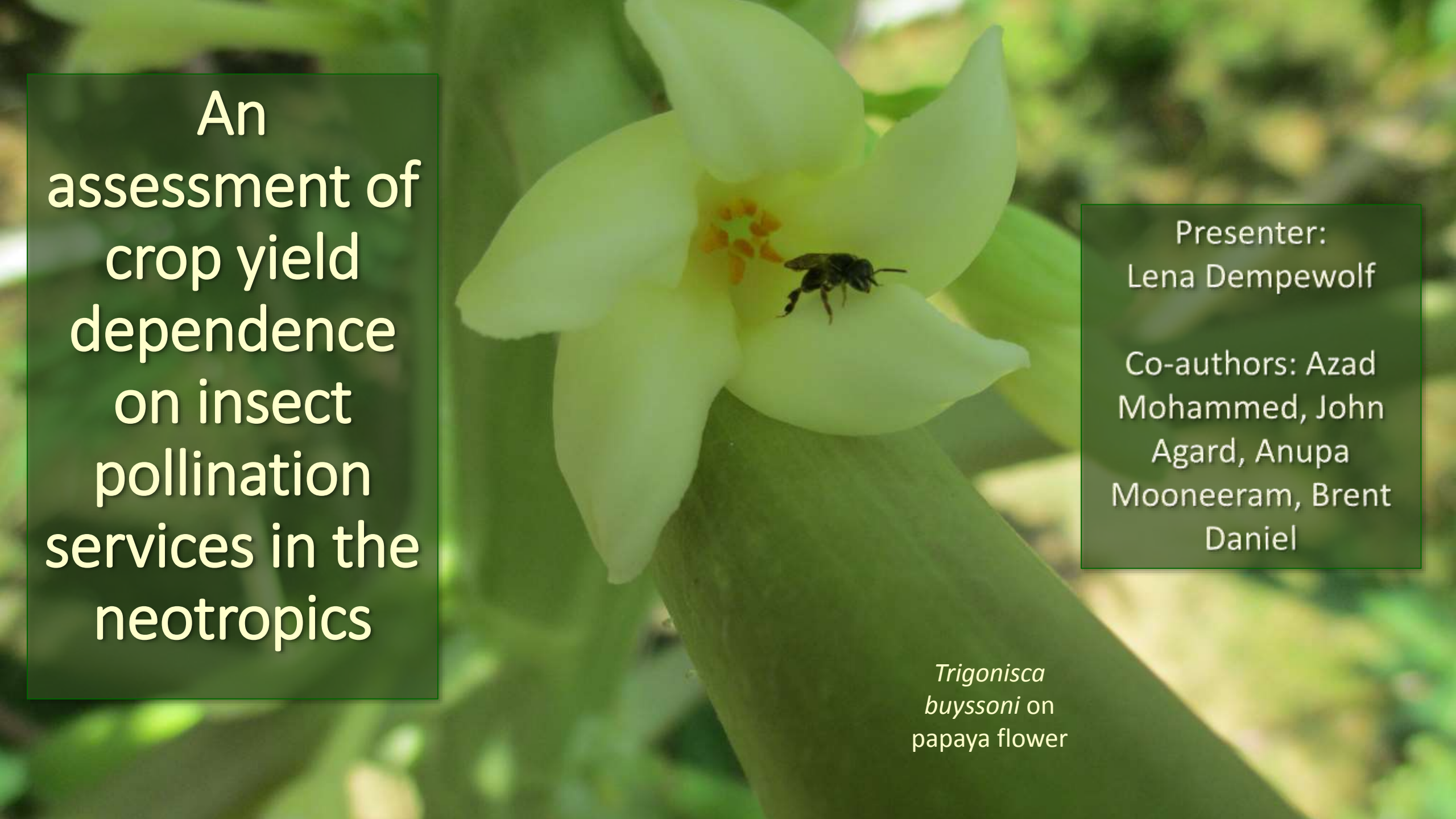
An assessment of crop yield dependence on insect pollination services in the neotropics

