COMMUNITY-BASED CONSERVATION OF THE LOCALLY THREATENED AND MEDICINAL *Securidaca longepedunculata* Fresen. (VIOLET PLANT); FOR THE PEOPLE, BY THE PEOPLE IN THE DRYLANDS OF KENYA.

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Cover Photo: Ngutwa study site, Wote Sub-county, Makueni County, Kenya. @Kaniaru

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DECLARATION

Information presented in this report represents the opinion of the authors and does not offer the opinion of the National Museums of Kenya or that of the Rufford Foundation. The information used was derived from field surveys, herbarium records, publications, personal experiences and indigenous knowledge from the local community.

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DEDICATION

I dedicate this work to my late boss and mentor Dr Patrick N. Muthoka.

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EXECUTIVE SUMMARY

This report has been prepared as an output of Community-Based Conservation of the Locally Threatened and Medicinal *Securidaca longepedunculata* Fresen. (Violet Plant); For the People, By the People in the Drylands of Kenya Project funded by the Rufford Foundation, UK and implemented in Kenya by researchers based at the National Museums of Kenya and Maseno University. This project focuses on strengthening the capacities of community groups through outreach and education, solving propagation difficulties of the violet plant utilized consumptively for medicinal purposes by the community through research and restoring the viable populations of this species and the integrity of its habitat through mass propagation and reforestation. The target species discussed in this report is described in detail from its ecology, life form, use, fruit and seed morphology, seed biology, its propagation protocol, the optimum time for seed collection and threats faced. A propagation protocol was developed for the species to ensure the production of high-quality seedlings for planting during the rainy season.

The aim of the Information in this report is to guide the local community members and other stakeholders to manage, conserve and sustainably use *Securidaca longepedunculata* species through seed collection at the optimum time of harvest, best media for its growth, on-farm propagation and cultivation of the target species and restoration of its degraded habitats. Additionally, it addresses key propagation difficulties of the target species and has devised techniques to solve them. Training of community focus group members and the local community as implemented by the project ensures sustainability and long-term conservation of the species and its habitats beyond the project period.

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CHAPTER ONE

1.1 Introduction

1.1.1 Target species

Securidaca longepedunculata Fresen (Violet plant) is a shrub in the family Polygalaceae (Beentje, 1994). Its height ranges from 2-7.5m and has a grey, smooth or flaking bark in rectangular patches and slash pale yellow stem (s). The leaves are narrowly ovate or elliptic with a cuneate or rounded base, its apex is rounded and usually puberulous when young. Its flowers are pink or violet and many in lateral or terminal racemes to 9 cm long and petals to 10 mm long. Its fruit is nut-like in form of a samara 8-10mm across and wing to 5x2.3cm) which is normally pale green with red or purple along the upper edge (Beentje, 1994).

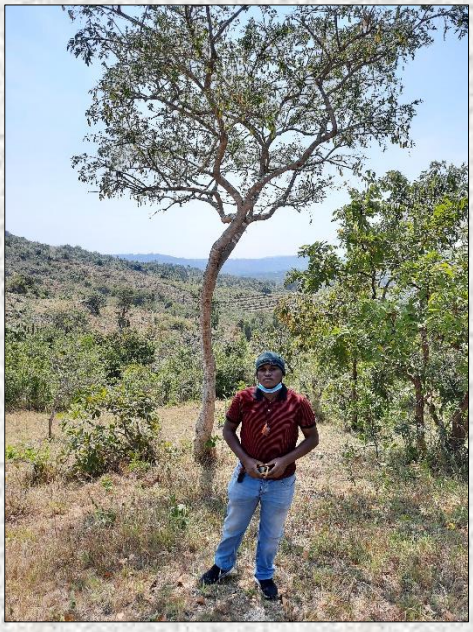

Fig 1a. A Violet plant tree

Fig 1b. A Violet plant fruit

Fig 1c. Grey, smooth and flaking bark of a Violet plant tree.

1.1.2 Distribution

The target species as described in section 1.1.1 above is native to Kenya and widespread in other African countries. The countries include Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Chad, Cote d'Ivoire, Democratic Republic of Congo, Eritrea, Ethiopia, Gambia, Ghana, Guinea, Guinea Bissau, Kenya, Malawi, Mali, Mauritania, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, Togo, Central African Republic, South Africa, Sudan, Tanzania, Uganda, Zaire, Zambia and Zimbabwe.

In Kenya, the species is endemic to Makueni, Embu and Kwale Counties only.

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Fig 1d. A map showing the distribution of *Securidaca longepedunculata* Fresen in Africa.
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1.1.3 Ecology

Securidaca longepedunculata species occurs in a broad range of vegetation, from semi-arid shrub to dense forests such as wooded and bushed grassland, open forests, scattered tree grassland and secondary bushland. It prefers rocky, light (sandy), medium (loamy) and heavy (clay) soils for growth. It does well in moist acid, neutral and basic (alkaline) soils as well. It can grow in semi-shade (light woodland) or no shade and has an altitude range of 0 -1800m with a mean annual rainfall of 600 -1000 mm.

Fig 1e. *S. longepedunculata* habitat: **Wooded and bushed grassland.**

Fig 1f. A *S. longepedunculata* sapling growing in a **rocky** habitat

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1.1.4 Phenology

From past and present field surveys in the area spanning from 2016 to date, the species is flowering from December up to February in the study area with fruit production commencing from March onwards.

1.1.5 Uses

After analysis of administered questionnaires and interview, it was found that the target species roots and bark were extracted and converted into powder form to treat:

1. Arthritis
2. Chest pains.
3. Cough.
4. Venereal diseases such as Genital Herpes, Gonorrhoea and Syphilis.
5. Snake bites.
6. Inflammatory conditions in case of injuries.
7. Headaches (Roots are burned and the ash rubbed on the forehead to relieve pain).
8. Toothaches (Chewing the roots).
9. Infertility.
10. Ascariasis
11. Fever
12. Stomach aches (Bark extracted, boiled in water and drank).

Ngutwa sub-location (study area) lacks a medical facility nearby and one has to go to town, which is about 12 km from Ngutwa shopping Centre. Transport fares from Ngutwa shopping Centre to the town is high due to lack of public means of transport on that route. Furthermore, the cost of treatment and purchase of medicine is high compared to their income prompting them to use *S. longepedunculata* and other indigenous plant species for medicinal purposes.

The project team observed other indigenous species used as medicine and are mixed with *S. longepedunculata* by the community for maximum efficacy. It was found that other community members were mixing concoctions of other medicinal plants as a preventive measure against the COVID-19 pandemic.

1.1.6 Propagation challenge

Previous studies on the methods of successful propagation of *Securidaca longepedunculata* Fresen species through seeds have been documented not to exist globally (Zulu, et al., 2011). Ex-Vitro germination rates of the target species have shown not to exceed 43% as compared to 67% - 90% In-vitro germination rates (Zulu, et al., 2011). This project has demystified this by increasing Ex-vitro germination rates of the species through seeds to 100% as explained and elaborated in Chapter 3. Moreover, it has established the best media for propagation of *Securidaca longepedunculata* as recommended by Zulu et al (2011) study.

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1.2 Objectives of the study

1.2.1 Main objective

The project aimed to solve propagation difficulties of the violet plant consumptively exploited for medicinal purposes by the community through research, strengthen capacities of the local community through outreach and education and to restore the populations of this species and the integrity of its habitat through mass propagation and reforestation.

1.2.2 Specific objectives

The specific objectives were as follows:

1. Document the threats facing *S. longepedunculata* species and their habitats.
2. Understand the seed biology of *S. longepedunculata* species: morphology, seed storage behaviour, viability and longevity.
3. Determine the effects of seed development on the germination of *S.* longe*pedunculata* seeds.
4. Identify the best media for the propagation of *S. longepedunculata* seeds.
5. Build capacity for sustainable use, conservation and management of the locally threatened and medicinal *S. longepedunculata* species through training and outreach.
6. Restore populations of *S. longepedunculata* and the integrity of its habitats through mass propagation and restoration in collaboration with the local community.
7. Disseminate research findings to the local community, stakeholders and the public for awareness creation and education.

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CHAPTER TWO

2.1 Materials and Methods

2.1.1 Study Area

This study took place in Makueni county (shown in fig 2a below), the South-eastern region and one of the drylands of Kenya specifically in Ngutwa, Wote sub-county. It covers an area of 8170Km^2 and has a population of about 987,653 people (Brinkhoff, 2019)

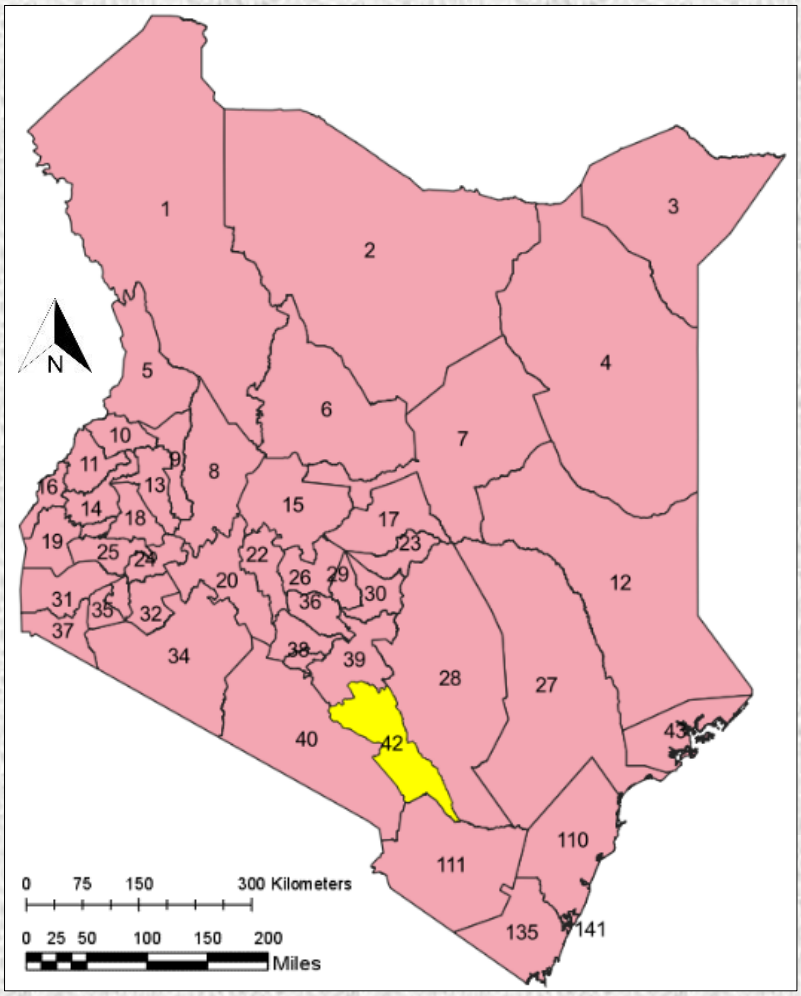

Fig 2a. A map of Kenya showing Makueni county study area highlighted in yellow as county 42

The county consists of Rivers Liuni, Ikondeni, Ikumba, Chiwa, Chakatsu, Muuani, Chania and Muoni; with fishing being practised in Rivers Kaiti and Muoni seasonally.

The area has three types of vegetation; Arid, Semi-arid and Forest vegetation although aridity and semi-aridity are most dominant hence the continuous need for conservation.

The main forests in the area are: Makueni forest, Nthangu forest, Kathonzweni forest, and Kibwezi forest.

These forests are of huge importance to the area as they shape the climate of the area, provide food resources to the people, act as habitat for animals such as Monkeys, Lions, Antelopes, Black Rhinos, Buffalo, Leopard, Birds, and plants with their resources utilized by the people for primary (medicinal) and secondary (Ornamental, fibre) uses.

It is one of the poorest counties in Kenya with no access to basic infrastructures such as limited standard drinking water, sanitation and electricity. This study area is arid with few forested areas that have been encroached by the local community.

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Apart from low species diversity in the Southeastern part of Kenya (Wass, 1995), the area has unique species on the verge of increasing threats of habitat loss and fragmentation comparable to the coastal forests and eastern arc mountains (Young, 1984).

Fig 2b. A map showing the fragmented *S. longepedunculata* habitats in the forested areas of Ngutwa, Wote, Makueni county

Consequently, the locals face challenges such as high levels of poverty and adult illiteracy, socioeconomic and political marginalization, lack or unimplemented conservation policies, overexploitation of natural resources especially plants for consumptive use as firewood, timber and medicinal purposes, inadequate land tenure policies, vulnerability to climatic variations due to low vegetation cover among others.

This warrants the need to protect these habitats and the biodiversity in them through collaborative conservation and restoration initiatives

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2.1.2 Sampling Design

The populations of *S. longepedunculata* were scattered randomly in the forest, without forming any vegetation patterns. A randomized sampling regime was done on the encountered individuals and populations of violet plants. Six populations were encountered and sampled; The GPS reference points and Height were taken for all saplings and shrubs/trees above 1.3 m high except in population 5. From a single mature individual tree encountered in each population, 25-100m^2 plots were established, threats documented, saplings counted and seeds collected in each of the 5 populations.

2.1.3 Population Assessment

This was done to ensure that a population meets the minimum quality and quantity standards for seed sampling. A pre-visit was done and in collaboration with on-site contact persons and field guides, the populations of the target species were located and their GPS coordinates, flowering and fruiting periods recorded. Assessing these populations enabled the seed collectors to know the number of individual plants that are fruiting (its reproductive stage), the extent of its population, stage of degradation and threats faced.

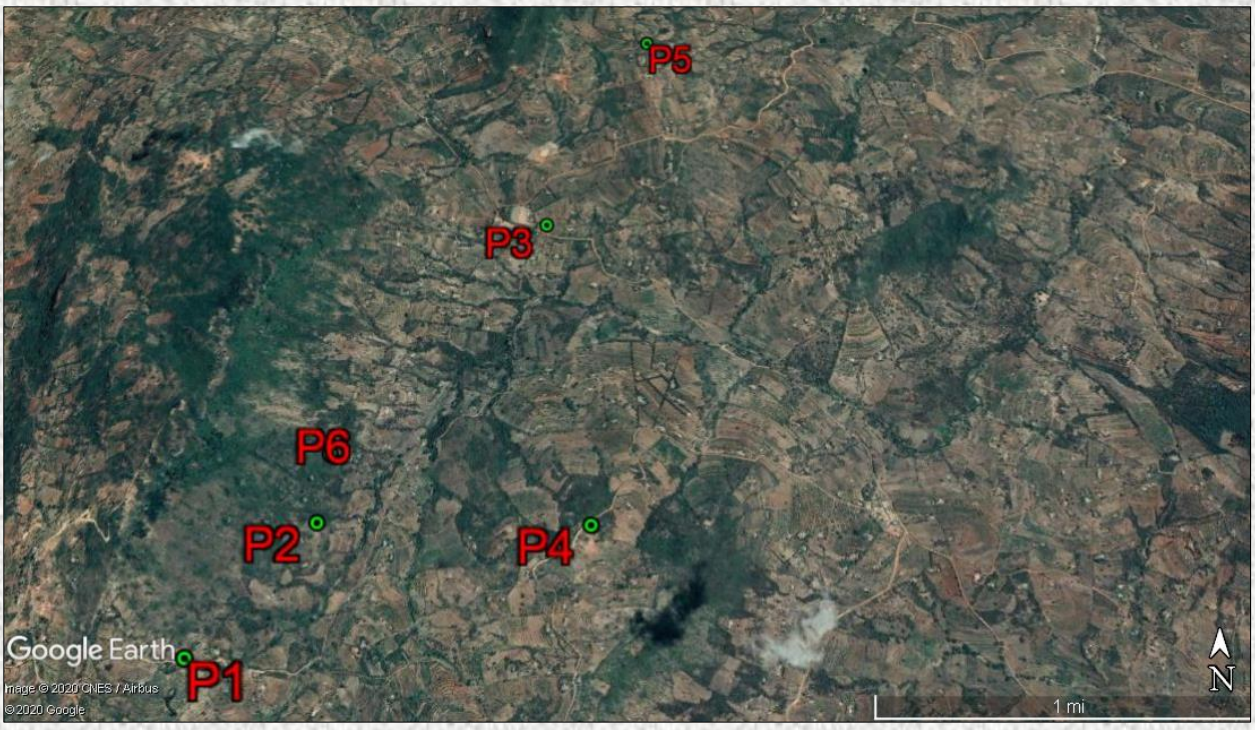

Fig 2c. A map of Ngutwa showing the 6 sampled populations of *S. longepedunculata.* © Google Earth

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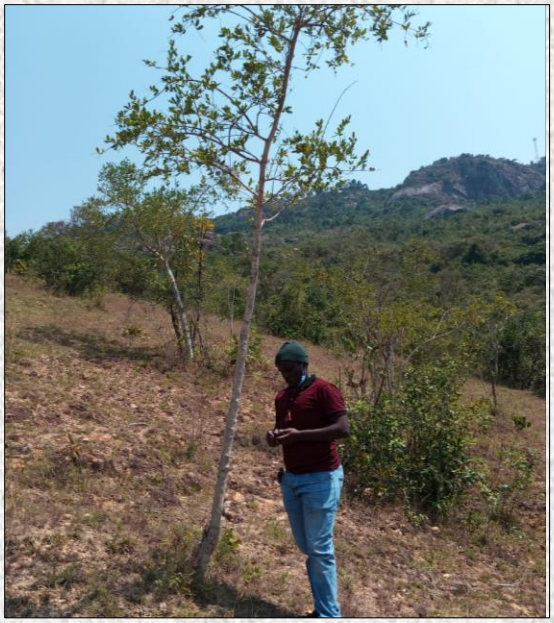

Fig 2d. GPS coordinates recording of *S. longepedunculata* populations.

