Review Article

Domesticating and Commercialisation of Indigenous Fruit and Nut Tree Crops for Food Security and Income Generation in the Kingdom of Eswatini

ABSTRACT

Indigenous fruit and nut crops are very important to the human diet and subsequent food security and income generation in the Kingdom of Eswatini. Indigenous fruits and nuts are important for the nutritional contribution as sources of Vitamins and minerals. They also provide fibre which is essential for proper digestion of food. Fruits, particularly nuts provide man with unsaturated fats which are good for the heat and the cardio vascular system. Indigenous fruits and nuts are aesthetic as they provide interesting colour, texture and variety. Despite the immense benefits of indigenous fruits and nuts to the people of the Kingdom of Eswatini, there has not been enough effort put towards domesticating the indigenous fruit and nut trees, and subsequent commercialising their products. The objective of this paper was to document strategies towards domestication and commercialisation of indigenous fruits and nuts for improved livelihoods of Emaswati citizens, which in turn will help achieve sustainable development goals (SDGs) pertaining to human health and food security in the Kingdom of Eswatini. It can be concluded that domesticating indigenous fruit and nut trees can be achieved through a multi-stakeholder involvement. Domestication can also help in conservation of indigenous fruit and nut trees. Value addition on indigenous fruits and nuts can generate more income.

Keywords: Biodiversity, food security, value addition, conservation, propagation, intellectual property rights, sustainable development goals

1. INTRODUCTION

The problem of food security especially in resource-poor third world countries has recently been complicated by climate change, poverty and threats to biodiversity. Indigenous fruits and vegetables have been serving *in-situ* soil conservation due to their adaptation to the natural ecosystem. Considerable efforts have been taken towards conservation and management of indigenous plants by the Eswatini government and relevant stakeholders such as Eswatini National Trust Commission (ENTC) [1].

The Swaziland Flora Protection Act of 2000 was established by the government of Eswatini to provide legal protection of certain species and special habitats. There are also *in-situ* conservation measures which involve the establishment of protected areas such as game and nature reserves. The Ministry of Agriculture runs a gene bank which preserves plant genetic resources mostly of crops and their relatives [2]. Eswatini supports a large variety of landscapes, geology, climate, and corresponding habitat and biodiversity. With her divergent geology, climate, and subsequent landforms, the physiographic regions within the country's boundaries are very distinct, thus a variety of indigenous fruit and nut trees found in the four agro-ecological zones [1].

The Sub-Saharan African region is rich with a variety of indigenous fruits which provide a variety of uses and benefits to the population [3,4]. Research on indigenous fruit and nuts has accumulated considerably in Sub-Saharan African countries including Eswatini, and their role are being recognized in the domain of poverty reduction. An *ex ante* impact analysis in southern Africa indicated that indigenous fruit can reduce vulnerability of rural households to overcome poverty [5]. Harvesting and utilisation of indigenous fruit and nuts have played a pivotal role in the livelihoods of African communities especially those in rural areas [6,7,8,9,10]. Indigenous fruit and nuts can make a difference during period of famine and food scarcity, and are not prone to issues of climate change [5,8]. Value-addition of fruit and nut either from the wild or semi-domesticated trees growing on-farm and homesteads, can have a substantially boost in rural income and employment opportunities in rural communities [6,10]. Market and financial analyses studies done in southern Africa show that indigenous fruits contribute to household income, and the major beneficiaries are women and children through value addition and fruit processing [11,12].

Wild fruit trees have become severely prone to over-exploitation and extinction as forests recede due to deforestation, and most Africans are using them for their medicinal purposes without replacing the cut trees [15]. Regardless of their importance as fruit crops and for their medicinal purposes, little research and development attention has been given to the development of indigenous trees as tree crops for wider cultivation. Domestication of indigenous fruit trees, emerged as a farmer-driven and market-led process, has become an important agroforestry initiative in the tropics [6,13]

There is increased interest among researchers, development practitioners and the food processing industry to explore opportunities to meet the food needs of humanity through indigenous fruit trees. More emphasis is put on promoting indigenous plants with economic potential as new cash crops, and for product development in the Kingdom of Eswatini. Hence, this review paper explores the prospects of commercialising and domesticating some indigenous fruit and nut tree crops for food security, and income generation in the Kingdom of Eswatini.