Presenter:
Lena Dempewolf

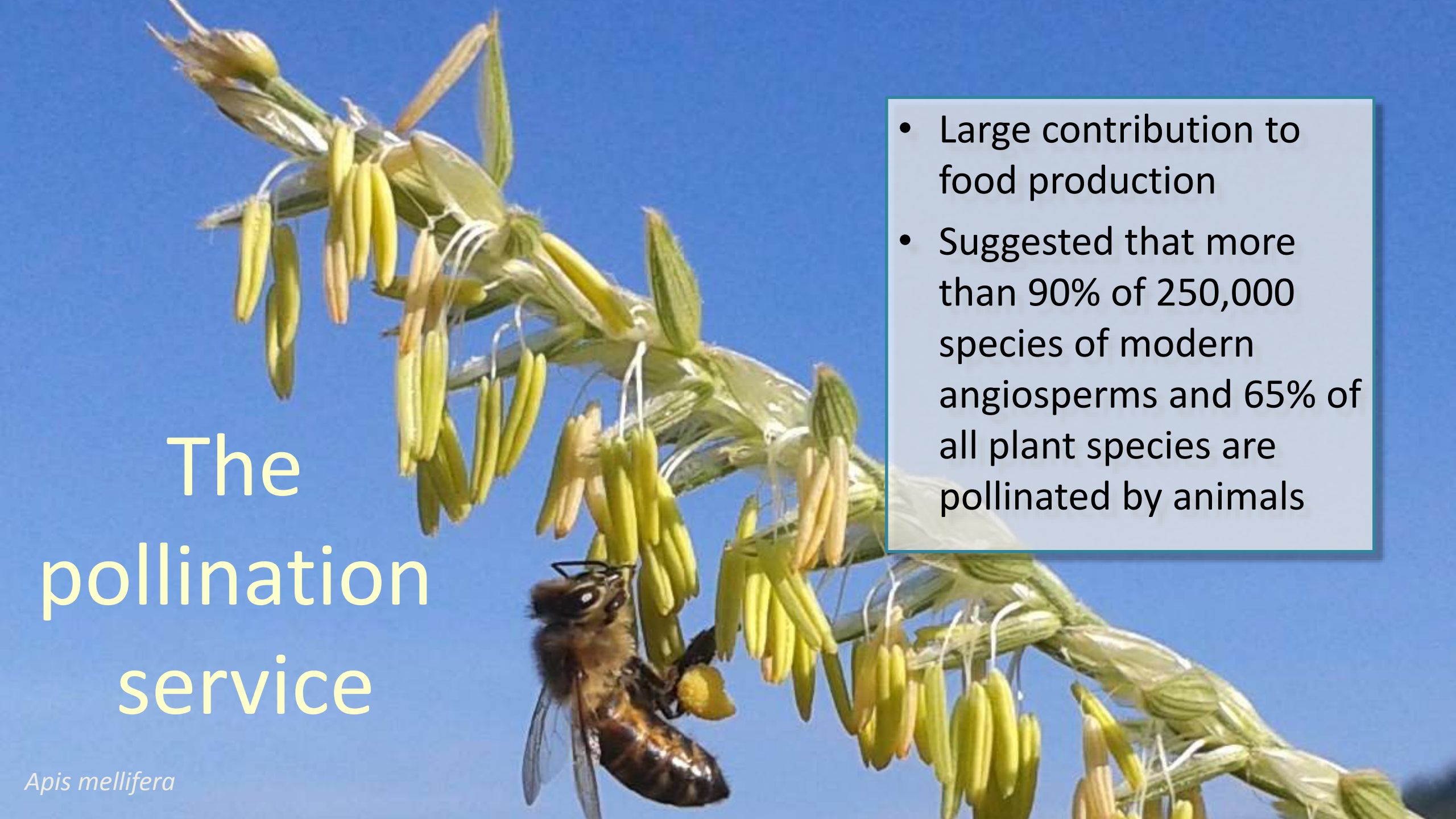
Co-authors: Azad Mohammed, John Agard, Anupa Mooneeram, Brent Daniel



