The use of earth observations and geospatial modelling approaches for implementing integrated pest and pollinators management options

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Pollination is a regulatory ecosystem service that is valuable for production of pollination-dependent food crops like avocado. Recently, it has been noted that human activities and climate change are modifying the landscape structure through fragmentation, degradation, and destruction of natural pollinators' habitats. Moreover, the use of synthetic pesticides to control the crop pests is also playing a key role in the reduction of pollinator populations and diversity. Hence, there is need to come up with sustainable techniques such as Integrated Pest and Pollinators Management (IPPM) tools to control the insect pests, while conserving the pollinators. Thus, the aim of the present study was twofold; (i) to explore the value-added by the earth observations (EO) for assessing IPPM implementation sites in avocado production system in Murang'a, Kenya, and (ii) to predict the co-occurrence of avocado pollinators and pests using climatic and cropping system variables as well as a maximum entropy model. In specific, we used the freely available Sentinel-2 (S2) data to characterize landscape dynamics in terms of vegetation productivity to guide the implementation of various IPPM options. Time series S2 data acquired during the dry (i.e., low rainfall) and wet (i.e., high rainfall) seasons were processed to calculate NDVI (normalized difference vegetation index) that was used as a proxy for vegetation production. Unsupervised k-means clustering was used to categorize the NDVI to three classes, viz., low, medium, and high. Furthermore, socio-economic baseline data on farmers' perception to implement one of four IPPM options were collected. The four options were IPPM, IPM (integrated pest management), P (pollinators), and Control (negative control). The landscape production classes were then combined with the farmers' preference to select sites for the four IPPM options. The results showed that k-means can accurately characterize landscape dynamic (overall accuracy = 83%). On the other hand, 36 farmers out of 410 were selected to implement the four IPPM options with three replicates. Also, the co-occurrence of avocado pests and pollinators was accurately predicted (accuracy = 0.70 – 0.83). Overall, the study showed the significance of the EO systems and ecological niche modelling approaches in guiding the implementation of sustainable and climate-smart agricultural technologies like IPPM, and in predicting the co-occurrence of crop pests and pollinators at a landscape scale.

Keywords: Sentinel-2, MaxEnt, Landscape structure, Avocado, Pests, Pollinators, Socio-economic