

A review on medicinal and ethnomedicinal uses, biological features, and phytochemical constituents of *Sesbania sesban* L. Merr., a nitrogen-fixing plant native to the Republic of Chad

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A review on medicinal and ethnomedicinal uses, biological features and phytochemical constituents of *Sesbania sesban* L. Merr., a nitrogen-fixing plant native to the Republic of Chad

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Abstract

This study reports on a literature review of the leguminous tree *Sesbania sesban* (L.) Merr is found in the N'Djamena region, the Republic of Chad. The study focused on *S. sesban*'s medicinal and ethnomedicinal uses, biological features, and phytochemical constituents to assist in future evaluations. A literature review was conducted using academic websites, such as Science Direct and Springer, online international plant databases, and data from national herbaria. *S. sesban* is a perennial shrub or tree that measures 3–4 meters in height. This species is becoming rare in Ndjama but can be found in the rainy season, while in winter, the species occurs mainly in ponds (called in the Chadian dialect "Bouta"), and in the shores of the Chari and Logone rivers. The local inhabitants in Chad use the species as medicine, livestock feed, fuelwood, and for improving soil fertility and repelling desert encroachment. Traditional healers use its leaves to treat breast cancer

and edema. *S. sesban* is an essential species native to the Republic of Chad that needs conservation and valorization. Viewing its importance and rarity in N'Djamena, a strategy for replanting the species in gardens, homes, and fields around Ndjamen and other regions of Chad is recommended.

Key words: Biological features, fixing-nitrogen, flora of the Republic of Chad, leguminous, medicinal and ethnomedicinal use, *Sesbania sesban*.

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Introduction

The taxonomic diversity of legumes is enormous. In addition, they provide important benefits to humans including food, medicines, and environmental services. For example, leguminous food grains include beans (*Phaseolus vulgaris* L.), peas (*Pisum sativum* L.), soya beans (*Glycine max* L.), and forage legumes such as clover (*Trifolium repens* L.), sainfoin (*Onobrychis* Mill.) and *S. sesban* L. Merr. These plants (leguminosae) also fix atmospheric nitrogen via their symbiotic association with soil bacteria, belonging to the genera *Rhizobium*, *Azorhizobium*, *Bradyrhizobium*, *Synorhizobium* [1]. They can be used for soil improvement [2]. Nitrogen is commonly the most limiting element in food production and one of the most expensive in fertilizers. This special ability of leguminous crops to work symbiotically with rhizobia to produce nitrogen is becoming increasingly important in world agriculture [3].

Some forage legumes such as *S. sesban* are used in agroforestry systems in tropical regions including Sub-Saharan Africa. They are also used for other purposes such as stakes, fuelwood, and reducing soil erosion. Land management practices featuring legumes include cereal-legume intercropping, relay cropping, biomass transfer, and fodder banks [4], [5], [6], [3].

Leguminous species (including *S. sesban*), also play a great role in reforestation development programs in arid areas, and the fight against desertification [7], [8], [2] They are suitable alone or mixed with other species [9].

In Africa, many indigenous species such *S. goetzei* Harms, *S. keniensis* J. B. Gillet, *S. rostrata* Bremek & Oberm, and *S. sesban* represent the genus *Sesbania*. These species and particularly *S. sesban*, possess several desirable characteristics that make them suitable for use as multipurpose trees in farming systems [10]. *S. sesban* is considered suitable to alternate and/or intercrop with other agricultural species. It grows fast and efficiently recycles available nutrients within the system, thus shortening the time required to restore fertility [11], [12].

In Chad, the genera *Sesbania* are represented by many species such as: *S. sesban*, *S. microphylla* Harms ex Phill & Hutch, *S. leptocarpa*, D.C., *S. pachycarpa*, D.C., *S. pubescens* D.C., *S. rostrata*

74 Brem. & Oberm., *S. sesban* (L.) var. *nubica* Chiov., *S. sesban* subsp. *punctata* D.C. & Gillett and
 75 *S. dalzielii* E. Phillips & Hutch.[13], [14]. *Sesbania* species found in Chad include *S. sesban*, *S.*
 76 *dalzielii*, *S. rostrata*, *S. leptocarpa*, *S. sericea* (Willd.) (*S. pubescens* DC), *S. hepperi* J.B. Gillett, *S.*
 77 *cannabina* (Retz.) Pers., *S. tetraptera* Hochst. ex-Baker, *S. pachycarpa* DC, and *S. microphylla*
 78 Harms [14].

79 The objective of this paper is to report medicinal and ethnomedicinal use, the biological activity and
 80 the phytochemical constituents of *S. sesban* based on a literature review. Potential uses of the
 81 species in Chad and other countries are reported in this paper. This paper contributes updated
 82 information concerning this useful but less exploited plant with the purpose to help develop and
 83 conserve it in Chad.

84 **Materials and methods**

85 The authors conducted a review of the literature on *S. sesban*, its applications, biochemistry, and
 86 interactions with other organisms and its environment. Sources for the review included various
 87 academic websites such as Science Direct and Springer, online international plant databases, and
 88 data from herbaria in Chad such the herbarium the Institut Supérieur de Sciences de l'Education
 89 de N'Djamena (ISSSED) and the herbarium of Toumaï University (N'Djamena).

90 **Results**

91 **Features of *S. sesban* and name**

92 *Sesbania* is a Persian term and in the Arabic language is *Seysaban*. The original taxon was created
 93 by Antonio Jose Cavanilles (1745-1804) and modified by George Bentham in 1859 in his book
 94 *Flora brasiliensis* [15]. However, the names *Sesbania* [16], *Seseban*, and *Sesban* already existed
 95 [15]. Related names or synonyms are *S. Sesban* var. *nubica* Chiov. [17], [5] or *S. aegyptiaca* auct.
 96 [18], [14]. The local name in Chad is “Torotoro” (in Chadian Arabic) (Ousman B. M., 2024)
 97 (unpublished). It is also called “Surridj”, “Surridj-alkoubar”, “Surridj-addougag” (Patrice 1997).
 98 Leonard in his botanical mission carried out on *S. sesban* in Lake Chad area in 1968 reported the
 99 local name of “Souri” to *S. sesban* (figure 4). Gaston & Fotuis [13] also reported others local names
 100 of *S. sesban* in different local Chadian dialects which are: “prepre” (in Baguirmi dialect), “sinu” (in
 101 gabri kemdé dialect), “gegelek” (in Massa-moulouhi dialect) and “dao dao” or “doo” (in Sara doba
 102 dialect). Table 1 shows the taxonomic classification of *S. sesban*.

103 **Table 1.** *S. sesban* taxonomic classification [15],[19], [20].

<i>S. sesban</i> Merr. (L.)	
Kingdom	Plantae
Division	Magnoliophyta or Angiosperms dicotyledonous (Flowering plants)
Tribe	Robinieae
Classe	Magnoliopsida
Order	Fabales
Family	Fabaceae
Subfamily	Papilionaceae

Gender	<i>Sesbania</i>
Species	<i>S. sesban</i> Merr. (L.)

104

105 **Distribution of *S. sesban* in Africa, Chad and other countries:** The genus *Sesbania* (Fabaceae
106 or Papilionaceae) consists of about 50 species of fast-growing trees and composed of annual
107 shrubs and perennial woody plants that are widespread in the tropics and subtropics [21], with a
108 large number of accessions collected [10], [22]. Some 33 species are found in Africa, distributed
109 between central and eastern Africa. *S. sesban* is widely distributed in semi-arid to subhumid
110 regions throughout the continent [18]. It develops in the wild in most geographical zones of Africa
111 and in many different soil types [22]. Orwa et al., (2009) [6] reported that the other African countries
112 where *S. sesban* is found in habitat are Chad, Egypt [14], Kenya, and Uganda. More recent
113 databases on species distribution such as the Plants Of the World Online [23] and Atlas World
114 Agroforestry (Climate Change Atlas) [24] showed that the native range of this species *S. sesban*
115 is Tropical & South Africa, Arabian Peninsula, Indian Subcontinent. It is a shrub or tree and grows
116 primarily in the seasonally dry tropical biome. Dufour-Dror, (2013) [25] reported that *S. sesban* is
117 an invasive species in Israel and the U.S. state of Hawaii [25] It has become naturalized in many
118 of the countries where it is cultivated, and is characterized by very rapid early growth [26] (Fig. 1).

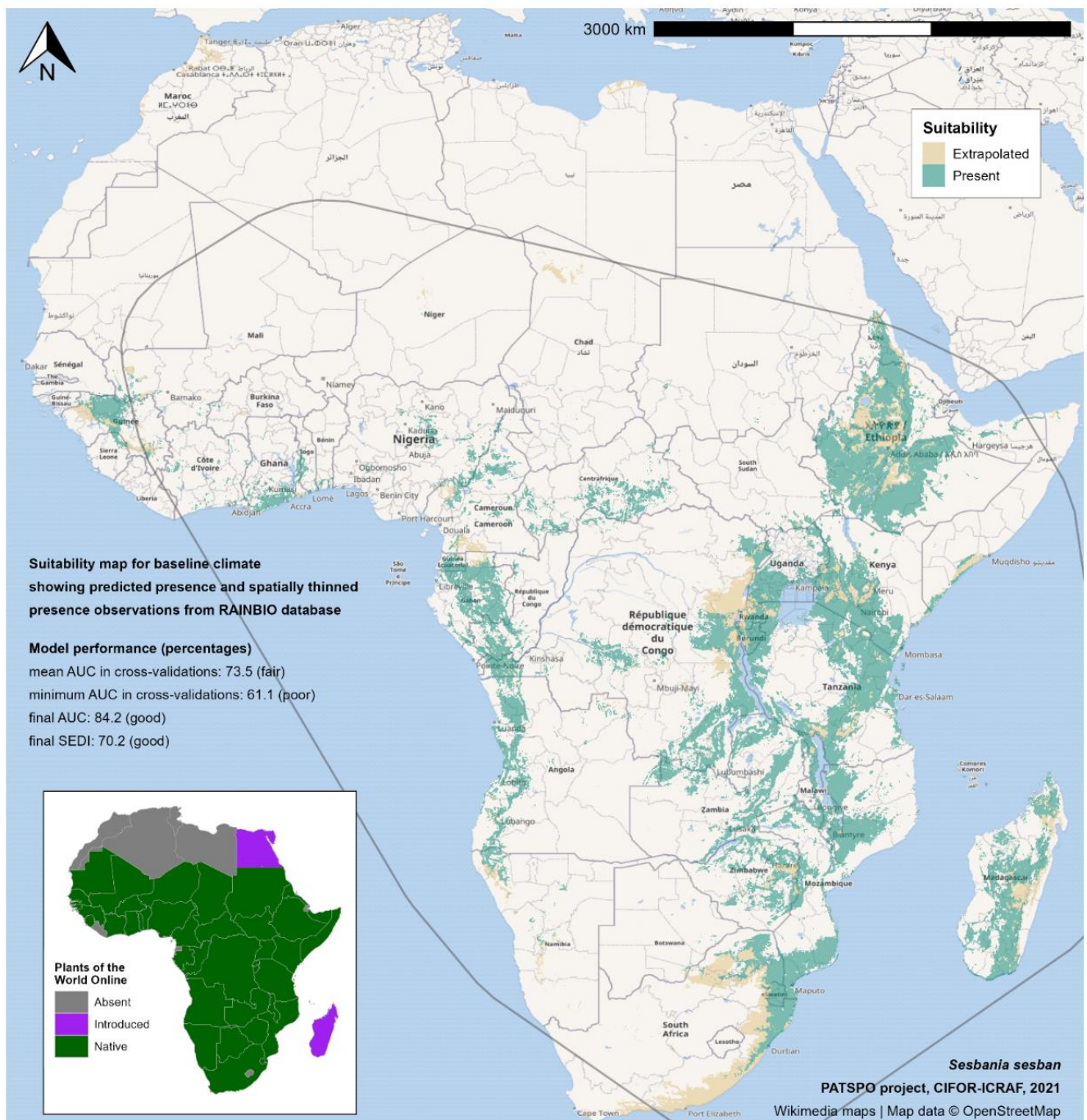


Figure 1. *S. sesban* Merr. (L.) is native in Chad and other countries [24].