Trigonisca buyssoni on papaya flower

The pollination service

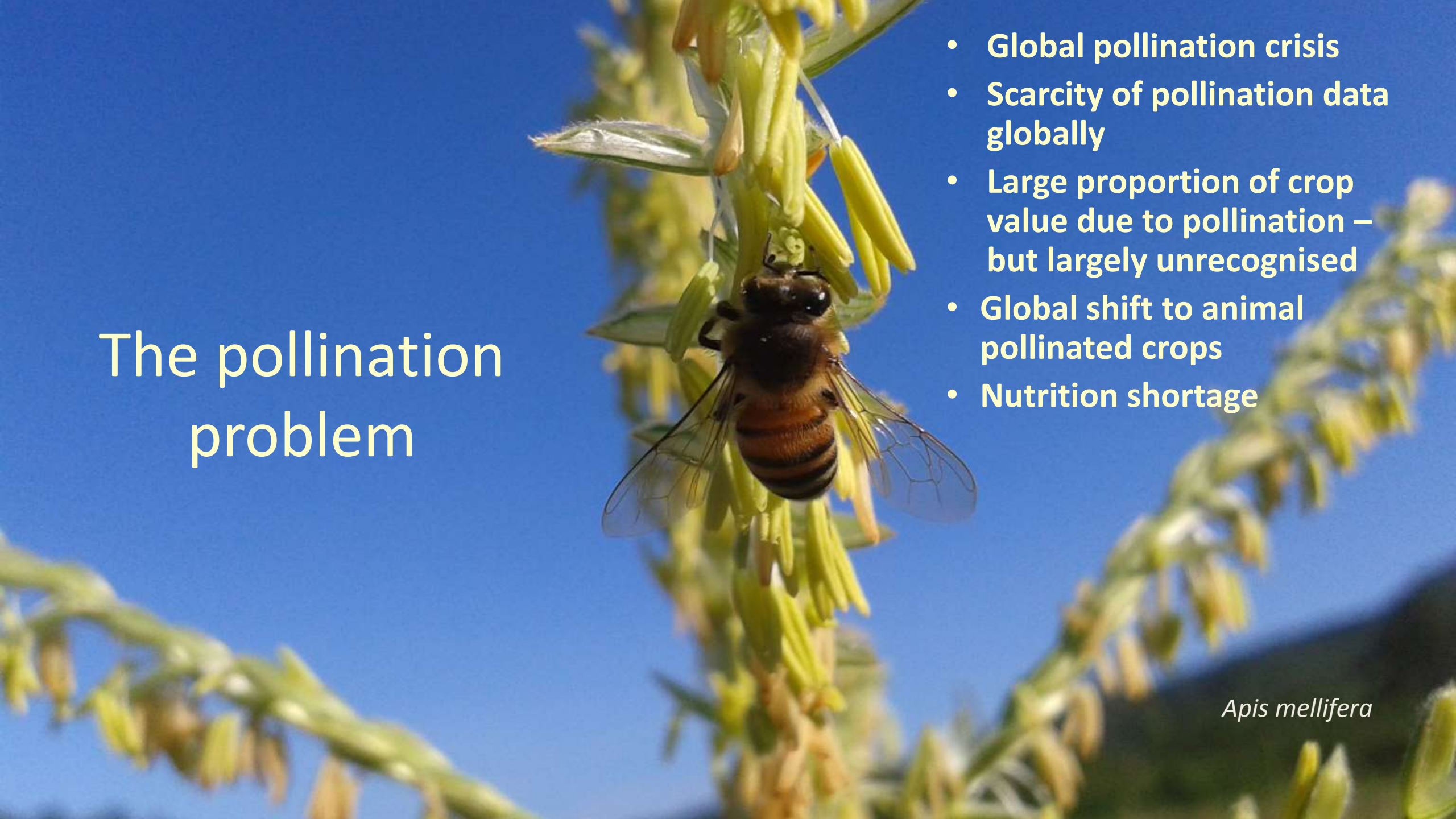
- Large contribution to food production
- Suggested that more than 90% of 250,000 species of modern angiosperms and 65% of all plant species are pollinated by animals



Apis mellifera

The pollination problem

- Global pollination crisis
- Scarcity of pollination data globally
- Large proportion of crop value due to pollination – but largely unrecognised
- Global shift to animal pollinated crops
- Nutrition shortage



