

The Impact of Invasive Alien species on Forage and Pasture Genetic Resource Diversity in Pastoral Area of Afar National Regional State, Northeastern of Ethiopia

Delessa Angassa

Ethiopian Biodiversity Institute, Addis Ababa, Ethiopia

email: delessa_2006@yahoo.com

Abstract— *Prosopis juliflora* is one of the most invasive species in arid areas of Afar region and protected area of Awash national park. The invasion of *Prosopis juliflora* increased at alarming rate devastating forage and pasture abundance and diversity that makes livestock rearing difficult; which ultimately affects the Afar pastoral livelihoods. The study focused on the impact assessment of impact of *Prosopis juliflora* on the forage and pasture diversity in the pastoral area of the region. Even though, the plant has several uses, it becomes out of control, deteriorates and reduced the diversity of forage and pasture species of the Region especially Amibara, Gewane and Buri Mudaitu Weredas by reducing their abundance, distribution and by changing grazing land ecosystem to *prosopis* thickets. This resulted in decrease in number of livestock per head of the pastoralists due to shortage of feed, decreased productivity of the livestock in terms of milk, meat and other products, migration of the pastoralists and their livestock to another place in search of feed source. Several control measures such as mechanical control, producing charcoal and collection of pods for feeding of the cattle has been implemented in the areas but lacks proper prevention and management methods of the plant. Thus, proper management and control of the invasive species and conservation of forage and pasture species are urgent issues for sustaining the livelihoods of the pastoral communities of the area.

Keywords— biodiversity, conservation, *Prosopis juliflora*, pastoral community, native trees.

I. Introduction

The Ethiopian pastoral areas are estimated to occupy about 61-65% of the total area of the country and are home to 12-13% of the total population. In addition, out of the total estimated livestock population of the country, the pastoral

areas constitute approximately 30% of the cattle, 52% of the sheep, 45% of the goats, and 100% of the camels^[1].

However, the pastoral areas are affected by recurrently occurring drought accompanied by mismanagement is leading to dramatic threats of the natural vegetation, deterioration of pasture both in quality and quantity and hence unable to sustain livestock production, which is the major occupation of the inhabitants. The more recent serious phenomenon is encroachment of native ranges and ecosystems in dry lands areas by exotic invasive alien species.

In the Afar region of North-eastern Ethiopia, *Prosopis juliflora*, *Azadirachta indica*, *Melia azadirach*, *Parksonia aculeata*, and *Delonix regia* are some of exotic species introduced to the area. *Prosopis juliflora* was intentionally introduced as an agroforestry species in Awash River Basin. Since recent years, the invasive nature of *Prosopis juliflora* has been revealed in the pastoral areas, protected area in Awash National Park and threatening the lives of the pastoral community and expanding at an alarming rate in the Region. The species spreads in a sporadic nature including in the wooden huts of the pastoral community. The major problems posed by *Prosopis juliflora* include invasion of the pasture lands which prohibited both the grazing and watering areas of the pastoral people, destroying grasses and displacing native trees and reducing the productivity of rangelands^[2]. This puts heavy pressure on the remaining pasture and browse able trees which leaves pastoral communities under frequent conflicts in the course of utilization^[3].

Thus, there is a need to gather and compile the available information on status and impact of alien invasive species of *Prosopis juliflora* on forage and pasture diversity of the areas before it is wiped out. Therefore the objectives to assess, generate and compile information on the influence

Prosopis juliflora on forage and pasture diversity in the pastoral areas.

II. Materials and Methods

The study was conducted in Amibara, Gewane and Buri Modeitu weredas of Afar National Regional State that were selected based on infestation of invasive alien species and treat level on the forage and pasture genetic resource with particular interest on *Prosopis juliflora*. The study was undertaken in collaboration with the Ministry of Agriculture and Rural Development offices of the areas and Awash National park.

To capture the information on the invasive alien species and the threat to the forage and pasture genetic material, a semi structures questionnaires and informal interviews with locally known elder pastoralists were conducted. Three kebeles were selected from each Weredas of Amibara, Gewane and Buri Mudaitu of the Afar Region and five locally known elder pastoralists were selected from each kebele.