2.1.4 Seed collection

Random seed samples of the target species were collected during four seed maturity stages; first Harvest (April 2020), second Harvest (June 2020), third Harvest (August 2020) and fourth Harvest (October). The target species have delicate, flaking stems (single and multi-stemmed) that are easily breakable so care was taken when collecting seeds from its branches. For tall trees/shrubs, a long-arm pruner/looper was used. This technique was suitable when collecting seeds at the terminal branches of the plant where the seeds are beyond the reach of the seed collectors. For hanging branches that were easily accessible, the fruits were picked by hand.

Fig 2e. Seed collection using a pruner/looper

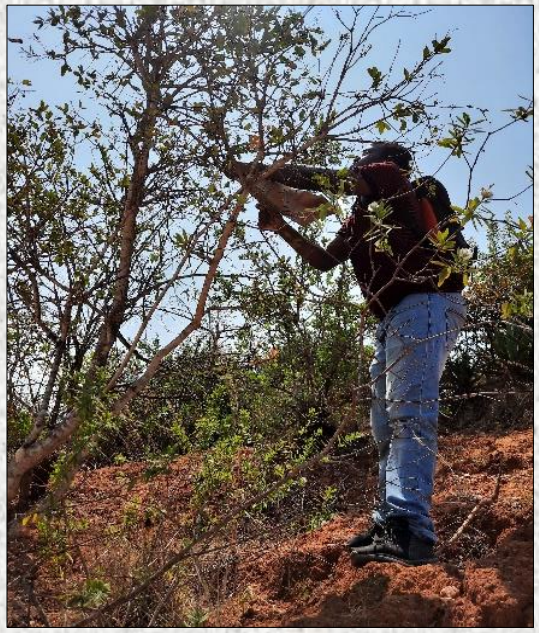

Fig 2f. Seed collection by plucking technique.

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The seeds were collected into khaki bags. The bags were labelled inside and out with a unique collection number, sealed, arranged in a crate and transported to the seed lab for processing, mass propagation and seed quality studies. Voucher specimens of each of the sampled trees were collected, processed and safely kept in the East African Herbarium, Kenya.

2.1.5 Seed Quality Assessment

2.1.5.1 Seed cleaning and cut testing

The collected *S. longepedunculata* seeds were spread in a thin layer and cleaned to reduce the risk of pests and disease infection and reduce bulkiness. Care and expertise were observed during cleaning to prevent physical damage and reduction in the viability of the seeds. The Hand-sorting technique was used to remove leaves debris, unwanted, empty and infested seeds.

Cut-testing was used as a method of assessing the physical seed quality of the collected seeds while in the field. This is to establish if the seeds to be collected are damaged or infected by insects, empty or badly formed. Twenty seeds were selected for cut testing for the proportion of 1000-5000 seeds collected as per Terry & Sutcliffe (2014) representative sub-sample of seeds for cleaning.

Fig 2g. *S. longepedunculata* seeds spread in a thin layer for ventilation

Fig 2h. An infested seed observed after a cut-test

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2.1.6 Seed Processing

A scalpel blade was used to open the stony endocarp of the fruit composed of a single seed.

Fig 2i: A processed fruit of *S. longepedunculata* showing the seed

Fig 2j. A split fruit showing the stony endocarp of *S. longepedunculata* without the seed.

2.1.7 Determination of Seed Development

There have been several studies on the desiccation tolerance and seed longevity of a range of species. However, there is no published information on the seed biology of *S. longepedunculata* to inform an appropriate conservation strategy. In this study, markers of seed quality were identified and measured. This will enhance the understanding of patterns of seed development and informing conservationists and the local community on the optimum time for seed collection to achieve maximum germination rates. They include percentage moisture content, fresh weight, dry weight and the weight of water.

In tracking seed development patterns in *S. longepedunculata* species across the 5 populations sampled for seed collection, a variety of parameters were measured and recorded. They include:

1. The visual changes in fruit morphology at the different maturity stages (first to fourth Harvest periods).
2. Changes in percentage moisture content, fresh weight, dry weight and water weight in the seeds across the different maturity stages.
3. Germination rates of the freshly harvested *S. longepedunculata* seeds in the different maturity stages to identify the appropriate timing of seed collection capable of achieving maximum germination rates.

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2.1.7.1 Screening for desiccation tolerance of S. longepedunculata seeds

The moisture content of the bulk collection composed of randomized seed collection from all the populations sampled for each of the 4 harvest periods was determined and data explored using a line graph for comparison.

Fifty seeds in replicates of 5 (10x5) were sampled from the bulk collection weighed and their fresh weights recorded. A low constant temperature oven method will be used to dry the fresh seeds in a ventilated oven at 103^0 for 17 hours (ISTA, 2007). The dry weight (*d.wt*) for each replicate of the seeds was weighed, recorded and the percentage moisture content calculated using the equation below and recorded.

$$\% \text{ MC} = \frac{(f.wt - d.wt)}{(f.wt)} \times 100$$

Where MC=Moisture Content, *f.wt*=Fresh weight and *d.wt* =Dry weight.

2.1.7.2 Germination determination of S. longepedunculata seeds

This is the most reliable way of assessing the viability of the target species' seeds. 30 seeds in replicates of 5 (5x6) were sown on different media namely: Vermiculite, Sand, Sawdust, Habitat and Forest soil to establish the best media for propagation and to determine the germination rates of *S. longepedunculata* seeds in the four maturity stages. The seeds were sown in both the incubator calibrated at 25 ° C and a propagator. Germination rates in each were recorded and data explored using line and bar graphs for comparison.

Fig 2k. Project PI (author) measuring and recording fresh weights and dry weights of the violet plant seeds.

Fig 2l. Seeds placed inside an oven for drying at 103^0 for 17 hours.

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Due to the nature of the seeds, the extracted seeds were placed on top of wet cotton wool to avoid drying and potential loss of viability during sowing. Germination scoring was done weekly from when the hypocotyl was at least 5mm in length up until no further germination was recorded. Date of sowing, days after sowing and the number of seeds that germinated were recorded on a test sheet. In the incubator, watering was done twice a week for all the media except vermiculite which was watered only once a week in the incubator and once in two weeks in the propagator as it is capable of holding water for long compared to other forms of media selected. The use of low technology non-mist propagator for growth and maturation of the target species seedlings was used as they are cheap to construct, effective and have no requirement for piped water nor electricity supply (Leakey, et al., 1990) and thus preferable for use by the local community.

Fig 2m. The project PI (author) mixing vermiculite media with water at a ratio of 1 litre of water: 100kg of vermiculite

Fig 2n. Prepared vermiculite media ready for sowing

Fig 2o. Sieved forest soil ready for sowing

Fig 2p. Decontamination of working surfaces by Mr. Sila, a project team member for sowing.

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Fig 2q. A non-mist propagator constructed for sowing

Fig 2r. Applying and levelling of the vermiculite media in the propagator

Fig 2s. Sown seeds in sawdust media

Fig 2t. Well labeled sown seeds in vermiculite media

Fig 2u. Sown seeds in improvised lunch boxes placed in an incubator calibrated at 25°C for germination.

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2.1.7.3 Germination test evaluation of S. longepedunculata seeds

In calculating the percentage germination of the target species seeds, seeds that did not germinate either by being empty or insect-infested were excluded from these calculations. To calculate percentage germination, the following equation was used:

% Germination = **G/X * 100** where **G**= The number of seeds that germinated; **X**= Number of seeds sown excluding the empty and the insect-infested seeds (Davies, et al., 2015).

Fig 2v. Sowing of *S. longepedunculata* seeds in a non-mist propagator

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2.1.8 Capacity Building

2.1.8.1 Community needs assessment

JAPEL Self-Help group was selected and integrated into the project. Project planning and implementation matrix for training and other project activities was developed ready for commencement of the project. Protocol for conducting workshops and community field days was developed with strict adherence to the World Health Organization protocol on Covid-19 prevention and control. A training curriculum was designed as in Annex 6 and used during the training sessions.

The team introduced themselves to the community members and explained the purpose, aim and impact of the project to the community and the environment according to the Principle of Full Disclosure as stipulated in the Code of Ethics of the International Society of Ethnobiology (ISE, 2008) and a verbal consent obtained from the participants.

Other local community participants were selected purposively to ensure a diverse representation. The factors considered while selecting the participants included gender, age and occupation. Key informants interviews were undertaken with community resource people such as Culturist, Conservators/Foresters, Herbalist, Environmentalist, Chief, Public Health and Religious people.

2.1.8.2 Training of community focus group members

The local community including JAPEL Self-Help group members were trained in groups of 10 as per the Government regulations on avoidance of large crowds to reduce the risk of Covid-19 prevalence. Additionally, the team employed local handwashing techniques.

Fig 2w. Devised hand-washing techniques against Covid-19 pandemic during training

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Awareness of sustainable management, conservation and restoration of the target species was raised through the training. Over 100 JAPEL Self-Help group members and local community members were trained by the project team with ethnobotanical, taxonomical, conservation and nursery management expertise from the National Museums of Kenya through presentations and practical demonstrations in groups of 10 members to avoid Covid-19 infection. Each group was tasked to do a presentation to establish the knowledge gained by the trainees. A workshop evaluation form (Annex 7) was administered to the trainees to evaluate the efficiency of the training.

2.1.9 Restoration

Enrichment planting, agroforestry and re-introduction of the target species in sites where the species is known to have existed but are now absent due to consumptive exploitation by the community were used as methods for restoring *S. longepedunculata* species populations and their habitats in collaboration with the local community.

2.1.10 Information Dissemination

Project Information and findings were disseminated effectively to all stakeholders, the local community and the public: The project findings have been submitted for review and publishing. The project-generated educational materials such as short video documentaries of project activities and the propagation protocol booklet produced, printed, distributed and used during workshops and training for awareness creation, education and outreach.

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CHAPTER THREE

3.1 Results and Discussion

Threats faced by *Securidaca longepedunculata* species and their habitats are humongous. They have led to**:**

(i) The reduced population size of the target species.
(ii) Habitat disturbance and loss.
(iii) Loss of seed dispersal areas and edge effects.
(iv) Loss or replacement of critical microhabitats such as riparian ecosystems and natural shade forests which are refugia for other sensitive plants (Fungi, Lichens, Aloes, Orchids and Bryophytes), useful species (medicinal plants), threatened species and animals.

Fig 3a. The bark of *S. longepedunculata* extracted by the local community to treat ailments

These threats include:

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3.1.1 Deforestation

3.1.1.1 Deforestation of violet plant, degradation and fragmentation of its habitats

The continued destruction of the target species and its associated species for medicine and firewood was noticed. This has led to the degradation and fragmentation of violet plants' habitats with declining vegetation cover and little natural regeneration. This has further led to increased soil erosion due to the damaged understorey and soil litter layer.

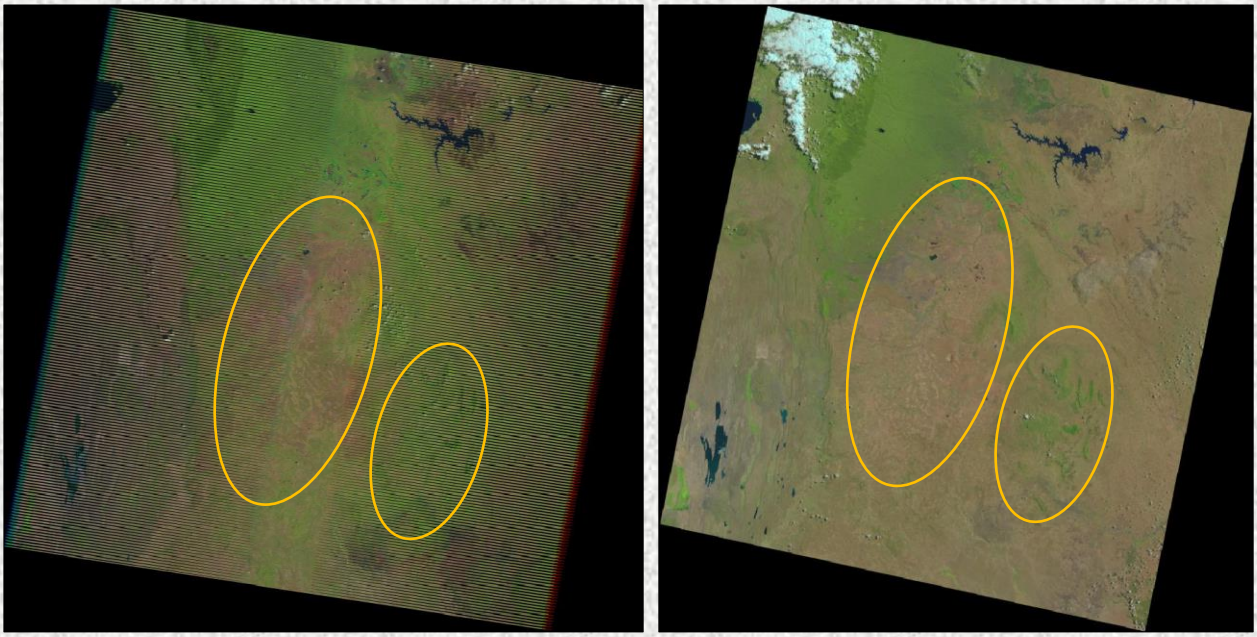

Fig 3b. A Landsat image showing land cover changes from 2010 (left) to 2020 (right) in the study area in 2010. @United States Geological Survey (USGS); https://earthexplorer.usgs.gov/

Fig 3c. Violet plant exploited for firewood

Fig 3d. Charcoal burning of the violet plant species

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Fig3e. A regenerating sapling growing on rocky, degraded habitats

Fig 3f. Depleting vegetation in the violet plant habitats leaving the ground bare

Fig 3g. Degraded conditions of the soil in the violet plant habitat (Population 4) leading to low fertility as witnessed by few *S. longepedunculata* seeds sampled with reduced size

Fig 3h. Formation of deep gulleys in the violet plants' habitats with growing of *Agave sisalana* – an invasive species

Fig 3i. Habitat degradation and fragmentation leading to edge effects

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3.1.1.2 Effects on watershed sites

A gradual reduction in vegetation around the upper watershed sites over time has affected the hydrology of the area. This has led to the conversion of permanent rivers to seasonal dry streams leading to reduced water quality and supply.

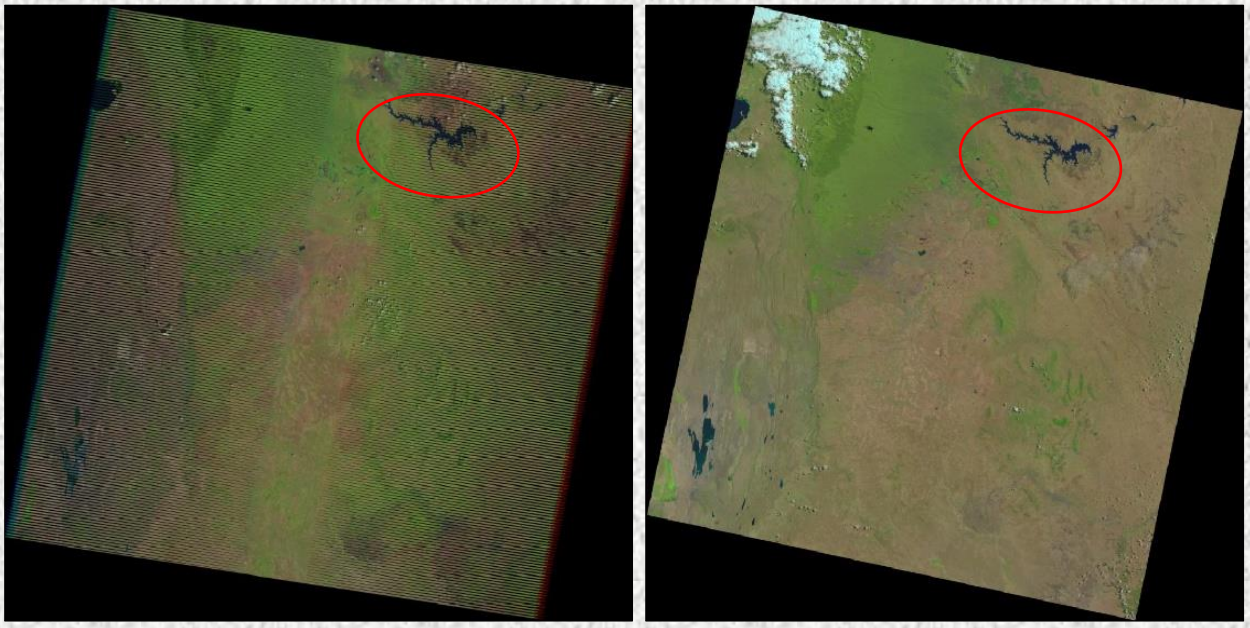

Fig 3j. A Landsat image showing vegetation cover changes around the upper watershed site in the study area from 2010 (left) to 2020 (right) in the study area. @United States Geological Survey (USGS); https://earthexplorer.usgs.gov/

Fig 3k. Dried streams on the uppershed sites of the study area that supply water to the local community around that area

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Fig 3l. Seasonal lower stream sampled on the same day, same month, different year showing different scenarios; Left (2020), Right (2021).

