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Climate Smart Gum Arabic Crop Investment in Arid Zones: An Agroforestry Model in Nigeria

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Abstract: *The interacting factors that determine the geomorphology and atmosphere status of the earth are traceable to complex organic and inorganic interactions. The consequence of these interactions in the present concern of climate change was highlighted. The emphasis was on the Sahel Savannah threatened by desertification and hence characterized by increased aridity, loss of arable land, poverty, starvation, low productivity, low tree population, migration, child labor, human trafficking, etc associated with the Sahel region of Wet Africa. Gum arabic based agroforestry model developed and recommended by Rubber Research Institute of Nigeria is in line with the FAO climate smart agriculture. In addition, there are pockets of successful arid zone agriculture as evidence of turning the dry and bare arid zone to possible forest of trees, shrubs, herbs, mixed farming and flourishing/sustainable socio-economic activities with settled communities. The objective of this paper therefore was to present the application of gum arabic based agroforestry in order to enhance tree population, green ground cover and check wind/water erosion. In addition, it will enhance socio-economic life of the people and hence ameliorate the challenges associated with social dislocation. This model is recommended for consideration and implementation at national, bilateral, multilateral, regional, international levels. The interest and support of donor agencies to facilitate application of the climate smart gum arabic based agroforestry in the Sahel zone of West Africa is hereby solicited.*

Keywords: *Climate, Agroforestry, Sahel, Acacia.*

INTRODUCTION

The world is threatened by hazards occasioned by climate change mainly due to increase in carbon, methane and other gasses leading to formation of a blanket inhibiting the return of heat waves to space, and hence global warming. Other green house gasses are Nitrous oxide, Nitrogen triflouride and Sulphur hexafluoride. Depletion of the ozone layer due to chemical reactions by carbon-halogens or halocarbons released into the atmosphere and hence infiltration of harmful radiation from space to the earth surface has also created spontaneous reaction among biotic and abiotic factors of the earth manifesting in weather changes. The concept of ozone depletion has been reasonably addressed through change in technology, but it is unlikely that the damage caused to the ozone layer has been reversed.

In the case of blanket of gasses leading to global warming, Carbon is a major gas implicated. Other gasses include methane, water vapour and ozone (Kiehl and Trenberth, 1997). In nature, water vapour blanket provides rain while ozone protects the earth against high doses of ultra violet radiation from the sun.

The complex interactions among organic and inorganic factors can be illustrated as inorganic versus inorganic, organic versus organic, organic versus inorganic and inorganic versus organic (Omokhafe, 2017a). These four interactions have determined what is evident in our time and it is noteworthy that these events are in a constant state of activity.

The ability of science to check inorganic vs inorganic in the hearth of the earth may be lacking for now. Organic vs organic, though on-going could be viewed as interaction from the perspective of carnivores, diseases and pests but these interactions have been accepted as factors ensuring stability of populations on the earth. Present conservation efforts are geared towards minimizing the devastating effects of organic versus organic interaction.

The organic vs inorganic and vice versa are of great concern. Managing these two interactions is necessary to guarantee the continued existence and good quality life of *Homo sapiens* on the face of the earth. Among organic factors in this complex is the role of man that has caused dramatic changes through technology and hence upset what may be referred to as atmosphere-geomorphologhy equilibrium as a threat to existence of man.

One notable consequence of the complex of organic and inorganic factors is climate change evident in abiotic factors such as global warming, changes in weather patterns, desertification, desert encroachment, melting glacier, flood, increase in ocean levels, wild fires, high temperatures etc. There are measures to check the release of Carbon to the atmosphere through renewable sources of energy. This approach alone cannot address the challenges of climate change. This is more so as the accumulation of green house gasses cannot be reversed by ‘renewable methods’ rather appropriate sinks will be required and the approach of Carbon sinks is therefore well advocated (Hodrein, 2008; Verbist et al., 2011). Without removing the excess carbon and other green house gasses (GHG), even with renewable energy, the multiplier effect of the current level of accumulation of GHG portends disaster (Solomon et al., 2009).

The role of man in addressing climate change will be to reduce further emission of green house gasses as in the case of renewable sources, minimize the current effect of climate change by reducing the load of green house gasses and develop means of survival of man while assuming a tolerable level of perhaps new atmosphere-geomorphology equilibrium. For the intervening phase before a new tolerable level is attained, there is virtually no prediction to the decades, centuries or millennia it will take to achieve this feat.

