



Setting the stage

Fall armyworm in Asia – a unique opportunity to revitalize IPM and advance biological control

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The protagonist

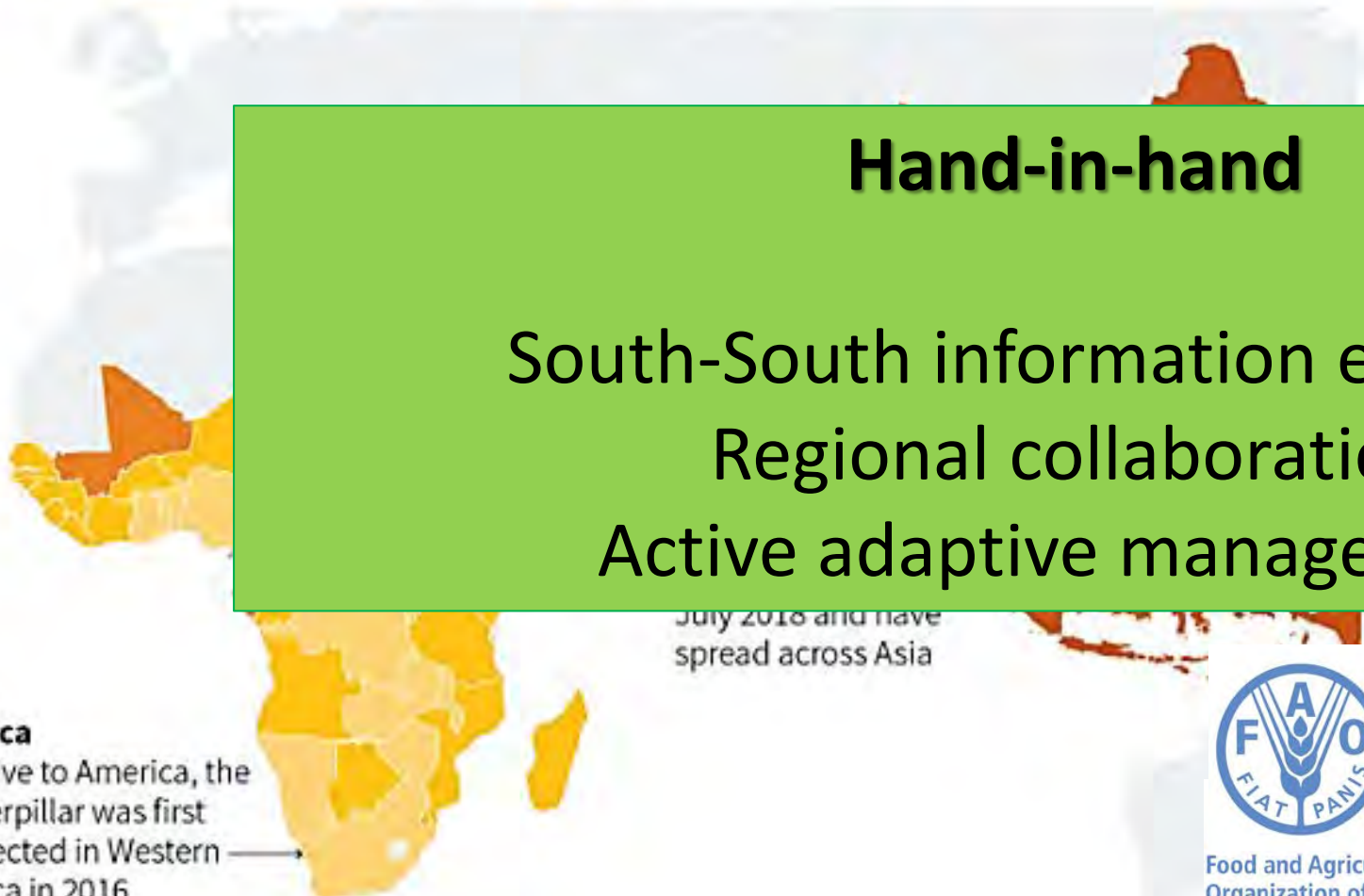
- *Spodoptera frugiperda* Smith
- Lepidoptera: Noctuidae
- Neotropics
 - Year-round pest in much of Central/South America + Caribbean
 - Annual migration into northern USA
- Key herbivore & occasional pest
 - Corn strain: maize & sorghum
 - Rice strain: rice & forage grasses
- Top-15 insecticide-resistance pests
 - Resistance to 41 active ingredients (Sparks et al., 2020)
 - Invasive population resistant to pyrethroids & organophosphates (Zhang et al., 2020)



