Effects of *Parthenium hysterophorus* on Grassland Community in Nyando Sub-County, Kisumu County, Kenya

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Abstract
Parthenium hysterophorus is an invasive alien species native to South and Central America. The plant is ranked as one of the most dreaded weeds of the world. *Parthenium hysterophorus* affects grassland community through the release of allelochemicals that inhibit the germination and growth of grass species. However, little is known about its effects on native grassland community in Nyando sub-county of Kenya. Therefore, this study sought to investigate the effects of *P. hysterophorus* on grass species, livestock production and its control. A total of 121 farm household heads were interviewed using semi-structured interview schedules. Descriptive analysis and the T-test at 5% level of significance were used to analyse data. Sixty-three percent of respondents reported that *P. hysterophorus* replaced major native pasture species consequently reducing the quantity of milk yield per cow significantly by 3.81 litres. Majority households (98.3%) controlled *P. hysterophorus* by uprooting, slashing and hoeing while the remaining households used herbicides. The cost of controlling *P. hysterophorus* is expensive at about Kes. 6,253.33 per acre. *Parthenium hysterophorus* has the potential to negatively affect grasslands in Kenya with adverse impact on human livelihoods by reducing milk and beef production, lack of high quality nutrition food as well as the attainment of development targets such as those set in the Big Four Agenda, the Vision 2030 and the Sustainable Development Goals.

Introduction
Invasive Alien Species (IAS) are those organisms that are introduced into new regions where they get established and have adverse impacts on biodiversity, food security, health and economic development (Early et al. 2016). IAS poses one of the greatest threats to biodiversity loss after climate change. Their distribution has been accelerated by the increase in world trade, transport, travel and tourism (Ziska and Dukes 2014). *Parthenium hysterophorus* is one of the most problematic IAS in Kenya. The weed is an annual herb native to South and Central America and now occurs as an alien invader in Africa, Asia and Australia (Bajwa et al. 2016). In Kenya, the weed was first reported as a problematic weed in coffee plantations in the current Kiambu County in 1975 (Njoroge 1986). The weed has since been declared an obnoxious weed threatening biodiversity, agriculture and human health (Government of Kenya 2010). *Parthenium hysterophorus* is a very aggressive invader that replaces native plant species due to its high invasion rate coupled with allelopathic properties. The weed releases allelochemicals which inhibit the germination and growth of other plant species (Adkins et al. 2018). Through the release of allelochemicals, *P. hysterophorus* directly competes with pasture species by reducing their vigour and seed set, leading to habitat and ecosystem change (Evans 1997). For instance, a study carried out in Queensland reported that *P. hysterophorus* significantly reduced pasture community diversity even when with relatively low densities (Nguyen et al. 2017). Equally, the weed is reported to be responsible for pasture scarcity, bitter and non-palatable meat and milk, loss of weight and diarrhoea in livestock (Niguse and Kifle 2016). *Parthenium hysterophorus* has the potential of suppressing the immune system of livestock as demonstrated using the Wistar albino rat (Yadav et al. 2010). Despite these adverse effects on livestock production, the control of *P. hysterophorus* is difficult. This is because *P. hysterophorus* produces a high number of seeds which have a prolonged seed viability of up to four to five year (Bajwa et al. 2016). The weed has a rapid growth rate besides preference to wide range of ecological conditions for its establishment (Adkins et al. 2018; Kaur et al. 2014). Therefore, because of these reasons this study investigated the effects of *P. hysterophorus* on grazing land, livestock production, farm labour requirement to control in Nyando sub-county, Kisumu County, Kenya. The information generated from this study can be used to enhance food security and in the attainment of development targets such as those set in the Big Four Agenda, the Vision 2030 and the Sustainable Development Goals.

Methods and Study Site

This study was carried out in Nyando Sub-county, Kisumu County, Kenya. Out of 657 farm households whose farmlands had been invaded by *P. hysterophorus* and practised livestock keeping, a sample size of 121 households was determined using the Sample Size Calculator at 95 % confidence level and 8.05 % confidence interval (Creative Research Systems 2013). Simple random sampling was employed to select farm households to be interviewed by assigning each household a random number then picking 121 random numbers. Semi structured interview schedules (Mugenda and Mugenda 1999) were used to collected data on the effect of *P. hysterophorus* on livestock production, pasture availability and cost of controlling the weed. Data was analysed using the T-test with the aid of SPSS version 11.5 statistical computer software at 5 % level of significance. The main economic activities in Nyando sub-county are subsistence farming, livestock keeping, rice and sugarcane farming, and small scale trading and therefore there was need to investigate the effects *P. hysterophorus* on human livelihoods (Government of Kenya 2013).

Results

Farm household interviews revealed that *P. hysterophorus* decreased the abundance of grass species. Majority of the respondents (63.3 %) reported that *P. hysterophorus* formed dense colonies which replaced native pasture species. This decline was confirmed by field observations as *P. hysterophorus* was seen to dominate much of the grazing land as shown in photograph 1 below.

Photograph 1: A section of grazing field in Nyando Sub-county highly invaded by *P. hysterophorus* (Source: Mutua, B. M. September 2018)

Our results also revealed that *P. hysterophorus* significantly contributed to an increase in livestock health complications. The average number of livestock health complications increased from 2.53 to 8.13 coughs, 2.17 to 8.10 diarrhoeas, 1.20 to 5.43 mouth ulcers, 1.33 to 4.23 deaths and, 1.07 to 4.87 emaciations cases per year. This increase in livestock disease incidents was significant at 5 % level of significance. Milk production per cow was also reported to drop from 7.20 litres to 3.81 litres after the invasion of *P. hysterophorus* in the region. Paired samples T-test results confirmed that this decline in milk production per cow (mean of 3.392 litres) as a result of *P. hysterophorus* invasion was significant at 5 % level of significance.

