FALL ARMYWORM Monitoring

Structure of the Countries Profile

January - June 2021 Issue

ETHIOPIA | MALAWI | RWANDA | UGANDA | ZAMBIA

Overview

This regional and country profile presents the potential spread of the Fall armyworm (FAW) within the maize cropping areas in Malawi, Rwanda Ethiopia, Uganda and Zambia. It suggests actionable solutions, mitigations and adaptation mechanisms that manage the FAW invasion. The main objective of this profile is to provide a broad panel of stakeholders with national-level information targeted at stimulating information sharing, inclusive policy drafting, engagement to design homegrown solutions, community-based monitoring for the FAW, and to improve the regional data collection mechanisms for increased data quantity and quality.

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During the period January to March 2021, the infestation level in the five countries is expected to be relatively low to moderate with comparative portions of the areas having high to very high probability of intense FAW infestation particularly in Ethiopia. Similarly, the April to June period will likely be characterized by low to moderate infestation levels since this period coincides with crop harvesting *(see crop calendars on page 9).*

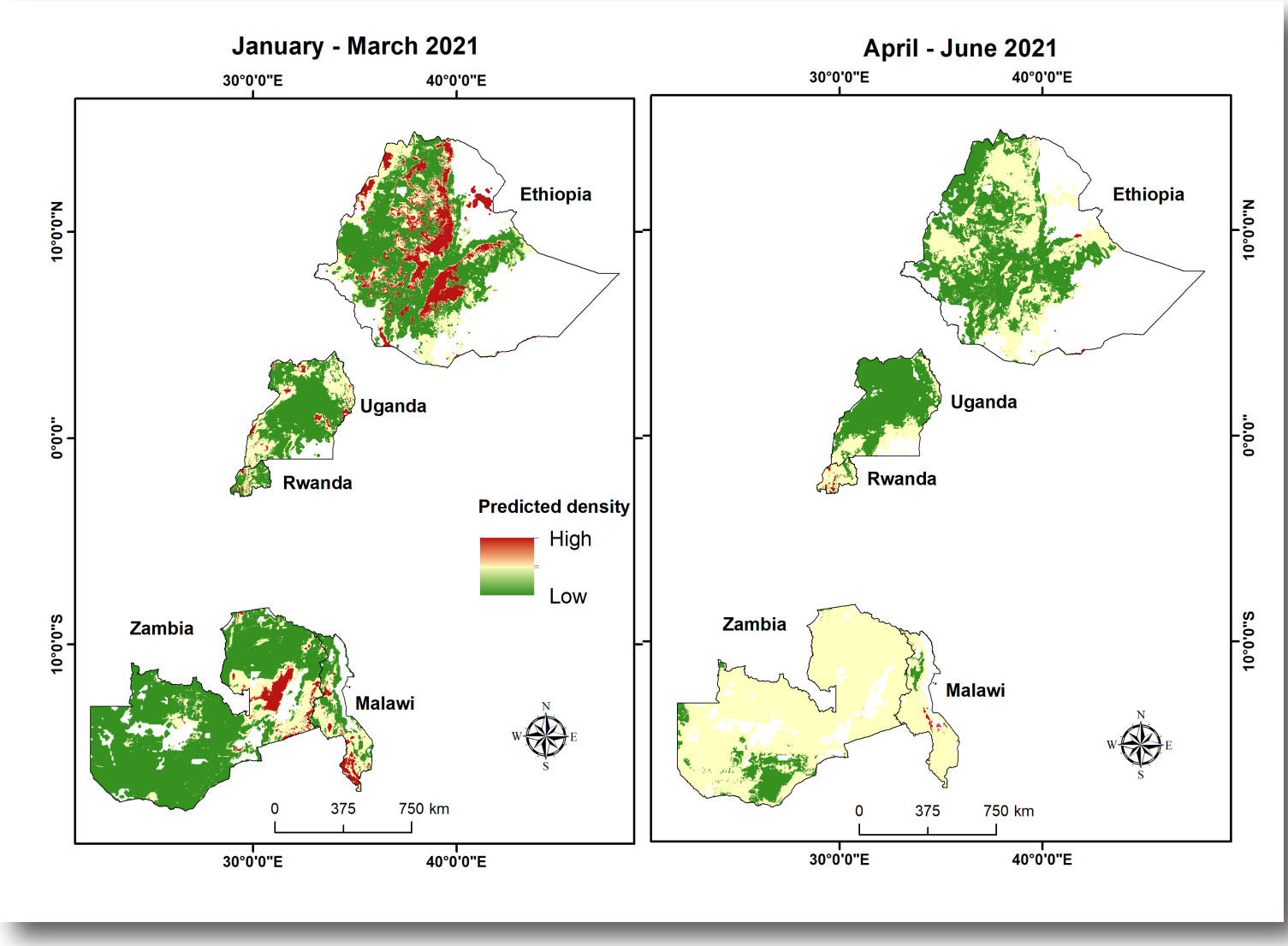

Figure 1: Probability of occurrence and predicted density of the Fall armyworm in Ethiopia, Uganda, Rwanda, Zambia and Malawi for the period January to March (left) and April to June (right).

FAW moth is a strong flier which can travel up to 1000km in a lifetime.

January to March 2021

In Malawi, the prediction map of the FAW infestation between January to March 2021 shows a moderate to high infestation of FAW, particularly in the northern, central (Lilongwe) and southern (Blantyre) regions. The areas around Zomba, Chitedze, and Mzuzu show moderate infestation level. The reporting period coincided with the peak season of maize growing in the southern Africa region.

April to June 2021

The infestation rate and spatial coverage shall reduce except for some few patches around Lilongwe, Lake Malawi and due west of Blantyre while the rest of the country shall experience relatively low infestation levels.

