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Key Informant Perceptions on the Invasive *Ipomoea* Plant Species in Kajiado County, South Eastern Kenya

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Abstract: Invasion of rangelands by undesirable plant species is one of the challenges facing rangeland productivity and to an extension livestock production in East Africa. They have affected communities in different ways in areas where they grow. Focus group discussions and interviews were held in two sites in pastoral and agro-pastoral regions of Kajiado County to get perceptions of farmers, livestock keepers and other stakeholders concerning the invasive plant species Ipomoea. This was accompanied by visits and field excursions to areas heavily infested by the invader species. The interviewed key informants agreed that the plant has more detrimental effects to the environment, ecologically and to the economy of the region. There is need for urgent interventions involving all stakeholders to curb the spread of the species, which is currently at an unprecedented rate. These include efforts by relevant institutions such as Government, Non-Governmental institutions through mobilization, training and capacity building and demonstrations in order to reverse the trend. Any trainings should however include aspects of recovery of invaded and degraded land primarily through pasture improvement and other interventions as this will enhance the utilization of these areas for increased livestock productivity and reverse degradation.

Keywords: Invasion, Ipomoea, Rangelands, Semi-Arid Lands

1. Introduction

Invasive plant species are hazards that have shown negative environmental and socio-economic impacts in East African drylands (Obiri, 2011). They have led to degradation of the environment leading to serious impacts on local communities' resource base. Invasive species remain one of the most understudied in developing countries (Pysek et al., 2008). In semi-arid rangelands, based on their impact and effect on grazing areas and natural pastures, invasive species cause massive losses in livestock production.

The livestock sector contributes to about 42% of the agricultural Gross Domestic Product (GDP) of Kenya. In the arid and semi-arid lands (ASALs), characterized by extensive rangeland grazing systems, livestock accounts for about 90% of employment and 95% of households derive their incomes from this subsector (Nyariki et al., 2005). Changing production systems have resulted in different degrees of degradation and productive capacity. Overgrazing has particularly impacted negatively on vegetation resources and biodiversity in general (Nyariki et al., 2009). In the rangelands, the major feed resource base is natural pastures found in communal grazing areas and individual farms as well.

Invasion by shrubs has been cited as one of the major causes of range deterioration in the Southern rangelands (Macharia, 2004). One of the species, which is a problem invasive species in natural and established pastures in Kajiado County, is Ipomoea spp. The species has been described as one of the most undesirable forage species for grazing livestock (Lusigi et al., 1984). Ipomoea spp. is a creeping annual herb, widespread in the semi-arid districts of Southern Kenya, which colonizes and spreads rapidly immediately after the onset of the rainy season (Mganga et al., 2010a). The species is mainly found in disturbed or degraded sites. The plant exhibits most characteristics common to invasive species, which include capacity for

rapid growth and so expansion, capacity to disperse and reproduce widely or by nurturing fewer progeny but with great efficiency (Emerton and Howard, 2008). The species also capable of effective competition with local species – for food, space, light and water.

Key informants are an important source of information and knowledge. The focus of this study was to better understand perceptions from farmers, pastoralists and key informants on the invasive weeds mainly in pasturelands and croplands in Mashuru and Kajiado Central divisions of the semi-arid Kajiado County.

2. Materials and Methods

2.1. Study site

The study was conducted in Kajiado County, of the Southern rangelands of Kenya. The climate of the region is arid to semi-arid falling between zone IV and V with very little potential for rain fed cropping. The mean annual rainfall ranges from 300-800 mm with a bimodal pattern experienced, the long rains are received in March to May while the short rains last from October to December. The vegetation varies from open grasslands, bushland to wooded grasslands with different distinct associations. Soils found in the region are predominantly shallow red sandy soils resulting from different soil formation processes and geological associations (de Leeuw et al., 1991). The predominant land use and management system in the region is free range grazing with the main livestock species kept being cattle and small stock. In most locations of Kajiado central, grazing land is used communally and individually, while livestock is managed by individual families.

