



Perceptions, use, and impacts of *Prosopis juliflora* alien plant in Taita Taveta County, Kenya

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Abstract

This study investigated the perceptions, uses, and impacts of mesquite (*Prosopis juliflora*) in Taveta Sub-County, Kenya. A total of 314 individuals were randomly selected from four wards, ensuring representation across age, gender, wealth, and occupation. Additionally, four focus group discussions were conducted with 78 participants (47 male and 31 female) were held in four locations within the pastoral and agropastoral communities. Data were collected through semi-structured questionnaires, focusing on community perceptions, impacts, and uses of *Prosopis juliflora*. The coverage of *Prosopis* was perceived to have increased by 98% of the respondents, with this high percentage indicating the spread was very fast in both the grazing areas and within homesteads across all the wards over the last 5-10 years. Regarding the origin of *Prosopis juliflora*, 63% of the respondents indicated that it was introduced by colonial veterinary workers. The *Prosopis* plant was perceived by 66% of the respondents to have reduced the availability of pastures. On the eradication of the plant, 79% of the respondents reported difficulty in eradication. The majority of the respondents (75%) indicated that the plant was harmful to both humans and livestock due to the poisonous thorns. Also, the majority of the respondents (54%) indicated that *Prosopis juliflora* reduces soil fertility. Among the three most common uses of *Prosopis* were as a source of firewood (64%), charcoal (24%), animal feed (23%), and as shade (13%). Poisonous thorns were cited as the major negative impact by 56% of the respondents. Despite these negative perceptions, the study suggests that *Prosopis juliflora* can be utilized to enhance livelihoods and food security in the region. Strategies for sustainable management and utilization of this invasive species should be explored to mitigate its negative impacts while maximizing its benefits.

Key words: Impacts; perceptions; *Prosopis juliflora*; respondents use

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Introduction

Species whose introduction into an area threatens the habitats, ecosystem, and other indigenous species are referred to as invasive alien species (Suietnov and Tulina, 2021). Biodiversity and the population of most ecosystems are usually affected by these invasive species (Lazzaro *et al.*, 2020). Loss of biodiversity is contributed to and derived by the fact that these species are very competitive, have a high germination and reproduction rate, and finally are favoured by their dispersal mechanisms (Pysyk *et al.*, 2020). Additionally, most invasive species usually have no known predators or parasites to help contain their spread and abundance in an area. The distribution and spread of these invasive species also change the available resources in an area, especially in areas that face ecological disturbance and stress (Finch *et al.*, 2021).

Although some of these species can be used for livestock production, they may also harm the animals, interfere with grazing lands, reduce livestock yields, and incur high maintenance and management costs (Panda *et al.*, 2018). Additionally, these invasive species impact rural livelihoods due to the affected resources, health threats, high management and control costs, and lower ecosystem productivity (Shackleton *et al.*, 2019). It is also observed that these effects further threaten human welfare and food security in most rural areas. Therefore, the management, control, and maintenance of these species require a comprehensive understanding of these pathways to implement appropriate management strategies (Barbet-Massin *et al.*, 2018). This will also enable the development of more effective interventions and strategies that will help combat invasion by these species.

In Kenya, the mesquite (*Prosopis juliflora*) species covers approximately 2% of the country and has invaded most Arid and semi-arid areas (ASALs) such as Taita Taveta, Tana River, and Isiolo Counties, among others (Choge *et al.*, 2022). The densest thickets of the *Prosopis* plant found in Taita Taveta County have currently begun to colonize grazing lands making it challenging to control and manage its spread (Githae, 2018). One of the challenges most developing countries face in controlling and managing the *Prosopis*

invasion is the fact that there is very limited information in literature on the invasion rate and impacts of the plant (Okumu, 2021). Little data exist on these factors hence the need for more research. New strategies, methods of control, and interventions applicable in developing countries should also be implemented to ensure efficient control (Eshete *et al.*, 2021). Lastly, very little information has been given on the socio-economic impacts of the *Prosopis* invasion and its spread and distribution rate. Therefore, the specific objectives of this study were to assess the community's perceptions and use of *Prosopis juliflora* and evaluate the perceived impacts of *Prosopis juliflora* on the livelihoods of farmers in Taita Taveta County, Kenya

Materials and methods

Study Area

The socio-economic study was conducted in Taita Taveta County, Taveta Sub-County, where data was collected in four administrative wards, namely Chala, Mata, Mahoo, and Mboghoni in Taveta Sub-County.