In Chad, *Sesbania* species includes *S. sesban* (Fig. 2), *S. microphylla* Harms ex. Phill & Hutch, *S. leptocarpa* D.C., *S. pachycarpa* D.C., *S. pubescens* D.C., *S. rostrata* Brem. & Oberm., *S. sesban* (L.) var. *nubica* Chiov., *S. sesban* subsp. *punctata* D.C. & Gillett and *S. dalzielii* E. Phillips & Hutch [13], [14]. Chad is a centre of diversity for some of these species. However, *Sesbania* species have not been fully exploited as multipurpose plants in many central African countries [13]. As reported by César & Chatelain (2019) [14] and [20], *S. sesban* is found in different niches in Chad such as: on riverbanks, in stream beds, wetlands and around the water sources of Borkou and Ennedi (Fig. 2).

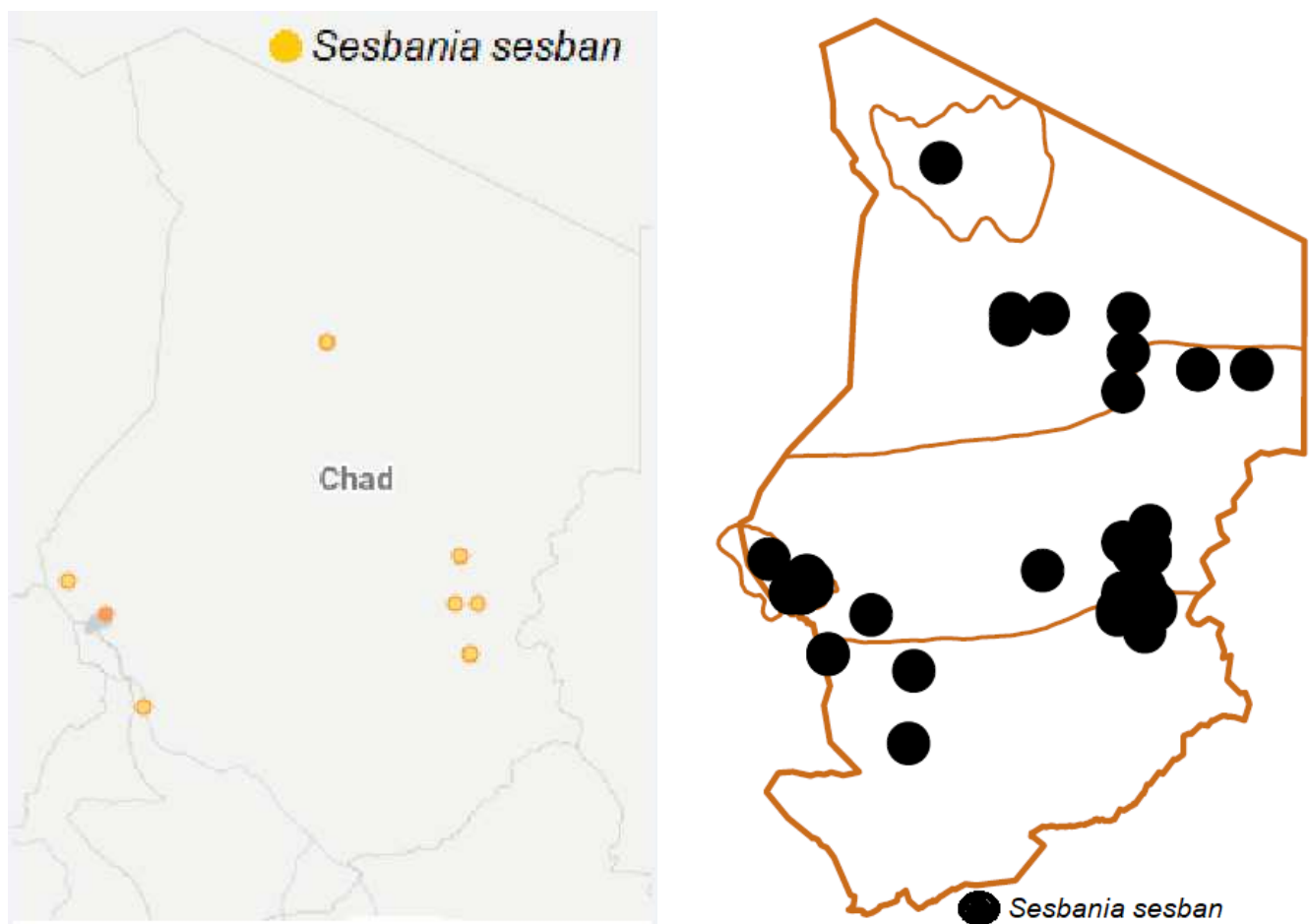


Figure 2. In orange color: zones of Chad where *S. sesban* is found [27]. In black color: zones of Chad where *S. sesban* is found according to [14].

Habitat and Ecology: Widely adapted, *S. sesban* tolerates drought, waterlogging, soil acidity, alkalinity, and salinity [28]. *S. sesban* grows well in the subtropics and in cooler, higher elevation regions of the tropics [6], [29]. It is ideally suited to seasonally flooded environments [6]. It occurs naturally in wet habitats such as lake shores, on muddy river banks and in seasonally flooded valley bottoms [5]. In Chad, *S. sesban* is becoming rare in Ndjamenia but can be found in rainy season, while in winter, the species occurs mainly in ponds (called in Chadian dialect "Bouta"), and in the shores of Chari and Logone rivers (Ousman B. M., 2024) (unpublished). It also grows in open savannah [30] and, dry semi-arid zones [22] [20]. It grows in a wide variety of soils from loose, sandy soils to heavy clays [31], [32]. *S. sesban* has moderate tolerance of frost [33]. *S. sesban* grows well on acidic and infertile soils in a semi-arid region of Rwanda [34].

Biophysical limits: The mean annual growing temperature of *S. sesban* is between 18 °C and 23 °C (maximum 45 °C) and the mean annual rainfall is from 500 to 2000 mm [6], [33]. Its altitude ranges between 100 and 2500m [6], [33].

Pests and diseases: *Sesbania* spp. is attacked by nematodes, insects, fungi, and viruses [6]. The leaf-eating beetle *Mesoplatys ochroptera* can completely defoliate *S. sesban* leading to mortality. Various caterpillars, *Hymenoptera*, and stem borers attack *S. sesban*. Some potentially destructive root-knot nematodes have been recorded in India on *S. sesban* [6]. *Sesbania* is infected by mild and severe mosaic disease virus, which is transmitted by sap and roots, showing vein clearing and

150 reduction of leaflets. The prevalence of infection of mosaic disease virus ranges from 5-20%.
151 *Sesbania* plants grown in vitro with mild mosaic virus inoculation had fewer pods and were very
152 small. The virus inoculated in vitro has a great tolerance of dilution (between 1000-10,000),
153 resistance to heat (40-60°C) and has longevity in vitro varying between 10 and 14 days [35]. Sileshi
154 et al. (2000) [36] conducted a survey in Southern Malawi and found that insects *Anoplocnemis*
155 *curvipes*, *Aphis fabae*, *Hilda patruelis*, *Megaleurothrips sjostedti*, *Mylabris dicincta*, *Nezara viridula*
156 and *Ootheca* spp. have the potential to become pests of *S. sesban*.

157 **Morphological description:** *S. sesban* is a soft, slightly woody, and short-lived shrub or small tree
158 reaching 3-4m tall, broadleaved, seed propagated (Fig. 3a) [26], [20], [23], [37]; [38]; [39]; [40] [41];
159 (Ousman B.M., 2024) (unpublished). Partey et al., (2017) [29] described *S. sesban* as a narrow-
160 crowned, deep-rooting, single or multi-stemmed shrub or small tree, 1–5 m tall (Fig. 3a). Shun-
161 ching (1960) [42] reported that in Taiwan, *S. sesban* measures approximately 4-5 meters in height,
162 after six months with a diameter of up to 12cm. César & Chatelain (2019) [14] also mentioned that
163 *S. sesban* is a tall shrub plant measuring 3–4 meters (Fig. 3a). The average diameter growth
164 measured in basal circumference is ranging from 16-28cm. Branches have opposite pairs in a
165 straight line, with points that look like hairs (Fig. 3b) [43]. There are at least 20 pairs of leaves that
166 cross one by one each 180° from the previous one, and forming a cone that gradually closes (Fig.
167 3b, 3c) [14] [43]. These leaves are odd-pinnate with one pair of leaflets at the base having large,
168 irregularly lobed terminal leaflets (Fig. 3b, 3c). The flowers are yellow and are arranged in clusters
169 forming from 2 to 20 flowers and almost 20cm long. The filament sheath is 9-13 mm and yellow-
170 purple speckled, and in rare cases, is pure yellow (Fig 3b, 3c) [14] [43]. The plant is glabrescent or
171 glabrous (Fig. 3a, 3b, 3c) [5], [14], [15]. Five to seven seedpods are grouped together in the form
172 of grapes (Fig. 3d) [14]. seedpods are subcylindrical, light green just after formation, and yellow in
173 color when maturing, straight or slightly curved, up to 30cm long and 5mm wide, containing 10-50
174 seeds (Fig. 3d) [14] [43]. A drawing seedpods and leaves are presented in figure 3e [14]. Soaking
175 the seeds in water for a few days is sometimes required to make them germinate [15].