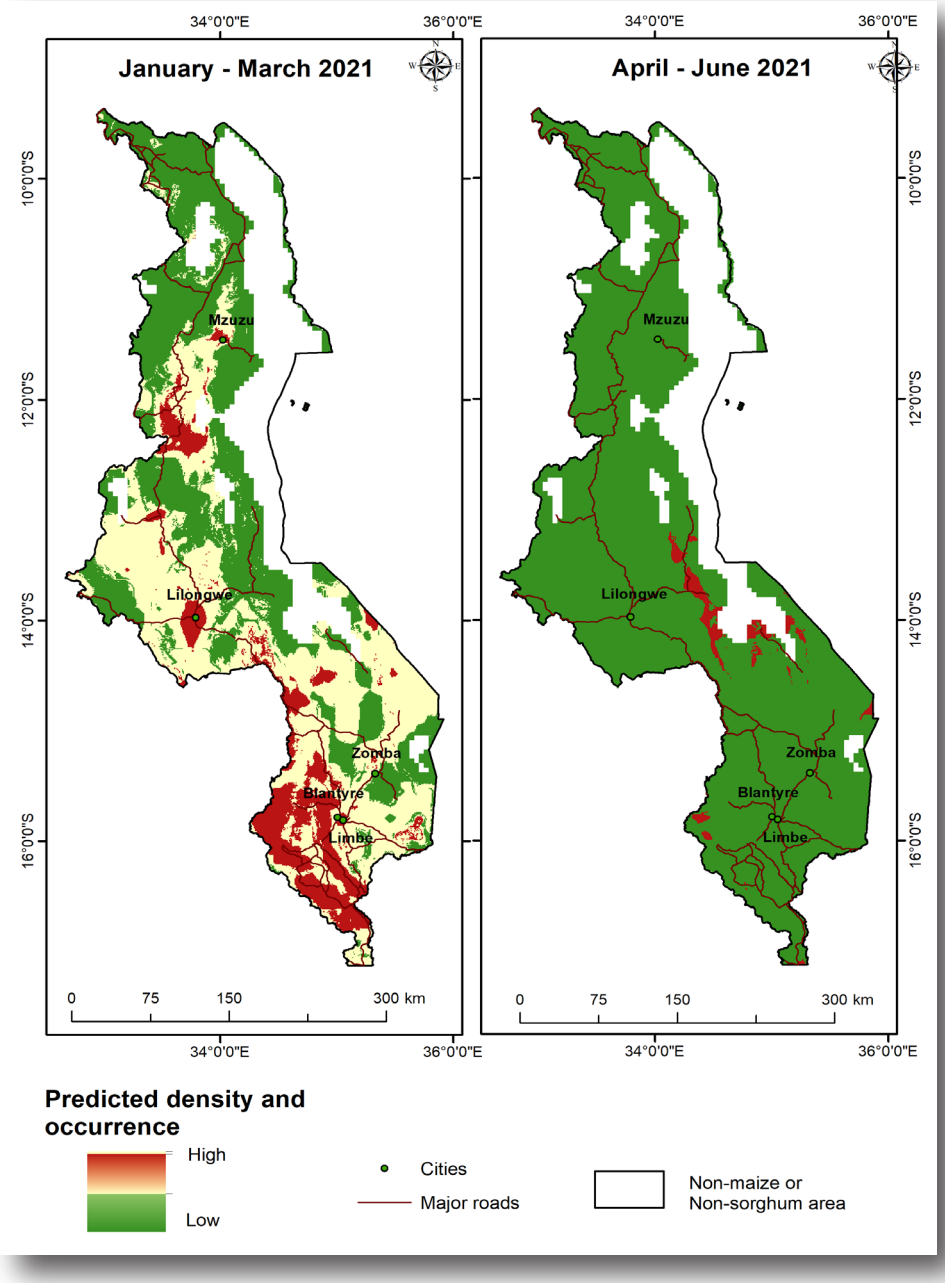

Figure 2: Probability of occurrence and predicted density of the Fall armyworm in Malawi for the period January to March (left) and April to June (right). The green color shows a relatively low density while the yellow and red signify moderate and high levels, respectively.

January to March 2021

Most land is fallow between January-March in Ethiopia. FAW infestation is high, particularly in Mekele, Dese, Awasa, moderate in Gonder, Bahir Dar and low in most western parts of the country where maize and sorghum are cultivated.

April to June 2021

Although most areas shall experience low to moderate infestation, farmers and extension officials need to be very vigilant particularly for areas depicted in yellow which will likely have moderate infestation across the country.