Taita Taveta County, Kenya, is located approximately 280 km southeast of Nairobi and about 60 km west of the Tanzanian border, at around 38.3565° E and 3.3969° S. The county covers a total land area of 17,083 km² and has a population of approximately 340,671 (KPHC, 2019). The region experiences semi-arid to arid conditions, with annual rainfall ranging between 300 mm and 1,200 mm. Temperatures vary between 14°C and 29°C, influenced by altitude and proximity to Mount Kilimanjaro and the Indian Ocean.

Study design

This was a cross-sectional survey conducted in four wards, which were purposively selected due to the abundance of the *Prosopis* plant.

Sampling and sample size determination

The questionnaires were administered to 314 respondents from four wards, namely Chala (84), Mahoo (75), Mata (79), and Mboghoni (76) respondents). The respondents were purposively selected from the four wards in order to ensure representation of different ages, gender, wealth categories, and occupations.

The sample size was determined using the Cochran (1963) formula $n = Z^2 * p * q / e^2$

Where n=Sample size, Z=z score, p=the estimated population proportion of users of *Prosopis juliflora*, q= the estimated population proportion of the non-target population, and e= the margin of error. For this study, assuming a confidence level of 95% (corresponding to $Z = 1.96$), a large population of unknown variability in the proportion that are users of *Prosopis juliflora*, therefore $p=q=0.5$ (maximum variability), and a margin of error of 5% (corresponding to $e = 0.05$):

$$n = (1.96^2 * 0.5 * 0.5) / 0.05^2$$

$$n=384.16 \approx 385$$

The sample size determined using the formula arrived at 385 households to be interviewed, but only 314 were interviewed due to logistical challenges in accessing the target population.

The key information collected during questionnaire administration focused on the community perceptions, use, and impacts of *Prosopis juliflora* in the area.

Household interviews

The enumerators were trained by the researcher on the Open Data Kit (ODK) platform to facilitate data collection and ensure consistency in the process. They had to be familiar with local norms and languages and conducted the interviews in English, Swahili, and the local language of the inhabitants to facilitate communication and understanding. Before data collection, the questionnaire was pre-tested by six enumerators in one household each in the study area, and the results were used to refine the questionnaire.

The household survey involved interviewing household heads to gather comprehensive data on how households perceived, utilized, and were impacted by *Prosopis* in Taita Taveta. A total of 314 questionnaires were filled out during the household survey.

Focus Group Discussions (FGDs)

Four FGDs comprising a total of 78 participants (47 males and 31 females) were held within the pastoral community of Mata ward (Salaita village: 11 males, and Njoro village: 17 males), and the agropastoral communities of Chala ward (Chala Kati C village: 14 males, 9 females) and Mbogholi ward (Kitobo village: 5 males, 22 females). The FGDs were carried out to help gain a more comprehensive understanding of how the local

community perceived *Prosopis juliflora*, its uses, and its social, economic, and environmental impact on their wellbeing. Two FGDs were held with pastoral communities and were attended exclusively by men due to cultural norms and taboos that prescribe the segregation of spaces for men and women. Local leaders, extension officers, chiefs, and farmers' group leaders, who were key informants in the study, were invited to the FGDs. Participants were allowed to express themselves through focused topics relating to *Prosopis*

Key Informant Interviews (KIIs)

The KIIs played a critical role in gathering insights from individuals with relevant expertise. The key informants selected for these qualitative interviews included sub-county extension officers and community leaders. The interviews delved into the experiences of key informants regarding the perception, utilization, and impact of *Prosopis juliflora*.

Through these interviews, valuable insights were gathered on the community's interactions with *Prosopis juliflora*, the challenges and benefits associated with its presence. The information shared by key informants provided a more informed view of *Prosopis*, which contributed to a deeper understanding of its role within the local ecosystem and its effect on community livelihoods and the environment in Taita Taveta.