III. Result and Discussion

Dispersal of *Prosopis juliflora*

The local known pastoralists told that *Prosopis juliflora* propagated through seeds and dispersed by domestic and wild animals. Different research findings confirmed their idea that *Prosopis juliflora* is propagated through seeds, root suckers and hardwood cuttings^[4]. The most important reasons for fast invasion of *Prosopis juliflora* in the area is due to the role of domestic animals (camel, cattle, sheep, goat and donkeys) and wild animals (monkey, warthog, rabbit, rodent and birds) in dispersal of seeds. Cattle are the major dispersers of *Prosopis juliflora* seeds followed by warthog, camels and goats. During the investigation, it was observed that areas previously used for grazing land were invaded by *Prosopis juliflora* but conserved areas were not invaded by the plant (Figure 1a and b).



Fig.1a: Elfora conserved grazing land



Fig.1b. Area invaded by *Prosopis juliflora* which is out of Elfora conserved grazing Camp

Uses of *Prosopis juliflora*

Fire Wood and Charcoal

The local communities and the urban dwellers are using *Prosopis juliflora* for cooking and heating. The local communities produce charcoal and sell the products to the urban dwellers even transported to major cities and used as a source of income. *Prosopis juliflora* is a good source of fuel wood with specific gravity of 0.7 or higher and the wood has been termed "wooden anthracite" because of its high heat content, burning slowly and evenly and holding heat well^[5].

Fodder, Shade and Fence

The leaves and pods are used as forage for cattle, Goat, Sheep, Camel and wild animals such as Warthog, Monkey, etc.. Foliage of *Prosopis juliflora* is rich in protein and minerals and is highly digestible, but the general unpalatability of the leaves to livestock severely limits the utilization of this resource as an animal feed. This is due to condensed tannins known to be present in the leaves of *Prosopis juliflora*. These are thought to be the primary determinants of leaf palatability for browsing ruminants^[6]. The value of leaves as browse depends on livestock species, which is palatable to goats, sheep and camels in decreasing order. However, during dry seasons or droughts when alternative sources of fodder are lacking, all livestock types will browse the foliage. Leaf age has a marked effect on intake, with leaf buds and young leaves being most palatable, possibly due to the low levels of tannins found in juvenile material. Palatability decreases as leaves mature and undesirable tannins, polyphenols and flavonoids are synthesised^[7].

Prosopis juliflora pods are used as a feed mainly for cattle but also for sheep, goats, camels and pigs. Pods are mainly used as forage, browsed directly from the tree or the ground below, rather than as a fodder, where the pods are collected and fed to stalled stock. Especially during the dry season, the pods of *Prosopis juliflora* are the main source of forage for livestock. However, the ingestion of pods alone over long period of time will result in death to cattle. Research

undertaken on consumption of rations containing up to 45% *Prosopis juliflora* pods was 1.5% of cattle body weight in India, with acceptable live weight gains [8]. Other studies have indicated that cattle rations containing less than 50% *Prosopis juliflora* pods lead to no adverse effects on consumption, digestibility, nutrient balance and animal health. However, there are several records of pods causing ill effects in livestock when used alone as a feed. This was assumed to be due to the regression of rumen bacterial cellulase activity due to the high sugar content of the pods. Rations containing *Prosopis juliflora* pods have been recommended for lactating animals, with milk production often said to improve following inclusion of pods in the ration. No effects on milk flavor were noted at less than 50% pods in the ration, though as a sole feed some taste change has been suggested [9]. It may be seen that pods have a valuable role either as forage for grazing animals, or as part of milled rations for stalled livestock. The tree is also useful for soil protection and as wind break. The local people use it as live fences, shade (both for human and livestock) as well as for ornamental purposes.

Negative Impacts of *Prosopis juliflora*

Forage and Pasture Diversity

Natural grazing lands (grasses, bushes and herbaceous plants) are the major source of feed for livestock in Afar region. According to pastoralists interviewed in Amibara, Gewane and Buri Mudaitu, forage grasses, browse trees and legume species were found abundantly before the invasion of *prosopis juliflora*. Currently, the natural pasture is decreasing in amount and some of the species are extinct from these areas. This is due to the invasion of *Prosopis juliflora* which covers the plains of grazing lands found in the Middle Awash following the Awash River banks. According to report obtained from Pastoralist Agriculture and Rural Development office of the area, all 9 kebeles of Gewane, 15 out of 18 kebeles of Amibara and 14 out of 19

kebeles of Buri Mudaitu Weredas are invaded by *Prosopis juliflora*. Only the hilly and mountainous areas are remained uninvaded by *Prosopis juliflora* in these areas.