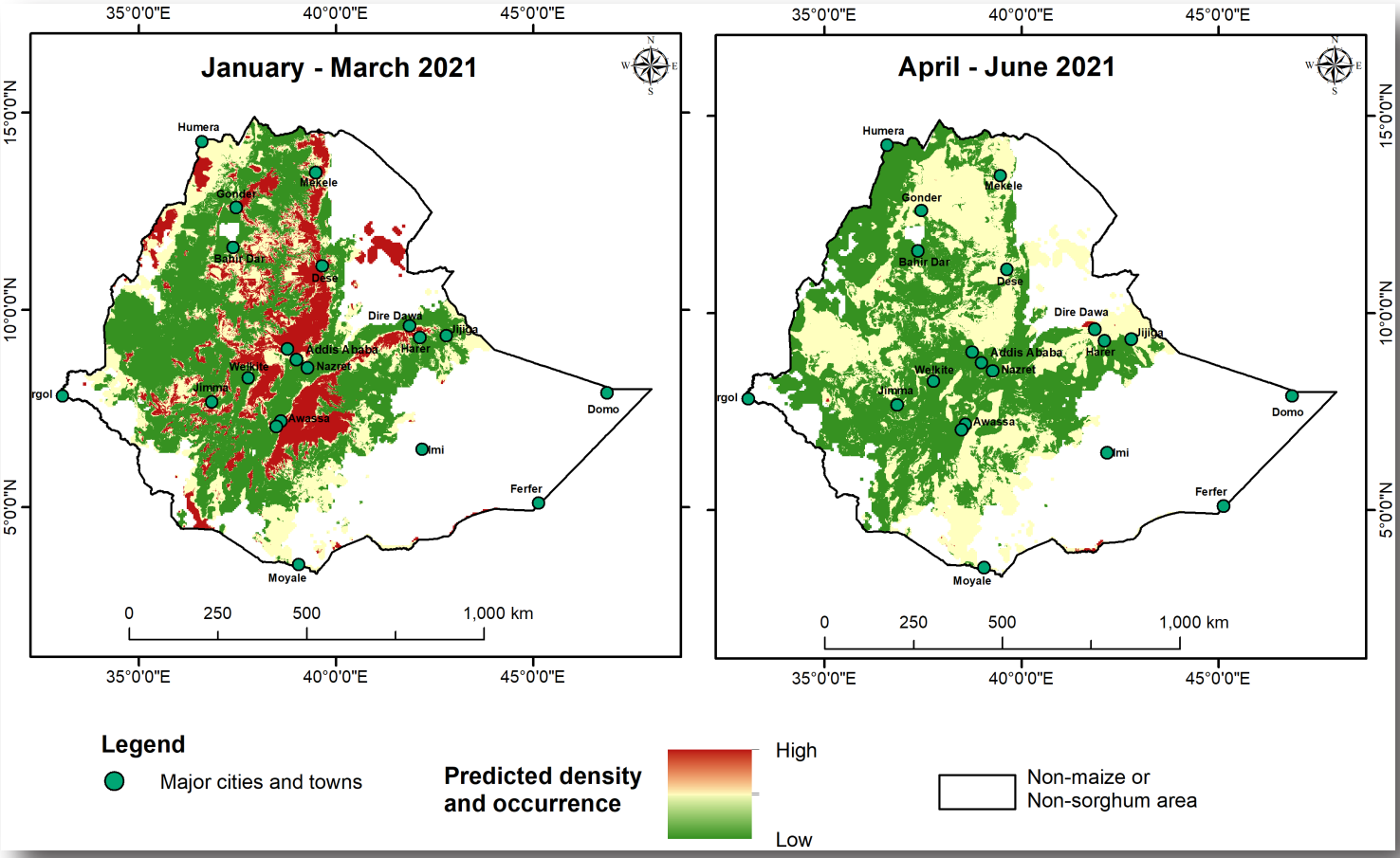

Figure 3: Probability of occurrence and predicted density of the Fall armyworm in Ethiopia for the period January to March (left) and April to June (right). The green color shows a relatively low density while the yellow and red signify moderate and high levels, respectively.

January to March 2021

The period, January to March 2021 in Uganda coincides with the end of the maize season and the sowing of millet in the south. FAW infestation is low in most parts of the country particularly the central and most parts of the southern region. Most of the moderately infested regions are in the northeastern (Kaabong and Kotido) and southwestern (Ibanda). The eastern region has small portions of highly infested areas such as in Bugiri and Kaliro.

April to June 2021

Most areas will experience low infestation during the period April to June 2021. However, extreme caution must be taken in non rainfed cropping systems that may provide optimum host facilities to the FAW during the harvesting period.

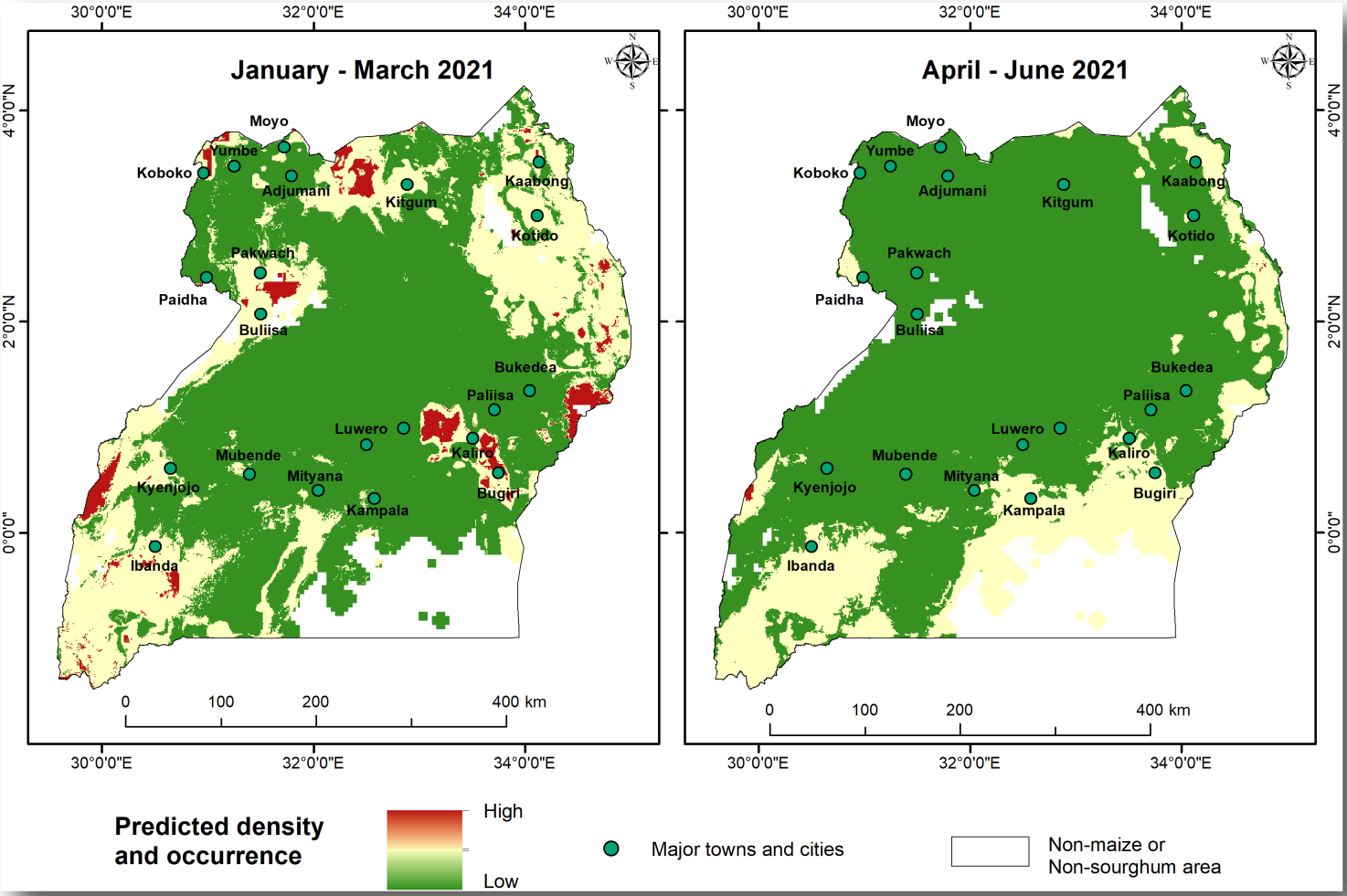

Figure 4: Probability of occurrence and predicted density of the Fall armyworm in Uganda for the period January to March (left) and April to June (right). The green color shows a relatively low density while the yellow and red signify moderate and high levels, respectively.

January to March 2021

The months from January to March coincide with the harvesting period of maize and beans. This period also marks the beginning of maize and sorghum sowing for season B. FAW infestation is high, particularly in the northwestern (Rubavu) and southwestern regions. FAW infestation is moderate along the valley following Huye, Nyamagabe, Nyanza, Ruhango, Muhanga, Kigali, Gicumbi, and Musanze. The areas due east and due west such as Karongi and Rwamagana, respectively, show low infestation of FAW.