2. METHODOLOGY

The study was carried out in the Kingdom of Eswatini in Southern Africa. The Kingdom of Eswatini covers an area of about 17,364 km^2, and lies between latitudes 25^o 43' N and 27^o 19' S, longitudes 30^o 47' W and 32^o 08' E [17]. The Kingdom of Eswatini is comprised of four agro-ecological zones which are the Highveld, Middleveld, Lowveld and Lubombo region (Figure 1).

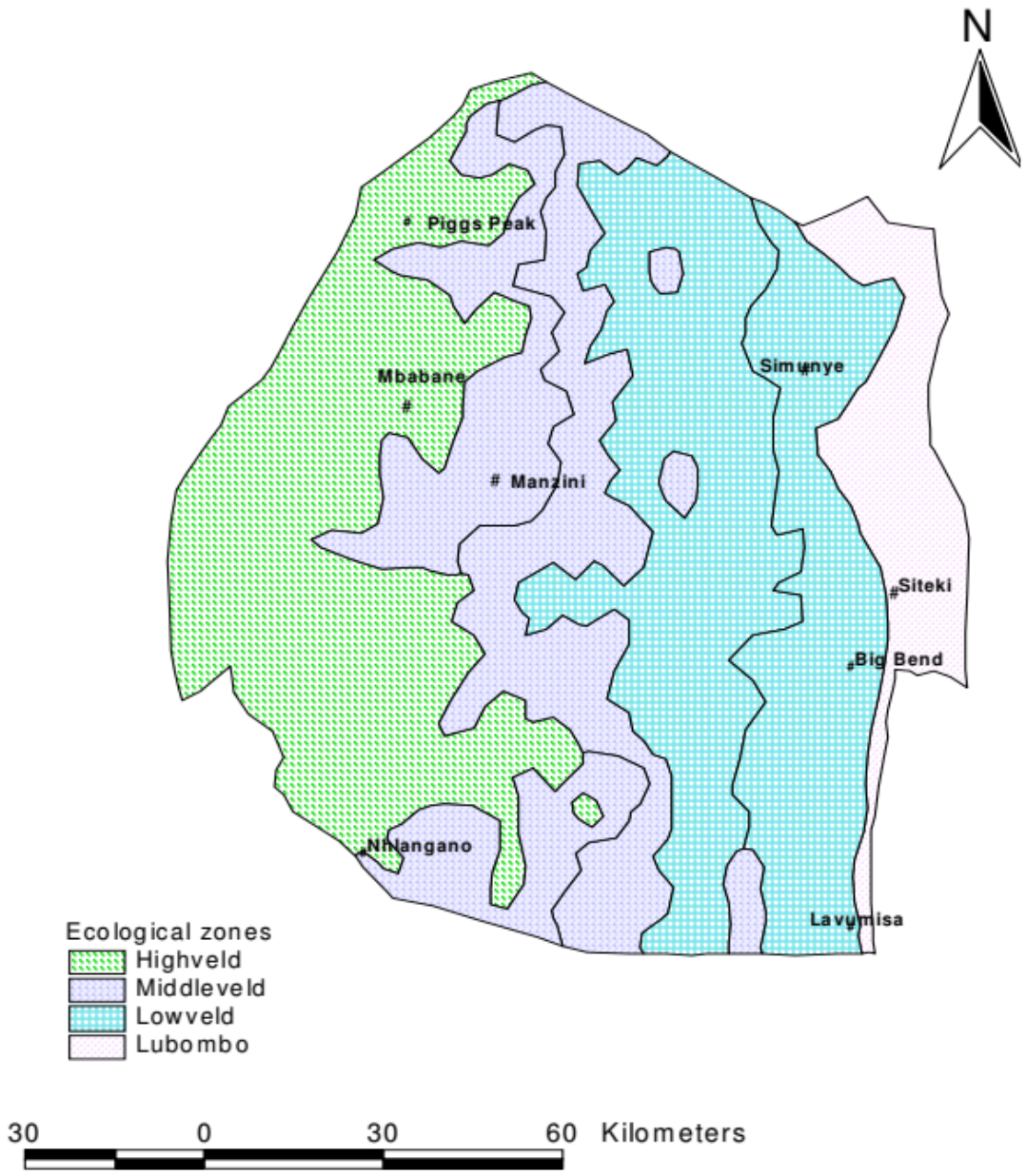

Figure 1. Ecological zones of the Kingdom of Eswatini.