Fig 3m. Other dry seasonal streams encountered during the study

Fig 3n. Local community including school children tasked with searching for water in the near by localities using donkeys due to lack of reliable water supply in Ngutwa study area

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3.1.1.3 Deforestation of other associated medicinal plants

One of the medicinal plants that were adversely exploited by the community at a high rate is *Aloe secundiflora* Engl. It is used by the community to treat wounds, typhoid, headaches, chest pains, malaria, diarrhoea, oedema, swollen diaphragm, fever and nosebleed. Breastfeeding mothers apply their exudant on their nipples to wean their children. Moreover, it was applied to drinking water in poultry farms to treat coccidiosis and Newcastle disease in poultry and the manufacturing of cosmetic products.

Fig 3o. Destruction of *Aloe secundiflora* Engl. by the local community for medicine preparation

This species is listed under **Appendix 2 of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)** warranting the need to be protected and conserved.

Another medicinal plant species listed under CITES found in the rocky habitats in the study area is *Rhipsalis baccifera* (J.Mill.) Stearn) whose stem is crushed and consumed with the juice of *Lonchocarpus chrysophyllus* to treat coral snake bites and the whole plant used as an ingredient in a curative herbal bath (DeFilipps, et al., 2004).

Other wild medicinal plants encountered in the study area include *Uvaria scheffleri, Osyris lanceolata* whose status has not been evaluated but in the IUCN Red List of Threatened Species but their numbers have been greatly reduced by overexploitation of their roots to treat diarrhoea and other plant parts for treating Hepatitis B.

Rapanea melanophloeos was/is still used to treat TB-related symptoms such as fever, cough, chest disease and night sweats as also in South Africa (Watt & Breyer-Brandwijk, 1962).In Makueni, it is used to control parasitism in ruminants as in other parts of Kenya (Githiori, et al., 2002).

Carissa spinarum roots were ground and used as a treatment for venereal diseases and as an antihelminthic against tapeworms, chest pains and coughs (Burkil, 1985).

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Terminalia brownii, a dominant tree species in the study area and a widely known African traditional medicine was used to treat cough, jaundice, malaria, tuberculosis, epilepsy, urinogenital problems, syphilis, gonorrhoea, as anthelmintic, against body swellings, yellow fever, stomach complaints, colic, diarrhoea, eye infections, fungal infections, ringworm and allergic reactions (Mosango, 2013) among other medicinal species.

Most of the medicinal plant species in the area are associated with some of the threatened species such as *Euphorbia friesiorum* (vulnerable), *Pavetta sepium* (Vulnerable), *Milletiia vatkei* (Endangered) and *Aloe ngutwaensis* which is currently Critically endangered (CR B1ab(i,ii,iii,iv) + B2ab (i,ii,iii,iv) pending IUCN red listing expert recommendations (Matheka, et al., 2020) and named after the project study area among others.

The consumptive exploitation of the medicinal plant species' has disrupted the ecological integrity of these habitats posing a risk of extinction of its associated threatened species.

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3.1.1.4 Deforestation of other associated keystone species

One notable keystone species found in the violet plant habitat that was consumptively exploited for timber and firewood is the *Ficus sycomorus*, a key component of tropical ecosystems. Its fruits are mainly eaten by the birds, invertebrates and are important in attracting pollinators and seed dispersers as it supports the birds' nests.

Restoration of the *Ficus sycomorus* is crucial in the recovery of the medicinal plants' habitats in the area as it solves dispersal limitation which is a major constraint to the ecological restoration goals and balances soil nutrients and microclimate which makes the area conducive for seed germination and sapling growth (Cottee-Jones, et al., 2016). *Ficus sycomorus* should be prioritized to facilitate effective ecological restoration in degraded landscapes (Cottee-Jones, et al., 2016).

Fig 3p. *Ficus sycomorus* tree

Fig 3q. *Ficus sycomorus* fruits, bark and roots

Fig 3r. Destruction of *Ficus sycomorus*, a keystone species for timber and firewood

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3.1.2 Slash-and-Burn Agriculture/Shifting cultivation

High population growth has led to human encroachment in the study area. This has resulted in the clearing and burning of the violet plants' habitats for farming to sustain the demand for food. Some of the food crops grown include maize, bananas, pawpaws, mangos, oranges and pigeon peas (*Cajanus cajan*), a common food crop in Makueni county. However, the cleared area remains fertile for a short time of which the farmer then moves to search for new, pristine land in the forest to proceed with farming. This has massively destroyed these habitats warranting protection and reforestation by the local community.

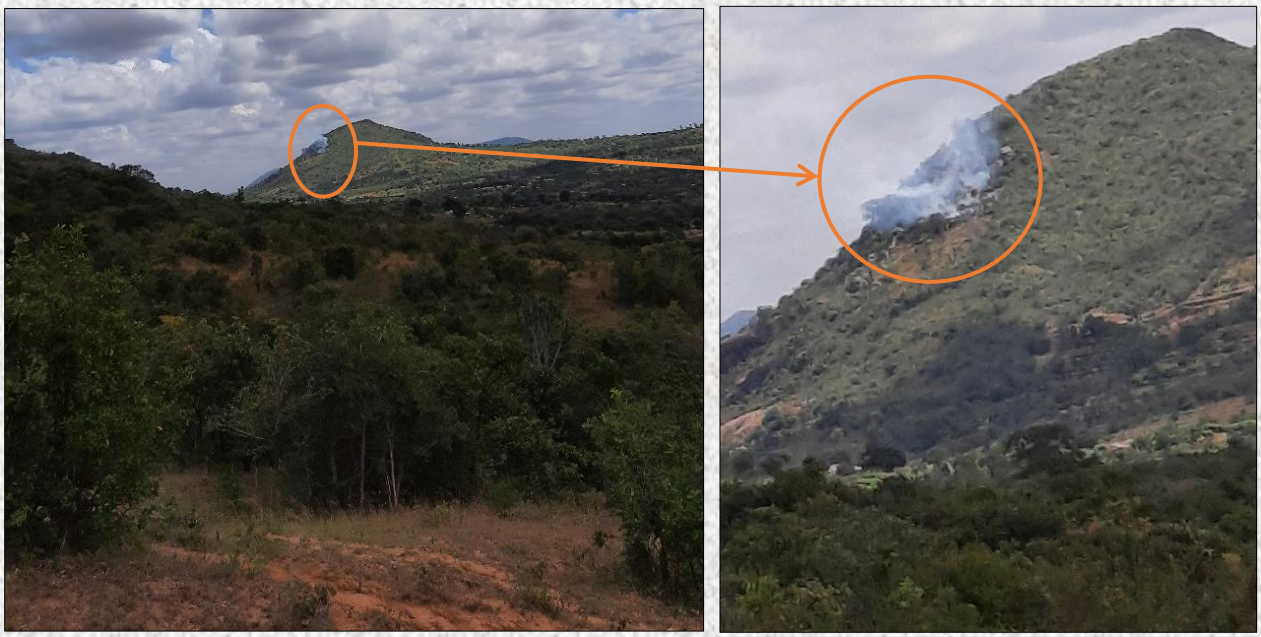

Fig 3s. Burning of the forested study area creating a swidden for farming purposes

Fig 3t. Burning of stiff grasses by a local household for farming maize

Fig 3u. Banana growing in the violet plant habitats

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Fig 3v. Pawpaw growing in the violet plant habitats

Fig 3w. Pigeon pea (*Cajanus cajan*) growing in the violet plant habitats

Fig 3x. Violet plant habitats converted to maize growing farmlands

Fig 3y. Human settlements prevalent in Ngutwa, Wote study area. © Google Earth

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3.1.3 Invasive species

Among the key laws governing the management of invasive species in Kenya include the Environmental Management and Coordination Act (EMCA), Plant Protection Act, Agricultural Produce Act, the Seeds and Plant Variety Act which are mainly implemented by the National Environmental Management Authority (NEMA).

Invasive species affect biodiversity and community structure in the violet plant habitats through exploitation and interference competition. Changes in community structure affect ecosystem services by the decline in species of economic importance such as medicine, food and fodder. Invasive species further disrupt mutualisms threatening pollination and natural pest control services.

Some of the invasive species growing in the violet plants' habitat include:

No	Family	Genus	Species
1	Asteraceae	*Tagetes*	*minuta*
2	Asteraceae	*Schkuhria*	*pinnata*
3	Asteraceae	*Bidens*	*pilosa*
4	Myrtaceae	*Eucalyptus*	*spp*
5	Asparagaceae	*Agave*	*sisalana*
6	Fabaceae	*Desmodium*	*spp*
7	Poaceae	*Digitaria*	*abyssinica*
8	Poaceae	*Cynodon*	*dactylon*
9	Asteraceae	*Ageratum*	*conyzoides*
10	Asteraceae	*Conyza*	*spp*
11	Amaranthaceae	*Achyranthes*	*aspera*
12	Verbenaceae	*Lantana*	*camara*
13	Boraginaceae	*Heliotropium*	*spp*
14	Asteraceae	*Sphaeranthus*	*suaveolens*
15	Asteraceae	*Aspilia*	*mossambicensis*
16	Malvaceae	*Triumfetta*	*tomentosa*
17	Lamiaceae	*Plectranthus*	*spp*
18	Fabaceae	*Cassia*	*singueana*
19	Fabaceae	*Caesalpinia*	*decapelata*
20	Malvaceae	*Pavonia*	*urens*
21	Fabaceae	*Indigofera*	*atriceps ssp kaessneri*
22	Brassicaceae	*Capsella*	*bursa-pastoris*
23	Cucurbitaceae	*Cucumis*	*dispaceus*
24	Acanthaceae	*Hypoestes*	*aristata*

Table 1. List of invasive species in *S. longepedunculata* habitats

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3.1.4 Herbivory

S. longepedunculata species growing along the roadside makes them susceptible to destruction by the browsers. Additionally, cattle grazing by the local community within the violet plants' habitats has altered the composition of plant community within these habitats leading to soil erosion, habitat destruction and reduced species richness.

Fig 3z. A violet plant growing on roadside under threat of herbivory by the browsers.

Fig 3a(1). Cattle grazing on the violet plants habitats

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3.1.5 Structure & Distribution of *S. longepedunculata* Populations

3.1.5.1 Description of Population 1

This population was sampled in Ngutwa-Kathuma sub-locations. In this population, fruits were collected in four intervals in only two of the three mature trees available with the third one neither fruiting nor flowering at the time of collection.

Population/ Tree (P1Tx)	Locality	Coordinates	Habitat	Associated Species
P1T1	Ngutwa-Kathuma sub-location, one kilometre from the roadside en route to Ngutwa market.	S 01°50'28.5" E 037°33'43.3"	Wooded grassland near a seasonal stream and next to a mango plantation.	1. *Gardenia volkensii* K.Schum 2. *Combretum molle* Engl. & Diels 3. *Faurea sp.* 4. *Aloe secundiflora* Engl. 5. *Bauhinia tomentosa* Vell.
P1T2	Ngutwa-Kathuma sub-location.	S 01°50'24.4" E 037°33'43.2"	A semi-arid mixed forest with an open canopy and open bushland characterized by depressions. Soil texture rocky brownish.	1. *Carissa spinarum* L. 2. *Catunaregam spinosa* (Thunb.) Tirveng. 3. *Gymnosporia senegalensis* (Lam.) 4. *Gymnosporia heterophylla* (Eckl. & Zeyh.) Loes. 5. *Pavetta crassipes* K.Schum. 6. *Terminalia brownii* Fresen. 7. *Indigofera brevipes* Bak. Schweinf

Table 2: Description of habitat and location of the individual trees/shrubs in population 1

In this population, 5 saplings of the target species were identified and their GPS reference points and altitude recorded.

Population/Saplings (P1Sx)	Latitude (E)	Longitude (S)	Altitude (m)
P1S1	-1.8401	37.5619	1331.783
P1S2	-1.8399	37.5619	1327.516
P1S3	-1.8402	37.5622	1334.927
P1S4	-1.8403	37.5621	1339.475
P1S5	-1.8406	37.5618	1348.153

Table 3: The number, location and altitude of the target species' saplings in population 1

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The distribution of each of the sampled individual shrubs/trees' and saplings' GPS reference points were recorded and mapped via Google Earth.

Fig 3b(1). *S. longepedunculata* shrubs/trees (in green icons and red labels) and saplings (in white icons and yellow labels) sampled along a roadside in Population 1.
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3.1.5.2 Description of Population 2

In Ngutwa-Kathuma sub-location, fruits were collected from the target species in four harvest intervals in five mature individual shrubs/trees that were fruiting in population 2.

Population/ Tree (P2Tx)	**Locality**	**Coordinates**	**Habitat**	**Associated Species**
P2T1	On Ngutwa-Kathuma sub-location boundary.	S 01°50'08.7" E 037°33'57.3"	A semi-arid land on a hillside characterized by depressions forming a seasonal river. On the lower side, there are signs of recent cultivation and heavy vegetation clearance.	1. *Gymnosporia senegalensis* (Lam.) 2. *Combretum molle* Engl. & Diels 3. *Harrisonia abyssinica* Oliv 4. *Euphorbia candelabrum* Trémaux ex Kotschy 5. *Searsia pyroides* (Burch.) Moffett 6. *Catunaregam nilotica* (Stapf)
P2T2	Ngutwa-Kathuma sub-location on the hill	S 01°83'56.2" E 037°56'59"	Secondary bushland partly wooded grassland dominated by *Gymnosporia senegalensis*, *Searsia pyroides* and *Carissa spinarum.*	1. *Gymnosporia senegalensis* (Lam.) 2. *Searsia pyroides* (Burch.) Moffett 3. *Carissa spinarum* L.
P2T3	Ngutwa-Kathuma sub-location	S 01°50'07.9" E 037°33'56.3"	Wooded secondary bushland and open grassland with rocky soil on a hillside.	1. *Pavetta crassipes* K.Schum. 2. *Gardenia volkensii* K.Schum. 3. *Carissa spinarum* L.
P2T4	Ngutwa-Kathuma sub-location	S 01°50'08.1" E 037°33'50.5"	Secondary bushland dominated by *Carissa spinarum.*	1. *Searsia natalensis* (Bernh. ex C.Krauss) 2. *Searsia pyroides* (Burch.) Moffett 3. *Gardenia volkensii* K.Schum.
P2T5	Ngutwa-Kathuma sub-location	S 01°50'13.1" E 037°33'94.8"	Wooded bushland with open grassland	1. *Gardenia volkensii* K.Schum. 2. *Searsia natalensis* (Bernh. ex C.Krauss) 3. *Searsia pyroides* (Burch.) Moffett

Table 4: Description of habitat and location of the individual trees/shrubs in population 2

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22 saplings of the target species were recorded in population 2.

Population/Saplings (P2Sx)	Latitude	Longitude	Altitude
P2S1	-1.8358	37.565924	1301.71
P2S2	-1.8358	37.565928	1301.25
P2S3	-1.8358	37.565923	1302.16
P2S4	-1.8357	37.565899	1300.48
P2S5	-1.8357	37.565928	1297.41
P2S6	-1.8357	37.565939	1297.49
P2S7	-1.8356	37.565812	1299.02
P2S8	-1.8356	37.565813	1298.39
P2S9	-1.8356	37.565828	1298.67
P2S10	-1.8356	37.565798	1299.36
P2S11	-1.8356	37.565772	1298.92
P2S12	-1.8355	37.565762	1300
P2S13	-1.8355	37.565751	1300.63
P2S14	-1.8356	37.565715	1301.08
P2S15	-1.8355	37.565715	1299.74
P2S16	-1.8355	37.565672	1299.66
P2S17	-1.8355	37.565678	1299.69
P2S18	-1.8356	37.565652	1300.2
P2S19	-1.8372	37.565432	1305.49
P2S20	-1.8373	37.565442	1302.91
P2S21	-1.8373	37.565383	1303.56
P2S22	-1.8373	37.565362	1303.15

Table 5: The number, location and the altitude of the target species' saplings in population 2

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3.1.5.3 Description of Population 3

This population was sampled close to a shopping center. Individual species of *S. longepedunculata* have been deforested for the construction of shops and houses. However, we found a single mature individual protected in a church compound that was fruiting and the project team managed to sample it for seed collection. 3 saplings of the target species were also found close to the mature tree/shrub and their GPS positions were recorded. However, one of the 3 saplings was found on the roadside 60m from Tree 1 in Population 3 (P3T1) as shown in figure 3g(1) below.

Population/ Tree (P3Tx)	Locality	Coordinates	Habitat	Associated Species
P3T1	Ngutwa Shopping centre	S 01°49'14.1" E 037°34'27.5"	On Mwanyani African Inland Church compound near the roadside, 60 metres from Ngutwa Primary School.	1. *Combretum molle* Engl. & Diels 2. *Pittosporum viridiflorum* Sims 3. *Grevillea robusta* A.Cunn. ex R.Br.

Table 6: Description of habitat and location of the individual trees/shrubs in population 3.