April to June 2021

Areas around Nyagatare, Rwamagana and Ngoma that lie in eastern and northeastern Rwanda will likely face high infestations as compared to other regions. However, the entire country will likely receive moderate infestation levels during the period April to June 2021.

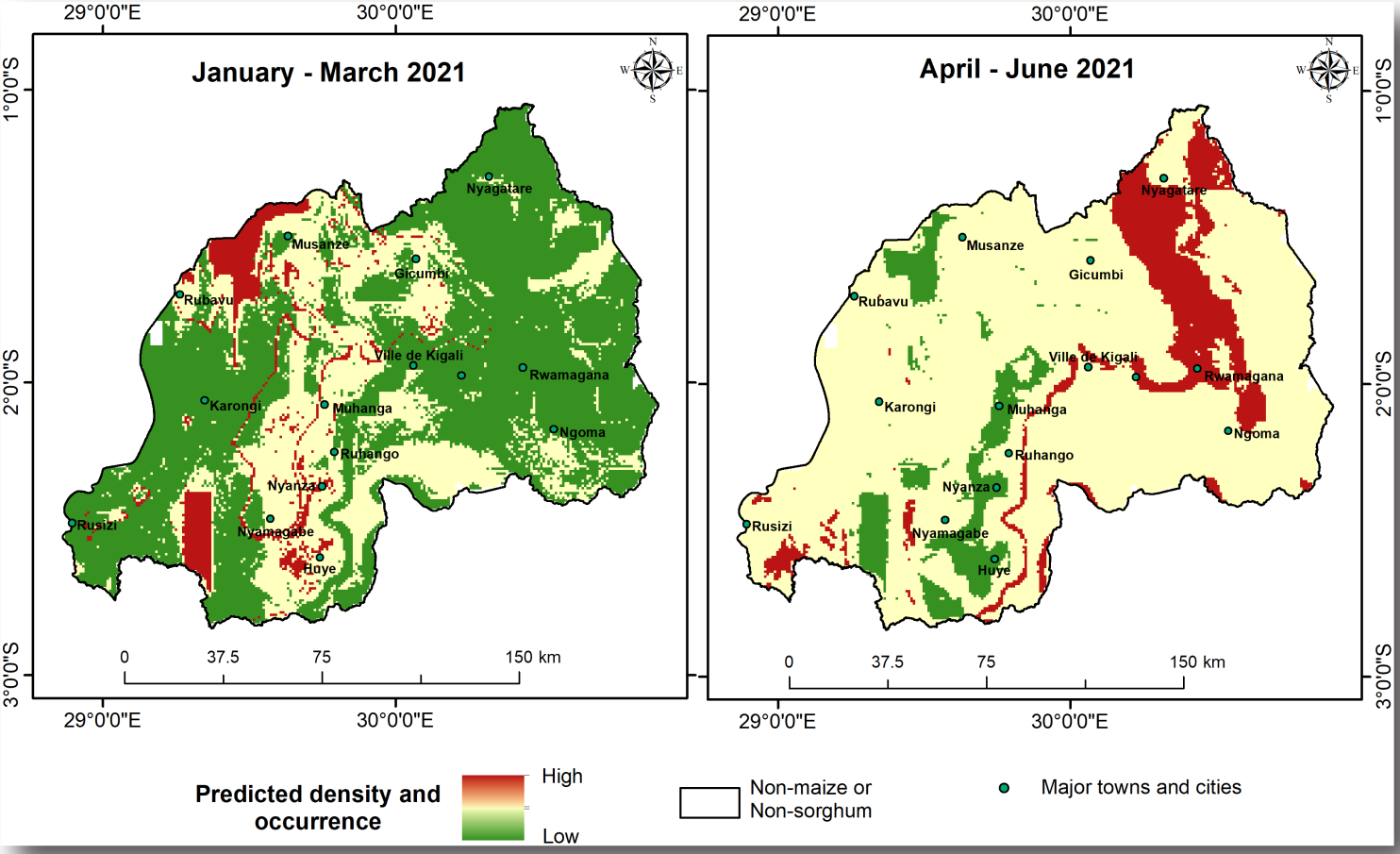

Figure 5 : Probability of occurrence and predicted density of the Fall armyworm in Rwanda for the period January to March (left) and April to June (right). The green color shows a relatively low density while the yellow and red signify moderate and high levels, respectively.

January to March 2021

During the period January to March 2021, FAW infestation is exceptionally high in the eastern region i.e. Mpika, moderate to high around Chipata, while the western (Mongu and Zambezi) southern (Livingstone and Chirundu), and northeastern (Tunduma, Kasama and Kawamba) regions have low infestation. The January to March 2021 reporting period coincides with the peak maize growing season in southern Africa *(see crop calendars on page 9).*

April to June 2021

The infestation is expected to be moderate to low during the April to June 2021 period which matches with the harvesting season of most southern African countries including Zambia and Malawi.