Apis mellifera

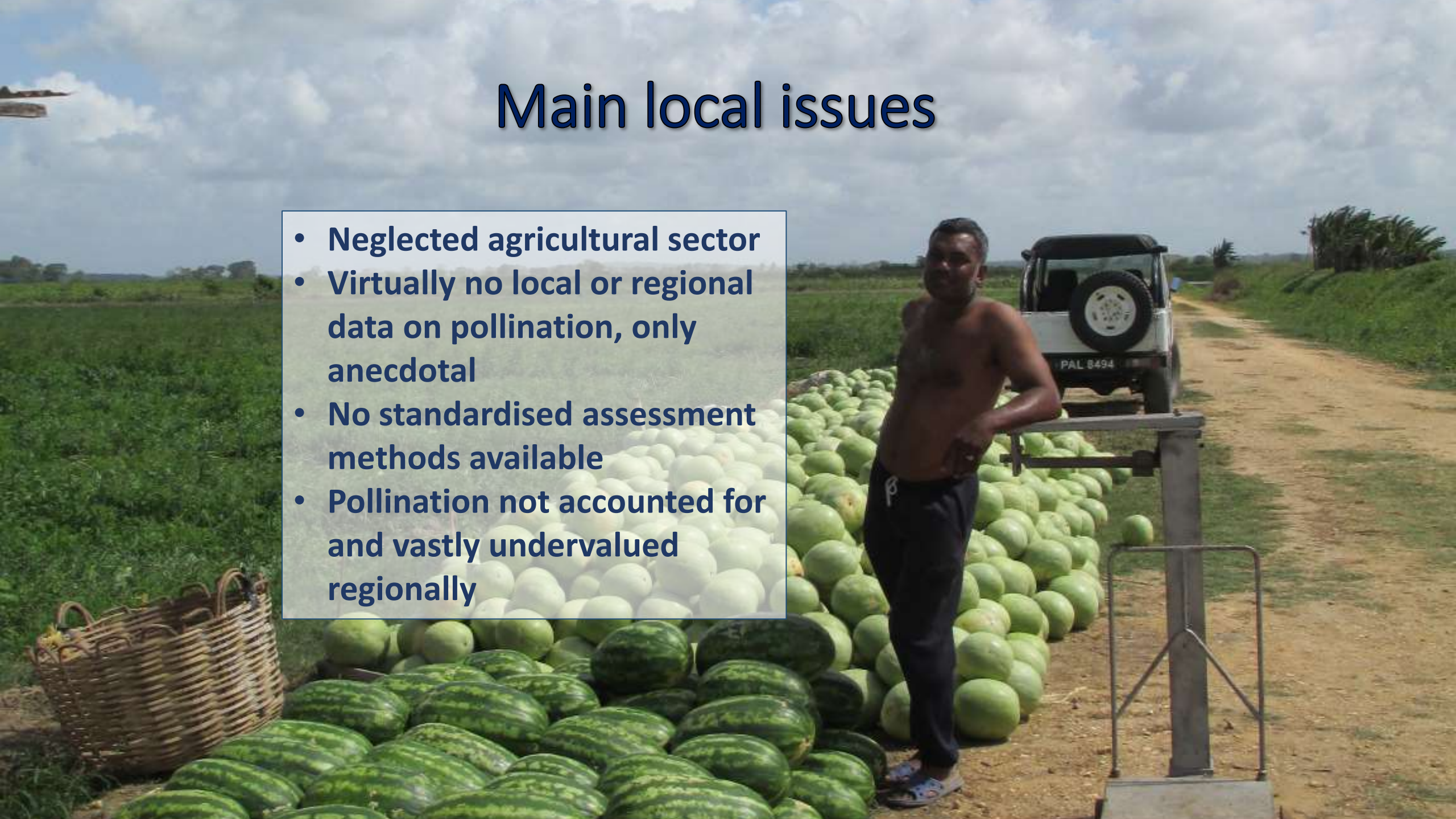
The value of pollination

- Range of valuation techniques
- Global pollination value estimated at €153 billion
- The estimated Insect Pollination Economic Value (IPEV) for the Caribbean and Latin America is 3.5 x 10^9 Euros (Gallai et al. 2009)
- Morse and Calderone (2000) used a simple function to assess the value of US honeybees: V x D x P

Megachile lanata on cucumber flower

Main local issues

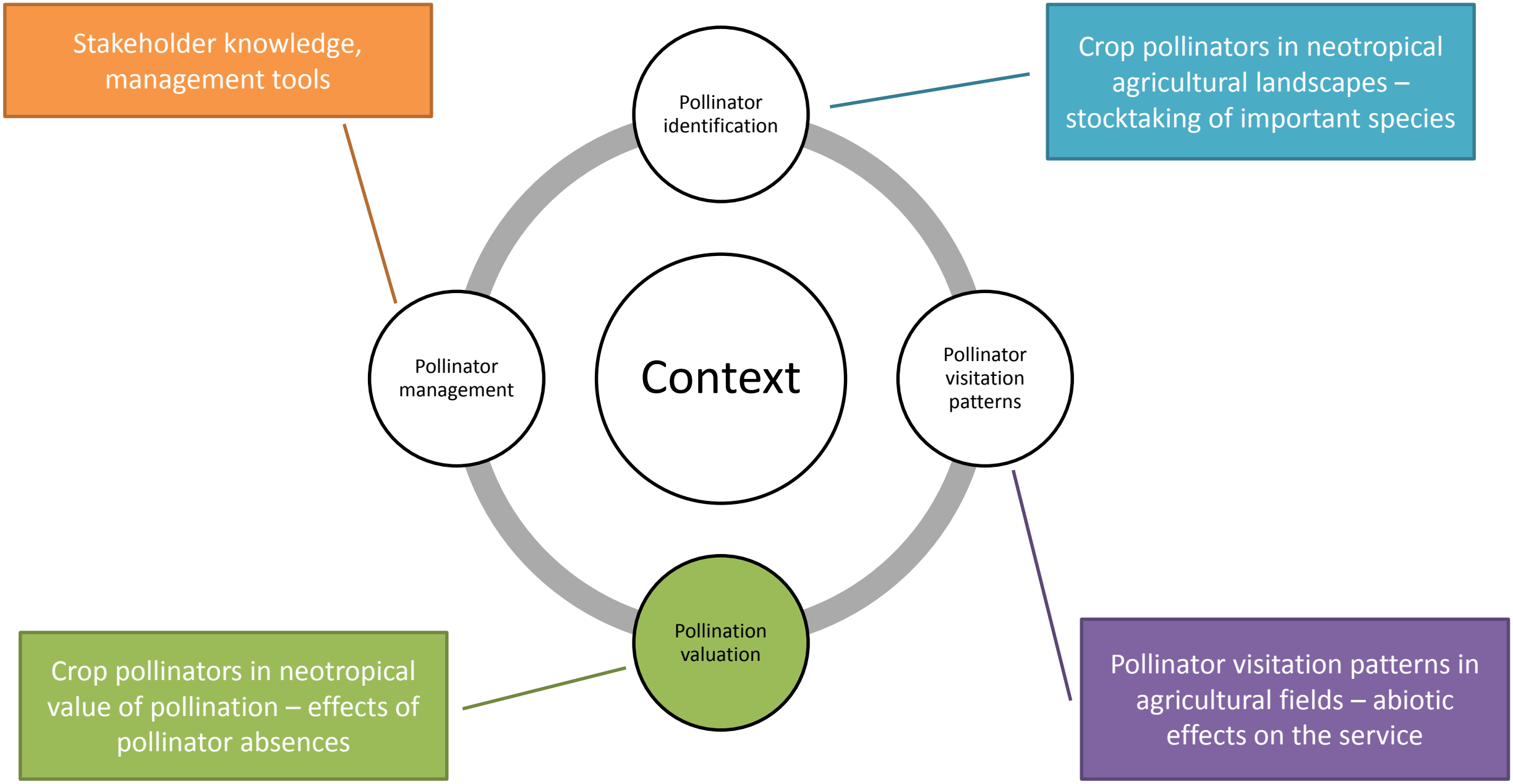
- Neglected agricultural sector
- Virtually no local or regional data on pollination, only anecdotal
- No standardised assessment methods available
- Pollination not accounted for and vastly undervalued regionally

