WAY FORWARD: SMALLHOLDER FARMERS' PERSPECTIVE ON MANAGEMENT OF FALL ARMYWORM IN KENYA

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EXECUTIVE SUMMARY

Fall Armyworm (FAW) (Spodoptera frugiperda) is a disastrous pest on food crops mainly maize which is the most staple food crops in Africa including Kenya. Since its first arrival in the country by 2016, a lot of crop yield losses had been experienced by smallholder farmers who rely on maize crop as their main nutritional supplement. To assess smallholder farmers' perspective on management of fall armyworm in Bomet County, Kenya, a baseline survey was done in five maize growing sub-counties of Bomet County in Kenya. A total of 384 households with 9 Self Help Groups (SHG) of smallholder farmers were sampled from different agro-ecological zones in order to understand their perspective on management. A structured questionnaire and checklist were used to envisage initial responses towards FAW on management. This study showed an ad hoc reaction by smallholder farmers' on FAW management pathways where a faster means of ridding off any new invasive pest was used. Results indicated a statistical significant association on FAW information and awareness (χ^2=.392(1), p<.001) while pesticide usage was significant (χ^2=14.479(1), p≤.05) and effectiveness. Alternative integrated pest management options were significant (N=51, p≤ 0.05). Farmers adopted strategies of early land preparation, crop intercropping and local varieties planting as a management of FAW (p≤.001). The study concluded that smallholder farmers' own FAW management strategies gave them enough food security and were safe towards the environmental. There is need to interrogate further on farmers' own management strategies in order to give a scientific recommendation and do an up-scaling of the study findings to other regions of the country.

INTRODUCTION

The emergence and rapid spread of the fall armyworm (FAW) *Spodoptera frugiperda* in Africa seriously has threatened the food and income security of millions of smallholder farmers (Day *et al.,* 2017; FAO 2017; Birhanu *et al.,* 2018). Fall armyworm's major preference for maize, a staple food for over 300 million African smallholder farm families, posed a threat to food security, nutrition and livelihoods (Goergen *et al.,* 2016; Sunderland et al., 2013; Kalleshwaraswamy *et al.,* 2018; Rwomushana et al, 2018; Frédéric et al., 2019; Banson *et al.,* 2020). The immediate reaction of governments in Africa including Kenya was to invest in chemical pesticides and their use remains the main farmers strategy to control the FAW (Wyckhuys and O'Neil 2007; Kumela *et al.,* 2018; Birhanu *et al.,* 2019). Smallholder farmers do not generally have a lot of experience with pesticides use and safe management where they often apply them incorrectly or unsafely, threatening their own health and jeopardizing the sustainability of the environment (Wyckhuys et al., 2006; Kabeer, 2008; Raudsepp-Hearne *et al.,* 2010; Wyckhuys *et al.,* 2010; Damalas *et al.,* 2011; Leeuwis C., 2013; Kebede 2014; FAO 2017; MoA 2018). Research studies have shown that crop pests build up resistance to chemical pesticides that are commonly sprayed but farmers have their indigenous knowledge (IK) measures on how to control these new invasive pests either by use of cultural or botanical management (Kebede 2014; Wyckhuys *et al.,* 2010; FAO 2017).

Most research done on agriculture did not involve smallholder farmers and failed to take cognizance of smallholder farmers' strength in indigenous knowledge towards management of crop pests (Van Huis *et al.,* 1997; Williamson *et al.,* 2003; Wyckhuys *et al.,* 2010; Okali 2012; Abebe *et al.,* 2013; Kebede 2014; Komba *et al*., 2018; Sharifzadeh *et al.,* 2018; Birhanu *et al.,* 2019). In Kenya, FAW is here to stay and there is need to look for appropriate measures including smallholder farmers IK technologies so as to manage FAW. The objective of the current study was to assess smallholder farmers' perspective on management of fall armyworm in Kenya. It was hypothesized that smallholder farmers have no effective management strategies against FAW based on collective or individual perceptive. The results helped in defining and documenting options to manage FAW as used by smallholder farmers' which are resilient towards food systems and sustainable environment in Kenya.