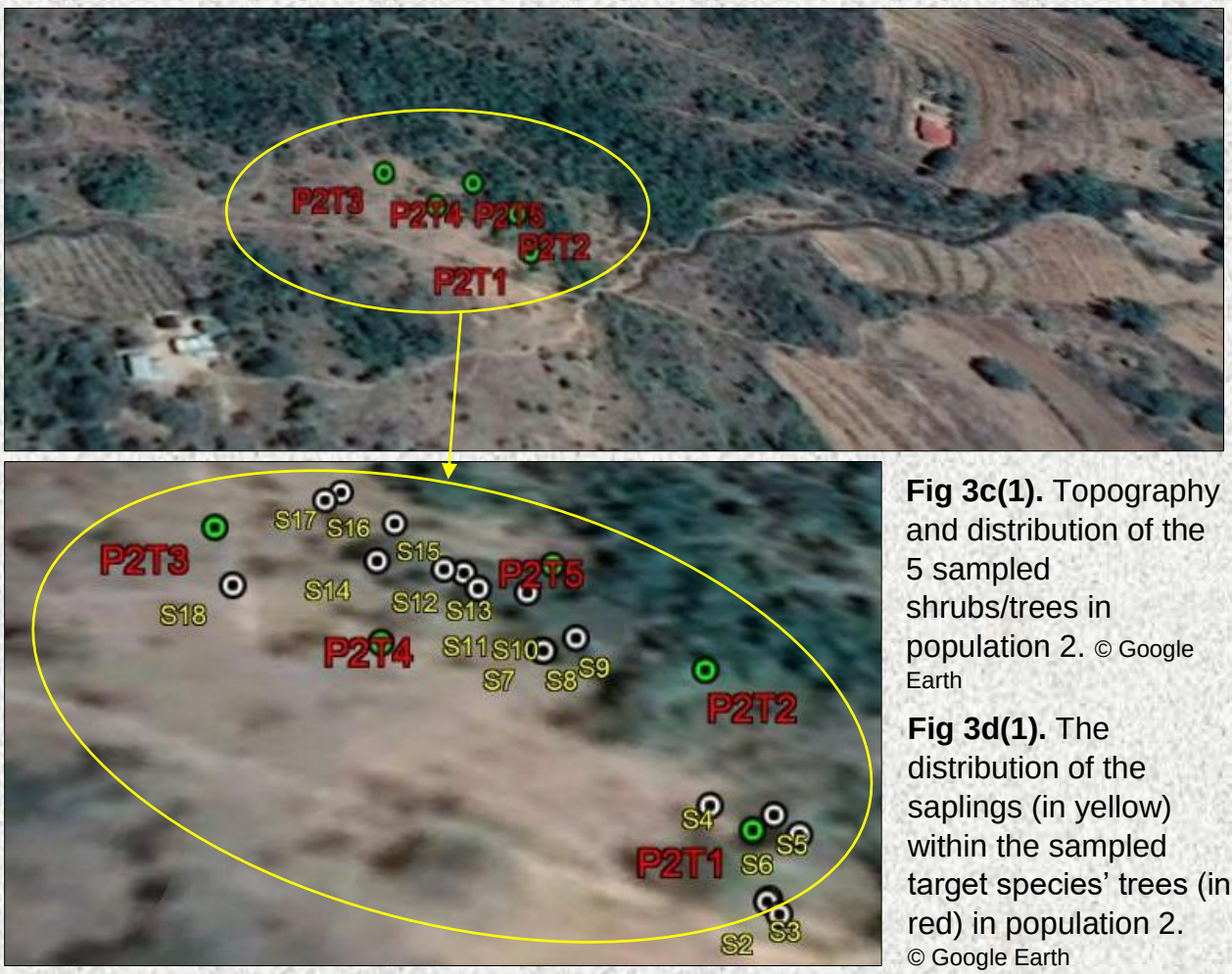

Fig 3c(1). Topography and distribution of the 5 sampled shrubs/trees in population 2. © Google Earth

Fig 3d(1). The distribution of the saplings (in yellow) within the sampled target species' trees (in red) in population 2. © Google Earth

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Population/Saplings (P3Sx)	Latitude	Longitude	Altitude
P3S1	-1.82062	37.5743	1263.91
P3S2	-1.82086	37.5748	1259.15
P3S3	-1.82061	37.5731	1245.42

Table 7: The number, location and the altitude of the target species' saplings in population 3

Fig 3e(1). Sapling (S3) on the verge of deforestation to pave way for a house construction.	**Fig 3f(1).** Location of the single tree sampled in population 3 and a sapling (S1) in a church compound	**Fig 3g(1).** Violet plant sapling of the target species on roadside, 60m from P3T1

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3.1.5.4 Description of Population 4

Only 1 mature shrub/tree and 27 saplings were found in this population. Most of the mature individuals were deforested by the local community for medicinal use. This has left the ground bare resulting in its degradation as shown below.

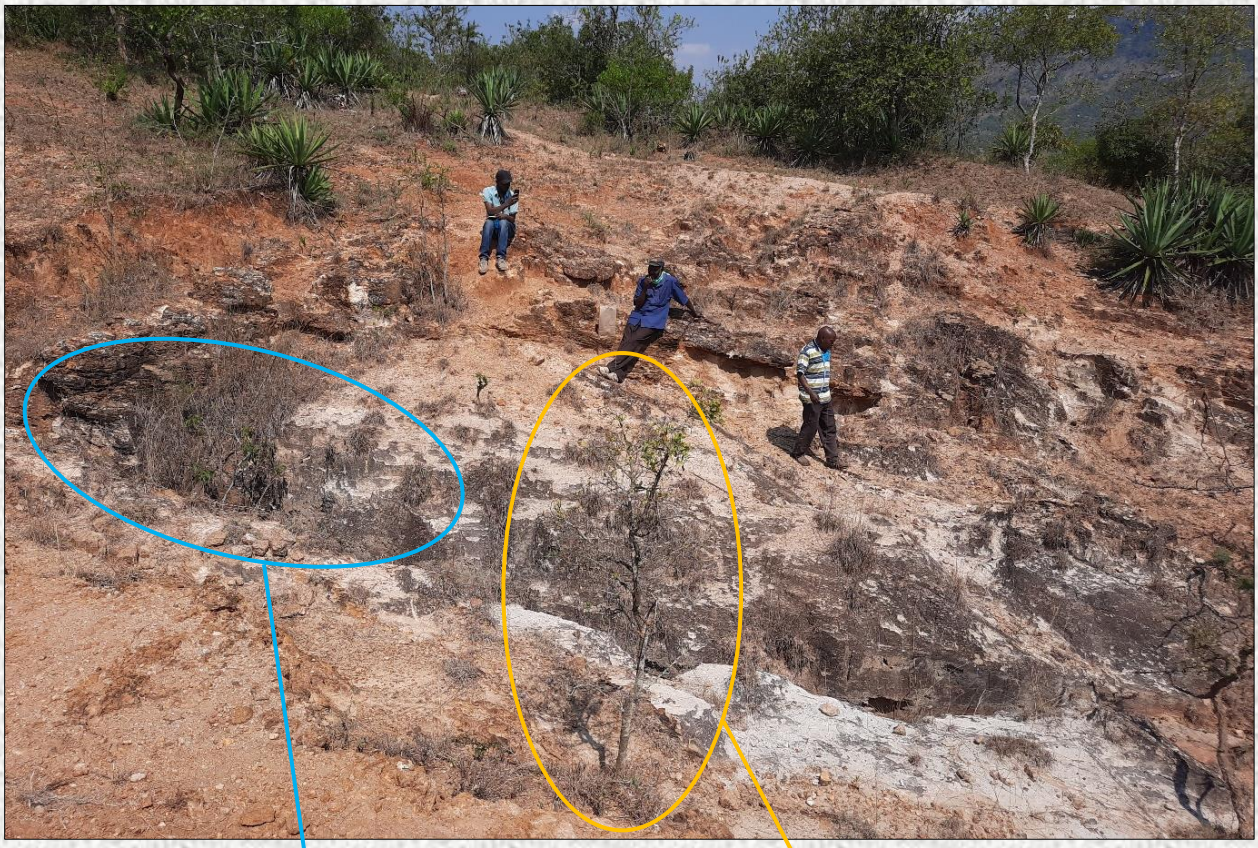

Fig 3h(1). Degradation of the sampled population 4 of violet plants' habitat due to deforestation

Fig 3i(1). Formation of depressions in violet plant's habitat sampled as population 4 habitat due to deforestation

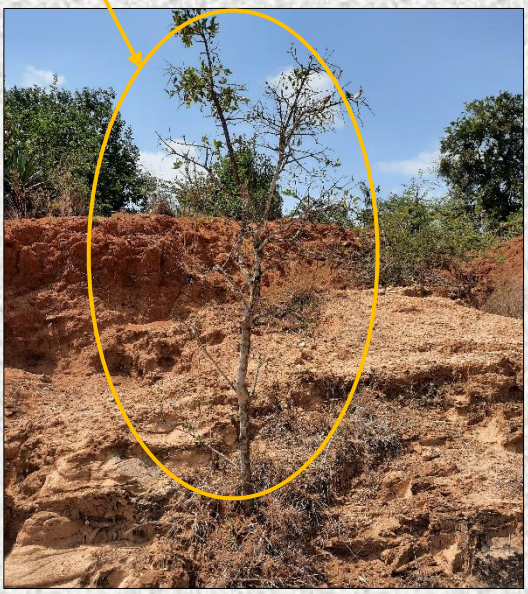

Fig 3j(1). A violet plant sapling growing in a degraded habitat in population 4

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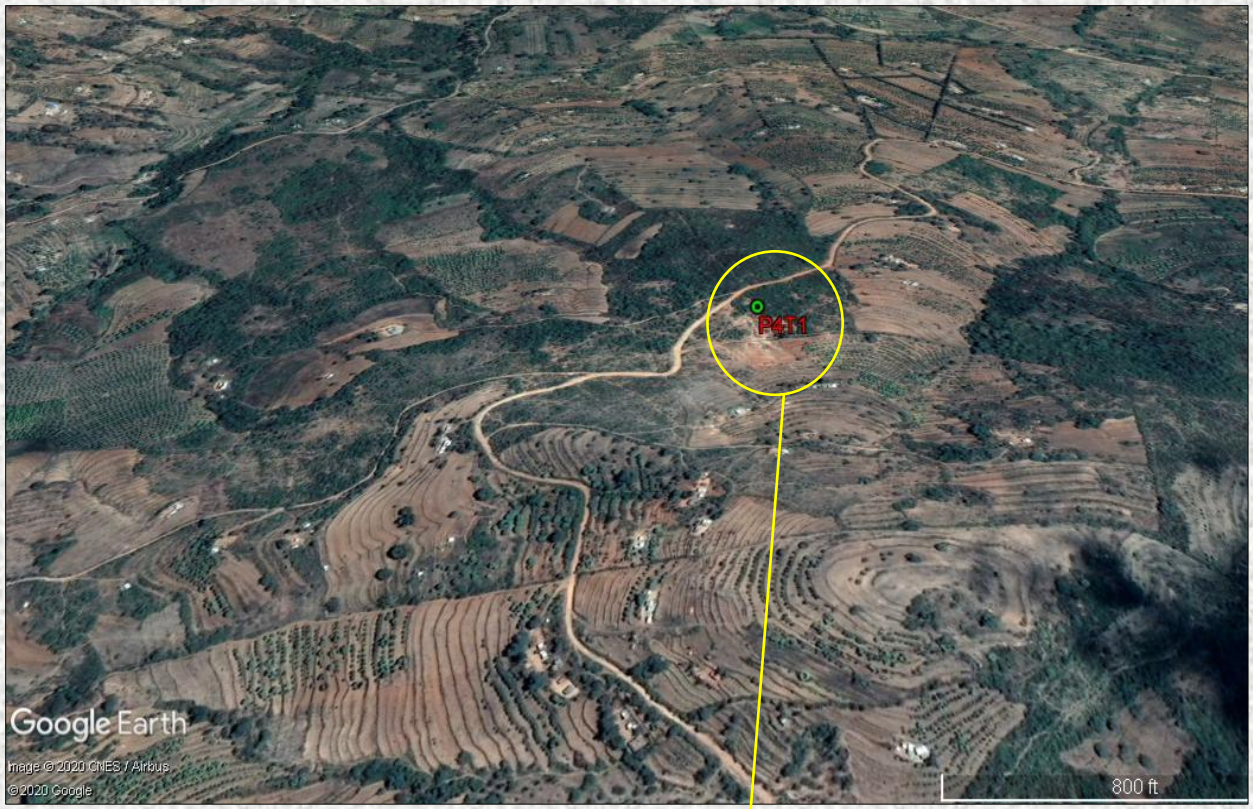

Fig 3k(1). The topography and position of the sampled shrub/tree in population 4

Fig 3l(1). The distribution of *S. longepedunculata* saplings (in yellow) within the sampled individual tree (in red pin) in population 4. © Google Earth

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Population/ Tree (P4Tx)	Locality	Coordinates	Habitat	Associated Species
P4T1	Ngutwa-Mutulani roadside	S 01°49'17.7" E 037°34'29.3"	On Ngutwa-Mutulani roadside, 5 km from Mutulani shopping centre. Bushland on rocky soil and degraded habitat with natural depressions.	1. *Pappea capensis* Sond. 2. *Combretrum molle* Engl. & Diels 3. *Searsia natalensis* (Bernh. ex C.Krauss) 4. *Ziziphus sp*. 5. *Gymnosporia heterophylla* (Eckl. & Zeyh.) Loes 6. *Carissa spinarum* L. 7. *Dodonaea angustifolia* L.f

Table 8: Description of habitat and location of the individual trees/shrubs in population 4.

Population/Saplings (P4Sx)	Latitude (E)	Longitude (S)	Altitude (m)
P4S1	-1.8357	37.5765	1327.16
P4S2	-1.8355	37.5763	1322.59
P4S3	-1.8354	37.5764	1320.96
P4S4	-1.8359	37.5767	1332.72
P4S5	-1.8358	37.5767	1326.5
P4S6	-1.8358	37.5767	1327.12
P4S7	-1.8358	37.5767	1327.48
P4S8	-1.8358	37.5767	1327.48
P4S9	-1.836	37.5767	1334.65
P4S10	-1.836	37.5767	1333.74
P4S11	-1.836	37.5767	1333.22
P4S12	-1.836	37.5767	1332.63
P4S13	-1.8363	37.5767	1332.81
P4S14	-1.8363	37.5768	1334.77
P4S15	-1.8363	37.5768	1334.79
P4S16	-1.8364	37.5768	1335.08
P4S17	-1.8364	37.5768	1335.7
P4S18	-1.8363	37.5768	1335.71
P4S19	-1.8363	37.5768	1331.02
P4S20	-1.8363	37.5768	1333.04
P4S21	-1.8359	37.5766	1325.53
P4S22	-1.8359	37.5763	1321.21
P4S23	-1.8357	37.5761	1321.68
P4S24	-1.8359	37.5761	1321.79
P4S25	-1.836	37.5761	1324.83
P4S26	-1.8356	37.5764	1322.66
P4S27	-1.8355	37.5763	1320.24

Table 9: The number, location and the altitude of the target species' saplings in population 4

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3.1.5.5 Description of Population 5

In this population, only one flowering individual was found in a cleared farm and so seed collection was not done. Target species individual trees were cleared for cultivation of pigeon pea (*Cajanus cajan* (L.) Millsp), a common food crop among the Kamba community. It was the only individual remaining to be deforested and was on the verge of being removed before the project team arrived. After a long discussion, Mr. Mbithi informed the project team that his grandfather used the species' bark to treat arthritis and roots to treat headaches, stomachaches and snake bites among other ailments.

Fig 3m(1). Mr. Richard Mbithi and author (in red) informing the team on the exploitation of *S. longepedunculata* tree for medicinal purposes and the history of the only remaining individual in his farm

Fig 3n(1). The only remaining 38-year-old *S. longepedunculata* tree in Mbithi's farm after deforestation of other individual trees.

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3.1.5.6 Description of Population 6

In this population, only 1 mature tree and 25 saplings were recorded. Other mature individuals were uprooted and their roots utilized for medicine preparation. Furthermore, their barks were removed by the local community thus cutting off food and nutrient supply to the roots resulting in the death of the plants.

Population/ Tree (P6Tx)	**Locality**	**Coordinates**	**Habitat**	**Associated Species**
P6T1	Ngutwa hillside	S 01°50'09.4" E 037°34'36.3"	Open bushland with few open forest trees on hillside elevation of 1271 m. Ngutwa sub-location 3km from the shopping centre	1. *Combretum sp*. 2. *Carissa spinarum* L. 3. *Searsia pyroides* (Burch.) Moffett 4. *Searsia natalensis* (Bernh. ex C.Krauss) 5. *Ziziphus sp*. 6. *Pappea capensis* Sond. 7. *Thespesia garckeana* F.Hoffm.

Table 10: Description of habitat and location of the individual tree/shrub in population 6

Population/Saplings (P6Sx)	**Latitude (E)**	**Longitude (S)**	**Altitude (m)**
P6S1	-1.8328	37.566	1296.28
P6S2	-1.8327	37.5661	1301.7
P6S3	-1.8328	37.5661	1301.37
P6S4	-1.8328	37.5661	1299.53
P6S5	-1.8328	37.5662	1299.56
P6S6	-1.8328	37.5661	1299.99
P6S7	-1.8329	37.5661	1300.38
P6S8	-1.8328	37.5661	1299.93
P6S9	-1.8327	37.5661	1298.31
P6S10	-1.8327	37.5662	1297.5
P6S11	-1.8326	37.5662	1295.93
P6S12	-1.8326	37.5661	1293.1
P6S13	-1.8325	37.5661	1293.3
P6S14	-1.8325	37.5662	1294.25
P6S15	-1.8326	37.5662	1294.95
P6S16	-1.8326	37.5662	1295.14
P6S17	-1.8326	37.5662	1295.07
P6S18	-1.8325	37.5662	1295.35

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P6S19	-1.8325	37.5662	1296.03
P6S20	-1.8326	37.5662	1295.15
P6S21	-1.8326	37.5663	1294.34
P6S22	-1.8327	37.5663	1294.41
P6S23	-1.8328	37.5662	1297.33
P6S24	-1.8327	37.5663	1294.02
P6S25	-1.8207	37.5734	1251.9

Table 11: The number, location and the altitude of the target species' saplings in population 6

Fig 3o(1). Distribution of a mature tree and saplings in population 6 under threat from human encroachment (circled in yellow).

