Impact of *Ipomoea Hildebrandtii* Vatke on Abundance of Native Grass in Namanga, Kajiado County

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Abstract

Invasive plant species are listed among the five drivers of global change because they pose a great threat to biodiversity and unfortunately are gradually restructuring the Kenyan savannah. Studies indicate that I. hildebrandtii is a native invasive species in Namanga which has aggressively spread threatening the natural resources with negative environmental effects. However, there is no data on plans and consistency aimed for the eradication of I. hildebrandtii. Therefore, this study sought to assess the abundance and methods of eradicating the invasive Ipomoea hildebrandtii in Namanga County. A total of 24 (20m^2) quadrats together with 120 (1m^2) was used to collect data from homesteads, hilly places, pasture land, road side and water source points located across five different villages namely: Olnga'rua, Kiluani, Inkati, Olmankeki and Narook-Lukunu. Abundance and Simpson's index of diversity was determined from the data that was collected. These findings reveals that the abundance of I. hildebrandtii differs from different localities as well as its impact due to availability of resources. It also highlights the need to consistently eradicate I. hildebrandtii because it has the ability to outcompete other plant species in Namanga if not well managed.

Keywords: *Ipomoea hildebrandtii*, Abundance and Diversity, Native species, Invasive plant species, Indigenous knowledge, Quadrat sampling.

Introduction

An invasive plant species is an introduced native or non-native species that spread beyond its areas of introduction making its morphological and physiological features abundant. In normal situations, migrating plant species are unable to establish well in new habitats as they quickly die out.

Once an invasive plant species has been established in a habitat, it alters the conditions of that environment completely due to its proliferation (With, 2002). Many invasive species are termed as harmful ecologically and pose socio-economic impacts (Nkombe *et al*., 2018). Invasion of indigenous invasive species in the rangelands, particularly pasture lands cause a decline in livestock production due to grass depression (Manyanza, 2018). For invasive plants, successful invasion may be related to superiority in competition with native species.

Kenya too has experienced plant invasion and there is a lot of research and monitory on invasive plant species. Invasion of an exotic species involves long distance transport to a suitable habitat where it becomes well establish, later spreads and becomes abundant in the area. These invasive plant species are characterized by rapid growth rate, highly reproductive and extensive proliferation (Zenni *et al*., 2014). I. hildebrandtii has caused significant problems on the rangelands and pasture land in Namanga Kajiado County.

This species is not only occupying the disturbed areas but is rapidly spreading to other areas. To alleviate the invasion, different eradication methods have been studied though the eradication is still slow, inadequate and labour intensive. However, indigenous methods of eradication need to be studied intensely so as to improve the rangelands in Namanga. This study proposes the use of biological methods in the eradication of *I. hildebrandtii.*

Materials and methods

Description of the study area

Namanga is found in Kajiado County which lies between longitudes 360 5' and 370 5' East and Latitudes 10 0' and 30 0' South. The County covers an area of 21, 292.7 sq km (Km^2) with an estimate population of 999,819 persons (Kajiado-CIDP) 2013) (Fig. 1). Namanga is located at a latitude of S 2˚32′39.8″and longitude E 36˚47′20.2″. The survey was carried out across five different villages in Namanga County namely: Olnga'rua, Kiluani, Inkati, Olmankeki and Narook-Lukunu. Quadrat method was used to determine the abundance of Ipomoea hildebrandtii.

