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Research Application Summary

Economic assessment of factors influencing the magnitude of losses due to fall armyworm: The case of maize infestation

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Abstract

Maize (*Zea mays*) is a principal staple crop in Kenya, largely grown under rain-fed agriculture. Its production has been coupled with numerous constraints both biotic and biotic, where the twin vagaries of climate change and poor prices have continued to affect maize production and the livelihood of farmers. Invasive alien species have emerged as a constraint, the most recent in Kenya being fall armyworm (FAW) (*Spodoptera frugiperda*) infestation, which if not effectively managed, can result in total crop failure. As a result, fall armyworm has further exacerbated the yield gap, which is detrimental to farmers' livelihoods. Most previous studies on invasive alien species hampering agricultural production have been studied regionally thus masking the specific impacts on rural communities' livelihoods. Therefore, the objectives of this study were to estimate the magnitude of economic losses due to FAW and to model the drivers influencing the magnitude of economic losses in Trans-Nzoia County, Kenya. Multistage and systematic random sampling procedures were used to select 257 maize farmers. Results indicate that the average yield loss due to FAW infestation at farm level ranged between 0.18 to 2.7 T per acre. The results further showed that FAW related maize losses increase with the area under maize cultivation and increased household size while access to extension and distance to the market were associated with lower losses.

Keywords: Maize, magnitude of economic losses, fall armyworm infestation

Resume

Le maïs (*Zea mays*) est l'une des principales cultures de base du Kenya, essentiellement cultivée en agriculture pluviale. Sa production a été couplée à de nombreuses contraintes, tant biotiques qu'abiotiques, où le double aléa de faibles prix et du changement climatique a continué à affecter la production de maïs et les moyens de subsistance des agriculteurs. Les espèces exotiques envahissantes sont devenues une contrainte, la plus récente au Kenya étant l'infestation par la chenille légionnaire d'automne (CLA) (*Spodoptera frugiperda*), qui, si elle n'est pas gérée efficacement, peut entraîner une perte totale de la récolte. En conséquence, la légionnaire d'automne a encore aggravé l'écart de rendement, ce qui est préjudiciable aux moyens de subsistance des agriculteurs. La plupart des précédentes investigations sur les espèces exotiques envahissantes qui entravent la production agricole ont été étudiées au niveau régional, masquant ainsi les impacts spécifiques sur les moyens de subsistance des communautés rurales. Par conséquent, les objectifs de cette étude étaient d'estimer l'ampleur des pertes économiques dues aux CLA et de modéliser les facteurs influençant l'ampleur ces pertes économiques dans la région de Trans-Nzoia, au

Kenya. Des techniques d'échantillonnage aléatoire systématique et à plusieurs niveaux ont été utilisées pour sélectionner 257 producteurs de maïs. Les résultats indiquent que la perte moyenne de rendement due à l'infestation par les CLA au niveau de l'exploitation varie entre 0,18 et 2,7 T par acre. Les résultats ont montré également que les pertes de maïs liées aux CLA augmentent avec la superficie cultivée du maïs et la taille du ménage, tandis que l'accès à la vulgarisation et la distance avec marché sont associés à des pertes plus faibles.

Mots clés : Maïs, ampleur des pertes économiques, infestation par la chenille légionnaire d'automne.

Introduction

In early 2017, fall armyworm (FAW), an alien invasive pest native to tropical and subtropical America was reported in Kenya (GoK, 2017). Associated with its ability to migrate long distances of 100 km in a single night, the pest has invaded Sub-Sahara Africa (SSA) at a quicker speed from West Africa where it was first detected to have ravaged maize fields resulting to far-reaching damage to host crops (Goergen *et al.,* 2016; Abrahams *et al.,* 2017). Fall armyworm has emerged to be the most damaging pest since it has the capacity to attack over 80 different crop species (Prasanna *et al.,* 2018). The pest preference is plants of the grass family (maize, wheat, sorghum, rice, millet and sugarcane); it also attacks other economically important crops such as cotton, peanuts, soybean and potato (Ali *et al.,* 1989). In Brazil, FAW is considered as one of the chief pests of maize (Christenson, 1966) where it has been reported to cause massive maize yield losses worth US$ 400 million (Sena *et al.,* 2003). Considering only rice, sorghum, sugarcane and maize, Abrahams *et al.,* (2017) estimated that FAW could result into US$ 13 billion per annum crop losses in SSA.

Maize is a principle staple for small holders farmers hence its high consumption among other cereal crops particularly in smallholder diets. Therefore, FAW infestation at farm level highly undermines progress on sustainable development goals for millions of poor resource constrained farmers. In addition to these yield losses incurred, farming household's capital cost is directly affected through increased need for labor, knowledge required to manage the pest, ability of agricultural lands to respond to shocks and financially to increased cost of production due to costs of control and its effect on income. It also indirectly affects household's social and physical assets (DFID, 2008).