In the current scenario of the earth and its space, there are two possible sinks, which are the soil/earth crust and biological absorbents. Injecting green house gasses into the earth crust may destabilize the geomorphology and it can lead to inorganic vs inorganic reactions of devastating proportions such as land slide, mud slide, earth tremor, earth quake, hurricane, tsunami etc (Omokhafe, 2017a). The second option of biological absorbents is a natural phenomenon, with little or no adverse effect with the right choice of biological absorbents.

Biological absorbents include plants, animals and lower organisms. The capacity to build up matter varies among these biological agents with higher capacity of plants and animals. In comparison, multiplication rate of plants is higher than animals and tree plants in particular have longer life span than animals. In addition, animals depend on plants for survival. In the case of plants, a population of plants can provide a renewable and sustainable source of sink. Furthermore, plants are more efficient absorbents than animals because of the autotrophic nature of plants. Animals rely on plants directly in the case of herbivores or indirectly for omnivores and carnivores. Lastly, it is believed that loss of plant population through urbanization/industrialization may be implicated in the current dilemma of climate change. Use of plants will therefore be a means of restoring the lost plant population. The place of microorganisms as biological absorbents is diminutive compared to plants.

In considering coping mechanism, the least developed and developing countries are vulnerable as they do not have the technology to adapt to changes in weather conditions especially as crop production depends on natural course of weather that has become haphazard (Seaman et al., 2014; Mohammed, 2015). The arid zone of Africa is typical of this vulnerable group in the world.

The arid zone

The arid zone of the world is about 40% of the land surface of the earth (Koohafkan and Stewart, 2008). It is characterized by low plant population, more severe absence of trees and hence low carbon sink. The harsh condition is responsible for migration from the arid zones resulting in social problems of child labour, human trafficking, poverty, food insecurity, starvation, deprivation, exploitation, underdevelopment, low gross domestic product, poor economy, etc as indices of vulnerability. For instance, increased aridity has led to loss of vegetation and downward trend of the Sahel Savannah in West Africa leading to migration of cattle herders and eventual conflict with crop farmers in Sudan and Guinea Savannah, and the Rain Forest (Cabot, 2017; Ofuoku & Isife, 2010; Olaniyan et al, 2015). The Edo North in Edo State, Nigeria ravaged by climate change leading to translation of Rain Forest to derived savannah is now experiencing security threat of insurgency with the discovery of an illegal factory for production of improvised explosive device (Omokhafe, 2017b, Osagie, 2018).

The arid zone worldwide is characterized by low population density, except along the coastline cities. The unproductive bare land can however, be coverted to flourishing vegetation for carbon sequestration. Typical examples of productive arid zone agriculture are Israel agriculture, Nile River agriculture in Egypt and arid tree crop agriculture in Sudan. Climate smart agriculture is designed to ensure environment-friendly and more efficient agricultural productivity with consideration for community social issues towards food security and enhanced income (FAO, 2013).

In the light of the foregoing, this paper has the objective of highlighting gum arabic agroforestry practices that will enhance greenery, tree population, food security and economic empowerment of arid areas of West Africa.

The model

The arid zone of West Africa consists of the northern fringes of Sudan Savannah, the Sahel Savannah and part of the Sahara desert (Fig. 1). The concept of desert encroachment suggests gradual loss of vegetation with the possibility of loss of Sudan Savannah transiting to Sahel and possibly the desert. This scenario is presented in Fig. 1, which therefore requires intervention to arrest this threat of loss of arable land.

The model is typical of the Sahel Savannah, which may be adapted for other arid areas. This is to build a crop based agroforestry consisting of trees and annual food crops. The critical component of this model is the tree as the Sahel Savannah supports several annual grain crops. Examples of trees adapted to arid climate are presented in Table 1 (FAO, 1989).