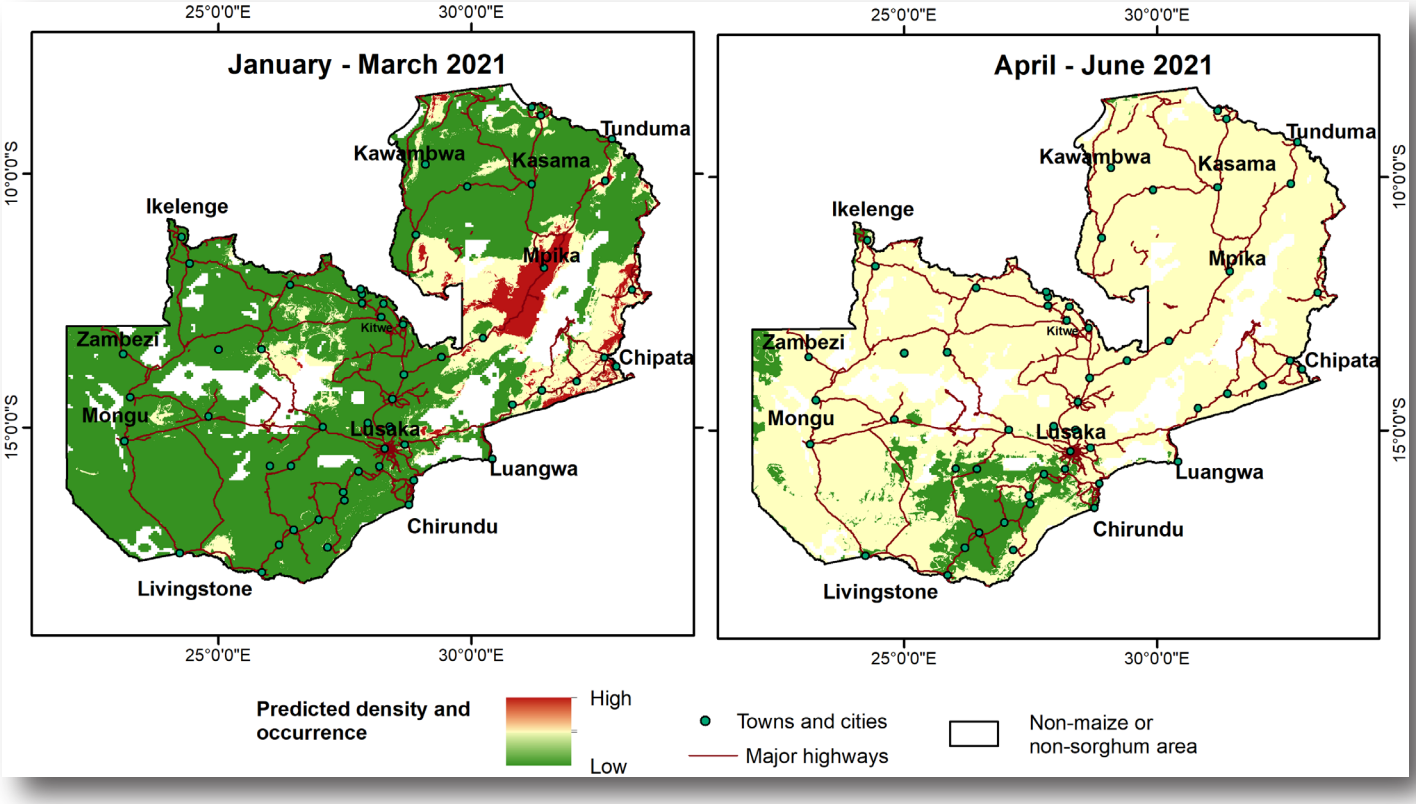

Figure 6 : Probability of occurrence and predicted density of the Fall armyworm in Zambia for the period January to March (left) and April to June (right). The green color shows a relatively low density while the yellow and red signify moderate and high levels, respectively.

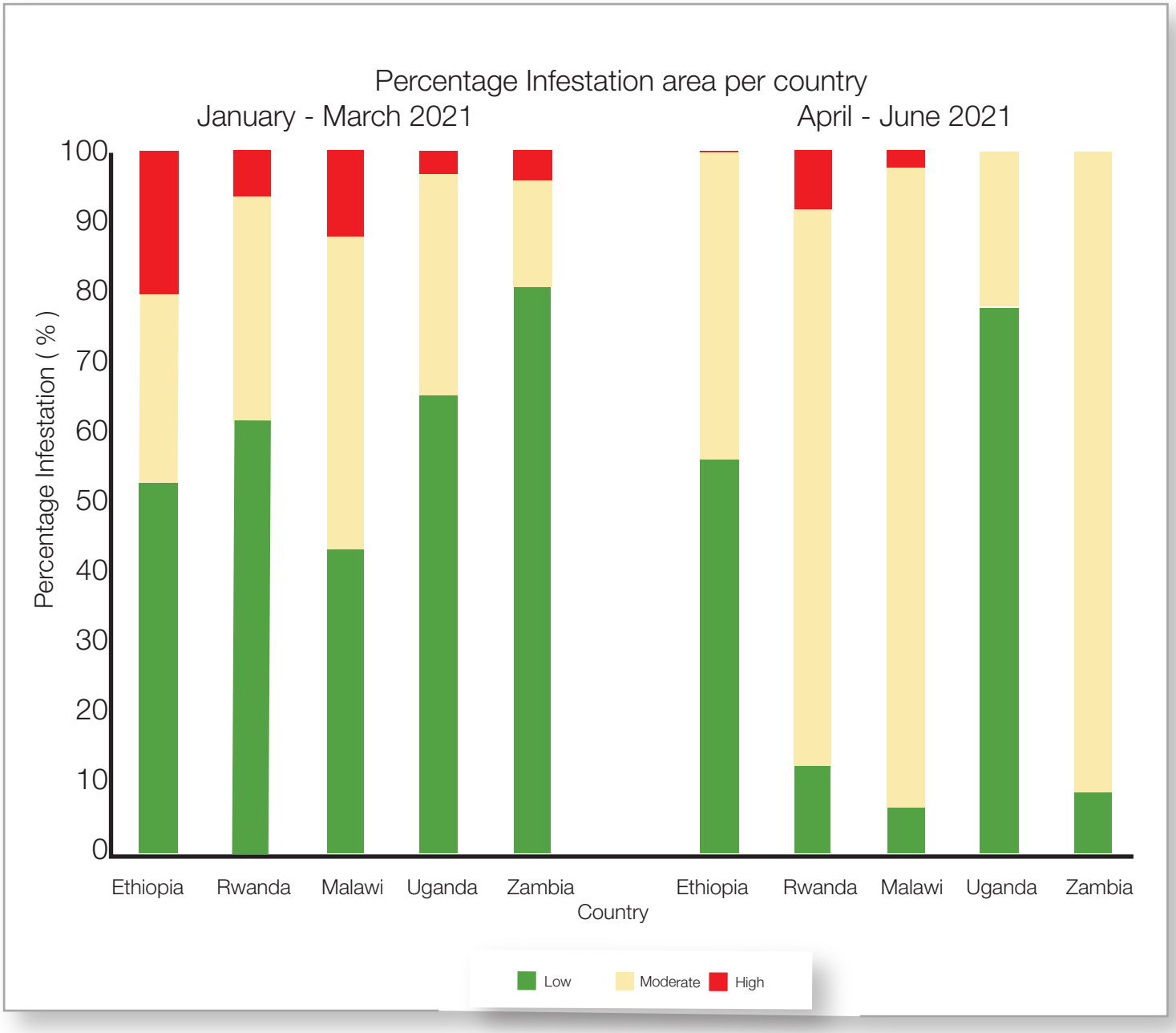

Figure 7: Area coverage of the different infestation levels in Ethiopia, Rwanda, Malawi, Zambia and Uganda

In general, the percentage of areas experiencing a high infestation level significantly reduces in the period April to June 2021 in most countries except Rwanda. For the countries in southern Africa i.e. Malawi and Zambia, that have a mono-modal rainfall season, most regions that had experienced high infestation in the period January to March 2021 were reduced to either moderate or low infestation level in the April to June 2021 period.

