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KEYNOTE ADDRESS

Alien plant invasions in sub-Saharan Africa – status, prognosis and key challenges

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Africa is rapidly being invaded by a host of invasive alien species (IAS), transforming landscapes into "green deserts" and reducing agricultural productivity. Despite the fact that the vast majority of people in sub-Saharan Africa (SSA) rely on natural resources for their very survival, most countries in the region have done little to address the issue of IAS, especially the threat posed by invasive plants. This can mainly be attributed to a lack of relevant policies and/ or their enforcement; insufficient capacity to deal with the issue, especially the management of invasive plants; and little awareness as to the threats posed by IAS.

Although there are some systems in place to prevent the introduction of IAS, the focus is mainly on agricultural and forestry pests, with no adequate measures in place to prevent or manage the insidious threat posed by invasive plants, with the possible exception of aquatic weeds. Governments have allocated some resources to the control of aquatic weeds through the introduction of host-specific biological control agents, but the introduction of agents for terrestrial invasive plants has generally been hampered by "conflicts of interest". This is mainly because of the absence of a regulatory framework and scientific methods for evaluating costs and benefits.

Many of these issues can be addressed if governments can be convinced of the threats posed by invasive species, not only to biodiversity but also water resources, food security, human health and economic development. More research needs to be undertaken to assess impacts in order to resolve conflicts over management and use of invasive species. Resources also need to be found to build capacity, create awareness and implement control strategies. Mechanical and/or chemical control methodologies are usually employed to manage troublesome plants in Africa with little investment in biological control, despite the fact that biocontrol agents are readily available in many countries which share these weeds. It is imperative that bigger investments be made in the integrated management of invasive plants, especially with regard to biocontrol, which is considered to be the most cost-effective management strategy for developing economies.

KEYWORDS: barriers; biocontrol; Invasive Alien Species; prevention; sub-Saharan Africa

INTRODUCTION

The majority of people in Africa, especially those living in rural areas, are largely dependent on natural resources for their survival. These include native plants which are used, amongst others, as building materials, fodder, firewood and herbal medicine. Most of those living in the countryside are also small-scale farmers, mainly growing food for their own consumption but also trading any surplus produce. Many of these small-scale farmers own livestock which are grazed on natural pasture adjoining croplands. Livestock products contribute significantly to the health and, in many cases, the wealth of poor rural populations. This dependence on the natural resource base makes poor communities especially vulnerable to the introduction and

proliferation of invasive alien species (IAS) which gradually erode the ecosystem services on which they all depend. Despite the considerable impact that IAS have on poor communities in Africa, little is known about their distribution and, more importantly, impact.

This paper provides a review of the importance of the natural resource base to people in Africa and attempts to ascertain as to why we know so little about IAS on this continent. It provides details as to the major barriers to effective invasive alien plant management in Africa and makes some recommendations as to how the current situation can possibly be resolved.

DISCUSSION

Native plants are widely utilized in Africa for a variety of purposes. For example, in Turkana, Kenya, 85% of 113 native woody species assessed had a domestic or pastoral value, such as using palm leaves for thatching, wood for charcoal, edible fruits, browse for livestock, medicinal uses, materials for traditional stools, shade provision, resin used as a glue substitute, and even flowers for decoration (Stave et al. 2007). Of the 98 plant species identified, with one or more uses, in the Tana River National Primate Reserve (dryland Kenya), 15 were used as food or beverages; 34 for construction material which included poles, canoes, and furniture; 43 for "technological purposes" including rope, traps, arrows, baskets, drums, brooms, etc.; 23 for medicinal purposes; two for commerce (traded items), and 20 for other purposes including firewood (Medley 1993). Most of these communities are dependent on plants for their primary health care. According to WHO (1978), up to 80% of the world's rural populations depend on medicinal plants, since western pharmaceuticals are often expensive, inaccessible or unsuitable (WHO 1978). Traditional medicine is seen as one of the surest means to achieve total healthcare coverage of the world's population (WHO 1978). For example, in Tanzania there are approximately 30,000-40,000 traditional practitioners in comparison to 600 medical doctors (Rukangira 2001). In the Kwahu district in Ghana, there are 224 people for every traditional practitioner, compared to nearly 21,000 people for every university-trained doctor (Rukangira 2001). The trade in medicinal plants also contributes largely to income generation, with at least 133,000 people employed in the trade of about 771 plant species in South Africa (Mander et al. 1999). The trade in traditional medicines in South Africa is worth about ZAR2.9 billion per annum with approximately 27 million consumers (Mander et al. 1999).