There are different species of grasses, browse trees and legumes grown in the area. Among grasses/herbs *Cenchrus ciliaris*, *Chrysopogon spp.*, *Cymbopogon spp.*, *Andropogon canaliculatus*, *Eragrostis spp.* and *Dactyloctenium spp.* were affected by *Prosopis juliflora* invasion in the areas. Grasses such as *Cymbopogon spp.* and *Andropogon canaliculatus* are also used for other purposes like roofing the traditional thatch houses. Similarly, *Acacia hecatopyla*, *Acacia nilotica*, *Acacia mellifera*, *Acacia oerofea*, *Grewia spp.*, *Dobera glabra*, *Acacia tortilis*, *Cadaba rotundifolia* and *Salvadora persica* are major affected browse tree species. Among browse tree species, fruits of *Grewia spp.*, *Dobera glabra*, *Cordia sinensis* and *Balanites aegyptica* are eaten by human. According to information obtained from interviewed pastoralists of weredas, the invasion of *Prosopis juliflora* started 20 years ago and the invasion was increased at alarming rate and invades the natural grazing lands by destroying and displacing the above mentioned under growing grasses and browse trees and changes the area to unusable land which forms thick thickets of *Prosopis juliflora* population (Figure 2a and b). The areas of grazing lands invaded by *Prosopis juliflora* will be very difficult and costly (in terms of time, money and logistic sources) to turn back to its original state. [10] reported that *Chrysopogon plumulosus*, *Cymbopogon pospischilii*, *Andropogon canaliculatus*, *Eragrostis cylindriflore* and *Terapogon cenchriformis* were frequently mentioned grasses to have been affected by *prosopis juliflora* invasion in the region. Also among the indigenous trees, *Salvadora persica*, *Acacia tortilis*, *Acacia senegal*, *Cadaba rotundifolia* and *Acacia nilotica*, which are browseable, were perceived to be affected more than others the invasion of *Prosopis juliflora* (Table 1).

Table.1: Plant species perceived to be threatened by *Prosopis juliflora*[10].

Grass/Herbs		Tree/Bush	
Scientific name	Frequency	Scientific name	Frequency
<i>Terapogon cenchriformis</i>	77 (54.2)	<i>Acacia senegal</i>	81 (57.0)
<i>Tribulus zeyher</i>	35 (24.6)	<i>Salvadora persica</i>	93 (65.5)
<i>Setaria acromelaena</i>	41 (28.9)	<i>Cadaba rotundifolia</i>	79 (55.6)
<i>Eragrostis cylindriflore</i>	49 (54.8)	<i>Acacia tortilis</i>	86 (60.6)
<i>Chrysopogon plumulosus</i>	97 (68.3)	<i>Acacia oerfota</i>	67 (47.2)
<i>Ipomoea sinensis</i>	38 (26.8)	<i>Dobera glabra</i>	47 (33.1)
<i>Cyndon dactylon</i>	69 (48.6)	<i>Grewia tenax</i>	44 (31.0)
<i>Cymbopogon pospischilii</i>	96 (67.6)	<i>Acacia nilotica</i>	76 (53.5)

<i>Sedge species</i>	35 (24.6)	<i>Cordia Sinensis</i>	25 (17.6)
<i>Andropogon canaliculatus</i>	78 (54.9)		
<i>Cenchrus ciliaris</i>	39 (27.5)		
<i>Ipomoea aquatica</i>	6 (28.6)		
<i>Cyprus spp.</i>	18 (85.7)		
<i>Vossia cuspidata</i>	19 (90.5)		

* Note: The numbers in bracket show the percentage

Therefore, the invasion of *Prosopis juliflora* deteriorate and reduced the diversity of forage and pasture species of the Region especially Amibara, Gewane and Buri Mudaitu Weredas by reducing their abundance, distribution and by changing grazing land ecosystem to prosopis thickets. This resulted in decrease in number of livestock per head of the pastoralists due to shortage of feed, decreased productivity of the livestock in terms of milk, meat and other products, migration of the pastoralists and their livestock to another place in search of feed source. The pastoralists of Amibara, Gewane and Buri Mudaitu Weredas migrated to the border of Somali National Regional State which caused conflicts between Ethnic groups in the past and economic and social crises of the pastoral communities that resulted from forced displacement from their home and grazing lands.



