general use was obtained from the local communities around the species hotsport forests, wildlife authority, Tanzania Forest Agency and the CITES authority and the factories involved in Sandalwood oil trade in Babati, Tanga (Mombo) and Dar es salaam

1.2.4. Determination of the national annual quota

1.2.4.1. Study design

In each selected forest, transects of 10 m width and different length depending on the size of the forest were laid out. The transects were parallel to each other and spaced at a distance of at least 250 m. In forests which were bordered by the main road, the transects were laid out perpendicular to the road. Depending on the size of the forest area, the number of transects ranged from 2 to 6. Within each transects, plots with a radius of 3 m were laid at every instance of encountering the *O. lanceolata* when traversing in the transect. The plot center was the location of the *O. lanceolata* stem. The number of plots depended on the frequency of encountering *O. lanceolata*. The plots aimed to collect data from the encountered *O. lanceolata* (regeneration and larger tree) and its associate tree species found within the plot area.The use and efficiency of this approach have been reported by different scholars (e.g. Buckland et al., 2007; Munishi et al., 2010; Peres, 1999). Number of plots and length of transects were determined for determination of sampling unit.

1.2.4.2. Data collection

The following measurement was taken in each plot:

a. For *O. Lanceolata* with dbh>1 cm:
    i. Diameter at beast height (Dbh); and
    ii. The Dbh and tree identity of all tree species within a radius of 3 m.
b. Regeneration counts of all *O. lanceolata* with dbh< 1 cm.

In addition, for forests with no information of forest area, we estimated the forest area

1.2.4.3. Data analysis

Stand parameters of *O.lanceolata*

Stand parameters of interest were the number of stems, basal area (G), volume (V), and biomass (B) per ha. The equations below was used to compute the stand parameters of the study species. Similar equation 1 were used to compute stand parameters for the associate tree species.

$$Y = \frac{\frac{\sum_i^k y}{a_j}}{m} \quad (1)$$

Where: Y is basal area, volume or number of stems per ha; y is the tree basal area, volume, biomass or number of a tree (y =1) of tree the $i$thtree of k trees in the plot or transect; and a is the area of the transect or plot j; and m is the total number of transects or plots.

The volume and biomass equation for miombo woodlands developed by Mauya et al. (2014) and Mugasha et al. (2013), respectively were applied to estimate the individual stem above ground volume and biomass.

1.2.4.4. Regeneration of *O. lanceolata*

Since in each plot and transect the regeneration was counted, equation (1) was used to estimate the number of regenerants per ha. The y's in equation (1) corresponds to one for each instance of encountering the regenerant in the particular transect or plot.

1.2.5. Associate tree species

Stand parameters for the associate tree species were computed as described in Section 2.5.1. It is important to document the stand density in which the *O. lanceolata* occur. To ascertain the common tree species associated with *O. lanceolata*, the frequency of occurrence of each associate tree species was calculated for each forest and to the overall data set. Tree species which had at least two occurrences were presented.

1.2.6. Distribution of *O. lanceolata in* Tanzania

Data from the National Forest Resources Monitoring and Assessment (NAFORMA) was the only source which was able to provide the distribution of *O. lanceolata* at national level. In this case, NAFORMA data may not give the status of the species since about nine years has elapsed since the assessment. A lot may have happened. However, NAFORMA data provides indication of potential sites with *O. lanceolata*for future in-depth assessment in these sites.For each identified site, stand parameters, i.e., stems (N) and basal area (G), were computed and presented.

II. BIOLOGICAL DATA

2.1. This section presents biological information of two Osyris species encountered in the study area namely *Osyris lanceolata Hochst. & Steud. ex A. DC* and *Osyris compressa* (P.J.Bergius) A.DC) commonly known as 'Msandali Dume'. *O. compressa* is named so because it has less oil compared to *Osyris lanceolata*. *O. compressa* grows in similar/same habitats as *O. lanceolata* and sometimes people confuse it in identification. Therefore, working on these two species one needs to have a competent botanist for identification. Phenotypically the two species differs in terms of size and shape of leaves and fruits. Leaves in *O. lanceolata* are lanceolate while in *O. compress*a are elliptical. Fruits of *O. lanceolata* are larger in size than that of *O. compressa*, but differ in size and shape (plate 1&2)

Plate 2: Osyris lanceolata branches, Male (left) (O. compressa) with flowers and Female (right) O. laanceolata with fruit

NOTE: For convenience, biological information of *Osyris lanceolata* will be presented as a dominant species and the most favored in trade

2.2. **Taxonomy:** PLANTAE - TRACHEOPHYTA - ANGIOSPERMOPHYTA - SANTALALES - SANTALACEAE – *Osyris-lanceolata*

2.3. Biogeographic realm

Tropics and Sub-tropics

2.4. Geographic range

Plant is found from South Africa to Zimbabwe and east Africa, including Tanzania, Kenya and Uganda; northwest Africa; the southern half of the Iberian Peninsula and Macaronesia.

2.5. Scientific, trade and common names

Table 1: Species description

SN	Item	Description
1	Species name	Osyris lanceolata Hochst. & Steud. ex A.DC
2	Local names	The name *Osyris lanceolata* belongs to the African/East African sandalwood which is also commonly traded as sandalwood with diverse common names in Tanzania; Common names: East African Sandalwood, African sandalwood (English), Mdumula (Sambaa), Mdunula (Hehe), Muvambalafidunda (Hehe), Kipaaatu (Iraqw), Mnyambalakidunda (Hehe), Mvambakidunda (Gogo), Mzilu (Sambaa), Mzulu (Sambaa), Kimbwalala (Rangi), Olosyesai (Maasai)
3	Family	family santaleceae (sny. Osyris abyssinica Hochst. ex A. Rich Osyris quadripartita Salzm. ex Decne)
4	Stem	multi-stemmed, evergreen hemi-parasitic plant has a round to irregular canopy and a grey smooth bark
5	Leaves	Leaves sparse, blue-green, simple, alternate, lanceolate, sometimes egg shaped, slightly glaucous, thick in texture, smooth with a waxy bloom, crowded along the stems; the apex is broadly tapering to rounded with a fine, sharp tip
6	Flowers	Flowers are small, unisexual, yellow-green, becoming red when ripe; borne in leaf axils in short panicles or clusters of 2-3 flowers. Male flowers in axillary cymes, female solitary; all floral parts in fours
7	Fruits	Fruit small, edible, 1-seeded drupe, about 1 cm long, fleshy, egg-shaped, and green at first, turning yellow and becoming bright red to purple-black when ripe; crowned with a persistent calyx.
8	Seeds	Seeds are produced during the rainy seasons. Young seeds are green in colour which then mature and turn to red or pink in colour while the over-mature seeds are black in colour

