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Review

A Review of the Geographical Distribution, Indigenous Benefits and Conservation of African Baobab (Adansonia Digitata L.) Tree in Sub-Saharan Africa

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Abstract: Indigenous trees have great economic potential and ecological benefits for enhancing environmental prosperity, mostly in forestry and the forest products sector in the developing countries of Sub-Sahara Africa. The baobab (Adansonia Digitata L.) is known as the African green jewel in both fruit production and medicinal benefits also remarkable for so many forest products exported across the world. Research conducted in the different Sub-Saharan African sub-regions has shown this iconic tree with a majestic outlook has a priority tree species for local and foreign use and conservation. However, data on the benefits and conservation of baobab trees in Africa, especially the Sub-Saharan countries is limited. This study aimed to assess the predominant geographical distribution of the tree, the indigenous (cultural, socio-economic, ecological, and medical/health) benefits, and the conservation strategies of the baobab resources in Sub-Saharan Africa. The baobab tree's succulent roots, bulbs, branches, fruit, pods, foliage, and petals are all nourishing. Baobab parts have been used for diverse reasons in Africa, some countries of Asia, and Europe for the past two centuries due to their medicinal well-being properties. In addition, the medicinal applications of the plant parts are discussed. Many authors have highlighted the baobab tree as one of the most important trees to be saved and localized in Africa because of its high indigenous usage and commercial worth. Anthropogenic global warming may induce a drop in baobab species, which could inflict negative impacts on African economies. As a result, it's critical to research the species' likely future distribution and develop conservation policies. Literature was consulted for records and availability of this tree in the Western, Central, Eastern, and Southern African species records and it was also analyzed what percentage of the current environment would be appropriate in the future. Recent studies suggested that farmers and the locals be provided free seeds and seedlings to encourage biological rejuvenation to maximize the plant's potential, people should be informed about the additional uses of baobab that have been discovered. Individuals must also be educated on simple sustainable agroforestry activities that can be performed in plant and forest management.

Keywords: agroforestry activities; anthropogenic global warming; conservation policies; forest management; forest products

1. Introduction

Africa contains the wildest edible fruit species relative to tropical Asia and North America [1]. The strong agricultural capability and substantial biological modification of Africa's wild edible plants imply that they could form the foundation for incorporating new raised species and hybrids into current agricultural production following domestication [2]. Inside that multinational Crop Wild Relatives project, their utilization and conservation are among the most critical challenges for humanity [3]. Untamed and uncontrolled indigenous trees are used for a variety of uses in Sub-Saharan Africa, including commercial agricultural goals [4-6]. One of the frequent names for the giant tree is the

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wooden or vegetal giant, due to its bulky shape, greyish wrinkled bark at the huge trunk, and widespread appearance in various African savannahs. Studies have identified that even these trees, which may live up to 3,000 years, were disappearing in huge numbers [7-9]. Sánchez-Bayo [10], illustrates what is in jeopardy for the indigenous populace if such massive trees go extinct.

Along with its twisted foliage, which is lush and green for many seasons of the year and mimics root hairs stretched through the horizon, the baobab is also known as Africa's upside-down tree [11, 12]. The gaze appearance of this one-of-a-kind tree has piqued the interest of many visitors, and it is frequently included as a theme in souvenirs, diaries, and booklets. Foods such as soft beverages, sandwich spreads, cereal bars, candies, and chocolates, as well as medical supplements and pharmaceutical items like shampoo, and foot spray, are among the products available. Local communities in humid, dry, semi-arid, and hyper-arid areas of Sub-Saharan Africa rely on the baobab for a range of meals, as well as fodder, weaving and rope-making fibres, seed oil and gums. The appearance of a baobab has spawned stories, poems, music, and mythology all over Africa [13]. Baobabs have a reputation for inspiring empathy and sometimes even adoration. Fruits, foliage, florals, branches, nuts, timber, and root hairs have all been used in various ways. Buchmann et al. [14] collated about 400 systems and applications from different ethnic groups and various zones in West Africa [14-16]. The baobab fruit pulp has the least moisture content but the greatest calories, accessible glucose, fibre, ash, vitamin C, and nutrients [17]. Several baobab research on various aspects has been undertaken in Western and Southern Africa over the last two decades. Numerous baobab experiments have been undertaken in sub-Saharan Africa on various elements of the plant, including physical variety, chromosomal characterisation, demographic reliability, nutrient benefits, gestation period assessment, development environments, infections, and socioeconomics [17-19].

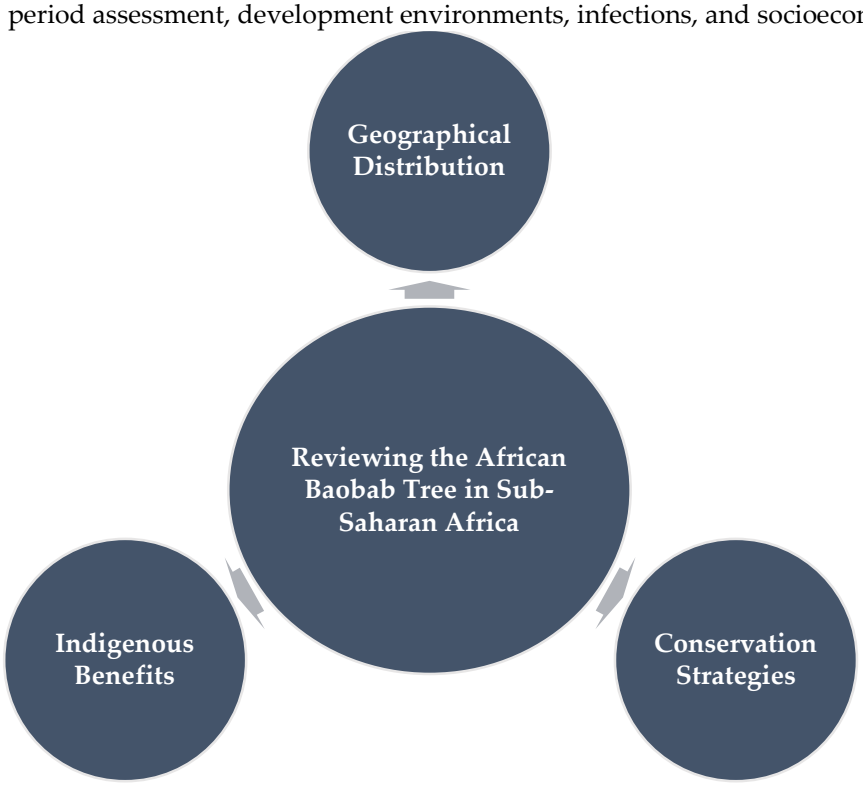

Figure 1. Showing the three key parameters for Adansonia Digitata L. assessment.

Food, housing, clothing, and medicine are all provided by the tree, as well as material for farming, hunting and fishing [20, 21]. It is said that every component of the baobab tree is helpful. The baobab has a large root system and can hold a lot of water [22]. Its average yearly average temperature is 25°C, but it can withstand temperatures as high as 45°C, is fireproof, and can withstand freezing weather as long as there is no winter. It is

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drought-resistant and cold resilient [23, 24]. This adaptation allows it to grow in zones with over 1500 mm of yearly precipitation, although plants in lower annual rainfall are generally withered. All of the nutritious parts of the plant, including the fragile roots, tuber, branches, fruits, pods, foliage, and flower petals, are used in traditional African cuisines. These same fruits are reported to have twenty times more vitamin C than a grapefruit and oranges, while the leaves are heavy in minerals and pro-vitamin A. Due to the obvious fatty acid content, the oils derived from the seeds are regarded as appetizing [24]. Most people in Africa, particularly in the continent's central part, eat the leaves as the main part of their diet [24-25]. They are cooked in potassium nitrate in Malawi with fresh vegetables, such as leafy vegetables and spinach, which are replaced by domestically farmed leafy greens in Zimbabwe [25]. The objective of this review is to evaluate the major geographical distribution of African Baobab trees, indigenous benefits, and baobab resource conservation techniques in Sub-Saharan Africa.

2. The Description of The Majestic African Baobab Tree

The taxonomy Adansonia contains majorly nine varieties of evergreens belonging to the hibiscus, or mallow, family (Malvaceae). Adansonia grandidieri, A. madagascariensis, A. perrieri, A. rubrostipa, A. suarezensis, and A. za are species dominant in Southern African, four are native to main island of Africa and the Arabian Peninsula (A. digitata and A. kilima), and one is unique to northwestern Australia (A. gregorii)[26]. These possess distinctive barrel-like trunks and are noted for their long lifespan and ethnobotanical significance and benefits [26, 27]. According to folklore, "the devil plucked up the baobab, thrust its branches into the earth, and left its roots in the air," according to an Arabic fable. Other names for the baobab (Adansonia digitata L) are boab, boaboa, tabaldi, bottled tree, and monkey bread plant [27]. This same Baobab Tree has been dubbed the "downward tree" in some writings [28]. The majestic baobab tree is an image of the African continent, according to the authors, and its bark and fruit have over 300 life-sustaining uses, making it the source of many African cures, traditions, and folklore [29]. As a result, the term "The Tree of Life" is fairly accurate according to Islam-Faridi et al [30], Gebauer et al [31] and Cron et al [32]. The primordial species predates both mankind and the 200 million-year-old division of the continents. The trees were thought to survive for up to 5,000 years by European explorers, but carbon analysis suggests they are only 3,000 years old. These massive trees, which can grow up to 100 feet tall and have a circumference of 100 feet, provide protection, nourishment, and moisture for thousands of men and livestock [30-32]. It seems these massive trees have long served as the focal point of African savannah towns [33, 34]. Africa is home to a plethora of novel plant species, many of which are known to be high in well-being chemicals but have yet to be identified or utilised by Western society. It is not agronomical grown or adequately domesticated. It has been recently implemented in areas beyond Africa (Asia, Australia, and the Americas). It's a symbol of Africa, and it's at the centre of a lot of traditional African cures and folklore. Baobabs are deciduous trees that grow to be between 5 and 20 metres tall. The baobab tree is an odd-looking tree found in low-lying parts of Africa and Australia [35].

In southern Africa, one ancient hollow baobab tree is so huge that it can house up to 50 people inside its trunk[36]. Baobabs have been utilized as a store, a prison, a dwelling, storehouse sheds, and even bus stations, among other things. The tree is unmistakably distinct from any other. The trunk is smooth and shiny, unlike the bark of other trees, and is pinkish grey or occasionally copper. The spreading branches of the Baobab tree, when bereft of leaves, resemble roots rising out into the air as if they had been planted upside-down. Baobabs are extremely difficult to destroy; they can be burned or stripped of their bark and will regrow new bark and continue to grow [37-39]. The baobabs are endemic to Africa and the Arabian Region's southern regions. These are long-lived pachycauls, with some individuals dating back over 2000 years according to carbon dating. They are most commonly seen in sub-Saharan Africa's dry, hot savannas, where they dominate the landscape and announce the existence of a waterway from afar[40]. They are a vital food source

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for many animals and have long been recognized as supplies of food, water, health cures, and shelter. Myth and mystery surround them. Many of the biggest and leading plants have disappeared in recent times, probably as a consequence of global warming. The baobab is also known as the monkey-bread tree, upside-down tree, and cream of tartar tree. Whenever they start dying, they decompose from within and disintegrate, producing a pile of threads, leading some individuals to realize that they do not even drop dead either and disappear entirely. The lives of many organisms, from the largest mammals to the hundreds of small insects darting in and out of its crevices, are supported by an old baobab tree, which can form its ecosystem. Birds build their nests in its branches, baboons eat the fruit, bush infants and fruit bats sip the nectar and pollinate the blossoms, and elephants have been observed to cut down and eat an entire tree. Local people have no practice of planting indigenous trees because they are considered "wild," [14, 41-42].

These were linked to indigenous belief systems, which included references to so many traditional beliefs and tree deities and prohibitions, among many other elements. Baobab leaf picking was mainly done also during the monsoon period, and only once a year on average [43, 44]. Additionally, the bark and roots could be gathered at any time of the year and if the process of recovery is not taken into account, this is also a cause for concern for seasonal bark renewal [45]. A considerable variation in the administration of African baobab by any particular management actions on the conservation of the African baobab was identified in the study. The baobab is fast-growing with diverse use as an indigenous tree in Sub-Saharan Africa [46]. bats and birds pollination improves fruit set rate, making it a significant element for in situ regeneration of baobab trees in SSA. Human actions, alter the structure and function of the environment, with cascading effects on human health, a concept is known as planetary health [47, 48]. Microclimates, hydrology, biogeochemistry, and diversity are all affected by agroforestry, which involves combining trees with crops and cattle [49]. Aside from the nutritional advantages of increasing fruit consumption, the effects of agroforestry on human health are rarely discussed. Some benefits provided by underutilized fruits and native trees such as baobab in combatting rising starvation and inequality have become increasingly evident as awareness of worries about agriculture and food security has grown[50, 51]. Baobab has been identified as one of the most important edible forest trees to be saved, domesticated, and treasured in Africa because of its impactful uses, high nutritional and medicinal value, drought resistance, and relatively easy cultivation. Annual precipitation and temperature seasonality were the key factors in forecasting baobab's global cultivation potential [52].

According to Islam-Faridi et al [53] the baobab is a magnificent, long-lived, and versatile tree native to Sub-Saharan Africa. Internationally, there has been an increase in demand for baobab products in the culinary, pharmaceutical, and cosmetics industries. Given this, scientific information on A. digitata genetics and breeding, including cytogenetics, genetic diversity, and reproductive biology, is required. According to Anjarwalla et al [54], the baobab is a dryland indigenous fruit tree species in Sub-Saharan Africa. Its leaves, fruits, and seeds are significant for local populations' money-generating as well as food and nutrition security. Its fruit pulp, among other minerals, is high in vitamin C and calcium [53, 54]. Hybridization of baobab trees, employing parent plants exhibiting desirable qualities for biological mass propagation and planting, could help meet the growing demand for baobab pulp while also reducing the vegetation population in natural ecosystems. Cross-linking procedures and rootstock ages were recommended and recorded as successful, and they can help with the creation of baobab domestication programs in Africa's drylands to improve food security and livelihoods[51-54]. The baobab, according to Stadlmayr et al [17], is a multipurpose tree native to Sub-Saharan Africa's semi-arid and sub-humid zones. Despite its many uses and valued traits, knowledge of the dietary and morphological aspects of this plant is scarce, especially in Sub-Saharan Africa. Magagula & Costello [55], discussed the benefits and importance of walking Safaris in South Africa. It is elucidated through guided walks and trails in national parks and game reserves.