A well adapted drought tolerant plant is *Acacia senegal*, which is an economic tree with the common name of gum arabic tree. *Acacia senegal* and *Hevea brasiliensis* are mandate crops of the Rubber Research Institute of Nigeria, Benin City, Nigeria (RRIN, 2009). The Institute has conducted research into gum arabic with the following technologies:

i. Production of planting materials of gum arabic: nursery techniques
ii. Plantation development
iii. Intercropping: crops such as sorrhel (Hibiscus sabdariffa), cowpea (Vigna ungiuculata), sorghum (Sorghum bicolor) were tested and found suitable for intercropping with gum arabic (Fig. 2)
iv. Improved greenery: mature trees versus bare Sahel Savannah (Fig. 3)
v. Water harvesting: a technique was tested to enhance soil moisture (Fig. 4)
vi. Harvesting techniques
vii. Collection and grading of gum Arabic
viii. Farm gate marketing
ix. Economic empowerment of farmers
x. Export market

Discussion

The world natural forests are threatened by climate change as reported by Khabarova and Savin (2015). This is coupled with desertification and desert encroachment threatening the savannahs (Aremu and Olatunde, 2012). The Sahel region is characterized by low tree population (Fig. 1) and extreme poverty resulting in migration, prostitution, forced labour, human trafficking etc (Seaman et al., 2014). When life becomes virtually meaningless due to helpless situation, the population will be vulnerable to recruitment into crime, even if it is with mere promise of a meal a day. The Boko Haram insurgency in Nigeria is restricted to the degraded Sahel Savannah in the north east. This hapless situation of available recruits is perhaps responsible for the resilience of Boko Haram in Borno State in north east Nigeria.

A holistic approach that will address socio-economic issues as well as climate change is necessary. It is possible to translate the Sahel Savannah to arid-forest or possibly the Sahara desert to desert-forest. Emphasis in this paper is the possibility of translating the Sahel Savannah to arid zone forest. An example of this suggestion is in the cold regions of North America and Eurasia which is home to flourishing vegetation called Taiga (Yaroshenko et al., 2001). The Taiga is a rich source of wood and wood products in Canada, the Scandinavian countries and Russia. It is sometimes referred to as snow forest.

It is noteworthy that there are over seventy species of trees and shrubs adapted to the arid zones of the world (FAO, 1989). Furthermore, over forty of these species are source of wood of commercial value. This potential can be exploited to convert the bare and arid Sahel Savannah into the arid zone forest to trap atmospheric carbon and source of wood.

Among the various species valued for wood is *Acacia* species with combined wood and gum attributes in three acacia species viz *A. senegal*, *A. seyal* and *A. nilotica* (Table 1). The *A. senegal* produces gum of premium grade valued in production of food, confectionary and pharmaceutical industries. The *A. senegal* is therefore an economic crop for the commercial grade gum and the use of the gum makes the plant important in concerns of food and health. The package of *A. senegal* eco-friendly, gum producing, economic and food security value is as follows:

i. Nursery activities: this is for production of planting materials for the purpose of propagation. Presently, gum arabic is propagated by seeds. Nursery activities are seed collection and scarification, preparation of potting mixture in polybags, planting of scarified seeds in polybags, provision of irrigation facility, maintenance, and sale/distribution of seedlings.

   Production of planting materials of *A. senegal* is an enterprise that can attract private sector participation, employ idle labour and provide income for proprietor and workers

ii. Plantation development: to apply recommended agronomic practices such as land preparation, planting, pruning, weeding, intercropping and water management

iii. Intercropping: this is to guarantee food production and good ground cover against wind and water erosion especially during the immature phase. Many of the arable crops typical of the local environment can be planted with gum arabic. Examples of intercropping fields of gum arabic are presented in Fig. 2. These include sorrhel (*Hibiscus sabdariffa*), cowpea (*Vigna ungiuculata*), sorghum (*Sorghum bicolor*). These annual crops are sources of income to the farmers before tapping maturity of the gum arabic trees and they are also assurance of food security. Economic and food security are critical factors in the Sahel region of West Africa. It is possible to alter the spacing of the trees in order to have a more enduring intercropping practice even at tapping maturity. This has been achieved for rubber tree, *Hevea brasiliensis* (Anegbe et al, 2014)

iv. Improved greenery: the improvement in plant ground cover from typical Sahel Savannah to intercropping and to mature plantation of gum arabic explains eco-friendly nature of gum arabic agroforestry (Fig.3).