This was a qualitative study. Information was obtained through literature review and informal surveys in the four agro-ecological zones of Eswatini. Local indigenous knowledge systems (links) were utilized.

3. POTENTIAL AREAS FOR COMMERCILISING INDIGENOUS FRUIT AND NUT TREES

In Eswatini, indigenous fruits are mostly enjoyed during the summer and autumn seasons when they are occur in abundance. These fruits are mostly consumed raw, and occasionally sold in informal local markets. Some of these fruits are processed into value-added products at small-scale subsistence level for economic gain [18,19]. Adding value to indigenous fruits, either harvested from the wild or from the semi-domesticated trees, through processing has been appreciated to make an economic impact [20]. The indigenous fruits hold a great potential in the development of new food products that will increase the food base, locally and internationally [21]. Some indigenous fruits have been technologically exploited into development of commercial products that include, sweets, fruit juices, jams, jellies, chutneys, vinegars, wines, liqueurs, novel flavours and gums [17,18]. It is from this knowledge base that science and technology can explore ways to improve the production, domestication and commercialisation of these plants.

3.1 Fermentation of Indigenous Fruits

A number of fruits that are available and consumed in Eswatini are widely processed by fermentation. Fermentation is basically a process where micro-organisms catabolise organic compounds to produce mass culture, enzymes, metabolites or new products [23]. Fermentation is an old economic processing technology that improves the quality of the fruits either by prolonging its shelf life or its nutritional and sensory characteristics [23,24,25,26]. Normally, the fermentation is spontaneous, making use of indigenous and natural microflora found in the surrounding environment and the fruits themselves. This theory holds a possibility of discovering new and unique strains of microorganisms [28] which may be useful in the food and pharmaceutical industries. In the food industry, fermentation technology has been used with various foods as substrates to develop other food products and food ingredients [23,24,25]. Commonly used microorganisms in the food industry are fungus and lactic acid bacteria. Some strains of lactic acid bacteria such as the *Leuconostoc mesenteroides* 12b have the ability to increase the antioxidant activity of the fermented fruit or juice, [32]. Fermentation has a good potential to add value to the underutilised indigenous fruits in Eswatini.

3.2 Jams and Jellies from Fruits

The amount of acid, pectin, sugar in the form of sucrose and moisture in a fruit are determinants for their suitability for jam and jelly making [27,28,24]. Ascorbic acid imparts a brighter colour in the jelly [34], and colour is one of the attributes that affect the quality of jam [35]. Pectin is a plant cell-wall polysaccharide consisting of a linear chain composed of D-galacturonic acid residues linked via a (1-4)-glycosidic bonds [35,36,37]. It has a number of uses in the food industry which include thickening agent, a gelling agent, colloidal stabilizer and imparting texture [38,39]. The pectin immobilises the

aqueous component by preventing it from separating, thereby providing a stable matrix [36]. The addition of sugar in jelly making increases the gel strength and reduces syneresis [36]. The acidity in the fruits helps the pectin to set and create a stable gel. Indigenous fruits with the previous characteristics need further studying so that they are properly exploited for commercialisation and industrial use [40]. Some of these fruits are already used for such products and may need improvement.

3.3 Other Uses

Most fruits have flavour characteristics that make them attractive to consumers. Flavour in fruits develops during the ripening where carbohydrates, lipids, proteins and amino acids are converted to volatile flavours [41]. Flavour in fruits can be grouped into acids, carbonyls, esters, lactones and phenols. Fruit flavours may also be derived from esters and other volatile compounds in the fruits [21]. Consumers have developed a trend to prefer natural and naturally produced food as a health concern, which has directed more research to that area [42]. Therefore, some unique and new flavours can be discovered from our indigenous fruits and nuts.