2.1. Baobab Mucilage (Baobab Leaves) and Fruit Pulp

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Enormous greyish white blooms blossom during nightfall just on the Baobab tree. The Baobab tree, which can develop nearly 450 metres in length and includes natural compounds and vitamins, could be swallowed or washed thoroughly for a cool drink. You can also roast and grind them to make a coffee-like beverage. The fruit of the Baobab isn't the only portion that can be used. The bark is hammered into the string, carpets, bins, parchment, and linen; the leaves are eaten and consumed, and the pollen is used to produce glue [56, 57]. It is a symbol of life and positivity in a terrain where nothing else can survive. It is native to the African savannah, where the climate is parched. The Baobab has responded to its surroundings over time. It's fleshy, meaning it collects and retains water in its massive stem during the monsoon rains, allowing it to generate nutritionally fruit during the summer months when everything else is parched [25, 41-50]. As a result, it was dubbed "The Tree of Life." According to studies, a different sample of trees approximately 120 randomly selected trees produces between 50 and 2300 fruits per tree, with an average of 600 fruits per tree in a season [58].

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b

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Figure 2. a) Showing Baobab Fruit Pulp. b) Baobab Mucilage (Baobab Leaves). c) Different shapes of Baobab fruit pulp in a dry state [50, 51].

2.2. The Africa Baobab in Perspective

The thick outer layer on the shapely pods of baobab is difficult to detach from the kernel. The seed has a butter flavour and is high in oil [59]. Seeds can be consumed raw, powdered, or baked, and oil can be extracted for baking and dermatological application. Whole seeds are ground into such a grain meal, dried, and then added to the traditional Sudanese cuisine 'Kurundu' [60]. Baobab fruit and nuts are still being used as additional food in water shortages areas, both of which have been recorded in Africa [61]. In recent years, there has been a growth in domestic and global interest in baobab goods, and more baobab pulp and seeds are being processed on a massive scale for tourism items such as sweetened baobab powder pellets and seed oil [62-63]. In eastern Africa, baobab pulp powder and seed oil are the most popular. Kehlenbeck et al. looked at the yields of more than 100 trees and the average amount of fruits per tree was 900, with an average of 1070 fruits per tree. They are however documented for use as a vegetable mostly across all the subregions, where they are cooked in similar greens or blended and cooked with coarser vegetables such as cassava leaves [60, 64]. Only two farmers mentioned the potential use of the leaves as a vegetable during discussions with farmers[59]. Domesticated animals enjoy the foliage and immature pods, so they are collected for feed. Similarly, across all the regions, animals graze fallen leaves during the start of the dry season. On

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various farmlands in the neighbourhood, the tree's population status was studied. The frequency of occurrence, diameter at breast height (dbh), and height of baobab trees observed were all recorded. The number of different segments of the variety was counted to establish the rate of occurrence [59-63]. The radius at height was calculated using only a classic radius tape, whilst also altitude evaluation was conducted using haga altimeter-the haga altimeter is a gravity-controlled pivoted pointer with a series of scales and proportion scales. Inferential data have analyzed the findings. Frequencies and proportions have been used in descriptive and inferential statistics. The tests were used to assess variations in African baobab management and utilization regarding the age and gender distribution of respondents. African baobabs are big, unique trees that generally grow as isolated individuals midst grassland or marshland habitat. They can reach a height of 8–35 m. The stem is usually large, cylindrical, or tubular, and has a buttressed, projecting bottom. Trunks may reach a diameter of 8–11 m and may be made up of different trunks merged around with a central cavity. Several native plants have hollow cores as just a result of wood loss, such as deterioration of the oldest, interior section of the trunk [18, 20-24].

2.3. Leaves, Flowers and Fruits

In mature trees, leaves are petiolate complex, with as many as 10 leaflets, while young and rejuvenating stems may also have simple leaflets. The change to compound leaves is slow and occurs with maturity. The simple leaves of African baobabs last significantly longer than those of almost all other Adansonia varieties [40]. Leaves range in size from stalkless to short-stalked. Flowering takes place during both the dry and rainy seasons. Buds have a cone-shaped apex and are rounded. The flowers are spectacular and occasionally paired, although they are normally produced solitary at the end of a 10-60 cm long floating stem. Five green triangular bent-back lobes sepals with a cream-coloured, hairy inside make up the crown. The flowers are white and curled in the bud, with nearly equal width and length – up to 8 cm. Flowers bloom in the late afternoon and last only one night. The flowers have a lovely perfume when they are new, but after about 24 hours, they turn brown and produce a carrion odour. The androecium is a white tube of fused stamens encircled by 5-8 cm long unfused filaments. There are an average of 1000 stamens per flower, which is quite a lot. Styles are white and extend beyond the staminal tube [65]. They're frequently curved at right angles and have an uneven stigma on top of them. Seedlings in the baobab family are round with spurs just on the exterior. Pollen grains have a thickness of 55 microns. Large circular elegant characteristic seeds with a thorny outermost casing are produced by all Adansonia species. The shape of African baobab fruits varies greatly, from nearly round to cylindrical. The thickness of the shell ranges an average of 9mm. The pulp within is meaty and creamy brown. The pulp hardens into a crumbly powder as it dries. The nuts are kidney-shaped and firm, with approximately a 0.8mm thick covering. They are dormant for a long time, only sprouting after a fire or going through the digestive tract of an animal. This is assumed to be since the seed coat must be broken or thinned for water to pass through before the seeds may sprout [7, 14, 20-25].

2.4. Geographical Distribution of Baobab Tree

The "Tree of Life" as it is commonly called can be found across Africa's arid zones, with an ocean stem that can grow to an average diameter of 10 meters and a height of 15 metres. Hollow wooden trunks are common in elderly adults, which are generated by the fusing of many stems over time. Bats and bushbabies pollinate the tree's unusual pendulous blossoms. Its young leaves are edible, and the enormous gourd-like woody fruit has a delicious mucilaginous pulp that can be used to make a pleasant drink. A. kilima was discovered to be a separate species from A. digitata in 2012, based on morphological and phylogenetic evidence [65]. Although visually similar to the African baobab, it grows in mountainous areas of continental Africa and has different floral and pollen properties,

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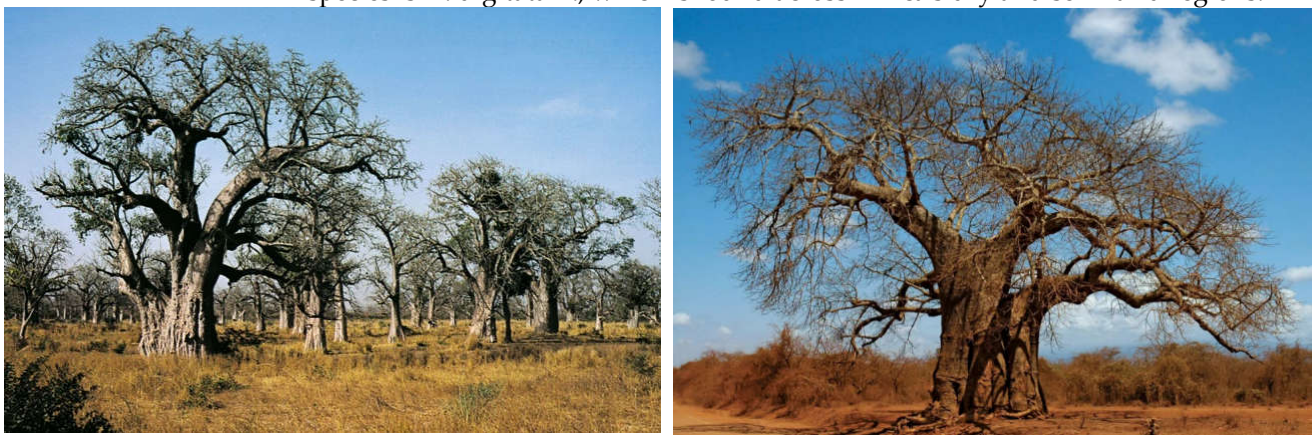
as well as fewer chromosomes. For Example, the six species of baobab found in Madagascar have dense tops and dark to red trunks that taper from top to bottom or are bottle-shaped to cylindrical. The blooming have five petals and range in colour from red to yellow to white. Bats and lemurs pollinate some species, while hawk moths pollinate others. Monkeys and raccoons also pollinate some species, while hawk moths pollinate others. Three other species, including the iconic baobabs of the famous Avenue of the Baobabs (A. grandidieri) in the Menabe district, are classified as threatened just on the IUCN red list of threatened species due to habitat degradation and delayed generation times [66]. Adansonia digitata L. belongs to the Bombacaceae family, a subfamily of the Malvaceae, and is the most extensively distributed Adansonia species on the African continent. Adansonia is a genus of plants with huge, showy blooms that bloom at night. One of these species is A. digitata L., which is found across Africa's dry and semi-arid regions.



a b

Figure 3. a) Baobab trees growing in the wooded-grassland area of Senegal in West Africa [66] b) Baobab tree (*Adansonia digitata*) in Kenya [67].

This African baobab is noteworthy not just for its size, lifetime, fruit, and bark, but also for the way it generates several fused stems continuously. The bark of the baobab regenerates in the spaces between the stems, known as false cavities [66,68]. In the arid African savannas, baobab trees are essential ecosystem elements. They contribute to nutrient recycling and decrease soil erosion by keeping soil conditions humid. Hundreds of animals, including birds, lizards, monkeys, and even elephants, rely on them for food, drink, and shelter. Elephants may even eat their bark for moisture when there is no water around. Bats fertilize the flowers, and feast on their juice [69]. Throughout the millennia, native human groups have managed to coexist with these great trees, benefiting from their numerous uses without depleting them. Nine of Africa's oldest and largest baobab trees have died in the last decade as a result of climate change [70]. Warming temperatures, according to scientists, have either destroyed the trees or made them weaker and more vulnerable to drought, disease, fire, or wind. Only by combining ecological, social, and economic studies with local communities will we be able to repair Africa's climate and ecology in the long run, ensuring that the baobab tree will survive and prosper for centuries [68-70]. Whenever grapes hit the ground, their fibrous covering cracks, allowing insects to penetrate and consume the fruit pulp. They do this by bringing dirt inside the fruit, which becomes moist when the rain begins to fall, creating an ideal setting for in situ fertilization. Humans are most likely one of baobab seeds' primary dissemination vectors. Fruit is a frequent dietary source for nomads and travellers. They spit out the seeds as they eat the sweet pulp, dispersing them along the roadside or in tree shade. It's also likely that riverine tree fruits are water-dispersed, which would explain why baobabs are so common all along the banks of the and at the Sudanese border. The baobab, in addition to its numerous health and cosmetic benefits, has the potential to change millions of lives. Baobab trees can be found in some of rural Africa's driest, most distant, and poorest areas. The scientific name Adansonia honours Michel Adanson (the early 1700s), a French

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traveller and scientist who published the first botanical description for the entire species. The name "Digitata" refers to the hand's digits, as the baobab has complex leaves with close to seven leaflets, similar to a hand [71]. The only species in the section Adansonia is A. digitata, which is the type species for the genus Adansonia. Except for A. digitata, all Adansonia species are diploid; A. digitata is tetraploid. Several African baobab populations show considerable genetic variations, leading to speculation that the taxon comprises many species. The form of the fruit, for example, varies greatly from place to region. The fruits in Angola are elongated rather than spherical. In 2012, a suggested new species (Adansonia was discovered in high-elevation areas in eastern and southern Africa and characterized. This species is now considered a synonym of A. digitata and is no longer recognized as a separate species. Different genetics and appearance are found in certain high-elevation trees in Tanzania, but further research is needed to establish if they could be declared a unique species [71].

2.4.1. Distribution

Tropical savannahs are connected with the African Baobab. It prefers the effects of drought, is susceptible to seasonal flooding and winter, and does not grow in locations with a lot of sand [65, 71]. The tree has also spread to other parts of the world, particularly Australia and Asia [72]. The northernmost boundary of its range in SSA is determined by precipitation pattern; only along the Atlantic coast and in the Sudanese Savanna does it naturally cross into the Sahel [71, 72]. This might be attributed to spreading following planting along the Coastline. Its distribution in Central Africa is quite limited, and it is only found in the far north of South Africa. Trees can be found in Eastern Africa's shrublands and along the shore. Baobabs may be found in savannas, woods, and coastal locations in East Africa. The African Baobab is found in all four sub-regions of Africa. It is a non-native species that has been introduced to North America and parts of Asia. It was brought to northern Madagascar by Arab traders, who planted baobab trees in the heart of settlements [71-73].

2.4.2. Habitat and Ecology

Many baobabs are seasonal, which means they lose their leaves during the dry season and are leafless for most of the year [73]. The African Baobab may be found mostly in savannah settings, which are prone to fire. A thick, burn wood and deep nuts are two adaptations for surviving repeated fires. Trees that are more than 20 years old have thick enough bark to resist the heat of most savannah fires, whereas younger trees can grow after a fire. The seeds may be protected by the fruit's thick outer shell. Fruit bats mostly pollinate the African baobab in West Africa [73, 74]. Animals and a variety of insects also frequent the blossoms and Baobab fruits have a strong covering that allows them to endure dehydration and continue to survive for extended periods. Most of the animals consume these fruit, and seeds that have been through an animal's digestive tract or been exposed to fire have a better chance of germinating. Since elephants and baboons are the primary dispersal agents, the seeds can travel large distances. African baobabs can be spread by water because their fruits float and their seeds are waterproof. Some parts of the baobab's reproductive biology remain unknown, however, pollen from another tree is assumed to be necessary for the development of the viable seed. Secluded plants that do not get pollen from some other tree do produce fruits, however, they are aborted at a later stage. The capacity to disseminate across long ranges yet consciousness could explain the presence of certain highly solitary trees [62, 63, 71].

2.4.3. The Growth Rate

Baobab trees develop weak growth rings, however counting growth rings is not a reliable approach to age baobabs because some years a tree will form numerous rings and some years none at all. A few A. digitata individuals have been identified using radiocarbon dating [71]. Two more trees in Southern Africa were believed to be around 2,000 years

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old, with one in Zimbabwe being 2,450 years old when it died in 2011, making it the oldest angiosperm ever documented and some different specimen, was dated after it died, and it was discovered to have been at minimum 1200 years old [75]. Baobabs' longevity may be related to their propensity to produce new stems regularly [73, 75-77].