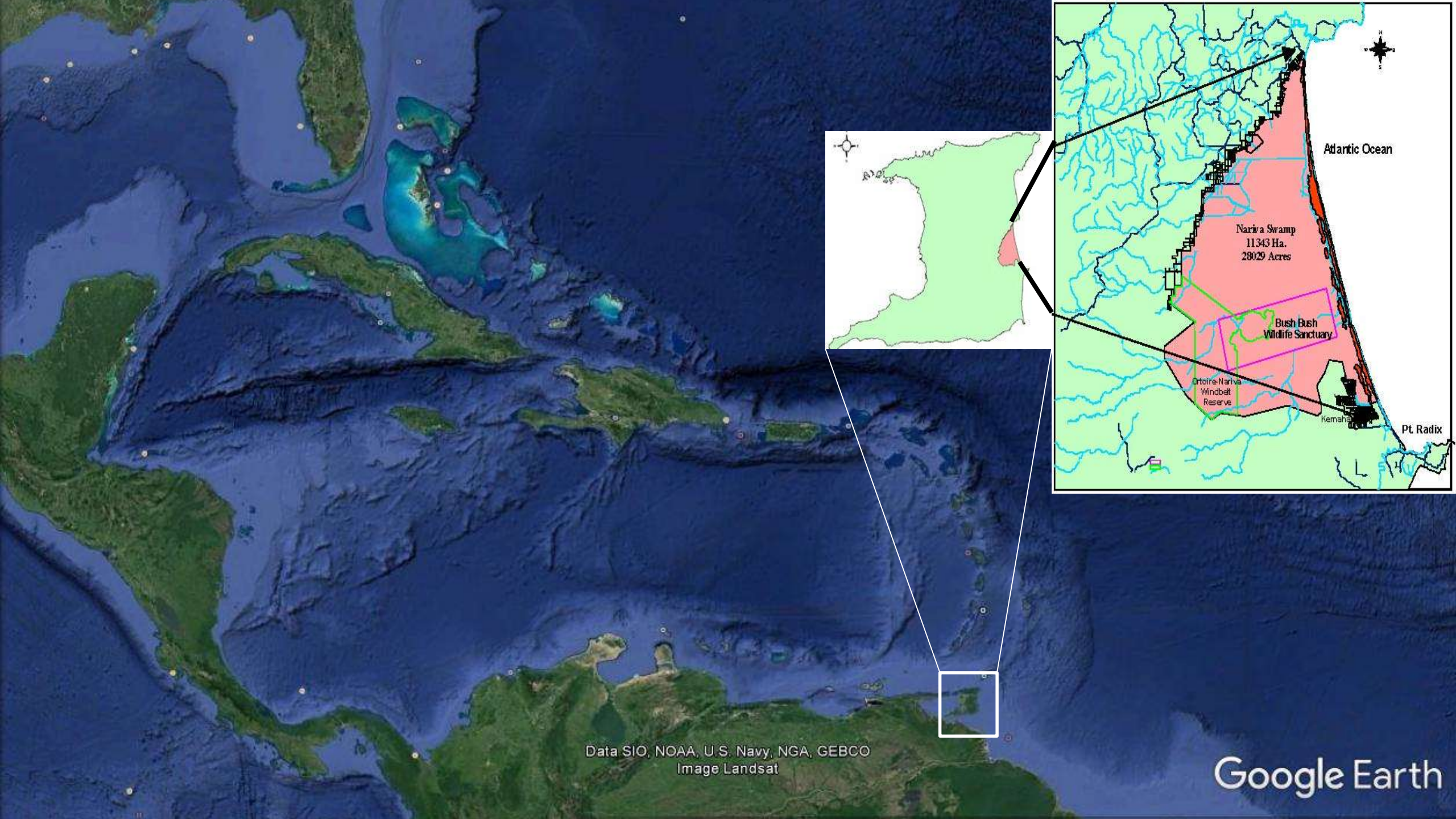


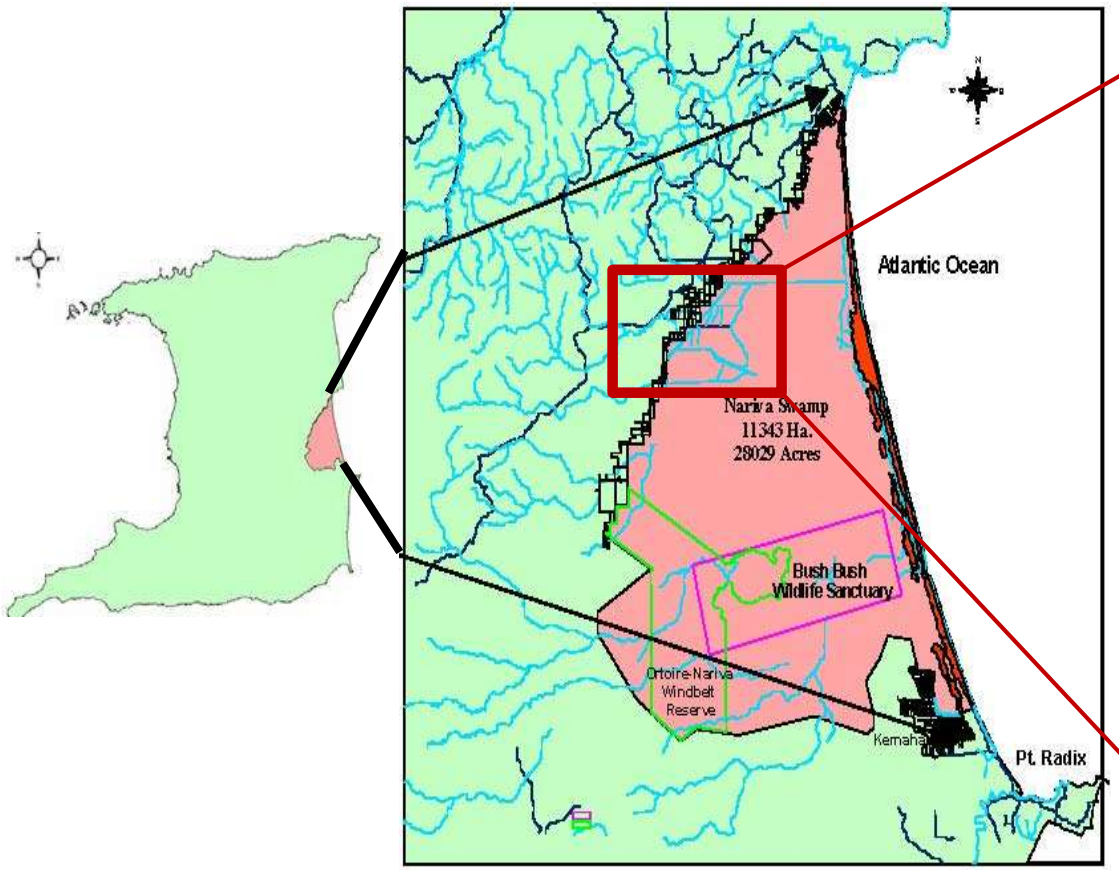
Objectives

- to provide simple order of magnitude valuations for selected pollination services in Trinidad
- to demonstrate the value of pollination services to farmers in a tropical wetland and the subsequent loss due to a reduction in pollination services

Trigona amalthea on pumpkin flower


Stakeholder knowledge, management tools
Crop pollinators in neotropical agricultural landscapes – stocktaking of important species
Pollinator identification
Pollinator management
Context
