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Sesbania sesban, a fodder species potential to rehabilitate wetland vegetation in Lake Ziway, Ethiopia

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Abstract
Wetland vegetation have significant roles in buffering effects of agro-chemicals and a mass of eroded soil entering in to lakes. Buffering wetland vegetation in the shore of Lake Ziway, a Lake in the Ethiopian mid-Rift Valley with 137 km shore length and 434 km^2 area supporting over 4,600 livelihoods in fisheries activity, is threatened by anthropogenic impacts in the semi-arid, drought stressed surrounding. A pre-test experiment was done to evaluate multipurpose, three fodder plant species, elephant grass, *Sesbania sesban* and *Leucaena pallida* in their potential to re-habilitate a degraded wetland around Lake Ziway. The planting materials of elephant grass and seeds of *Sesbania sesban* and *Leucaena pallida* were planted in a selected littoral zone of the Lake during June 2009, after which they were protected by fencing and let to grow. All of the three species were well established during the first season. However, *Leucaena pallida* and elephant grass were dry out after August when the Lake's water level increases and inundate the area. Being submerged partially under water, *Sesbania sesban* tolerated the inundation caused by the rise of water level in the late rainy months and developed a mass of adventitious roots from the stems which mechanically trapped the incoming eroded soil from the immediate farm lands. Very dense grass of height up to 1 m, established in the protected area around the experimental plots was also the indication of the rehabilitation of wetland vegetation for its better buffering capacity. The *Sesbania sesban,* multipurpose plant and the established grass, potentially provides a high protein source green roughage to livestock in this drought affected Rift Valley area.

Keywords: fodder plants, Lake Ziway, rehabilitation, *Sesbania sesban*, wetland vegetation

1. Introduction
Fresh water ecosystems is economically important for drinking, irrigation, hydroelectric power generation, fisheries, recreation, transport and industrial growth. Regardless of their use, fresh water ecosystems of East Africa in general are threatened as a result of policies that emphasize exploitation rather than management and conservation [1]. Moreover, fisheries management experts recognize that the underlying causes of fisheries resource over-exploitation and environmental degradation are often of social, economic, institutional and/or political origins [2]. Aquatic resources, although renewable, are not infinite [3] and therefore need to be properly managed, if their contribution to the nutritional, economic and social well-being of the growing world's population is to be sustained. The impact of deforestation, irrigation, fertilizers, pesticides and municipal wastes causing silt and nutrient load and water quality deterioration have existed for quite some time in Ethiopia [4, 5]. Aquatic resources in mid-rift valley lakes are threatened with problems of overexploitation, environmental degradation and consequently un-recovered resources resulting in loss of its potentials [6]. According to Ayenew [7] major changes in the rift valley are related mainly to recent improper utilization of water and land resources in the lakes' catchment and direct lake water abstraction which are aggravated intermittently by climatic changes. These changes appear to have grave environmental consequences on the fragile rift ecosystem, which demands extremely urgent needs of integrated basin-wide sustainable water management.
The fisheries sector of Lake Ziway supports a livelihood of over 4,600 people [8]. The use of beach seine with smaller mesh size (below the recommended 8cm for tilapia) for fishing is one of the major problem [6]. On the other hand, wetland vegetation found in the shore line of the lakes is playing an important role in keeping the aquatic ecosystem functional.
Wetland vegetation, being a buffer zone in lakes, potentially alleviate a number of problems posed on to The lake by trapping agrochemicals, nutrients and silt load that would otherwise

go in to the lake directly. Moreover, the shore vegetation helps as a breeding ground for most of the fish species and shelter for young fish. Shore vegetation of Lake Ziway are composed of plant species like *Paspalidium geminatum* Pers. (bulrush), *Cyperus papyrus* L. (papyrus), *Nymphaea nouchali* Burm. f. (blue water lily), and *Aeschynomene elaphroxylon* (Guill. & Perr.) Locally called bofoffe [9]. Bulrush is used for thatching houses and making fences, bofoffe used for making raft boats and stools, while papyrus is used for making raft boats in fishing. Despite their social and ecological importance, the shore vegetation are being degraded in some parts of Lake Ziway because of over grazing, tool making, and plowing of shore land following the retracting water during the dry season (personal observation). Vegetable farm near the shore of the Lake is expanding in a faster rate, posing agrochemicals, nutrients load and silt deposit to the Lake environment.