Dried fruits are consumed as snacks or added to porridges for flavour [43]. Drying is a traditional method of preserving food by reducing the water content and water activity. The dried fruits can be eaten as they are, or pounded into a powder. Dried fruits can also be used to add nutritious and organoleptic value to snacks and other foods [42,43]. When the fruits are dry, they can be kept at ambient temperatures in dry, dark areas to extend the shelf life. They also become easy to handle when taken to trading areas such as markets [46]. Nutrient preserving techniques and packaging materials can be applied to make sure that nutrients are not lost during processing. These fruits can help meet the demands for healthy snacks, especially among the working class. In the areas where access to nutritious foods is limited, such snacks help curb malnutrition before it advances [46].

4. ESWATINI INDIGENOUS FRUIT AND NUT TREES WITH COMMERCIALISATION POTENTIAL

3.1 Sour plum (*Ximenia caffra*) – (SiSwati name: *Umtfundvuluka*)

The *Ximenia caffra* is an indigenous fruit tree with oval shaped red fruits that have a pronounced astringent taste which intensifies during storage [47]. It is the juicy pulp surrounding the stone that is edible as fruit, however, the seed is also edible and is a rich source of proteins (18.8 %) and fats (48%), [22]. The seeds can potentially be used as a protein supplement in meals for adults [48]. The *X. caffra* fruit peel is reportedly rich in total phenolic and flavonol content, while the fruit pulp is rich in ascorbic acid (27%) [22,47]. Fruit extracts of *X. caffra* showed significantly higher ferrous ion chelating and free radical scavenging capacity when they were compared with synthetic antioxidants [49]. These compounds are good for health because they remove elements that cause degenerative

diseases in the human body, maintain proper functioning of vital organs and reduce oxidative stress [48,49,50].

The seed nut of *X. caffra* has 59% oleic acid [53] which compared with olive oil (50-58%) [54]. Oleic acid can prevent the development of breast cancer tumours by suppressing the oncogene that causes breast cancer tumours [55,56], reduce high blood pressure [57], and slow the progression of atherosclerosis [58].

The juice of and dried *X. caffra* fruits are added to porridge to flavour it, while the fruit jelly is used as an ingredient in tarts [22]. These practices are evidence that the fruit has some desirable flavours that they impart to other dishes. These flavours may be unique and need further research and exploitation for industrial use. It was found that the fruit juice and pulp are processed into a beverage [59].

3.2 Black monkey orange (*Strychnos madagascariensis*) – (SiSwati name: *Umhlala*); and green monkey orange (*Strychnos spinosa*) – (SiSwati name: *Umkhwakhwa*)

The *Strychnos madagasgarensis* and *Strychnos spinosa* fruits are round and yellow with hard wood shell that encloses a yellow or brown sweet-sour juicy pulp [60]. These fruits can be consumed fresh or processed into several products. When consumed fresh, the hard shell is cracked and the pulp immediately eaten before they spoil [60]. *Strychnos madagasgarensis* and *Strychnos spinosa* fruits are good sources of micronutrients such as Vitamin C, zinc and iron [60]. People in most parts of the world have been found to be deficient in the micronutrients [61], and ascorbic acid intake declines during the dry season [62] which is when the *Strychnos* spp. are available where they play a vital role in supplying the much needed nutrients [63].

As the fruits ripen, there is accumulation of sugars and organic acids which owe to the characteristic pungent sweet sour taste [19,64]. Fresh monkey orange fruits release unique mixture of aromatic volatile flavour compounds [19] when opened. The *Strychnos cocculoides* volatile flavour compounds found are mainly from the alcohol and ester groups, which impart a sweet fruity aroma [65]. These compounds present a potential study area for further research on value addition of the fruits. As the fruits ripen, some enzymes solubilise the pectin and cellulose, making them juicier [66].

The fruits are preserved through domestic processing that include, jam making, drying, juice extraction, wine, beer, fritters and muffin making or dried fruit leathers [67]. Most of the processes that the fruits undergo involve thermal treatment for several reasons that include convenience, drying, and preservation [60]. The juice and the jam made from the pulp of the *Strychnos* spp. fruits are preferred over other fruits' products [68]. The pulp of the fruits can be added to porridges to impart an acidic flavour as well as micronutrient fortification [19].