Distribution & spread dynamics

AREAS OF INFESTATION BY YEAR OF DETECTION

2016 2017 2018 2019



* In the tropics, **continuous reproduction** with 4-6 generations/year

Hand-in-hand

South-South information exchange
Regional collaboration
Active adaptive management

~ 100 km per

migrant: yearly
northern China,

lications of

good/bad management

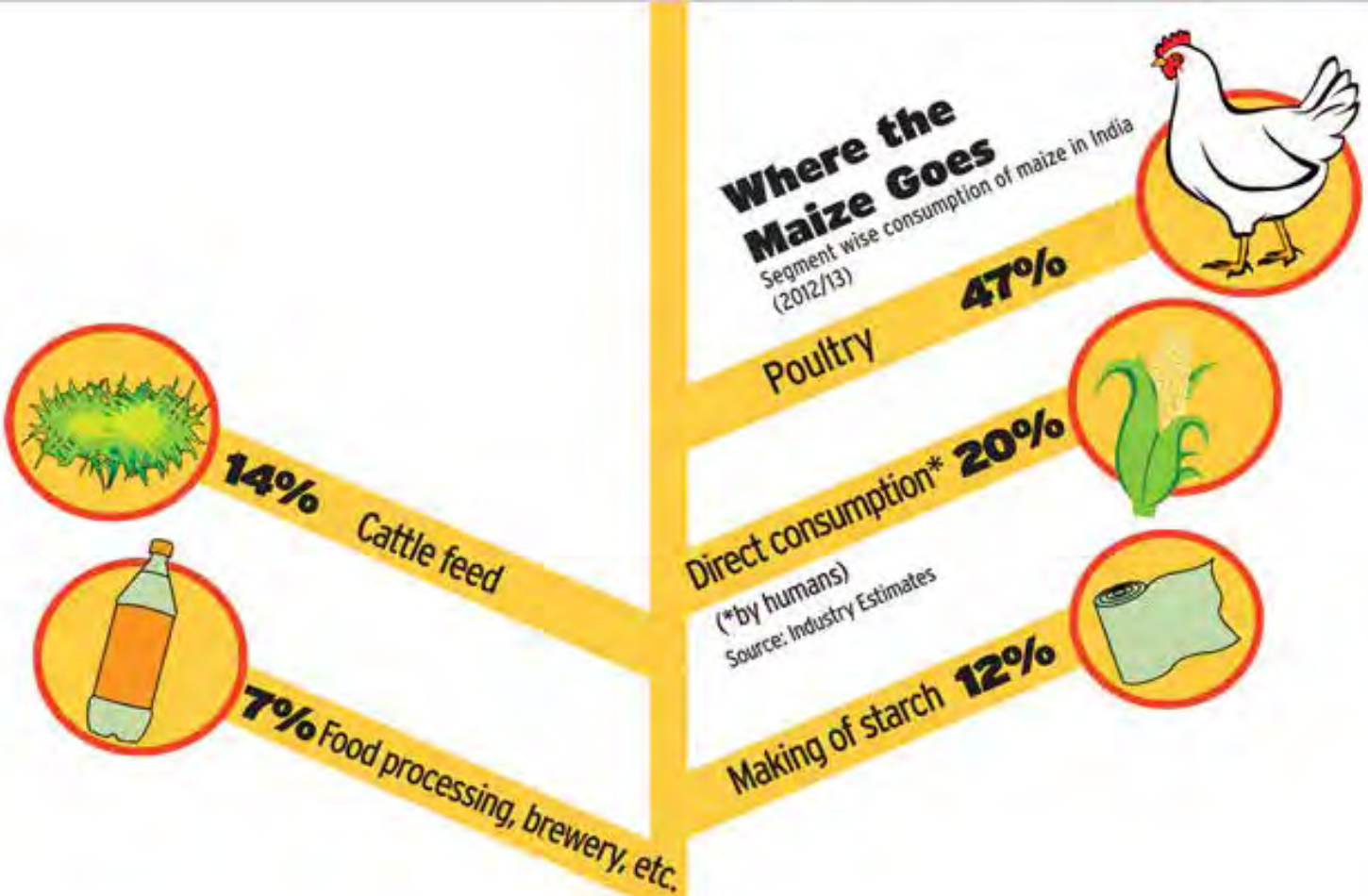
Africa
Native to America, the caterpillar was first detected in Western Africa in 2016

July 2018 and have spread across Asia



Food and Agriculture Organization of the United Nations

Engage the entire value chain!