Figure 1: Pre-Testing of Questionnaire- Njoro County

METHODOLOGY AND SAMPLING PROCEDURES

Kenya's main staple crop (maize) is grown in many counties with different agro ecological zones (AEZ) starting from the coast lowlands (1-1250 meters above sea level (masl)) to the high potential highlands (>2100 masl (Appendix 1). The study used a cross sectional study design to select households (HHs) and farmers Self Help Groups (SHGs). A sample frame was achieved by getting different HHS sub-county classification lists from the Ministry of Agriculture's Extensions (MOA). Names of Self Help Groups (SHGs) were also fronted with priorities given on those groups whose group were officially registered and group members were engaged in crop farming.

To get a fair HHs and SHG sample representation, a probability proportional sampling method was applied for an apt representative sample size for each sub-county ranging between a minimum of 63 HHs to 100 HHs and 1 SHGs of either male alone, female alone, mixed male and female or youth totaling to 9 SHGs. Using appropriate local languages and national language (Kiswahili), the questionnaires were discussed with SHG farmers at their farm meeting places and their responses recorded. The discussions of SHGs relied on their resourcefulness and aptitude of the members on how they recalled previous farming activities and other relevant information.

PRE-TESTING AND DATA COLLECTION

Pre-Testing

The research questionnaires were pilot tested by researchers in Kamwaura Ward; Njoro Sub-county in Nakuru County where samples of 30 questionnaires were enumerated (fig. 1). The researchers used the pre-testing exercise to train the enumerators on the data collection tools, validated the instruments with the extension officers, community leaders and field enumerators. The difficulties that were identified during the piloting exercise were documented and changes were subjected to necessary corrections and adjustments of the instruments that increased their validity and reliability.

Data Collection:-The developed questionnaire was administered to different HHs within 5 sub-counties of different agro-ecological maize growing zones of Bomet County (fig. 2). In order to enhance reliability and validity of data obtained from the enumerated respondents; methodological triangulation was used that gave appropriate information about the target population.

There were classifications of crop production based on agro ecological zones (AEZ) within the five sub-counties in Bomet County. The roles of men and women smallholder farmers in the various farm activities, their access to

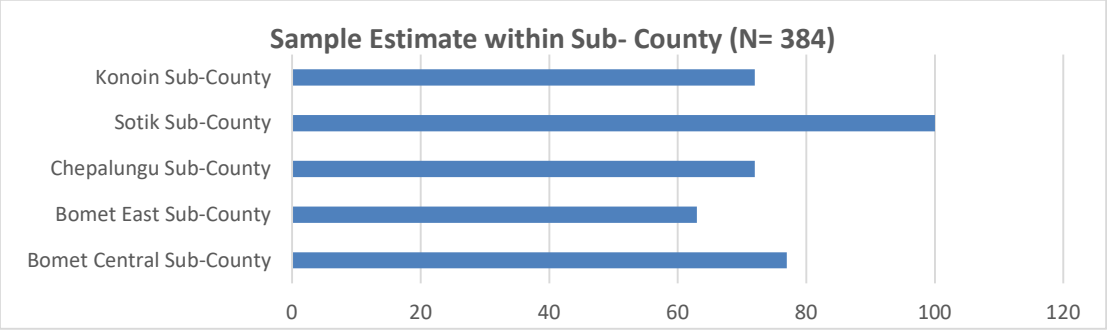


Figure 2: No of Sampled Households

farm resources, and the control of income generated from the farm were extracted. The access of both men and women smallholder farmers to extension services and credit facilities were analysed. The constraints faced by both men and women on the crop production chain were established during both the individual household surveys and farmer group discussions. The discussions were either conducted in the local languages with the help of a translator or there was use of an alternative language which the respondents were familiar with.