a



b

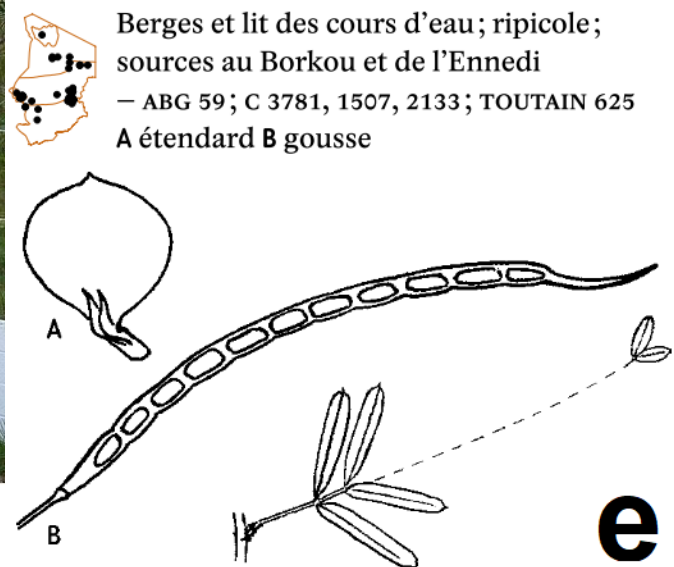


Figure 3. a: *S. sesban* tree or shrub [41]. b: *S. sesban* leaves and stem [43]. c: *S. sesban* flowers [43]. d: *S. sesban* seedpods [43]. e: Drawing of seedpods and leaves [14]

We note that the botanical missions carried out on *S. sesban* date from 1968 by the botanist Léonard [44] and from 2019 by the botanists César and Chatelain [14]. Léonard collected this species in 1968 in the region of Lake Chad [44] (Fig. 4).



Figure 4. The figure shows the botanical mission carried out on *S. sesban* in Lake Chad area by Léonard in 1968 [44].

Uses of *S. sesban*: Medicinal use, biological activity and phytochemistry

Medicinal use and biological activity: In sub-Saharan Africa, the use of plant resources for therapeutic/medicinal, agricultural, and other purposes is common, hence the need for intervention in protecting and enhancing these resources [45]. The local population in Chad is aware of the importance of the species *S. sesban* and benefits from its use for medicine, for improving land

cover and soil fertility, for feeding and shading livestock and for wood [46], [47]; (Ousman B.M, 2023) (unpublished). Abdelgawad et al., 2023 [48] conducted a holistic overview on *S. sesban* leaves and their phytoconstituents and pharmacological activities or effects [49] and presented that *S. sesban* leaves exhibited several therapeutic potentials such as antioxidant, antimicrobial, antiviral, anthelmintic, molluscicidal, antifertility, anti-inflammatory, antidiabetic, antihyperlipidemic, anticancer, antianxiety, and mosquito repellent properties. More detail is provided in the subsections text below.

Antioxidant activity: Mani et al., (2011) [37] evaluated the *in vitro* antioxidant and antimicrobial activities of *S. sesban* leaves' ethanolic extracts. The phytochemical screening reports the presence of saponins, tannins, phenolic compounds, and flavonoids. The antioxidant activity of ethanolic extracts was demonstrated by the DPPH (Diphenyl -2-Picryl hydrazyl) radical scavenging test, which shows a remarkable scavenging activity depending on the dose of 100µg/ml. The reducing capacity increased with the increasing concentration of the sample. When the 100µg/ml ethanol extract was found, the active free radical scavenging activity increased from 16.71% (20µg/ml) to 76.25% (100µg/ml). This reducing power serves as a significant indicator of antioxidant activity.

Kathires et al., (2012) [38] found further evidence of *S. sesban*'s antioxidant activity. They extracted anthocyanin compounds, total phenol, and flavonoids from *S. sesban* flower petals using methanol and acidified methanol extracts. The anthocyanins content confirmed by ferric chloride and aluminium chloride tests were used for analysing the antioxidant and antimicrobial properties. The total anthocyanin content obtained from the methanol and acidified methanol extracts were 0.38mg/100g and 0.28mg/100g respectively. The antioxidant activity of acidified methanol extracts using the hydrogen peroxide test showed high scavenging activity of 84% at lower concentration (1mg/ml) along with the standard butylated hydroxytoluene (37.65%).

Anti-microbial activity: Kathires et al., (2012) [38] found further evidence of *S. sesban*'s antimicrobial activity. The antimicrobial property of *S. sesban* flower extract was explained by the zone of inhibition occurring around the wells containing different concentrations of the extracts in the disc diffusion assay. This antimicrobial activity of the samples after 24 hours showed that the zone of inhibition was found in Gram-positive bacteria (*Staphylococcus aureus* (1mg) and *Staphylococcus saprophyticus* (12.5mg)) whereas there was no inhibition in Gram-negative bacteria (*Escherichia coli*, *Klebsiella pneumoniae*, *Klebsiella oxytoca*, *Proteus vulgaris*, *Streptococcus pyogenes*, *Pseudomonas aeruginosa*, and *Enterococcus faecalis*).

Arif Ahmed et al., (2013) [50] found further evidence of *S. sesban*'s antimicrobial features justifying the use of the bark to treat a number of ailments in Bangladesh. They investigated the phytochemical screening of ethanol, ether and chloroform extract of the plants bark and found the presence of carbohydrates, flavonoids, steroids, alkaloids, tannins and saponins. The antimicrobial activity using the disc diffusion assay after 18 hours showed that the chloroform extract (at the dose of 250µg/ml and 500µg/ml) and the ethanol extract (500µg/ml) of *S. sesban* bark inhibited all

bacteria used: 5 Gram-positive bacteria (*Staphylococcus epidermidis*, *Streptococcus pyogenes*, *Staphylococcus aureus*, *Enterococcus faecalis*, *Bacillus subtilis*), 9 Gram-negative bacteria (*Shigella boydii*, *Shigella flexneri*, *Shigella sonnei*, *Shigella dysenteriae*, *Escherichia coli*, *Proteus vulgaris*, *Erwinia amylovora*, *Klebsiella pneumonia*, *Pseudomonas aeruginosa*). In a disk diffusion assay, 250µg/ml of the ethanol extract of bark inhibited all microorganisms except *Proteus vulgaris* and *Enterococcus faecalis*. The ether extracts (both 250µg/ml and 500µg/ml) of *S. sesban* bark inhibited all microorganisms except *Proteus vulgaris*.

Anthelmintic activity: Ibrahim (1992) [51] examined the anthelmintic activity in vitro of *S. sesban* leaves (aqueous extract (0.25-50mg/ml) using the free-living rhabditid nematode, *Cuenorhabditis elegans*. A considerable amount of anthelmintic activity was demonstrated by extracts of *S. sesban* leaves (2.5 mg/ml) when the percentage mortality of *Cuenorhabditis elegans* nematodes was 30% and 96% after 2h and 6h treatments, respectively. Seed extracts introduced a percentage mortality of 5.6-25.5% at concentration levels of 0.25-50mg/ml. They concluded that *S. sesban* showed the highest anthelmintic effect upon *Cuenorhabditis elegans* survival at concentration levels 2.5 mg/mL, and the median lethal concentration LC₅₀ values of *S. sesban* leaves were the most effective compared to other plant species studied. The LC₅₀ attained 8.0 mg/mL at a minimum effective concentration 2.5 mg/ml.

In the study of Limsay et al., (2014) [52], the hydroethanolic and aqueous leaf extracts of *S. sesban* (at a concentration of 5 and 10 mg/mL and, 30 mg/mL for hydroethanolic leaf extract and ethyl acetate fraction) were evaluated for their anthelmintic activity *in vitro*, against *Moneizia expansa* and *Paramphistomes* by a petri-dish method, with fenbendazole as the control. The methanolic extract was also evaluated in rats for its anthelmintic effect *in vitro* against two intestinal parasites *Hymenolepis diminuta* (in rats), a cestode, and *Syphacia obvelata* (in mice), a nematode, with Praziquantel and Albendazole as reference drugs. Interesting results were obtained for this anthelmintic effect with the inhibition zone of 15.17 mm against *Syphacia obvelata*-mice at the concentration dose of 30 mg/mL of hydroethanolic leaf extract, and 7.56 mm against *Moneizia expansa* at the concentration dose of 5 mg/ml of aqueous leaf extract [53] [54] .

Numerous studies across the world have shown that *S. sesban* has considerable potential for combatting disease and improving health. Kamel et al., (2011) [55] reported that the administration of *S. sesban* leaves' methanol extract to infected mice exhibited a moderate antischistosomal effect (against the parasite *Schistosoma mansoni* which infected mice). The results suggest that the administration of *S. sesban* has antischistosomal properties, hence ameliorating liver function.

Anti-bacterial activity: Mythili & Ravindhran (2012) [39] observed the presence of alkaloids, flavonoids, phenols, and phytosterols, fixed oil and gum in the phytochemical analysis of methanol and ethanol extracts from *S. sesban* in India. The authors tested the biological screening effects of *S. sesban* methanol stem extract against ten bacterial species (Gram+ pathogens: *Staphylococcus aureus* (ATCC 25923), *Enterococcus faecalis* (ATCC 29212), *Escherichia coli* (ATCC 25922), *Bacillus subtilis* (ATCC 441), and Gram- pathogens: *Salmonella typhi* (MTCC 733),

270 *Erwinia amylovora* (MTCC 2760), *Proteus vulgaris* (MTCC 1771), *Pseudomonas aeruginosa*
271 (MTCC 424), *Klebsiella pneumoniae* (ATCC 15380), *Shigella dysenteriae* (MTCC 5151)). The
272 results showed highly significant activity against the bacteria *Erwinia amylovora* with 17.25 mm in
273 diameter followed by *Escherichia coli* with 16 mm in diameter at 250 µg/ml of the extract. In most
274 of the bacteria examined, a better zone of inhibition was obtained at 250µg/ml and 500 µg/ml of
275 the extract. When compared to the standard flavonoid quercetin, the plant extract showed a
276 substantial amount of inhibition in the case of *Bacillus subtilis* (15.5 mm) (500 µg/ml), *Escherichia*
277 *coli* (16 mm) (250 µg/ml), *Enterococcus faecalis* (12.75 mm) (250 µg/ml), *Erwinia amylovora*
278 (17.25mm) (250 µg/ml) and *Shigella dysenteriae* (10.25 mm) (500 µg/ml).