Statistical analysis

Data from the questionnaire was exported to Excel from ODK, cleaned, sorted, and transferred to the Statistical Package for Social Sciences (SPSS) software for analysis. Generated descriptive statistics, such as means, frequencies, and percentages, were used to analyze community perceptions, uses, and impacts of *Prosopis juliflora* in Taita Taveta County, Kenya. Data collected from FGDs and KIIs from different were analyzed and compared with the responses provided by the respondents in the household survey to identify similarities, and any discrepancies, and enhance the credibility of the findings.

Results

Social-economic characteristics

The distribution of demographic and socio-economic characteristics of respondents is summarized in Table 1.

Table 1*Social-economic characteristics of respondents in Taita Taveta County, Kenya(%)*

Characteristic	Percentage of respondents per Ward				Total (%) (n= 314)
	Chala (n=84)	Mahoo (n=75)	Mata (n=79)	Mboghoni (n=76)	
Gender					
Male	57.1	48.1	52.0	64.5	55.4
Female	42.9	51.9	48.0	35.5	44.6
Total (%)	100	100	100	100	100
Age					
18-35	34.7	40.1	44.7	26.5	36.5
36-60	59.2	51.9	42.4	60.3	53.4
>60	6.1	8.0	12.9	13.2	10.1
Total (%)	100	100	100	100	100
Education level					
No formal education	6	13.3	36.7	11.8	16.9
Primary	58.3	50.7	44.3	55.3	52.2
Secondary	33.3	21.3	11.4	27.6	23.6
Tertiary	2.4	14.7	7.6	5.3	7.3
Total (%)	100	100	100	100	100

At least 55% of the respondents were males. Except for Mata ward, more than 50% of the respondents in all the other wards were aged between 36-60 years, while 50% had attained a primary level of education. In Mata ward, only 44% of respondents had attained the primary level of education (Table 1).

Type of farming practices

The majority of respondents (73%) practiced mixed farming with a minority practicing monocropping (10%) or keeping livestock only (17%). However, there was variation in this trend in Mata ward, where those keeping livestock only (52%) were more than those practicing monocropping (47%) because the ward mainly comprises of a pastoral community (Table 2).

Table 2

Type of farming practiced in Taita Taveta County, Kenya (%)

Type of farming practiced	Percentage of respondents per Ward				Total (%) (n= 314)
	Chala (n=84)	Mahoo (n=75)	Mata (n=79)	Mboghoni (n=76)	
Mixed (Crop/livestock)	78.6	84	46.8	81.3	72.7
Crops only	10.7	10.7	1.3	18.7	10.3
Livestock only	10.7	5.3	51.9	0	17
Total (%)	100	100	100	100	100

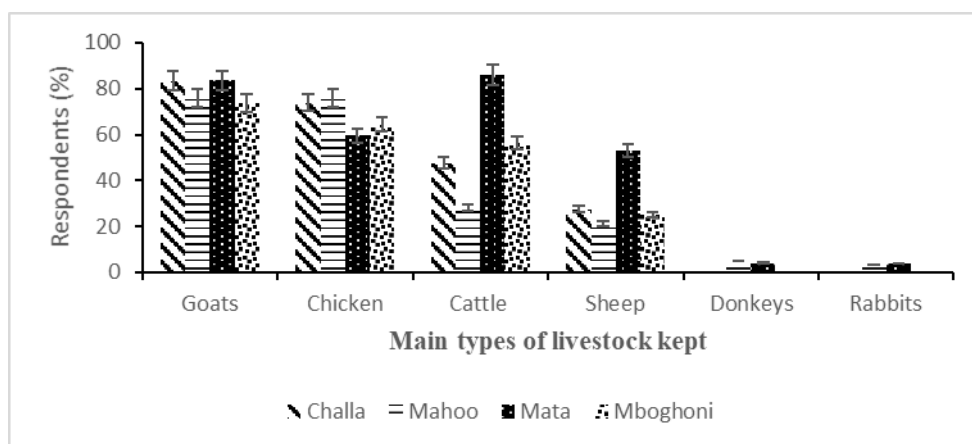
Types of livestock kept

Cattle ownership varied significantly, with Mata ward having the highest number of cattle (86%) while Mahoo had the lowest (28%). Mata also had the highest percentage of respondents (53%)

keeping sheep, while donkeys and rabbits were less common, where only a few respondents reporting having them (Figure 1).