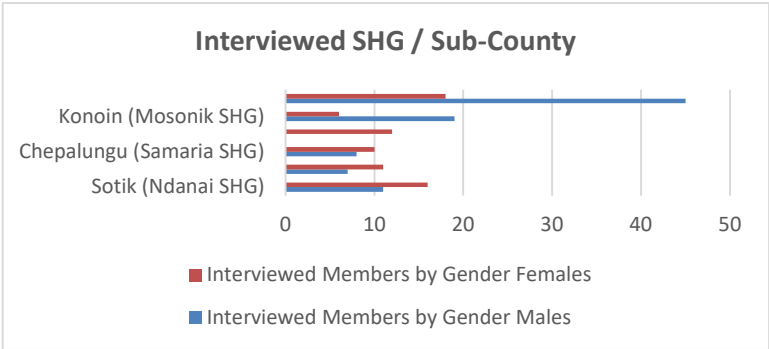


Figure 3: Interviewed Self Help Group per Sub-County

The data collection on SHGs involved either a single or double SHGs at each of the study site. Separate SHGs were enumerated by clustering them in age groups while separating women, men and youths SHGs by Likert age of 18-35 years, 36-45 years, and 46 years and above enabling a cross-referencing and verification from the views given by the smallholder farmers. The results of SHGs together with those of the HHs baseline survey provided essential information that guided in answering the overall study objective on assessing smallholder farmers' perspective on management of fall armyworm in Bomet County, Kenya.

RESULTS AND DISCUSSIONS

Sample Characteristics

The surveyed respondents were all smallholder farmers who practiced maize production as their main staple crops. The result showed homogeneous membership goals (93%) where members were collectively drawn to joining groups with one basic agenda either to benefit from "free food for all" (65%) or to have a merry-go-round where they supported each other with little finances from their table banking (35%). This implied that joining SHG had a personal motivation and not crop pest management including FAW.

Smallholder Farmers Awareness about FAW

During the time of the field survey (2017-2018), 78% of sampled SHG farmers had received information about FAW and were able to compare its larval stage signs with other crop pests. In this study, receiving information

was referred to as smallholder farmers knowing to differentiate the physical appearance and damage caused by FAW on maize crops and the best management options used for control of FAW.

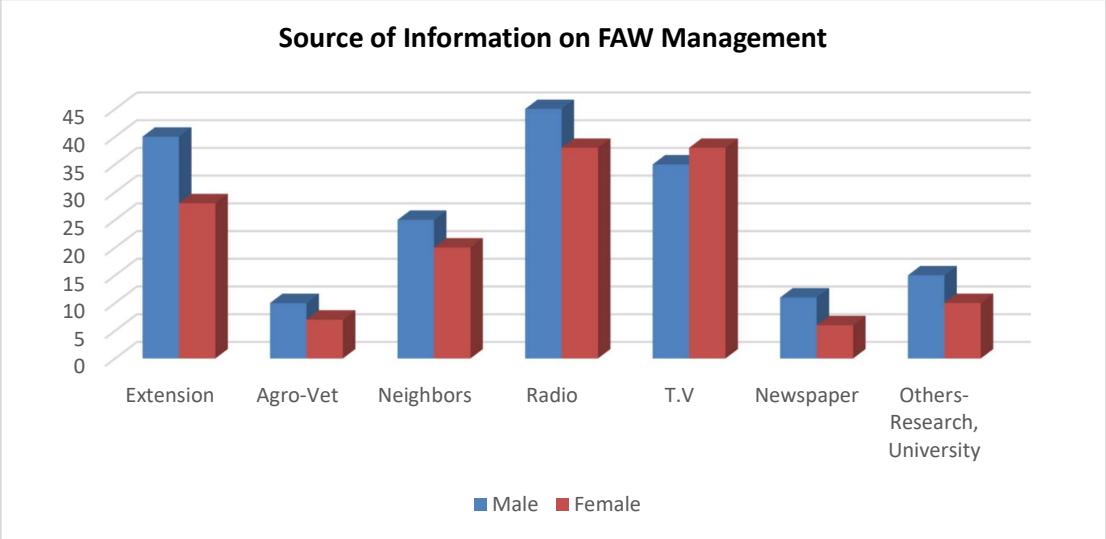


Figure 4: Source of FAW Information by Gender

The results showed (fig. 3) respondents had information on FAW management with a significant difference on gender correspondence between male (χ^2=14.479(1), p≤.001) and female farmers (χ^2(1) =.392, p<.001). There was a significant association by gender on pesticide information sourcing and use within different media platforms (χ^2=24.039(6), p≤.05). Lack of not having enough information on pesticide use (p≤.05) affected both genders equally prompting use of cultural and botanical methods (p≤.001).