When making jams, no pectin is added to the mixture which means the fruits have sufficient amount of pectin for jam making and possibly low enough pH [63]. These fruits present a great potential for

industrial scale production of new food products and food ingredients because of their biochemical make up, and as a result improve the food industry landscape of not only the Kingdom of Eswatini but the southern African region as a whole. The ripe fruits are used to treat coughs when mixed with honey [67].

3.3 Wild Medlar (*Vangueria infausta)* - (SiSwati name: *Umntulwa*)

The ripe fruits of *Vangueria infausta* are round, brown in colour, with a leathery skin enclosing three to five seeds embedded in a soft pulp that tastes like an apple with a sweet, sour, somewhat bitter, slightly astringent taste [69]. The pulp and skin are the edible parts which are consumed either fresh or dried, while the seeds are discarded [69]. The fruit contains sugars, dietary fibre, essential micro- and micro-nutrients as well as organic acids, contributing to the diets of human beings [70]. The fruits are widely dried and sometimes ground into powder because of their short shelf life. *V. infausta* dried with sucrose and by solar-assisted pervaporation (SAP) had a softer texture when compared with other commercially dried fruits, and prolonged drying was shown to lose some volatile aroma compounds [71]. Fruits dried by this method are good as snack food and the nutrients are well retained. The volatile flavour compounds associated with the *V. infausta* fruits are mainly from the ester group [72], which contribute to the pungent and fruity flavour.

Local communities in southern Africa, including those in Eswatini, prepare juice, jam and puddings by adding water and sugar, or cook the fruits to make marmalade. The pulp can also be fermented to produce an alcoholic drink. Some households in Eswatini extract the pulp in water and use the juice to flavour maize-meal porridge [69]. Other plant parts contain some useful phytochemicals such as alkaloids, anthraquinones, coumarins, glycosides, polyphenols, saponins, secoiridoids, steroids, tannins and terpenoids, which are associated with different biological activities [69].

3.4 Marula *(Sclerocarya birrea* subsp. *caffra*) – (SiSwati name: *Umganu*)

The pulp of the *Sclerocarya birrea* subsp. *caffra* is edible and can be eaten fresh, made into a jelly and jam as well as fermented into an alcoholic or non-alcoholic beverage [73]. The juicy flesh is fibrous and mucilaginous with a sweet-sour taste and a burst of aroma [74]. The juicy pulp is rich in ascorbic acid (168mg/100g) and citric acid as well as sugars. These compounds play a very vital role during the processing of the fruits. The acids may work with some pectin which is in abundance in the pulp, to create a firm jelly [74,75]. Ascorbic acid and the pectin are also important in human nutrition as they boost the immune system and bowel movement, respectively. The aromatic flavours have made this fruit very popular and been able to gain space in the commercialisation of the fruit in liqueur and spirits. The peel of the fruit has an oil that is used in the manufacture of cosmetics [74]. Other parts of the plants such as leaves and the bark, are largely used for and have been tested for medicinal importance [74]. A clinical trial of the juice administered on patients, resulted in a reduced total serum cholesterol of about 8% [74]. In Eswatini and Namibia, this fermented alcoholic beverage

made from the fruits of marula play a socio-cultural role where the brew is presented to the King and Chief, respectively, as gifts from the people. The different uses and applications of the marula tree and fruits present a potential for domesticating and protecting the tree for commercial and industrial use.

3.5 Waterberry (*Syzygium cordatum*) – (SiSwati name: *Umncozi*)

The fruit *Syzygium cordatum* is an oval berry, sweet and succulent, fleshy fruit that has a deep purple colour when ripe. The flesh surrounds a seed that is discarded by humans during consumption of the fruit. The fruit has a slightly acidic flavour and is widely consumed by animals such as birds and monkeys [76]. The fruit has a protein content of 5.91% and a lipid content of 0.72% [51]. The fruits pulp is also processed into an alcoholic drink, and jam [40]. A combined formulation of up to 32% of *S. cordatium* with other fruits in jam making produced a highly desirable jam with a score of 0.914 [40]. A concoction of the leaf, fruit and bark of the stem of the *S. cordatium* is used to treat mouth sores in South Africa [77], and has a fair content of antioxidants which are associated with reducing chances of chronic diseases [78]. The *S. cordatium* fruit tree is widely used for medicinal purposes in South Africa, treating a wide range of ailments [77], however, there is little research that has been conducted on the fruits as food. Since this fruit is used and/or consumed during its abundance, it would be justifiable to conduct studies that will establish its physicochemical composition and how it benefits the consumers.