Devastating damage = 'massive' impact??

- Controlled studies in the Americas & Africa
 - **10-20% yield loss** at high infestation pressure
 - In Zimbabwe, 32-48% FAW incidence is reflected in a 11.6% yield loss (Baudron et al., 2019)
- **Little yield reduction** at <25% incidence
 - Does not (economically) justify pesticide use
- Diverse smallholder systems – limited impacts
 - ET levels of 40% in subsistence maize (Andrews & Rueda, 1986)
- **Judiciously assess yield losses & economic impacts**



Monitoring

- Tracing the FAW invasion / forecasting spread dynamics
 - Sex pheromone for monitoring purposes
 - Lures through ChemTica, Trece, PheroBio, NewCon Inc.
 - Light-traps
 - Insect radar technology
- In-field scouting
- Citizen science e.g., FAMEWS app
- Guide pest management interventions





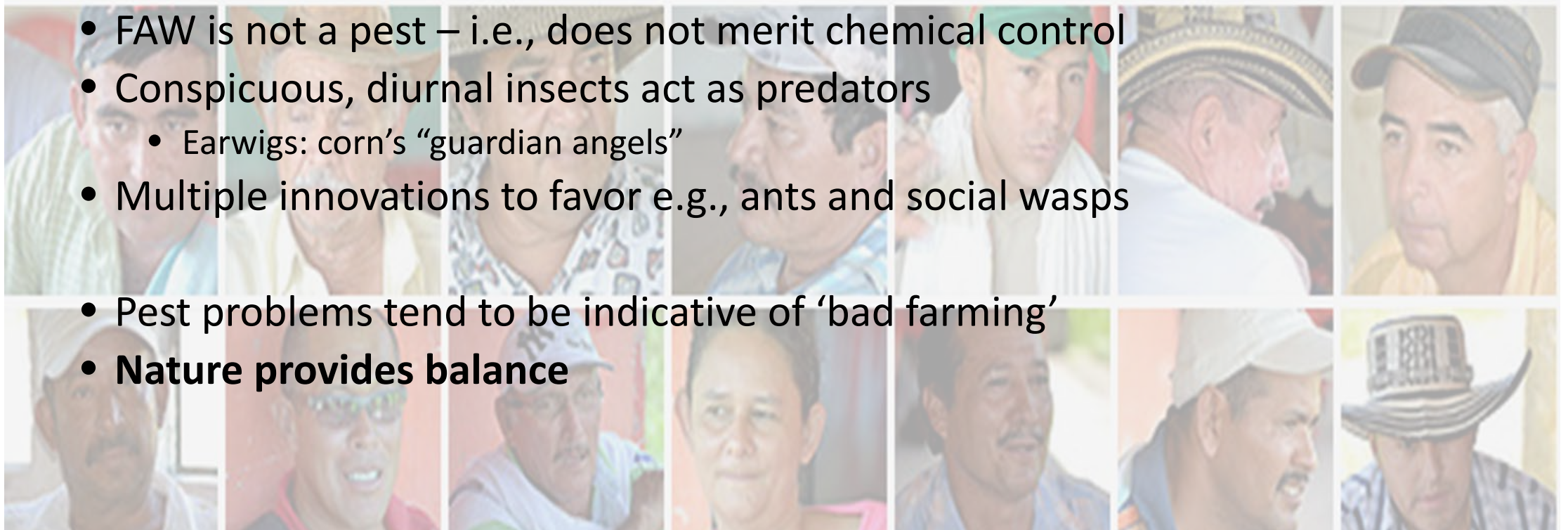
- **Field observations:**

- FAW at background infestation levels (3-5%)
- Diverse complex of natural enemies
- High levels of biological control