On weed control methods, majority (98.3 % of the respondents) used physical methods (uprooting, slashing and hoeing) to control *P. hysterophorus* while only 1.7% respondents used herbicides to control. Control of *P. hysterophorus* was reported to significantly increase farm labour requirements with an average of Ksh. 10,111.67on labour per acre per year prior to *P. hysterophorus* invasion compared to Ksh. 16,365 after the invasion of *P. hysterophorus* over the same time period. This significantly increased by 61.8% (Kes. 6,253.33 per acre) (p=0.000).

Discussion [Conclusions/Implications]

This study revealed that *P. hysterophorus* significantly decreased pasture species availability. These findings are consistent with those in Ethiopia which reported that *P. hysterophorus* critically endangers the biodiversity of grazing lands, particularly for the different native grass and forb species (Nigatu et al. 2017). Similar findings were also reported in a Queensland's study, which revealed that *P. hysterophorus* significantly reduced pasture community diversity (Nguyen et al. 2017). The study also revealed that *P. hysterophorus* adversely affected livestock health. These findings were in agreement with the results of other studies. For instance, Niguse and Kifle (2016) reported that *P. hysterophorus* was responsible for the loss of weight and diarrhoea in livestock. Another related study reported that *P. hysterophorus* extracts reduced the number of white blood cells in Wistar albino rats an indicator of weakened immune systems (Yadav et al. 2010). Lastly, this study revealed that *P. hysterophorus* was mainly controlled through physical methods by uprooting, slashing or hoeing. These methods were reported to offer only a temporary solution and exposed farmworkers to the associated health risks (Kaur et al. 2014). Furthermore, farmers reported that *P. hysterophorus* control increased farm labour requirements. These findings were consistent with the findings of a study carried out in Tanzania which revealed that the labour for weed management was scarce and expensive (Wambura 2018). From the findings of this study, it was evident that *P. hysterophorus* invasion negatively affected pasture forage quantity and quality which consequently affected livestock carrying capacity hence compromised human livelihoods in Kenya leading to poverty and poor health.

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References

Adkins, S. W., McClay, A., and Bajwa, A. A. 2018. Biology and ecology. In: Adkins, S., Shabbir, A. and Dhileepan, K. (Eds.), *Parthenium weed: biology, ecology and management.* Centre for Agriculture and Bioscience International, London, pp 7-39.

Bajwa, A. A., Chauhan, B.S., Muhammad, F., Shabbir, A. and Adkins, S.W. 2016. What do we really know about alien plant invasions? A review of the invasion mechanism of one of the world's worst weeds. *Planta,* 244*,* (1): 39-57.

Early, R., Bradley, B. A., Dukes, J. S., Lawler, J. J., Oldens, J. D., Blumenthal, D., Gonzalez, P., Grosholz, E. D., Ibanez, I., Miller, L. P., Sorte, C. J. B., and Tatem, A. J. (2016). Global threats from invasive alien species in the twenty-first century and national response capacities. *Nature Communications,* 7, 12485.

Evans, H. C. 1997. *Parthenium hysterophorus* L. a review of its weed status and the possibility of biological control. *Bio-control News and Information*, 18: 89-98.

Government of Kenya. 2010. *The Suppression of Noxious Weeds Act (CAP. 325), Kenya Gazette Vol. CXII-No 44*. National Council for Law Reporting, Nairobi.

Government of Kenya. 2013. *Kisumu County: First County integrated development plan 2013-2017*. Government Printing Press, Nairobi.

Creative Research Systems. 2013. Available online https://www.surveysystem.com/sample-size-formula.htm.

Kaur, M., Aggarwal, N. K., Kumar, V. and Dhiman, R. 2014. Effects and Management of *Parthenium hysterophorus*: A Weed of Global Significance. *International Scholarly Research Notices*.

Mugenda, O. M. and Mugenda, A.G. (1999). *Research Methods: Quantitative and qualitative approaches*. African Centre for Technology Studies, Nairobi.

Nguyen, T., Bajwa, A. A., Belgeri, A., Navie, S., O'Dennell, C. and Adkins, S. 2017. Impact of an invasive weed, *Parthenium hysterophorus*, on a pasture community in southeast Queensland, Australia. *Environmental Science and Pollution Research*.

Nigatu, L., Hassen, A., Sharma, J., and Adkins, S. 2010. Impact of *Parthenium hysterophorus* on grazing land communities in north-eastern Ethiopia. *Weed Biology and Management,* 10: 143-152.

Niguse, H., and Kifle, B. 2016. Socio-economic impacts of *Parthenium hysterophorus* L. in east Shewa and West Arsi zones of Ethiopia. *International Journal of Agricultural Research, Innovation and Technology,* 6 (2): 5-11.

Njoroge, J. M. 1986. New weeds in Kenya coffee*. Kenya Coffee*, 51: 333–335*.*

Wambura, H. D. 2018. *Impact of parthenium weed (Parthenium hysterophorus L.) on the production of maize and common beans in Arusha, Tanzania*. (Unpublished master's thesis). Sokoine University of Agriculture, Morogoro.

Yadav, N., Saha, P., Jabeen, S., Kumara, S., Kumara, S., Verma, S. K., ... Sinha, M. P. (Eds.). 2010. Effect of methanolic extract of *P. hysterophorus* L. on haematological parameters in Wistar albino rat (Special issue). *The Bioscan,* 2: 357-363.

Ziska, L. H. and Dukes, J. S. 2014. *Invasive species and global climate change*. Centre for Agriculture and Bioscience International, London.