The majority of people in sub-Saharan Africa are small-scale farmers and thus dependent on the natural resource base for food security. For example, the agricultural labour force, as a percentage of the total labour force in countries such as Angola, Zambia, Malawi, Uganda, Mozambique, Ethiopia, Sudan and others, is between 80 and 90%. Livestock production, an important contributor to food security, currently accounts for about 30% of the gross value of agricultural production in Africa, with 70% of the rural poor owning livestock, including pastoralists living in arid and semi-arid zones (World Bank 2009). Of these, over 200 million rely on their livestock for income (sales of milk, meat, skins) as well as draught power and fertilizer for crop growing (FAO 2011, 2012). A key means of making an income for women and the landless, livestock also provide high-quality nutrition for families, especially children. Demonstrated benefits of animal-source food consumption by children include improved growth, micronutrient status, cognitive performance, and level of physical activity (Murphy and Allen 2003). Milk in itself supplies essential macronutrients, micronutrients, fatty acids, and growth factors required for appropriate development throughout childhood (Smith et al. 2013).

It is evident that natural resources are critical to sustain livelihoods in sub-Saharan Africa. For example, Seyam et al. (2001) calculated that the annual economic values of the Zambezi basin wetlands are, amongst others, US$50 million for flood plain recession agriculture, US$78.6 million for fish production, US$70.6 million for livestock grazing, and US$2.6 million for natural products and medicine. Loss of these services as a result of IAS will have a dramatic impact on communities which depend on them. Although there are no data specific to sub-

Saharan Africa, it is estimated that the cost of the impact and management of IAS globally accounts for US$1.4 trillion annually or 5% of annual global GDP (Pimentel et al. 2001). Put in context, this was double the GDP for the whole of the African continent in 2001.

Despite the significant impacts of IAS, little is known about which IAS are present in sub-Saharan Africa, their distribution or their impacts, other than for a handful of species. For example, the larger grain borer (LGB), *Prostephanus truncatus* (Horn) (Coleoptera: Bostrichidae), is responsible for maize losses of US$91 million per annum in Tanzania and in West Africa contributes to cassava losses of US$800 million annually (Boxall 2002). *Striga hermonthica* (Del.) Benth. (Orobanchaceae), native to parts of Ethiopia, has invaded large parts of Africa, where it contributes to maize losses of US$7 billion annually, and as such impacts on the lives of 300 million Africans (Parker and Riches 1993; Sauerborn 1991). Some research has also been undertaken on widespread invasive alien plants such as *Parthenium hysterophorus* L. (Asteraceae), particularly in Ethiopia (Tamado and Milberg 2000; Tamado et al. 2002), *Prosopis juliflora* (Sw.) DC. (Fabaceae) in Kenya (Maundu et al. 2009), *Chromolaena odorata* (L.) King & Rob. (Asteraceae) in West Africa (Lucas 1989), and *Eichhornia crassipes* (Mart.) Solms (Pontederiaceae) in many regions throughout the continent (Kasulo 2000). To date, most research on IAS has been undertaken in South Africa. This dearth of information on IAS outside of South Africa does not adequately reflect the true situation with regard to the presence and impacts of IAS.

According to McGeoch et al. (2010), the number of documented cases of IAS in many countries, especially in sub-Saharan Africa, with the exception of South Africa, is a significant underestimate, because its value is negatively affected by country development status and positively by research effort and information availability. It is recognized that there is a strong bias in the regions of the globe where research is being done, with notably lower representation of developing countries (Pyšek et al. 2008). Research undertaken by Pyšek et al. (2008) demonstrated that Africa (with the exception of South Africa) and Asia were severely understudied with regard to IAS. Only 15.8% of all the published papers in the subject areas of ecology and biodiversity conservation related to exotic species had authors from developing countries and only 6.5% had authors solely from developing countries (Nuñez and Pauchard 2009).

Reviews of CABI's Crop Protection Compendium (CPC) (www.cabi.org) and the Global Invasive Species Database (GISD) (www.issg.org) reveal that there are indeed major gaps and omissions with regard to the presence and distribution of invasive plants and animals in sub-Saharan Africa. For example, a review of CABI's CPC revealed that South Africa had the highest number of recorded invasive "weeds" with 208, followed by Kenya, Tanzania and Egypt, with only 29 invasive "weeds" having been reported from Djibouti. A search of the GISD under the categories "present but not invasive or unspecified, present and invasive, present and causing impact (may also be invasive), present and agricultural impact, biostatus uncertain" indicated that South Africa had the most recorded species (55), followed by Mauritius, Swaziland, Tanzania and Kenya (S. Pagad pers. comm.). Only four species were listed for Djibouti, followed by Angola and the Comores with only one species each. Reviews of individual species on the CPC revealed that *Acacia mearnsii* De Wild. (Fabaceae) was only recorded as being present at a small number of localities in Africa, despite the fact that it is known to be widespread in South Africa, Zimbabwe, Kenya and Tanzania. *Opuntia stricta* (Haw.) Haw. (Cactaceae), which is abundant in many parts of Kenya, is not even recorded as being present in East Africa in the CPC. According to the CPC, *Broussonetia papyrifera* (L.) Vent. (Moraceae) and *Limnocharis flava* (L.) Buchenau (Limnocharitaceae) are not present in Ghana, although both species are actually widespread in that country. Species which are known to be invasive in Kenya, such as *Tithonia diversifolia* (Hemsl.) A.Gray (Asteraceae), *Antigonon leptopus* Hook. & Arn. (Polygonaceae), *Anredera cordifolia* (Ten.) Steenis (Basellaceae), *Cardiospermum grandiflorum* L.

