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Research Application Summary

Maize farmers' perceived benefits on use of drone technology for controlling fall armyworm in Northern Ghana

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Abstract

This paper reviews use of drone technoloyg. It presents results of an exploratory study that involved 150 farmers in Ghana to explore their knowledge about drone technology, and its percieved benefits. Overall, 22% of the farmers were aware of the drone technolog and they percieved its benefits as being fast, saves time and labour, and provides for precise application of pesticides, thus less wastful.

Key words: Agriculture, drone technology, Ghana

Résumé

Cet article examine l'utilisation de la technologie des drones. Il présente les résultats d'une étude exploratoire qui a impliqué 150 agriculteurs au Ghana pour explorer leurs connaissances sur la technologie des drones et les avantages qu'ils en perçoivent. Dans l'ensemble, 22% des agriculteurs connaissaient la technologie des drones et percevaient ses avantages comme étant rapides, permettant d'économiser du temps et de la main d'œuvre, et permettant une application précise des pesticides, donc moins de gaspillage.

Mots clés : Agriculture, technologie des drones, Ghana

Introduction

The invasion and widespread occurence of invasive plant and animal species has serious implication for food productions systems globally. CAB I (2017a) observed that different invasive species found in Africa have been destroying crops resulting in severe losses for smallholder farmers. These harmful organisms attack rangelands and lower the productivity of major staple food including maize by up to about 45 percent in some instances including in high-value, healthy and perishable crops such as vegetables, pulses and fruits (Landmann, 2017). Among the five prominent invasive species known to be pervasive in Africa are the South American tomato leaf miner (*Tuta absoliita*), the spotted stem borer (*Chilo partellus*), Maize Lethal Necrosis Disease (MLND) caused by a dual viral infection, invasive 'famine weed' (*Parthenium hysterophorus*) and the fall armyworm (*Spodoptera frugiperda*), with the later noted to be most recent and destructive (CA B I, 201 7b).

The Fall Armyworm (*Spodoptera frugiperda*) (JE Smith), is a subtropical and tropical native insect from the Americas regions (FAO, 20 18). By scientific nomenclature the insect is a derivative of the feeding behaviours of the larval cycle, frugiperda meaning “lost fruit” in Latin (FAO, 20 17). The caterpillar form of the insect causes destruction to crops resulting in severe yield loss - feeding on over 80 different crop species comprising cereals and grains (maize, sorghum, sugarcane, rice, millet, and pasture grasses), vegetables (alfalfa, beet, cabbage, tomato and onion), legumes (groundnut and soybean), fibre (cotton) and roots and tubers (potato) (CABI, 2017a, 2017b; Day el al., 2017). The incidence of the FAW was first reported on the African continent at the beginning of 2016 (FAO, 2017; Prasanna *et al*., 2018; Sisay *et al*., 20 19).

Studies in academic joumals has revealed that the FAW have been seen in almost all countries in sub-Saharan Africa (SSA), where it is reported to be causing extensive havoc to maize and sorghum fields (Prasanna *et al*., 2018). Although there have not been reported cases of FAW in North Africa, the continued spread of the invasive pest has been reported in over 44 countries in Africa (Rwomushana *et al*., 2018). lnitial reports of the incidence of the FAW were from West Africa countries of Benin, Nigeria, Togo, Mali, Sierra Leone, Liberia, Senegal, Cöte d’Ivoire and Sao Toine’ and Principe and spread to Cape Verde, the Seychelles and Madagascar (Day *et al*., 2017; FAO, 2017; Prasanna *et al*., 2018). A household study by Rwoinushana *et al*. (2018) in Ghana and Zambia revealed that 98 percent of farm household surveyed reported the incidence of FAW on maize fields. The average maize yield losses reported by farmers in both Ghana and Zambia was 26 and 35 percent, respectively.