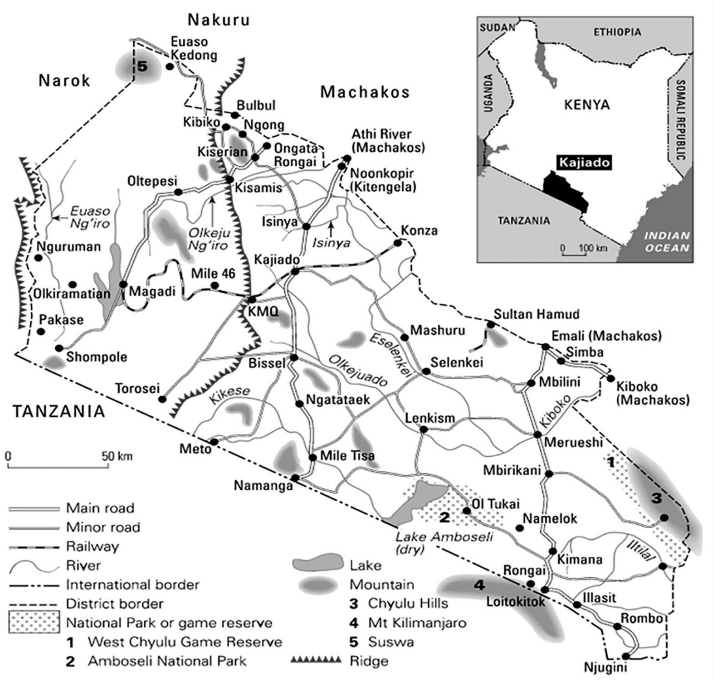

Figure 1: An administrative map showing the location of Kajiado county and Namanga in Kenya

Source: https://www.ascleiden.nl/Pdf/workingpaper66.pdf

Climate and Economic activities in Namanga

Namanga is part of Arid and Semi-Arid lands which receives an average rainfall ranging from 300-800mm. Short rains are experienced in the month of October and December while long rains fall between the month of March and May. Namanga is primarily inhabited by the Maasai people who practice nomadic pastoralism and subsistence agriculture in well-watered areas. Traditional diet of the Maasai people comprises of raw blood, milk, honey, meat and tree bark (Roulette *et al*., 2018). Currently, economic activities of Namanga has increased as it cease to depend only on pastoralism and tourism (Kessy *et al.*, 2018; Shebe, 2020). Crop growing is another economic activity which is highly practiced by majority of the population in Namanga (Sikira & Mamuya, 2016). Cultural and economic factors in Namanga contribute to the locals level of education (Saitakwet, 2012).

Data collection

Quadrat Method

Quadrat sampling method was selected in this survey because it is more efficient to assess both the richness and abundance of *I. hildebrandtii* as it ensures that the number recorded are respective for the habitat. A total of 24 (20m^2) quadrats together with 120 (1m^2) nestled within the larger quadrats were surveyed to provide the data required for the study. Quadrats were laid at a regular distance of ten metres (10m) along a line transect of 150m

as shown in Figure 2. The goal was to reveal whether the invasive species is competing with the native grass and herbs for the limited resources. This was verified also by the use of Simpson's index which was used to show the diversity.

In order to assure that the areas were well covered, sampling was done in the following sites roadside, hilly places, pastureland, water source (rivers and riverside) and homesteads. These study sites were precisely selected to cover and reflect the characteristics of the study area. The number of quadrats laid were distributed as follows: 24 quadrats were laid in each of the selected five villages, out of the 24 quadrats, 5 were laid in the roadside, pastureland, water source and homestead while 4 were laid in hilly places.

Abundance of *I. hildebrandtii* was determined from the multiple quadrat samples. The data collected was used to determine the abundance within the entire habitat. The number of *I. hildebrandtii* were determined from each quadrat per m². Finally the total number of *I. hildebrandtii* was summed up from all the quadrats. To get the abundance, the formula below was used to calculate.

$$\text{Abundance} = \frac{\text{Total number of } \textit{I. hildebrandtii} \text{ in all quadrats}}{\text{Total number of species in all quadrats}}$$

Quantitative analysis was employed on the data collected from the quadrats. These were meant to help the researcher in making some predictions on how the abundance of the invasive species can be reduced and finally eradicated.