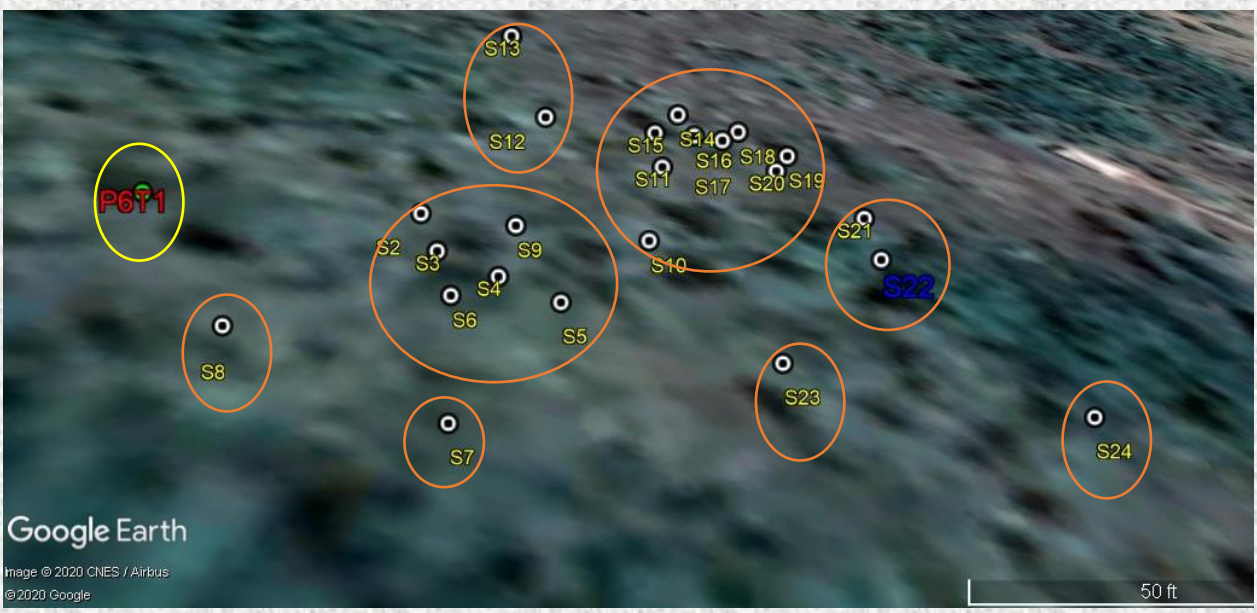

Fig 3p(1). A map showing possible deforestation of mature trees as seen in the position of the mature individual and other saplings in population 6

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3.1.6 Fruit Morphology

Securidaca longepedunculata fruit is a dry indehiscent fruit with a membranous wing about four cm long in form of a samara.

The fruit is on one side of the wing enabling its dispersal by wind. It changes its colour at different developmental stages and drops to the ground upon complete maturation and drying. The fruit is green sometimes with purple colouration along the edge of its wing. However, other fruits have a pale green-yellow colouration on their wings.

Fig 3q(1). A pale green-yellow winged fruit of a violet plant.

Fig 3r(1). Fruits borne on a violet plant shrub

Fig 3s(1). Red/purple-winged fruit of a violet plant.

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The fruits of *S. longepedunculata* change their outer colouration as they mature as shown below. Notice the changes in wing structure and colour in each of the four harvests.

Fig 3t(1). Seed sample collected during the first harvest

Fig 3u(1). Seed sample collected during the second harvest.

Fig 3v(1). Seeds collected during the third harvest.

Fig 3w(1). Seeds collected during the fourth harvest. Fruit colour changes from Green to Brown

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3.1.7 Seed Morphology and Maturation

Seed maturity affects the quality of seed collections for storage and conservation. The timing of maturity varies within each species. In this study, the immature seeds collected during the first harvest cannot be dried for storage nor used for conservation due to lack of viability and low germination rates.

Fig 3y(1). Cross-section showing the internal morphology of an immature *S. longepedunculata* seed

Notable characteristics of an immature *S. longepedunculata* seed include:

i) Fleshy and watery endosperm.
ii) Lack of a cotyledon
iii) A greenish broad embryo that splits into two halves.
iv) Thin whitish integument.

Notable characteristics of a mature *S. longepedunculata* seed include:

a) Endosperm disintegrates
b) Oily cotyledon.
c) Embryo changes from green to white.
d) Seeds are large, white, ovoid-globose with a low seed coat ratio (SCR), a distinctive morphological character of a recalcitrant/desiccation sensitive seed (Joshi, et al., 2015).

Fig 3z(1). Mature *S. longepedunculata* seeds

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3.1.8 Moisture Content

A decrease in percentage moisture content was observed from the first harvest to the fourth Harvest. However. The slope was much steeper from first to the third harvest as compared to the slope from third to the fourth harvest as shown in figure 3a(2) below.

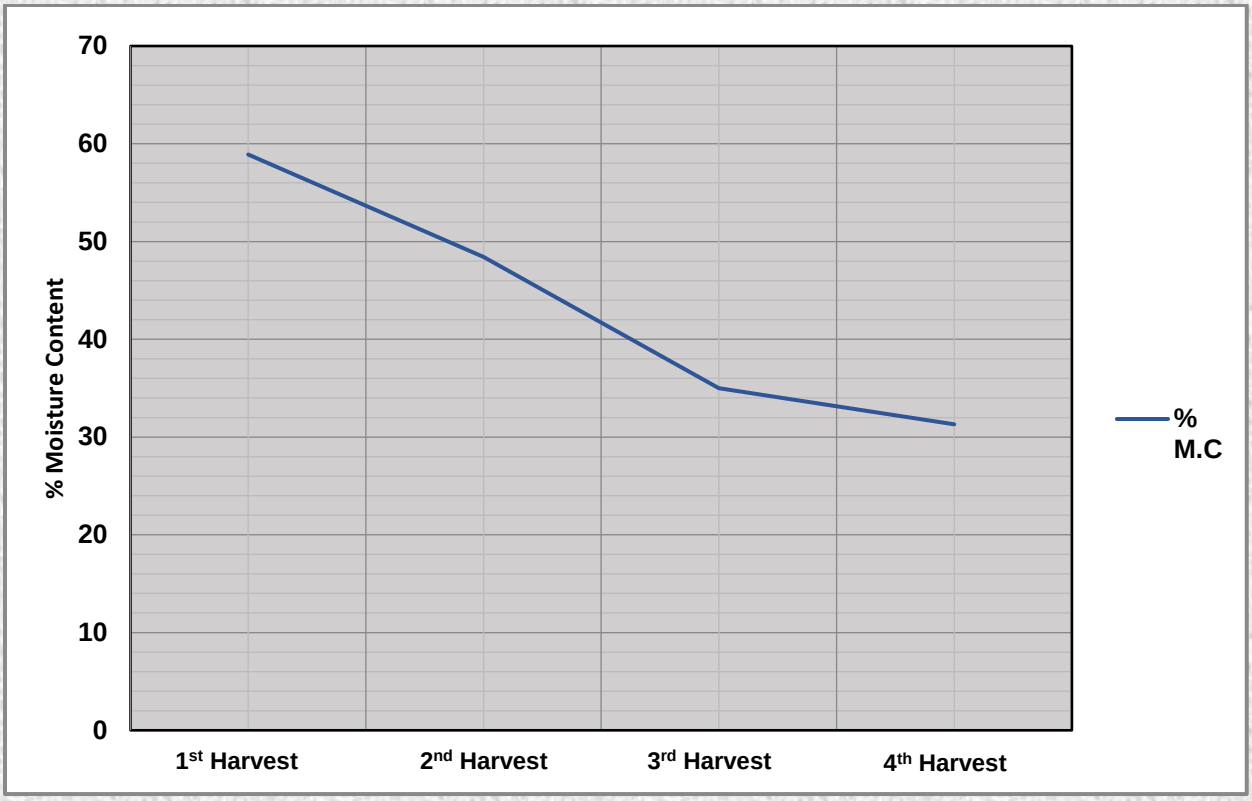

Fig 3a(2). A graph showing % Moisture Content trend against the four maturity stages of *S. longepedunculata* seeds

A decrease in both fresh weight and water weight and subsequent increase in the dry weight from the first harvest to the fourth harvest was observed.

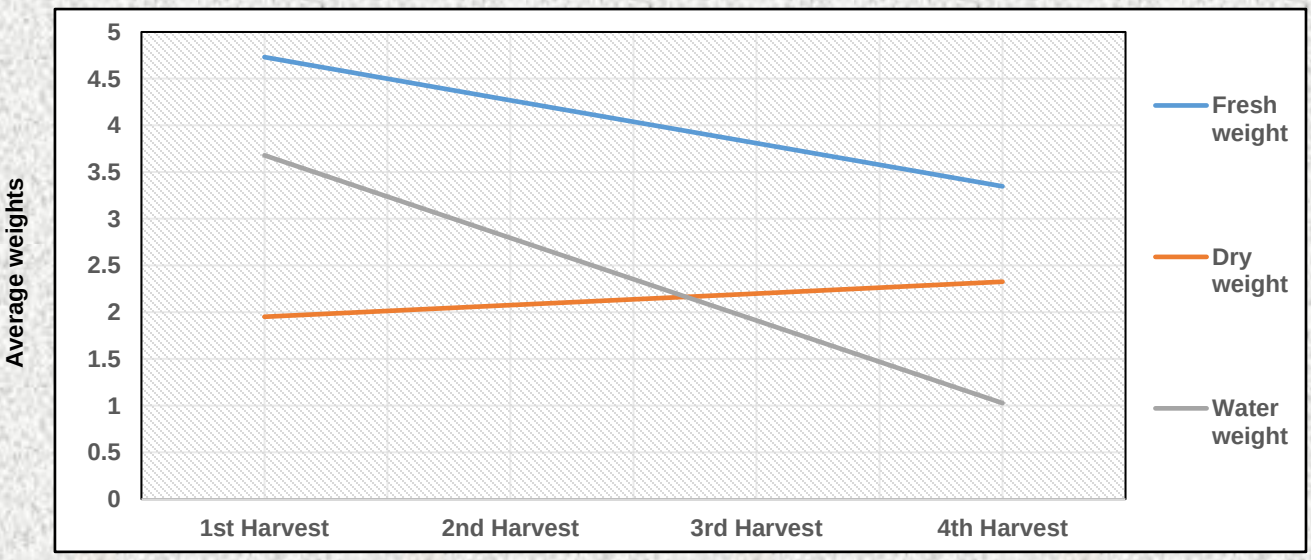

Fig 3b(2). A graph showing the selected seed quality parameters against the four maturity stages of *S. longepedunculata* seeds.

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During the first harvest, the embryo was underdeveloped and watery after a cut-test as shown in Fig 3y(1) above. This contributed to higher fresh weight and water weight. During this harvest, the samples collected from the 5 populations sampled had an average moisture content of 56.6%. Gradual seed development throughout the maturity stages was observed by the morphological change in the fruit colour. A decrease in the percentage moisture content to 46.4% was observed in the second harvest period. Continued declined was noted in the third harvest (35%) and fourth harvest (29%).

Moisture content, fresh weight and water weight levels fell continuously during the seed maturation phase as the dry weight increases. This was a result of food accumulation as the seed matures. Of the seed quality parameters investigated, percentage moisture content was identified to be the greatest marker in establishing seed development of *S. longepedunculata* seeds.

3.1.9 Seed viability

Germination tests for bulk collections were determined for each of the maturity stages. This was done in the selected media to determine the best suitable media for propagation and in both an incubator and a propagator to determine best conditions for germination of *S. longepedunculata* seeds and the suitability of propagator use by the local community

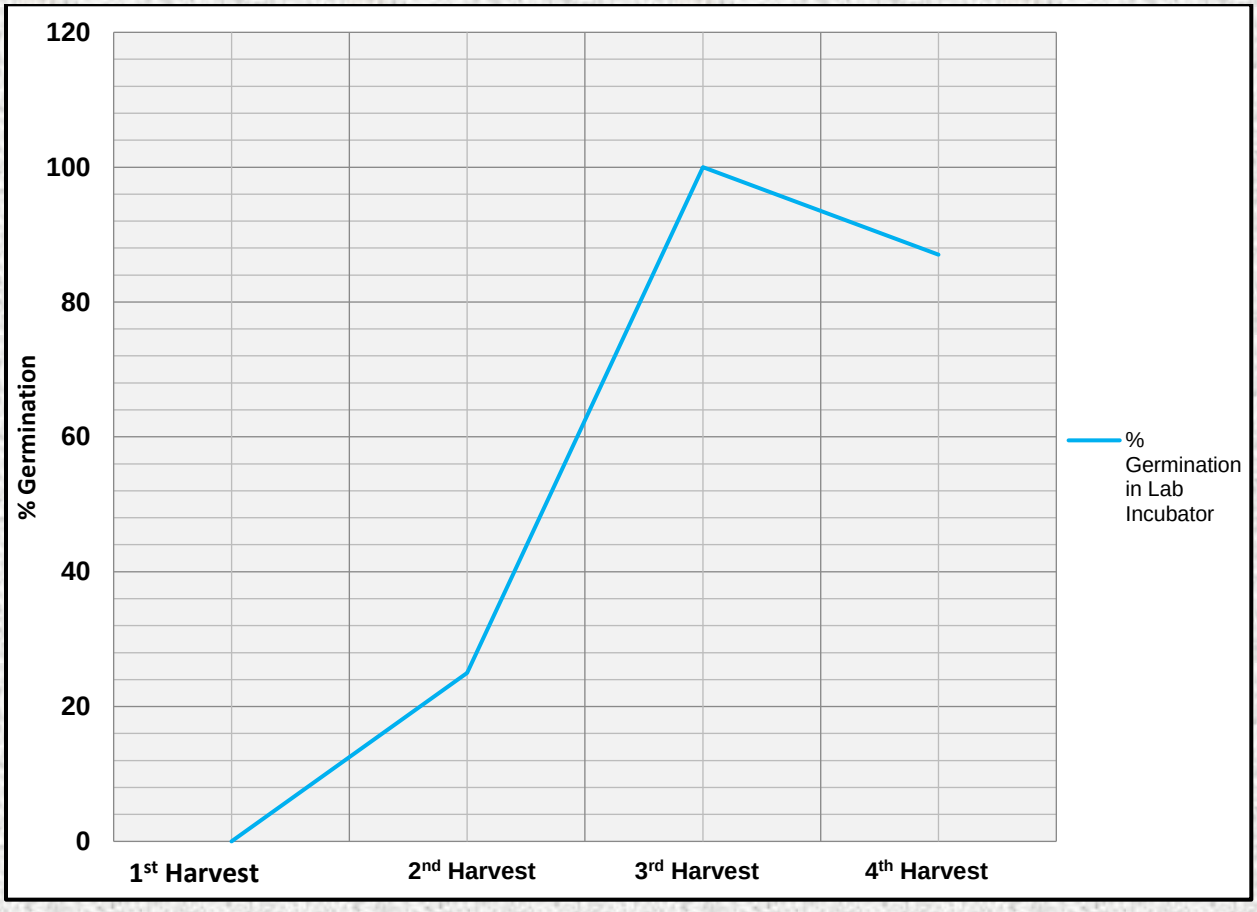

Fig 3c(2). A line graph showing % Germination Rates for bulk collections in an incubator at 25°C

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In an incubator calibrated at 25°C, germination was recorded at 0% for the first harvest since the seeds were immature and the embryo underdeveloped. Gradual seed development was observed as the percentage germination increased from 0% in the first harvest, 25% in the second harvest to a maximum rate of 100% in the third harvest. However, percentage germination declined to 87% in the fourth harvest onwards.