Damage is done by the larvae on young plants causing windowing or holes on leaves, boring of maize cobs and ears.

CROP CALENDERS (JANUARY - JUNE 2021)

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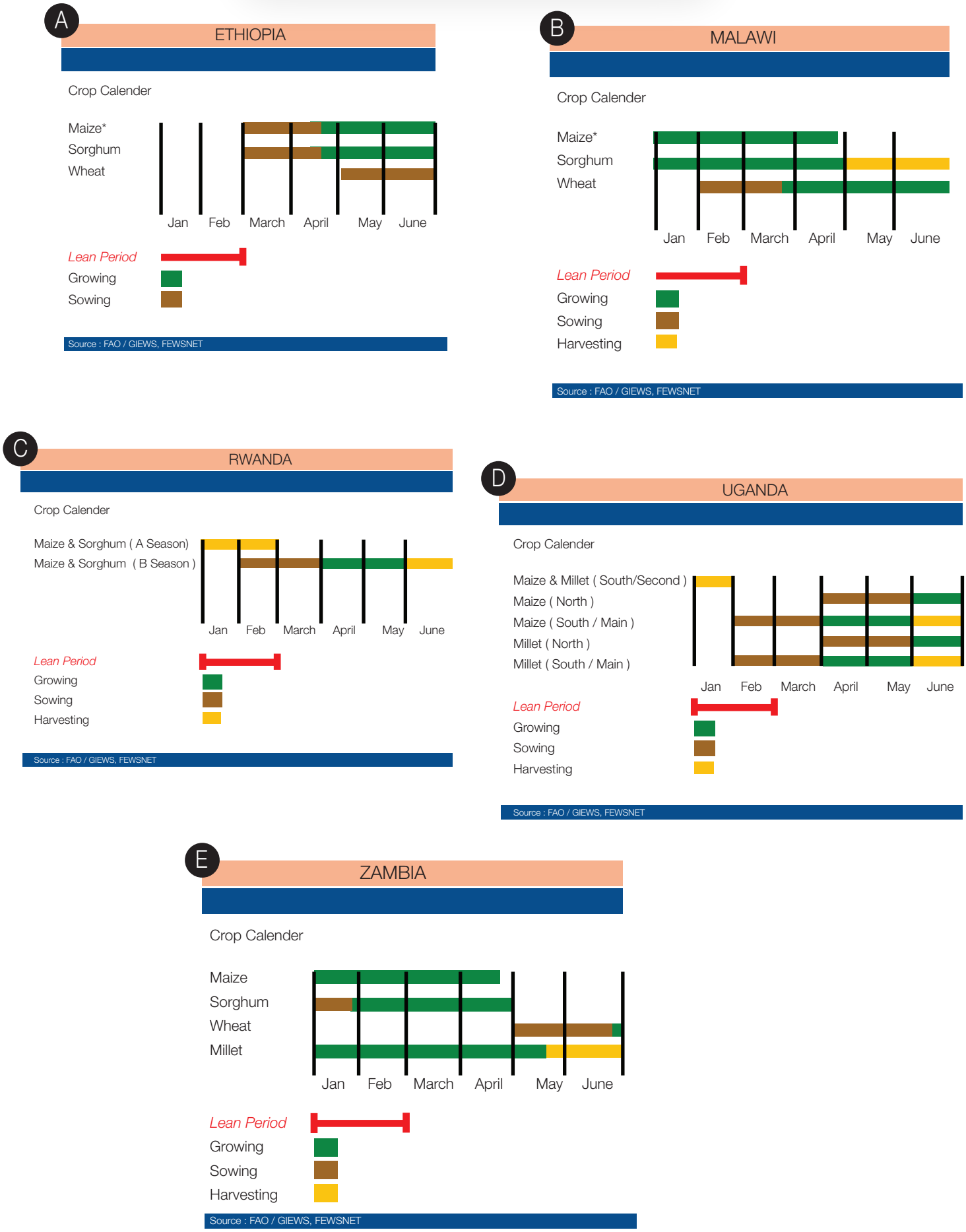

Figure 8 : Crop calendars of the five countries namely ,A- Ethiopia, B- Malawi, C- Rwanda D - Uganda , E - Zambia

PRACTICAL RECOMMENDED ACTIONS

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Technology	GAP and Cultural Practices	Push-Pull	Legume Intercropping	Biopesticides & Biorationals	Natural Enemies
Description	Timely land preparation, planting and weeding, timely application of fertiliser or manure in the proper doses, use of certified and recommended seed varieties.	Push ~~-Pull~~ involves intercropping of Maize with desmodium legume and Brachiaria grass.	Involves intercropping of maize with other legumes, i.e. Beans, Green grams, Mucuna etc.	These are fungal based and plant derived pesticides.	Beneficial parasitoids of FAW eggs and larvae: *Trichogramma Chilonis*, *Telenomus remus*, *Cotesia icipe*)
Application Rate	Continuous Recommended in most low infestation regions (Green)	Applied once Legume intercropping and Push - Pull	Applied every season Need to facilitate introduction in Ethiopia	Applied every season Mass release recommended in highly infested regions	3-4 releases per season
Cost	A routine does not come with a cost	120 USD/acre or 30USD if seeds are locally produced	38 USD/acre	20- 40 USD /liter	Rearing costs
Where to get the service/ Technology	Own practice	Seeds: *Link* **Training**: Ministry, DARS, TLC in Malawi RAB, FH, SAC -Rwanda ZARI, KATC, SAC - Zambia	Seeds: **Training:** Ministry, DARS, TLC in Malawi RAB, FH, SAC Rwanda ZARI, KATC, SAC Zambia	**Training**: Ministry, DARS, TLC in Malawi RAB, FH, SAC Rwanda ZARI, KATC, SAC Zambia	Training: Ministry, DARS, TLC in Malawi RAB, FH, SAC Rwanda ZARI, KATC, SAC Zambia.
Malawi	North	Introduce in South	Promote in Eastern and the Northern areas with low infestation	Promote in South and Central regions	Promote in South and Central regions
Zambia	Promote alongside other technologies in all maize and cereal growing areas	Eastern, Central North	Western	East and North	East and North
Rwanda	Promote alongside other technologies in East and Western	Promote in Western and Eastern	East, South, and West	South and Northern regions	South and Northern regions
Uganda	Promote alongside other technologies in all maize and cereal growing areas	North Eastern, North and South.	Promote in Central	East, West, and North	Promote in Eastern and Western
Ethiopia	Promote alongside other technologies in all maize and cereal growing areas	Promote in East, North, South	Promote in Western	East, South and North	East, South and North