Smallholder Farmers' Management Recourse to the effects of FAW

Smallholder farmers had a variety of options towards management of FAW where management strategies were undertaken in an *ad hoc* way, with mixed results. The study findings indicated pesticide usage as the main FAW management practices (86%) mustered (no documented data) during the SHG meetings. The gender indicator results showed 48% male SHGs, 20% female SHGs and 60% Mixed SHGs and opted for chemical use as a coping strategy while 8% Youth SHGs were mainly service renders (spraying). This showed a strong association (χ^2=21.861(2), p≤.001) between male and female farmers towards FAW management.

Due to costs implications and no more free subsidized chemicals from the government, smallholder farmers resorted to alternative pest management option which involved cultural and botanical management. The cultural options that were conveniently used were early land preparation, use of local maize varieties, crop intercropping and crop rotation while botanical controls were sand, ash, detergent and peppers.

Smallholder farmers made choices over unconventional FAW management strategies where each management options were either individually influenced or group oriented. The study found that 78% of SHGs opted for at least one or more different management options towards food systems resilience and sustainable environment. Statistically, the result showed a significant difference between different genders and different management options (p≤0.001) while managing FAW. The result had a gender bias where 38% of female in SHG resulted to either spiritual prayers or taking risks by waiting for natural interventions like rainfall. There were significant differences on gender between female and male farmers towards spiritual prayers as an alternative FAW management strategy (χ^2 =43.115(3), p≤0.001).

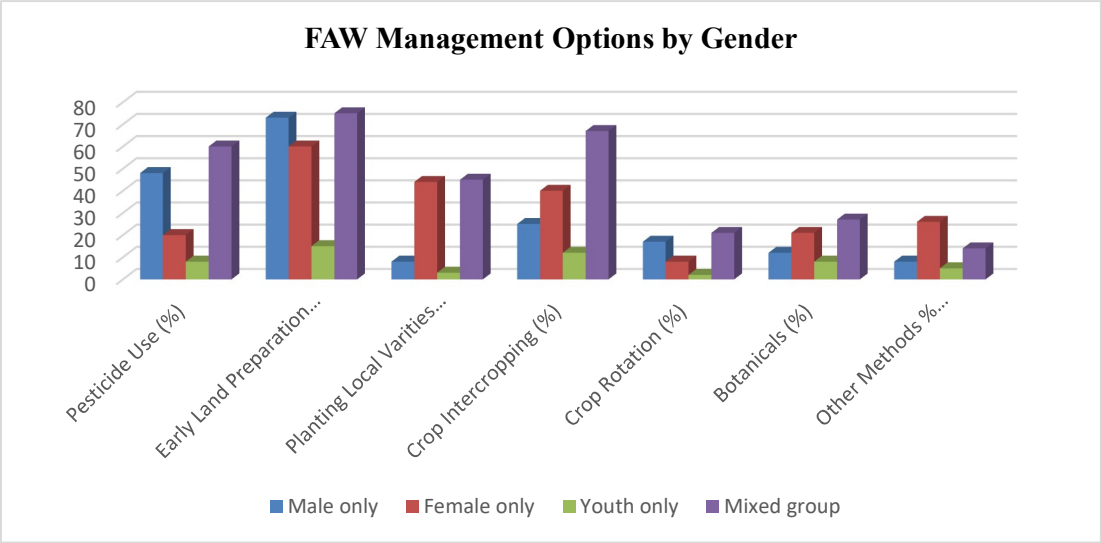


Figure 5: Management Options by Gender

Conclusions and Recommendations

This study showed that smallholder farmers had a variety of options towards management of FAW which required thorough research and recommendation. The source of information was a major fortress in controlling FAW used by smallholder farmers' thus there is need for a continuous updating of information sources in regard to emergence of any new crop pest. There is need to target the right gender during information dissemination as the results indicated a gender difference on receiving FAW information. Smallholder farmers opted for local varieties as a measure for food systems resilience and used botanical management as a sustainable method for the environment. The study concluded that smallholder farmers' own FAW management strategies gave them enough food security and were safe towards the environmental. There is need to interrogate further on farmers' own management strategies in order to give a scientific recommendation and do an up-scaling of the study findings to other regions of the country.