Interestingly, most of the indigenous fruit and nut trees in Eswatini have some medicinal properties which are used in traditional medicine, and they have some cultural use as well. Table 1 shows some indigenous plants with different uses in the Kingdom of Eswatini.

Table 1. Some indigenous fruit and nut trees and their uses in Eswatini [26,78].

Common Name	Scientific Name	SiSwati Name	Uses
Wild custard apple	*Annona senegalensis*	*Umtelemba*	Edible fruits. Treatment of parasitic worms, diarrhoea, gastroenteritis, lung infections, toothaches, and snakebites
Bird plum	*Berchemia discolor*	*Vuka*	Edible fruits; high sugar and Vitamin C content Wood furniture, bark for medicinal purposes
Red ivory	*Berchemia zeyheri*	*Umneyi*	Furniture and ornaments. Used to treat anaemia, and bark used for back pains. Edible fruits which could be made into sugary sweetmeat or condiment

Dwarf Turkey-berry	*Canthium ciliatum*	*Umvutfwamini*	Bark and leaves used as enemas. Edible fruits.
Tree strawberry	*Cephalanthus natalensis*	*Umfomfo*	Edible fruits and leaves. Leaves made into powder and used for the treatment of eye problems in cattle
Cape fig	*Ficus sur*	*Umkhiwa*	Edible sweet fruits which could also be processed into jam. Latex used for burns and septic conjunctivitis
Sycamore fig	*Ficus sycomorus*	*Umkhiwabovane*	Edible fruits and leaves. Bark and latex for chest, glandular complaints, diarrhoea and inflamed throats
Governor's plum	*Flacourtia indica*	*Umtabhala*	Edible fruits. Bark and roots for sore throats and rheumatism. Leaf tonic for asthma
Shepherd's tree	*Boscia albitrunca*	*Ingwavuma*	Edible leaves and roots for beer or coffee substitute. Fruits used for juice making.
Mountain rock	*Ficus glumosa*	*Inkhokho lemhlophe*	Bark used to treat diarrhoea. Edible fruits and leaves.
Wild date	*Fadogia homblei*	*Ndhlaleni*	Fruits are edible.
Sour plum	*Ximenia caffra*	*Umtfundvuluka*	For treatment of inflamed eyes, asthma, flue. Fruits processed into Jams and jellies.
Wild Medlar	*Vangueria cyanescens*	*Umntulwa*	Edible fruits are high in Vitamin C content. Treatment of coughs, fevers and wounds. Roots for snake bites.
Black nightshade	*Solanum nigrum*	*Umsobo*	Edible fruits and leaves. Treatment of eye inflammation, skin disorders, ulcers, eczema
Green monkey orange	*Strychnos spinosa*	*Umhlala*	Edible fruits, delicious fresh pulp. Treatment of snakebites. Root an emetic for fevers and inflamed eyes.
Black monkey orange	*Strychnos madagascariensis*	*Umkhwakhwa*	Edible fruit pulp and leaves. Roots and barks for treatment of stomach disorders.

Waterberry	*Syzygium cordatum*	*Umncozi*	Edible fruits which could be processed into jelly and wine. Bark for the treatment of diarrhoea
Marula	*Sclerocarya birrea*	*Umganu*	For the treatment of dysentery, diarrhoea and malaria. Used to process Wine, liquors, cosmetics, confectionary, livestock feed

5. DOMESTICATION OF INDIGENOUS FRUIT AND NUT TREES

Domestication is a man-driven process involving selection processes from wild species to cultivate them, thereby, increasing their usefulness to human beings by improving the yield and/or quality of the desired product [80]. Through domestication, various propagation techniques can also be developed for *ex situ* conservation [81]. Domestication of any plant species consists of selection and management by humans, and is not only about breeding *per se*, but definitely an aspect of whole species improvement [82]. This is an iterative procedure involving the identification, production, management and adoption of desirable germplasm [82]. These techniques can help clone elite specimens and avoid the long juvenile periods from seeds [81]. Under domestication, and in response to purposeful man-led selection, species like *D. edulis* have reduced juvenile phase, larger fruit size, extended fruiting season, more complementary rooting system if intercropped in agroforestry context with companion crops and are significant carbon sinks within the production system [83]. Farmers in southern Africa deliberately maintain indigenous fruit trees on their farms mainly for their fruits and nuts [84].