v. Water management: this is critical as the rainfall period is short lasting about three months in the Sahel Savannah. Even in the desert, the limiting factor to vegetation is availability of soil moisture, hence with scanty, irregular rain shower, there is lush vegetation. In a description of impact of rain in the desert, it was reported that "… *the whole face of a land is changed by the rains. With them come meadow-grasses and flowers, hillside vines and bushes, field of yellow grain, orchards of pink-white blossoms*" (Dyke, 1994). This means with adequate water management, even the desert can sustain plant population as typical of Israel agriculture (IEICI, 2012). Recommended methods of agricultural water use in the Sahel Savannah include:

- Wetland agriculture: there are water bodies across the Sahel which are virtually stable throughout the year. They are sources of water for irrigation which may be aided by mechanical or animal drawn facility. During the dry season, the receding bank of the wetland is suitable for organic farming.
- Rivers/Lakes/Oasis: these are of wider dimensions than wetland, and hence present great opportunities for agriculture. A good example is the Lake Chad whose basin supports agriculture in North East Nigeria, North Cameroon and parts of Chad. The case of Lake Chad is worrisome as it has reduced in area from 25,000 sq. km. in 1963 to 1,350 sq. km in 2018. It has there affected livelihood in its catchment area (NSPD, 2019).
- Dams: these are artificial lakes created by a dam across a flowing river and a receptacle. It serves to provide water for irrigation and sometimes to generate power for electricity.
- Open Wells: these are dug into shallow aquifer to draw out water (Fig. 5). This may be subject to weather changes (AWC, 2008)
- Tube wells: dug where either the aquifer is very deep or to reach fossil water. The advantage is more stable water supply with less of influence of weather (AWC, 2008).
- Desalinated water: obtained from the sea or ocean. Coastline countries may take advantage of this opportunity. Even landlocked countries can benefit from desalinated water running through the coastline countries. If it is possible to pipe gas along several national boundaries it should be feasible to pipe water to the hinterland. Many arid coastline countries can take advantage of this opportunity to convert the unproductive hinterland to agricultural land.
- Water harvesting: this is a method of keeping the plant in a pool of water captured during rainfall. Such pool of water can nourish the plants for days or weeks after rain. This has been found to enhance growth of gum arabic at sapling, shrub and even tree stage (Fig. 4).

vi. Harvesting: this includes harvesting of the intercrops as well as the gum arabic trees. Harvesting of intercrops follows the usual agronomic practices for the respective crops. In the case of gum arabic, the trees attain tapping maturity in about five years and gum exudes in response to wounding during the dry season. Wound inflicted during the rainy season will not produce gum. Prior to the dry season, i.e. as the rains wind up, the plants are pruned to provide branch free trunk for tapping of gum. In Sahel Nigeria, pruning is carried out in August to September. This will allow the pruning wounds to heal before the tapping cuts, which are inflicted at the onset of the dry season. In Nigeria, tapping cuts are made on the trees in October – November while picking of exuded gum is from late December and it is carried out every month till March or April depending on how prolonged is the dry season. There is no monthly fresh cut but the cuts made in October to November can produce gum as the process of pulling out the exuded gum creates fresh wound. Monthly picking of gum is to allow the gum air dry under the effect of the severe dry season, called harmattan in West Africa. Omokhafe et al (2010) recommended maximum of five incisions per tree in order to avoid slaughter tapping.

vii. Collection and grading of gum: gum collected is graded. When pure stands of *A. senegal* is cultivated, the gum yield is expected to be golden and called grade 1 gum. Where gum is collected from the wild or the plantation was raised from unselected gum arabic, there is bound to be a mixture of various grades of gum. In which case, sorting and grading could be labour intensive including the female gender (FAO, 2009; Fig. 6). The grade 1 is premium grade and it is highly priced. It is the grade for food, food products and drugs.

viii. Farm gate marketing: gum is sorted by the farmers and packed in sacks for buyers who are mainly middlemen. It may be necessary to organize the farmers into cooperative societies to seek for market in order to reduce the exploitative tendency of middlemen.