Pollinator visitation patterns
Pollination valuation
Crop pollinators in neotropical value of pollination – effects of pollinator absences
Pollinator visitation patterns in agricultural fields – abiotic effects on the service


Atlantic Ocean
Nariva Swamp
11343 Ha.
28029 Acres
Bush Bush
Wildlife Sanctuary
Ortoire-Nariva
Windbelt
Reserve
Kemahar
Pt. Radix
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat
Google Earth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Google earth

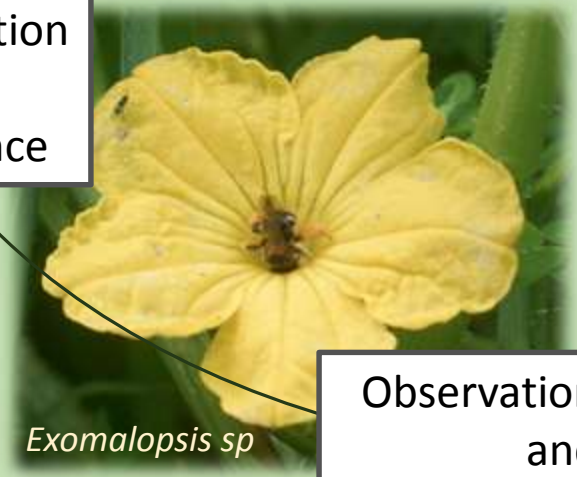
What are local pollination services worth?