(Sapindaceae), *Solanum mauritianum* Scop. (Solanaceae), *S. seaforthianum* L., *Nicotiana glauca* Graham (Solanaceae), *Canna indica* L. (Cannaceae), *Opuntia elatior* Mill., *O. monacantha* Haw., *Austrocylindropuntia subulata* (Muehlenpf.) Backeb. (Cactaceae) and others are not included in the CPC or GISD database for Kenya. That said, species can in most cases only be included in international databases if their presence in a particular country is reported in a peer-reviewed journal paper – the lack of publications on the presence and impact of IAS in sub-Saharan Africa is as such a significant impediment. However, there is also a lack of data on IAS on the International Plant Protection Convention's (IPPC) portal (www.ippc.int) – all signatories to the IPPC should submit lists of regulated pests and pest reports but only a few countries in sub-Saharan Africa have done so. Despite the current dearth of information, efforts are currently being made to enhance data pertaining to Africa on CABI's Invasive Species Compendium (www.cabi/isc) and other international and regional databases.

The current status with regard to IAS management in Africa, especially Invasive Alien Plants (IAPs), can be summarized as follows:

- There are no or very poor inventories of IAPs in all African countries, with the exception of South Africa and Swaziland, although there are indications that this situation will improve in the near future with more publications becoming available on IAPs in countries such as Zimbabwe, Kenya, Ethiopia, and others;
- There are no country maps on the distribution of IAPs, with the exception of South Africa;
- Very few studies have been undertaken on the impacts of IAPs on the continent, with the possible exception of South Africa. We need to gain a better understanding of the costs associated with IAPs in order to convince policymakers as to the threats they pose to economic development;
- We probably know far more about aquatic than terrestrial invasive plants, with most research focusing on the management of aquatic weeds, particularly water hyacinth, probably because infestations are more visible on water bodies and their impacts are easier to quantify;
- In the recent past, in sub-Saharan Africa, biocontrol agents have mainly been released on aquatic weeds (excluding South Africa), with only a few agents being officially released on terrestrial invasive plants such as *C. odorata* (Ghana) and *Lantana camara* L. (Verbenaceae) (Zambia);
- Cost-benefit analyses of so-called "conflict" species also need to be undertaken in order to resolve any issues surrounding their control;
- No country in Africa has a body with the responsibility and/or the means of coordinating IAS activities, with the possible exception of South Africa, although even here coordination is still rather fragmented with regard to the control of IAS across all taxonomic groups. The absence of any coordinating mechanism means that there is inadequate sharing and exchange of information between different stakeholders;
- There are gaps, overlaps, and inconsistencies in existing policies, regulations, strategies and institutional arrangements concerning IAS;
- Preventing the accidental and intentional introduction of IAS into sub-Saharan Africa is not high on the agenda of many countries, despite prevention being the most cost-effective management strategy. Very few countries undertake a Pest Risk Assessment on introduced/imported plants and virtually no country, with the exception of South Africa, has a functioning early detection and rapid response mechanism, especially with regard to the detection of IAPs;
- Related to some of the issues listed above, there is a general lack of awareness and capacity amongst all sectors with regard to the issue of IAS;
- There is a serious lack of resources to deal with the IAS issue in all developing countries. The development of cost-recovery mechanisms whereby revenues for IAS management are raised through levies and taxes may partly resolve the issue, but additional resources will be required from

national governments in order to adequately manage the problem.