Figure 1

Main types of livestock kept by farmers in Taita Taveta County, Kenya



Perceptions on Prosopis invasion in Taita Taveta County

On the origin of *Prosopis juliflora*, more than 63% reported that they thought it was introduced. In all the wards, 88% of the respondents reported that the rate of spread of the weed was fast and that it had negatively affected them, with 66% indicating that it reduced the availability of pastures (Table 3). More than 60% of all the

respondents reported that they found it difficult to eradicate the *Prosopis* plant, and 75% indicated that the plant was harmful to both humans and livestock and that *Prosopis* reduces soil fertility (Table 3).

Table 3*Perceptions (%) On Prosopis invasion in Taita Taveta County, Kenya*

		Respondents per ward (%)				
Characteristic		Chala (n=84)	Mahoo (n=75)	Mata (n=79)	Mboghoni (n=76)	Total n=314
Origin of Prosopis	Indigenous	26.2	49.3	35.4	36.8	37.0
	Introduced	73.8	50.7	64.6	63.2	63.0
Rate of spread over the last 5-10years	Fast	86.2	89.0	90.6	86.2	88.0
	Slow	2.1	2.5	1.2	1.1	1.1
	Don't know	11.6	8.5	8.2	12.7	10.3
Prosopis reduced the availability of pastures.	Yes	63.1	60.0	60.8	81.6	66.4
	No	36.9	40.0	39.2	18.4	33.6
Ease of eradication	Easy	28.6	10.7	36.7	7.9	21.0
	Difficult	71.4	89.3	63.3	92.1	79.0
Harmful to humans and livestock	Yes	75.0	76.0	87.3	61.8	75.0
	No	25.0	24.0	12.7	38.4	25.0
Effect on soil fertility	Improves fertility	42.8	60.0	44.3	36.8	46.0
	Reduces fertility	57.2	40.0	55.7	63.2	54.0

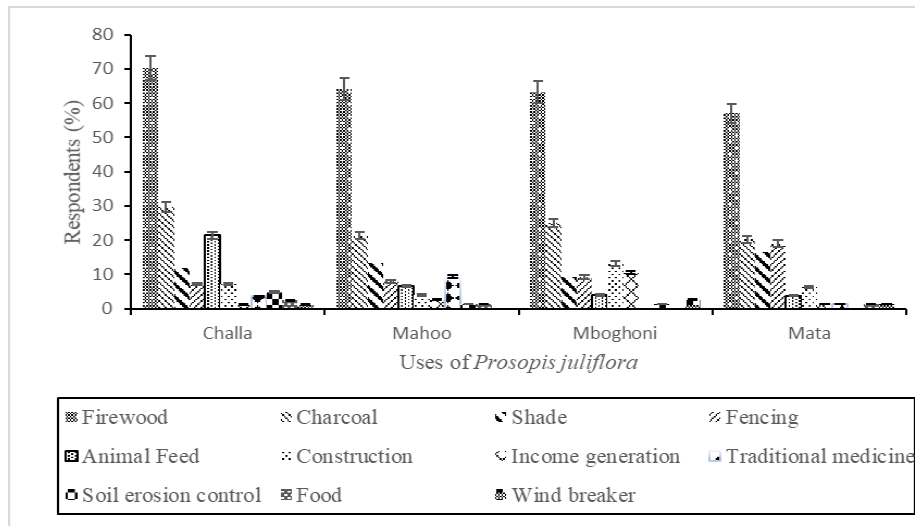
Uses of Prosopis juliflora in the study area and income generated from the sale of its charcoal

In terms of uses of prosopis, 64% of the respondent reported using it as a source of firewood and 24% for charcoal while in Challa ward 21% reported using it as an animal feed. Other uses included shade, fencing, animal feed,

construction, income generation, traditional medicine, soil erosion control, food, and a wind breaker, which was reported by $\leq 10\%$ of the respondents (Figure 2).