2.2. Methodology

Two cluster sites were purposively selected based on the extent of the *Ipomoea* spp. invasion, - Kajiado central (Olbelbel and Sajiloni) and in Mashuru (Mashuru and Nkatu). The two sites were settled on after a consultation with government and non-government departments who identified these areas in the county as highly infested with *Ipomoea* spp. A survey questionnaire tool was then developed to capture the farmers' perceptions on the most problematic weeds and the challenge they pose in pasture and crop fields. The team adopted a participatory methodology in carrying out the study where key informant persons in administration and ministries in charge of State Department of Agriculture, Livestock and Fisheries (MoALF) in Kajiado were consulted and followed by intensive one-on-one interviews. In addition, focus group discussions (FGD) were conducted to triangulate the information obtained from key informants. Two FGDs and four key informant interviews were conducted. Visits to some of the remote areas that are highly infested were done with guidance of the local community.

3. Results and Discussion

3.1. Origin of the Weed

According to the informants, the causative agent of the invasive species was reported as overgrazing and climate change. Unique climatic episodes cited was the 1997/98 *el nino* rain events, believed to have brought about the species in agreement with what was reported by Macharia P. N. (2004). In as much as frequent droughts and rainfall events also cause changes in vegetation attributes, the plant is reported to have been in the region as early as the 1960s (Kedera and Kuria, 2003); and had simply increased (Macharia and Ekaya, 2005). In East Africa, origins and patterns of introduction of invasive species are however not known (Gichua et al., 2013).

3.2. Extent and Spread

Visual estimation by authors of this work place the spread of the plant in different heavily infested localities in Kajiado at 60% - 80% of the pasturelands. This is corroborated by results from the FGDs from which participants estimated the degree of invasion in pasture fields at 65% and 50% respectively in Kajiado Central and Mashuru areas of the county. The degree of invasion was however less for crop fields (10% for both sites) – mainly due to the low number of persons practicing crop production.

Continued degradation due to poor management, has however encouraged the establishment and spread of *Ipomoea* species. Invasive species can enter and establish in a disturbed or degraded habitat more easily than into a system that is stable (Emerton and Howard, 2008). Invasive plants are known to have characteristics of non-native species favouring local conditions and being more vigorous than native species. These include attributes such as unpalatability, formation of thickets, production of spines and thorns, allelopathic effects, toxicity to animals and fire tolerance (Mworia, 2011). More so, some of the species are able to produce many seeds that have long dormancy which tolerate the dry seasons. These attributes are in agreement with what was mentioned by the participants in reference to *Ipomoea* spp. Its ability to out-compete other existing grass and forage species in Kajiado County was also mentioned and noted by the farmers. This is through competition for nutrients and water from soil due to its aggressive growth nature.

Table 1. *Physiognomic features and environmental conditions for Ipomoea establishment.*

Features	Kajiado Central	Mashuru
Terrain	Lowland levels (flat land)	Flat and gently sloping areas
Soil	Black cotton and Red soil	Red soil
Rainfall	Normal rainfall	Little rainfall
Others	Highly overgrazed lands Drastic change in climate leading to land degradation hence – opportunistic weeds	Highly overgrazed lands

3.3. Physiognomic and Environmental Features Preferred by the Plant Species

The conditions required for *Ipomoea* establishment are summarized in Table 1.

The community indicated that the plant prefers red soils although it can also be found in black cotton soils. Mostly *Ipomoea* spp. weeds are found in lowlands although they can also be found in the fairly sloppy lands. The onset of rains normally herald a resprouting of the seeds that are dispersed over the season upon drying.

3.4. Control of Invasive Ipomoea Species

Past and present attempts of technologies and innovations to control *Ipomoea* spp. invasion, source of the information, mode of dissemination and effectiveness were also assessed in the area. These are outlined in Table 2.