Rift valley is a semi-arid area where a shortage of animal feed is common, especially during the dry season while the farmers of this area are livestock producers suffering with feed shortage in dry season. Fodder plants such as elephant grass, *Sesbania sesban* and *Leucaena pallid* are potential plants that can establish in this rift system.

The elephant grass, *Pennisetum purpureum* (L.), also known as Napier grass is a tall, stout and deep rooted perennial bunch grass well known for its high yielding capability and used as forage for livestock [10]. Elephant grass occurs naturally throughout tropical Africa [11] and particularly in East Africa [12]. Elephant grass has been introduced to all tropical countries and to sub-tropical areas of the world [13] and grows from sea level to altitudes of 2000 m where rainfall exceeds 1000 mm [14]. It is vigorous and highly productive forage that withstands considerable periods of drought although little or no growth is produced during these periods [13]. But it rapidly recovers with the onset of rain and can survive for more than five years at elevations exceeding 900 m [15].

The *Sesbania sesban* is a fast growing plant commonly used as fuel wood and is also used as a feed for ruminant animals. *S. sesban* is very common throughout Africa and in Asian countries such as India, Malaysia, Indonesia and the Philippines where it is commonly seen growing on the dikes between rice paddies, along roadsides and in backyard vegetable gardens. The plant has also proved to be extremely tolerant of a wide range of sites including those which can be regarded as difficult for other plants such as saline, alkaline and waterlogged areas [16]. Being a legume, the tree fixes nitrogen and has proved to be popular as a fallow species and as an agro-forestry species.

Establishing fodder plants in the shore of Lake Ziway will have two main purposes. First, the degraded shore vegetation will rehabilitate and provide its ecological value to the lake and to the environment, and secondly it will provide a high protein source green roughage to livestock of the area who are suffering from recurrent drought. As a result, farmers will then protect and manage the shore vegetation because of the benefits.

Hence the objective of the present study was to identify promising fodder plants that can help in wetland rehabilitation and provide high protein source green roughage to livestock.

2. Materials and Methods

A. Description of the study area

The study was conducted in mid-Rift valley at the Eastern shore of Lake Ziway called Herera, 7 °55.789'N, 38 °52.711'E at an altitude of 1640m.a.s.l on a plot of 100 m x 25 m during 2009-2011. Lake Ziway is a shallow lake fed by two major rivers, the Meki River from West and Katar River from East with one out flowing river, the Bulbula River draining in to Lake Abijata (Fig.1). Ziway has a total catchment area of about 6834 km^2, lake area of 434 km^2, a shoreline length of 137 km and a mean and maximum depth of 2.5 m and 9m respectively [17, 18]. The average annual rainfall of the area is about 700 mm and its mean maximum and minimum temperatures are 27 and 14 °C, respectively [19].

Experimental site was purposely selected considering the socio-economic and ecological importance. Farmers were growing crops near the shore of the Lake (Fig.1). The site was selected based on the vicinity of farm land to the shore, flooding rout and interest of the farm owner to own and guard the fodder plants to be planted next to/at the bottom of his farm in the littoral part of the lake. The soil class of the experimental area was silt loam (analyzed).

B. Experimental plants

Three fodder species were tested as treatments of the experiment

1. Elephant grass,
2. *Sesbania sesban* and
3. *Leucaena pallida*

C. Plantation of the fodder plants and growth evaluation

Plot size of each of the three fodder plant was about 30m X 20m. Planting materials of elephant grass and seeds of *Sesbania sesban* and *Leucaena pallida* were obtained from Adami Tullu Agricultural Research Center. The plots were ox-ploughed and prepared for plantation in June and fenced for protection against animals grazing in the shore area. The elephant grass was planted at a spacing of 2 m between rows and 50 cm between plants. The *Sesbania* and *Leucaena* seeds were sown in rows having about 1m spacing and thinned out to 50cm spacing between plants after emergence.

The rows of plantation for each of the three fodder species were running across the slope of the area to facilitate trapping of the sediments. The plants were wedded by hand in the first season to control the weed. The survival and growth of these fodder plants was attended for two years. Finally the result was demonstrated to the local people, kebele and the district administrative bodies.

3. Results and Discussion

The cuttings of elephant grass were planted in the prepared plots. As this plant grows well in the lowlands from sea level to altitudes of 2000 m where rainfall exceeds 1000 mm [14], the cuttings were survived and started to re-generate during the first year. The survival percentage was more than 70% for each row. Similarly, the *Sesbania sesban* and *Leucaena pallida* were successfully germinated and thinned out according to the designed spacing. The experimental site was in the littoral zone of the lake, i.e. the site where the lake water covers at its high level in the late rainy season and retracts during the dry season.

