Balancing between social and ecological systems to define opportunities for IPM and conservation biological control in subsistence maize agriculture in Central America

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In-field dynamics FAW ~ natural enemies

- **Goal:** Identify endemic natural enemies and quantify their association with fall armyworm population densities in farmers’ fields.
- **Approach:** Population dynamics of fall armyworm and arthropod predators were measured in 40 maize fields during the 2002 and 2003 cropping season and fall armyworm larvae were collected to screen for parasitism and disease. We assessed the relationships between natural enemy abundance and fall armyworm population dynamics, while correcting for abiotic factors such as altitude.
- **Results:** We recorded high variability in FAW infestation between fields located within the same community. FAW infestation generally remained below the locally-defined economic threshold of 30-40%. Fall armyworm larvae correlated with altitude, with maize fields at higher altitude characterized by lower pest infestation. Parasite densities ranged between 2.7-11.5%, with a total of 13 parasitoid species reared from FAW larvae.

The arthropod predator community was highly abundant and diverse, dominated by Dermaptera (85-70%), Formicoidea (15-18%) and Araneae (6%) during both years. The fire ant Solenopsis geminata was the most commonly recorded ant morphospecies on maize plants (16-46%) and on tuna fish bait (55%).

Between-field variability in FAW infestation was related to abundance (categories) of spiders, ground beetles and the ant S. geminata. When correcting for the effect of altitude, significant differences in FAW infestation were found for abundance categories of spiders and ground beetles.

Rationale

To increase agricultural productivity, farmers often rely on chemical inputs that can instigate pest outbreaks. Compare agro-ecological knowledge of trained vs. untrained farmers and link farmer knowledge to understanding and adoption of IPM, including conservation biological control.

- **Goal:** Determine farmers’ knowledge of major pests and associated natural enemies in maize production systems. Compare agro-ecological knowledge of trained vs. untrained farmers and their knowledge to understanding and adoption of IPM, including conservation biological control.
- **Approach:** A total of 30 farmers per community were surveyed on their perception of FAW and their knowledge of major pests and associated natural enemies in maize, as well as their willingness to adopt various pest management strategies. Farmers were categorized into two groups: trained (IPM-trained) and untrained (IPM-untrained).
- **Results:** Although 92% of farmers mentioned FAW as an herbicide in their fields, crop losses from this pest were considered negligible. Many farmers ascribed low FAW infestation to weather anomalies (47%), while the role of biological control (2.5%) was poorly recognized.

Farmers were aware of several natural enemies operating in their fields, with local knowledge largely restricted to easily observable predatory species. On a community level, farmers who used insecticides knew little about biological control and pesticide alternatives. Trained farmers mentioned more natural enemies and were familiar with a broader range of pesticide alternatives than untrained ones.

Lessons learned & implications for IPM extension

**Lessons learned:**
1. Natural enemies are important in preventing FAW pest outbreaks; the natural enemy complex includes spiders, earwigs, carabid beetles, ants and social wasps.
2. Characteristics of the enemy community are set by patchiness of the agro-ecosystem, which is mainly shaped through shifting cultivation.
3. Complex of natural enemies in different agro-landscapes is sufficient to moderate FAW dynamics to prevent outbreaks in farmers’ fields across communities.
4. Farmers have a good appreciation of abundant, conspicuous predatory species, and their knowledge reflects ecological features of their respective fields.
5. Farmers evaluate pest severity well and make pest management decisions accordingly, with IPM training boosting farmer technical and agro-ecological knowledge.
6. Information on natural enemies and pesticide alternatives diffuse through the social network of farmers and is adopted by those who learn about IPM.

**Implications for IPM extension:**
1. A solid understanding of ecological facets of subsistence maize production is crucial to implementing participatory, locally-specific IPM modules.
2. Visualizing results from field surveys in a GIS environment could shed light on regional patterns of pest severity and availability of “ecological tools” for pest management.
3. Extra-field contribution to pest management represents a knowledge gap in farmer knowledge on habitat manipulation, ev. through adaptive co-management and active involvement of farmers and IPM / NRM professionals.
4. Availability of a range of pest management options in folk knowledge may be necessary for livelihood strategies to remain adaptive over time.
5. Patterns in natural enemy diversity within and between communities stress the need for participatory IPM extension that embraces differences as well as similarities.
6. The sharing of pest management information through interpersonal channels creates opportunities for IPM extension modules such as “Going Public.”

Role of social connectedness & information sources in IPM diffusion

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- **Approach:** We related densities of key predators in fields with the characteristics of the surrounding landscape, through a combination of in-situ vegetation classification and spatial analyses. Fossilic and vegetational surveys provided an estimate of presence and quality of critical resources within subsistence maize fields. Spatial analyses allowed us to examine effects of landscape structure.
- **Results:** In-field abundance of social wasps was related to floral diversity, while earwigs were associated with grass cover in habitats situated beyond the field border. Within-field density of the fire ant, Solenopsis geminata, was associated with its presence in the surrounding agro-landscape.

Relationships were explored between predator abundance and spatial distribution of habitats that dominate the extra-field environment. Earwigs were associated with grassland patches located in the field surroundings. Abundance of spiders and ground beetles was highest in environments dominated by coffee plantations or mid-successional habitats.