2.6. Distribution

In Tanzania O*syris lanceolata* is widely distributed in many forests (Fig 3); both reserved and unreserved. Those forests are found in Arusha, Manyara, Dodoma, Singida, Iringa, Njombe, Rukwa, Pwani and Mbeya regions; and in Eastern Arc Mountains (i.e. Kilimanjaro, Tanga and Morogoro regions) However, the National Forest Resources Monitoring and Assessment (NAFORMA) of Tanzania Mainland that was carried 2009 – 2014 revealed a large concentration (78%) of *O. lanceolata* in the Bush land of Northern and Southern ecozones. *Osyris lanceolata* is also distributed in woodlands of Southern Highlands (9%) and Eastern (2%), forest of Southern Highlands (2%), Bush land of Central (3%) and Grassland (6%) of Southern Highland zones.

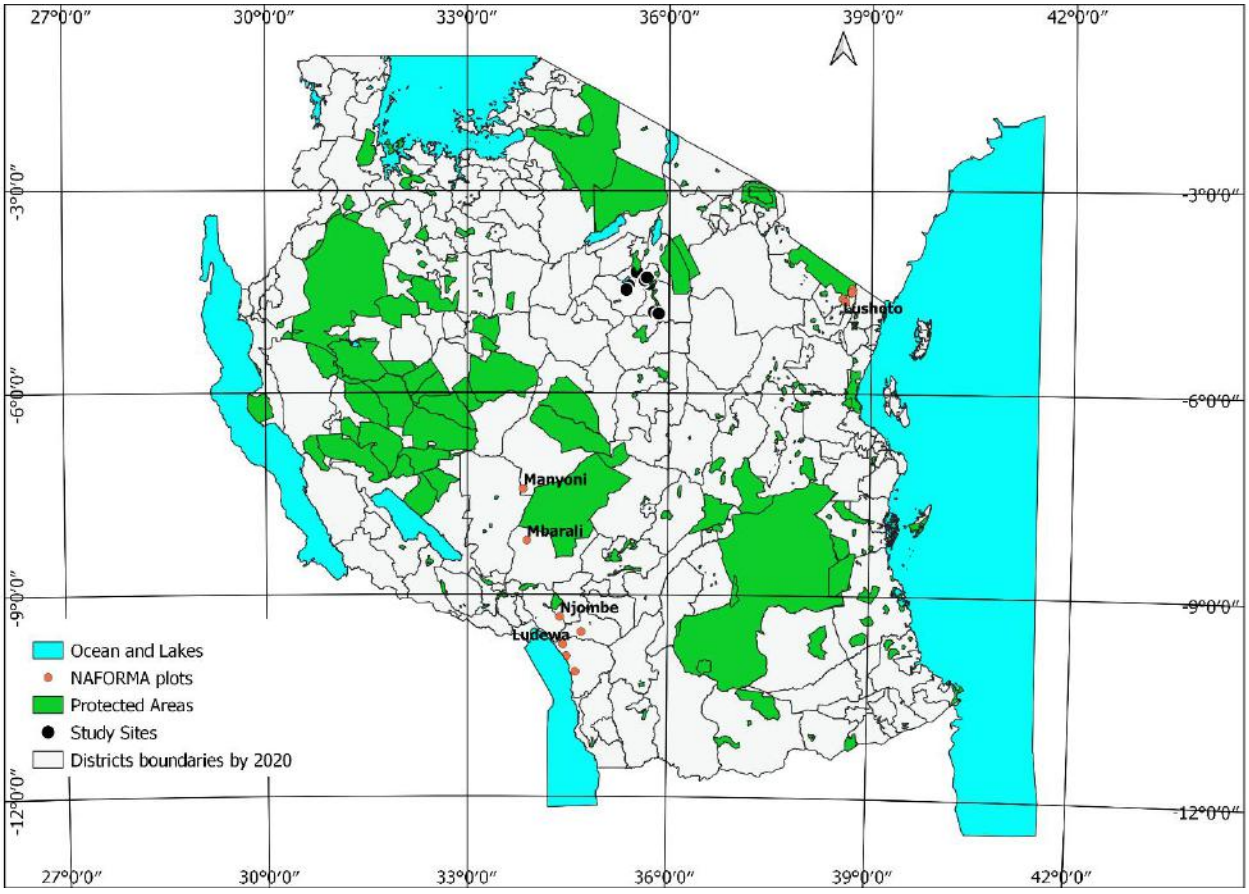

Figure 3. Distribution of *O. lanceolata* in Tanzania

2.7. Biological characteristics

2.7.1. General biological and life history

Osyris lanceolata is a large, slender hardy shrub or a small tree (7-10 m tall). This multi-stemmed, evergreen hemi-parasitic plant has a round to irregular canopy and a grey smooth bark (later thick and rough).

Leaves sparse, blue-green, simple, alternate, lanceolate, sometimes eggshaped, slightly glaucous, thick in texture, smooth with a waxy bloom, crowded along the stems; the apex is broadly tapering to rounded with a fine, sharp tip. The base is broadly tapering; lamina 2.5-7.5 cm, entire and rolled; petiole short, winged up to 0.6 cm, attachment to the stem forming ridges running down the stem. Twigs and leaves point upwards.