279 In Sudanese folk medicine, the leaves and fruit of *S. sesban* were found to treat sore throat and
280 gonorrhoea in the study of Elegami et al., (2001) [56]. They investigated that leaves and fruit of *S.*
281 *sesban* have antibacterial activity. They found that methanol extracts at the concentration dose of
282 100 mg/ml (0.1 ml/cup) were effective against pathogens bacteria used namely *Bacillus subtilis*
283 *NCTC 8236*, *Staphylococcus aureus NCTC 6447*, *Escherichia coli NCTC 8196* and *Pseudomonas*
284 *aeruginosa NCTC 6750*.

285 **Anti-fungal activity:** Mythili & Ravindhran (2012) [39] tested the biological screening effects of *S.*
286 *sesban* methanol stem extract against five infectious fungal species (*Aspergillus fumigatus*,
287 *Colletotrichum gloeosporioides*, *Curvularia lunata*, *Fusarium oxysporum* and *Verticillium glaucum*)
288 using the disc diffusion assay. The fungi *Curvularia lunata* and *Fusarium oxysporum* were inhibited
289 completely by *S. sesban* methanol stem extract at the dose of 100µg/ml and 500 µg/ml. *Aspergillus*
290 *fumigatus*, *Curvularia lunata*, and *Verticillium glaucum* a higher degree of inhibition was obtained
291 with the dose 500 µg/ml. They concluded that the stem extracts of *S. sesban* possess a broad
292 spectrum of activity against common bacterial and fungal diseases in the region of Coimbatore in
293 India.

294 Arif Ahmed et al., (2013) [50] evaluated the anti-fungal activity of *S. sesban* bark against 7 fungi,
295 *Trichophyton rubrum*, *Microsporum fulvum*, *Candida albicans*, *Curvularia lunata*, *Aspergillus*
296 *fumigatus*, *Fusarium oxysporum* and *Sacharomyces cerevacaе*) using the disc diffusion assay.
297 The result showed that the highest zone of inhibition was 14.2 mm against *Fusarium oxysporum*.
298 Minimum inhibitory concentration (MIC) of these extracts was determined by broth macro dilution
299 assay. After 12 hours, the MIC of the extracts (ethanol, ether, and chloroform) was obtained at a
300 higher concentration (8000µg/ml) than the extract content in the disc (250µg/ml and 500µg/ml).

301 **Anti-inflammatory activity:** In India, many people use *S. sesban* leaves to relieve rheumatic pain
302 and the biochemical evidence supporting this is clear [40]. Crude saponins (containing
303 triterpenoids and steroids) extracted from *S. sesban* leaves showed an anti-inflammatory effect on
304 experimental-induced rats and mice [40]. Rats pretreated with saponins significantly decreased
305 ($p<0.01$) the carrageenan-induced paw edema by 59% at a higher dose of 500 mg/kg, 3h after the
306 injection of noxious agent. Rats pretreated with saponins significantly inhibited ($p<0.01$) the
307 histamine induced rat paw edema by 38.41 and 43.02% at the dose of 250 and 500mg/kg,

308 respectively. The test of cotton pellet granuloma in rats showed that saponins (500mg/kg) inhibited
309 the formation of fibroblast by 38.17% which was comparable with that of standard diclofenac
310 sodium (44.32%). In the oxazolone induced delayed hypersensitivity test, saponins (500mg/kg)
311 showed maximum inhibition (69.68% after 22days) of ear edema comparable to the standard drug
312 which gave 73% inhibition after 22days. Saponins therefore showed significant activity in the acute
313 phase of inflammation in the *in vivo* and *in vitro* model at the oral dose of 500mg/kg body rats'
314 weight when compared to the control and standard drug.

315 Similarly, Shaikh et al., (2012) [31] evaluated the anti-inflammatory activity of *S. sesban* leaf
316 extracts of petroleum ether (60-800), chloroform and methanol. The acute toxicity study of extracts
317 of leaves of *S sesban* showed 50% mortality at a dose (2500 mg/kg). Hence 1/10th of the same
318 dose for all these extracts was taken as a therapeutic dose i.e., 250mg/kg. The methanolic extract
319 showed a significant anti-inflammatory activity reducing paw edema (the dose of 250mg/kg
320 administrated reduced 45.34% of the reduction within three hours) compared to the control group,
321 carrageenin and Ibuprofen. Petroleum ether (60-80°) extract and chloroform extract showed
322 comparatively less reduction in paw edema volume. The thin layer chromatography using solvent
323 system Toluene: Chloroform: Methanol (1:1:0.8) followed by the column chromatography for
324 separation and isolation of the constituents of the methanolic extract showed three separated
325 constituents. Constituent I (fluorescent green colour), Constituent ii (pink colour) and Constituent
326 III (fluorescent green colour). Constituent II showed significant reduction in paw edema (at the
327 dose of 250mg/kg) meaning significant anti-inflammatory activity after three hours (with a
328 percentage of 54.06) as compared to standard. The preliminary phytochemical investigation *S.*
329 *sesban* extracts showed the presence of the following active principles: sterols, saponins,
330 flavonoids in methanol extracts; fats and oil in petroleum ether (60-80°) extracts; and sterols,
331 alkaloids, flavonoids in chloroform extracts. The study did not show any approximate percentage
332 while it showed simply the presence or absence of these active principles obtained.

333 Arif Ahmed et al., (2013) [50] found further evidence of *S. sesban*'s cytotoxic features, The
334 cytotoxicity activity was investigated by the brine shrimp lethality bioassay to determine the percent
335 mortality nauplii caused by the test extracts. The LC₅₀ (lethal concentration in half) values of
336 ethanol, ether, and chloroform extracts of bark were found to be 1280, 640, and 320µg/ml,
337 respectively after 24 hours.

338 **Antidiabetic activiy:** Pandhare et al., (2011) [57] evaluated the aqueous leaf extract of *S. sesban*
339 for its antidiabetic potential on normal and streptozotocin (STZ)-induced diabetic rats. The doses
340 of 250 and 500mg/kg body weight per day for 30 days were administered to normal and
341 streptozotocin-induced diabetic rats. The aqueous leaf extract administrated (250 and
342 500mg/kg/day) to streptozotocin induced diabetic rats (compared to the antidiabetic drug
343 glibenclamide (0.25mg/kg body weight) indicated significant increase in the body weight, liver
344 glycogen, serum insulin and high-density lipoproteins cholesterol levels and decrease in blood
345 glucose, glycosylated haemoglobin, total cholesterol and serum triglycerides. Finally, the study

concluded that the aqueous leaf extract of *S. sesban* has beneficial effects in reducing elevated blood glucose levels and the lipid profile of streptozotocin-induced diabetic rats, but has no effect on normal rats.

Manjusha et al., (2012) [58] found that *S. sesban* roots extract may have a hypoglycaemic potential for treating type 2- diabetes. Their results show that the doses (250, 500, and 1000mg/kg) of *S. sesban* roots extract administered orally to normal and streptozotocin (STZ) induced type- 2 diabetic mice caused a marked decrease of fasting blood glucose in STZ induced type -2 diabetic mice. *S. sesban* roots extract decreased the cholesterol, triglyceride, urea, and creatinine levels and increased insulin, high density lipoproteins, cholesterol, and total protein levels.

Antinociceptive activity (analgesic): Nirmal et al., (2012) [59] investigated wood's antinociceptive agents that are compounds capable of diminishing pain without negative effects on consciousness or without producing anaesthesia [60]. The anti-nociceptive activity was determined by hot plate and acetic acid induced tests. Doses were selected on the basis of a toxicity study and mice were divided into 18 groups of 6 animals each. The experiment was terminated 20 seconds after their placement on the hot plate to avoid damage to the paws. Petroleum ether, chloroform, and ethyl acetate extracts (50 and 100mg/kg) showed significant results just 30 minutes after treatment while their action was blocked by the opioid antagonist, naloxone (1 mg/kg). The involvement of opioid receptors (transmembrane neurotransmitters) was revealed by giving the extracts after an opioid antagonist (naloxone) (1mg/kg). The mechanism of the analgesic effect of the extracts of *S. sesban* wood could probably be due to blockage of the effect or release of endogenous substances that excite pain nerve endings [59]. They concluded that petroleum ether, chloroform, and ethyl acetate extracts of wood showed potent antinociceptive activity while naloxone blocked the antinociceptive activity of the extracts by inducing opioid receptors.

Control of fertility: Some studies suggest that *S. sesban* may have potential as an ingredient of contraceptives. Shiv (1990) [61] studied the effect of *S. sesban* seed powder in female albino rats to evaluate its effects on genital organs and fertility. In the results, rats of the control group did not show any change in body weight and genital organ weight. The dose 100mg/kg for 30 days of administration caused no deleterious effect on ovarian tissues, whereas the 250mg/kg dose severely affected the ovarian structure, mature follicles underwent atresia, some developing follicles showed lysis of ova and the stroma was compact with poor vascularity. However, the genital organ weight was reduced significantly ($P < 0.05$) after the treatment at 250 and 400mg/kg/day doses for 30 days. The dose 250mg/kg reduced endometrial height and size of the uterine glands. The administration of 400mg/kg for 30 days caused a great reduction in endometrial height, uterine glands. The control group of rats showed normal fertility; all became pregnant and showed a good number of implants, whereas the dose 100mg/kg dose showed pregnancy and reduction of implants. The doses 250 and 400mg/kg showed 100% antifertility activity and no implants were recorded in the uterus of these rats on the 10th day of pregnancy. The experiment

383 showed that *S. sesban* seed powder inhibits ovarian function, changes the uterine structure, and
384 prevents implantation and, thus, controls the fertility of female albino rats [61].

385 In another study, Nilanjana et al., (2011) [62] isolated from *S. sesban* roots extracts an active
386 principle oleanolic acid 3-beta-D-glucuronide (OAG) which is suggested to have a potent
387 spermicidal activity. In the experiment, the dose of the minimum effective concentration (MEC) of
388 OAG was 50mcg/mL after one hour of the treatment and, induced 100% immobilization of the
389 sperm. More than 97% of the OAG-treated sperm lost their hypo-osmotic swelling responsiveness
390 in a dose-dependent manner. The transmission electron microscopy and sperm membrane lipid
391 peroxidation revealed that OAG affected the sperm membrane integrity. All observations in the
392 experiment clearly demonstrated that OAG has very strong antifertility activity and other properties
393 that qualify the agent to serve as an active ingredient of vaginal contraceptives [62].