Establishment of four farmer plots

Construction of exclusion enclosures

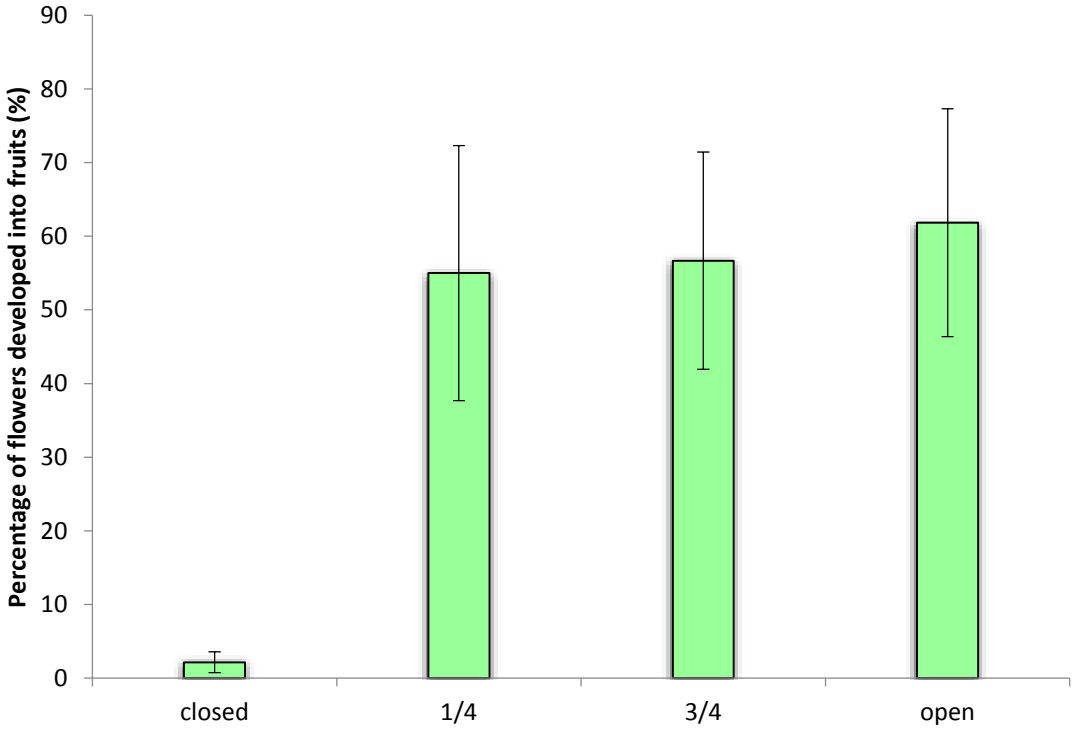
Tagging and bagging of flowers in various enclosure types (cucumbers and hot peppers)

Observation of development and harvest



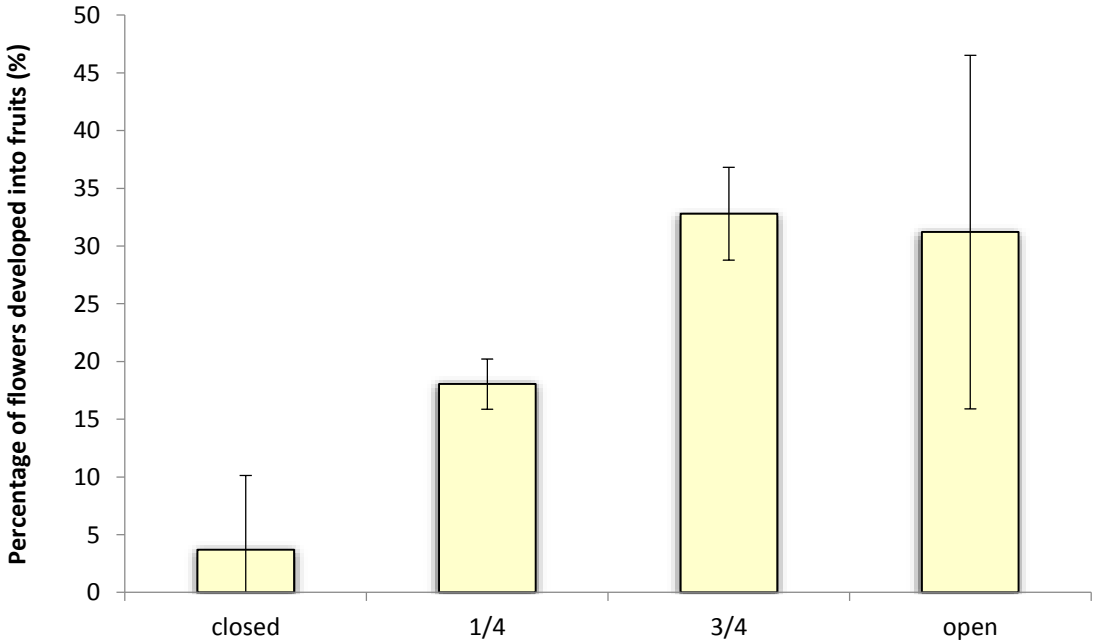
Exomalopsis sp

Determination of dependence



Percentage of tagged cucumber flowers developed into fruits under each exclusion condition (H = 8.748, 3 df, p = 0.033)

Percentage of tagged hot pepper flowers developed into fruits under each exclusion condition (H = 9.993, 3 df, p = 0.019)