	GAP and cultural	Push-Pull	Legume intercropping (Agroecological management options)	Biopesticides and Biorationals	Natural enemies
Policymaker					
Ethiopia	Introduce incentives to promote adoption of GAP among small Support training and extension activities to strengthen adoption of GAP	Support seed certification for the locally produced Desmodium and Brachiaria seeds	Sensitize policy makers on the effectiveness of intercropping and support development of policies to facilitate access to seeds.	Support certification ,commercialization and distribution of biopesticides	Support licensing of mass rearing and distribution of natural enemies in the country
Malawi	Establish National programs to promote adoption of GAP Establish National programs strengthen technical know how in application of GAP	Integrate into the national Extension system Support local seed production	Sensitize policymakers on the effectiveness of intercropping and support development of policies to facilitate access to seeds.	Provide subsidy for local manufacture of biopesticides Implement national programs on farmer sensitization and training on biopesticides an d biorationals as safe alternative to chemical pesticides	Support licensing of mass rearing and distribution of natural enemies in the country
Rwanda	Support certification and accreditation for established GAP in the country Establish National programs to promote adoption of GAP	Integrate Push -Pull into the National Extension system Officially roll out a scaling strategy technology for adoption	Sensitize policy makers on the effectiveness of intercropping and support development of policies to facilitate access to seeds.	Implement Agri -policies on chemical pest reduction. Provide subsidies on biopesticides	Promote national programs on research and farmer sensitization on the use of natural enemies alongside other techniques in the management of FAW
Uganda	Introduce incentives to promote adoption of GAP among small scale farmers	Integrate into the national Extension system Promote local seed production	Sensitize policy makers on the effectiveness of intercropping and support development of policies to facilitate access to seeds.	Promote national biopesticide programmes to promote the uptake and utilization of Biopesticides and biorationals.	Support licensing of mass rearing and distribution of n atural enemies in the country Promote national programs on research and farmer sensitization on the use of natural enemies alongside other techniques in the management of FAW
Zambia	Promote national programs to sensitize and train farmers	Integrate the technology in national Agriculture programs and extension system	Sensitize policy makers on the effectiveness of intercropping and support development of policies to facilitate access to seeds.	Support registration, commercialization and distribution of biopesticides	Support licensing of mass rearing and distribution of natural enemies in the country Promote national programs on research and farmer sensitization on the use of natural enemies alongside other techniques in the management of FAW

FAW is now wide spread in Asia, Africa, North, South and Central America and the Caribbean

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	GAP and cultural	Push-Pull	Legume intercropping (Agroecological management options)	Biopesticides and Biorationals	Natural enemies
Research / Academia					
Ethiopia	Establish standards and guidelines for GAP in various Agro-ecological zones in the country Conduct research on the challenges to adoption of GAP and advise policy makers	Conduct trials on suitable areas for the production of desmodium and brachiaria seeds Provide evidence on quality of local seeds to facilitate seed certification	Conduct research on best edible legumes for intercropping and the most varieties considering agroecological context and cultural practices.	Validate the proven biopesticides for commercialization and release Conduct efficacy trials to facilitate local registration	Conduct validation trials Facilitate mass rearing of parasitoids Provide trai ning and protocols on mass rearing of parasitoids to interested farmers
Malawi	Establish standards and guidelines for GAP in various Agro-ecological zones in the country Conduct research on the challenges to adoption of GAP and advise policy makers	Research on alternative crops for Push -pull intensification	Conduct research on best edible legumes for intercropping and the most varieties considering agroecological context and cultural practices.	Validate the proven biopesticides for commercialization and release Conduct efficacy trials to facilitate local registration	Conduct validation trials Facilitate mass rearing of parasitoids Provide training and protocols on mass rearing of parasitoids to interested farmers
Rwanda	Establish standards and guidelines for GAP in various Agro-ecological zones in the country Conduct research on the challenges to adoption of GAP and advise policy makers	Officially release the technology for wide -scale adoption Research on alternative desmodium s pecies suitable for the Northern region	Conduct research on best edible legumes for intercropping and the most varieties considering agroecological context and cultural practices.	Validate the proven biopesticides for commercialization and release Cond uct efficacy trials to facilitate local registration	Conduct validation trials Facilitate mass rearing of parasitoids Provide training and protocols on mass rearing of parasitoids to interested farmers
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Zambia	Establish standards and guidelines for GAP in various Agro-ecological zones in the country Conduct research on the challenges to adoption of GAP and advise policy makers	Research on alternative crops for Push - pull intensification Conduct PPT validation in the Southern region	Conduct research on best edible legumes for intercropping and the most varieties considering agroecological context and cultural practices	Conduct experiments to validate the technology Conduct efficacy trials to facilitate local registration	Conduct validation trials Facilitate mass rearing of parasitoids Provide training and protocols on mass rearing of parasitoids to interested farmers

DID YOU KNOW?

FAW prefers hosts in the grass family i.e., maize, millets, rice, sorghum, sugarcane, but it also attacks banana, cotton, cowpeas, ginger, peanut, tobacco, some forage legumes, and vegetables, e.g., beans (including soybean), cabbage, capsicum, cauliflowers, cucumber, eggplant, potato, sweet potato, tomato, and some weeds and ornamentals

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	GAP and cultural	Push-Pull	Legume intercropping (Agroecological management options)	Biopesticides and Biorationals	Natural enemies
Private Sector					
Ethiopia	Facilitate timely access to farm inputs	Commercialize production of Desmodium and brachiaria seeds Fast track certification of locally produced seeds	Facilitate access and availability of seeds at affordable prices.	Collaborate with researchers in validation trials Fast track local registration of the proven biopesticides Commercialize and avail the products in the market	Establish and strengthen mass rearing and release of parasitoids
Malawi	Facilitate timely access to farm inputs	Strengthen seed availability through local production and imports	Facilitate access and availability of seeds at affordable prices.	Collaborate with researchers in validation trials Fast track local registration of the proven biopesticides Commercialize and avail the products in the market	Establish and strengthen mass rearing and release of parasitoids
Rwanda	Facilitate timely access to farm inputs	Strengthen local production of seed Promote packaging of seed in smaller quantities affordable to small holder farmers strengthen collaboration with local agro dealers to improve accessibility of seeds	Facilitate access and availability of seeds at affordable prices.	Collaborate with researchers in validation trials Fast tr ack local registration of the proven biopesticides Commercialize and avail the products in the market	Establish and strengthen mass rearing of parasitoids
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Zambia	Facilitate timely access to farm inputs	Strengthen local production of seed promote packaging of seed in smaller quantities affordable to small holder farmers strengthen collaboration with local agro dealers to improve accessibility of seeds	Facilitate access and availability of seeds at affordable prices.	Collaborate with researchers in validation trials Fast track local registration of the proven biopesticides Commercialize and avail the products in the market	Establish and strengthen mass rearing and release of parasitoids