The impact of the destruction of maize fields by the FAW cannot be over emphasized especially since the crop is a key food security crop. Day *et al*. (2017) stated that maize is one of the most extensively cultivated crops in Africa because of its role as a staple for almost half the continent’s population. The crop is cultivated across diverse agro-ecological zones and serves as a food security crop for over 200 million households. In the face of the growing population in Africa, there is need to increase maize production to feed the increasing population (FAO 2017; FAO and ITU, 2018; FAO and ITU, 2019). However, Kalibata (2019) posits that in the last three years, the number of people living in hunger on the African continent has grown to about 34.5 m, a phenomenon attributed to climate emergency that has reduced yields of key crops like maize by 40 percent. Furthermore, Day *et al*. (2017) reported that the estimated national mean loss of maize in 2017 in Ghana and Zambia due to the incidence of FAW was 45% (range 22-67%), and 40% (range 25-50%), respectively. Day *et al*. (2017) further reported that Ghana made between US$ 138.5m and US$ 418.8m economic losses from maize production in 12 months due to the incidence of Ihe FAW in the country that same year. The efiect of effect of climate emergency and FAW attack if not checked has the potential of plunging the continent and for that matter Ghana into food security crises. Climate change is already making farmers more vulnerable, and the effect of FAW would make the situation daunting (Tsan *et al*. , 2019).

Research has shown that the adoption and use of digital technologies such as radios, digital cameras, telephones, videos, televisions, internet, emails and mobile phones have helped to mitigate the myriad of challenges in agriculture, including the incidence of climate emergency and FAW (Nuer *et al*., 2018; Rainbaldi and Guerin, 2018). Digitalisation can help to fast-track agricultural revolution in Africa. Tsan *et al*. (2019) defines digitalisation for agriculture (D4Ag) as “the use of digital technologies, data and business model innovations to transform practices across the agricultural value chain and address bottlenecks *in, inter- alia*, agricultural productivity, postharvest handling, market access, finance and supply chain management so as to achieve greater incomes for smallholder farmers, improve agriculture value chain economics for agribusinesses both large and small, expand the economic inclusion of youth and women, improve overall food and nutrition security and build climate resilience -all while mitigating the potential negative environmental effects of agricultural intensification.

Digital technological innovation is part of the solution to transforming agricultural productivity with limited effect on the environment (Trendov *et al*., 2019). A switch by smallholder farmers toward agricultural digitalisation will provide them with opportunities to help increase crop yields, reduce postharvest losses and create more efficient agricultural supply chains to improve food retail, and distribution which are known to be major challenges facing smallholders (FAO and ITU, 2019). Integration of D4Ag tools in agriculture would help deal with challenges to agricultural transformation in a faster and more economically manner than status quo of using rudimentary methods because accelerated innovations, improved cost efficiency and rapid product and service diffusion are the attributes of digitalisation (Tsan *et al*., 20 19). Digital tools stich as artificial intelligence, analytics, breeding infonnatics, big data, cloud computing, digital services, internet of things, mobile devices and GIS/UAVs are being deployed in agriculture all over the world for great benefits (ICRISAT, 2016). The use of these digital technologies in agriculture will drive research and policy on their adoption and use to improve the livelihoods of smallholder farmers in Africa. The African Union Commission in 2016 appointed a ten member high level experts on emerging technologies to provide evidence-based analyses of digital technologies used in agriculture with special focus on artificial intelligence, precision agriculture and UAV technology and make recommendations to inform pol icy direction at the national, regional and continental level on the application of existing and emerging digital technologies (NEPA D, 20 16). One of the modem advances in the use of digital devices is the upsurge in the use of small, unmanned aerial vehicles (UAVs), usually referred to as drones, for agriculture (FAO and ITU, 2018). Drones are deployed in many fields such as disaster management, humanitarian relief, in the military, and in agriculture (FAO and ITU, 20 18). The drone is a 'remote-controlled pilotless aircraft that has many applications for agriculture field surveillance and remote diagnostics of agronomic conditions such as plant and crop diseases, water resources, and soil qiiality (Tsan *et al*., 2019). In agriculture, Probst *et al*. (2017) posits that drones are deployed for soil and field analysis, crop monitoring and health assessment, irrigation, aerial planting and crop spraying. FAO and ITU (2018) noted that the application of drones in agriculture was growing at a fast pace in crop production, forestry, disaster risk reduction, early warning systems, fisheries and wildlife conservation. With the use of drones Soesilo and Rainbaldi (20 18) observed that large agricultural fields can be inspected within hours or perhaps minutes, creating an opportunity to monitor vast plantations of crops on a periodic basis. These activities other-wise would have taken days to complete with a car or on foot.