Figure 2

Uses of Prosopis juliflora in Taita Taveta County, Kenya

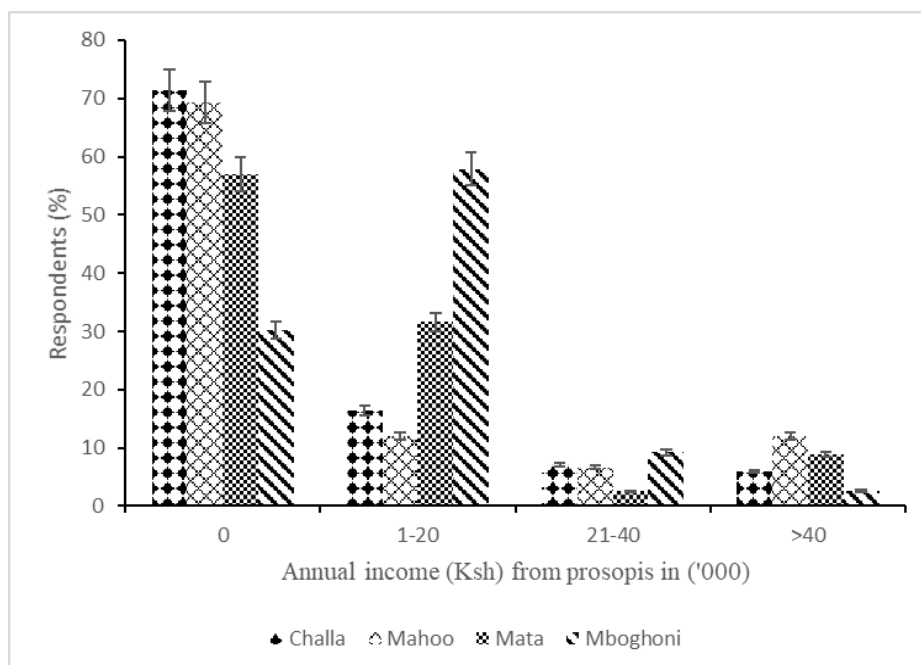


Except for Mboghoni, where 58% of the respondents reported generating income of between KES 100 – 20,000 from prosopis, majority (71%) of the respondents in Challa ward, 69% Mahoo, 57% Mata, and 30% Mboghoni generated

zero income. Less than 10% of the respondents reported generating between KES. 20,001- 40000 from the weed (Figure 3).

Figure 3

Estimated annual income (Kshs) from Prosopis juliflora charcoal sale in Taita Taveta County, Kenya