394 **Central nervous system stimulant:** The aqueous extract of *S. sesban* bark has a potential central
395 nervous system (CNS) stimulant effect [63]. The investigation of CNS stimulant activity was carried
396 out on albino mice and caffeine was used as a reference drug. The animals receiving the treatment
397 were divided into three groups: Group I served as control and treated orally with vehicle (normal
398 saline), Group II served as standard, and caffeine 30mg/kg was given, and Group III received
399 aqueous extract of *S. sesban* bark at the dose of 400mg/kg. In the elevated plus maze experiment,
400 the animals received the treatment 45min before the start of session. At the beginning of the
401 session, a mouse was placed at the centre of the maze, its head facing the closed arm. It was
402 allowed to explore the maze for 5 minutes. The time spent in the open arms, percent entries in the
403 open and closed arms, and total entries were recorded. An entry was defined as the presence of
404 all four paws in the arm. Naik et al., (2011) [63].concluded that the crude aqueous extract at the
405 dose of 400mg/kg after 48 hours showed significant central nervous system CNS stimulant activity
406 in comparison to the control group and the results were comparable to the activity shown by the
407 reference drug. Table 2 summarizes *S. sesban*'s medicinal use, the biological activity, the plant
408 parts used and optimal solvents; the dosage regimen and its corresponding concentrations and
409 the active constituents.

410 **Molluscicidal activity:** *S. sesban* leave extracts showed molluscicidal activity. In the study of [64],
411 the effects of sublethal concentrations of methanol extract of *S. sesban* leaves on survival rate,
412 egg laying of *Bulinus truncatus* snails, hatchability of their eggs, infection rate with *Schistosoma*
413 *haematobium* miracidia, cercarial production and certain physiological parameters of treated snails
414 were studied. In the results, after 24 hours of exposure, the sublethal concentrations of the tested
415 plant extract ($LC_0=1.8$ ppm, $LC_{10}=8$ ppm, $LC_{25}=14$, $LC_{50}=18$ ppm and $LC_{90}=31$ ppm) caused
416 considerable reduction in survival rates; egg production of *Bulinus truncatus* snails; hatchability of
417 eggs as well as in the infectivity of *Schistosoma haematobium* miracidia to the snail. The longevity
418 of *Bulinus truncatus* snails exposed continuously to sublethal concentrations of methanol extract
419 of *S. sesban* decreased from $LC_0=22.5\pm6.2$ days to $LC_{10}= 11.8\pm4.2$. The death rate of *Bulinus*
420 *truncatus* snails in groups treated with LC_0 was highly significant as compared with those in groups

421 treated with LC₁₀ and LC₂₅ (p < 0.01). A reducing of the cercarial production per snail and the
422 period of cercarial shedding was also observed. Glycogen level, protein content and the activities
423 of hexokinase (HK), pyruvatekinase (PK) and lactate dehydrogenase (LDH) showed a decrease in
424 soft tissues when compared with the control group. They concluded that the application of sublethal
425 concentration of methanol extracts of *S. sesban* leaves may be helpful in snail control as it
426 interferes with the snails' biology and physiology.

427 Furthermore, in the study of [65], the molluscicidal activity against snail species *Biomphalaria*
428 *alexandrina* infected with *Schistosoma mansoni* was investigated. *Biomphalaria alexandrina*
429 species was treated with aqueous extracts of *S. sesban* leaves. The extracts significantly lowered
430 the infection rate of the snail. Exposure of snails for 4 weeks to LC₁₀ and LC₂₅ of *S. sesban* leaves
431 (dry powder) considerably suppressed their fecundity and the reproduction rate. The reduction rate
432 of reproduction for the exposed snail to LC₂₅ of *S. sesban* was 76.4%. infection rates of snails
433 treated during miracidial exposure with LC₁₀ of *S. sesban* was 52.2% compared to 92.6% for
434 control group (P < 0.01). Snails exposed to LC₂₅ of *S. sesban* leaves extracts showed a reduction
435 of the duration of cercarial shedding and cercarial production/snail with a value of 223.2
436 cercariae/snail compared to 766.3 cercariae/infected control snail (P < 0.01). It is concluded that
437 LC₂₅ of *S. sesban* leaves aqueous extracts negatively interferes with biological and physiological
438 activities of *Biomphalaria alexandrina* snails, consequently it could be effective in interrupting and
439 minimizing the transmission of *Schistosoma mansoni* [65]. Saponins are some of the secondary
440 metabolites that are synthesized by many plants [66]. Molluscicidal activity of *S. sesban* can be
441 attributed to saponins whose mode of action is believed to cause cell membrane rupture causing
442 water and ions to flow uncontrollably into and out of the cell. This causes the cell to lose integrity
443 leading to death of the snails [49].

444 **Table 2.** Medicinal use, biological activity, plant parts used, dosage regimen and its
445 corresponding concentrations and active constituents of *S. sesban*.

	Biological activity	Plant part used and optimal solvents	Dosage regimen and corresponding concentrations	Active constituents	References
Medicinal use	Antioxidant activity	Leaves, seeds (ethanolic and methanol extracts)	100µg/ml after one and half hour 1mg/ml after one and half hour	Saponins, flavonoids, anthocyanins	[37] [38]
	Anti-microbial activity	Flower petals (methanol and acidified methanol)	1mg -12.5mg/ml after 24 hours	Anthocyanins	[38]
	Antimicrobial activity	Bark (ethanol, diethyl ether, chloroform)	250µg-500µg:ml after 18 hours 250-8000 µg/ml for the MIC after 12 hours	Carbohydrates, flavonoids, steroids, alkaloids, tannins, saponins	[50]
	Anthelmintic activity	Leaves, seed (aqueous extracts)	2.5 mg/ml after 6 hours	Saponins, glycosides	[51]
		Leaf (Hydroethanolic and aqueous extracts)	5 and 10 mg/mL	Saponin, flavonoids, betulinic and ursolic acids	[52] [54] [53]
		Leaf powder	1000 mg/kg/day for 9 weeks post infection (PI)	Methanol extract	[55]
		<i>S. sesban</i> has highly significant antibacterial and antifungal activity	250µg/ml and 500 µg/ml for bacteria at 37°C after overnight. 100µg/ml and 500 µg/ml for fungi at 28±2°C after 48 hou	Carbon tetrachloride partitionate, alkaloids, flavonoids, tannins, phytosterols	[39]
	Cytotoxic activity	Bark (ethanol, diethyl ether, chloroform)	320-1280 µg/ml after 24 hours	Carbohydrates, flavonoids, steroids, alkaloids, tannins, saponins	[50]
	Anti-inflammatory activity	Leaves (methanol)	500 mg/kg after 3 hours until 22 days.	Saponins	[40]
			250mg/kg after 3 hours		[31]

Medicinal use	Antidiabetic activity	Leaves (aqueous extracts)	250 and 500mg/kg after day	Triterpenoids, tannins, saponins, glycosides, steroids	[57]
	<i>S. sesban</i> roots extract exhibited significant antihyperglycemic activities in streptozotocin STZ-induced diabetic mice	Roots (Petroleum ether extract)	200-1000mg/kg after 2hours and blood samples were withdrawn until 15 days	Phytosterols, fixed oils, fats, saponins, proteins, gums, mucilage and amino acids	[58]
	Antinociceptive activity (analgesic)	Wood (petroleum ether, chloroform, ethyl acetate)	50 and 100mg/kg after 30 minutes	Sterols, triterpenes, flavonoids	[59]
	Control the fertility of female albino rats	Seeds (distilled water)	250 and 400 mg/kg/ - for 30 days		[61]
	Potent spermicidal activity	Roots (ethylacetate, n-butanol saturated, ethanol, water)	50 mcg/ml after one hour	Oleanolic acid3-beta-d-Glucuronide	[62]
	Central nervous system stimulant	Bark (aqueous extract)	400mg/kg after 48hours	Carbohydrate, alkaloids, phytosterols	[63]
	Molluscicidal activity	Leaves (methanol and aqueous extracts)	LC ₀ =1.8ppm to LC ₉₀ =31ppm after 24 hours for aqueous extracts. LC ₀ =5.11pm to LC ₉₀ =62.4ppm after 4 weeks for aqueous extracts.	Saponins	[64], [65]
	Antioxidant, antimicrobial, antiviral, anthelmintic, molluscicidal, antifertility, anti-inflammatory, antidiabetic, antihyperlipidemic, anticancer, antianxiety, mosquito repellent properties	Leaves	-	steroids, triterpenoids, saponins, flavonoids, coumarins, lipids, and other miscellaneous compounds.	[48], [49]

Phytochemistry of *S. sesban*: *S. sesban* has different chemical compounds that are, once extracted, very useful for treating diseases such antibacterial, antioxidant agents, for manufacturing drugs, organic or chemical supplements. They are also useful for manufacturing biological manure [67], [38]. The phytochemical screening test of different leaf extracts of *S. sesban* (Methanol, Chloroform, and Petroleum ether (60-80°)) in the study of [31] revealed the presence of sterols, saponins, flavonoids. alkaloids, fats and oil, proteins, sterols, anthraquinone glycosides, gums and miscellaneous compounds. Carbohydrates, vitamins, amino acids, tannins and saponin glycosides are also detected in the screening test of the aqueous extracts in the study of [57]. Arif Ahmed et al., (2013) [50] studied the chemical screening of *S. sesban* bark and the results indicated the presence of carbohydrates, flavonoids, steroids, alkaloids, tannins and saponins in the ethanol, ether (diethyl ether) and chloroform extracts (95% each one).

Samajdar & Ghosh, (2017) [68] reported from different studies that the preliminary phytochemical screening of *S. sesban* uncovered the presence of triterpenoids, starches, vitamins, amino acids, proteins, tannins, saponins glycosides and steroids. Blossoms contain cyanidin and delphinidin glucosides. Dust and dust tubes contain alpha- ketoglutaric, oxaloacetic and pyruvic acids. Leaf and unit contain campesterol cholesterol, beta-sitosterol, triterpenoids, proteins and tannins. Bark and stem contain glucose, fructose, erythritol, arabinitol, myo-inositol. Different sorts of lignin made out of guaiacyl, syringyl and P-hydroxyphenylpropane building units and furthermore antitumor vital kampferol disaccharide [69], [68], [70]. Sterols and triterpenes are detected in petroleum ether and chloroform extracts of *S. sesban* wood, and flavonoids in ethyl acetate extract in the study of [59]. carbohydrates, alkaloids, phytosterols, saponins glycosides, and phenolic compounds are detected in petroleum ether chloroform and aqueous extracts of *S. Sesban* bark [63]. In the study of [39], the phytochemical analysis of the methanol and ethanol extracts of both stem and root of *S. sesban* revealed the presence of alkaloids, carbohydrates, proteins, phytosterol, phenol, flavonoids, fixed oil and gum. The leaf extract showed the presence of alkaloids, carbohydrates, protein, phytosterol, flavonoids and fixed oil.