Based on the barriers/impediments listed above, the prognosis for IAS management in sub-Saharan Africa does not look promising, at least for the foreseeable future. With increased trade and tourism, together with climate change, the situation will, in all likelihood, worsen unless action is taken to rectify the various shortcomings in countries. As a result of climate change some of the most damaging IAPs in Africa are bound to expand their ranges significantly. For example, as a result of lower rainfall, tropical forests will be more prone to fire which will facilitate the invasion of *B. papyrifera* and *C. odorata* in forests in West and Central Africa. The unsustainable utilization of forests will fuel the spread. *Prosopis juliflora* is likely to expand its range as a result of an increase in droughts, flooding, overgrazing and the movement of livestock, while its ability to invade new habitats will improve significantly as carbon dioxide levels increase (Polley et al. 1996). Utilization of this "conflict species" will probably also facilitate the spread of mesquite in Africa. *Parthenium hysterophorus*, which is currently spreading at a rapid rate throughout Africa, will benefit significantly as a result of climate change for reasons similar to those provided above. However, an aspect which has facilitated the spread of this weed and is often not highlighted in the literature is food aid. It is thought that parthenium was first introduced to Ethiopia in the 1980s as a contaminant of food aid. As the frequency of droughts increases as a result of climate change, food aid will be distributed more widely in Africa, contributing to the spread of this noxious weed. Increased flooding and drought cycles and the proliferation of artificial water impoundments will allow semi-aquatic weeds such as *Mimosa pigra* L. (Fabaceae) to flourish. Climate change and an increasing demand on the natural resource base as a result of population growth will contribute to increased land degradation, facilitating further plant invasions. As such, it is imperative that countries in sub-Saharan Africa address the barriers listed above.

The challenges are to develop and/or strengthen IAS policy, build IAS capacity, create awareness as to the presence, distribution and impacts of IAS, develop and implement effective IAS management protocols and acquire resources to manage IAS. With regard to policy, countries need to develop and implement National Invasive Species Strategies and Action Plans (NISSAPs), modify their National Biodiversity Strategies and Action Plans (NBSAPs) to take cognizance of IAS, establish National IAS Coordination Units and develop strategies to raise sustainable funding for IAS management. It is critical that countries raise the profile of IAS as one of the biggest threats to biodiversity and economic development – as such the exchange of information and awareness creation amongst all sectors of society is important. The development and implementation of national Communication Strategies will go a long way to raising awareness. Any strategy should ideally be focused on those sectors of society which are more likely to bring about change. However, information is required before any awareness campaign can be initiated. To this end it is important to build capacity in countries with respect to IAS identification, determination of impacts, and management – a capacity-needs assessment undertaking in countries should highlight specific training needs. This can largely be achieved, amongst others, by developing and implementing training modules for use during training workshops or similar; including IAS issues in the curricula of secondary and tertiary learning institutions; supporting post-graduate students to undertake research on IAS; and the attendance of country participants in various international fora. Ultimately countries need to develop and implement various management strategies, especially those related to prevention of incursions by IAS. It is imperative that countries implement Risk Analysis systems to prevent the introduction of invasive or potentially invasive species. In addition, countries need to invest in the development and implementation of Early Detection and Rapid Response mechanisms. Since so many invasive species are already present in most sub-Saharan countries, they need to develop species-specific

control strategies, which should include manual/ mechanical, chemical and biological control. There is still considerable resistance to the use of herbicides in Protected Areas and the introduction of damaging and host-specific biocontrol agents. If countries do not embrace management technologies that have been in use in other countries for a considerable amount of time, they are unlikely to succeed in the effective management of IAS. One critical issue that also needs to be resolved for effective management to be realized is that pertaining to the issue of "conflict species".

A number of donors and NGOs have not only supported the introduction of various invasive and potentially invasive species but have also promulgated the use of some of these species. The fact that some of these species may have beneficial attributes despite having negative impacts on the natural resource base has made it more difficult to implement management strategies against them. For example, a book entitled, "Useful trees and shrubs for Kenya" (Maundu and Tengnäs 2009) makes reference to a number of exotic species, 72% of which have been recorded as environmental weeds in Kenya or elsewhere. Other publications freely available in countries such as Kenya promote the use of species such as *Calliandra calothyrsus* Meisn. (Fabaceae), various *Leucaena* species (Fabaceae), *Morus alba* L. (Moraceae), *Chamaecytisus prolifer* (L. f.) Link (Fabaceae) and *Gliricidia sepium* (Jacq.) Kunth ex Walp. (Fabaceae), all of which have been recorded as being invasive in the region or elsewhere in Africa. Unless donors and NGOs take cognizance of the negative impacts of these invasive plants and stop promoting their introduction and proliferation, management will be difficult.

CONCLUSIONS

Despite the various barriers/impediments to effective IAS management in sub-Saharan Africa, it is not too late to make a difference. Unlike the situation in countries such as South Africa which have introduced a myriad of exotic species, many of which have become invasive, the horticultural industry is largely in its infancy in most countries in Africa. In comparison, there are not nearly as many invasive plant species as in developed countries, although those that are present are widespread and having a significant impact on livelihoods. What is in these countries' favour is that most of these invasive plant species are also problematic in developed countries such as South Africa and Australia, where they have been well studied and as such best management practices are known. In addition, effective and host-specific biocontrol agents have been released in these countries, providing poor countries in sub-Saharan Africa the opportunity to implement biocontrol programmes at minimum cost as most of the work has already been undertaken. As such, countries in sub-Saharan Africa need to be encouraged to implement strategies that have largely been developed elsewhere.

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