Eggs are laid on the underside of lower leaves with up to 8 batches laid by a single moth

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NGO	GAP and cultural	Push-Pull	Legume intercropping (Agroecological management options)	Biopesticides and Biorationals	Natural enemies
Extensionist / NGOs					
Ethiopia	Strengthen farmer training to understand and apply GAP Promote GAP alongside other FAW IPM techniques	Create awareness and Introduce Push-pull in areas where it is not practiced Strengthen farmer training for correct application through demos	Promote legume intercropping in areas where it is uncommon. Establish demonstration sites showing various maize-edible legume intercropping options.	Support field validation Strengthen farmer training and conduct demonstrations on correct application Conduct field days to demonstrate results and benefits of the technology	Create awareness on the use and benefits of natural enemies Identify sites and promote field release of parasitoids
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DID YOU KNOW?

Young larvae are green, with dark heads and dark lines alongside the body; at first they feed together skeletonizing leaves and making 'windows'.

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	GAP and cultural	Push-Pull	Legume intercropping (Agroecological management options)	Biopesticides and Biorationals	Natural enemies
General Public / Media					
Ethiopia	Create massive awareness on the multiple benefits of applying GAP in increasing productivity , food safety and FAW management	Create extensive scale awareness about the technology and its benefits in addressing multiple production constraints Sensitize the policymakers on the benefits and the need to support adoption of the technology.	Create awareness among farmers and the general public on the benefits of intercropping with edible legumes on FAW management and the additional benefits in household food security.	Create large-scale awareness on availability of biopesticides and biorationals and its benefits Link farmers to service providers Create awareness on the effects of using chemical pesticides	Create massive awareness on the benefits of applying GAP in increasing productivity and food safety Host experts to address farmer questions and challenges to adoption of the technology
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There are six stages of development taking approximately 14-21 days in total

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	GAP and cultural	Push-Pull	Legume intercropping (Agroecological management options)	Biopesticides and Biorationals	Natural enemies
Smallholder Farmers					
Ethiopia	Sensitize other farmers on the benefits of GAP through farmer to farmer e xtension and being good models	Train fellow farmers on the establishment and management of Pull plots Attend trainings and adopt the technology Host field days to demonstrate the results and benefits of the technology to other farmers and policy makers	Sensitize farmers on the effectiveness of intercropping with edible legumes on FAW management and the additional benefits in household food security.	Sensitize other farmers on the benefits of using biopesticides through field days and farmer fiel d schools	Take part in field validation process Sensitize other farmers on the benefits of using natural enemies Attend trainings and adopt the technology
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The wingspan of FAW is about 32-40mm with a brown or grey forewing and white hindwing

METHODOLOGY 7

Data

The FAW locational and density data were obtained from the Food and Agriculture Organization (FAO). These data are collected using the FAW Monitoring and Early Warning System (FAMEWS: http://www.fao.org/fall-armyworm/monitoring-tools/famews-mobile-app/en/) that is facilitated by a global-wide network of data collectors across continents using smartphones. The locational and density data were downloaded from the FAO platform (http://www.fao.org/fall-armyworm/en/) in a .csv file format for the entire African continent. The data contained several rows and key columns corresponding to individual locational trap data, the date of data collection, the cropping system, and the corresponding FAW density data. This database was then subjected to rigorous automated elimination criteria of the observations through spatial data validation and duplicate removal criterion to standardize and ensure consistency of the data.

All the climatic data used in this study were obtained in raster format from TerraClimate (http://www.climatologylab.org/-terraclimate.html) global gridded database (Abatzoglou et al., 2017). The data are provided on a monthly timestep at a spatial resolution of 4 km x 4 km pixel size. The period January 2018 – December 2019 was used in this analysis and was selected because it matched with the time the trap data was collected across the African continent. The monthly grid layers that were used are precipitation (PPT), actual evapotranspiration (AET), maximum temperature (Tmax), minimum temperature (Tmin), wind speed (WS), and the Palmer drought severity index (PDSI). These climate data were then extracted from the raster images using the locational data (longitude and latitude) of the FAW traps. They were matched with their corresponding month of data collection for each row of the FAMEWS data.

The elevation was obtained from the 30m resolution Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) Global Digital Elevation Model Version-2 (GDEM-V2; METI and NASA, 2011). The physical areas covered by either maize or sorghum crop were derived from the International Food Policy Research Institute (IFPRI) under the harvest choice database (https://www.ifpri.org/project/harvestchoice). The physical area of both sorghum and maize we also extracted using the trap locational data and added as explanatory variables to the occurrence and density of the FAW.

Model calibration and prediction

Model fitting and prediction were done using the random forest (RF) algorithm (Breiman, 2001) in the 'ranger' package (Wright and Ziegler, 2017) as implemented in the R environment for statistical computing (R Core Team, 2020). RF running in the 'ranger' is fast and efficient at handling large datasets at regional and continental scales (Hengl et al., 2017). The developed continent-wide database of the dependent variable (FAW density) and the respective explanatory variables matched to each month of data collection were used to develop the RF regression model and used to predict the occurrence and density of the FAW monthly. In addition to the climate data, the specific month data as obtained from the month of trap data collection were added to the training data as explanatory categorical variables. The value 1 was assigned to observations in a specific month, while the rest were assigned value 0 to depict no data collection for that specific month. The trained model was evaluated using the out-of-bag (OBB) error rate and the R-squared value of the RF regression algorithm. The model was then used to predict the occurrence of the quarterly (3 months) occurrence of the FAW in five African countries i.e., Ethiopia, Rwanda, Uganda, Zambia, and Malawi by averaging the predicted monthly occurrence of the target months within the quarter.

The output maps were developed in a geographic information system (GIS) and three levels of infestation were used to describe the intensity of the potential density per target quarterly period i.e., low (0-10), moderate (11-30), and high (>30). These three levels of infestation were informed by the quantile classification analysis of the input density data obtained from the FAMEWS.

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The purpose of the Country Profile brief is to enhance FAW data collection and collating. Please help us to achieve this by directly contributing.

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