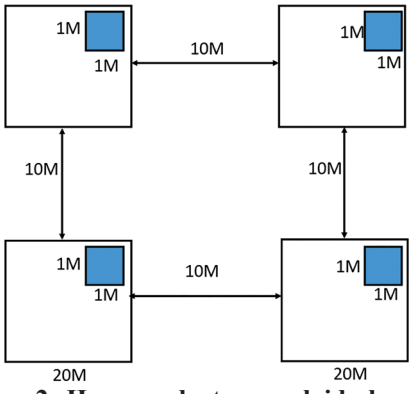

Figure 2: How quadrats were laid along the transect

Questionnaire

The data from the questionnaire was used to document the possible methods that can be used to eradicate *I. hildebrandtii* among the Maasai community in Namanga Sub-County. It employed descriptive survey to analyze. This approach provided relevant and accurate information to the researcher. For the respondent (40 locals) the survey employed judgmental and purposive sampling method in the selection of the respondent. First it enabled the researcher to save on time. It also help the survey to get sufficient information from the small population, valuable content was equally attained and it enabled the survey to squeeze a lot of information out of the data that was collected. Qualitative analysis enabled the researcher to obtain insights and understanding from the respondent due to their real experience and opinions from the invasive I. hildebrandtii. In addition, it enabled the researcher to remain focused on the intention of the survey.

Results

Abundance of *Ipomoea hildebrandtii*

The study sought to first establish the abundance of *I. hildebrandtii* and then enumerate the abundance of native grass and herbs in the roadside, hilly places, pastureland, riverine and homesteads sites in Namanga. The grass species included *Eragrostus superba* (Maasai love grass), *Cenchrus ciliaris* (foxtail grass) and *Enteropogon macrostachyus* (rye grass) while the herbs included *Vachellia tortilis* (Oltepesi), *Vachellia mellifera* (Oiti), *Salvadora persica* (Oremit) and *Balanites aegyptiaca* (Olong'osua). The result shows variation in the number of *I. hildebrandtii* in the five study sites. Overall, the results in Table 1 revealed that *Ipomoea hildebrandtii* is abundant in different localities in Namanga area. The values from the individual site are significant because of the availability of resources which are essential for the growth and development of the invasive species. From the hilly area, with 65 % which is the highest percentage could be due to the presence of moisture and minerals from the weathering rocks and decomposing debris. This area too experiences little or no disturbance so once *I. hildebradntii* has been established

thrives well. Equally, the roadside showed equally high level of invasion with 58%. This could be attributed to frequent disturbances along the roadside as human and animals move which lead to more spread of the invasive species. Vehicles too have been attributed to be very good dispersers (Mack & Lonsdale, 2001). From the survey 50% of invasion was recorded in the homestead this could be due to availability of water from the house chaos and minerals from the livestock manure from the cowshed near the homestead. This signifies that despite the disturbance, its deep rooting, tolerance and herbivore defense enables it to continue sprouting (Zedler & Kercher, 2004). Water source areas has significantly high level of 47% due to the availability of water for the invasive species.

Methods of eradicating *I. hildebrandtii*

Achievement of invasive species management plans to remove the species and restore the ecosystem. From the information given by the locals regarding the methods commonly used in the eradication of *I. hildebrandtii*, it is evident that there are several possible methods which can be employed in the eradication as indicated in Figure 3 below. The main eradication technique used by the respondents to suppress is by "uprooting and burning them this was expressed by the majority who were (52%)". This is a local way of management and despite it being labour intensive, it guarantees total eradication. One of the disadvantages is that when uprooting is done, this can cause soil disturbance which can in turn favor more invasion. To minimize the disturbance, a special traditional wooden tool "ortage" is used. (Gallardo *et al.*, 2019).

Table 1: Abundance of *Ipomoea hildebrandtii* in Namanga sub-county

Site	Grass	Herbs	*I.hildebrandtii*	Total	Simpson's index	Abundance
Hilly places	1540	1406	1905	4851	0.998	65%
Roadside	201	202	234	637	0.895	58%
Homestead	761	856	801	2418	0.993	50%
Riverine	1213	696	899	2808	0.995	47%
Pastureland	473	465	354	1283	0.974	37%
						51%

Source: Primary Data

Finally, the lowest percentage of *I. hildebrandtii* in pasture land areas could be attributed to human settlement and high level of disturbance in these area. This makes the locals to uproot it immediately after sprouting as they carry out their daily activities of herding and farming.

From the above Simpson's index values are as follows 0.993 for the homestead, 0.974 for the pasture land areas, 0.995 for the water source places, 0.998 for the hilly places and 0.895 for the roadside. Simpson's diversity index measures how diverse a community is. It also takes into account the relative abundance of each species. As species richness and evenness increase, so also do its diversity is considered to be high. The high index indicates a good diversity of the *I. hildebrandtii* population (Musese *et al*., 2020).