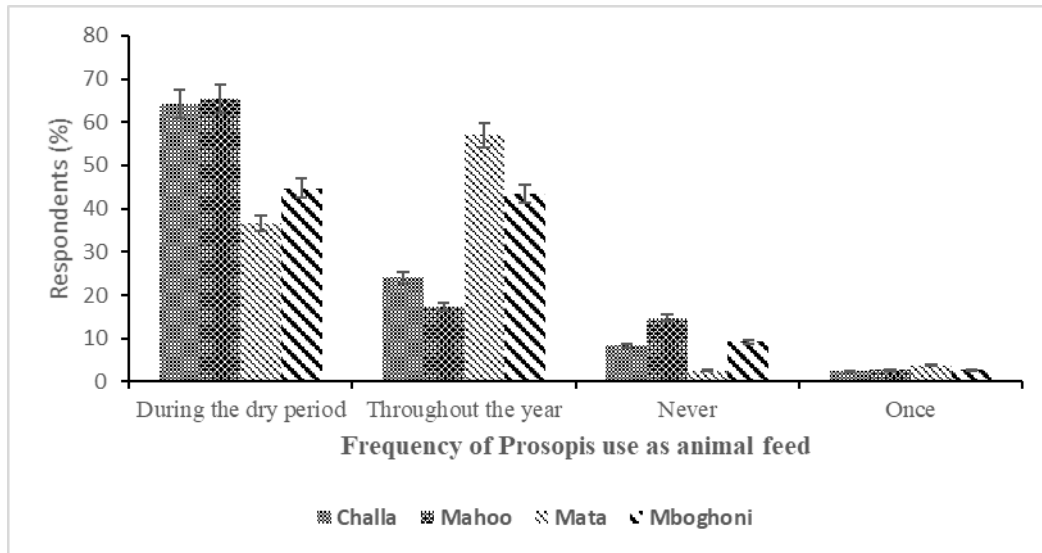
Use of prosopis as animal feed

Most respondents (53%) used Prosopis during the dry period, and 35% all year-round. Challa (64%) and Mahoo (65%) primarily used it during the dry period, while Mata (57%) relied on it

year-round. Less than 10% of respondents in each ward reported never using it or using it only once (Figure 4).

Figure 4

Frequency of Prosopis use as animal feed in Taita Taveta County, Kenya



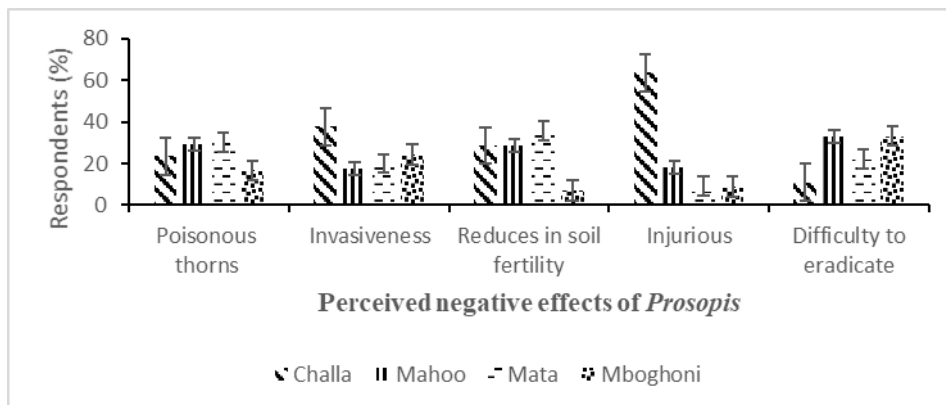
Negative impacts of Prosopis juliflora

Challa reported the highest concern about Prosopis being injurious (64%), while Mahoo and Mboghoni reported significant difficulties in

eradicating Prosopis (33%). In Mata, 36% of respondents reported that Prosopis reduced soil fertility (Figure 5).

Figure 5

Perceived negative effects of Prosopis juliflora in Taita Taveta County, Kenya



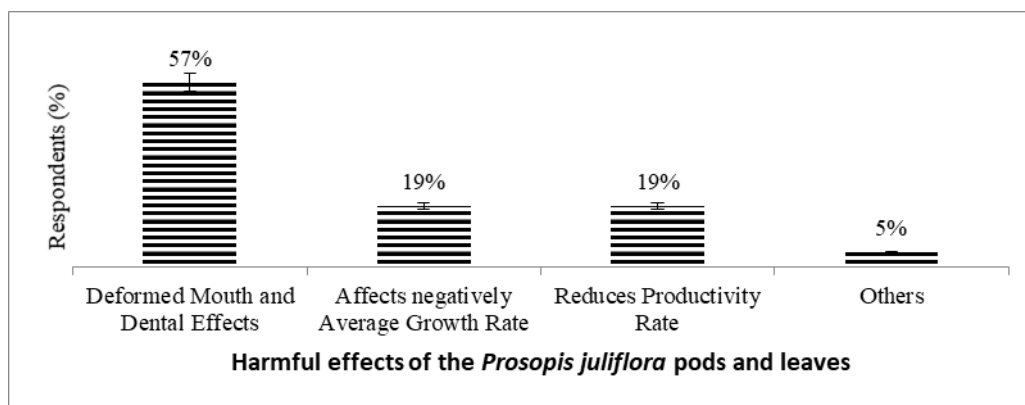
Harmful effects of excessive *Prosopis juliflora* consumption on livestock

According to the majority of the respondents (57%), livestock consuming *Prosopis* pods negatively resulted in deformed mouth and dental effects, while 19% reported that *Prosopis* pods and leaves negatively affected both the

average growth rate and productivity rate (milk yield and fertility rate) of livestock. A few (5%) reported other harmful effects of *Prosopis* on animals, such as the death of livestock when they starve as a result of not being able to chew feed properly due to loss of teeth (Figure 6).