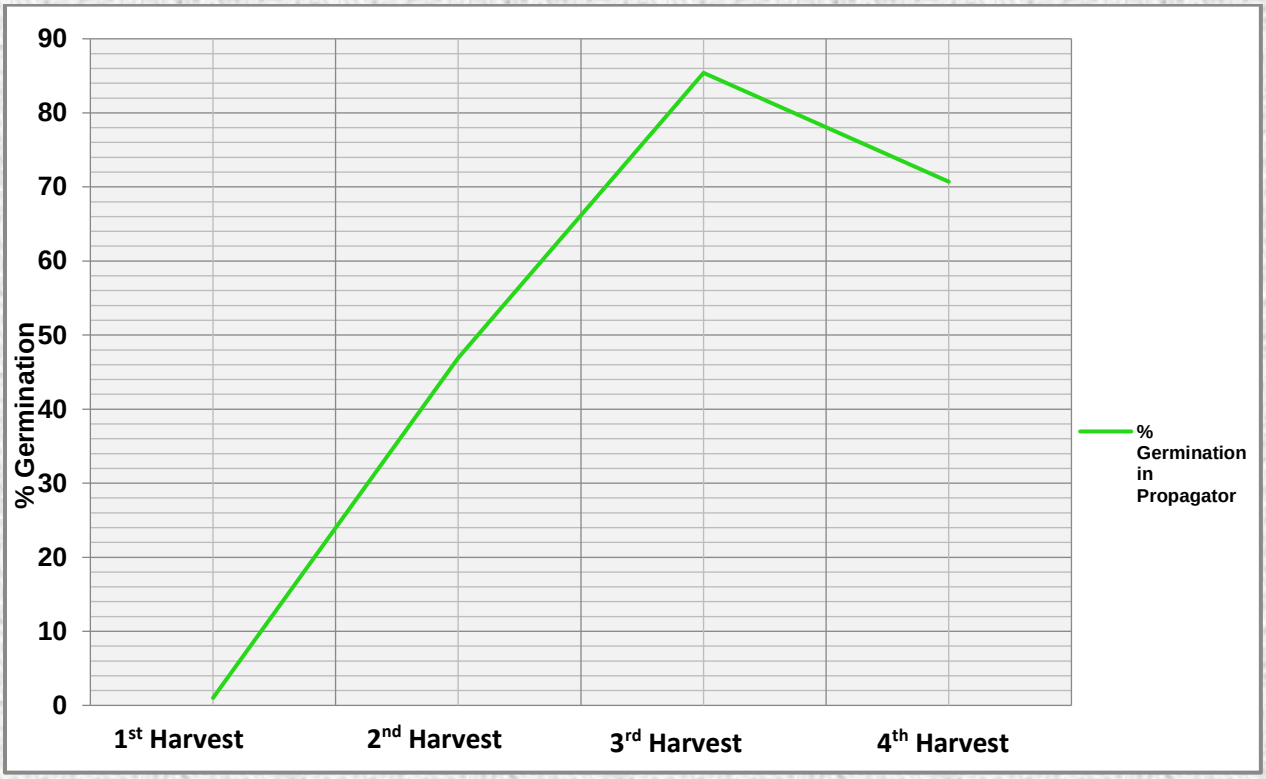

Fig 3d(2). A line graph showing % Germination Rates for bulk collections against harvest periods in a propagator

In the propagator, germination was recorded at 0% during the first harvest. Gradual seed development was observed as the percentage germination increased from 0% in the first harvest, 46.9% in the second harvest to a rate of 85.4% in the third harvest. However, percentage germination declined to 70.7% in the fourth harvest.

High viability was observed in both the Incubator and the Propagator in the third harvest as per the genebank Standards for Plant Genetic Resources for Food and Agriculture regeneration standard where at least 85% germination rates of a seed collection show high viability (FAO, 2014). Propagation in an Incubator is most preferred to a propagator as it recorded a 100% germination rate in the third harvest. However, a propagator is preferable for use by the local community as it achieved over 85% germination rate which is high viability as per FAO (2014) regeneration potential standard.

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Percentage germination rates of the bulk collections of *S. longepedunculata* seeds were performed in each of the selected media to establish the best media for propagation, a recommendation for further research by Zulu et al (2011).

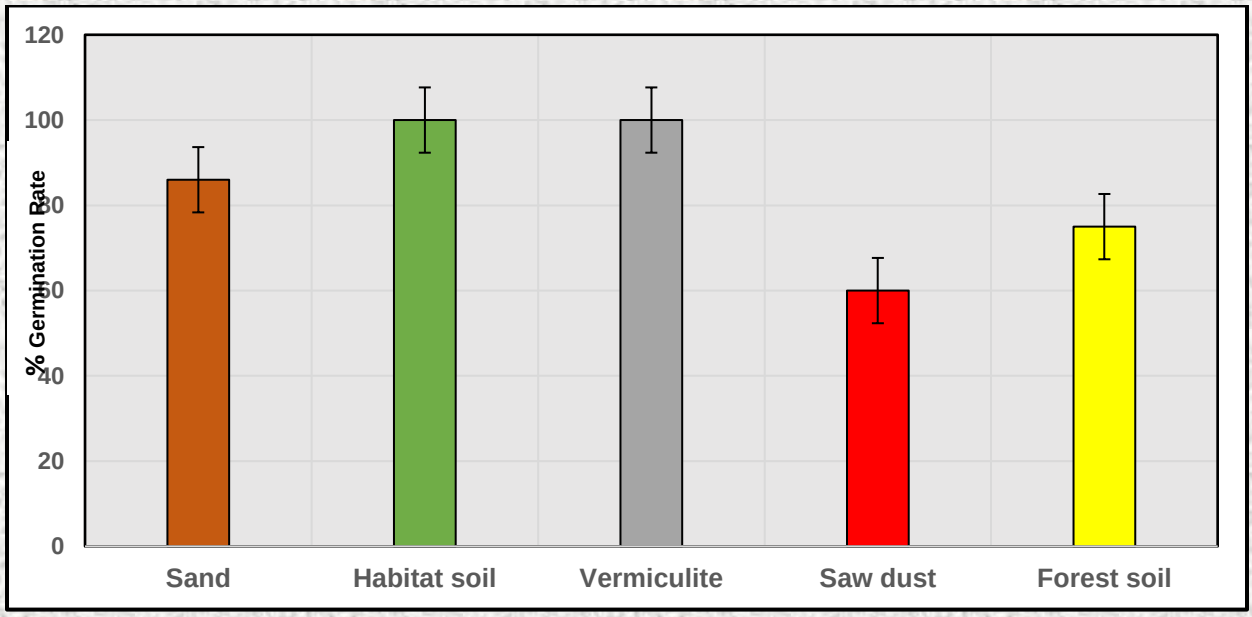

Fig 3e(2). A bar graph showing % Germination Rates of bulk collection against the selected growing media

100% germination rate for the bulk collections of *S. longepedunculata* seeds sown in vermiculite media makes vermiculite the best media for propagating *S. longepedunculata* seeds as compared to sand, sawdust and forest soil which recorded 86%, 60% and 75% germination rates respectively.

Additionally, the use of vermiculite is most preferred in a local community setting especially in the drylands of Kenya where water supply

is a predicament. This is because the media has high water and nutrient retention ability as compared to other media resulting in the watering of the target species seeds only once in two weeks thus saving on water. Moreover, it does not rot and can be recycled for the next propagation period. In the absence of vermiculite, sand is a preferred option as it recorded 86% germination rates from the randomised bulk collections which is a higher viability rate according to the FAO (2014) regeneration potential standards.

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3.1.10 Effects of Seed Development on Germination Rates

This study identified the best time for seed collection to achieve the maximum germination rate of *S. longepedunculata* seeds. For the bulk collection, a 100% germination rate was achieved in the third harvest at 35 % moisture content in an incubator as shown in figure 3j(2) below.

Fig 3f(2). Sprouting of *S. longepedunculata* seeds

Fig 3g(2). *S. longepedunculata* seedlings on the bench for germination scoring

Fig 3h(2). Matured seedlings ready for pricking out

Fig 3i(2). Sprouting of *S. longepedunculata* seeds in a propagator

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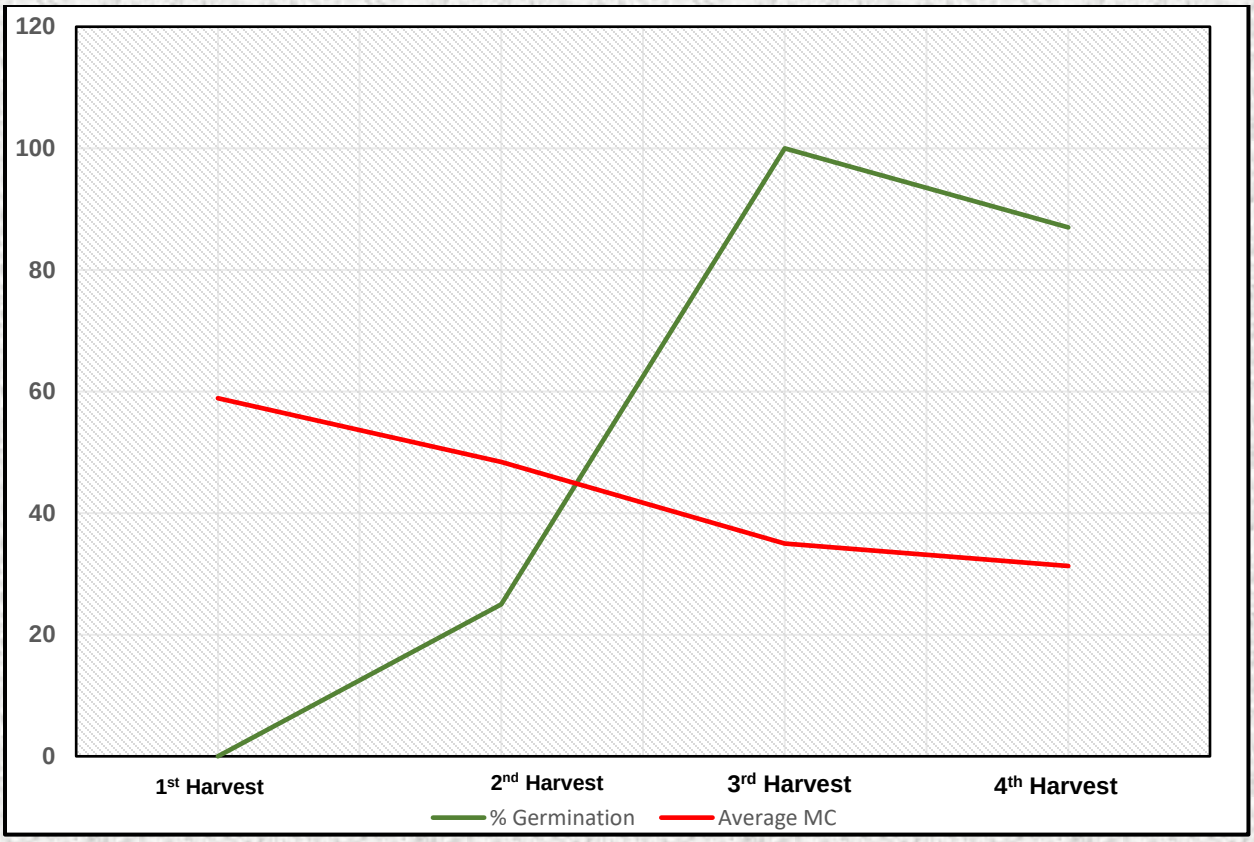

Fig 3j(2). A combined line graph showing the relationship between % germination rates and % moisture content during the four maturity stages.

In summary, during the first harvest, there was seed formation and differentiation of cells thus the 0% germination score. Maturation and food reserve accumulation within the seed followed during the second harvest period and onset of the third Harvest. The ripening and post-abscission period within the seed took place during the third Harvest stage thus the maximum germination rates recorded (100%). During the latter stages of the third harvest and fourth harvest onwards, the seed started to experience post-harvest ageing thus a decline in viability and longevity as elaborated by figure 3k(2) below.

The optimum time for seed collection of *S. longepedunculata* in Ngutwa sub-location Makueni county, was identified in mid-August during the 3rd harvest at the onset of natural dispersal.

The seed achieves maximum maturity during the third harvest resulting in higher germination rates. From the last phase of the third harvest to the fourth harvest onwards, post-harvest ageing sets in and the seeds start to gradually lose viability.

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Optimum timing of *S. longepedunculata* seed collection is crucial to ensure the collection of mature seeds at their optimum stage of development for successful restoration of the species.

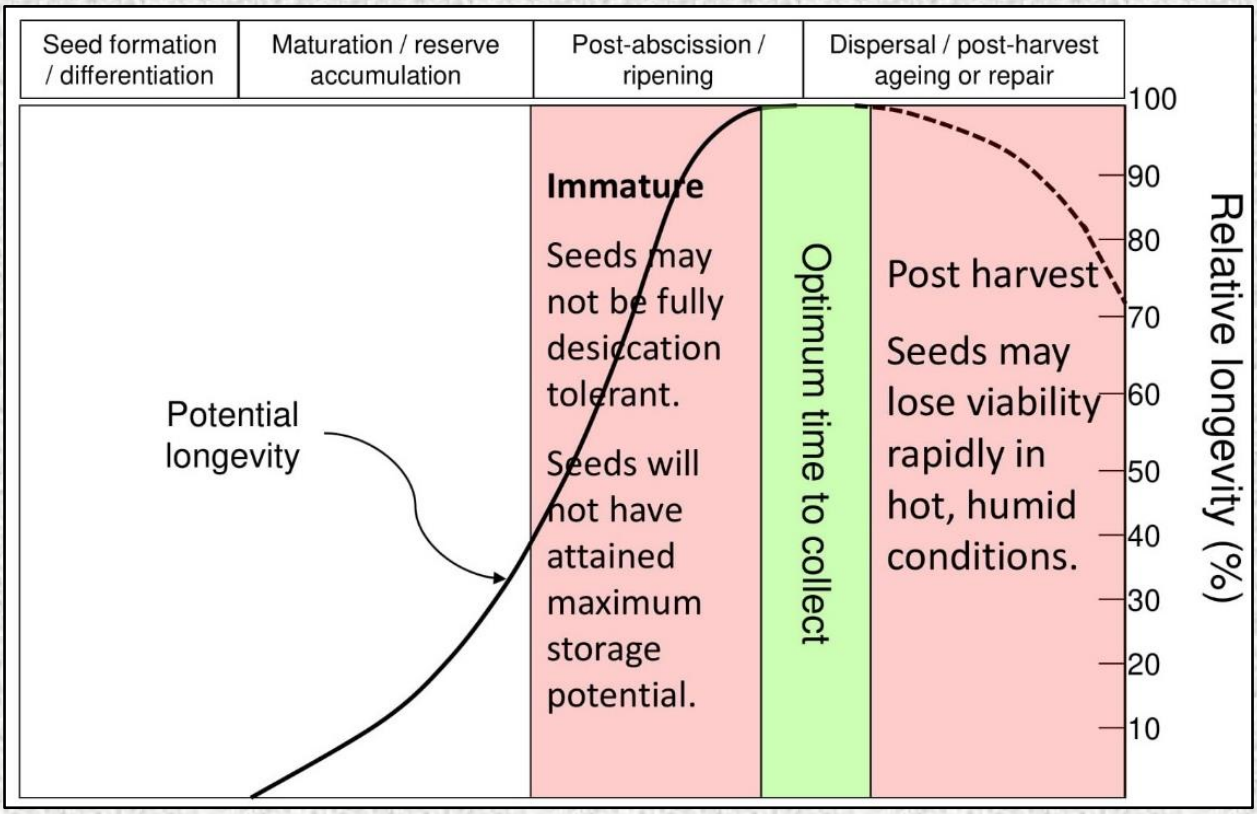

Fig 3k(2). Development of seed quality during the different maturity stages. © Pritchard et al (2004)

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3.1.11 Seed Storability

Securidaca longepedunculata seeds start to lose water immediately upon processing when the seed is removed from the fruit wall. Due to its recalcitrant nature, the seeds start to lose viability as it loses weak and loosely bound water in its structure.

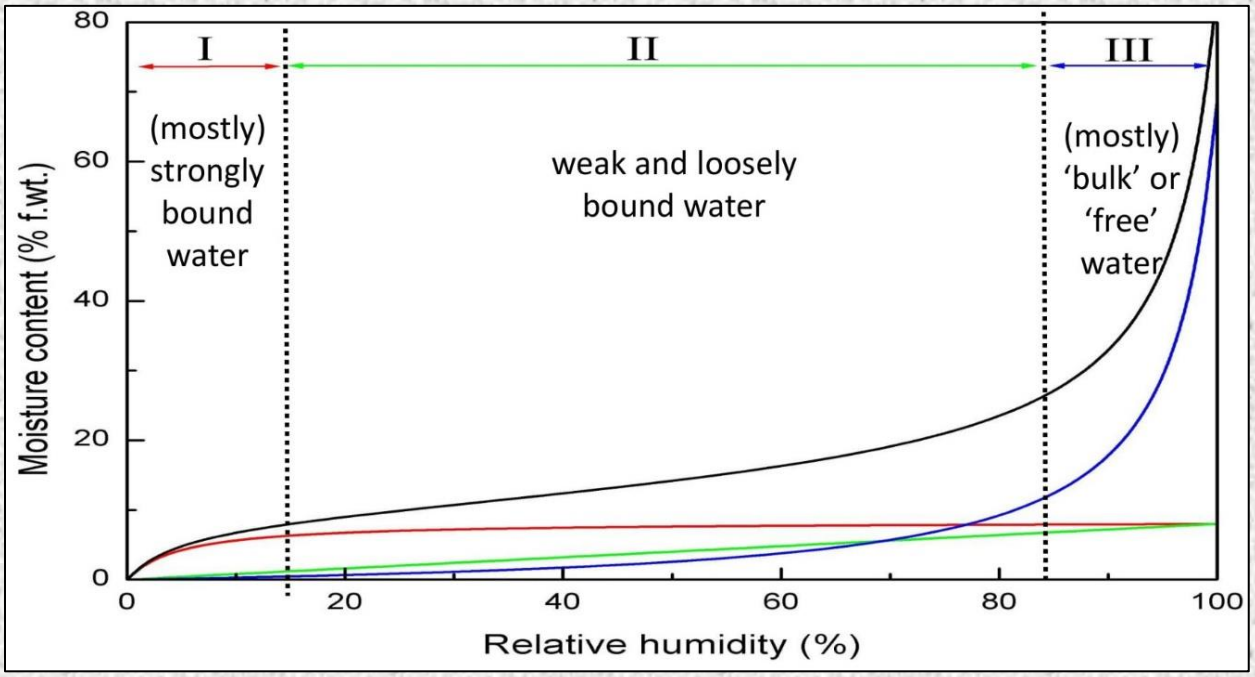

Fig 3l(2). A graphical representation of response of a recalcitrant seed to water removal.
© Pritchard et al (2004)

According to figure 3l(2) above, removal of water in a recalcitrant seed at 95-98% equilibrium Relative Humidity (eRH) in Region III is lethal, stressful to the seed and presents a high risk of the seed losing viability.