16 % of the total respondents felt that minimizing the number of livestock will help to curb the invasive *I. hildebrandtii*. Overgrazing has been known to cause disturbances thus contributing to the spread of invasive. As the animals move within the rangelands in search of pasture they too become potential dispersers as they carry seeds and fragments of *I. hildebrandtii* in between their hooves. Reducing their movement can be achieved by having some protected areas which should not be grazed into by looking for alternative methods of getting the livestock foliage example by planting of hay.

The third method with (10%) of the respondents entails cutting the overgrown *I. hildebrandtii*. This offers short term solutions as sprouting can reoccur. It thus needs to

be continually done after sprouting until eradication has been achieved. This makes it to be expensive as other follow up methods need to be used for total eradication to be achieved.

Surveillance, control, eradication and early detection, use of chemicals and planting of other crops were other methods which accounted for 6% each. It mitigates any potential damage which can be caused by the species. Once the intervention has been done they provide early warning information which degraded areas. Moreover, cultivating beneficial plant life will help slowly to reduce the spread of *I. hildebrandtii* (Fig. 4) and restore the balance to these natural rangelands.

4% of the locals felt clearing and cultivation of the farms is effective as it helps one to remove any visible plant species or plant fragments as well as any debris. This is effective as it becomes routinely in that when one is cultivating the land, it is automatically that the farmer will uproot any invasive species which is sprouting.

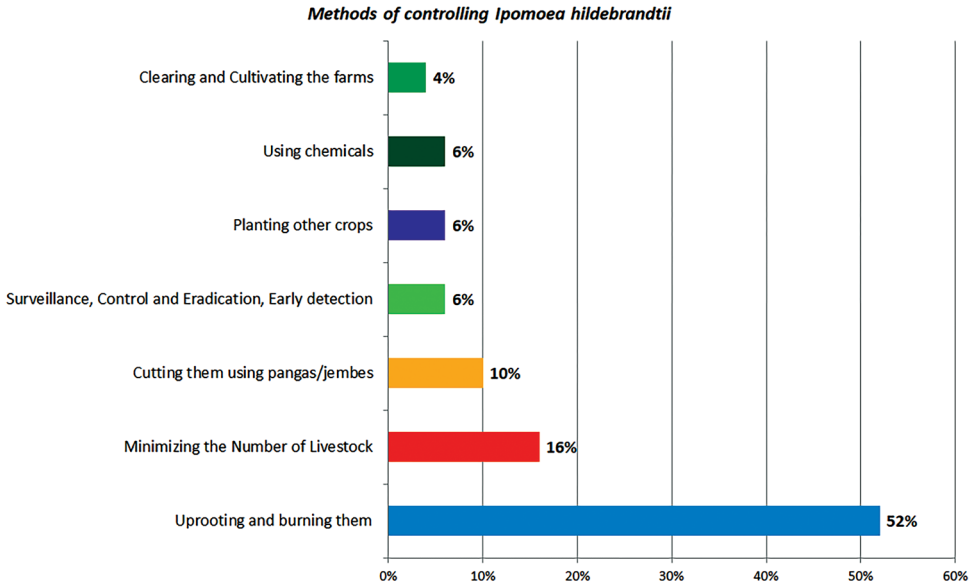

Figure 3: Methods of Eradicating *Ipomoea hildebrandtii*

help the stakeholders to intervene and prevent the spread. It was further observed that other 6% of the respondents had used chemicals to control *I. hildebrandtii*, in small scale set up. Herbicides represent one of the most powerful tools for invasive plant species management in the range lands (Gaskin *et al*., 2021; Tataridas *et al*., 2022). One of the herbalist indicated that there is an organic herbicide known as Orkonyil (Rhamnus prinoides) which is known to eradicate *I. hildebrandtii* having no effects on other plant species though very little about it has been done.

Moreover, few 6% of the respondents felt that planting of other crops especially the native grass and herbs is still another method of controlling the spread of *I. hildebrandtii*. They felt that these would restore the disturbed and

Figure 4: Picture of An Overgrown *I. hildebrandtii* in Namanga Rangelands

In all the eradication methods, a rigorous and disciplined follow up are necessary in order to have the best results.