2.5. Indigenous Benefits and Uses of Baobab Tree

Baobab trees may be found growing in 32 of Africa's 54 sovereign countries. They can live for up to 5,000 years, grow up to 30 meters tall, and have a diameter of up to 50 meters [74]. Many savannah cultures have established their homes around Baobab trees because they can offer shelter, food, and water for animals and humans. While many people are familiar with the baobab tree, few are aware that it produces a fruit, and even fewer are aware that this fruit is one of the world's most nutrient-dense meals[74,75]. The bark of the baobab tree may be used to manufacture rope and clothes, the seeds can be used to make cosmetic oils, the leaves are edible, the trunks can retain water, and the fruit is extremely nutritious and antioxidant-rich. For ages, African women have used the baobab fruit as a natural source of health and beauty. The baobab is the world's only fruit that dries naturally on its branch. Rather than falling and deteriorating, it remains on the branch and bakes for 6 months in the sun, changing its green velvety coating into a hard coconut-like shell. The fruit's pulp dries off completely. To make a delightful pure fruit powder, the fruit just has to be gathered, deseeded, and sieved. Baobab powder does not need to be spray-dried, freeze-dried, or altered in any way, unlike many other supplements. In its natural state, it is 100% pure fruit[75-77]. Surprisingly, the fruit has a natural shelf life of three years and contains no preservatives or chemicals. Aduna Baobab Powder is one of the best-kept secrets in the health and beauty industry. It's high in vitamin C, contains about half the fibre of an entire fruit, and has the greatest antioxidant concentration of any whole fruit. The benefits of baobab for human health are numerous, as it aids in energy production and weariness reduction. It strengthens the immune system by increasing nutrient balance in the bloodstream, which aids in the fight against disease and illnesses induced by germs. Assists in the absorption of meals and the prevention of wrinkles in the body [75, 77].

a b

Figure 4. a) Showing Baobab Fruit dried Pulp. b) Baobab processed powder- showing the section thru the pulp and the processed seeds converted into powdered additives ready for use and export [78].

There are no baobab farms; instead, each plant belongs to family members and is picked wild. The current harvest, which is so plentiful that it is generally wasted, has enough baobab to feed an estimated fifteen million households. As shown by National Geographic, the global demand for baobab trees might be worth one billion dollars to rural Africa each year [41, 79]. The only problem is that 80% of the population has never taken use of the African baobab's natural benefits. The fruit, bark, roots, and leaves of these trees offer food for many animals, while the trees themselves provide shade and

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shelter. In the past, people used them as sources of food, water, health remedies, and shelter [79]. The baobab is a regional food plant in Africa, although it is mostly unknown in the rest of the globe and of all of the trees studied, the baobab is the most beneficial," the majority of the authors stated [70-81]. Drinking the baobab juice regularly a day while it helps to stay healthy [79]. The fruit has been claimed to improve nutrition, increase food security, encourage rural development, and aid in long-term land management. In most parts of West Africa specifically Nigeria, the leaves are used to make a soup called *miyan kuka*, which is high in phytochemicals and minerals [80, 81]. Cooking oil can be derived by grinding the seeds, although this is not widely common as the derived products are still underutilized locally. During the dry season, baobab leaves are occasionally utilized as feed for ruminants. The animal feed may be made from oil meal, which is a byproduct of oil production [81-83]. Fabric may be made from the bark's fibres. Animals eat the juicy wood behind the bark of the baobab when there is a drought. Above importantly, it has helped SSA's economy since the European Union allowed the use and consumption of baobab fruit in 2008 [82]. Smoothies and cereal bars frequently contain it as an ingredient. Baobab dried fruit pulp was accorded generally recognized safe classification as a food ingredient by the United States Food and Drug Administration (USFDA), western and developed countries-Americas, Asia, Europe and Oceania in the last two decades [42, 83-85].

2.6. Conserving the Baobab Tree: Regional Strategies and Efforts

Several nations have been discovered to have no adequate or healthy baobab ecology in the long term. In situ conservation in protected areas, ex-situ conservation in seed banks, and conservation via continual domestication and sustainability are the main conservation techniques. The European Commission has approved the import of baobab fruit pulp as a portion of new food [61, 62]. The baobab tree, which has over 300 applications and commercial value in the EU and the US, has been designated as one of the most important trees to be saved and domesticated in Africa [40, 50, 51]. As a result, it's critical to research the species' likely future range and develop conservation policies. The coordinates and geographical position of the trees, as well as the climatic and soil layers, must be obtained to determine the geographical dispersion. First, from simple grassland savanna to the dry savanna forests, they flourish on sandy and rocky soils and persons or small groups of individuals distributed over broad spaces are common occurrences. Baobabs may also be found on mountain slopes in central Sudan and Southern Africa [41].

Those who worked in different parts of Senegal, on the other hand, documented a total of 502 uses for the African baobab, of which almost half (50%) were for nutritional purposes, 14% for medical purposes, 14% for spiritual purposes, 1% for veterinary purposes, and 35% for other purposes. In eastern Burkina Faso, Schumann et al [61, 86], discovered 25 different uses for the African baobab. There were 17 medical uses, 7 culinary uses, and 1 construction use among them. The Omusati Region of Namibia, meanwhile, cited ten distinct uses for the African baobab [62]. Despite the commercialization of baobab in the study region, the main restrictions to baobab use in Nigeria are certain unfavourable socio-cultural attitudes held by people of various groups regarding the plant. It reveals that most people are unaware of the tree's native advantages. In the face of so many dangers, the baobab tree is a protected species in Africa, however, it is endangered by mining and development [15, 20, 60-65]. Drought, desertification, and overuse of the fruit have all been mentioned as grounds for worry in the Sahel. Although the IUCN Red List has not yet categorized African baobab, there is evidence that populations are diminishing due to the mortality of certain tree species. Baobab's lifespan appears to be harmed by greenhouse gases, climate change, and global warming. Several particular baobab trees fascinate sightseers because of their age, size, history, location, or rare occurrence, as evidenced by the noteworthy examples photographed by so many writers.

2.7. The Cultivation Model

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Baobab plants are important ecological factors in the arid African savannas, as well as being helpful to people. Importantly, baobab trees help to keep the soil moist and promote ecosystem processes, and erosion control [59, 87]. They also offer food, water, and shelter for a variety of creatures, including butterflies, reptiles, squirrels, and elephants, who may chew their bark to get some moisture when there isn't any nearby[88, 89]. Baobab trees, as ancient as they are, maybe nurtured, as certain West African communities have done for decades. Birds and other animals pollinate the blooms, which travel great distances to dine on their nectar. Most producers are deterred by the fact that producing trees can take up to 10 years to bear fruit, but a new study shows that just by grafting the stems of bearing trees on smaller plants, they can bear fruit in as little as five years. Many "indigenous" trees have a wide range of fruit morphological and nutritional features, and finding the most cultivable kinds requires years of research and selection. Domestication is a term that refers to the selection and nurturing of the best trees present in nature, rather than genetic engineering [80-88]. It may appear simple, but selecting the perfect plants takes a bit of time, and most are withering in the meantime. The loss of the world's oldest and largest baobab trees is heartbreaking, but the news should spur us to safeguard the world's remaining huge baobabs and begin a process of close monitoring of their health. If researchers can master the method of selecting the finest trees to nurture, they may one day be as widespread in our stores as fruits [48, 56, 89].

3. Methods

This study did an exploratory literature review of selected countries of watershed management in Africa and also explored a comparative analysis of the watershed/catchment and river basins in Africa. With the emphasis on the four sub-regions of Sub-Saharan Africa (SSA). This study emphasized *Geographical Distribution*, *Indigenous Benefits* and *Conservation* of the African Baobab Tree in SSA and the need to elucidate the natural distribution. In Eastern Africa (South Sudan, Sudan, Tanzania, and Uganda) baobabs are most frequently found in the southern part of the country. The three key drivers of this review study are the geographical distribution, the indigenous benefits and the conservation strategies (in-situ and ex-situ), the study discussed the four major parts of baobab and did a short assessment of the actual use of the parts (*Fruits*, *Seed*, *Roots* and *Barks*). This study examined simulated models for the four selected sub-regions in SSA. These habitat proportions were compared with the protected areas in Africa. Although potential future distributions were different depending on the model, scenario and records used, in all cases only a percentage of the present distribution was predicted to remain suitable in the future. A three-stage random sampling procedure was produced. Descriptive statistics including frequency counts, percentages and means were employed in presenting the findings of the study. The logit regression model was used in the determination of the factors of usage among the respondents. The level of awareness determines the usage of the baobab in the SSA. The study explores each sub-region considering their availability, traditional use, medicinal (indegenious) use and export trades.

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Table 1. Showing the matrix used to assign priority scores on the key parameters according to selected literature.

Authors	Availability	Uses and Benefits	Conservation	Total Assessment	Focused Country/Sub-region	Remarks
Prehsler (2009)	***	****	****	****	Senegal (West Africa)	Baobab fruit pulp was unanimously implemented as a new food by the European Commission. The multifunctional baobab is widely utilized in rural West Africa [90].
Assogbadjo et al (2021)	****	****	***	****	Sub-Saharan Africa	This study discussed a decade-long adventure through an orphan African baobab to improve Africa's food and nutrition security [91].
Omotesho et al (2013)	**	****	*	****	Nigeria (West Africa)	In rural villages in Nigeria's Kwara State, the baobab is known and used [92].
Amusa et al (2017)	****	****	*	****	Nigeria (West Africa)	The baobab extract was reported to have the greatest level of usage in the research area. The nuts are usually eaten as a snack and used to make a native drink [93].
Munyebvu (2015)	****	****	*	****	Namibia (South Africa)	The focus of this research was to describe the ecology and indigenous utilization of baobab trees in the Omusati Region of Namibia's Outapi and Onesi sites. Among the two study sites, density, spatial patterns, morphology, seasonal variations, stem characteristics, and baobab usage were compared [94].
Magagula et al (2021)	*	****	****	**	South Africa (Safaris)	Nature Reserves and Conservation Areas offer guided walks and trails [55].
Kamatou et al (2011)	****	****	*	****	Sub-Saharan Africa	Discussed Adansonia digitata, an economically valuable African tree, gets an upgrade [52].
Birhane et al (2020)	**	*	****	****	Ethiopia (Eastern Africa)	Baobab tree vulnerability to population perturbations and global warming. The author emphasises the concerns and objectives of Biodiversity [95-98].
Schweiger, & Svenning (2020)	*	**	***	****	Sub-Saharan Africa	Comparable losses of animals and plants, socioecological repercussions, and an inclusive paradigm for mega biota regeneration centred on increasing carbon retention by preserving, expanding, and interconnecting old ecosystems to allow a diverse range of species to develop and propagate [99].
Sanchez et al (2010)	****	****	*	***	Sub-Saharan Africa	Discussed using natural range modelling, determining the broadly utilized for baobab tree farming [98].
Islam-Faridi et al (2020)	****	****	*	****	Sub-Saharan Africa	African Baobab has a unique chromosomal number and cytomolecular identification [53].
Anjarwalla et al (2017)	****	****	*	****	Kenya (East Africa)	Various grafting techniques for baobab photosynthetic activity are being tested to aid adaptation and improve production [54].
Stadlmayr et al (2020)	****	****	*	****	Kenya (East Africa)	The dietary makeup of baobab fruit pulp was collected from various geographic regions [17].

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Sanchez, et al. (2011)	****	****	**	***	Western and South-Eastern Africa	A systematic review of baobab fruit pulp morphological diversity across several geographical regions with specific domestication options [50].
Schumann et al. (2010)	****	****	*	****	West Africa	The effect of land use and leaves extract extraction on the baobab plant's population dynamics and harvest output [45].
Schumann et al (2012)	****	****	*	****	Eastern Burkina Faso (West Africa)	The baobab's uses, cultivation, and demographic status across the eastern part of the country[100].
Buchmann et al (2010)	**	**	****	****	West Africa	The value of baobab in subsistence farming indicates a conservative approach to baobab fruit distribution to overseas countries [61].
Gebauer et al (2016)	****	****	*	****	Sudan and Kenya (East Africa)	A review of the baobab tree, Africa's wooden elephant metaphorically [7, 8, 9].
Asogwa et al (2021).	****	****	*	****	Sub-Saharan Africa	Its contribution to dietary modification, hygiene, and environmental conditions in sub-Saharan Africa [81].
Jama et al (2008)	****	**	***	****	East and Central Africa	This research established a model for the long-term conservation of indigenous fruit trees in both East and Central Africa's arid landscapes [101].
Meinhold et al (2022)	****	****	*	****	Sub-Saharan Africa	The baobab's role in integrating rural non-timber agricultural and forestry merchants into the global market [102].
Darr et al. (2020)	***	****	***	****	Southern Africa (Malawi nine districts)	In Malawi, processed baobab food products range from low-cost staples to high-end fresh produce. In Sub-Saharan Africa, the baobab tree is a major source of non-timber forest products [103].
Patrut et al (2019)	****	****	****	****	Southern Africa (Botswana)	Longevity, Development, and Decay of a Country Symbol: Radiometric dating was used to examine many timber specimens collected from the branches during its fall [104].
Chamberlain et al (2020)	**	***	****	****	Review article (Worldview)	Trying to recapture the Role of Forests and Woodlands in Food Security Systems Transition Rainforest plants, fungus, and animals have long given nutritional, health, economic, and cultural benefits. Timber production was a major component of "forest and land management" around the world [105].

The annotation * represents the report/data on the Geographical Distribution/Availability, Usage/Benefits and Conservation: 4*(Most Adequate), 3*(Adequate), 2*(Fairly Adequate), 1*(Inadequate), 0 (Not Available).

This study considered 120 pieces of literature and closely considered twenty-four (24) selected articles due to their connection to sub-Saharan Africa which is within the scope of the study.