ix. Value addition: gum produced can be processed into powder before it is sold to end users. This is a factory based exercise. Gum arabic is though an arid and economic tree, the gum is used in food, confectionary and pharmaceuticals as a binder, emulsifier, hence it is a highly valued product world-wide (Ibrahim et al., 2014).
x. Source of fodder: gum arabic tree retains its leaves all year round and hence rich source of fodder when other plants would have faded off especially during the severe dry weather. This suggests that with controlled grazing, gum arabic agroforestry can support homestead herbivores such as goat, sheep and cattle, and it will improve the quality of life of the farmers (Koohafkan and Stewart, 2008; Table 1; Fig. 7).
xi. Economic empowerment: production of seedlings for planting is a productive venture that can sustain a family. In addition, cultivation of intercrops may be beyond subsistence level and hence provide income for farmers. Production of gum is an economic venture to lift farmers above poverty level as well as contribute to export. In this regard, the government of Sudan is sustained mainly by export of gum arabic. This feat can be replicated in many countries of the Sahel region.
xii. Job opportunities: a major social problem in the Sahel is migration of idle or under-engaged labour. This can be minimized by gum arabic agroforestry as almost all activities require human effort. In a study conducted in Rubber Research Institute of Nigeria, it was found that more than 300mandays will be required for one hectare per year from nursery to processing (RRIN, 2012). This means one person could be gainfully employed for one hectare gum arabic in a year and one thousand persons for 1000ha.
xiii. Export market: almost all the countries of the Sahel region are in dire need of foreign exchange to meet up with the demand of development. Gum arabic is an export crop that can fetch millions or perhaps billions of foreign exchange if the potential is well harnessed as in the case of Sudan.

Sustainability

The presentation of the gum arabic agroforestry is from the perspective of sustainability. This is so because the model is participatory involving farmers. This may be in contrast with other tree planting campaigns in many arid countries, which are based virtually on government vision. The gum arabic agroforestry model is to sensitize farmers to carry out combined tree and arable crop cultivation, and sometimes integrated livestock. Government/Funding agencies will sensitize the farmers through demonstration plots, input supply, workshops, seminars, field visits, field days, etc while the drive for continuity will be the enhanced economic returns to the farmers.

Present concerns

The effort of the past to promote tree planting is hereby noted. Among such effort is tree planting campaigns and green belt projects. This effort is commendable but sustainability is a major limitation. This being because the projects are government driven and they focus on use of trees to control desertification or desert encroachment.

Farmer focused agroforestry is such that farmers will integrate the practice into their farm activities. This will guarantee sustainability with attendant ecosystem and socio-economic benefits. This can be extended to mixed farming such as integration of livestock and bee keeping into the agroforestry system. This has been conducted successfully in the case of the rubber tree, *Hevea brasiliensis*, and the potential for same practice in gum arabic can be explored (Omokhafe and Eguavoen, 2014). In Table 1, many of the arid zone trees and shrubs can support bee keeping (FAO, 1989; IEICI, 2012).

The Sahel region is estimated to measure 5,400km in length stretching from the Gambia and southern Mauritania on the West Coast of Africa to Sudan and North Eritrea on the East Coast. The width is about 1000km at the widest point covering other countries from west to east as follows: central Mali, northern Burkina Faso, extreme south of Algeria and Niger, extreme north of Nigeria, central Chad, central Sudan and northern Eritrea. By dimension, it is about 305,000,000 ha or 3,053,200 sq. km. This vast expanse of land is relatively bare (Fig. 1b), sparsely populated or depopulated due to migration. It can receive the lifeline of gum arabic agroforestry, provide veritable sink for green house gasses to mitigate climate change, source of income for the dwellers, enhance gross domestic product of the respective countries, support settled rural population to check out-migration and hence minimize social and environmental problems associated with unplanned urbanization of cities caused by in-migrants.

Way forward

i. Dissemination of information on gum arabic agroforestry including demonstration farms
ii. Farmer-participatory gum arabic agroforestry
iii. Planned gum arabic based farm settlements in the Sahel Savannah
iv. Commitment of national governments
v. Collaboration across national or regional boundaries
vi. Support from international agencies

Conclusion

The potential for use of gum arabic tree in climate smart agriculture will provide carbon sink for climate change mitigation, as a major concern world-wide. Other benefits will be to check desertification/desert encroachment, minimize poverty among indigenous populations, and encourage growth of the indigenous communities through gum arabic agribusiness from field to factory activities. The arid zone gum arabic based agroforestry through national, regional, international, bilateral or multilateral effort is hereby encouraged.