Discussion

Ability of *I. hildebrandtii* to out compete other plant species has been evident in the area. Presence of bare ground below the shrub of the invasive species indicated the great decline of the grass species which is of great importance to this region. This significantly indicates that the native invasive species is posing some threat to both the grass and the herbs. These results into reduced livestock and wildlife forage as well as reduction in livestock production and quality. The ground too being bare makes it to be prone to soil erosion.

Secondly, *I. hildebrandtii* occupies a greater space on the ground than the native grass and the herbs. This is a threat to the biodiversity of the area as the other plant species are disappearing at a high rate and the area is being colonized by *I. hildebrandtii.* It is clear that herbs and grass are very vital among the Maasai community for medicinal value and livestock respectively. (Manyeki *et al.*, 2015) stated that forage plants mostly herbaceous and few browse species have either declined or disappeared due to the presence of invasive species.

Rangelands needs to be well managed due to their resources which include forage production, wildlife habitat improvement and crop farming as well. For proper management of *I. hildebrandtii*, it is necessary to understand the biology, ecology, vectors of spread and the most appropriate methods of invasive plant species management. It is necessary to ensure that there is collaboration which should include strategies and actions which should be continually improved for better management results. This will ensure that control is based on relevant knowledge of potential damage, the cost of control methods and the impact which has already been caused by *I. hildebrandtii* and the control measures. This information aims at increasing awareness so that various stakeholders will take action to effectively manage the threats.

Grazing areas especially the riparian lands needs to be well managed. This ensures that pasture improvement and rehabilitation on the degraded land has been achieved. Effective grazing management practices prevent excess damage of the stream banks, soil erosion, forage and other native plants when they are most susceptible to grazing related stress. Most of the herbivores seek the most palatable forage which are constantly found in riparian lands. Riparian zones can be also managed by fencing them in order to limit livestock and wildlife access which in return prevents erosion. Planting native vegetation which include native grass, shrubs and trees should be done.

Rehabilitation is meant to ensure rangeland stability and functionality. On the other hand, restoration is meant to bring back the proper functioning of the ecosystem. This is necessary so as to restore the ecological function and to prevent further infestations of the native plant species. Successful management is required to protect and enhance the natural environment, the social wellbeing and economic vibrancy. After rehabilitation and restoration prevention strategies remains the most efficient management tool. This is cost effective as it avoids invasion and their costs prevention and eradication. In order to ensure consistency in rehabilitation a permanent body with explicit management strategies has to be established to regulate the system. The body should be strengthened through allocation of resources identify and control *I. hildebrandtii* management at a wider national scale.

Conclusion

Invasive plant species effects runs through various global disciplines which include: loss of native species, food security and loss of natural resources among others. This study indicated that *I. hildebrandtii* is abundant and dispersed in Namanga. Due to its abundance across the rangeland, some of the grass species have eventually been wiped away. It is likely that *I. hildebrandtii* is a colonizer herb thus competing for the available resources through seeding and propagules. This is clearly indicated from the data gathered using the quadrats and its correlation value with grass and herbs which indicates very high correlation as indicated by the Simpson's index of diversity. The potential

of the invasive species to be thriving in these areas (homestead, water source areas, hilly places, roadside and pasture land) clearly shows that I. hildebrandtii is a great threat in the areas. In addition, there is decrease in pasture and grass as well as other plant species in the area. Most of these plant species commonly used for medicinal value have also decreased. There is still clear evidence from the respondent that some of the land have actually been left with little or no economic activities taking place there. The results can be used in predicting the spread of I. hildebrandtii by informing in the conservation efforts and developing policy relevant for curbing the spread. Systematic monitoring to detect changes on the risk is required. This will prevent the altering of the abundance and diversity of other native species which are important to both wildlife and livestock.

Acknowledgements

The authors would like to acknowledge the catholic scholarship program for funding this research. Special thanks goes to the community of Namanga who cooperated by providing valuable information throughout the study.

Declaration of Conflict of Interest

I Jane Wangari Maina, hereby declare that this research work is my original work achieved through diligent personal reading and research and has not been submitted before for the award of a degree in any other university or for any other award. All the sources that have been used or quoted have been cited and acknowledged in the references.

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