- **Farmer testimonials:**

- FAW is not a pest – i.e., does not merit chemical control
- Conspicuous, diurnal insects act as predators
 - Earwigs: corn’s “guardian angels”
- Multiple innovations to favor e.g., ants and social wasps
- Pest problems tend to be indicative of ‘bad farming’
- **Nature provides balance**

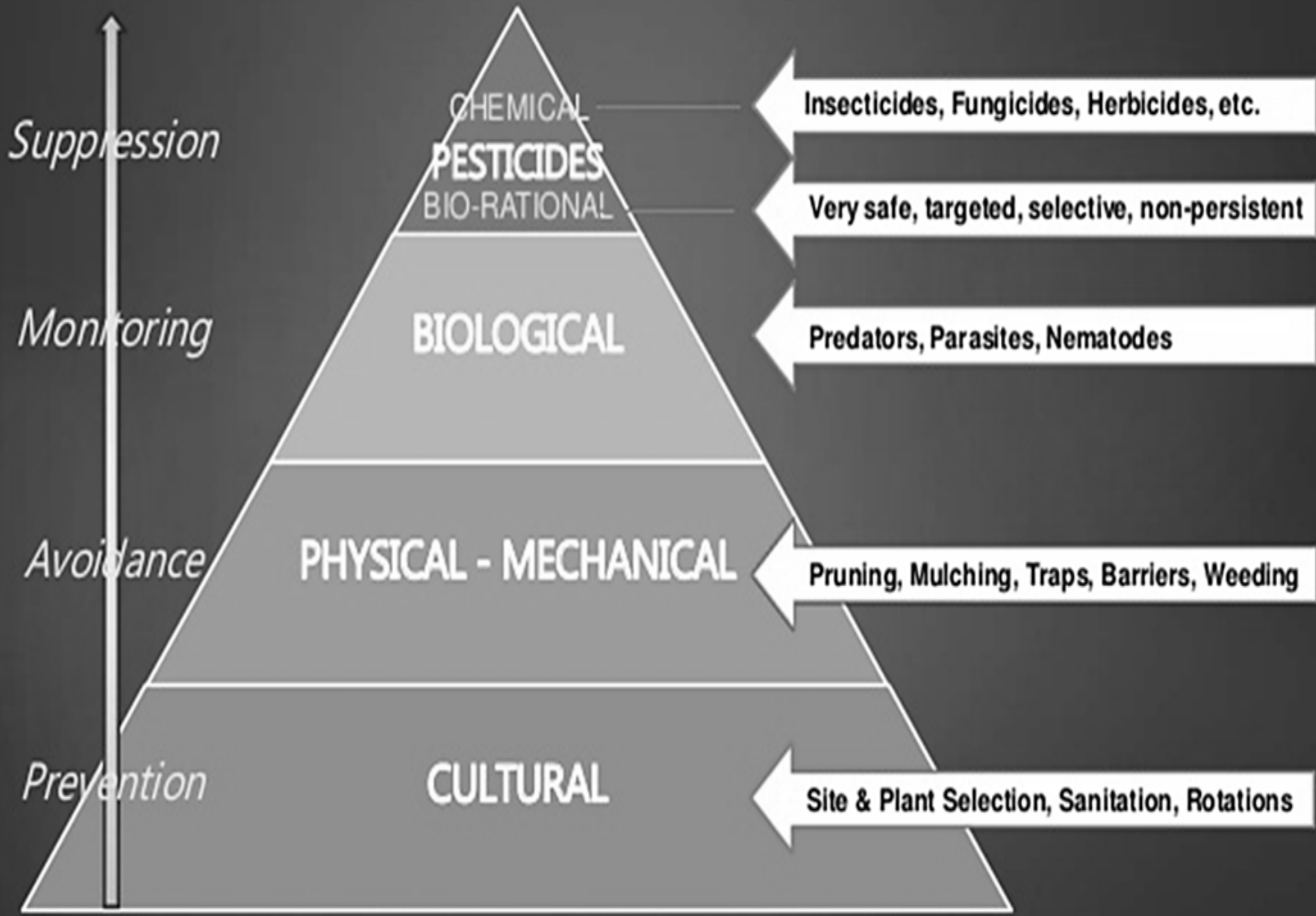


Ecological balance is key

- Invasive pest
 - 'Released' from co-evolved natural enemies
- Importation biological control
 - *Chelonus insularis* (CABI)
- Bolstering ecological resilience
 - 'New associations' biological control
 - Generalist predators
 - Ants, spiders, ground beetles
 - *Telenomus remus* (org. Malaysia/PNG), *Trichogramma* spp., *Bracon brevicornis*