Flowers small, unisexual, yellow-green, becoming red when ripe; borne in leaf axils in short panicles or clusters of 2-3 flowers. Male flowers in axillary cymes, female solitary; all floral parts in fours. Fruit small, edible, 1-seeded drupe, about 1 cm long, fleshy, egg-shaped, and green at first, turning yellow and becoming bright red to purple-black when ripe; crowned with a persistent calyx. *O. lanceolata* is monoecious, flowering from March to August or even later, September to February with fruits ripening between May and September. In some areas the fruit is available throughout the year, but most abundant from July to December.

2.7.2. Habitat type and ecology

O. lanceolata occurs in a diverse range of habitats including upland dry evergreen forests and mist forests characterized by bushland and grassland that usually extend downwards to rivers and slightly into deciduous woodlands at 900–2700 m above sea level. Other suitable habitats for *O. lanceolata* include: dry savanna forests and woodlands, moist woodlands, thicket edges and dry submontane grasslands at an elevation range of 1000 m to 1730 m above sea level. However, the species also occurs in rocky and non-rocky habitats at even higher altitudes ranging from 900 m to 2250 m and with mean annual rainfall of 600 to 1600 mm with well-drained soils, but it cannot tolerate frost conditions.

2.7.3. Role of the species in its ecosystem

Osyris lanceolata is semi parasitic forming underground association with known host plants. This association have some functions that are not known

2.8. Population and trends

2.8.1. Global population size

Widely distributed in undisturbed forest.

2.8.2. Current global population trend

___increasing
_X__decreasing
___stable
____unknown

2.8.3. Densities and occupancy maps

Stand level parameters in term of number of trees (N), basal area (G), and biomass (B) are presented in Table 2. The stem density of *O. lanceolata* in Babati and Hanang ranged from 6 to

94 stems/ha (highest in Haisamu and lowest in Gedagerere village forests) and from 7 to 103 stems/ha(highest in Gidagewong and lowest in Sebas village forests). Forests in Kondoa were found to have relatively lower stem density compared to the former districts ranging from 1 stems/ha in Hachwito 12 stems/ha in Gubalivillage forests. Basal area and the AGB followed the same trend as the number of stems per ha ranging from 0.0001 to 0.096 m^2/ha and from 0.001 to 0.231 tones/ha, respectively.

Table 2. Stand parameters of *O. lanceolata*

District	Forest name	code	Forest Area	Amount per ha			Total amount available		
				Stem	G (m^2)	AGB (tones)	Stems	AGB (tones)	Total AGB in the district (tones)
Babati	Warimbu VLFR	0	50	12 - (9)	0.008 - (0.006)	0.019 - (0.016)	647	0.96	110.1
	Duru VLFR	0	1400	25 - (3)	0.015 - (0.002)	0.032 - (0.005)	35,548	45.45	
	Haisamu VLFR	0	180	94 - (44)	0.096 - (0.052)	0.28 - (0.184)	16958	50.4	
	Ayatlaa VLFR	0	30	45	0.022	0.048	1363	1.45	
	Gedagerere VLFR	0	1200	6 - (3)	0.004 - (0.001)	0.01 - (0.003)	8151	11.84	
Hanang	Gidagewong VLFR	0	720	103 - (31)	0.09 - (0.022)	0.231 - (0.058)	74480	166.05	183.38
	Gabadau VLFR	0	230	39 - (17)	0.029 - (0.014)	0.073 - (0.039)	8991	16.82	
	Sebas VLFR	0	40	7 - (1)	0.006 - (0.001)	0.013 - (0.002)	303	0.51	
Kondoa	Gubali VLFR	0	900	12 - (5)	0.006 - (0.003)	0.014 - (0.006)	10944	12.31	45.9
	Gubali VLFR	1	900	2	0.001	0.001	1902	1.09	
	Hachwi VLFR	0	1503	6 - (1)	0.004 - (0.001)	0.01 - (0.004)	9856	14.39	
	Hachwi VLFR	1	1503	1	0.0001 -	0.001	1233	1.32	
	Kolo VLFR	0	1030	8 - (5)	0.006 - (0.005)	0.016 - (0.014)	8494	16.79	
Total biomass in three districts									339.4

In brackets are the standard error; Code 0: Male; Code 1: Female.

The total standing AGB in Babati, Hanang and Kondoa is estimated to be 110.1, 183.38 and 45.9 tons respectively. A survey carried out earlier, URT (2005) reported sandal wood standing biomass of 29, 62 and 1 tons in Babati, Hanang and Karatu districts respectively. It seems the ban on harvesting the species has helped stock build up significantly.

2.9. Diameter distribution of O. lanceolata

The distribution of number of stems per ha by diameter classes in most of the studied village forests indicated active regeneration as expected in a natural forest, i.e., large number of stems for lower diameter classes that decreased with the increase of diameter except for Kolo, Gubali, Gedagerere and Sebas village forests Figure 4. Forests which did not comply to this expected pattern suggest having poor recruitmentstrend and therefore jeopardize the sustainability of*O. lanceolata.*

Of 11 studied village forests, only Kolo, Haisamu and Gidagewong forests have trees in largest diameter class. The other forests had no tree in the largest diameter class, i.e., >8 cm. the maximum Dbh attained in the studies forests was 11.6 cm. The distribution of number of trees, volume and biomass per ha over diameter classes is presented in Appendix 1. Based on the NAFORMA data base, the Dbh of *O. lanceolata* can potentially reach24 cm. This implies that for most of the studied village forests, *O. lanceolata* is in the regrowth phase suggesting that harvesting took place in past as reported earlier URT (2005). This was also confirmed by local communities claiming that there had been illegal harvesting of *O. lanceolata* in the past. In addition, most of the identified stems of *O. lanceolata* originated from coppices following tree cut.