Most African native fruit species have not been brought up to their full potential in terms of quality breeding and selection, scale of production and distribution, value addition and availability [80,83]. The potentials in recurrent selection programmes for breeding of indigenous fruit trees are limited by the relatively long expected time until first fruiting for many of the species [80]. Gains from selection of superior phenotypes in the field may be harvested sooner if these selected individuals are vegetatively propagated and deployed directly as clones without any additional breeding [51]. Vegetative propagation refers to the regeneration of selected plants from vegetative organs such as roots, stems, leaves, buds and even single cells/tissues; and it offers a wide range of benefits for any domestication programme of indigenous fruit and nut trees [82]. Vegetative propagation techniques were developed to domesticate two important indigenous nut tree species, *Barringtonia procera* (cut nut) and *Inocarpus fagifer* (Tahitian chestnut), of Melanesia in the Solomon Islands, through single-node, leafy, stem cuttings [86].

Other vegetative propagation methods include grafting, budding, marcotting (air-layering), and micropropagation. Marcotting or air layering is a technique that produces roots on the stem while the stem is still attached to the parent plant [82], and is commonly used for difficult-to-root species from cuttings [86]. It is a technique used to make a genetic copy of a desirable genotype from a mature tree [86]. It is one of the oldest methods of vegetative propagation, although it still has relevance in present day plant multiplication, domestication and conservation efforts [82]. Air-layering propagation was successful on *Barringtonia procera* and *Inocarpus fagifer* [86].

These propagation techniques should encourage use of locally available material e.g. river sand, wood shavings, compost, polythene bags/containers etc. for the rooting of cuttings. This will enable even the community members to be easily trained in the basic principles of vegetative propagation so that they can, on their own, produce and bulk up 'cultivars' from the trees that they know and value in their area [87].

In Cameroon, farmers have selected certain trees based on their taste, fruit size and yield, resulting in the domestication of *Dacryodes edulis* trees [88]. The degree of farmer-driven domestication, in which farmers bring a species into a managed environment by planting or retention indicates that farmers are convinced that it is worth investing in indigenous fruit species [86,87]. In South Africa, the mean fruit yield of marula (*Sclerocarya birrea* subsp. caffra) trees is significantly higher from village trees than protected area trees, and the fresh mass of individual fruits and mean kernel mass are also greater [88]. Marula domestication should be encouraged because there is a large and sustained demand for its products in both local and international markets [81]. In Eswatini, traditional marula brew has a significant annual cultural value [26]. Domesticating marula trees in Eswatini could be well accepted since its intrinsic beverage value is intertwined with culture. Marula oil is extracted from the seed kernels. It is traditionally used in skin care and the treatment of leather [81]. This a clear indication that indigenous fruit and nut trees have a potential for diversified products.

Another technique of domesticating the indigenous fruit and nut trees is the use of plant biotechnological tools i.e. *in vitro* propagation [90]. In the modern age of science, plant tissue culture is an indispensable part of biotechnology [91]. This method provides the possibility of producing clones of native plants with appropriate attributes and mass reproduction [92], and is appropriate for those plant species which are recalcitrant and lose viability in a short period of time [93]. *In vitro* culture methods not only offer the possibility of cloning these genotypes, but also preserving them for an indefinite time, through cryopreservation, while field trials are being carried out [88,92]. An *in vitro* propagation protocol of *Irvingia gabonensis*, an African indigenous tree, was developed, and could be used as an alternative to conventional propagation and breeding [91]. An efficient micropropagation protocol was established for *Citrus megaloxycarpa* Lush., a highly acidic citrus cultivar of Manipur, India, through shoot tip explant culture [93], and for rudraksha (*Elaeocarpus sphaericus*) through nodal explants [95]. A promising method for *in vitro* propagation of white sapota (*Casimiroa edulis* L.)

was established through shoot tips and nodal segments [96]. A micropropagation protocol for olive (*Olea europaea* L.) was developed [92].