Leaves of *S. sesban* are used as supplementation on growth and reproduction performance for 30 male Ethiopian highland sheep and 25 East African goats [71]. In this study, many chemical compositions in *S. sesban*' leaves for the feed ingredient were detected among them dry matter, crude protein, gas production, ash, neutral detergent fibre, acid detergent fibre, neutral detergent fibre bound nitrogen, soluble proanthocyanidins, quercetin, and saponin [72] [71]. Anthocyanins, phenols, flavonoids are identified in methanol and acidified methanol extracts of *S. sesban* flower petals [38]. The oleanolic acid 3-β-D-glucuronide has been isolated and evaluated from the root extracts of *S. sesban* [62]. In the chemical study of Abdelgawad et al., 2023 [48], many phytochemical compounds of *S. sesban* leaves was presented and have a variety of essential metabolites belonging to different chemical classes including steroids, triterpenoids, saponins, flavonoids, coumarins, lipids, and other miscellaneous compounds. Details of phytochemical

484 compounds extracted from part of the species *S. sesban* with the extraction solvent are shown in
 485 Table 3.

486 **Table 3.** *S. sesban*: phytochemical compounds, parts used for extraction, and their extraction
 487 solvent.

Phytochemicals compounds	Part used for extraction	Extraction solvent	References
Sterols, saponins, flavonoids. Alkaloids, fats and oil, proteins, sterols, anthraquinone glycosides, gums, miscellaneous compounds	Leaves	Methanol, Chloroform, Petroleum ether 60-80°	[31]
Triterpenoids, carbohydrates, vitamins, amino acids, proteins, tannins, saponin glycosides, steroids	Leaves	Aqueous extracts	[57]
Carbohydrates, flavonoids, steroids, alkaloids, tannins and saponins	Bark	Ethanol Ether (diethyl ether) Chloroform	[50]
-Cyanidin and delphinidin glucosides. -Alpha- ketoglutaric, oxaloacetic and pyruvic acids. -Campesterol cholesterol, beta- sitosterol, triterpenoids, proteins and tannins. -Glucose, fructose, erythritol, arabinitol, myo-inositol. -Guaiacyl, syringyl and p- hydroxyphenylpropane, kampferol disaccharide.	-Blossoms. -Dust (pollen) and dust tubes. -Leaf and pods -Bark and stem. -Lignin.	Aqueous extracts	[68], [69], [70]
Sterols, triterpenes. flavonoids	Wood	Petroleum ether and chloroform Ethyl acetate	[59]
Carbohydrates, alkaloids, phytosterols, saponins glycosides, phenolic compounds	Bark	Petroleum ether, chloroform and aqueous extracts	[63]
Alkaloids, carbohydrates, proteins, phytosterol, phenol, flavonoids, fixed oil and gum	Stem, roots and leaf	Methanol, ethanol	[39]
Dry matter, crude protein, gas production, ash, neutral detergent fibre, acid detergent fibre, neutral detergent fibre bound nitrogen, soluble proanthocyanidins, quercetin, saponin,	Leaves	-	[72] [71]

488

Anthocyanins, phenols, flavonoids	Flower	Methanol and acidified methanol	[38]
Oleanolic acid 3-β-D-glucuronide	Root	Ethyl acetate and n-butanol saturated extracts	[62]
Steroids, triterpenoids, saponins, flavonoids, coumarins, lipids, and other miscellaneous compounds	Leaves	-	[48]

489 **Ethnomedicinal uses of *S. sesban*:**

490 **Treating breast cancer, oedemas and wounds:** Healers in Chad use the leaves and bark of *S.*
491 *sesban* alone to treat breast cancer, oedemas and wounds. Breast cancer is treated in traditional
492 medicine by macerating the leaves for 48 hours or using an infusion of root and bark. After macerating
493 the leaves, the juice obtained is drunk in the morning and evening. To treat edema and swollen
494 glands, the leaf powder is mixed with oil and then applied to the body until cure. In Chad, traditional
495 healers often sell *S. sesban* formulations from leaves and bark to patients in the form of syrup or
496 powder to treat breast cancer, oedema and wounds as the same manner of previous use. Healers
497 sold such medicine about 360 times per year, earning an average of \$1.74 per sale. Annual revenue
498 thus amounted to about \$US 625\$/year (Ousman B. M., 2024) (unpublished).

499 **Treating livestock diseases:** *S. sesban* is also used in treating livestock diseases. Harun-or-Rashid
500 et al., (2010) [73] reported that the leaves of *S. sesban* are used in Bangladesh for the treatment of
501 cattle diseases. The leaves are administered orally to treat the retention of urine of cows, goats, and
502 buffaloes. Similarly, Rahmatullah et al., (2010) [74] conducted an ethnoveterinary survey among
503 selected villages of Bagerhat district in Bangladesh and documented that *S. sesban* leaves and stem
504 are used topically to treat pain arising out of pox of cattle. The leaves are dried in sunlight and then
505 spread over the bodies of cows, goats, or buffaloes. At the same time, the bodies of cows, goats, or
506 buffaloes are brushed with stems and leaves [74]. Sori et al., (2004) [75] reported that pastoralists of
507 Borana district in the Southern Ethiopia use *S. sesban* root and bark to treat mastitis in order to control
508 the disease of the livestock. The Infusion of root and bark are topically used for the treatment of
509 mastitis.

510 **Treating malaria:** Chinsembu (2015) [76] in Zambia and Rasoanaivo et al., (1992) [77] in
511 Madagascar reported respectively that the vapor of *S. sesban* leaves obtained from boiling is inhaled
512 two times a day for three days, and a drinking decoction of aerial parts used to cure malaria.

513 **Mosquito repellent:** Samajdar & Ghosh (2017) [68] reported that *S. sesban* leaves are used as
514 mosquito repellent in India for livestock. The preparation method is to wash the bodies of animals
515 with water leaf extracts until cure [68]. The leaf decoction is used for cattle drench to repel tsetse flies
516 in India [68].

517 **Demulcent, anthelmintic, purgative, anti-inflammatory and treating eczema:** Abdelgawad et *al.*,
518 (2023) [48] mentioned that *S. sesban* leaves have been traditionally used as an anthelmintic,
519 demulcent, purgative, and anti-inflammatory agent in the treatment of eczema, in addition to its
520 agricultural uses. Table 4 shows the ethnomedicinal use of *S. sesban*, plant part used, dosage
521 regimen and mode of preparation.

522 **Table 4.** Ethnomedicinal use of *S. sesban*, plant part used, dosage regimen and mode of
523 preparation.

	Disease treated	Plant part used	Mode of preparation	Dosage regimen	References
Ethnomedicinal use	Breast cancer:	Leaves, bark, roots	Maceration of leaves for 48 hours or infusion of root and bark.	Drink the maceration morning and evening	(Ousman B. M., 2024) (unpublished)
	Oedema and swollen glands	Leaves	Leaf powder and oil were applied to the body	Apply to the body until cure	
	The retention of urine of cattle (cows, goats, and buffaloes)	Leaves	Fresh leaves and stems administrated orally	-	[73]
	Pain arising out of pox of cattle	Leaves and stem	The leaves are dried in sunlight and then spread over the bodies		[73]
	Treating mastitis of livestock	Root and bark	The Infusion is topically used	Apply to the body until cure	[75]
	Antimalarial	Leaves and aerial parts	The vapour from boiling leaves is inhaled or a decoction of the parts is drunk	Inhaling vapour two times a day for three days	[76] [77]
	Mosquito repellant	Leaves	Wash the bodies of animals with water leaf extracts	Wash the body until cure	[68]
	Repel tsetse flies	Leaves	Leaf decoction is drenched	Until cure	
	Demulcent, anthelmintic purgative, and anti-inflammatory agent in the treatment of eczema	Leaves	-	-	[48]

524

525 ***S. sesban* use for soil improvement in agriculture and in cropping systems**

526 Land degradation and declining soil fertility are critical problems impacting livelihoods in many parts
527 of Africa [3].

Induces root nodules of *Rhizobium* strains and fixes nitrogen on the soil to improve it: In Chad, the local population uses *S. sesban* to enrich soil fertility of the cited soils for increasing yields of crops such as *Oryza sativa* L., *Zea mays* L., *Sorghum bicolor* L., *Cenchrus americanus* (Pearl millet) (Ousman B. M., 2024) (unpublished).

In México, Bashan et al., (2012) [8] have demonstrated that native leguminous trees such *S. sesban* are essential to ensure the revegetation of eroded desert lands and restoration of severely eroded soil by fixing nitrogen, resisting salt and drought and producing high biomass under desert conditions at the southern limit of the Sonoran desert in agricultural and agroforestry systems. The population plants the leguminous trees such as *S. sesban*, *Prosopis articulata*, *Parkinsonia microphylla* and *Parkinsonia florida* and inoculates with growth promoting bacteria *Azospirillum brasilense*, *Bacillus pumilus*, a native fungus arbuscular mycorrhizal (AM), and small quantities of compost. A high density of these leguminous trees with shrub and trees was obtained in these severely eroded soil areas with a remarkable degree of revegetation and more stabilized soil with a high volume of organic matter.

Samajdar & Ghosh (2017) [68] mentioned that *S. sesban* is appreciated for its nitrogen fixing quantities and as a windbreak on farms in India.

Abbas et al., (2001 [22] found in Egypt that *S. sesban* intercropped with some annual grasses (barley, pearl millet, and Rhodes-rye and Sudan-grasses) and inoculated with rhizobia improved the quality and quantity of field forage crops. They also found that intercropping improved productivity of non-legumes, in particular barley mixed with the legume *S. sesban* and the calculated N-transfer from legumes to non-legumes ranged from 20 to 70kg N/ha. They concluded that intercropping of forage grasses with legumes is economic and has a high environmental return under the semiarid conditions of Egypt and that *S. sesban* performs better when intercropped with Sudan grass.

Sobere (1991) [78], Bala et al., (2002) [79], and Sharma et al., (2005) [80] reported in the same way that *Rhizobium* strains induce root nodules and fix nitrogen from the air in symbiosis with *S. sesban*.

Curasson (1956) [7] and Rochester et al. (2001) [81] reported that *S. sesban* is cultivated in rotation with cotton in Sudan and Australia and it may enhance soil fertility and improve soil conditions. *S. sesban* yields are reported to range from 28 to 35 tons/hectare after three years of growth [7].

Balaisubramanian & Sekayange (1992) [34] reported on an experiment in a semi-arid site in Rwanda with *S. sesban* grown as a hedge spaced 5 meters apart in cultivation with beans (*Phaseolus vulgaris* L.), sorghum (*Sorghum bicolor* L.), maize (*Zea mays* L.) and sweet potato (*Ipomoea batatas* L.), The produced foliar biomass was 1.78 and 0.59t/hectare respectively for 1983/84 and 1985/86. The wood produced was 0.27 and 0.28 t/hectare for 1983/84 and 1985/86, respectively. In addition, it allowed the production of nutrients for the soil of 25.6 kg of nitrogen/ha, 1.4 kg of phosphate/ha, 14 kg of potassium/ha, 16.2 kg of calcium/ha and 4.4 kg of magnesium/ha, significantly improving soil fertility. Other studies have found that *S. sesban* improves soil fertility. Bakhoun et al., (2018) [82] reported that planting nitrogen-fixing trees such as *S. sesban* is an effective in increasing soil productivity.