Furthermore, its long-term storage at -20°C in seed banks is impossible due to crystallization of the loosely bound ice leading to ice formation within the seed thus destroying the seed structure.

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3.1.12 Growing Media and Plant Propagation

This was prepared by a mixture of forest soil, sand, vermiculite and habitat soil at a ratio of 1:1:1:1 and potted in polythene tubes for growing of the violet plant seedlings.

The target species seedlings were pricked out from the incubator and the propagator and planted into the potted polythene tubes in the National Museums of Kenya glasshouse for growth and maturation. This was aimed at producing high-quality seedlings for restoring the degraded target species' habitats.

Watering of the seedlings was done twice a week as a nursery practice of tending the seedlings using a hand-sprayer to avoid damping-off of the seedlings. Weed control was done weekly by hand to avoid competition for the available nutrients and space and suppression of growth.

After two months of growth in the glasshouse, the plants were hardened off and repatriated to the local community for restoration.

Fig 3m(2). Potted media ready for transplanting

Fig 3n(2). Watering of the potted media ready for planting

Fig 3o(2): Uprooting of seedlings from the propagator

Fig 3p(2): Transplanting seedlings in potted media for growth

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Fig 3q(2). Hardening off and standing down of *S. longepedunculata* seedlings for repatriation to the local community for restoration

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3.1.13 Community Workshop and Training

3.1.13.1 JAPEL Self Help Group

This Self-Help group was formed by a group of men and women to execute various community programs for empowerment. The group is mainly composed of women who were the primary users of the violet plants as medicine as noticed during reconnaissance. Due to their cohesiveness, organization, passion and willingness to be involved in the project during the community need assessment period, they were integrated into the project and trained on:

1. Benefits of protecting violet plants habitats through community forestry model.
2. Sustainable use of the plant.
3. Seed collection, propagation and restoration of the violet plant using the propagation manual booklets generated in section 3.1.14 below.
4. The optimum time of seed collection to achieve maximum germination.

The members who received the information passed using the various project outreach and information dissemination pathways possessed the desired attitude and awareness on the benefit of the target plant species and protection of its habitats. Conservation and restoration action was successfully implemented by the Self-Help group members and other local community members and showed improved skills and confidence.

Percentage participation of women in the community workshops and training was more at 71% as compared to the men at 29%. More women participation was key as they are the main users of the violet plant for medicine and various household purposes such as firewood, charcoal burning and clearance for agriculture.

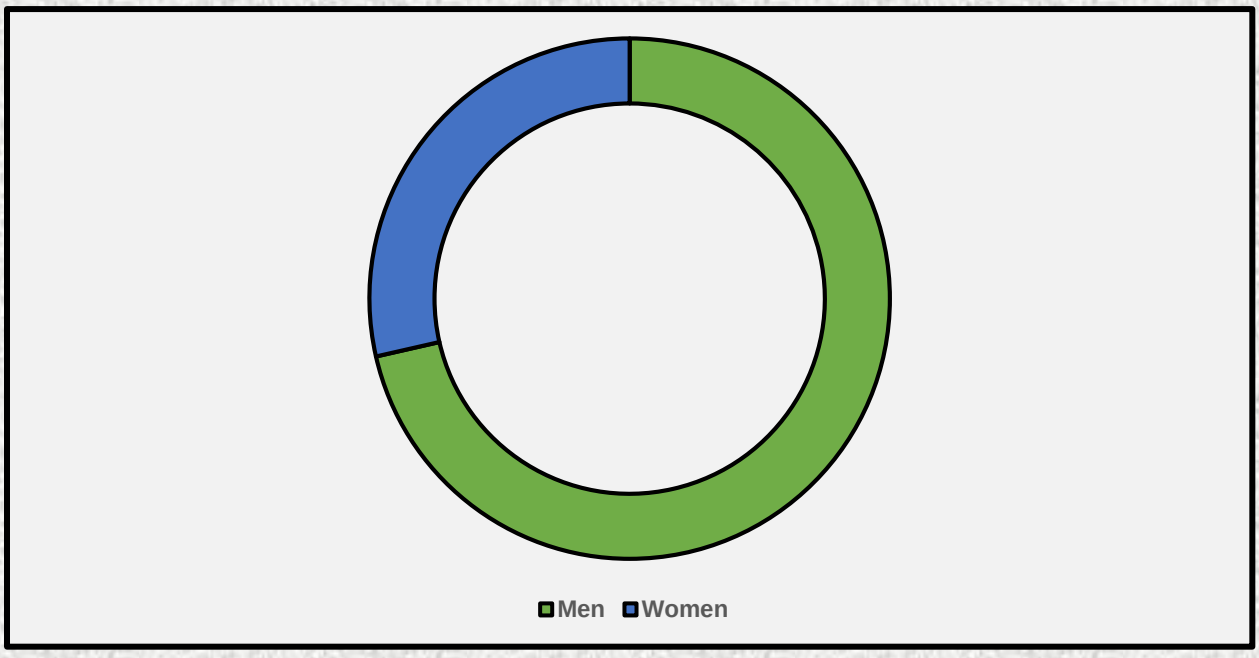

Fig 3r(2). A pie chart showing comparative participation of women and men in community workshop and training.

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Fig 3s(2). A group photo of the trained first group of JAPEL Self-Help group members

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Fig 3t(2). Distribution of *S. longepedunculata* seedlings for restoration

Fig 3u(2). Planting of *S. longepedunculata* seedlings in collaboration with the local community

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3.1.13.2 Conservation constraints raised by JAPEL Self-Help Group

1. There have been low successes in the propagation of priority tree species in the past due to a lack of information and skills.
2. Inadequate water supply to water tree seedlings for restoration thus curtailing seedlings production and restoration efforts in the area as rainfall is unreliable in the area.
3. Lack of incentives from the conservation work thus channelling efforts towards growing food crops.
4. Social perception:
    - Due to the high illiteracy levels in the area, some members believe in the existence of precious stones that can be commercialized beneath certain plant species such as *Dodonaea angustifolia* resulting in uprooting most of the species in search of the precious stone.

    - There are wide knowledge gaps in Information on medicinal plants diversity, use, mode of application and administration from the old to the young as it is considered witchcraft.
5. Lack of economic tree species to be used for timber, firewood and charcoal burning thus resulting in exploiting native species in the wild.
6. Inadequate facilities such as non-mist propagators and community tree nurseries to propagate seedlings hence reliant on traditionally made nurseries as shown in figure 3v(2) below.

Fig 3v(2). Traditionally made nurseries made up of sticks, grasses and dried maize plants

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3.1.13.3 Action plans raised by JAPEL Self Help Group

a) Further seed testing research crucial to guide the local community in the storage and planting of the priority species. More propagation protocols for other medicinal plant species produced, published, distributed and used to further educate the local community.

b) Rainwater harvesting system through the installation of water tanks managed by the Self Help Group will provide water for the growth of the planted seedlings thus limiting seedling loss due to desiccation.

c) Support to biodiversity value chains such as honey and economic tree seedling production and commercialization would ensure that the women are empowered economically thus motivation to propagate and restore more species through funding from the biodiversity products.

d) More workshops and training sessions should be organized and implemented to demystify the false social perception with facts and to pass knowledge on the importance of conservation of biodiversity on the study area.

e) Identify and document traditional indigenous knowledge on medicinal plant species'; distribution and abundance useful for culture and heritage preservation, biodiversity protection, conservation and restoration

f) Mass propagation, planting and commercialization of economic tree species for timber and firewood production will ease the pressure off the natural indigenous forest from further destruction.

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3.1.14 Information Dissemination

3.1.14.1 Propagation Manual Booklets

To solve propagation difficulties experienced by the local community in the propagation of *S. longepedunculata*, a guide on Seed Collection, Processing, Germination, Propagation and Nursery Practices of medicinal *Securidaca longepedunculata* species was produced. The booklets were used for skill transfer to the local community to achieve higher germination rates of the target species.

A sample booklet is available online via the link below:
https://ruffordorg.s3.amazonaws.com/media/project_reports/29804-1_Promotional_Materials.pdf

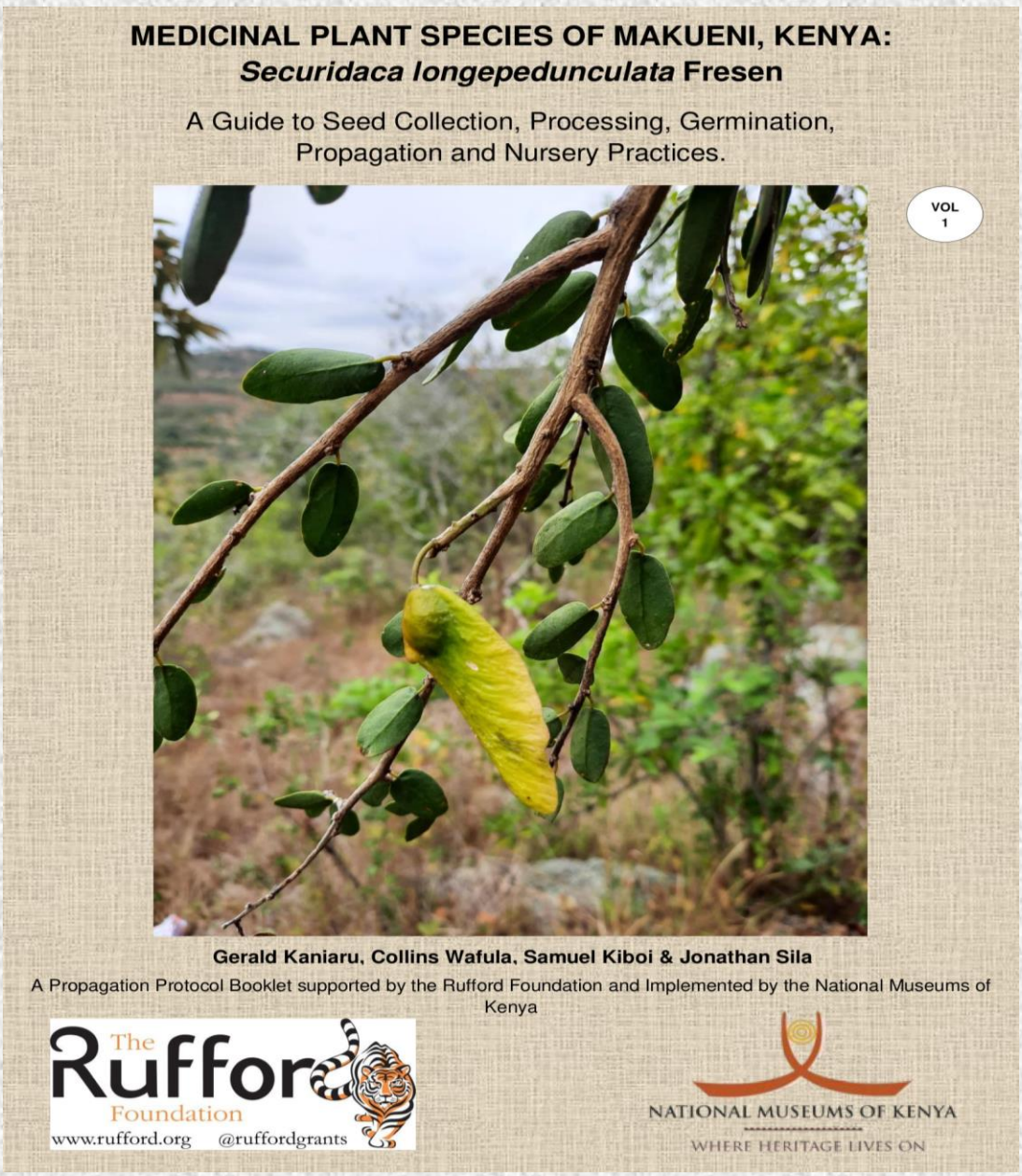

Fig 3w(2). Coverpage of Propagation protocol manual for training and skill development

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3.1.14.2 Short-Video Documentaries

Some of the project activities were filmed during the fieldwork expeditions mainly to inform and educate. They were uploaded on the YouTube page. Link: (https://www.youtube.com/channel/UCZ3RM7BOn4E5YZ2LviOJzmQ).

The Rufford Foundation has been acknowledged in all the videos on the description box and through tagging of the Rufford Foundation logo at the end of each video.

	Description	Links
1	Degraded and Fragmented Medicinal Violet plant Habitats in Makueni drylands of Kenya	https://youtu.be/Y0kwJ7g5rjk
2	Dried Upper watershed sites and Seasonal River streams in Makueni drylands of Kenya	https://youtu.be/K709DUvViDM
3	Threats facing the violet plants and their habitats in the Makueni drylands of Kenya	https://youtu.be/vUk-k7yIDuE
4	Medicinal Violet plant: Seed collection, Breaking Seed Dormancy, Propagation, Community Training and Restoration	https://youtu.be/i7Mi75UkNxI

Table 12. Links to various project activities undertaken

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CHAPTER FOUR

4.1 Conclusions and Recommendations

A. *Securidaca longepedunculata* seeds get damaged upon removal of water as seen by reduced viability from third to fourth harvest onwards as the seed loses more water during the post-abscission period. Furthermore, they lose viability once stored making them difficult to store for long-term use. Coupled with morphological characteristics described in section 3.1.7 above qualifies them as **Desiccation sensitive/Recalcitrant** type of seeds as initially described by Hong et al (1996).

B. *S. longepedunculata* seeds should be kept moist during processing as best seed-handling practice. Preferably, once the seeds are processed for germination, they should be placed on top of wet cotton wool and covered with another wet cotton wool before sowing to avoid loss of loosely bound water within the seeds to the dry air with low relative humidity in the atmosphere. This can result in damaging the seed structure thus loss of viability.

C. Incubator is better in achieving maximum germination score (100%) of the target species seeds as compared to a non-mist propagator. It provides optimum germination condition especially a temperature of 25°C for maximum seed germination and seedling growth. However, a non-mist propagator is preferred in propagating seeds by the local community as it achieved an 85.4% germination rate, which is above regeneration potential standard by FAO (2014). Additionally, a propagator is cheap to construct, effective, no requirement for electricity or piped water and can hold water for long especially in an area with inadequate water supply as described by Leakey et al (1990).

D. Vermiculite media is the best media for the propagation of *S. longepedunculata* seeds.

E. At a percentage moisture content of 35±1%, 100% germination rate of *S. longepedunculata* seeds is obtained.

F. Optimum time for seed collection in the study area is in Mid-August (during the third Harvest).

G. Of the seed quality parameters investigated, % Moisture Content and maximum dry weight were the greatest markers of seed quality.

H. Maturity stages of *S. longepedunculata* seeds can be estimated visually by the changes in the fruit colour.

I. Identification, documentation, conservation and restoration of other associated medicinal plant species used and their habitats are required due to heavy reliance on plants for medicinal use by the local community.

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J. The violet plant is consumptively exploited daily for firewood and at least twice a week for medicinal purposes in the study area as per questionnaires and interviews analysis. Due to this, mass propagation of the species in ex-situ conservation facilities such as community tree nurseries, restoration and training of more local community members should be upscaled.

K. Knowledge gaps in population dynamics of *S. longepedunculata* sp and its pollination agents should be filled.

L. *Securidaca longepedunculata* species cannot be stored in seed banks for long-term purposes at -20°C due to ice formation within the seed thus reducing viability.

M. Cryopreservation of the recalcitrant seeds, somatic embryos (excised or embryonic axes), and shoot tips of *S. longepedunculata* species at liquid nitrogen (-196°C) in place of conventional seed storage in seed banks like in orthodox seeds is a probable technique for storage of the species. However, further detailed research is needed to achieve this.

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4.2 Opportunities

- During the project, the Project Principal Investigator Mr. Gerald Kaniaru was trained on Seed Conservation and Ecological Restoration Techniques by experts from the Millenium Seed Bank, Royal Botanic Gardens (Annex 9). This enhanced the expertise in the team to enable successful current and future conservation undertakings.

- Strong relationships/close links created with different stakeholders, community focus group and the local community. Through these linkages, the community were/will be willing to participate fully in the current and future projects workshops, training and restoration programs.

- Technology advancement enhanced the use of online platforms such as YouTube for information dissemination and publicity to reach a wider audience. The Uploaded YouTube short video documentaries were used as educational materials to train the community members.

- The presence of community focus groups in the area makes current and future collaborations easier. This provides a platform for skill transfer to the community through workshops, training, practical demonstrations and restoration program.

- There are opportunities for reviving other dysfunctional community focus groups in the study area to ensure that the next project encompasses more community groups thus wider reach in terms of skill transfer and conservation.

- The existence of knowledge gaps in the area provides an opportunity for more conservation initiatives from conservation of other medicinal plant species to ecological restoration of their degraded habitats in the area.

- The existence of the Makueni County integrated development plan 2018-2022 that aligned with some of the project's intended goal guided part of the project work. The project contributed to this plan through skill transfer, environmental and natural resource conservation, management and sustainable utilization of resources, in this case, the violet plant.