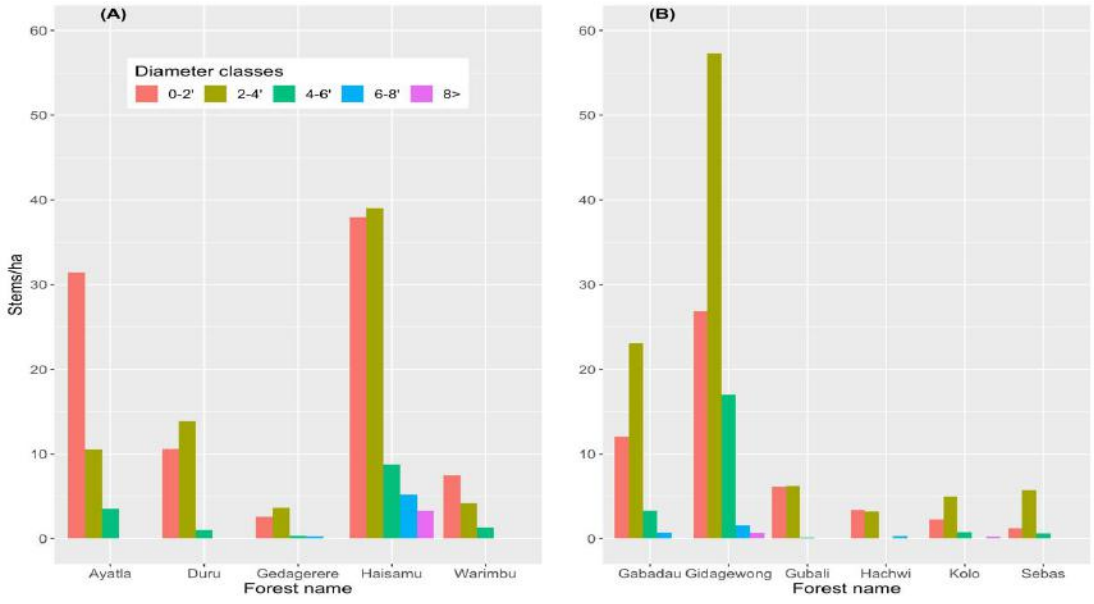

Figure 4. Distribution of the number of stems per ha by diameter classes for each studied village forests

2.9.1. Regeneration

This study considered regeneration as a tree with a Dbh of less than 1 cm. Few studied village forests were found to have promising regeneration mainly from coppicing stumps following removal of the main stem. These forests include Duru (19 stems/ha), Gidagewong (24 stems/ha), Gubali (28 stems/ha) and Kolo (8 stems/ha)Table 3. The remaining forests had at most 6 stems/ha. Poor regeneration of *O. lanceolata* is possibly caused by high forest degradation (mostly extraction of firewood and charcoal; and grazing) as observed during field workcampaigns and therefore reduce stocking of associate tree species. Tree species which have been found often to be associated with *O. lanceolata* are presented in subsequent Section.

Table 3. Regeneration of *O. lanceolata*

District	Village	Forest	Code	Stems/ha
Babati	Ayaasanda	Warimbu VLFR	0	3.3
Babati	Duru	Duru VLFR	0	19.4
Babati	Gidimu	Haisamu VLFR	0	6.0
Babati	Riroda	Gedagerere VLFR	0	4.1
Hanang	Barjomot	Gidagewong VLFR	0	24.0
Hanang	Gabadau	Gabadau VLFR	0	4.9
Kondoa	Gubali	Gubali VLFR	0	28.3
Kondoa	Gubali	Gubali VLFR	1	1.1
Kondoa	Hachwi	Hachwi VLFR	0	4.6
Kondoa	Hachwi	Hachwi VLFR	1	1.5
Kondoa	Kolo	Kolo VLFR	0	8.3

Code 0: Male; Code 1: Female.

2.9.2. Associate tree species

Tree species appearing in association with *O. lanceolata* in at least two forests is presented in Table 4. Tree species which appeared in all studied village forests were *Rhus natalensis* and *Combetum mole*. These were followed by *Jubelnadiaglobiflora, Vachelliahockii, Catunaregum spinosa, Eucleadivinorum, Brachystegiaspiciformis, Canthiumoligocarpum, Dombeya rotundifolia* and*Senna singuena* which show up in at least four studied forests. Similar observations of associate species were repoterd in earlier surveys (URT 2005)

The findings suggest that *O. lanceolata* have broad geographical ranges from lowland forests (Gidagewong and Gabadauforests in Hanang district) to miombo woodlands (the remaining studied forests). Some of the associate tree species such as *Rhus natalensis, Vachelliahockii, Combetum mole, Catha edulis, and Dodonaeaviscos*a were also common in both cover types suggesting their strong association with *O. lanceolata* (Appendix 2). Nevertheless, it is apparent that some of the associated tree species had higher frequency at forest level due to cover type and site condition differences. For example, associated tree species which were found in at least 50% of the plots at forest level were *Carissa edulis*(Haisamu forest); *Rhus natalensis*(Duru, Gedagerere and Gidagewong, Sebas and Warimbu forests); and *Jubelnadiaglobiflora*(Hachwi and Kolo forests). These findings suggest that site conditions and type of cover is important since it decide what tree species should be associated with *O. lanceolata*. Therefore, efforts towards domestication of *O. lanceolata* should take consideration of these factors.

Table 4. Frequency of occurrence and percentage of plots with associate tree species

Local name	**Botanical name**	**Average percentage of plots with associate species in all forests**	**Number of forests with associate species**
Sirongi, Datrii	*Rhus natalensis*	48	11
Nafumo, Mhangala	*Jubelnadiaglobiflora*	41	4
Warfi	*Catha edulis*	29	3
Titiwi	*Carissa edulis*	25	3
Gendaii,	*Combetummolle*	24	11
Hhatsmo, Slontli	*Apodytesdimidiata*	23	2
Hhewasi	*Brachystegiamicrophylla*	23	4
Fitsitoo	*Vachelliahockii*	23	8
Getalongo	*Catunaregum spinosa*	23	5
Sirongi	*Rhus vulgaris*	21	2
Pararaamo	*Schreberatrichoclada*	20	3
Pararaamo	*Schreberaalata*	20	2
Miningiti	*Eucleadivinorum*	19	6
Tsilenaii, Mtarima	*Lanneaschimperi*	18	4
Mhasa	*Euphorbia candelabrum*	17	4
Bermi	*Dodonaeaviscosa*	17	6
Tsapenai	*Flacourtia indica*	17	4
Seese	*Vernonia exserstiflora*	17	3
Barang'u	*Vangueriainfausta*	16	3
	Rytigyniaschumanii	15	3
Nistiay	*Omorcarpumkirkii*	15	3
Irocktum	*Protea rochetiana*	14	2