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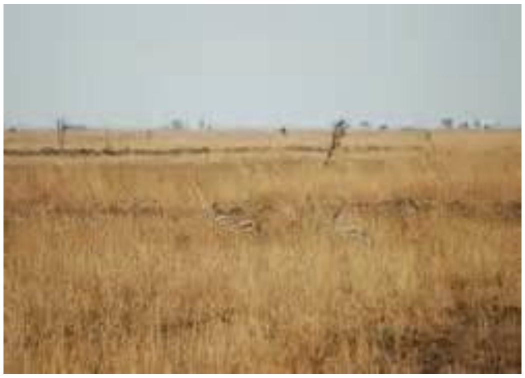
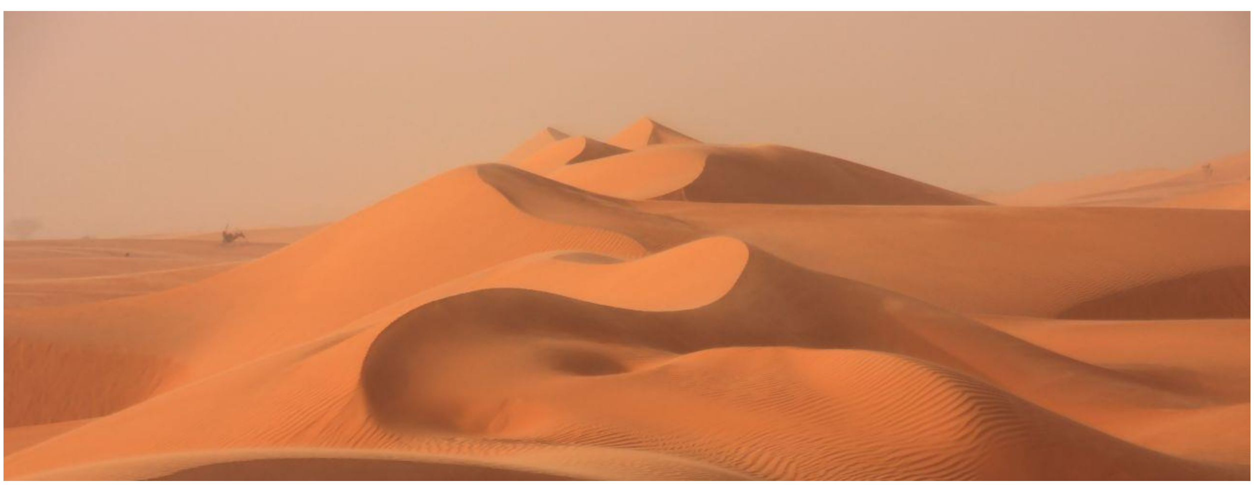


a. Typical Sudan Savannah

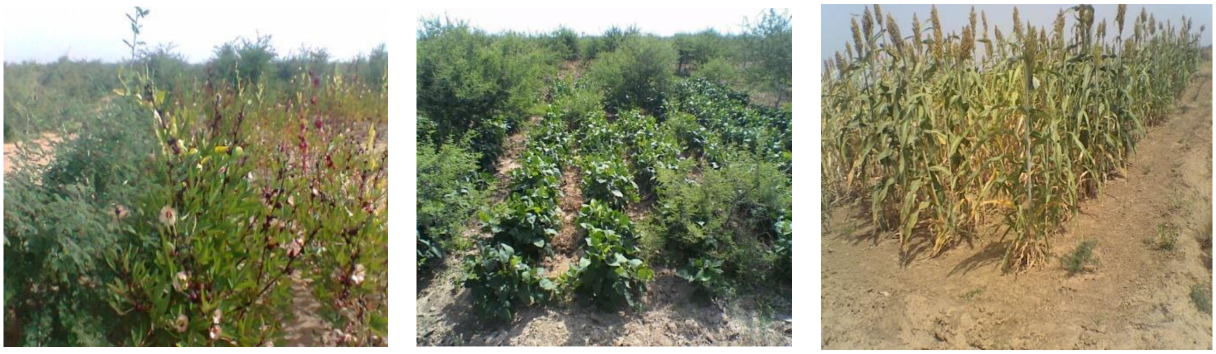
b. Threatened Sudan Savannah with wild *Acacia* trees