The UAS services are provided by entrepreneurs who invest in the equipment, learn the skills to rise it, conduct or sub-contract data analysis, interpret the findings and advise their customers. Cutting edge use of specially designed drones allows the devices to spray crops with liquid herbicides, fertilizers and pesticides on large fields at efficient and tiinely manner (Giles and Billing, 2015; Probst *et al*., 20 17; Spoorthi *et al*., 2017; Hentschke *et al*., 20 18). The application of drone technology offer smallholder farmer enormous benefits (De Rijk *et al*., 20 18; Hentschke *et al*., 2018; Lori *et al*.; 2018; Mogili and Deepak, 2018). The design and development of these digital technologies should however, involve the end users to ensure the technologies are accepted and effectively used in the field.

Methodology

Mixed method research approach invol v ing quantitative and qualitative procedures, descriptive survey and paHici patory action research designs were used for data collection. Using sample population of maize farmers in seven communities in three districts of Northern Ghanan(Salanpkang, Kplijine and Dijo in the tion District, Kukua and Loagri in the West Mamprusi District and Nyankpala and

Kpalsogu in the Todon District), 150 farmers were sampled using multi stage sampling technique to participate in the study. The instrument for preliminary data collection was a validated structured interview schedule on farmers' awareness and perception of the use of drone technology in agriculture. This was followed by field demonstrations on the use of drones for spraying fall armyworm on maize plots in the study area. A follow-up survey was then conducted among the selected maize farmers to evaluate their perceived benefits on the use of drones for the control of fall armywotm. At the end of the survey, 145 farmers out of the 150 sampled participated in the study, accounting for 99.67 percent response rate during the two separate surveys. The data gathered were subjected to Friedman rank and Wilcoxon signed rank tests means, standard deviations, and multivariate distribution of variables, embedded in the IBM-SPSS software (version 25) application. The results were displayed in tables, charts, and graphs. The diagrams generated from the IBM-SPSS were exported to Excel for editing for better visual presentation.

Preliminary results of the study

Farmers' awareness of Drone Technology in Agriculture. The survey results show that majority of the farmers who participated in the survey were males (53.10%). Also 26 representing (17.90%) out of the 145 farmers were aware (seen or heard) of drone technology. The results indicate that close to one fifth of the farmers had seen or heard of drone technology for spraying agro-chemical (61.54%), picture taking (46.15%) and film making (42.30%), whilst others were aware that drone technology is used for monitoring security, oil and gas and mineral explorations, medical supplies, land surveying and remote sensing (Table 1). The result of this study is in line with findings of FAO and ITU (2018) and Probst *et al*. (2017) who reported that drones are used in various fields including agriculture. The respondents also reported that they gained their awareness from watching television (38.46%), amending ceremonies where drones were used (34.62%) and from security agencies using the drone for security activities in the area (26.92%).

The results further show that only four (2.80%) of the farmers had participated in an agricultural programme where drone technology was used (Table 1). The four farmers participated in programmes organised by Non-Governmental Organizations (NGOs), the Ministry of Food and Agriculture and Research institutions. The result of this study confirm the optimism of Soesilo and Rambaldi (2018) about the prospects of deployment of drone technology in agriculture despite the limited use of the technology on the African continent.