	Animalia - Braconidae
	Animalia - Chalcididae
	Animalia - Eulophidae
	Animalia - Trichogrammatidae
	Animalia - Pteromalidae
	Fungi - Cordycipitaceae
	Fungi - Clavicipitaceae
	Fungi - Entomophthoraceae
	Protozoa - Nosematidae
	Protozoa - NA
	Animalia - Noctuidae



**Insecticides –
expensive & toxic
products**

**Last
option**

Constructing IPM - ancient Egyptian style



Architectural marvels that have stood the test of time...

... constructed on a large and firm base.

Convenience pesticides & preventative usage modes



Silver bullet #1: biodiversity



First line of defense of the agri-food system



Provide shelter & alternative foods

Beetle banks



Mulching & manure



Zero/minimum tillage



Nectar & pollen



Bird boxes





ENVIRONMENT JANUARY 8, 2020 / 6:19 PM / UPDATED 10 MONTHS AGO

Malaysia bets on barn owls to control rats in palm plantations

By Reuters Staff

2 MIN READ



Silver bullet #2: crop diversity

DIVERSIFICATION OF CORN AGROECOSYSTEMS AS A
MEANS OF REGULATING FALL ARMYWORM
POPULATIONS¹

MIGUEL A. ALTIERI



Intercropping is widely-used in Asia:

- * In China, maize farmers intercrop with **beans or groundnuts**
- * In India, **redgram (or pigeonpea)** used for FAW control
- * In Vietnam, upland farmers grow maize as a first crop, followed by **beans**

- * Intercropping diversifies **farmers' income sources**
- * Intercropping **lowers FAW pressure** & can boost **natural enemy action**
- * **Benefits of intercropping** - in terms of natural enemy enhancement - **are eliminated by pesticides**

Silver bullet #3: biopesticides

- Safe for humans & environment
- Mostly compatible with IPM
- Equally or more (cost-)effective than chemicals
- Can be used as seed-coatings & deployed in 'attract-and-kill' schemes (Akutse et al., 2020; de Lira et al., 2020)
- **Need to be formally built into IRM modules!**
- Some biopesticides (esp. botanicals) can be locally produced
- Easy for individual farmers to collect inoculum, store & field-apply (e.g., NPV)



Table 2. Percentage larval mortality of *Spodoptera frugiperda* caused by different concentrations of SFNPV applied by backpack sprayer and naturally-occurring parasitoids.

Doses of <i>Baculovirus</i> (P.I.B. / ha)	Mortality (%) \pm SE ¹		
	NPV	Parasitoids	Total
2.50 x 10 ¹¹	71.0 \pm 5.2 b	7.4 \pm 1.9 bc	78.4 \pm 4.3 b
1.25 x 10 ¹²	77.6 \pm 1.4 ab	10.5 \pm 1.7 b	88.1 \pm 2.0 a
2.50 x 10 ¹²	82.4 \pm 3.0 a	6.4 \pm 1.8 bc	88.7 \pm 3.2 a
1.25 x 10 ¹³	85.0 \pm 1.2 a	3.4 \pm 1.3 c	88.4 \pm 1.8 a
2.50 x 10 ¹³	84.0 \pm 3.7 a	6.7 \pm 2.4 bc	90.8 \pm 2.1 a
Untreated	33.0 \pm 2.5 c	21.1 \pm 4.0 a	54.1 \pm 4.6 c
CV (%)	9.4	34.7	8.4

¹Means within each column followed by the same letter are not significantly different ($P \leq 0.05$; Duncan's multiple range test).

Take-home messages

1. Fall armyworm cannot be eradicated – learn to ‘live with it’
2. Economic losses may be much (!) smaller than anticipated – do not panic
3. Low-cost, effective IPM technologies abound
4. **Agro-ecology** boosts resilience to pest attack
5. **Conserve** biological control agents; their role will increase over time
6. **Diversify** field, farm & agro-landscape – it will help safeguard farmer’s income
7. **Integrate & prioritize** management tactics
8. **Resist** reliance on synthetic pesticides
9. **Educate** maize growers about non-chemical control
10. **Empower** farmer innovators