References

Abebe, G. K., Bijman, J., Pascucci, S., & Omta, O. (2013). Adoption of improved potato varieties in Ethiopia: The role of agricultural knowledge and innovation system and smallholder farmers' quality assessment. *Agricultural Systems*, *122*, 22-32.

Banson, K. E., Asare, D. K., Dery, F. D., Boakye, K., Boniface, A., Asamoah, M., & Awotwe, L. E. (2020). Impact of fall armyworm on farmer's maize: systemic approach. *Systemic Practice and Action Research*, *33*(2), 237-264.

Birhanu, S., Josephine, S., Peter, M., Paddy, L., Esayas, M., Nsami, E., Mulatu, W., Gashawbeza, A. Tadele, T. First report of the fall armyworm, *Spodoptera frugiperda* (Lepidoptera: Noctuidae), natural enemies from Africa. *Journal of Applied Entomology.* 2018. 142:8, pp 800-804. *https://onlinelibrary.wiley.com/doi/abs/10.1111/jen.12534*

Birhanu, S., Tadele, T., Mulatu, W., Gashawbeza, A. and Esayas, M. The Efficacy of Selected Synthetic Insecticides and Botanicals against Fall Armyworm, *Spodoptera frugiperda*, in Maize. 2019. *Insects* 10:2, pages 45. *https://www.mdpi.com/2075-4450/10/2/45*

Damalas, C. A., & Eleftherohorinos, I. G. (2011). Pesticide exposure, safety issues, and risk assessment indicators. *International journal of environmental research and public health*, *8*(5), 1402-1419.

Day, R., Abrahams, P., Bateman, M., Beale, T., Clottey, V., Cock, M., Colmenarez, Y., Corniani, N., Early, R., Godwin, J., Gomez, J., Moreno, P., Murphy, S. T., Oppong-Mensah, B., Phiri, N., Pratt, C., Silvestri, S. and Witt, A. Fall Armyworm: Impacts and Implications for Africa. Volume 28, Number 5, October 2017, pp. 196-201(6). https://doi.org/10.1564/v28_oct_02