Mwirela	*Brachystegiaspiciformis*	12	4
Frankii	*Canthiumoligocarpum*	11	4
Gudaati	*Dombeya rotundifolia*	10	4
Msisivili	*Albizia harvey*	10	2
Miningiti	*Eucleanatalensis*	10	2
Irocktum	*Protea angolensis*	9	2
Daraa'ghw	*Senna singuena*	9	4

2.9.3. Biomass distribution in the country

The primary data collected from the field campaign were not adequate to provide useful information on the distribution of *O. lanceolata* at national level. Available secondary source which is NAFORMA database is over 9 years which might not be reliable to provide the status of *O. lanceolata*. However, this source is crucial since it is the only available that indicate hotspot sites with significant population of *O. lanceolata*. NAFORMA data show that *O. lanceolata*is mainly found in five districts namely Lushoto, Mbalali, Manyoni, Njombe and Ludewa (Figure 2). It is apparent that the species is found elsewhere (Table 1). The good news is that most of the plots except for Lushoto district fall outside the protected areas and therefore potentially available for harvesting. The narrow distribution of the species in NAFORMA data is attributed to the lowsampling intensity applied by NAFORMA reducing chances of its detection in the field. In addition,NAFORMA sampling design intentionally favoured areas with high wood biomass while *O lanceolate* prefers stony hill side sites with often poor vegetation cover (Mwangingo et al 2003).

The findings from NAFORMA database show that large number of plots with *O. lanceolata* were found in Lushoto having the largest stand parameters (i.e., G = 16.9 m^2/ha; V = 87.2 m^3/ha) except for number of stems per ha. This was followed by Njombe region (Ludewa and Njombe districts). The district with the least value of stand parameters was Mbarali and Manyoni.

Table 5. Stand parameters of *O. lanceolata* based on NAFORMA data

Region	**District**	**Number of plots**	**Diameter (cm)**			**G (m2/ha**	**Stems/ha**	**Biomass (tones/ha)**	**V (m^3/ha)**
			Min.	**Max.**	**mean**				
Njombe	Njombe	3	10.4	14.5	12.5	15.0	1193.7	66.9	68.6
Njombe	Ludewa	8	5	13	7.8	8.5	1591.5	32.4	33.5
Mbeya	Mbarali	1	10.5	10.5	10.5	6.9	795.8	27.8	28.7
Singida	Manyoni	3	6.4	7.7	6.9	9.1	2387.3	30.2	31.3
Tanga	Lushoto	18	5	24	12.8	16.9	1101.8	85.4	87.2

2.10. Conservation status

2.10.1. Global conservation status (according to IUCN)

___Critically endangered

___Near Threatened

___Endangered

___Least concern

X__Vulnerable

___Data deficient

2.10.2. National conservation status for the case study country

Least concern

2.11. Main threats within the case study

____No Threats

X Habitat Loss/Degradation (human induced)

_X__Over-harvesting

____Accidental mortality (e.g. Bycatch)

____Persecution (e.g. Pest control)

____Pollution (affecting habitat and/or species)

____Other____

____Unknown

III. MANAGEMENT MEASURES OF OSYRIS LANCEOLATA IN TANZANIA

3.1 Management history

Listing the species under CITES Appendix II regulates international trade in the species and enhance population monitoring through trade volumes records. The ban was imposed by the Minister for Natural Resources and Tourism on 2006 Conservation and management of *O. lanceolate* in Tanzania is mainly depends on type of forest ownership (right and management responsibility of a given forest land). In Tanzania, forests falling under four ownership types as prescribed in Part II, section 4 of the Forest Act No. 14 of 2002. These includes: 1) National

Forest Reserves (NFRs), 2) Local Authority Forests Reserves (LAFRs), 3) Village Forests (VFs) and Private Forests (PFs).

National forests are owned by Central Government and their management is vested under the Tanzania Forest Service (TFS) Agency in the Ministry of Natural Resources and Tourism (MNRT). They consist of forest reserves, nature forest reserves, and forests in general land. LAFRs are owned and managed by local authorities including city councils, municipal councils, town councils, and District councils; all under the President's Office – Regional Administration and Local Government (PO-RALG). These consist of reserved forests (natural or plantation) that are under the jurisdiction of the city councils, municipal councils, town councils, and District councils; and forests on general land. The VFs and PFs are owned and managed by Village Government and private entities respectively. VFs consists of all forests found within a registered village, land demarcated and agreed to as village land by the relevant village government, including Village Land Forest Reserves (VLFRs), Community forest reserves (CFRs) and Unreserved forests (URT, 2002).

Other reserved areas where there is a chance of finding *O. lanceolata* in Tanzania but do not fall under the four forest ownership categories mentioned above are National Parks (NPs), Ngorongoro Conservation Area (NCA), Game Reserves (GRs), Game Controlled Areas (GCAs), and Wildlife Management Areas (WMAs). The NPs are managed by Tanzania National Parks Authority (TANAPA) while NCA is managed by Ngorongoro Conservation Authority (NCA). Tanzania Wildlife Management Authority (TAWA) is responsible for management of GRs, and GCAs. WMAs are managed by villages in collaboration with TAWA. TANAPA, NCA, and TAWA are under MNRT, WMAs (villages) are PO-RALG. Table 6 presents forests of which previous research activities have shown to have *O. lanceolata*.