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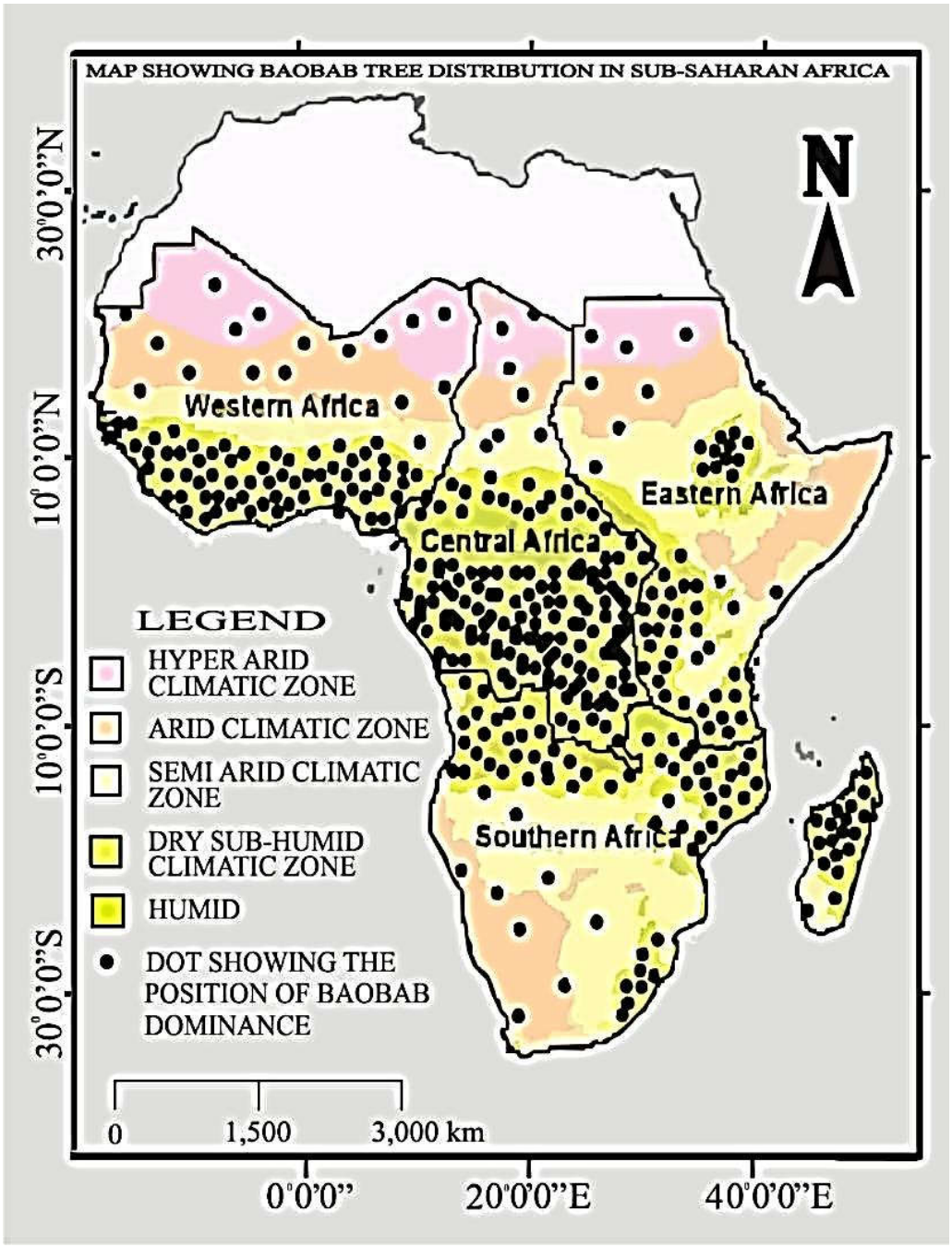

Figure 5. Map showing the geographical distribution and dominant geolocation of Baobab in Sub-Saharan Africa.

Table 1 assessed the matrix parameters of geographical distribution (availability), regional usage and benefits and conservation strategies. The total assessment revealed that the reports were given by the twenty-four (24) selected authors are generally adequate (4*) taking the average of the three study parameters.

However, the conservation of baobab appears limited in most of the studies as there was not much said about the conservation strategies except by; Prehsler [90], Buchmann et al [61], Birhane et al [95-98], Magagula et al [55], Patrut et al [104], Chamberlain et al [105] and a some selected authors that gave few data on the indigenous conservation of baobab. Mature, unblemished baobab fruits used in this study were obtained from populations established in SSA. Although genetic heterogeneity between baobab populations from various climatic zones/provenances was discovered, tree fruit density, fruit size, leaf canopy, and tree height were sampled at random to identify the type of trees in each

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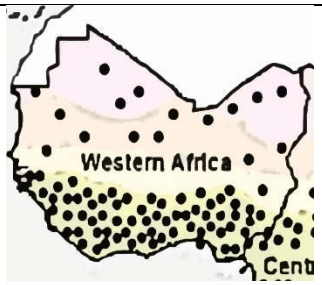
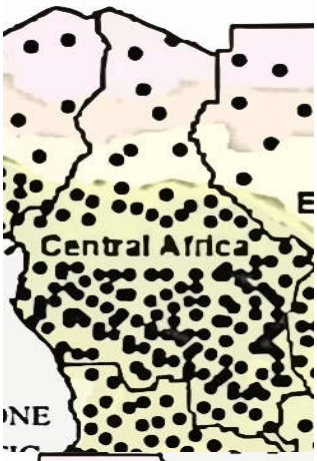
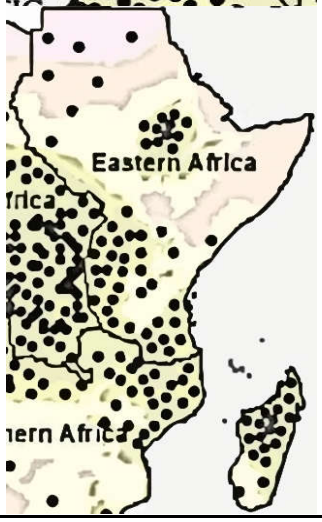
region. A composite bulk sample from each tree consisted of several fruits from the same tree. A baobab population was defined in this study as a group of baobab trees that were spread randomly and spontaneously in an agroforestry system. A global positioning satellite was used to record the location of sampling trees from the baobab populations.

3.1. Data Collection and Analysis

This study captured the collected data from various selected literature and merged the details with a comparative description of the identified sub-regions in sub-Saharan Africa as shown in the tables and chart below.

Table 2. Table showing the geographical distribution/dominance and the total land area of the four sub-regions.

Sub-regions	Sub-regional Maps	Total Land Area (Km2)	Baobab Species Dominance (Approx %)	Remarks
Western Africa		6,140,000 km²	28	Benin, Burkina Faso, Cape Verde, Ghana, Guinea, Guinea-Bissau, Ivory Coast, Liberia, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, and Togo,
Central Africa		6,667,433km2	32	Cameroon, Central African Republic, Chad, the Democratic Republic of the Congo, Republic of the Congo, Equatorial Guinea, Gabon, So Tomé and Principe, Rwanda, and Burundi are among the countries represented.
Eastern Africa		6,182,917km2	22	Burundi, Comoros, Djibouti, Ethiopia, Eritrea, Kenya, Rwanda, Seychelles, Somalia, South Sudan, Sudan, Tanzania, and Uganda are among the 13 nations.

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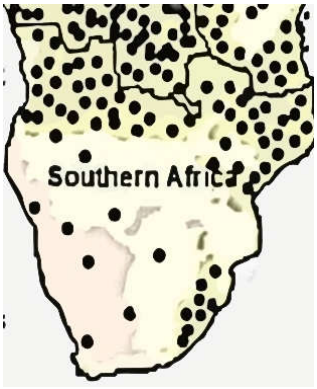
Southern Africa		6,642,950km²	18	Angola, Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Zambia, and Zimbabwe make up the African continent's southernmost area.

Table 2 elucidates the various sub-regional maps, their landmass and the percentage of Baobab Species dominance showing the geographical distribution of Baobab dominance in Sub-Saharan Africa.

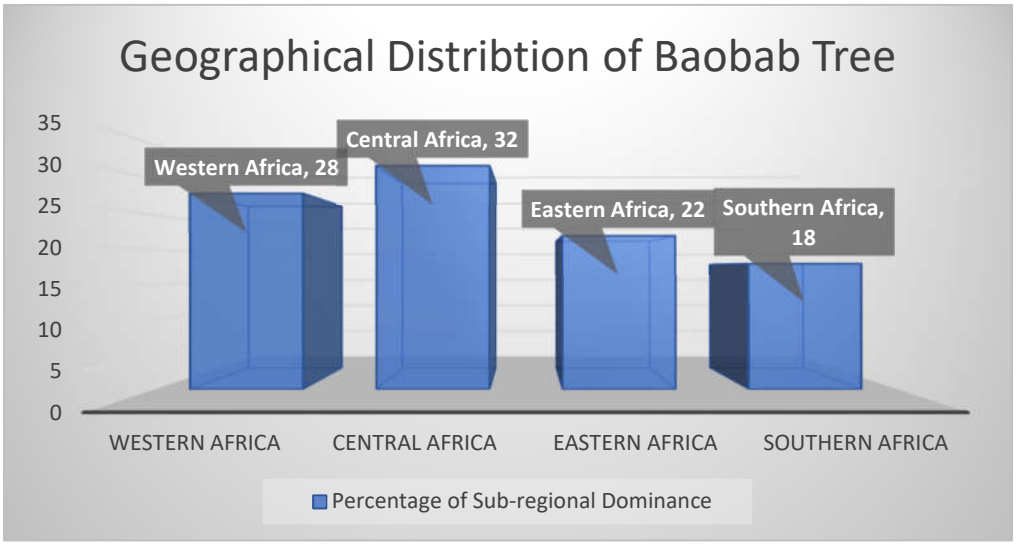


Figure 6. Showing the geographical distribution of Baobab dominance in Sub-Saharan Africa in line with the works of literature under review.

The Central Africa sub-region has the highest ranking in terms of the availability of baobab followed by Western Africa and Southern Africa seems to have the least. However, this availability ranking does not determine the level of its usability and conservation as this varies according to the present microclimatic conditions and government policies on conservation in each of the countries.

Table 3. Table showing the percentage distribution of indigenous use of Baobab.

SSA Sub-regions	Availability (%)	Traditional Use (%)	Medicinal Use (%)	Export Trade (%)
Western Africa	28	25	20	28
Central Africa	32	28	35	32
Eastern Africa	22	25	30	22
Southern Africa	18	22	20	18

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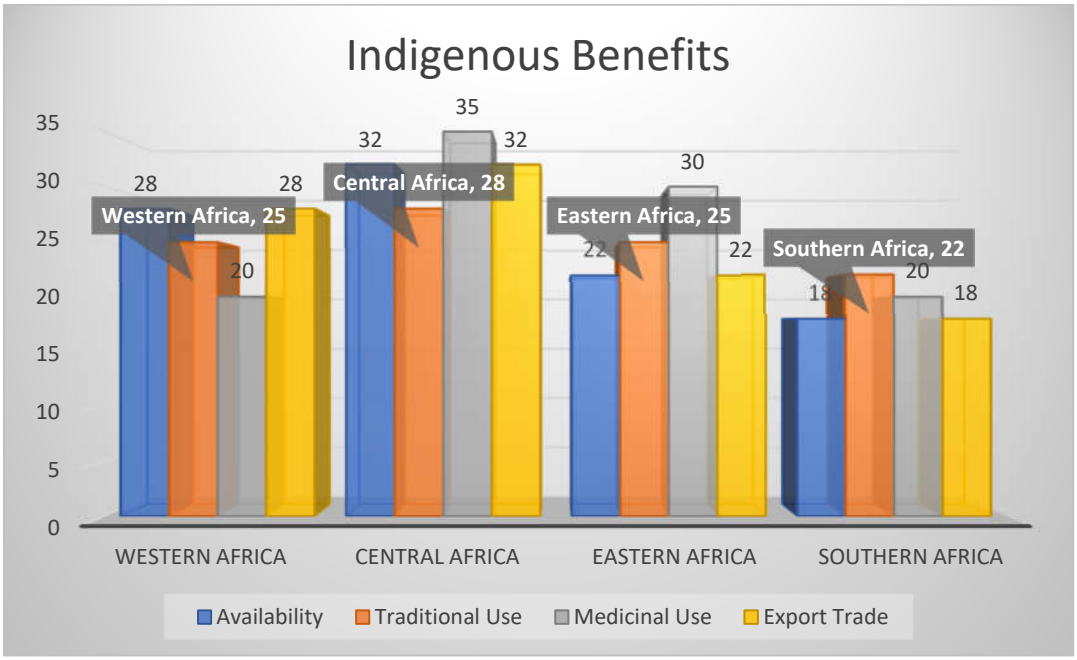

Figure 7. Showing the indigenous benefits of baobab in Sub-Saharan Africa.

Table 4. Showing the in-situ and ex-situ approaches to conserving Baobab in Sub-Sahara Africa.

SSA Sub-regions	Types of conservation	Major location in the region
Western Africa	Both In-situ and Ex-situ	Protected areas, national parks, wildlife and sanctuaries.
Central Africa	Both In-situ and Ex-situ	Protected areas, national parks, wildlife and sanctuaries.
Eastern Africa	Both In-situ and Ex-situ	Protected areas, national parks, wildlife and sanctuaries.
Southern Africa	Both In-situ and Ex-situ	Protected areas, national parks, wildlife, reserved areas(safaris) and sanctuaries.

Table 5. Showing the in-situ and ex-situ approaches to conserving Baobab in sub-Sahara Africa.

SSA Sub-regions	In-situ Rating (/10)	Ex-situ Rating (/10)	Remarks
Western Africa	4.3	2.4	Limited conservation approach. Weak institutions and conservation enforcement agencies in Nigeria, The Gambia and Ghana.
Central Africa	4	4.4	Adequate. Fast developing tourism in the regions.
Eastern Africa	3.5	1.8	Most Adequate. Increased tourism in Kenya, Uganda and Tanzania.
Southern Africa	4.5	2.8	Adequate. Fast-growing tourism in the region.

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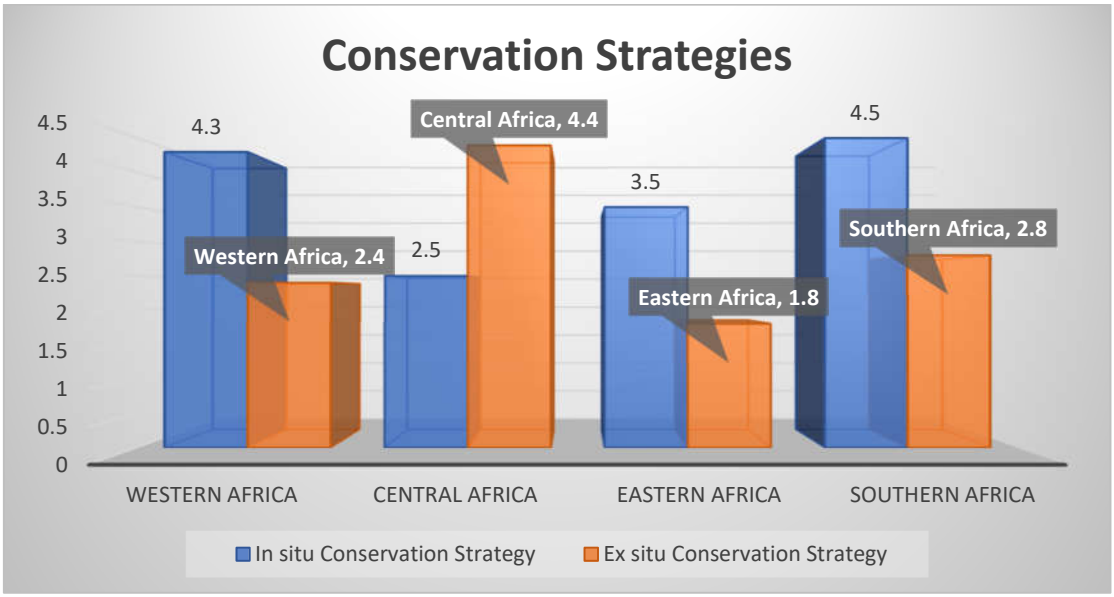

Figure 8. Shows the predominant conservation strategies of baobab in Sub-Saharan Africa as there were not many significant differences in conservation strategies in the four sub-regions.