Fig.2a: Area invaded by *Prosopis juliflora*



Fig.2b: Previously conserved grazing land found in Amibara wereda

Control Methods of *Prosopis juliflora*

Mechanical Control

Manual clearance of *Prosopis juliflora* either in groups or individually is practiced by majority of pastoralists and they claimed that this practice aggravate the invasion. This is due to the fast regenerating nature and ability of the plant from the remnant root and stem stock and covering a lot of area in short period of time have discouraged the local people to continue their controlling activity. ^[4]Found out those individuals stumped 10 cm below ground did not regenerate after a couple of months, however, those individuals cut at any height above ground had high regeneration. Hence, cutting individual plants above ground may aggravate the invasion by *Prosopis juliflora* unless proper management such as repeated clearance is employed. On the other hand, information obtained from Worer Agricultural Research Center revealed that cutting the plant 20 cm below the ground was effective in controlling the invasion of *Prosopis juliflora* population.

Producing Charcoal

The interviewed pastoralists of Amibara, Gewane and Buri Mudaitu Weredas told that *Prosopis juliflora* was introduced to Middle Awash especially around Worer areas and dispersed to Gewane and Buri Mudaitu weredas. In these areas, the *Prosopis juliflora* strongly established itself and form thick thickets and serve as seed bank for the areas. In order to control the invasion of *Prosopis juliflora*, the Regional Government gave permission of producing charcoal for individual and group of people in these weredas (Figure 3). Since it was started in limited areas, no much effect was seen on the control of the invasion. On the other hand, there was deforestation leftover of *acacia spp.* from the area and are used for charcoal producing.



Fig.3: Charcoal produced from *Prosopis juliflora* in Gewane wereda

***Prosopis juliflora* Pod Collection**

Seeds retained in intact pods are the main source of dispersal and propagation of *Prosopis juliflora*. In order to prevent and decrease the dispersal of seeds in the areas, Sideha Fage Cooperative association was established before four years in Amibara wereda of Melka Sedi town and the association comprises of 90 members. According to information obtained from the members, the association focuses on the activities that control the invasion of *Prosopis juliflora* by producing Charcoal from *Prosopis juliflora* and collecting pods from their surroundings. The association has two pods milling (one big and one small) and sells 1 kg of grinded *Prosopis juliflora* pods at 2.75 birr to the pastoral communities and urban dwellers (Figure 4 a and b). The members explained that the grinded *Prosopis juliflora* has no negative effect on the health condition of the livestock. But, these activities are limited Melka Sedi town and its surrounding and have not brought visible change on the prevention and control of *Prosopis juliflora* invasion.

Considerable research has been undertaken on the use of milled pods in livestock rations, particularly in Brazil and India. Pods would be ground or milled to secure the full nutritive value as most of the protein rich seeds, otherwise pass undigested through the digestive tract of livestock. Whole pods *Prosopis juliflora* were found to provide 7%

digestible crude protein and 75% total digestible nutrients on a dry matter basis. The digestibility of crude protein from *Prosopis juliflora* pods was 50-60%, with the average digestibility of ether extract being 70%, crude fiber 80%, nitrogen free extract 79% and organic matter 74% [8].



Fig.4a: collected *Prosopis juliflora* pods



Fig.4b: Grinded pods of *Prosopis juliflora*

IV. Conclusion

The invasion of *prosopis juliflora* especially in Amibara, Gewane, and Buri Mudaitu Weredas of Afar Region continue at alarming rate due to lack of proper prevention and management methods. Despite of their use, the invasive species brought huge loses of grass and browse biodiversity in the area and displacing pastoralists from their areas. It is advisable to set priority to the areas where forage and pasture genetic resources are under extinction like the Afar Region because of invasive species which are prevailing all over the Regions. Since the advent of this exotic species, a great numbers of cattle, goats, sheep and camels as well as considerable number of wild life have been lost due to shortage of feed and the poisoning of the plant. Therefore, the possible attention must be given to this hazardous instance to alleviate and mitigate the disastrous phenomenon of invasion and conservation of threatened species of forage and pasture biodiversity.

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