Previous studies took a regional approach in quantifying FAW yield losses thus masking the specific impacts on rural communities. Such empirical evidence is essential to provide insights on resource allocation information for management of the pest. Such information provides a basis for decision making with reference to the relative importance of FAW in maize farming. Thus, the objective of the present study was to estimate the magnitude of economic losses and to model the drivers influencing these losses due fall armyworm infestation in maize farming in Kenya.

Materials and Methods

Study site. The study was carried out in Kiminini Sub-County of Trans-Nzoia County, Kenya. The region is a major maize growing area in the County. The area has a bimodal rainfall pattern

which ranges between 1,000 mm to 1,700 mm per annum while temperatures range from a low of 10 ^{0}C to a high of 30 ^{0}C. Located in the Upper Midland Agro-ecological Zone (UMZ), the area is enriched with fertile and well volcanic soils suitable for maize production.

Study design and Data collection. Multistage sampling was used to obtain a representative sample from the target population of maize growing farmers. The area was purposively selected in the first stage to include the regions where FAW infestation incidence was first reported in Kenya (GoK, 2017). A sampling frame of 1,073 maize farmers was assembled with the help of Sub-County Agricultural Officers (SCAOs). In the second stage, 257 respondents were drawn from the sapling frame using systematic random sampling procedure.

Interviews were conducted between February and March 2019 using a semi-structured questionnaire. This was preceded by a focus group discussion (FGD) and pretesting of the survey tool. Data collected included farmer demographics, socio-economic characteristics, production levels and magnitude of losses due to FAW. Literature from previous studies informed the choice of vector independent variables comprising of farmer-specific, farm specific and external institutional support variables hypothesized to influence the magnitude of yield loss.

To assess the magnitude of yield losses, farmers were asked to state their estimated loss incurred with reference to a pre-estimated initial bid of 11 bags of 90 kg bag per acre, an average value that was derived from the FGD. Regardless of the response from the initial bid, subsequent bids were presented to the farmer at a decreasing or increasing rate of ± 1 bag of 90 kg bag per acre. In modeling the drivers on the magnitude of maize losses due to FAW infestation, the hypothesized vector variables were fitted in a robust regression as follows:-

$$Economic\ Loss = \beta_0+\beta_1\ Pest\ management+\beta_2\ Years\ of\ maize\ farming+\beta_3\ Farming\ system+\beta_4\ Education\ in\ years+\beta_5\ Credit\ Access+\beta_6\ Farm\ size+\beta_7\ Farm\ size\ under\ maize\ production+\beta_8\ Extension+\ \beta_9\ lnIncome+\beta_6\ Household\ size+e$$

Results and Discussion

The male to female household head ratio was 1:8, where 64 percent of the respondents were male farmers who were household heads whereas 36 percent were female respondents who were household heads. The average household size was found to be 6 persons implying that most farmers have small family units. In tandem with (CIDP, 2018), the average age for the farmer was found to be 54 years, while the average number of years of those engaged in maize farming, a proxy for experience, was 18 years. From the sample, 27 percent of the farmers in the study site had achieved primary education. This implies that most of the farmers had acquired post-primary education with the average number of completed years of formal schooling being 11 years. This translates to a high propensity of maize farmers being likely to access and utilize information.

Most farmers, 99%, were aware of fall armyworm. Further analysis showed that 93% of the farmers perceived fall armyworm as the major devastating maize pest in the area while the rest noted that stem borer was the problematic pest. As a result, 96% of the affected farmers resorted to various pest management practices to manage FAW infestation levels. The magnitude of losses ranged between n 0.18 to 2.7 tones per acre.

Several factors had a statistically significant impact on the magnitude of losses incurred at farm level as a result of FAW infestation. These included portion of land under maize cultivation, pest management, household size, group membership, distance to the market, and access to extension. For instance, an increase in the area under maize cultivation was coupled by a higher percentage loss. Precisely, an increase in the size of land under maize by 1 acre was associated with a 41 percent increase in the magnitude of economic loss due to fall armyworm damage. This can be attributed to managerial weaknesses that arise with increase in production area.

Farmers were considered to have had access to extension services to help in the control of maize pests if they had attended a related training seminar, workshop, field day, had listened to a program aired on radio or had contacted an extension officer in the last twelve months before the interview. Farmers who had access to extension services experienced lower losses by 22 percent compared to those farmers who had no extension contact.

Conclusion

This finding indicate that raising awareness through training is a very important component with the perspective of imparting the required information to farmers in managing the pest. Additionally, findings also provide insights on resource allocation with regard to the pest, thus providing a basis for decision making with reference to the relative importance of FAW in maize farming. This is a dimensional impact key for policy formulation and resource prioritization in rural communities which are endowed with limited resources.

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