Table 6. Table showing the Percentage Rating of the Use and Export of African Baobab parts.

Baobab Parts	Western Africa	Central Africa	Eastern Africa	Southern Africa	Key Use and Exports Remarks
Leaf	40	20	25	15	It is the most often utilized section of the baobab for making the sauce (soup) and is peppery and primarily enjoyed in the communities.
Bark	25	25	25	25	To make the traditional snacks and indigenous medicinal potions
Root	20	30	25	25	Used to make ropes (cotton ropes) and sell jute bags for potatoes storage.
Fruit	15	25	30	30	Put to indigenous drinks as an ingredient, and maybe eaten straight first from the plant as a delicacy.

West Africa has the ranking on the use and processing of baobab leaf as a non-timber forest product (NTFP). The bark seems to be generally appreciated through SSA due to its overwhelming medicinal use. However, the root has its prominence in the Central African sub-region where it is widely processed for export. Both Eastern and Southern Africa could be seen having similar characteristics in their use of baobab fruits and seeds. Here the production of local drinks and domestic ingredients is common amongst the people.

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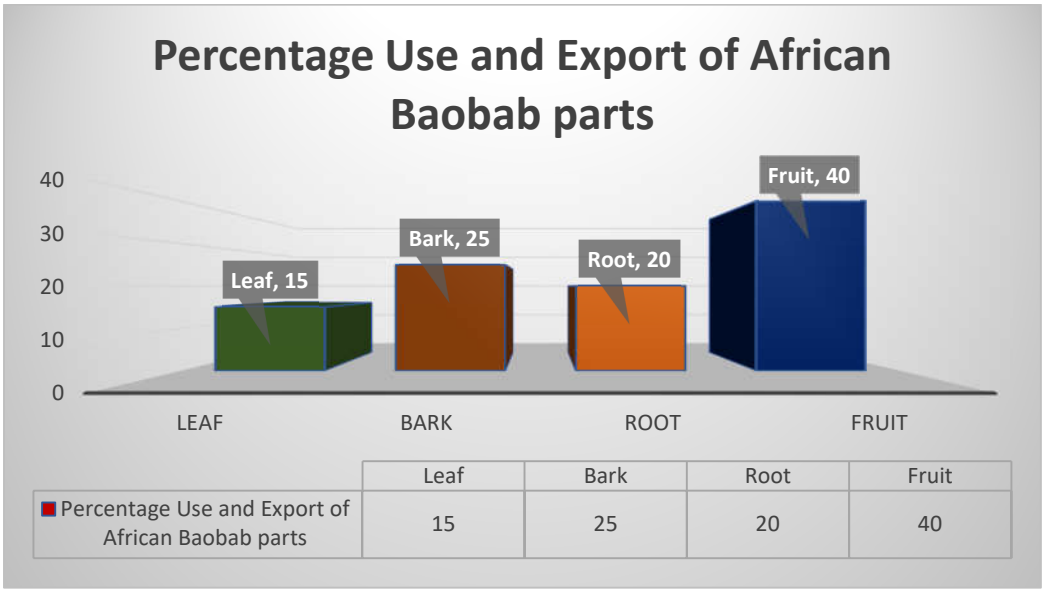

Figure 9. Shows the percentage of usage and the foreign export of the products.

The figure (Figure 9) above identifies the fruit products as the most promising part of the baobab tree followed by the tree bark and the root. However, the leaf appears to be the last of all due to known storage reasons peculiar Africa lacking storage facilities, especially in the local communities where the trees are mostly found.

4. Discussion

This study reveals that fruits are the most obvious benefit of baobab in these four SSA sub-regions, with different components being used in diverse ways (Figure 9). Fruits are collected by hand or with a long rod with a hook, as they are often well attached to the branches. They're either smashed on a stone or chopped up with a machete. The farinaceous pulp in the capsules is cream-coloured and high in vitamin C, calcium, magnesium, and potassium. The fruit may readily be preserved for months under dry circumstances because of its naturally low water content sugary moisture pulp is frozen in little plastic packets and consumed as an ice confection in some parts of Africa, where the freezer is accessible. It has been stated that nine of Africa's oldest and largest baobab trees have died in the last ten years [105]. These plants, which range in age from 1,500 to 2,000 years, seemed to have succumbed to changing climate. Rising temperatures, according to researchers, either have destroyed the trees outright or rendered plants poorer and more vulnerable to droughts, infections, wildfire, and weather.

Figure 8 reveals the conservation approaches by each of the region which is generally weak and not sustained and the impact of global warming has affected the trees of all ages across the SSA, not only baobabs. The African baobab is a unique plant, it is unique not just in terms of size and lifetime, but also in the manner it generates numerous connected stems. Bark, which is peculiar to the baobab, develops in the spaces between these stems. Fruit provides six times more vitamin C than oranges, making it a valuable nutritious supplement across the world [106, 107].

4.1. Geographical Distribution

Baobab grows in Sub-Saharan Africa's arid regions. Baobab trees may be found in belts throughout Sub-Sahara Africa. They may be found growing in a variety of locations around the region but are mostly located between the Limpopo and the Zoutpansberg ranges of South Africa in the Southern African subregion [108]. The edible portions of the baobab (leaves, seeds, and fruit pulp) are mostly consumed by rural populations, who also sell them in local markets, while the non-food components (wood, fodder, and fibres) are primarily utilized for revenue creation in Sub-Saharan Africa. Furthermore, the

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species plays several functions in traditional medicine, as well as cultural and religious beliefs that regard the tree as revered [109]. The baobab (Adansonia digitata L.) is found across the SSA and has a variety of applications, including medicinal, food, and drinks. Linnaeus gave the name Adansonia digitata to honour Michel Adanson, a French botanist who visited Senegal in the eighteenth century and characterized Baobab [102]. A separate variety (A. gibbosa) is only found in New Zealand and Australia (Oceania), and some parts of South East Asia, while the remaining group are unique to SSA.

4.2. Indigenous Benefits

Aside from eating, the baobab may be utilized for a variety of uses. Inner bark fibre is robust and is commonly used to make rope, basket nets, snares, and fishing lines, as well as weaving. Vitamin C, calcium, potassium, and dietary fibre are all abundant in the naturally dry fruit pulp. The pulp is commonly employed as a fermenting ingredient in local brews, cereals, and cuisine preparations, as well as in the manufacture of fruit juice, snacks, and sweets [92-95]. Young tender leaves are often consumed fresh in SSA as a replacement for commercial veggies, sauces, and even as a dry powder. Baobab seeds are roasted and consumed, and when powdered or fermented, they are employed as thickening agents or flavour enhancers. The roasted baobab seeds, also known as Maari in Burkina Faso, are high in fatty acids and vital amino acids and are a staple of the native diet. Because its edible sections provide vitamins, minerals, proteins, and energy that is not usually found in the cereal-dominated diets of Africa's drylands, baobabs serve a vital role in providing balanced nutrition. Ropes, baskets, textiles, musical instrument strings, and waterproof headgear are all made from bark fibre. Pollen from African and Australian baobabs is combined with water to manufacture glue, while the delectable and nutritious fruits and seeds of several species are eagerly for. Nonetheless, the usage of baobab leaves for sauce and fruit pulp for drinks and snacks is still quite important [81, 110].

Encountered a similar case in the use of baobab roots to make strings tied around premature babies to speed up growth, while the people of Gulimanceba, Burkina Faso also use the bark as a strengthening agent for babies. Age has little impact on the applications of African baobab in the research region, according to a test of significant differences in their usage. This shows that knowledge about baobab usage is widely disseminated among people of all ages. The considerable difference in the usage of African baobab by gender distribution of respondents, on the other hand, revealed the contrary. The baobab tree's fruit is high in vitamin C, making it a valuable dietary supplement. Researchers have discovered that these trees, which may live up to 2,500 years, are dying in droves. Studies illustrate what is at risk for local populations if these massive plants become extinct [81-87, 111].

4.2.1. Medicinal Applications of Baobab Seed

Conventional medicine is a type of treatment that has been Indigenous peoples use the bark, roots, leaves, fruits, and seeds of the baobab tree for human and animal medicine. In traditional medicine, the leaves and fruit pulp are used to treat fevers as an antipyretic or febrifuge. Anti-stress qualities can be obtained from the leaf extract. They're used to cure weariness, insect bites, guinea worm, internal discomfort, and diarrhoea, among other things. In situations of dysentery and to stimulate sweating, the fruit pulp and powdered seeds are utilized. Hiccoughs are also treated with seeds. Seed oil is used to treat sore gums and soothe damaged teeth. The use of the bark as a replacement for quinine in situations of fever or as a preventive is perhaps the most widespread in traditional medicine. Due to the presence of mucilaginous compounds, the decoction of the bark decomposes quickly. Headaches and diarrhoea are treated by SSA, a traditional drink created by soaking fruit pulp in water. Herbalists in these regions also use magic spells and A. digitata salve to cure terminal diseases in Africa. Southern African region, baobab bark is used in a mixture to cure swelling limbs. Some parts of Asia also use the bark, leaves, fruit pulp, and seed to alleviate oedema. The iron status of youngsters with

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low iron levels in their blood is improved by baobab fruits. An aqueous bark extract of A. digitata is traditionally used in Nigeria for treating sickle-cell anaemia.

4.2.2. Mucilage (Baobab Leaves)

Many foods in West Africa are mucilaginous, which gives indigenous soups and stews their intended slimy quality. Nigeria and Ghana which are two countries in Western Africa conducted a thorough investigation of the mucilage generated by baobab leaves the high protein and mineral content of both crude and purified leaf mucilage was the most intriguing aspect [83]. The neutral sugars rhamnose and galactose are found in trace amounts in the mucilage. Uranic acid is made up of glucuronic acids in a combination because of its large concentration of uranic acids, mucilage is classified as an acidic polysaccharide. The amount of carbohydrates, proteins, and minerals in the mucilage determines its viscosity, which is reduced by heating at extreme heat. Baobab soluble fibre, on the other hand, has a lot of promise as a thickening agent. Mucilage derived from okra fruit and baobab foliage were shown to be excellent stiffening agents in research.

4.2.3. Fruit Pulp

It is one of the most significant food-producing sections of the tree. By kneading ripped fruit pulps in cold water, the fibres and seeds are removed, and the resultant emulsion is sieved. Thinner gruels are made by adding this to heavy grain mixtures. The dry pulp is eaten fresh or added to gruels after they have cooled, which is also a wonderful means of storing it. The pulp is often crushed to form a delightful beverage with a wine-gum flavour. It's used to speed up the fermentation of sugar cane for beer production. The Fulani and Hausa of northern Nigeria utilize the fruit pulp emulsion to make a drink by mixing it along with yoghurt. The pulp may be kept for a long time and used in soft drink manufacture, but it must be kept in sealed containers. The usage of sodium material used in construction improves storage. If crushed to a powder, it may also be frozen. Baobab powder combinations are widely accessible in the open market, although their quality varies, and others are counterfeit. The fruit pulp is normally sundried, but it is sometimes cultured, and it is used in cooking and baking as a replacement for cream of tartar. The fruit pulp is used as a condiment and appetizer in the native cuisine. The fruit pod may also be burned to produce a vegetable salt that can be used to make soap.

4.2.4. Energy value and Mineral Contents

The typical moisture content of ripe fruit is 9%, with 3% protein, 0.3% fat, 75% carbohydrate, 9% fibres, and 6% ash. Fructose, sucrose, and glucose levels in the pulp produce sweetness. The presence of organic acids such as citric, tartaric, malic, succinic, and ascorbic acid makes the fruit pulp acidic. The energy content of pulp is comparable to baobab leaves. The baobab fruit pulp's amino acid makeup, mineral content, and chemical composition, respectively. Some scientists have undertaken studies on fruit pulp. The chemical and nutritional components of the Adansonia digitata L. fruit pulp, as well as the solubility of seed protein, have been studied. According to his findings, the Adansonia digitata L. kernel is high in energy, protein, and minerals, and might be used as a dietary protein source in tropical and subtropical areas. Due to its high calcium concentration, fruit pulp can be used as a calcium supplement. Furthermore, the baobab seed protein's excellent protein solubility at acidic and alkaline pH implies that it might be a useful dietary additive. A study on the chemical composition of baobab fruit was conducted by, the researchers concluded that baobab fruit pulp has a low degree of esterification and low intrinsic viscosity and therefore, probably does not give it a good media to form jelly with high solid content due to rapid precipitation and therefore form an irregular gel. In addition, it is of lower quality compared to others. Many researchers have also studied the variability of Baobab fruits, their physical characteristics, and their nutrient content in the West African Sahel.

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4.3. Conservation Strategies

Natural renewable assets, such as non-timber forest products, confront several problems that jeopardize their long-term availability and capacity to contribute to humanity's inclusive growth. Some of these issues are directly tied to how these resources are managed and the tactics that are used to govern the others. Many NTFPs utilized to address a huge variety of demands are gathered in an unsustainable way to this level. Meanwhile, the forest and woodlands' ability to meet the demand for NTFPs is dwindling due to the extinction of NTFP-producing tree species based on overharvesting, poor utilization patterns, and poor management techniques used by the locals. The African baobab is a tree species that produce non-timber forest products and may be found in the humid savanna and Sudan-Sahelian environments of the west, east, and southern Africa. In many places of Africa, there is a scarcity of knowledge about baobab's present state, management tactics, and benefits to rural economic growth.