Table 2. *Past control strategies of Ipomoea spp in Kajiado County.*

Innovation/ technology	Source	Mode of dissemination	Effectiveness*
Manually uprooting using small equipment	Own initiative	Learn from neighbours	Fairly effective
Hand removal of young seedlings	Own initiative[1] and ASAL programme[2]	Seminars	Effective
Application of soda Ash	ASAL programme[2]	Training and Demonstration	Not effective
Spraying using chemicals	ASAL programme[2]	Training and Demonstration	Not effective

*Very effective, effective, fairly effective, not effective
[1]Both done in Olbelbel and Sajiloni
[2]Happened only in Olbelbel

Only hand removal and manual uprooting were found to be effective in both sites while the others were not effective at all. The manual removal has specifically been applied in localized areas such as individual grazing fields or around compounds. It is also an advantageous method due to its selective nature and avoidance of non-target species. A repeated follow-up control however is generally required, as well as subsequent rehabilitation measures, because disturbed ground and soil erosion in cleared areas may encourage re-invasion (Boy and Witt, 2013). Two examples of fenced sites, previously invaded, had been reclaimed through manual removal followed by pasture establishment and management. This represents a success story in the region. The benefits of hand removal are high in the short term, although for this to be sustained in the long term.

Other methods that have been tried in the same region include chemical control and other integrated approaches, in which soda ash and wood ash were applied to freshly cut stems stumps of the plant in an attempt to dry them up. However, success of managing the weed was not realized during these initiatives, tested by a local non-governmental organization (NGO). Instead, according to one participant, there was an incidence of increase of the species in one area where the plants were cut and soda ash applied to the fresh stumps.

3.5. Control Constraints

Table 3 shows the perceptions on controlling the weed species by the community.

Table 3. *Summary of community perception constraints associated in controlling Ipomoea species.*

Attribute	Kajiado	Mashuru
High financial* cost	√	√
High technical skill required	×	×
Low benefit of controlling *Ipomoea*	×	×
Labour intensive	√	√

*On average an acre would cost KES 4,000 ($40) on manual uprooting in the two sites
√ = Yes, × = No

The high cost and the labour intensiveness being the key reason to failure of control and eradication of the weed. Perceptions on constraints associated with controlling *Ipomoea* spp. were similar in the two sites. Manual removal of the weed, being the most appropriate and beneficial option for many, was ranked as expensive and labour intensive initiative. An excursion visit to some farmers who have heavily invested in uprooting of the weed revealed information that the initial costs of control are very high. One pastoralist, whose 20-acre farm was heavily infested with the weed, spent Ksh. 36, 000 (about $360) to uproot some of the plants at part of the farm. Based on farmer estimates, up to Ksh. 4000 ($40) had been spent to control the weed per acre, which is high and unaffordable to many farmers and livestock keepers. However, those interviewed mentioned a subsequent reduction in control costs in the subsequent season. This is because there are only a few new and young plants that are easy to uproot having grown or sprouted.

Table 4. *Summary of community perceptions on the positive and negative effects of Ipomoea spp.*

Custer site	Positive	Negative
Kajiado	Sources of honey production Concoction of its leaf sap and water used to control fleas	Reduction in pasture* Bitter honey that also cause dizziness During flowering it causes flu Poisonous when eaten by animals Restricted access and movement
Mashuru	Sources of honey production Beautiful flowers – aesthetic value	Reduction in pastures* Chickens get sick when they feed on flower Bitter honey which also causes dizziness

*noted as the most important effect of the invader species in all the sites.

3.6. Positive and Negative Effects

Positive and negative consequences of *Ipomoea* spp. were

also enumerated by the community. They are summarized in the Table 4.

The notable effect of invasive *Ipomoea* spp. was the reduction in pastures in the grazing lands at both sites. The weed poses the greatest challenges to pasture and eventually livestock production in semi-arid rangelands of Kenya. The plant has managed to colonize most of the grazing regions in the sites visited. Fresh and heavy biomass of *Ipomoea kituiensis* has been reported to suppress the growth and development of the grasses underneath it resulting in high incidences of grass seedling mortality. This is through deprivation of sunlight necessary for normal photosynthetic function. The net effect is the poor establishment of grasses with much of the denuded areas remaining bare after the end of the rains (Mganga et al., 2010b). *Ipomoea hildebrandtii, has* been reported to depress native grass biomass production in addition to changes in site hydrologic and nutrient dynamics patterns in Kajiado County (Mworia et al., 2008).