Nigussie & Getachew (2013) [83] and Degefu et al., (2011) [18] reported that *S. sesban* has the ability to restore eroded soil by fixing nitrogen in the soil. Mengistu et al., (2002) [84] reported on the use of

566 *S. sesban* as green manure in Ethiopia. *S. sesban* biomass decomposes rapidly due to the soft plant
567 structure and high N content, and it provides nutrients to the soil and other plants. It is used for
568 improvement of fallows, mixed cropping, relay cropping, and biomass transfer [85]. *S. sesban* helps
569 restore and enhance soil fertility by drawing up nutrients from lower soil layers and then adds nutrients
570 to the soil in litter fall [85].

571 Sontosh et al., (2017) [86] harvested the biomass of *S. sesban* accessions 20 days after sowing and
572 used it as a green manure crop in a rotation of Rice-Rice-Mustard. They demonstrated that *S. sesban*
573 can be grown and harvested over a very short period and still be useful for adding organic matter to
574 the soil. They also pointed out that the decomposability, organic matter accumulation, and N₂-fixing
575 ability of *S. sesban* biomass make it a suitable cultivar for poor, nutrient-deficit soils [87].

576 In intercropping and alley cropping, agricultural crops are grown simultaneously with a long-term tree
577 crop to provide annual income while the tree crop matures. Muimba-Kankolongo (2018b) [88]
578 reported that intercropping sweet potato with *S. sesban* improves yield of the crop. In the same way,
579 intercropping *S. sesban* with rice and annual grasses in semi-arid conditions helps manage weeds
580 and optimize the yield of dry-seeded rice [22], [89]. Singh et al., (2007) [89] concluded that application
581 of wheat residue mulch at 4t/ha and *S. sesban* intercropped for 30 days were equally effective in
582 controlling weeds associated with dry-seeded rice. Economic analysis showed that *S. sesban* was as
583 effective as mulch in realising higher economic returns for dry-seeded rice yields during 2003 and
584 2004.

585 *S. sesban* also has considerable potential in saline environments where many plants cannot grow. In
586 southern Morocco, agriculture systems are limited by the lack of water resources and salinization of
587 surface and underground freshwater sources. The National Institute of Agronomic Research (INRA)
588 has become interested in the adaptation of *S. sesban* to saline environments and its contribution to
589 improving food and fodder production in desert areas. INRA scientists have successfully introduced
590 *S. sesban* in a saline environment for these purposes in the region of Laâyoune [90]. Bala et al.,
591 (1990) [91] found also that biological nitrogen fixation can be significantly increased by inoculating
592 tree legumes such *S. sesban* with salinity-tolerant rhizobia under saline conditions.

593 **Tolerates high salinity soil (up to 20%):** Some authors reported on the species' ecological services
594 such as nodulation and its use in intercropping. Nohwar et al., (2019) [92] found that *Rhizobia* species
595 isolated from *S. sesban* root nodules growing in different areas of Mumbai, India, have a capacity to
596 adapt in high salinity (up to 20%) zones and have pH tolerance. They claim that these *Rhizobia*
597 species from *S. sesban* are therefore suitable to be used as biofertilizers in unfavourable
598 environmental conditions for legume cropping and could also help to reduce the use of chemical
599 fertilizers. They propose that they could be tested in agricultural fields to exploit their natural benefits.

600 **Increase the plant cover:** *S. sesban* can play an important role, along with other leguminous species,
601 in land restoration and protection and conservation of indigenous species in Chad [47]. In Chad, the
602 local population, particularly pastoralists plant *S. sesban* in the different type of soils in the South
603 region such as the vertisols, fluvisols, subarid soils on sand, tropical ferruginous soils and the arenosol
604 along the banks of Lake Chad [93]. Their objective is to increase the plant cover, to use its wood for

construction, and to repel desert encroachment in zones with little vegetation (Ousman B. M., 2024) (unpublished), [7], [22], [47] [90].

Improving fallows: The International Centre for Research in Agroforestry (ICRAF) has had great interested in the role of *S. sesban* in improving fallows especially in the savannah woodland region of southern Africa [94], [5], [4].

Improved fallows involve planting mainly legume tree/shrub species in rotation with cultivated crops. In Eastern Zambia, Phiri et al., (2003) [95] quantified the yield, root zone, soil water balance, and water use efficiency of maize in rotation with 2 years *S. sesban* fallow and of continuous maize with and without fertilizer. The authors found that growing *S sesban* in depleted agricultural fields or on fallow land for 2 or 3 years and then introducing a hybrid maize crop after the fallow period produced encouraging results. *S. sesban* fallow increased grain yield and dry matter production of subsequent maize per unit amount of water used. Average maize grain yields following *S. sesban* fallow and in continuous maize with and without fertilizer were 3, 6, and 1mg/ha with corresponding water use efficiencies of 4.3, 8.8 and 1.7kg/mm/ha, respectively. *S. sesban* fallow increased the soil water storage in the soil profile and drainage below the maximum crop root zone compared with conventionally tilled non-fertilized maize [95]. Many farmers in Eastern Province, Zambia, started using *S. sesban* improved fallows in the late 1990s and early 2000s, but the practice declined for a number of reasons including a reduction in extension support and the introduction of fertilizer subsidies [96].

Detail of use of *S. sesban* for soil improvement in agriculture and in cropping systems are summarized in Table 5.

Table 5. Use of *S. sesban* for soil improvement in agriculture and in cropping systems.

	Detail of use	Part used	References
For soil improvement in agriculture and in cropping systems	<i>S. sesban</i> induces in symbiosis the root nodules <i>Rhizobium</i> strains and fixes nitrogen on the soil	Whole tree Germinated seedlings	[78], [28], [79], [80]
	Cultivated in rotation with cotton to enhance nitrogen fertility and improve soil condition	Whole tree	[7], [81]
	<i>Rhizobium</i> bacteria isolated from <i>S. sesban</i> root nodules can tolerate high salinity soil (up to 20%) and high pH, which make them suitable to be used as biofertilizers in unfavourable environmental conditions for legumes cropping	Root nodules	[92]
	<i>S. sesban</i> is planted to increase plant cover in desert areas and area with little vegetation, and to enrich soil fertility for increasing yields of crops in sandy soil and in desert areas	Whole tree	[7], [22], [47], [90], (Ousman B. M., 2024) (unpublished)
	<i>S. sesban</i> improves fallow systems and enhances agricultural productivity by increasing the yields of maize and sorghum	Whole tree	[5], [3], [95], [96].
	The foliar biomass production of <i>S. sesban</i> allows the production of nutrients nitrogen, phosphorus, calcium, magnesium and	Whole tree Bark, Stems	[34], [22]

For soil improvement in agriculture and in cropping systems	potassium when the species is intercropped with <i>Phaseolus vulgaris</i> L., <i>Sorghum bicolor</i> L., <i>Zea mays</i> L., and <i>Ipomoea batatas</i> L.		
	<i>S. sesban</i> accessions are used as green manure crops in short fallow and used as sources of organic matter and nitrogen for improvement of poor, nutrient-deficit soils	Seeds accessions Whole tree	[86], [84], [87]
	Intercropping sweet potato with <i>S. sesban</i> improves yield of the crop	Whole tree	[88]
	Intercropping of <i>S. sesban</i> with rice and annual grasses in semi-arid conditions for managing weeds and optimizing the yield of dry-seeded rice	Whole tree Bark	[22], [89]
	Improved fallows and as herbaceous cover crops	Whole tree	[94], [5], [4], [85]
	Restore eroded soil by fixing N ₂	Whole tree	[83], [18]
	<i>S. sesban</i> grows in the salt-affected soils and limits the effect of salinity	Whole tree	[82], [91]

Use as feed for livestock and as food for humans

Some studies conducted at the University of Queensland in Australia reported that *S. sesban* was shown to have high nutritive value (28% crude protein) and high dry matter digestibility (86%) [28]. Roothaert and Paterson (1997) [97] found in Kenya that *S. sesban* had the highest dry matter digestibility compared to some common fodder tree species such as *Leucaena leucocephala* and *Calliandra calothyrsus*. *S. sesban* also had low acid detergent fiber levels and average crude protein content, which gave it a high nutritive value overall. *S. sesban*'s seeds contain 39% protein [98]. One hundred g of dry seeds contained 29–32g of crude protein, 5–6g of crude lipid, 16g of crude fibre, 18–19g of total starch with 7.2–7.4g of digestible starch, 4.85–5.95g of total phenols, 1.97–2.02g of tannins, 5.05–5.14g of condensed tannins, 2.35–2.37g of phytate, and 1.26–1.46g of saponins [98].

Feed for livestock: Numerous studies confirm *S. sesban*'s high feed value. Access to adequate livestock feed is the main constraint limiting livestock productivity in Africa [99]. *S. sesban* is widely used as a feed across the continent, as evidenced in the following examples. In Chad, livestock keepers cut, carry, and feed the leaves to ruminants. The pods are cut and fed to dairy sheep, goats, and oxen. The leaves and pods are considered high-protein fodder to increase milk productivity (Ousman B. M., 2024) (unpublished). *S. sesban* is sometimes also cultivated in rotation with sugar cane, or alone as a feed for sheep and goats, which consume the leaves and young stems [7].

Many studies have been conducted in East Africa to assess animal production characteristics such as growth rates, milk production levels, and fertility when cattle, sheep, and goats were fed tree fodder such as *S. sesban* [100]. although its uptake has not been as significant as that of *Calliandra calothyrsus*. However, in Uganda, *S. sesban* is widely grown. In Ethiopia, *S. sesban* is the most important planted fodder tree and is generally grown in home gardens [33]. Smallholders feed it to goats, sheep, and cows. Roothaert and Paterson (1997) [97] also reported on a study in which

653 separate groups of local goats with an average initial age and live weight of 8 months and 8.4kg
654 were allowed to graze daily on the natural ranges for two wet and two dry seasons. They were
655 supplemented at night with sun-dried leaves and small twigs of *S. sesban*. The mean intake was
656 76g day⁻¹ per head and the mean daily live weight gain was 24g day⁻¹ per head. Mekoya et al.,
657 (2009) [101] conducted a study in the central highlands of Ethiopia on the effect of the
658 supplementation of *S. sesban* on the milk yield of sheep. They concluded that supplementation of
659 *S. sesban* at 30% of the ration (0.98% of their body weight) during lactation improved the milk yield
660 of ewes and the growth rate of lambs compared to supplementation with concentrates. *S. sesban*
661 thus has the potential of increasing milk and meat production of sheep and can serve as a
662 substitute ration to commercial concentrates for resource poor farmers [101]. Studies conducted
663 by Peters (1988) [102] have shown that the leaves of *S. sesban* from Ethiopia are highly nutritious
664 as the crude protein content of the leaves is high (25% to 30% of dry matter) and they contain little
665 tannin and other polyphenols They reported that *S. sesban* is a useful source of protein for ruminant
666 diets, and may prove useful to farmers with livestock and the need for improved fodder [102].