Several challenges, notably human pressure, fire, uncontrolled livestock grazing, and wild animals, have consistently challenged the tree's contributions to rural residents' lifestyles in the Nigerian humid grassland biodiversity hotspot. Given the aforementioned, studies were done in some Northern Nigerian cities based on the uses, management measures, and demographic status of African baobab in a savanna village. The research goals were to describe the baobab's usage and management, as well as to estimate its demographic condition in the research area of the West Africa sub-region. This would be intended to result in information that will help to improve the soil's ecological and commercial possibilities. Many dietary studies on the baobab have already been undertaken, however, the reported data varies greatly depending on the source of the fruits and the analytical methods utilized. The impact of soil features on the bioactive compounds present in baobab sections has been recorded throughout three agro-climatic zones of SSA. The nutritional content of baobab fruit pulp has been observed to be influenced by topsoil features and tree origin in Mali. Even though baobabs are widely accessible throughout East and Southern Africa, research on their nutritional content is limited. Furthermore, no research has been done on the effect of tree origin on the nutritional content of baobab seeds and fruit pulp from these places. Having a provision of thorough dietary data can help many cultures increase their use of this fruit. To assess if the location of origin impacts the nutritional content of baobab fruit pulp and seeds in East, South, and West African nations, and to investigate the proximate composition and mineral content of baobab fruit pulp and seeds in East, South, and West African countries. The findings of this study will aid in the implementation of policies aimed at reducing hunger, improving nutrition, increasing the value of baobab products, and improving the economic well-being of rural people in Sub-Saharan Africa. Furthermore, the availability of heterogeneity in nutritional characteristics between nations would allow for the selection of better mother trees for domestication, breeding, and conservation from current agroecosystems.

4.4. African Superstitious Belief about Baobab

Certain communities in SSA think the Baobabs were erect and haughty when the earth was young. The gods were enraged and uprooted the Baobabs, forcing their roots upward to the ground. The reptile fulfilled their requests when they pleaded for rain, healthy harvests, and good hunting. The serpent was shot by the first white poacher, as well as the result was devastating. Another of the biggest Baobabs in Zambia's Kafue Nature Reserve is regarded as the plant which swallows young women. The four lovely ladies who resided in its shadow were infatuated with this massive tree. Once they fully matured, they began looking for spouses, making the branch envious. The forest extended its branches and brought the young woman within one evening throughout a furious rainstorm. A resting stop had already been constructed among the massive tree leaves. These cries of the trapped ladies, not the noises of the wild beasts, make everyone within shudder during tumultuous days. A small child is said to grow up to be a huge and powerful man if he is bathed with water used to soak baobab bark. Some indigenous beliefs have

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been scientifically validated. This makes up for any nutritional deficiencies in their diet. Doctors have proven that this does increase fertility. The deity is mentioned in an African bushman tradition. He didn't like the Baobab tree in his garden, so he flung it across the fence of Eden onto Mankind beneath, where it grew even though it was inverted. It's not surprising that a tree with such an unusual appearance would be associated with superstitions. Several folks think that picking a flower from a Baobab tree would then result in a wild animal invasion, but that freshwater immersed in Baobab seedlings will protect the guest from reptile attacks. After the delivery of a new baby boy, they are washed in baobab bark soaked in water by certain local tribes in Southern Africa. This will help the baby boys to grow up to be great, strong, powerful and confident, much like the indigenous baobab tree.

5. Conclusions

The baobab tree is an important multifunctional plant that serves as a model fruit tree for domestication. Modern science on baobab from East Africa is sparse when contrasted to Africa, although it would be a valuable addition to the final look of the "tree of life". Integrating demographic backgrounds' indigenous practices with current scientific investigations might improve the species' exploitation, propagation, and preservation in SSA. This study revealed the extent to which the diversity has been discovered and reported in tree growth patterns, leaf size and form, and fruit size and shape. How much of this diversity is due to environmental factors? Which important traits may be utilized to differentiate between the various types of baobabs species. The development of a characteristic list for baobabs is the first step toward providing globally recognized standards and a commonly recognised vocabulary for characterizing the based on inter variability of baobabs, and the list must be tested throughout Africa's baobab populations.

Due to the obvious low degree of local use, the socio-economic value of baobab trees in the research region has not been fully exploited. While the baobab tree harvesting regimes and methods appear to be suitable for supporting existing numbers, there has been a lackadaisical attitude toward management and conservation. Furthermore, while there are large populations of baobab trees in the neighbourhood, the plant's ability to regenerate was a serious worry. Mounting and trimming the branches of baobab trees, as well as debarking and root excavation may have a detrimental influence on the plant in the long run. It is suggested that producers be given free seeds and seedlings to stimulate simulated regrowth. To maximize the plant's viability, people should be informed about the additional applications of baobab that have been discovered in other regions. People should also be educated on simple silvicultural activities that may be performed in the plant's management. Africa's renowned baobab tree is a valuable medicinal and functional resource. It possesses antioxidant, antifungal, and anti-inflammatory effects, according to the research, and has been used widely in traditional medical and culinary applications since antiquity. Nevertheless, from the literature, the main finding is that baobab fruit pulp is abundant in vitamin C and has a more potent antioxidant activity than some other commonly consumed fruits with significant antioxidant activity. Regulatory organizations have permitted the use of baobab fruit in some healthy snacks. Seed oils have been utilized for the treatment of skin treatment since ancient times, and there is an increasing tendency in the cosmeceutical sectors to replace synthetic oils with natural oils due to the hazardous effects of synthetic oils. Baobab seed oil is employed in the pharmaceutical and cosmetic sectors because of its high fatty acid content, which has been shown to have skin-beneficial benefits. Based on the findings, the baobab tree encouraging results in terms of the dietary advantages of the fruit pulp in terms of nutritional composition, as well as the mineral and vitamin A substance of the foliage. The pulp, which is a rich nutritional source of fibre, potassium, calcium, magnesium, iron, and zinc, is naturally dry and entirely organic food. These nutrients are present in significantly higher concentrations in the pulp than in regularly eaten fruits including guava, mango, berries, and bananas. Consumption of the fruit pulp may help to alleviate micronutrient deficiencies,

particularly iron and zinc deficits, which are common in Africa. Baobab fruits may significantly enhance community meals and public health. Since the fruits are inexpensive, they should be marketed throughout Africa.

Overall, the nutritional content of baobab fruit pulp and seeds from diverse provenances varies significantly throughout the nations studied. The variety should be leveraged during the selection of populations to concentrate on during soil seed bank for use in conservation, breeding initiatives, and domestication of this "tree of life," resulting in wider use of baobabs outside of SSA. In addition, research should work on recovering this variety and exposing it to new climes. Although some research labs and breeding lines have greater baobab seeds, analytical and scientific experimental studies could be conducted to see if the seeds can sustain, proliferate, and flourish in difficult conditions. Considering juveniles will be reared in the very same habitat, this study discussed the influence of tree genetics on nutrient heterogeneity. While baobab trees coexist with other native plant species in agroecosystems, the consequences of organism's interactions that may alter nutrient availability will need to be considered. Furthermore, research is needed to determine the impact of soil properties on calcium variations over diverse weather ranges. The future directions on this research theme are the main barriers and limitations to its geographical distribution, usage and indigenous benefits (localisation and indigenisation) and conservation in the SSA were a strong psychological behavioural and cultural perception of the plant, an inadequate knowledge of its advantages, and a lack of understanding of its processing and medicinal benefits. There is a need for further studies to raise knowledge of the plant's economic and ecological advantages as well as give information on baobab processing methods. The SSA's four sub-regional countries with numerous agribusiness organizations, in partnership with the agricultural research centres, can go a long way towards guaranteeing that the tree's potential is maximized not just in Africa (locally) but globally.

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References

1. He, Wenshu, Can Baysal, Maria Lobato Gómez, Xin Huang, Derry Alvarez, Changfu Zhu, Victoria Armario-Najera et al. "Contributions of the international plant science community to the fight against infectious diseases in humans—part 2: Affordable drugs in edible plants for endemic and re-emerging diseases." *Plant biotechnology journal* 19, no. 10 (2021): 1921-1936. https://doi.org/10.1111/pbi.13658.
2. Zhu, Haocheng, Chao Li, and Caixia Gao. "Applications of CRISPR–Cas in agriculture and plant biotechnology." *Nature Reviews Molecular Cell Biology* 21, no. 11 (2020): 661-677. https://doi.org/10.1038/s41580-020-00288-9.
3. Heywood, Vernon, Alejandro Casas, Brian Ford-Lloyd, Shelagh Kell, and Nigel Maxted. "Conservation and sustainable use of crop wild relatives." *Agriculture, ecosystems & environment* 121, no. 3 (2007): 245-255. https://doi.org/10.1016/j.agee.2006.12.014.
4. DeGeorges, Paul Andre, and Brian Kevin Reilly. "The realities of community-based natural resource management and biodiversity conservation in Sub-Saharan Africa." *Sustainability* 1, no. 3 (2009): 734-788. https://doi.org/10.3390/su1030734.
5. Murphree, M.W. The strategic pillars of communal natural resource management: benefit, empowerment and conservation. *Biodivers Conserv* **18,** 2551–2562 (2009). https://doi.org/10.1007/s10531-009-9644-0.
6. Bekele, Melaku, Habtemariam Kassa, and Christine Padoch. "Diminishing Status of Land Rights of Communities in Dry Lowland Areas and Their Implications: The Case of Ethiopia." In *Dryland Forests*, pp. 25-52. Springer, Cham, 2016. DOI: 10.1007/978-3-319-19405-9_2.
7. Gebauer, Jens, Yahia O. Adam, Aida Cuní Sanchez, Dietrich Darr, Muneer ES Eltahir, Kamal EM Fadl, Gabriele Fernsebner et al. "Africa's wooden elephant: the baobab tree (Adansonia digitata L.) in Sudan and Kenya: a review." *Genetic Resources and Crop Evolution* 63, no. 3 (2016): 377-399. https://doi.org/10.1007/s10722-015-0360-1.

8. Gebauer, J., and E. Luedeling. "A note on baobab (Adansonia digitata L.) in Kordofan, Sudan." *Genetic Resources and Crop Evolution* 60, no. 4 (2013): 1587-1596. https://doi.org/10.1007/s10722-013-9964-5.
9. Omondi, Monica, Fredah Karambu Rimberia, Cornelius Mbathi Wainaina, John Bosco Njoroge Mukundi, Justine Orina, Jens Gebauer, and Katja Kehlenbeck. "Fruit morphological diversity and productivity of baobab (Adansonia digitata L.) in coastal and lower eastern Kenya." *Forests, Trees and Livelihoods* 28, no. 4 (2019): 266-280. https://doi.org/10.1080/14728028.2019.1659861.
10. Sánchez-Bayo, Francisco, and Kris AG Wyckhuys. "Worldwide decline of the entomofauna: A review of its drivers." *Biological conservation* 232 (2019): 8-27. https://doi.org/10.1016/j.biocon.2019.01.020.
11. Nadkarni, Nalini. "Between earth and sky." In *Between Earth and Sky*. University of California Press, 2008. https://doi.org/10.1525/9780520933125.
12. Crowther, Thomas W., Henry B. Glick, Kristofer R. Covey, Charlie Bettigole, Daniel S. Maynard, Stephen M. Thomas, Jeffrey R. Smith et al. "Mapping tree density at a global scale." *Nature* 525, no. 7568 (2015): 201-205. https://doi.org/10.1038/nature14967.
13. Anyokwu, Christopher. "Osundare's poetry and the Yoruba worldview." (2011). Retrieved from https://ir.unilag.edu.ng/bitstream/handle/123456789/2257/CLCWeb?sequence=1.
14. Buchmann, C., Prehsler, S., Hartl, A., & Vogl, C. R. (2010). The importance of baobab (Adansonia digitata L.) in rural West African subsistence—suggestion of a cautionary approach to international market export of baobab fruits. Ecology of Food and Nutrition, 49(3), 145-172. DOI: 10.1080/03670241003766014
15. Chadare, F. J., J. D. Hounhouigan, A. R. Linnemann, M. J. R. Nout, and M. A. J. S. Van Boekel. "Indigenous knowledge and processing of Adansonia digitata L. food products in Benin." *Ecology of food and nutrition* 47, no. 4 (2008): 338-362. https://doi.org/10.1080/03670240802003850
16. De Caluwé, Emmy, S. De Smedt, A. E. Assogbadjo, R. Samson, B. Sinsin, and Patrick Van Damme. "Ethnic differences in use value and use patterns of baobab (Adansonia digitata L.) in northern Benin." *African Journal of Ecology* 47, no. 3 (2009): 433-440. https://doi.org/10.1080/03670240802003850.
17. Stadlmayr, B., Wanangwe, J., Waruhiu, C. G., Jamnadass, R., & Kehlenbeck, K. (2020). Nutritional composition of baobab (Adansonia digitata L.) fruit pulp sampled at different geographical locations in Kenya. Journal of Food Composition and Analysis, 94, 103617. https://doi.org/10.1016/j.jfca.2020.103617
18. Muthai, Kinuthia U., Mbuthia S. Karori, Alice Muchugi, Abwao S. Indieka, Catherine Dembele, Simon Mng'omba, and Ramni Jamnadass. "Nutritional variation in baobab (Adansonia digitata L.) fruit pulp and seeds based on Africa geographical regions." *Food science & nutrition* 5, no. 6 (2017): 1116-1129. https://doi.org/10.1002/fsn3.502.
19. Aluko, A. E., John Kinyuru, Lucy Mlipano Chove, Peter Kahenya, and Willis Owino. "Nutritional quality and functional properties of baobab (Adansonia digitata) pulp from Tanzania." *Journal of Food Research* 5, no. 5 (2016): 23-31. http://dx.doi.org/10.5539/jfr.v5n5p23.
20. Chabite, I. T., I. F. Maluleque, V. J. Cossa, I. J. Presse, I. Mazuze, R. A. Abdula, and F. Joaquim. "Morphological characterization, nutritional and biochemical properties of baobab (Adansonia digitata L.) fruit pulp from two districts of Mozambique." *EC Nutrition* 14, no. 2 (2019): 158-164. Retrieved from https://www.academia.edu/download/58548165/ECNU-14-00550.pdf.
21. Gurashi, Nasreldin A., Maha AY KordofaniP, Khalid A. Abdelgadir, and Alsamani AM. "Variation in chemical composition of Baobab (Adansonia digitata L)." (2016). Retrieved from https://www.researchgate.net/profile/Maha-Kordofani-3/publication/346087695.
22. De Smedt, S., A. Cuní Sanchez, N. Van den Bilcke, D. Simbo, G. Potters, and R. Samson. "Functional responses of baobab (Adansonia digitata L.) seedlings to drought conditions: differences between western and south-eastern Africa." *Environmental and Experimental Botany* 75 (2012): 181-187. https://doi.org/10.1016/j.envexpbot.2011.09.011.
23. Rahul, Jitin, Manish Kumar Jain, Shishu Pal Singh, Rakesh Kant Kamal, Aliya Naz, Anup Kumar Gupta, and Sujeet Kumar Mrityunjay. "Adansonia digitata L.(baobab): a review of traditional information and taxonomic description." *Asian Pacific Journal of Tropical Biomedicine* 5, no. 1 (2015): 79-84. https://doi.org/10.1016/S2221-1691(15)30174-X.
24. Zacarías-García, Jaime, Florencia Rey, José-Vicente Gil, María J. Rodrigo, and Lorenzo Zacarías. "Antioxidant capacity in fruit of Citrus cultivars with marked differences in pulp coloration: Contribution of carotenoids and vitamin C." *Food Science and Technology International* 27, no. 3 (2021): 210-222. https://doi.org/10.1177/1082013220944018.
25. Ligowe, Ivy Sichinga, E. H. Bailey, S. D. Young, E. L. Ander, V. Kabambe, A. D. Chilimba, R. M. Lark, and P. C. Nalivata. "Agronomic iodine biofortification of leafy vegetables grown in Vertisols, Oxisols and Alfisols." *Environmental geochemistry and health* 43, no. 1 (2021): 361-374. DOI: https://doi.org/10.1007/s10653-020-00714-z.
26. Malabadi, Ravindra B., P. Kolkar, T. Meti, and K. Chalannavar. "The Iconic Baobab (Adansonia digitata L.): Herbal medicine for controlling Coronavirus (SARS-CoV-2) disease (Covid-19)." *International Journal of Innovation Scientific Research and Review* 3, no. 8 (2021): 1635-1647. Retrieved from https://www.researchgate.net/profile/Ravindra-Malabadi/publication/354325355.
27. Goel, Parul, Monika Bhuria, and Mamta Kaushal. "Efficacy of medicinal plants in combating COVID-19." *Journal of Pharmacognosy and Phytochemistry* 10, no. 5 (2021): 147-157. Retrieved from https://www.phytojournal.com/archives/2021/vol10issue5/PartB/10-4-93-389.pdf.
28. Joyce, Peter. *This is Botswana*. Penguin Random House South Africa, 2016. Retrieved from https://books.google.com.ng/books?hl=en&lr=&id=vg9bDwAAQBAJ&o.
29. Bolen, Jean Shinoda. *Like a tree: How trees, women, and tree people can save the planet*. Mango Media Inc., 2011. https://books.google.com.ng/books?hl=en&lr=&id=uJQREAAAQBAJ&oi.