Farmers' perception on benefits of drone technology for the control of FAW. The results of the study on the farmers' perception on the benefits of drone technology for the control of FAW indicate that, generally, the farmers perceived the benefits of the drone to be very high (Composite mean = 8.71, S.D = 0.99) out of a scale of ten (Table 2). Five most important benefits of the drone technology mentioned by the farmers were that drone technology is very beneficial, it saves time, requires less labour, makes pesticides application easier and enhances effectiveness of the application of pesticides. The banners also indicated that using drone technology for the control of FAW was superior to other methods of pesticide application known to them, because the drone could apply pesticides precisely to kill the caterpillar of the FAW with less wastage of chemicals during spraying. The fi ndings of this study are consistent with the findings of Spoorthi *et al*. (2017), De Rijk *et al*. (2018), Hentschke *et al*. (2018), Loti *et al*. (2018), and Mogili and Deepak (2018) who all reported similar benefits of the use ot drone technology in Africa.

Table 1. Farmers' awareness of Drone technology

Sex	Frequency	Percentage
Males	77	53.10
Females	56	46.90
Total	145	100.00
Seen or heard of drone tech.	Frequency	Percentage
Yes	26	17.90
No	119	82.10
Total	145	100.00
Perceived uses of drone technology	Frequency*	Percentage
Spraying Agro chemicals	16	11.00
Picture taking	12	8.30
Film making	11	7.60
Monitoring Security	3	2.10
Oil and Gas exploration	2	1.40
Mineral exploration	2	1.40
Medical supplies	2	1.40
Land surveying and Remote sensing	2	1.40
Source of information on awareness	Frequency	Percentage
Television	10	38.46
Ceremonies	9	34.62
Security services	7	26.92
Total	26	100.00
Participated in the use of drones in agriculture	Frequency	Percentage
Yes	4	2.80
No	141	97.20
Total	145	100.00
Source of activity	Frequency	Percentage
NGOs	2	50.00
MoFA	1	25.00
Research institutions	1	25.00
Total	4	100.00

Source: Field Data, 2019. n = 83. *Multiple responses

Table 2. Farmers' perceived benefits of drone technology

Benefits of drone technology	Range	Min.	Max.	Mean	S.D
The drone technology is very beneficial	6	4	10	9.12	1.44
The drone technology saves time	8	2	10	9.08	1.69
The drone technology makes pesticides application easier	9	1	10	9.03	1.63
The drone technology requires less labour	8	2	10	9.02	1.63
The drone technology enhances effectiveness of pesticide application	9	1	10	8.86	1.72
Drone technology is superior to other methods of pesticide application known to me	8	2	10	8.84	1.75
Drone technology reduces the negative impact of pesticides on the environment	9	1	10	8.81	1.75
The drone technology apply the exact quantity of pesticides	8	2	10	8.55	1.85
The drone technology fits well with the way pesticide is applied in my area	9	1	10	8.48	1.99
There is less wastage of chemicals in the use drones to spray pesticides	7	3	10	8.48	1.81
The drone technology apply pesticides to precisely kill the caterpillar stage of the FAW	10	0	10	8.32	2.19
The drone technology will not require a shift in behaviour of farmers in the application of pesticide in the control of FAW	10	0	10	8.19	2.36
Less amount of pesticides are used in drone applications	10	0	10	8.08	2.27
The drone technology saves money	10	0	10	8.06	2.39
The drone technology will not require a shift in the belief of farmers in the application of pesticide in the control of FAW	10	0	10	7.92	2.51
The drone technology will not require a shift in the attitudes of farmers in the application of pesticide in the control of FAW	10	0	10	7.57	2.86
Composite mean	10	0	10	7.57	1.86

Source: Field Data, 2019. n = 145.

Conclusion

Only about one fifth of the farmers had seen or heard of drone technology for spraying agro-chemicals, picture taking, film making, monitoring security, oil and gas and mineral explorations, medical supplies and land survey ing and remote sensing. A few farmers had participated in agricultural programmes organised by Non-Governmental Organizations (NGOs), the DepaHment of Agriculture under the Ministry of Food and Agriculture and Research institutions on drone technology before this study. There were generally high agreements on the benefits of the use of drone technology for agriculture in the study area. These findings therefore indicate high prospects and potentials for employing drone technology in the improvement of the agricultural systems in Ghana.

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