Figure 6

*Harmful effects of the *Prosopis juliflora* pods and leaves to livestock in Taita Taveta County, Kenya*



Discussion

Perceptions on the effects of *Prosopis juliflora* plant invasion

Most of the respondents perceived that *Prosopis* was introduced (Table 3). According to Akwee and Nambafu (2023), the *Prosopis juliflora* plant was introduced in Kenya in the 1970s in Mombasa and 1980s in the Baringo region. It was promoted by government agencies and organizations like the National Irrigation Board and Kenya Forestry Research Institute to combat desertification and fuelwood shortages (Shackleton *et al.*, 2014) and continued to be introduced to other areas, such as Taita Taveta, Turkwel, and Tana River in an initiative to reduce desertification and to provide firewood and shade, among other uses.

Prosopis was introduced to various regions to benefit the pastoral communities, it has negative impacts (Mbaabu *et al.*, 2021). The positive and negative perceptions on the introduction and spread of *Prosopis* may be attributed to its impacts on the farmers' activities and livestock growth and health (Degefu *et al.*, 2022). The

negative perception may be due to negative impacts such as land degradation, invasion of croplands and rangelands, and effects on human and animal health (Zeray *et al.*, 2017). The rate of spread of *Prosopis* in the region was perceived as high. The perception of respondents on the rapid spread and invasion rate of *Prosopis* species in Taita Taveta County could be attributed to the fact that the species has reached most of the cultivation land and near water sources in the region as observed by the respondents. The findings of this study are similar to those reported by Shiferaw *et al.* (2019) who found that the rate of spread of *Prosopis juliflora* continues to increase and may become the dominant plant species if left uncontrolled or unmanaged.

The overall perception of the respondents in Taita Taveta County about *Prosopis juliflora* was mostly negative. This was influenced by its rapid rate of spread, reduction in the availability of pastures, harmful to humans and livestock (because of the poisonous thorns), and effects on cultivated lands and soil fertility. The findings of this study are similar to those reported by Degefu *et al.* (2022) that *Prosopis* invasion had several negative effects, such as reduction of soil moisture,

reduction of pasture sources, physical injuries to livestock and pastoralists, and land unusable for agriculture by affecting soil fertility. In addition, a study by Huho and Omar (2020) reported that the majority of the respondents in Garissa region, Kenya, have a negative attitude towards the *Prosopis* species due to the factors stopping them from exploiting the plant. These factors include a lack of a reliable market, price fluctuation, poor roads, and a lack of natural enemies or favorable climate to control the species' spread (Huho and Omar, 2020).

More than (20%) of the farmers had a positive perception of the plant depending on the amount of income generated from the species, how the species meets the farmers' financial needs, the occupations of the respondents, and the low level of damages caused by the farmers' land. Others can also be biased in their opinion depending on factors such as management and control of *Prosopis*, the aesthetic nature of the plant and the general view of the media (Mudoio, 2022).

Uses of Prosopis juliflora

The majority of the respondents in Taita Taveta County generated between Ksh. 0- 20,000 from *prosopis*. The income generated was low, and this could have been attributed to the fact that harvesting of the plant is very challenging since it has poisonous thorns, yet it can provide tons of biomass suitable for charcoal production. A study by Shiferaw *et al.* (2020) reported that 11% and 3.2% of respondents in Awash Fentale and Amibara districts, respectively, earned income from *P. juliflora* charcoal production. *Prosopis* pods are sold and used as livestock feed in most drought-stricken areas since they survive even during long periods of drought (Hussain *et al.*, 2021).