30. Islam-Faridi, Nurul, Hamidou F. Sakhanokho, and C. Dana Nelson. "New chromosome number and cyto-molecular characterization of the African Baobab (Adansonia digitata L.)-"The Tree of Life"." *Scientific reports* 10, no. 1 (2020): 1-15. DOI: https://doi.org/10.1038/s41598-020-68697-6.
31. Gebauer, Jens, Cory W. Whitney, and John RS Tabuti. "First record of baobab (Adansonia digitata L.) in Uganda." *Genetic Resources and Crop Evolution* 63, no. 5 (2016): 755-762. DOIhttps://doi.org/10.1007/s10722-016-0387-y
32. Cron, Glynis V., Nisa Karimi, Kelsey L. Glennon, Chukwudi A. Udeh, Ed TF Witkowski, Sarah M. Venter, Achille E. Assogbadjo, and David A. Baum. "One African baobab species or two? Synonymy of Adansonia kilima and A. digitata." *Taxon* 65, no. 5 (2016): 1037-1049. https://doi.org/10.12705/655.6.
33. Pooley, Simon. "A historical perspective on fire research in East and Southern African grasslands and savannas." *African Journal of Range & Forage Science* 39, no. 1 (2022): 1-15. https://doi.org/10.2989/10220119.2022.2028187.
34. Rashford, John. "A Historically Contextualized Account of the Baobab Trees (Adansonia digitata L.) of Tobago." *Economic Botany* (2022): 1-31. DOI: https://doi.org/10.1007/s12231-022-09547-6.
35. Russell, Roly, Anne D. Guerry, Patricia Balvanera, Rachelle K. Gould, Xavier Basurto, Kai MA Chan, Sarah Klain, Jordan Levine, and Jordan Tam. "Humans and nature: how knowing and experiencing nature affect well-being." *Annual review of environment and resources* 38 (2013): 473-502. https://doi.org/10.1146/annurev-environ-012312-110838
36. Keniger, Lucy E., Kevin J. Gaston, Katherine N. Irvine, and Richard A. Fuller. "What are the benefits of interacting with nature?." *International journal of environmental research and public health* 10, no. 3 (2013): 913-935. https://doi.org/10.3390/ijerph10030913
37. Bratman, Gregory N., Christopher B. Anderson, Marc G. Berman, Bobby Cochran, Sjerp De Vries, Jon Flanders, Carl Folke et al. "Nature and mental health: An ecosystem service perspective." *Science advances* 5, no. 7 (2019): eaax0903. DOI: 10.1126/sciadv.aax0903.
38. Zylstra, Matthew J., Andrew T. Knight, Karen J. Esler, and Lesley LL Le Grange. "Connectedness as a core conservation concern: An interdisciplinary review of theory and a call for practice." *Springer Science Reviews* 2, no. 1 (2014): 119-143. DOI: https://doi.org/10.1007/s40362-014-0021-3.
39. Marselle, Melissa R., Terry Hartig, Daniel TC Cox, Siân De Bell, Sonja Knapp, Sarah Lindley, Margarita Triguero-Mas et al. "Pathways linking biodiversity to human health: A conceptual framework." *Environment International* 150 (2021): 106420. https://doi.org/10.1016/j.envint.2021.106420.
40. Ibrahim, Alia Mutasim Ali. "Extraction of Oils from the seeds of Baobab (Ophelussitularius) and Balanites (Aegilopsgeniculata)." PhD diss., University of Khartoum, 2016. Retrieved from khartoumspace.uofk.edu.
41. Watson, Rupert. *The African Baobab*. Penguin Random House South Africa, 2014. https://books.google.com.ng/books?hl=en&lr=&id=lQ1bDwAAQBAJ&oi=fnd&pg
42. Sidibe, M., J. T. Williams, A. Hughes, N. Haq, and R. W. Smith. "Baobab." *Adansonia digitata* 100 (2002). https://www.doc-developpement-durable.org/file/Culture/Arbres-Fruitiers/FICHES_ARBRES/baobab/The%20Amazing%20Baobab%20Tree%20-%20Culture%20and%20Uses.pdf.
43. Ryan, Casey M., Rose Pritchard, Iain McNicol, Matthew Owen, Janet A. Fisher, and Caroline Lehmann. "Ecosystem services from southern African woodlands and their future under global change." *Philosophical Transactions of the Royal Society B: Biological Sciences* 371, no. 1703 (2016): 20150312. https://doi.org/10.1098/rstb.2015.0312.
44. McNicol, Iain M., Casey M. Ryan, and Edward TA Mitchard. "Carbon losses from deforestation and widespread degradation offset by extensive growth in African woodlands." *Nature communications* 9, no. 1 (2018): 1-11. DOI: https://doi.org/10.1038/s41467-018-05386-z.
45. Schumann, K., Wittig, R., Thiombiano, A., Becker, U., & Hahn, K. (2010). Impact of land-use type and bark-and leaf-harvesting on population structure and fruit production of the baobab tree (Adansonia digitata L.) in a semi-arid savanna, West Africa. Forest Ecology and Management, 260(11), 2035-2044. https://doi.org/10.1016/j.foreco.2010.09.009.
46. Djossa, Bruno Agossou, Hermann Cyr Toni, Ibrahim Dende Adekanmbi, Florida K. Tognon, and Brice Augustin Sinsin. "Do flying foxes limit flower abortion in African baobab (Adansonia digitata)? A case study in Benin, West Africa." *Fruits* 70, no. 5 (2015): 281-287. https://doi.org/10.1051/fruits/2015029 .
47. Fleury, G. S., M. T. Hoffman, and S. W. Todd. "Land reform and its impact on the arid South African environment: Riemvasmaak as a case study." *African Journal of Range & Forage Science* 38, no. 2 (2021): 157-168. https://doi.org/10.2989/10220119.2020.1783700.
48. Rosenstock, Todd S., Ian K. Dawson, Ermias Aynekulu, Susan Chomba, Ann Degrande, Kimberly Fornace, Ramni Jamnadass et al. "A planetary health perspective on agroforestry in Sub-Saharan Africa." *One Earth* 1, no. 3 (2019): 330-344. https://doi.org/10.1016/j.oneear.2019.10.017.
49. Krishnamoorthy, Macy A., Paul W. Webala, and Tigga Kingston. "Baobab fruiting is driven by scale-dependent mediation of plant size and landscape features." *Landscape Ecology* (2022): 1-17. DOI: https://doi.org/10.1007/s10980-022-01435-7.
50. Sanchez, A., S. De Smedt, N. Haq, and R. Samson. "Comparative study on baobab fruit morphological variation between western and south-eastern Africa: opportunities for domestication." *Genetic Resources and Crop Evolution* 58, no. 8 (2011): 1143-1156. DOI: https://doi.org/10.1007/s10722-010-9647-4.
51. Sanchez, A.C., Osborne, P.E. & Haq, N. Identifying the global potential for baobab tree cultivation using ecological niche modelling. Agroforest Syst 80, 191–201 (2010). https://doi.org/10.1007/s10457-010-9282-2.
52. Kamatou, G. P. P., I. Vermaak, and A. M. Viljoen. "An updated review of Adansonia digitata: A commercially important African tree." *South African Journal of Botany* 77, no. 4 (2011): 908-919. https://doi.org/10.1016/j.sajb.2011.08.010.

53. Islam-Faridi, N., Sakhanokho, H.F. & Dana Nelson, C. New chromosome number and cyto-molecular characterization of the African Baobab (Adansonia digitata L.) - "The Tree of Life". Sci Rep 10, 13174 (2020). https://doi.org/10.1038/s41598-020-68697-6.
54. Anjarwalla, Parveen, Daniel Ofori, Alfred Owino, David Matuku, Winnie Adika, Kennly Njogu, and Katja Kehlenbeck. "Testing different grafting methods for vegetative propagation of baobab (Adansonia digitata L.) in Kenya to assist its domestication and promote cultivation." *Forests, Trees and Livelihoods* 26, no. 2 (2017): 85-95. https://doi.org/10.1080/14728028.2016.1202791.
55. Magagula, Hlengiwe, and Denis Costello. *Walking Safaris of South Africa: Guided Walks and Trails in National Parks and Game Reserves*. Penguin Random House South Africa, 2021. Retrieved from https://books.google.com.ng/books?hl=en&lr=&id=tnQYEAAAQBAJ&oi=fnd&pg=PT5&dq=1. Accessed on 17 May 2022.
56. Msalilwa, Upendo. "Assessment of the status of African Baobab populations and fatty acids composition of its crude oil in semi-arid areas of Tanzania." PhD diss., NM-AIST, 2021. Retrieved from dspace.nm-aist.ac.tz. Accessed on 17 May 2022.
57. Juma, Calestous. "The gene hunters." In *The Gene Hunters*. Princeton University Press, 2014. https://doi.org/10.1515/9781400860258.
58. Yang, Yaodong, Amjad Iqbal, and Rashad Qadri. "Breeding of coconut (Cocos nucifera L.): the tree of life." In *Advances in Plant Breeding Strategies: Fruits*, pp. 673-725. Springer, Cham, 2018. DOI: 10.1007/978-3-319-91944-7_17.
59. Kamatou, G. P. P., I. Vermaak, and A. M. Viljoen. "An updated review of Adansonia digitata: A commercially important African tree." *South African Journal of Botany* 77, no. 4 (2011): 908-919. https://doi.org/10.1016/j.sajb.2011.08.010.
60. Dandjouma, A. K. A., C. Tchiegang, C. Kapseu, and R. Ndjouenkeu. "Source title Reference." *Rivista Italiana delle Sostanze Grasse* 81, no. 5 (2004): 299-303. Retrieved from http://www.fruits.soton.ac.uk/files/2012/01/Tamarind-annontated-bibliography.pdf. Accessed on 17 May 2022.
61. Buchmann, Christine, Sarah Prehsler, Anna Hartl, and Christian R. Vogl. "The importance of baobab (Adansonia digitata L.) in rural West African subsistence—suggestion of a cautionary approach to international market export of baobab fruits." *Ecology of Food and Nutrition* 49, no. 3 (2010): 145-172. DOI: 10.1080/03670241003766014.
62. Gebauer, Jens, Yahia O. Adam, Aida Cuní Sanchez, Dietrich Darr, Muneer ES Eltahir, Kamal EM Fadl, Gabriele Fernsebner et al. "Africa's wooden elephant: the baobab tree (Adansonia digitata L.) in Sudan and Kenya: a review." *Genetic Resources and Crop Evolution* 63, no. 3 (2016): 377-399. DOI: https://doi.org/10.1007/s10722-015-0360-1.
63. De Smedt, S., A. Cuní Sanchez, N. Van den Bilcke, D. Simbo, G. Potters, and R. Samson. "Functional responses of baobab (Adansonia digitata L.) seedlings to drought conditions: differences between western and south-eastern Africa." *Environmental and Experimental Botany* 75 (2012): 181-187. https://doi.org/10.1016/j.envexpbot.2011.09.011.
64. Maundu, M. P., W. G. Ngugi, and H. S. C. Kabuye. *Traditional food plants of Kenya*. National Museums of Kenya, 1999. https://agris.fao.org/agris-search/search.do?recordID=KE20051001.
65. Giesen, Wim, Paul Giesen, and Kris Giesen. "Flora and vegetation of Lewa Wildlife Conservancy." *An introduction to the plants and vegetation types found at Lewa Wildlife Conservancy, Kenya. Available from the authors* (2007). https://www.researchgate.net/profile/Wim-Giesen/publication/335240639.
66. Petruzzello, M.. "baobab." Encyclopedia Britannica, Invalid Date. Retrieved from https://www.britannica.com/plant/baobab-tree-genus. Accessed on 17 May 2022.
67. Paris, Dans, and CONTACTS–LES INDEPENDANCES. "Christophe Honoré." *IFC Films* (2006). http://lesindependances.com/wp-content/uploads/2019/06/Christophe-Honore%CC%81-biographie.pdf. Accessed on 17 May 2022.
68. Mashapa, Clayton. "Adansonia digitata distribution, structure, abundance and elephant damage across Gonarezhou National Park, southeast Zimbabwe." (2013). Retrieved from http://hdl.handle.net/10646/1124. Accessed on 17 May 2022.
69. Ndoro, Onias. "Impact of elephants (Loxodonta africana L.) on baobab trees (Adansonia digitata L.) in Mana Pools National Park of the mid-Zambezi Valley region." PhD diss., M. Sc. Thesis. University of Zimbabwe, Harare, Zimbabwe, 2013. https://d1wqtxts1xzle7.cloudfront.net/67879913/ndoro.
70. Kupika, Olga L., Shakkie Kativu, Edson Gandiwa, and Angella Gumbie. "Impact of African elephants on baobab (Adansonia digitata L.) population structure in northern Gonarezhou National Park, Zimbabwe." (2014). http://localhost:8080/xmlui/handle/123456789/104.
71. Venter, Sarah M., and Ed TF Witkowski. "Fruits of our labour: contribution of commercial baobab (Adansonia digitata L.) fruit harvesting to the livelihoods of marginalized people in northern Venda, South Africa." *Agroforestry Systems* 87, no. 1 (2013): 159-172. DOI: https://doi.org/10.1007/s10457-012-9532-6.
72. Buerki, Sven, Martin W. Callmander, Steven Bachman, Justin Moat, Jean-Noël Labat, and Félix Forest. "Incorporating evolutionary history into conservation planning in biodiversity hotspots." *Philosophical Transactions of the Royal Society B: Biological Sciences* 370, no. 1662 (2015): 20140014. https://doi.org/10.1098/rstb.2014.0014
73. Lisao, Klushetile, Coert Johannes Geldenhuys, and Paxie W. Chirwa. "Assessment of the African baobab (Adansonia digitata L.) populations in Namibia: Implications for conservation." *Global Ecology and Conservation* 14 (2018): e00386. https://doi.org/10.1016/j.gecco.2018.e00386
74. Dhillion, Shivcharn S., and Gunnar Gustad. "Local management practices influence the viability of the baobab (Adansonia digitata Linn.) in different land-use types, Cinzana, Mali." *Agriculture, ecosystems & environment* 101, no. 1 (2004): 85-103. https://doi.org/10.1016/S0167-8809(03)00170-1.