Table 6: Size, Legal status, ownership, governance and administration

SN	Forest Name	Size (Ha)	Legal status	Ownership	District	Region	Source
	Mgwashi-Ula forest	No data	No information	Village forest	Lushoto	Tanga	District Forest Office,2020
	Bereko	9,956.0	Gazetted: GN No 296 of 1941	Central government through TFS	Babati	Manyara	URT 2019a
	Image	8,616.0	Gazetted: GN No 392 of 1934	Central government through TFS	Kilolo	Iringa	URT 2019a
	Nundu-Itoni forest	200	No information	Central government through TFS	Njombe	Njombe	URT
	Sao Hill	135,903*	Gazetted	Central government through TFS	Mufindi	Iringa	URT 2019a
	East Matogoro	3,533	Gazetted: GN No 260 0f 06/11/1951.	Central government through TFS	Songea	Ruvuma	URT, 2017a
	Kabulo	3,218	Gazetted: GN No. 548 of 28/08/98 with Border map: Jb 2237(1:25,000) 1994.	Central government through TFS	Kyela	Mbeya	URT, 2017b
	Essimingor	6070	GN No. 187 of 2/7/1954	Central government through TFS	Monduli	Arusha	URT, 2017c
	Mbembe Mlimanyoka	625	Gazetted: GN 199 of 02/01/1994	Central government through TFS	Mbeya Rural District	Mbeya	TAFORI, 2019
	Baga	578.0	Gazetted: GN 347 of 1955	Central government through TFS	Lushoto	Tanga	FBD, 2007; URT, 2019
	Mazumbai	320	-	Sokoine University of Agriculture (SUA)	Lushoto	Tanga	https://www.cfwt.sua.ac.tz/index.php/research/mazumbai
	Mzuku/Mkusu	3,674.4	Gazetted: GN 114 of 1964	Central government through TFS	Lushoto	Tanga	FBD, 2007; URT, 2019
	Magamba NFR	9,283	Gazetted: 103 of 23/3/2016.	Central government through TFS	Lushoto	Tanga	URT, 2017b
	Mramba	3,355.0	Gazetted: 352 of 1958	Central government through TFS	Mwanga	Kilimanjaro	FBD, 2007; URT, 2019
	Minja	520.6	Gazetted: 197 of 1955	Central government through TFS	Mwanga	Kilimanjaro	FBD, 2007; URT, 2019a
	Chome	14,283	Gazetted: 105	Central	Same	Kilimanjar	Japhet,

	NFR		of 25/03/2016	government through TFS		o	2016; TFS, 2017
	Loliondo GCA	450,000	Gazetted	Central government through TAWA	Loliondo	Arusha	
	Ngorongoro Conservation Area	829,200	Gazetted: Ngorongoro conservation ordinance cap.413 of 1959	Central government through TCCA	Karatu, Monduli and Ngorongoro	Arusha	https://www.ncaa.go.tz/pages/welcome

**Osyris lanceolata* in Sao Hill Forest Plantation was found in small part of natural forest retained for protection of catchment

All forests are managed in accordance with Forest Management Plan (FMP) or annual plan operation (APO's) which depend on the specific budget to implement the activities in the forest reserve. In additions, management of all forests are governed by National Forest Policy of 1998, the Forest Act (2002), National Forest Programme (2001), other related policies and global and regional conventions, agreements, resolutions and recommendations

Core activities in the management of forests include boundary consolidation (i.e. boundary resurvey, marking and clearance), forest protection (including all activities aimed at reducing the risk of forest destruction through human activities such as forest patrols fire campaign meetings), and forest restocking (enrichment planting) and natural regeneration

3.2. Community forestry

In September 1994, the LAMP project initiated the first modern Community-based forest management (CBFM) regime in Tanzania, in the Duru-Haitemba forests (DHF) in Babati District in Arusha Region in North Tanzania. The DHF are one of the few remaining Miombo woodlands in Babati District, comprising an area of approximately 9,000ha. They are a series of linked ridges of high woodland characterized by an open canopy of trees of usually medium height, interspersed with grassland. The focus of LAMP was community empowerment, and particularly community-based management of Duru-Haitemba forests. This is strategically a largest institutional cultural change from the protectionist, militaristic approaches to one of facilitation and dialogue. Creation of Community Based Forest Management (CBFM) reflects a truly community-based, transparent and participatory process in resource management. A simple relationship based on good communication flows and transparency is the ideal model. LAMP ensured that the government and village leaders launched a dynamic process of reviewing

every aspect of the forest to establish what was required to restore the forest and to keep it intact for potential future use.

Despite the good intention of CBFM, more effort was total protection of the ecosystem without putting attention to selected vulnerable plant species. Local communities were oblivious of a growing trade on *Osyris lanceolata* by the nearby industry in Babati. Unawareness on the value of this species for its valuable oil robed conservation efforts until the ban by the government in 2016.

3.3. Purpose of the management plan in place

Tanzania is one among countries in Africa that has banned trade of *Osyris lanceolata*. This government decision, which was officially announced in 1993, aimed to ban the harvesting of sandalwood to prevent them from disappearing following the presence of severe harvesting.

However, before the trade of *O. lanceolata* was banned or even a period when illegal harvesting of the tree dominated, the tree was harvested in both reserved and unreserved forests. The most preferred harvesting regime was uprooting the whole tree. A reason for this was a fact that the most preferred part of the tree is the root and a small proportion of the root collar. This has resulted in adopting uprooting as a harvesting method. Uprooting has wiped out the tree in other areas of the country. The fact that roots are more preferred for the high content of essential oils is a threat to the existence of the tree (FBD, 2007).

3.4. General element of the management plan

— Using the network from several organization of law enforcement, conservation agencies and local communities to address the problem, share information, investigate issues and implement.

— The national strategy plan needs to enhance public awareness of local community and understanding of their local natural resources and conservation.

3.5. Restoration or alleviation measures

In situ conservation: prohibited harvesting to allow regeneration of plants in natural forests.

For sustainable conservation: The local community nearby the original habitat of *O. lanceolata* collected the orchids from the forest and planted in their house for many years, and the botanist from botanical garden has been collecting the seed pods from these plants and using aseptic

media for seed germination in laboratory. After transplanting and nursing the seedling in the nursery for one year, the Garden has a project to exchange ten of one-year plant with one plant from the local community. The wild orchid plants have been introduced to the area where people had collected.

3.6. Management activities, production and harvesting quotas

3.6.1 Existing management of *O. lancelata*

Currently no management per se is instituted on *O. lancelata*. Although the ban to harvest the species was placed its enforcement was weak in some districts. In the surveyed districts there was evidence of tree cut and removals. Also holes in the soil indicating uprooting of the species were detected. This may indicate illegal harvesting to feed the industry in Babati.