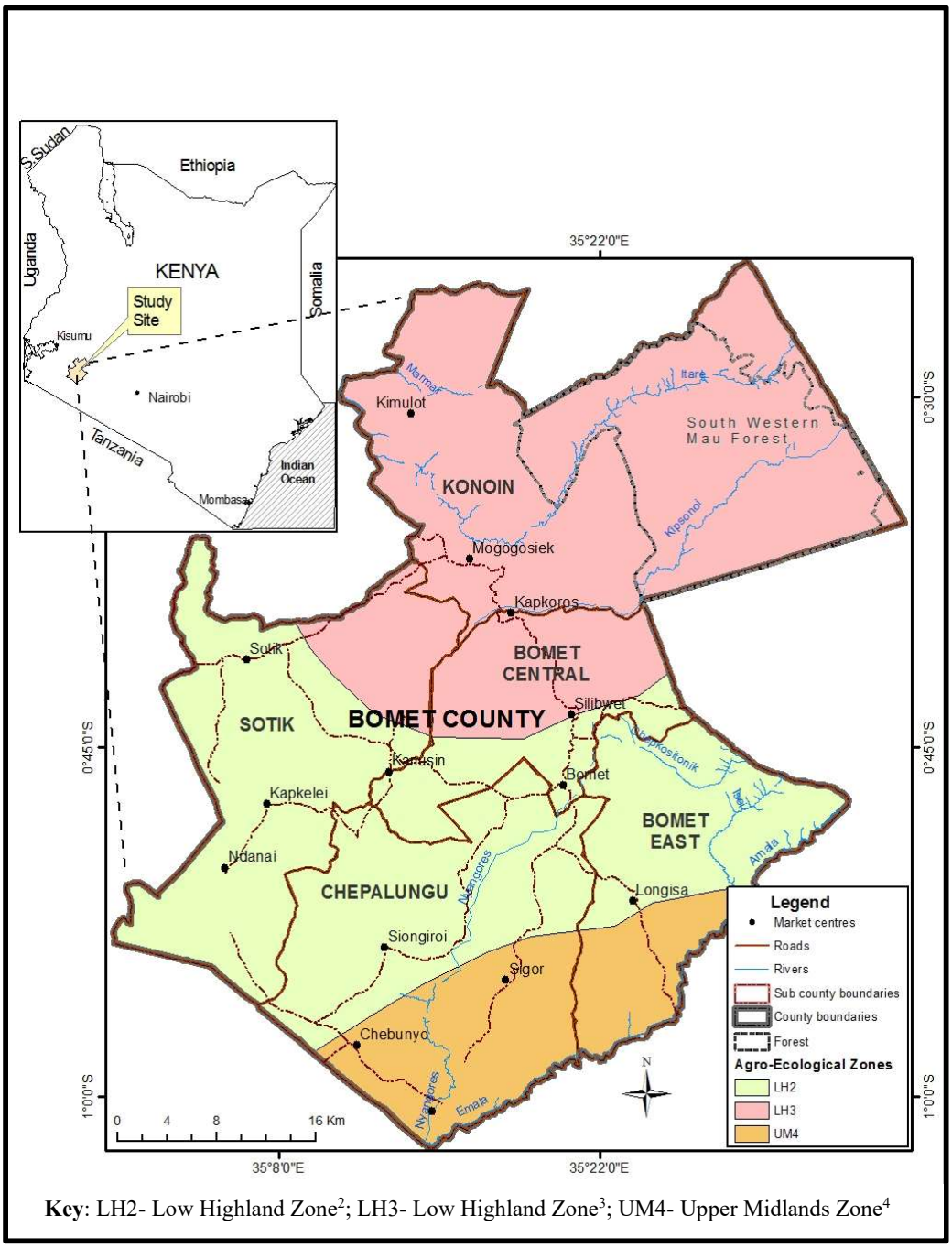
Food and Agriculture Organization of the United Nations. Sustainable Management of the Fall Armyworm in Africa. Plant Production and Protection Division. 2017. Rome, Italy. www.fao.org/3/a-i7861e.pdf

Frédéric, B., Mainassara, A. Z., Isaac, C., Newton, C. and Peter, C. Understanding the factors influencing fall armyworm (*Spodoptera frugiperda* J.E. Smith) damage in African smallholder maize fields and