75. Patrut, Adrian, Karl F. Von Reden, Daniel A. Lowy, Andries H. Alberts, John W. Pohlman, Rudolf Wittmann, Dana Gerlach, Li Xu, and Clark S. Mitchell. "Radiocarbon dating of a very large African baobab." *Tree Physiology* 27, no. 11 (2007): 1569-1574. https://doi.org/10.1093/treephys/27.11.1569
76. Patrut, Adrian, Stephan Woodborne, Roxana T. Patrut, Laszlo Rakosy, Daniel A. Lowy, Grant Hall, and Karl F. Von Reden. "The demise of the largest and oldest African baobabs." *Nature Plants* 4, no. 7 (2018): 423-426. DOI: https://doi.org/10.1038/s41477-018-0170-5.
77. Patrut, Adrian, F. Karl, Diana H. Mayne, Daniel A. Lowy, and Roxana T. Patrut. "AMS radiocarbon investigation of the African baobab: Searching for the oldest tree." *Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms* 294 (2013): 622-626. https://doi.org/10.1016/j.nimb.2012.04.025.
78. Aduna. Registered in England and Wales, Registration number: 7641546. Retrieve from https://aduna.com/products/baobab-moringa-bundle , 2010, Accessed April 2022.
79. National Research Council. *Lost crops of Africa: Volume II: vegetables*. Vol. 2. National Academies Press, 2006. Retrieve from https://books.google.com.ng/books?hl=en&lr=&id=jR-dAgAAQBAJ&oi=fnd&pg=PT24&dq=There+are+no+baobab+farms.
80. C. C. Ogbaga, F. A. Nuruddeen, O. O. Alonge and O. F. Nwagbara, "Phytochemical, elemental and proximate analyses of stored, sun-dried and shade-dried baobab (Adansonia digitata) leaves," 2017 13th International Conference on Electronics, Computer and Computation (ICECCO), 2017, pp. 1-5, DOI: 10.1109/ICECCO.2017.8333339.
81. Asogwa, Ifeyinwa Sabina, Ajibola Nihmot Ibrahim, and Johnpaul Ifechukwu Agbaka. "African baobab: Its role in enhancing nutrition, health, and the environment." *Trees, Forests and People* 3 (2021): 100043. https://doi.org/10.1016/j.tfp.2020.100043.
82. Salami, K. D., and A. A. Lawal. "Description of Economical Trees and Shrubs Species in Northern Part of Nigeria and Their Potentials Part of Nigeria." 2018. Retrieve from https://www.researchgate.net/profile/Kaseem-Salami/publication/343040462. Accessed April 2022.
83. Zahra'u, B., A. S. Mohammed, H. M. Ghazali, and R. Karim. "Baobab tree (Adansonia digitata L) parts: nutrition, applications in food and uses in ethnomedicine–a review." *Ann Nutr Disord & Ther* 1, no. 3 (2014): 1011. Retrieve from https://www.doc-developpement-durable.org/file/Culture/Arbres-Fruitiers. Accessed April 2022.
84. Van Putten, M. C., G. A. Kleter, L. J. W. J. Gilissen, B. Gremmen, H. J. Wichers, and L. J. Frewer. "Novel foods and allergy: Regulations and risk-benefit assessment." *Food control* 22, no. 2 (2011): 143-157. https://doi.org/10.1016/j.foodcont.2010.08.002.
85. Meinhold, Kathrin, and Dietrich Darr. "Keeping Up With Rising (Quality) Demands? The Transition of a Wild Food Resource to Mass Market, Using the Example of Baobab in Malawi." *Frontiers in Sustainable Food Systems* 6 (2022). DOI: 10.3389/fsufs.2022.840760.
86. Owen-Smith, N. G. I. H., G. I. H. Kerley, B. Page, R. Slotow, and R. J. Van Aarde. "A scientific perspective on the management of elephants in the Kruger National Park and elsewhere: elephant conservation." *South African journal of science* 102, no. 9 (2006): 389-394. Retrieve from https://hdl.handle.net/10520/EJC96609. Accessed April 2022.
87. Marques, Maria Jose, Gudrun Schwilch, Nina Lauterburg, Stephen Crittenden, Mehreteab Tesfai, Jannes Stolte, Pandi Zdruli et al. "Multifaceted impacts of sustainable land management in drylands: a review." *Sustainability* 8, no. 2 (2016): 177. https://doi.org/10.3390/su8020177.
88. Leakey, R. R. B., J. Wilson, and J. D. Deans. "Domestication of trees for agroforestry in drylands." *Annals of Arid Zone* 38, no. 3/4 (1999): 195-220. Retrieved from https://www.researchgate.net/profile/Leakey-Rrb-2/publication/264694580. Accessed on 17 May 2022
89. Mbow, Cheikh, Meine Van Noordwijk, Eike Luedeling, Henry Neufeldt, Peter A. Minang, and Godwin Kowero. "Agroforestry solutions to address food security and climate change challenges in Africa." *Current Opinion in Environmental Sustainability* 6 (2014): 61-67. https://doi.org/10.1016/j.cosust.2013.10.014.
90. Prehsler, Sarah. *The use and management of Baobab (Adansonia digitata) and Tamarind (Tamarindus indica) by three ethnic groups (Peulh, Serer, Wolof) in Senegal: an ethnobotanical study*. na, 2009. Retrieved from https://epub.boku.ac.at/obvbokhs/content/titleinfo/1031661/full.pdf. Accessed on 17 May 2022.
91. Assogbadjo, Achille E., Flora J. Chadare, Leonard Manda, and Brice Sinsin. "A 20-year journey through an orphan African baobab (Adansonia digitata L.) towards improved food and nutrition security in Africa." *Frontiers in Sustainable Food Systems* (2021): 477. DOI: 10.3389/fsufs.2021.675382.
92. Omotesho, K. F., F. E. Sola-Ojo, A. H. Adenuga, and S. O. Garba. "Awareness and usage of the baobab in rural communities in Kwara State, Nigeria." *Ethiopian Journal of Environmental Studies and Management* 6, no. 4 (2013): 412-418. DOI: 10.4314/ejesm.v6i4.10.
93. Amusa, T. O., S. A. Aderinoye-Abdulwahab, S. O. Akanbi, and O. P. Idowu. "Uses and prevalence of African baobab (Adansonia digitata L 1759) in Okoo community, Kwara State, North-Central Nigeria." *Journal of Agriculture, Food and Environment* 13, no. 1 (2017): 43-49. https://www.researchgate.net/profile/Sheu-Usman-Akanbi/publication/332344295.
94. Munyebvu, Faith, I. Mapaure, and E. G. Kwembeya. "Abundance, structure and uses of Baobab (Adansonia digitata L.) populations in Omusati Region, Namibia." *South African Journal of Botany* 119 (2018): 112-118. https://doi.org/10.1016/j.sajb.2018.08.020.
95. Birhane, Emiru, Kidane Tadesse Asgedom, Tewodros Tadesse, Hadgu Hishe, Haftu Abrha, and Florent Noulekoun. "Vulnerability of baobab (Adansonia digitata L.) to human disturbances and climate change in western Tigray, Ethiopia: Conservation concerns and priorities." *Global Ecology and Conservation* 22 (2020): e00943. https://doi.org/10.1016/j.gecco.2020.e00943.

96. Ourge Wegasie, Mekdes, Kari Klanderud, Ørjan Totland, and Katrine Eldegard. "Ontogenetic niche shifts in a locally endangered tree species (Olea europaea subsp. cuspidata) in a disturbed forest in Northern Ethiopia: Implications for conservation." *PloS one* 16, no. 9 (2021): e0256843. https://doi.org/10.1371/journal.pone.0256843.
97. Fischer, Sahrah, Lisa Jäckering, and Katja Kehlenbeck. "The baobab (Adansonia digitata L.) in southern Kenya–a study on status, distribution, use and importance in Taita–Taveta County." *Environmental management* 66, no. 3 (2020): 305-318. DOI: https://doi.org/10.1007/s00267-020-01311-7.
98. Sanchez, Aida Cuni. "Predicting suitable areas for cultivation and conservation of the baobab tree and investigating superior sources of planting material." PhD diss., University of Southampton, 2010. URI: http://eprints.soton.ac.uk/id/eprint/196555.
99. Schweiger, Andreas H., and Jens-Christian Svenning. "Analogous losses of large animals and trees, socio-ecological consequences, and an integrative framework for rewilding-based megabiota restoration." *People and Nature* 2, no. 1 (2020): 29-41. https://doi.org/10.1002/pan3.10066.
100. Schumann, Katharina, Rüdiger Wittig, Adjima Thiombiano, Ute Becker, and Karen Hahn. "Uses, management, and population status of the baobab in eastern Burkina Faso." *Agroforestry Systems* 85, no. 2 (2012): 263-278. DOI: https://doi.org/10.1007/s10457-012-9499-3.
101. Jama, B. A., A. M. Mohamed, J. Mulatya, and A. N. Njui. "Comparing the "Big Five": A framework for the sustainable management of indigenous fruit trees in the drylands of East and Central Africa." *Ecological indicators* 8, no. 2 (2008): 170-179. https://doi.org/10.1016/j.ecolind.2006.11.009.
102. Meinhold, Kathrin, William Kwadwo Dumenu, and Dietrich Darr. "Connecting rural non-timber forest product collectors to global markets: The case of baobab (Adansonia digitata L.)." *Forest Policy and Economics* 134 (2022): 102628. https://doi.org/10.1016/j.forpol.2021.102628.
103. Darr, D.; Chopi-Msadala, C.; Namakhwa, C. D.; Meinhold, K.; Munthali, C. Processed Baobab (Adansonia digitata L.) Food Products in Malawi: From Poor Men's to Premium-Priced Specialty Food? Forests 2020, 11, 698. https://doi.org/10.3390/f11060698.
104. Patrut, A.; Woodborne, S.; Patrut, R.T.; Hall, G.; Rakosy, L.; Winterbach, C.; von Reden, K.F. Age, Growth and Death of a National Icon: The Historic Chapman Baobab of Botswana. Forests 2019, 10, 983. https://doi.org/10.3390/f10110983.
105. Chamberlain, James L., Dietrich Darr, and Kathrin Meinhold. "Rediscovering the contributions of forests and trees to transition global food systems." *Forests* 11, no. 10 (2020): 1098. https://doi.org/10.3390/f11101098.
106. Patrut, Adrian, Karl F. Von Reden, Daniel A. Lowy, Andries H. Alberts, John W. Pohlman, Rudolf Wittmann, Dana Gerlach, Li Xu, and Clark S. Mitchell. "Radiocarbon dating of a very large African baobab." *Tree Physiology* 27, no. 11 (2007): 1569-1574. https://doi.org/10.1093/treephys/27.11.1569.
107. Anjarwalla, Parveen, Daniel Ofori, Alfred Owino, David Matuku, Winnie Adika, Kennly Njogu, and Katja Kehlenbeck. "Testing different grafting methods for vegetative propagation of baobab (Adansonia digitata L.) in Kenya to assist its domestication and promote cultivation." *Forests, Trees and Livelihoods* 26, no. 2 (2017): 85-95. https://doi.org/10.1080/14728028.2016.1202791.
108. Munyati, Christopher, and Tibanganyuka A. Kabanda. "Using multitemporal Landsat TM imagery to establish land use pressure-induced trends in forest and woodland cover in sections of the Soutpansberg Mountains of Venda region, Limpopo Province, South Africa." Regional Environmental Change 9, no. 1 (2009): 41-56. DOI: https://doi.org/10.1007/s10113-008-0066-4.
109. Burgoyne, Christopher, Clare Kelso, and Fethi Ahmed. "Human activity and vegetation change around mkuze game reserve, South Africa." *South African Geographical Journal= Suid-Afrikaanse Geografiese Tydskrif* 98, no. 2 (2016): 217-234. https://hdl.handle.net/10520/EJC186971.
110. Sidibe, M., J. T. Williams, A. Hughes, N. Haq, and R. W. Smith. "Baobab." *Adansonia digitata* 100 (2002). Retrieved from https://www.doc-developpement-durable.org/file/Culture/Arbres-Fruitiers. Accessed April 2022.
111. Evang, Esther Charlotte, Tsige-Yohannes Habte, Willis Omondi Owino, and Michael Bernhardt Krawinkel. "Can the supplementary consumption of baobab (Adansonia digitata L.) fruit pulp improve the haemoglobin levels and iron status of schoolchildren in Kenya? Findings of a randomized controlled intervention trial." *European Journal of Nutrition* 60, no. 5 (2021): 2617-2629. DOI: https://doi.org/10.1007/s00394-020-02447-2.