The *Leucaena pallida* could not survived the water inundation at all during the late rainy season while the elephant grass hardly survived it during the first year. Unfortunately, the water level was raised to cover half of the 20m plot width during the first year and it was difficult to control the weeds. When the lake's water level reduced following the succeeding dry season, the weakly established elephant grass were dried out because of their weak establishment during the inundation period, unable to compete with dominating grass.

Natural grass was highly proliferating and made a very dense mass in this fenced and protected plot area especially after the retraction of the lake water starting from late October (Fig.2). The hippopotamus often come to the plot and damage the elephant grass through grazing and pressing it to the ground with its legs. The plots planted with elephant grass and *Leucaena pallida* were later covered with grass than the planted fodders. The grass can obviously be mowed and given to animals.

The *Sesbania sesban* was successful to survive the inundation tolerating the water logged condition of the area during and after the rainy season. More than 90% of the plant survived after the inundation of the first year, the population of which later became denser by making a bushy structure having two or more main stems at the bottom. The plant was grown rapidly that it attained an average plant height of 3.3 m in 10 months (Fig.3a) and an average final height of 4.0 m in 18 months (Fig.3b) after sowing. The growth rate attained in the current experiment was lower than a height of 4-5m attained in 6 months of previous reports [20]. The difference might be attributed due to variety and/or ecological and management differences.

The *S. sesban* is normally cut three to four, even up to eight times per year to feed animals [21]. The plant thrives under repeated cutting and coppices readily with many branches arising from the main stem below cutting. According to previous studies [20]-[22] the yield of *S. sesban* have ranged from 4 to 12 tonnes dry matter/ha/year depending upon location. Therefore, based upon these information and the result of the current experiment, the *Sesbania* is a potential plant species to be used as animal feed in this drought affected Rift Valley area.

Regarding to its ecological value as wetland vegetation, the submerged stems of *Sesbania* plants initiated mass of floating adventitious roots (Fig.4) protecting their stems, roots and nodules with spongy, aerenchyma tissue when inundated by water. Such type of root development is an ideal structure to form a buffer area that mechanically and biologically trap the incoming soil and other pollutants. This showed the potential of the *S. sesban* to trap the soil, nutrients and other pollutants eroded from the upper farm lands making a buffer zone in the shore area of a lake.

Theoretically, shore vegetation is a fish breeding ground, where broods lay their eggs; where young fish get shelter to escape from their predators, and get a variety of feed during and after the rainy season. Hence, *S. sesban* can provide these services as it was able to establish on a bare shore of the lake and survived the water logging condition. By occupying the shore area of the lake, the plant discourages the hauling of destructive beach seine in the Lake [8] which was recommended to be ban [23] in the Rift Valley Lakes to sustain the fishery sector. Moreover, *Sesbania* as a tree has a contribution in mitigating a climatic change by trapping carbon dioxide from atmosphere. It can also be used as agro forestry tree, shade tree for coffee and tea, fire wood, fencing wood, medicine in which aqueous extract of *S. sesban* reduced development of diabetic nephropathy in streptozotocin-induced diabetic rats [24].

4. Conclusion and recommendations

Among the three fodder plants tested to be grown in the shore of Lake Ziway, *S. sesban* has been well established and adapted to the water logged condition. This *Susbania susban* attained the desired ecological values such as buffer zone, fish breading ground, discouraging beach seine and rehabilitating the degraded wetland; and socio-economic values such as green feed for animals during the prolonged dry season that have drowned attention of the local people and the researchers. Having a multi-directional purpose, *Susbania susban* can be an ideal wetland fodder that can also alleviate the wetland degradation problem in Rift Valley Lakes.

Finally, it is recommended to quantify the buffering capacity in terms of soil sediment or nutrient load trapped by the plants; the number of *Susbania* rows required to control the erosion coming from a given area of farm land in the surrounding catchment; the dry mater yield produced for animal feed and its nutritional value before scaling up the technology.

5. Appendix

Pictures taken from the experimental sites

Fig 1: *Farmland in shore of Lake Ziway (left and center);* Siltation in Lake Abijata (right)

Fig 2: *Natural grass rehabilitated in the protected plot*

Fig 3: Established S. sesban in the shore of Ziway at 10 months (a) and 18 months (b) of age

Fig 4: Development of adventitious roots on the stem of S. sesban when covered by water

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