Space as a Tool for Climate-Smart Management of Insect Pests in Food Crops

Abstract

Insect pests are major constraints in crop productivity and the effects of climate change further aggravate the problem. With the projected impacts of climate change, tools to effectively manage insect pest population and mitigate risks on crop production are needed. Space data combined with crop-insect information can be used to provide state-of the-art pest risk intelligence for improved management decisions. Examples show that both local and international efforts benefit from this approach in order to maximize effectiveness and lessen costs of controlling insect pests. These endeavors are crucial towards attainment of food security in the future amidst global climate change.

Insect pest outbreaks can reduce productivity of food crops and the risk can become higher due to the changing climate. According to recent estimates, annually between 20 to 40 percent of global crop production including food crops are lost to pests (FAO 2019). As a way to adapt to climate change, the goal is to reduce vulnerability against its effects including food insecurity (IPCC 2014). Especially that more than 820 million people in the world still suffer from moderate to severe hunger, underscoring the immense challenge of achieving the Zero Hunger target by 2030 (FAO, IFAD, UNICEF, WFP and WHO 2019).

The major predictions on changing pest scenario due to climate change include expansion of the geographic ranges due to shift in cultivation areas of host crops at higher latitudes and altitudes. Another is increased number of generations due to accelerated growth rates and shorter generation times. Also, increased risk of introducing invasive alien species and breakdown of host (Fand et al., 2014). Indeed, it entails a more detailed understanding of insect pests' responses to climate warming (Lehmann et al., 2020). With projected impacts of climate change to insect pest, effective tools to monitor and manage its populations must be in place.

Monitoring and surveillance play key roles in insect pest management. To do these, the first step is field data collection to establish status of an insect pest species in a defined geographic location. The surveillance data normally is in the form of population actual count or estimate. Afterwards, crop-pest data collected can then be geo-referenced. Together with relevant climate factors for example temperature and rainfall, it can be imported to a Geographic Information System (GIS) software for pest risk analysis and modelling.

One reliable source of climatic data that can be used to model insect populations in a defined geographic boundary is satellite-based imagery. A widely used source of high-quality and publicly-made satellite data for the said purpose is Landsat program (Young et al., 2017). With the availability of various satellite data such acquired from space, use of spectral data and its application in agriculture including insect pest management can be made possible (Alberto, 2019). Ranging from moderate to high resolution satellite imageries, it provide spectral availability that allow discrimination between healthy and infested plants of invasive or destructive insect pests.

Integrating satellite based data and field observations of both insect pest and host crops can provide an accurate, detailed, timely and location accurate risk map or model for improved pest management decisions. For instance, satellite images of the California valley were combined with ground survey data on the crop system and used to construct maps for the whitefly *B. argentifolii*, a serious agricultural pest in the U.S. (Brewster et al., 1999). Notably, this approach facilitated understanding and prediction of whitefly incidence or outbreak in the said area.

CropWatch, a leading global crop monitoring system has also adopted such approach to assess national and global crop production and related information using remotely sensed and ground based indicators for pest monitoring. Using spectral data they derive important environmental and agronomic indices to monitor pest populations with the aid of pre-designed algorithm. In connection with, CropWatch uses several monitoring and reporting units and several major production zones, as well as 31 individual countries as the basis for its global and regional analyses for more precise insect pest monitoring.

Locally, similar efforts are now being done in the Philippines to take advantage of the various space-borne data. One currently implemented is the Pest Risk Identification and Management (PRIME), a collaborative project among agricultural research institutions with focus on rice. PRIME's goal is to improve rice productivity, welfare, and competitiveness of Filipino farmers by providing targeted management recommendations to mitigate risks of major pests to serve as a model for other economically important crops. Intensive field surveys coupled with satellite imageries for crop mapping and monitoring and risk factor analysis for pest outbreaks is being done to generate pest risk intelligence to be used for sustainability plan in rice production.

Another example which utilizes latest satellite-based data to understand crop-insect interaction in the Philippines is SARAI (Smarter Approaches to Reinvigorate Agriculture as an Industry in the Philippines). Under the program, a crop protection component called Insect Pest and Disease Advisory System (IPDAS) was formulated. Through IPDAS, a mobile application called SPIDTECH was developed to help in the accurate identification and monitoring major insect pests. Potentially, insect pest data acquired can then be georeferenced and when combined with satellite imagery data can be used to examine pattern and analyze insect pest population dynamics for nine priority food crops.

Considered as a breakthrough in the country's pest management efforts, historical and satellite data will be also tapped to predict which areas are likely to be infested by the fall armyworm (FAW) *Spodoptera frugiperda* that has affected at least 2,600 hectares of corn nationwide since its detection in 2019. The information from this can benefit both private and public sectors when it comes to area-wide integrated FAW management. This seems exigent as FAW is now considered as a major transboundary insect pest that has become a significant threat to crop production worldwide (FAO n.d.).

Indeed a more informed decision to allocate resource and time wisely for interventions to prevent further spread and infestation of insect pests across borders must be the new norm. But this information depends on reliable and quality data which currently space-based technologies can provide. It may potentially help improve management strategies as it will aid in precise determination of areas of ground pest searches and optimal timing in order to maximize effectiveness and reduce costs.

To conclude, efforts being done at the national and global level such as those discussed to fully utilize space data as a tool in insect pest management is very promising. End products derived such as pest risk and resource maps or models can aid major stakeholders to better manage insect pests. These can contribute towards attaining a food-secure world amidst the climate crisis.

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