667 **Food for humans:** *S. sesban* is not widely consumed by humans, but Bunma & Balslev (2019)
668 [98] reported that there are many uses of *S. sesban* for humans food. Details of use of *S. sesban*
669 as feed for livestock and as food for humans are summarized in Table 6.

670 **Table 6.** Use of *S. sesban* as feed for livestock and as food for humans.

	Detail of use	Part used	References
Feed for livestock and food for humans	Potential of improving traditional sheep husbandry by increasing milk and meat production.	Leaves and young twigs. Whole tree	[101], [33]
	<i>S. sesban</i> has high feed quality		
	<i>S. sesban</i> had the highest dry matter digestibility		[97]
	<i>S. sesban</i> is used as feed for livestock (cattle, goats, sheep) and thus contributes to improve food security, income and livelihoods.	Whole tree Leaves and pods	[102] [28], [100], [33]. (Ousman B. M.,2024)
	Leaves and pods of <i>S. sesban</i> are fed by ruminants and considered as a high-protein fodder increasing milk productivity.		(unpublished)
	<i>S. sesban</i> is used for humans' food and their nutrition	Seeds	[98]

671

672 **Other uses of *S. sesban***

673 **As fuelwood:** Fuelwood availability is a key problem throughout Africa and particularly in Chad
674 [103]. Robert & Abdel-Hamid [103] reported that some important forest trees (including *S. sesban*)
675 will continue to be used as fuelwood for quite some time to come in most sub-Saharan cities and
676 the sustainability of supply is questionable. Research conducted by the World Agroforestry Centre
677 (2002) [46] found that *S. sesban* is used in many African countries as a source of fuel and is
678 appreciated because it grows fast, burns well and can be coppiced.

679 In western Kenya, Swinkels et al., (2002) [104] reported that three-quarters of farmers had *S.*
680 *sesban* in their cropped fields (mainly maize), and that 20 percent planted it. Its main use was as

fuelwood but farmers also appreciated its contribution to soil fertility [46]. Adelanwa & Tijani (2016) [105] in Nigeria and Muimba-Kankolongo (2018a) [85] reported that the biomass of *S. sesban* can produce wood within just 3-6 months when grown with *Cajanus cajan* (leguminous).

Shade or shelter, and hedge: *S. sesban* is also used as a shade for humans and their animals, a windbreak, a cover crop, an ornamental plant, as fish poison, and for sticks for construction. It is also used for building huts, making charcoal, and preparing gunpowder [7] [15] [68] (Ousman B. M., 2024) (unpublished). *S. sesban* also grown as a hedge [7].

As fiber for ropes and fishing nets, and as gum: *S. sesban* is used as a fiber for ropes and fishing nets, and the seeds produce gum [46].

Enhancing phytoextraction of heavy metals from soil: Gupta et al., (2011) [106] found that *S. sesban* may enhance the phytoextraction of heavy metals like cadmium (Cd), lead (Pb), and zinc (Zn) from artificially contaminated soil by application of ethylene di-amine tetra-acetic acid (EDTA). They reported that *S. sesban* may enhance chemically by chelate induction, the phytoextraction of the cited heavy metals from the spiked soil through the application of 5mmol EDTA/kg.

Ecological service concerning N nutrition: Dan & Brix (2009) [107] evaluated the growth responses of *S. sesban* to NH_4^+ (about 70mg/l) and NO_3^- in a hydroponic culture. They found that *S. sesban* can grow without an external inorganic N supply by fixing atmospheric N_2 gas via root nodules. They also found that the addition of external concentrations NH_4^+ and NO_3^- alone or mixed at a range of 0, 0.1, 0.2, 0.5, 2, and 5mM stimulated the growth of seedlings of *S. sesban*. Resulting relative growth rates (RGRs) range from 0.19(RGRs)/day and 0.21(RGRs)/day. The authors concluded that these characteristics of *S. sesban* concerning N nutrition make it a very useful plant as N_2 -fixing fallow crop in N-deficient areas. Thus, *S. sesban* has a broad ecological amplitude concerning N nutrition, and the wide geographical distribution of this species in subtropical and tropical areas may in part be due to its adaptability to a variety of environmental conditions, including water regime and nutrient availability. *S. sesban* has great use in tropical and subtropical areas not only as a N_2 -fixing fallow crop in nutrient deficient areas, but also as a recommended species for use in constructed wetland systems for the treatment of NH_4^+ rich waters.

Treating wastewater in tropical areas: Dan et al., (2011) [108] evaluated the potential of using *S. sesban* as an N_2 -fixing plant in constructed wetland systems. *S. sesban* plants grew well in the vertical flow and horizontal flow systems. The parameters measured such as root elongation rate, shoot elongation rate, leaf production rate, and biomass production were generally high in the two systems. The biomass production for the experimental periods was 20.2 and 17.2 kg/m²/year for the vertical flow and horizontal flow systems, respectively. Nitrogen content in *S. sesban* biomass was relatively high in general. They concluded that *S. sesban* can be used to treat high-strength wastewater in tropical areas while the species grows well and produces a large amount of nitrogen containing biomass which is used as fodder and for soil amendment [108].

Gas production and rumen degradation characteristics: *S. sesban* leaves are investigated *in vitro* and *in sacco* in rumen fistulated cows fed on a diet of grass hay ad libitum supplemented with

cotton seed cake [72]. The results showed that *S. sesban*’ leaves are used for gas production (methane, carbon dioxide) and rumen degradation characteristics, and the growing of *S. sesban* leaves (in a heavy clay vertisols with near neutral to alkaline pH (6-8)). offered advantages over herbaceous species in terms of superior persistence, higher dry matter (DM) yields, better resistance to mismanagement and a capacity to retain high-quality foliage livestock depend on grazing unimproved native under stress conditions. It provides also fertilizer in the pastures and crop residues, and can play a role as protein supplements to poor quality forages [72]. Details of other uses of *S. sesban* discussed in this section are summarized in Table 7.

Table 7. Other uses of *S. sesban*.

	Detail of use	Part used	References
Other uses	<i>S. sesban</i> biomass is used as firewood for cooking and heating.	Whole tree	[46], [103] [105], [85]
	<i>S. sesban</i> is used as shade. windbreaks, cover crops, ornamental plant, as fish poison and sticks for construction and as hedge	Whole tree	[7], [15] [68] (Ousman B. M., 2024) (unpublished)
	As fiber for ropes and fishing nets, and the seeds produce a gum	Stem and thick branches, Bark	[46].
	<i>S. sesban</i> may enhance chemically the phytoextraction of heavy metals (cadmium, lead, and zinc) from the soil, when 5mmol EDTA/kg is applied.	Whole tree	[106], [107]
	<i>S. sesban</i> can tolerate relatively high concentrations of ammoniac ion NH4+ in a hydroponic culture	Whole tree	[107]
	<i>S. sesban</i> , as an N2-fixing shrub, is used for treatment of polluted water	Whole tree	[108]
	<i>S. sesban</i> leaves are investigated <i>in vitro</i> and in <i>sacco</i> in rumen fistulated cows fed to produce gas and rumen degradation characteristics, higher dry matter (DM) yields, better resistance to mismanagement and a capacity to retain high-quality foliage livestock depend on grazing unimproved native under stress conditions.	Leaves	[72]

729

730 Conclusion

731 *S. sesban* is a leguminous tree native to Chad used to increase crop yields and vegetation in some
732 desert areas. The local population and particularly pastoralists plant it in arid zones to increase the
733 plant cover, to obtain shade for humans and their animals, and to use its wood for construction.
734 The local population also uses *S. sesban* to enrich soil fertility for increasing yields of crops such
735 as rice, maize, and sorghum. The species is also used also as a medicinal plant to treat breast
736 cancer, wounds and oedema. However, some important problems exist which threaten *S. sesban*
737 and other leguminous trees in Chad. Robert & Abdel-Hamid (2005) [103] pointed out that around

cities such as Ndjamenā; the high demand for fuelwood threatens the sustainability of supply. They also explained that this demand for fuelwood does not need to be a problem; if supplies are made available then woodfuel can also be an engine of economic growth, particularly in rural areas. Land degradation, decline of soil fertility and carbon stocks, and reduced availability of fuelwood and livestock feed are key problems in Chad as well as throughout Africa. Nwilo et al., (2020) [109] noted that vegetation in northern Nigeria including the region of Lake Chad declined by 49.3% between 1984 and 2016. The causes included agricultural activities such as extensive grazing and annual cropping, deforestation, and variations in climate. Excessive exploitation poses risks to the conservation of the whole flora in these and other tropical and subtropical regions [110], [111]. Moreover, effective strategies for biodiversity conservation should focus on regions with rare and endangered species, on locally abundant species that are functionally vital in maintaining the plant community, and on regions with considerable heterogeneity of vegetation [111]. Rukangira (2001) [110] noted that policy makers, other stakeholders, and citizens need to support conservation and help increase awareness of the problem. The collection of plant material and documentation, botanical identification, and preparation of herbarium vouchers are tasks that cannot be automated and thus require specialists who are becoming increasingly rare [112], [113]. As reported by Mosier et al., (2021) [114] restoring soil fertility on degraded lands to meet food, fuel, and climate security needs perennial cropping systems using perennial vegetation and thus can simultaneously provide additional ecosystem services. These alternative combinations of ecosystem services are climate change mitigation (bioenergy cropping systems), animal protein production (intensive rotational grazing), and biodiversity restoration (conservation plantings). Finally, this review paper demonstrates that *S. sesban* has considerable potential for addressing problems such land degradation, decline of soil fertility and carbon stocks and reduced availability of fuelwood and livestock feed as well as for improving human and livestock health and treating diseases. Various phytochemical constituents with essential metabolites and drugs can be extracted from different parts of *S. sesban* including the leaves, bark, stem, flower, roots, and seedpods. *S. sesban* also has important uses in particular niches, such as on saline soils, constructed wetlands, and for phytoextraction of metals. This paper contributes to the knowledge base on *S. sesban* and will hopefully help in its protection, use, and value for future generations. Although the plant grows naturally in and around N'Djamena, it has become rare and needs to be replanted in order to avoid its complete disappearance in the future.

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