Domesticating indigenous fruit trees has to recognise, to a greater extent, the local community people and their traditional knowledge. They may provide valuable information on the use, growth and development of the tree species, intra- and inter-specific variations, and their favourable environmental conditions as well. The selection, retention or deliberate planting and management of trees by farmers can be considered as the beginning of the domestication process of the species [87,95,96]. Indigenous people have good knowledge of how and when to utilise the fruits around them for their benefit [5,97,98]. This approach conforms to the aims of the Convention on Biological Diversity, which seeks to protect the rights of local people to their indigenous knowledge and germplasm [83,85] and the land property rights [101]. A project that engages and empowers the local people at the beginning is likely to succeed, as rural communities have strong social and economic attachment to indigenous fruit trees [102]. Domesticating indigenous fruit and nut trees has to start within the communities in which they naturally occur, and then be introduced to new communities. If the tree domestication project is adopted and successful, every yard or farm of most homesteads in that particular community will have those tree species growing. In Eswatini there are indigenous plant conservation communities which were established by a UNDP project called 'Strengthening of National Protected Areas Systems' [103]. Since the people from these areas were capacitated on conservation, they would be the right people to pilot the domestication and commercialisation of indigenous fruit and nut trees in Eswatini.

Indigenous fruit and nut tree domestication requires the support of the government. The multifaceted nature of the support required for domestication of indigenous fruit demands a coherent and consistent policy approach [86,102,103]. The key issue at national policy level is for governments, in light of current evidence, to give greater recognition to the potential of indigenous fruit trees to contribute to poverty reduction as components of more diversified, sustainable and environmentally friendly livelihood options [86,98]. Enacting legislation ensures that the intellectual property rights of 'farmer-breeders' are protected, so that the benefits of high-yielding cultivars produced by communities and individual farmers through participatory domestication are not unfairly exploited by large-scale commercial growers [88].

Domesticating and commercialising indigenous fruit and nut trees calls for all relevant stakeholder involvement e.g. farmers, extension officers, researchers, processors marketers, and consumers [86,104,105]. They all have important roles to play in the indigenous tree domestication and commercialisation process [96,104,98].

CONCLUSION

It is apparent that local people have been using the indigenous fruit and nut trees throughout their history. The indigenous knowledge on the use of these fruit and nut trees is a fundamental component in scaling up their commercialisation. Modern processing technologies are key in value addition of indigenous fruit and nut trees. If the benefits of the commercial aspect of these fruits are to be realised, a sustainable supply of the raw material is vital. This could be achieved through domesticating these indigenous fruit and nut trees. Domesticating these indigenous fruit crops could be through plant propagation and cultivation, using both conventional methods and plant biotechnology techniques.

Domestication of indigenous fruit and nut trees is not a top down approach. It is a multi-stakeholder project where each and every stakeholder has a role to play. The local people or the communities are very key in domesticating and commercialising of these fruit crops. Their knowledge on the type of trees which exist in their locality and their potential for commercialisation is very vital. Therefore, if the indigenous fruit and nut trees of Eswatini are to be brought under domestication and commercialisation, the community members have to be involved from the beginning of the project. No matter how good the project may look like, if the community members are not involved that project may be bound to fail.

The political will is also important. If the government buys into the idea of commercialising the indigenous fruit and nut trees it may speed up the process. The government also has to ensure that the domestication and commercialisation process adheres to the international conventions on biodiversity and exchange of genetic material in which the government is a party to. Government might be able to facilitate establishment of processing companies for value addition, and may help in securing markets for the product from indigenous fruits and nuts. Researchers, from various disciplines, are equally important in this project as they will bring in innovative ideas and develop technologies to improve the industry.

Tree domesticating will not only support commercialisation of the tree products, but will also ensure that these indigenous plant genetic resources are conserved even for future generations. This will of course, lessen pressure on the naturally occurring stands of the indigenous fruit and nut trees. Therefore, it is important that tree domestication should not be viewed with the sole objective of commercialisation, but with that of biodiversity conservation too.

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