c. Sahel Savannah



c. Sahara desert

Fig. 1. Arid lands

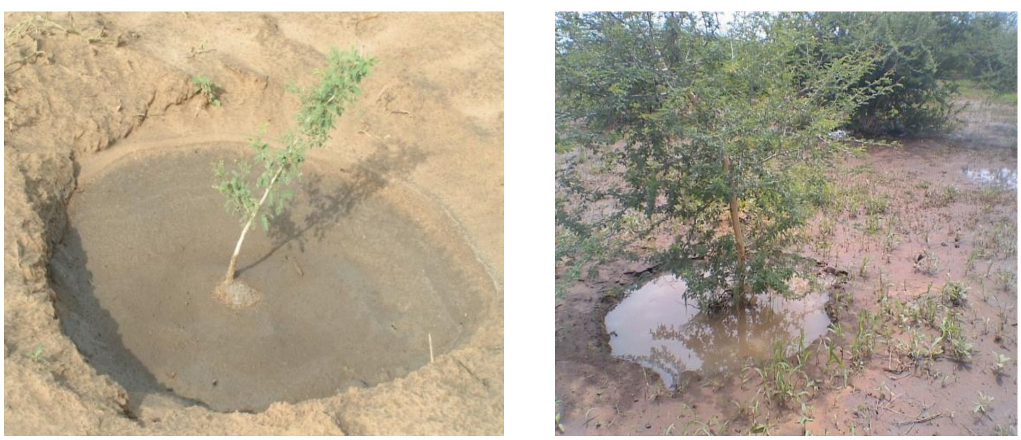


Immature gum arabic and sorrel | Immature gum arabic and cowpea | Immature gum arabic and sorghum

Fig. 2. Intercropping trials

Typical Sahel Savannah | Ground cover: immature gum arabic with intercrop | Ground cover + wind break with mature gum arabic

Fig. 3. Improvement in ground cover and plant population in gum arabic agroforestry



Sapling | Shrub

Fig. 4. Water harvesting in sapling and shrub of gum arabic

Source: Internet
Fig. 5. Open well

Source: FAO (2009)
Fig. 6. Sorting of acacia gum

Source: Koohafkan and Stewart (2008)
Fig.7. Goats feeding on solitary gum arabic shrub

Table 1. Tree species of the arid areas of the world

S/No.	Species	Fodder	Additional Uses/Remarks*
1.	*Acacia aneura*	XXX	**Posts and poles**
2.	*Acacia brachystachya*	X	**Small wood items, wood durable**
3.	*Acacia cambagei*		**Posts**, termite-resistant
4.	*Acacia cyanophylla*	X	Sand dune stabilization, windbreaks and shelterbelts
5.	*Acacia Cyclops*	X	Sand dune stabilization
6.	*Acacia farnesiana*	XX	**Posts**, tannin from bark, hedges
7.	*Acacia mellifera*	XX	**Round wood**, hedges
8.	*Acacia nilotica*	XXX	**Building material**, tannin from bark and pods, gum, **wood** durable
9.	*Acacia senegal*	XXX	Soil improvement, agroforestry, gum arable, **round wood**
10.	*Acacia seyal*	XXX	**Round wood**, gum, **wood hard**
11.	*Acacia tortilis*	XXX	**Posts**, sand dune stabilization
12.	*Acacia victoriae*	XX	No information
13.	*Albizia lebbek*	XX	**Lumber, furniture**, soil improvement, leaves for manure
14.	*Anogeissus leiocarpus*	XX	**Round wood**, tannin from leaves and bark
15.	*Anogeissus latifolia*	XX	**Round wood** , gum, tannin, silkworms
16.	*Argania sideroxylon*	XX	**Construction material**, oil from seed
17.	*Atriplex canescens*	XX	Wind-breaks and shelterbelts
18.	*Atriplex nummulria*	XXX	Wind-breaks and shelterbelts, sand dune stabilization
19.	*Atriplex glauca*	XX	No information
20.	*Atriplex halimus*	XXX	Wind-breaks and shelterbelts
21.	*Atriplex semibaccata*	XX	No information
22.	*Atriplex vesicaria*	XX	No information
23.	*Atriplex indica*	X	Poles, furniture, tannin, oil, windbreaks and shelterbelts, shade
24.	*Azadirachta indica*	X	Poles, furniture, tannin, oil, windbreaks and shelterbelts, shade
25.	*Balanites aegyptiaca*	X	Edible fruits, oil

XXX: High fodder value, XX: Good fodder value, X = Moderate fodder value
*: Wood products in bold; Source: www.fao.org/docrep/t0122e/t0122e00.HTM