Perceived negative effects of Prosopis juliflora

The majority of the respondents in Taita Taveta County reported that *Prosopis* plants have poisonous thorns that cause injuries to both humans and livestock. The findings are similar to those of Hussain *et al.* (2020), who reported that livestock often sustain injuries from *P. juliflora* thorns, which can also cause skin septicemia on scratching or cause injuries in humans. *Prosopis* thorns cause flesh injuries and wounds in livestock. In addition, *Prosopis juliflora* causes alterations in soil properties, which cause an

increase in moisture content, bulk density, and organic carbon content, thus affecting ecosystem functions and soil health (Shiferaw *et al.*, 2019). A study conducted by Kumar and Viswanathan (2016) about the invasion of *Prosopis* reported that it is difficult to eradicate *Prosopis* due to its ability to grow quickly and its invasive nature.

Harmful effects of the Prosopis juliflora pods and leaves on livestock

Pastoralist communities in Kenya have reported dental effects of *Prosopis* in their livestock, especially goats (Mutavi, 2020). These dental problems occur when an animal chews very hard pods (Hussain *et al.*, 2020). Some animals have ended up with disfigured jaws (Hussain *et al.*, 2020), tooth decay and tooth loss have also been reported, and sometimes the animal may have difficulty eating and chewing, thus starving to death (Huho and Omar, 2020). Animals also suffer from a neuron disease that affects their physiological activities when they consume more than 20% *Prosopis* leaves in their diet (Zapata *et al.*, 2021). The disease, often called denervation atrophy, affects livestock's well-being and is mostly attributed to the juliprosopine and juliprosine compounds (Hussain *et al.*, 2020).

Inhabitants of areas invaded by *Prosopis* in Kenya, such as Baringo, Tana River, and Garissa Counties, have also reported that overfeeding of livestock on the pods leads to digestion impairment, mortality, diarrhoea, and livestock sickness (Hussain *et al.*, 2020). The *Prosopis* leaves also contain high amounts of tannin that may lead to constipation in livestock (Chaudhary *et al.*, 2018). In these areas, it has been reported that when animals feed on the pods directly, the seed gets stuck in the livestock's rumen, leading to illness (Hussain *et al.*, 2021). This is because the *Prosopis* seeds have a hard to crack or digest coating that can cause constipation and blockages in animals (Hussain *et al.*, 2020).

Conclusion

The study revealed a predominantly middle-aged population in the study area, with a significant proportion of respondents possessing a primary level education. These demographic characteristics influenced livelihood strategies, with mixed farming being a common source of

income, particularly among those with limited educational opportunities. The findings underscore the need for targeted interventions to support sustainable livelihoods in areas affected by *Prosopis juliflora* invasion. Further, the findings of this study reveal that the community in Taita Taveta County, Kenya, perceives *Prosopis juliflora* as a significant environmental challenge. Respondents reported a decline in pasture quality and soil fertility, attributed to the invasive nature of the species. Additionally, the thorny nature of *Prosopis juliflora* poses a threat to both livestock and humans, hindering agricultural activities and human safety.

Despite its negative impacts, the study also highlights the community's recognition of the potential benefits of *Prosopis juliflora*. The species can be utilized for various purposes, including fencing, income generation, shade, windbreaks, food, traditional medicine, soil erosion control, construction materials, and as feed for livestock. These findings underscore the complex relationship between the community and *Prosopis juliflora*. While the species presents significant challenges, it also offers opportunities for sustainable resource management. Future research and interventions should focus on developing strategies that mitigate the negative impacts of *Prosopis juliflora* while maximizing its benefits for the local community.

Recommendations

The recommendations from the study include: National and county governments should implement targeted education and skills training programs to equip the communities with the knowledge and skills necessary for diversified livelihoods.

Community-based organizations (CBOs) and NGOs should encourage community-led initiatives to manage *Prosopis juliflora* through activities such as manual removal, grazing, and profitable use of the weed, such as incorporation into animal feeds.

Local Entrepreneurs and Business Development Agencies should promote the development of value chains for local products, including those derived from *Prosopis juliflora*, to increase income

generation opportunities.

It is also recommended that long-term studies to assess the ecological and socioeconomic impacts of *Prosopis juliflora* invasion and the effectiveness of management strategies should be conducted. Further research to document and promote indigenous knowledge related to the use and management of *Prosopis juliflora* to inform sustainable practices should also be conducted.

Conflict of interest

The authors declare that they have no conflicts of interest.

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