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4.3 Challenges

Some of the challenges encountered during the study include:

(I) The mature trees sampled for seed collection were <30 mature trees. This was in complete contrast to Brown & Marshall (1995) classic genetic theory where at least 30 and 59 randomized individuals are chosen in an outcrossing and selfing species respectively. Due to this, less than 95% of alleles were present in a single population at a frequency of less than 5%. This was as a result of rapid, continuous deforestation of the target species.

(II) Cessation of movement imposed by the Kenyan Government disrupted some of our fieldwork expedition's timelines and limiting access to project expendables and non-expendable supplies. However, the team had to adjust the project timetable and put extra man-days in the field.

(III) During questionnaire administration and interviews, some of the local community members were unwilling to cooperate with the project team members due to the perception of transmission of Covid 19 infection from urban areas where the project team resided to the rural areas.

(IV) Inadequate water supply due to lack of rainwater harvesting system in the area curtails seedlings production and restoration efforts in the area as rainfall is unreliable.

(V) School pupils were not involved in the training sessions as indicated in the project document as the schools were closed until further notice due to the Covid-19 pandemic. Interactions with them were discouraged by the government as they were classified as a vulnerable group. However, additional adults who pose a direct threat to the target species existence replaced them.

(VI) Some of the local community members were hostile during interviews and questionnaire administration due to the feeling of their time being wasted.

(VII) The project team encountered snakes and got injured traversing the rough terrain while sampling in the bushy habitats.

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4.5 Annexes

Annex 1: Field data form on seed collection of *S. longepedunculata* sp.

MILLENNIUM SEED BANK PARTNERSHIP Kew

FIELD DATA FORM | Project | | Accession No. |

Please complete all mandatory fields marked in grey with an asterisk (*). If hand written, Please use BLOCK CAPITAL LETTERS.

COLLECTION DATA

Collected From*	Wild Plants ☐ Cultivated Plants ☐	**Donor Organisation**	
Date Collected*	dd / mm / yyyy	**Collection Number***	
Main Collector*	name	institute affiliated to	
Other Collector(s) Names & Institutes			

PLANT NAME & IDENTIFICATION DATA

Family*		**Identifier's Name**	
Genus*		**Identifier's Institute**	
Species*		**Identification (ID) Date**	dd / mm / yyyy
Infraspecific	rank	species	
ID Status* *(circle):*	Collector's ID	Provisional ID	Field ID by Specialist / ID by Other Institution
ID From *(circle):*	Living plant material	Herbarium specimen	Photo / Seed
Plant Description* (flower colour, scent, etc.)		**Height (m)**	
Plant Form* *(circle):*	Epiphyte / Forb / Grass / Liana / Shrub / Succulent / Tree / Erect Herb / Creeping Herb / Climbing Herb / Other:		
Uses *(circle):*	Animal Food / Bee Plant / Food / Food Additive / Fuel / Materials / Medicine / Poison / Environmental Use / Social Use / Other:		

LOCATION DATA

Country*			
Province/State		**District/Municipality**	
Description of Location			
Latitude/Easting*	units	or **Grid Ref**	
Longitude/Northing*	units	**GPS Datum*** (e.g. WGS 84)	
Method *(circle):*	Compiler / Google Map / Earth / GPS / Map / Website	**UTM Zone**	
Altitude (m)	**Altitude Method** *(circle):*	Altimeter / GPS / Map / Website	

HABITAT DATA

Habitat*			
Associated Species			
Factors Affecting Habitat (e.g. floods)			
Land Form (e.g. hill)		**Soil Type** *(circle):*	Clay / Loam / Silt / Sand
Land Use (e.g. farm)			
Geology (e.g. basalt)		Other:	

Slope *(circle):* 0° / 1-5° / 5-15° / 15-30° / 30-45° / >45° **Aspect** *(circle):* N / NE / E / SE / S / SW / W / NW

SAMPLING DATA

Number of Plants Sampled*		**Area Sampled (m^2)***	
Number of Plants Found*		**% Plants Producing Seed***	
Herbarium Specimen* *(tick)*	Yes ☐ No ☐	**Specimen Sent to Kew**	Yes ☐ No ☐
Other Notes			

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MILLENNIUM SEED BANK PARTNERSHIP Kew

PRE-COLLECTION ASSESSMENT

Assessment Date dd / mm / yyyy
Location
Latitude
Longitude
or Grid Ref

IDENTIFICATION

Taxon identified and similar taxa distinguished *(tick)* Yes ☐ No ☐

Family
Genus
Species

POPULATION ASSESSMENT

Approx. area of population & units (i.e. m^2; km^2; hectares) units
Approx. number of accessible individual plants *(circle):* 1-10 11-50 51-100 101-1000 >1000
Evidence of damage/disturbance Yes ☐ No ☐
(*give details* e.g. fire; herbicides)

READINESS OF POPULATION FOR SEED COLLECTION

Most frequently occurring stages *(tick or give percentage)*

Vegetative	☐	%	**In bud**	☐	%
Flowering	☐	%	**Immature seeds**	☐	%
Around natural dispersal	☐	%	**Post dispersal**	☐	%

Estimated number of plants at natural dispersal

PHYSICAL QUALITY OF SEEDS

Cut-test 10-20 seeds from the sample examined & indicate the most frequently occurring state
(tick or give percentage)

Full seeds	☐	%	**Empty seeds**	☐	%
Infested seeds	☐	%	**Immature seeds**	☐	%

AVAILABILITY OF SEEDS

Average number of seeds per fruit/dispersal unit
Average number of fruits/dispersal units per individual plant

It is possible to collect 5,000-10,000 healthy seeds around natural dispersal without taking more than 20% of available seeds? Yes ☐ No ☐

For populations NOT yet at natural dispersal, estimate a suitable date to return and collect seeds dd / mm / yyyy

Other Notes

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Annex 2: Datasheet on *S. longepedunculata* seed quality parameters for each harvest period

Population/Tree (PxTx)	Seed Quality Parameters	First Harvest (Average)	Second Harvest (Average)	Third Harvest (Average)	Fourth Harvest (Average)
P1T1	Fresh weight (g)				
	Dry weight (g)				
	Water weight				
	Moisture content (%)				
PIT2	Fresh weight (g)				
	Dry weight (g)				
	Water weight				
	Moisture content (%)				
P2T1	Fresh weight (g)				
	Dry weight (g)				
	Water weight				
	Moisture content (%)				
P2T2	Fresh weight (g)				
	Dry weight (g)				
	Water weight				
	Moisture content (%)				
P2T3	Fresh weight (g)				
	Dry weight (g)				
	Water weight				
	Moisture content (%)				
P2T4	Fresh weight (g)				
	Dry weight (g)				
	Water weight				
	Moisture content (%)				
P2T5	Fresh weight (g)				
	Dry weight (g)				
	Water weight				
	Moisture content (%)				

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P3T1	Fresh weight (g)				
	Dry weight (g)				
	Water weight				
	Moisture content (%)				
P4T1	Fresh weight (g)				
	Dry weight (g)				
	Water weight				
	Moisture content (%)				
P6T1	Fresh weight (g)				
	Dry weight (g)				
	Water weight				
	Moisture content (%)				

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Annex 3: Test sheet for recording Germination data for *S. longepedunculata* sp seeds

TEST SHEET

COLLECTION

SERIAL NO	FAMILY	BANK NO	SEED QTY	ADJ SEED QTY
DATE HARVESTED	GENUS	DATE BANKED	NO. X-RAYED	
SEED PER FRUIT	SPECIES	DATE RECEIVED	NO. EMPTY	
TZ RESULT	SUB-SPECIES		NO. INFESTED	
TZ DATE	VER. STATUS		NO. PART-FILLED	

GEOGRAPHICAL LOCATION: ALTITUDE:

GERMINATION DATA

	DATE															
	DAY										FRESH	MOULDY	EMPTY	INFESTED	ABNORMAL	DATE STARTED
X	REP 1															
	TOTAL															%GERM

CONDITIONS:

NOTES:

	DATE															
	DAY										FRESH	MOULDY	EMPTY	INFESTED	ABNORMAL	DATE STARTED
X	REP 1															
	TOTAL															%GERM

CONDITIONS:

NOTES:

	DATE															
	DAY										FRESH	MOULDY	EMPTY	INFESTED	ABNORMAL	DATE STARTED
X	REP 1															
	TOTAL															%GERM

CONDITIONS:

NOTES:

	DATE															
	DAY										FRESH	MOULDY	EMPTY	INFESTED	ABNORMAL	DATE STARTED
X	REP 1															
	TOTAL															%GERM

CONDITIONS:

NOTES:

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Annex 4: A Key Informants Guide on the use and conservation of the violet plant.

KEY INFORMANTS INFORMATION ON THE UTILIZATION OF *Securidaca longepedunculata* **IN MAKUENI COUNTY**

Date of the interview: _____ Interviewer's Name: _____

Location_____ GPS coordinates: _____

Sub-location:_____ Village: _____

PART 1: GENERAL INFORMATION ON THE PLANT
a) Local Name of the plant: ……
b) Meaning of the name? .....
c) Local/exotic:……
d) Cultivated or wild:……
e) If cultivated, cultivated for? (*Ornamental, medicine, food, roofing, fodder, rituals*)
f) If wild, availability in nature: (easy/difficult/very difficult)……..
g) If wild, which habitat (map)?.....
h) The season when it is available? (dry, rainy, all seasons)……..
i) Uses of the plant? (**go to PART 2 or 3 or 4 or 5**)
PART 2: HUMAN FOOD
a) In which form is the plant eaten? (vegetable, main meal)……..
b) Who eats (gender, age)? ……
c) A period when it is highly used? (drought, rainy, disease breakout)……
d) Specific plant part consumed (**entire plant, aerial part, roots, leaves, fruits, bark, flowers, exudates/sap, seeds, inflorescence, infructescence, galls**)……..
e) What is the importance of consuming the plant (***appetizer, energize***,)? ……
f) Harvesting process (***collection season, time and methods***) and why? ……..
g) Stage of harvest (**seedling, flowering, seeding stage**) why?.....
h) What quantity harvested (Kg/over a visit) why?.....
i) What informs the quantity of the harvest?.....
j) Frequency of harvest (days/month/Annual/As per need)……
k) Mode of preparation: (**raw, cooked, *powdered, food additives, added to the local brew, speed up milk souring process***)…….....
l) Preservation method if any? (Salted, dried, smoked, etc.)……..…
PART 3: LIVESTOCK FORAGE/FODDER
a) Which livestock feed on the plant (Cows, goats, sheep)?.....
b) A period when it is highly used? (drought, rainy, throughout the year)……
c) Specific plant part consumed (**entire plant, roots, leaves, fruits, bark, flowers, exudates/sap, seeds, inflorescence, infructescence, galls**)……
d) Benefits the livestock gets by consuming the plant? ……
e) Harvesting process (***collection season, time and methods***) and why?.....……..

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f) Stage of harvest (**seedling, flowering, seeding stage**) why?.....
g) What Quantity harvested (Kg/over a visit) why?.....
h) What informs the quantity of the harvest?.....
i) Frequency of harvest (days/month/Annual/As per need)……..……
j) Mode of preparation?.....
k) Preservation method if any?.....

PART 4: MEDICINAL VALUE OF THE PLANT TO HUMANS

a) Who uses it as medicine (Age, gender, religion)……
b) Human disease/condition treated?…….....
c) Health conferring properties?……..……
d) Mode of preparation (*chew raw, boiling, ashes, powdered*)……
e) Mode of administration (*poultice/warm dressing, including dosage*):……
f) Preservation method if any? (*Salted, dried, smoked, etc*.)……...

PART 5: OTHER USES

a) Any other use of the plant?.....
b) Any cultural aspects/taboos associated with the plant?.....
c) Is there a product traded from the violet plant? (if yes, state market)……..
d) Is the value addition done? (Processed, Packaged)……..……..

PART 6: CONSERVATION OF THE VIOLET PLANT/ GENERAL FOREST MANAGEMENT

a) Is the Violet plant threatened?.....
b) List the destructive utilization activities?.....
c) Who is responsible for the destruction? (Local people, outsiders, Both)……
d) What do you think it can be done to conserve the plant: ……
e) What challenges hinder the conservation efforts of the plant in this community?.....
f) How does the community contribute to the conservation efforts of the plant……...

PART 7: RESPONDENT INFORMATION

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a) Name of the respondent……
b) Sex of the respondent(Male/Female)……..
c) Age of respondent in years……
d) Education level of respondent (*some primary/completed primary/some secondary/completed secondary/vocational training/college/University/Informal education/none/ Other (Specify*)…….....
e) Occupation/**Main source of income** (Livestock keeper/Cultivator/casual /labour/business/employment/Student /Other (specify)…….....
f) An alternative source of income(Livestock keeper/cultivator/casual labour/business/employment/Student /Other (specify)…….

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Annex 5: Questionnaire administered for collection of general information about *S. longepedunculata* species.

LOCAL COMMUNITY UTILIZATION OF *Securidaca longepedunculata* (VIOLET PLANT) IN MAKUENI COUNTY

Date of the FGD: _____ Moderator's Name: _____

Location_____ GPS coordinates: _____

Sub-location:_____ Village:_____

PART 1: GENERAL INFORMATION ON THE VIOLET PLANT

1. Can you identify this plant? .....
2. Local Name of the plant:……
3. Meaning of the name?.....
4. What comes to your mind when you see this plant?.....
5. Local or exotic:……
6. Cultivated or wild:
7. If cultivated, cultivated for? (*Ornamental, medicine, food, roofing, fodder, rituals*)……...
8. If wild, how is its availability in nature: (*easy/difficult/very difficult*)……..……...
9. The season when it is available? (*dry, rainy, all seasons*)…...…….
10. If wild, location?.....
11. Uses of the plant?.....
12. Mode of preparation if medicinal: (*processed fibre, boiled, burned to ashes, powder*)……..……
13. Mode of administration if medicinal?.....
14. Mode of preservation? (*Salted, dried, smoked*)……..
15. Cultural aspects/taboos associated with the plant?.....
16. Plant population rate over time (whether changes have been registered over time): (*increase/decrease/constant*), Why?.....
17. Is there a product made/traded from the violet plant? (if yes, state market)……..……...
18. Is there any value addition done? (Processed, Packaged,)…..……..…
19. Is it threatened?.....
20. List the destructive utilization activities?.....
21. Who is responsible for the destruction? (Local people, outsiders, Both)……
22. What do you think it can be done to conserve the plant: ……..……
23. What challenges hinder conservation efforts of the plant in this community?..……..
24. How does the community contribute to the conservation efforts of the plant?.....……

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PART 2: PARTICIPANTS' INFORMATION						
NAME	**GENDER**	**AGE**	**EDUCATION LEVEL**	**OCCUPATION**	**CONTACTS**	**SIGNATURE**

[1]Contact: **Gerald Keneth Kaniaru**, Email: kengerald566@gmail.com / kengerald566@yahoo.com

Annex 6: A training curriculum used to train the local community and other stakeholders

ROLES	ACTIVITIES	TRAINING AIDS
(A) Introduction of the project	(i) Introduce the community focus group members to the project and the Scope (history, the area covered, and feasibility in the community), aims, purpose and objectives of the project. (ii) Of what essence it is to the local community and their environment.	• Use the Project document.
(B) Introduction to *Securidaca longepedunculata* species commonly known as the violet plant	(i) Show a sample of the target species. (ii) Availability in the area. (iii) Why we need them. (iv) Address the challenges faced/associated with the target species.	Use demos in form of: • Voucher specimen • Live specimens • Photos • Poster • Short video documentaries.
(C) Conservation of the target species	(i) Address sustainable use and management of this species. (ii) Different methods of propagation for *Ex-situ* and *In-situ* conservation. (iii) Collection techniques and optimum time for seed collection. (iv) The best collections tools	• Practical demonstrations on site. • PowerPoint Presentations
(D) Restoration of the target species	(i) Identify violet plant degraded habitats. (ii) Methods of restoration of these habitats eg Enrichment planting among others. (iii) Management inclusivity in protecting these habitats.	• Photos • Videos • Leaflets • Propagation manual
(E) Training Evaluation	(i) Assess the efficiency of the training.	• Questionnaires. • Interviews

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Annex 7: A training evaluation form administered to the local community and other stakeholders.

Training Workshop Evaluation Form

1. Which of the following best describes your current position?

a) Farmer ☐ d) Administrator ☐

b) Agricultural scientist ☐ e) Student: Undergrad ☐ Graduate ☐ Post-grad ☐

c) Educator ☐ f) Other: .....

2. What is your overall assessment of the training? (1 = Poor - 5 = Excellent)

1 2 3 4 5

☹ ☺

3. Which topics or aspects of the workshop did you find most interesting or useful?

.....
.....
.....
.....
.....

4. Did the workshop/training meet your expectations?

Yes ☐ Partly ☐ No ☐

If no, why not?

.....
.....
.....
.....
.....

5. Knowledge and Information gained from participation

i) Will be useful/applicable in my work

Definitely ☐ Mostly ☐ Partially ☐ Not at all ☐

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6. How do you think the workshop could have been made more effective?

.....
.....
.....
.....
.....

7. Please comment on the organization of the event (from 1 = Poor to 5 = Excellent)

1	2	3	4	5
☹				☺

8. Comments and suggestions (including activities or initiatives you think would be useful, for the future).

.....
.....
.....
.....
.....

9. Further comments or suggestions

.....
.....
.....
.....
.....

THANK YOU!

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Annex 8: A Certificate of Training of the Project Principal Investigator on Seed Conservation and Ecological Restoration Techniques.

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