During the dry season, out of desperation, livestock may sometimes feed to some invasive species resulting in serious health hazards and even death if ingested. Though no cases for cattle mortality were reported by the participants, there is a possibility that livestock may feed on the species since it remains green even during the dry season. All these lead to reduced carrying capacity in the long run and economic losses for the community.

Other effects of the invasive *Ipomoea* species noted elsewhere include toxicity to grazing wild animals. *Ipomoea carnea* species seeds have been reported as a threat to wild herbivores when ingested (Lahkar et al., 2011). Kajiado County is home to many ungulates roaming the community conservancies and plains. Impacts on wild herbivores are likely to be similar to those reported for livestock. In general, all informants agreed that the species causes more negative effects than positive hence no benefits are accrued from it. However, ecologically, invasive species have the potential for carbon sequestration depending on plant traits. Such traits include wood and lignin concentration, fire resilience and tolerance, resprouting, deep rooting and herbivore defence traits (Mworia, 2011). *Ipomoea* spp found in the region possess some of these traits.

Table 5. *Ranking of possible options and strategies in controlling the spread of Ipomoea spp.*

Listing in order of importance	Kajiado Central	Mashuru
1	Use herbicide to eliminate *Ipomoea*	Use Herbicide to eliminate *Ipomoea*
2	Holistic community advocacy to remove *Ipomoea*	Financial aid for labour costs to remove the plant
3	Train in pasture improvement and rehabilitation of degraded land	Train in pasture improvement and rehabilitation of degraded land
4	Financial aid from different partners or government	N/a
5	Sensitisation on management of rangelands	N/a

3.7. Possible Control Mechanisms and Approaches

The farmers revealed key research areas and possible strategies of controlling the invasive *Ipomoea* spp. weeds. These are summarized in Table 5 in order of importance for the two sites.

Research on appropriate herbicides for a complete elimination of Ipomoea weeds topped the lists. All possible solutions are to be accompanied by extensive training on pasture improvement that is lacking in the two sites.

Due to the costs and limited success of the control of invasive species, many government institutions across the globe have abandoned the management of these species hence their continuous spread and establishment (Borokini and Babalola, 2012). The participants suggested the need for financial aid for holistic elimination of this weed, possibly from the County and Central Governments, in initiatives such as money-for-work programs. These would go a long way in controlling invasive species as well as employment creation by involving the youth.

The best method of management of invasion however remains the prevention of establishment and spread (Borokini and Babalola, 2012). For semi-arid grazing lands in the Southern rangelands, rehabilitation of degraded grazing lands using natural pastures such as Cenchrus ciliaris, Enteropogon macrostachyus and Eragrostis superba is beneficial due to the competitive advantage these species possess in suppressing weeds such as Ipomoea kituiensis (Mganga et al., 2010b). Cenchrus ciliaris in particular is primarily recommended because of its allelopathic properties and deep root system hence the necessity to include the species in any reseeding initiative (Mganga, 2009). Application of organic fertilizers hastens the process of recovering such lands. Having many species in an area, that is, high biodiversity also helps in control and prevention of invasion (Obiri, 2011). In this case, rehabilitating degraded areas with many different grass species mixtures is recommended as well as other plant species. This would subsequently result in invasion resistance.

4. Conclusions and Recommendations

Short-term solutions that have been applied in the management and control of the spread and impact of the species are not adequate. There is need for an integrated approach involving other initiatives such as rangeland rehabilitation through reseeding to restore severely degraded areas – an opportunity to prevent the problem of invasion from occurring. Training and advocacy on pasture improvement and suitable range management practices to conform to the changing conditions remain key. The trend in many parts of Kajiado leans towards land privatization hence fenced demonstrations for a village; responsible model famer groups and/or individuals are ideal initiatives of control of invasive *Ipomoea* species and other weeds. Of course, economic and ecological analysis of the process of eradicating or controlling invasive species indicates that the

most cost-effective and least environmentally damaging method is spread prevention. In addition, more research should also focus on the potential benefits and use of these invasive species in semi-arid regions.

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