26.	*Bolswellia papyrifera*		Frankincense gum
27.	*Boswellia serrate*		Frankincense gum
28.	*Brachychiton populneum*	XX	Wind-breaks and shelterbelts
29.	*Brosium alicastrum*	XXX	Construction material
30.	*Callitris glauca*		Posts, poles, house-building, windbreaks and shelterbelts, resistant wood
31.	*Cassia auriculata*	X	Tannin, tea, hedge plant
32.	*Cassia siamea*	X	Roadside plantations, lumber
33.	*Cassia sturtii*	XX	No information

34.	*Casuarina equisetifolia*		Posts, poles, tannin, sand dune stabilization, windbreaks and shelterbelts
35.	*Casuarina.cunninghamiana*	X	Wind-breaks and shelterbelts, shade
36.	*Ceratonia siliqua*	XXX	Honey, soil conservation
37.	*Colophospermum mopane*	XX	Round wood, carvings
38.	*Conocarpus lancifolius*	XX	Poles, ship building, shade
39.	*Cordeauxia edulis*	XX	Seeds for food
40.	*Cupressus arizonica*		Wind-breaks and shelterbelts
41.	*Cupressus sempervirens*		Carpentry, furniture, windbreaks and shelterbelts
42.	*Dalbergia sissoo*		Furniture, building material, posts
43.	*Desmoodium spp.*	XX	No information
44.	*Dichrostachus cinerea*	XX	Posts, sand dune stabilization
45.	*Eucalyptus camaldulensis*		Lumber, honey, windbreaks and shelterbelts
46.	*Eucalyptus gomphocephala*		Construction material, windbreaks and shelterbelts, soil protection, roadside plantations
47.	*Eucalyptus salmonophloia*		Wood durable, round wood, windbreaks and shelterbelts, roadside plantations
48.	*Euphorbia tirucalli*		Hedges, windbreaks and shelterbelts, latex
49.	*Faiderbia albida*	XXX	Tanning from wood, soil improvement
50.	*Gleditsia triacanthos*	XXX	Wood durable, round wood, windbreaks and shelterbelts

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51.	*Gleditsia triacanthos*	XXX	Wood durable, round wood, windbreaks and shelterbelts
52.	*Haloxylon aphyllum*	XX	Wind-breaks and shelterbelts
53.	*Haloxylon persicum*	XX	Sand dune stabilization
54.	*Juniperus osteosperma*		Posts, berries for wildlife food, windbreaks and shelterbelts
55.	*Juniperus monosperma*		Posts, berries for wildlife food, windbreaks and shelterbelts
56.	*Juniperus depeeana*		Posts, berries for wildlife food
57.	*Juniperus scopulorum*		Posts, berries for wildlife food, windbreaks and shelterbelts
58.	*Leucaena leucocephala*	XXX	Round wood, soil improvement
59.	*Parkinsonia aculeate*	XX	Soil fixation, erosion control
60.	*Pinus halepensis*		Construction material, resin, soil conservation
61.	*Pithecellobium dulce*	XX	Posts, edible fruits, tannin, shade, hedges
62.	*Prosopis chilensis*	XXX	Posts, soil conservation, sand dune stabilization, wood durable
63.	*Prosopis spicigera*	XXX	Soil improvement, agroforestry
64.	*Prosopis tamarugo*	XX	Furniture
65.	*Quercus arizonica*		No information
66.	*Quercus emoryii*		No information

67.	*Quercus gambelli*		Posts
68.	*Quercus hypoleucoides*		No information
69.	*Robinia pseudoacacia*	X	Posts, soil improvement
70.	*Salvadora persica*	XX	Edible fruit, seeds give fat, roadside plantations
71.	*Schinus moue*		Windbreaks and shelterbelts, shade planting
72.	*Simmondsia chinensis*	X	Jojoba oil from seeds
73.	*Tamarix aphylla*		Turnery, carpentry, sand dune stabilization, windbreaks and shelterbelts
74.	*Tamarindus indica*	XX	Round wood, construction material, furniture, edible fruits, drinks

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75.	*Tetraclinis articulate*		Furniture, lumber, timber, resin, erosion control
76.	*Zizyphus jujube*	XX	Agricultural implements, edible fruits, drinks, fences, shellac
77.	*Zizyphus spina-christi*	XX	Posts, hedges, erosion control

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