3.6.2 Harvesting potential

The minimum harvesting sizes for different tree species are specified by the Government in the Fourteenth Schedule of Forest Regulations of 2017 (URT 2017). Unfortunately, there is no mention of *O. lanceolate* making it difficult to conclude whether the available stems have reached harvestable sizes or not. However, given the fact that the species can reach Dbh of 24 cm it appears the maximum size of 11 cm found in the studied sites are still juvenile. Nonetheless, as observed in Section 3.1 the harvesting ban instituted on *O. lanceolate* seems to have helped stock build up despite evidence of illegal harvesting.

According to URT 2005, the lowest capacity of a sandal wood processing factory is 30 tonnes per month, and hence 360 tons per year. The estimated total biomass of sandal wood currently growing in Babati, Hanang and Kondoa districts is 339 tons including small tree down to 1 cm Dbh. It is clear that this amount is inadequate to feed the Babati factory even for 1 year. It is therefore premature to think of any harvesting of the species currently.

3.6.3 Propose/develop strategies for the conservation of these tree species

Given the current status of *O. lanceolate*, we propose the following conservation strategies;

- Conducting a detailed forest management inventories in each site;
- Defining harvesting quota for each site;
- Drafting the simple management plan for each site;
- Strengthening law enforcement to control illegal harvesting; and
- Establishment of research trials to better refine management parameters, propagate and domesticate *O. lanceolata.*

IV. UTILIZATION, TRADE, MONITORING, CONTROL, CONSERVATION AND PRECOUTIONARY PRINCIPALS

4.1. Utilization

Apart from the common use by local communities including medicinal and wood fuel, the survey in study areas did not record current commercial exploitation as source of oil. Despite the detail investigation among the local communities, there was no report on confiscation at the common outlets such as Airports and harbor. There was no report at the government export registry whatsoever raising suspicion of lack of attention or records by the control authority of what is happening in the wild.

Is was reported that commercial harvesting was common before government restrictions in 2016. Three factories namely Siera Limited located in Babati-Manyara, Afro-Aromatics in Mombo-Tanga and Natural Aromatics LTD in Dar es Salaam were visited to get the trade insight. According to factories management there is no local purchase of raw materials. Four sandalwood processing factories were licensed and established in 2004. However, due to shortage of raw materials, only three are operating.

Siera Limited factory sources for its raw materials from mostly from Austaralia (Australian sandalwood) and to the little extent from India (Indian Sandalwood) and from Uganda, South Sudan, (African sandalwood), Dubai and China (pers. Comm. manager, Sierra Ltd, June 2022).

This factory exports sandalwood oils and spent dust mainly to India, United Arab Emirates, Taiwan, China, Australia, Singapore and Sudan as well as Dubai through Kilimanjaro International Airport, Julius Nyerere international Airport and Dar es Salaam Port.

On the other hand Afro-Aromatics Factory in Mombo-Tanga Imports sandalwood raw materials from East Africa(African sandalwood) only (Congo, Uganda and South Sudan).
The factory exports Sandalwood oil to Dubai, USA and India through Port of Tanga

Natural Aromatics LTD Factory in Dar es Salaam imports sandalwood raw materials from Uganda, Congo and South Sudan (African sandalwood) , this factory exports sandalwood oil and spent dust to India , Saudi Arabia and China through Julius Nyerere international Airport and Dar es Salaam Port.
Trends for import and export of Sandalwood with three factories is shown IN TABLE 7-9 whereas the leading import source in Africa is Uganda

Table 7. SNAPSHOT OF THE IMPORT AND EXPORT OF SANDALWOOD OIL BY NATURAL AROMATIC CO. LTD IN DAR ES SALAAM

DATE	KG	VALUE (USD)	DESTINATION	EXPORT FEES	source
3/8/2016	550	40,246	INDIA	302,200	
12/8/2016	200	80,000	INDIA	302,200	
5/9/2016	450		INDIA	302,200	
15/9/2016	400	25,378	INDIA	302,200	
29/9/2016	550		INDIA	302,200	
20/10/2016	350		India	302,200	Uganda
2/11/2016	500	200,000	INDIA	302,200	Uganda
2/11/2016	50	10,000	INDIA	302,200	Uganda
30/11/2016	600	240,000	INDIA	302,200	
15/12/2016	450		INDIA	302,200	
21/12/2016	250	10,000	INDIA	302,200	Uganda
11/1/2017	300	120	INDIA	302,200	
24/1/2017	650	32,648	INDIA	302,200	
6/2/2017	450		INDIA	302,200	
20/2/2017	550		INDIA	302,200	
2/3/2017	600	240,000	INDIA	302,200	UGANDA
23/3/2017	600		INDIA	302,200	UGANDA
3/4/2017	400	60,000	INDIA	302,200	
17/4/2017	550	220,000	INDIA	302,200	
16/5/2017	450	120,342	INDIA	302,200	

31/5/2017	150		DUBAI	302,200	
8/6/2017	700		INDIA	302,200	UGANDA
20/7/2017	600	270,000	INDIA	302,200	
25/8/2017	540	31,413	INDIA	308,900	
4/9/2017	350	157,000	INDIA	308,900	
18/12/2017	500	225,000	INDIA	308,900	
20/12/2017	450	202,500	INDIA	308,900	
25/1/2018	500		INDIA	308,900	
12/2/2018	500	225,000	INDIA	308,900	
13/2/2018	500	225000	INDIA	308,900	
12/3/2018	500	225000	INDIA	308,900	
20/4/2018	400		INDIA	308,900	
19/6/2018	450		INDIA	308,900	
18/10/2018	150		INDIA	308,900	
19/11/2018	150		INDIA	308,900	
12/12/2018	250	68750	INDIA	308,900	
9/1/2019	200	55,000	INDIA	308,900	
23/1/2019	150	41,250	INDIA	308,900	
15/2/2019	200	55,000	INDIA	308,900	
4/3/2019	250	68,750	INDIA	308,900	
13/3/2019	250		INDIA	308,900	
29/3/2019	150		INDIA	308900	
30/4/2019	250	68750	INDIA	308,900	
9/5/2019	250	68750	INDIA	308,900	
27/6/2019	255	61,875	INDIA	308,900	
30/7/2019	400	110,000	INDIA	308,900	
23/8/2019	250	68,750	INDIA	308,900	
10/9/2019	300	68,750	INDIA	308,900	
26/9/2019	300		INDIA	308,900	
27/11/2019	200		INDIA	308900	
24/12/2019	325		INDIA	308900	
16/1/2020	150	14250	INDIA	308900	
5/2/2020	250	68750	INDIA	308900	
17/2/2020	150		INDIA	308900	
9/3/2020	300	82500	INDIA	308,900	
19/3/2020	150	41250	INDIA	308,900	