quantifying its impact on yield. A case study in Eastern Zimbabwe. 2019. https://www.sciencedirect.com/science/article/pii/S0261219419300304
Goergen, G., Kumar, P. L., Sankung, S. B., Togola, A. and Tamo, M. First report of outbreaks of the fall armyworm (*Spodoptera frugiperda)* (JE Smith) (*Lepidoptera, Noctuidae*), a new alien invasive pest in West and Central Africa. 2016. PLoS One, 11 (2016), pp. 1-5; https://doi.org/10.1371/journal.pone.0165632; Google Scholar
Kabeer N 2003. *Gender Mainstreaming in Poverty Eradication and the Millennium Development Goals: A Handbook for Policy Makers and Other Stakeholders*. Ottawa: International Development Research Centre. Accessed 26 May 2021.
Kebede, M. (2018). Out-break, Distribution and Management of fall armyworm, Spodoptera frugiperda JE Smith in Africa: The Status and Prospects. *Academy of Agriculture Journal*, *3*(10).
Kalleshwaraswamy, C. M., Asokan, R., Swamy, H. M., Maruthi, M. S., Pavithra, H. B., Hegbe, K., ... & Goergen, G. E. (2018). First report of the fall armyworm, Spodoptera frugiperda (JE Smith)(Lepidoptera: Noctuidae), an alien invasive pest on maize in India.
Komba, C., & Muchapondwa, E. (2018). Adaptation to climate change by smallholder farmers in Tanzania. In *Agricultural adaptation to climate change in Africa* (pp. 129-168). Routledge.
Kumela, T. Simiyu, J. Sisay, B. Likhayo, P. Mendesil, E. Gohole, L. Tefera. T.; Farmers' knowledge, perceptions, and management practices of the new invasive pest, fall armyworm (Spodoptera frugiperda) in Ethiopia and Kenya; Int. J. Pest Manag., 0874 (2018), pp. 1-9; https://doi.org/10.1080/09670874.2017.1423129.
Leeuwis, C. (2013). *Communication for rural innovation: rethinking agricultural extension*. John Wiley & Sons.
Ministry of Agriculture, (2018). Status of the Fall Army worm (FAW) (2018). Ministry of Agriculture. *Armyworm-Ad-Artwork.* Accessed 12/9/2018.
Raudsepp-Hearne, C., Peterson, G. D., Tengö, M., Bennett, E. M., Holland, T., Benessaiah, K., ... & Pfeifer, L. (2010). Untangling the environmentalist's paradox: why is human well-being increasing as ecosystem services degrade?. *BioScience*, *60*(8), 576-589.
Rwomushana, I., Bateman, M., Beale, T., Beseh, P., Cameron, K., Chiluba, M., Clottey, V., Davis, T., Day, R., Early R., Godwin, J., Gonzalez-Moreno, P., Kansiime, M., Kenis, M., Makale, F., Mugambi, I., Murphy, S., Phiri, N. W, N., Pratt, C., Tambo J. (2018); Fall armyworm : impacts and implications for Africa. Evidence Note Update, October 2018: (2018) Oxfordshire, UK; Google Scholar

Sunderland, T., Powell, B., Ickowitz, A., Foli, S., Pinedo-Vasquez, M., Nasi, R., & Padoch, C. (2013). Food security and nutrition. *Center for International Forestry Research (CIFOR), Bogor, Indonesia*.
Sharifzadeh, M. S., Abdollahzadeh, G., Damalas, C. A., & Rezaei, R. (2018). Farmers' criteria for pesticide selection and use in the pest control process. *Agriculture*, *8*(2), 24.
Shaiba, Z., Amoore, B., Amoore, I., & Renne, E. (2019). Assessing the impact of neem on fall armyworm damage to maize crops: a field-based study in Nabdam District, UER, Ghana. *Journal of Agriculture and Sustainability*, *12*(2).
Van Huis, A., & Meerman, F. (1997). Can we make IPM work for resource-poor farmers in sub-Saharan Africa?. *International Journal of Pest Management*, *43*(4), 313-320.
Williamson, S., Little, A., Ali, M. A., Kimani, M., Meir, C., & Oruko, L. (2003). Aspects of cotton and vegetable farmers' pest management decision-making in India and Kenya. *International Journal of Pest Management*, *49*(3), 187-198.
Wyckhuys, K. A., & O'Neil, R. J. (2010). Social and ecological facets of pest management in Honduran subsistence agriculture: implications for IPM extension and natural resource management. *Environment, Development and Sustainability*, *12*(3), 297-311.
Wyckhuys, K. A., & O'Neil, R. J. (2007). Local agro-ecological knowledge and its relationship to farmers' pest management decision making in rural Honduras. *Agriculture and Human Values*, *24*(3), 307-321.
Wyckhuys, K.A.G., O'Neil, R.J. (2006). Population dynamics of Spodoptera frugiperda Smith (Lepidoptera: Noctuidae) and associated arthropod natural enemies in Honduras subsistence maize. *Crop Protection* 25:1180 – 1190. Available in:
https://doiorg/10.1016/j.cropro.2006.03.003: Accessed 12/10/2019.

Appendix 1: Map of Kenya Showing Study Sites



Key: LH2- Low Highland Zone[2]; LH3- Low Highland Zone[3]; UM4- Upper Midlands Zone[4]