TABLE 8: SNAPSHOT OF IMPORT AND EXPORT OF SANDALWOOD OIL BY SIERA LTD IN BABATI MANYARA				
Importer Name	**Consignment Value**	**Origin Country**	**Import Port**	**Quantity**
SIERRA LIMITED	212906.4 USD	Australia	Dar es salaam Port	24.472 Tons
SIERRA LIMITED	300000 TZS	Australia	Dar es salaam Port	24.472 Tons
SIERRA LIMITED	300000 TZS	Australia	Dar es salaam Port	24.472 Tons
SIERRA LIMITED	300000 TZS	Australia	Dar es salaam Port	24.472 Tons
SIERRA LIMITED	150000 TZS	United Arab Emirates	Dar es salaam Port	12624 Kg
SIERRA LIMITED	212906.4 USD	Australia	Dar es salaam Port	24.472 Tons
SIERRA LIMITED	225515 USD	United Arab Emirates	Dar es salaam Port	8510 Kg

TABLE 9: EXPORT OF FOREST PRODUCT -SANDALL WOOD (2006-2021,)TANGA PORT

S/N	NAME OF EXPORTER	TYPE OF FOREST PRODUCTS	SPECIES	TONS	REVENUE COLLECTED	COUNTRY OF DESTIN
1	CIELMAC (T) LTD	OIL	SANDAL WOOD	0.3	285,000.00	USA
2	COASTAL CONSORTIUM LTD	OIL	SANDAL WOOD	0.15	140,000.00	NIL
3	LIVERPOOL LTD	OIL	SANDAL WOOD	0.2	145,000.00	DUBAI
4	LIVERPOOL LTD	OIL	SANDAL WOOD	15	50,000.00	MOMBO
5	COASTAL CONSORTIUM LTD	OIL	SANDAL WOOD	0.004	255,780.00	NIL
6	AFRO AROMATIC LIMITED	SANDAL WOOD	INCENSE POWDER	80	762,000.00	INDIA
TOTAL COLLECTION				95.654	1,637,780.00	

4.2. General elements of control

4.2.1 Method used to monitor harvest

Conduct the surveys at the border and domestic trade around the country, along with the reports of seizures of illegal Sandalwood trade in the local market.

Carry out periodic field survey at the natural habitat of this species to monitor the population. CITES has been visited and interviewed the local community about the trade and conservation of the *Osyris* species.

4.2.2 Confidence in the use of monitor

Lack of records at the monitoring cetres creates suspicion of laxity in monitoring. Availability of three local factories with each importing raw materials from outside Tanzania while there is enough stock in the country needs more investigation.

4.3. Legal framework and law enforcement (national and international to the conservation of the species)

There are laws and regulations related to natural resources and environmental protection in Tanzania; such as the Forest Act, 2002 (Act No. 7 of 2002) and the Environmental Management Act, 2004 (No. 20 of 2004).

To implement the CITES Convention, regulations has been issued under the Wildlife Conservation Act, No. 12/1974. These regulations include sections on management and scientific authorities; control of trade in species listed in the CITES appendices; general conditions for the issuance of permits and certificates; exemptions; and the export of live specimens.

CONCLUSIONS AND RECOMMENDATIONS

Although *Osyris lanceolata* is widely distributed in Tanzania, there is no enough quantitative documentation that can justify legalization of harvesting in their range states. It is reported that harvesting was restricted by the government decree in 2016, however there is no proof that harvesting is on complete stop as long as the local industries are operating by exporting sandalwood oils claimed to be sourced from imported raw materials. The major source of raw material in Africa being Uganda and South Sudan. The rest imports are from Asia and Australia.

Harvesting ban instituted on *O. lanceolata* by the government seems to have helped stock build up despite evidence of illegal harvesting. The inventory in the study area reported gradual rejuvenating biomass of Osyris species, yet the the minimum harvesting sizes have not reached sizes of harvestable diameters as specified by the Government in the Fourteenth Schedule of

Forest Regulations of 2017 (URT 2017). The maximum size of 11 cm found in the studied sites are still juvenile.

Given the capacity of a sandal wood processing factory of 30 tonnes per month, and hence 360 tons per year. The estimated total biomass of sandal wood currently growing in Babati, Hanang and Kondoa districts is 339 tons including small tree down to 1 cm Dbh. It is clear that this amount is inadequate to feed the Babati factory even for 1 year. It is therefore premature to think of any harvesting of the species currently.

Most these species like *O. lanceolata* populations occur on the public lands where there is little government control in terms of management. Therefore, special strategies need to be developed to assist its management and conservation. The option for increasing population of the target species is through enrichment planting in the forest and on farm planting and management include available options for increasing the stock of the two species. Planting material can be raised in the nurseries to obtain seedlings or selective collection of the wildings (seedlings in the forest floor).

There is urgent need to determine current status and more elaborative information on biological, ecology and conservation status contrywide. This is important for establishment of NDF in order to understand status for smooth local and international trade on the species

More research and dissemination on propagation and seedling management is needed for domestication of this species as one of the opportunities for economic growth especially for rural communities. Efforts by private firms, local communities and NGOs to expand commercial *ex-situ* should be given priority. Lead research and academic institutions on forestry should joined hands to establish ex-situ seed and living collections of the species for conservation purposes

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