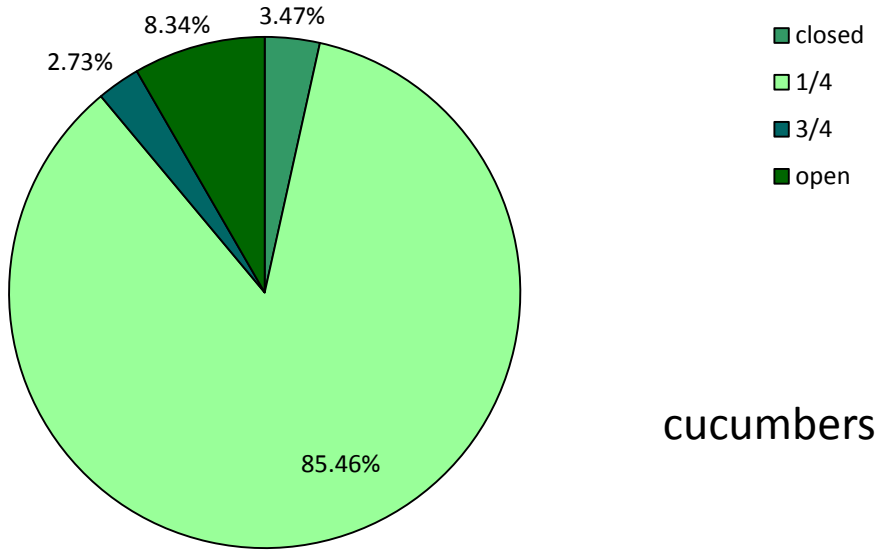
Percentage of the additional contribution made by each subsequent (larger) exclusion type for cucumbers

Cucumbers

- The largest contribution is made by the ¼ inch exclusion
- smallest insect group makes the largest contribution to cucumber pollination

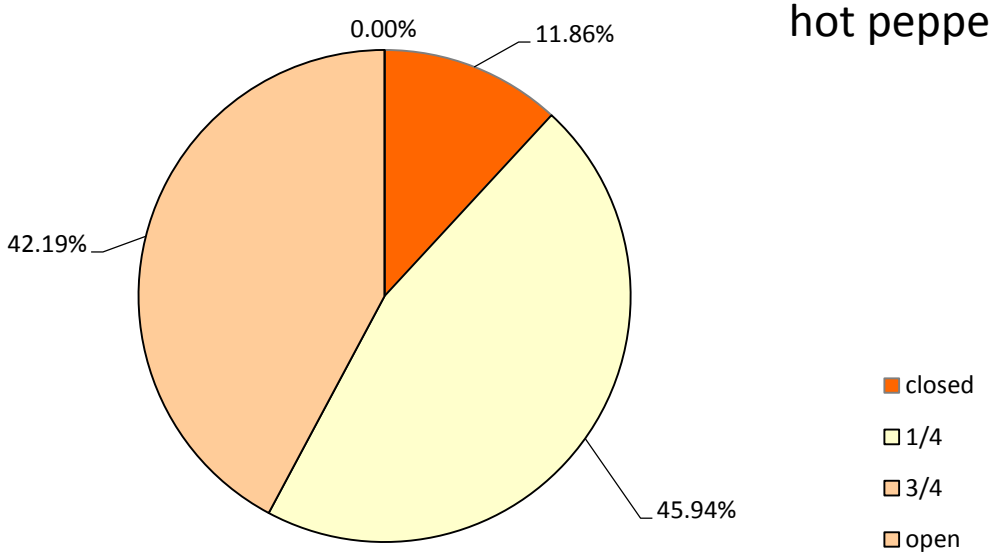
Hot peppers

- The largest contributions made by ¼ and ¾ inch exclusions
- yield was higher in ¾ inch enclosures than open enclosures
- insects able to access ¾ inch enclosures were considered to make the final contribution to production
- no extra value added by insects only able to access open enclosures



cucumbers

hot peppers



Loss of income in complete absence of pollinators

Crop	Mean % reduction in yield	Yield	Approximate yield per acre	Wholesale price (US$)	Approximate loss per acre (US$)
Hot peppers	88.1	0.54 to 7.25 peppers per plant per week	1,456 to 19,553 peppers per week	5.55 per 100	**71 to 956 per week**
Cucumbers	96.5	646g/m^2 to 3492g/m^2	2,614.27 kg to 14,131.64 kg per crop	0.9 per kg	**2,270 to 12,273 per crop cycle**
Ochro/okra/gumbo	86.2	N/A	N/A	N/A	**N/A**

Prices listed for crops during time experiments were conducted (NAMDEVCO 2007). All prices shown in US$ converted using exchange rate: US$1 = TT$6.4

Differences in weekly income from hot pepper harvests based on location

Location	Weekly harvest per plant (number of hot peppers)	Weekly income per plant	Weekly income per acre
Site S	7.25	0.54	**1,467.24**
Site K	5.28	0.40	**1,067.96**
Site F	0.54	0.04	**109.94**

- A difference was observed between locations (H = 11.526, 2 d.f., p = 0.03).
- Importance of landscape in pollination supply
- No difference was determined between the average number of flowers produced per location (H = 1.201, 2 d.f., p = 0.549) or enclosure type (H = 1.268, 2 d.f., p = 0.531)

Upscaling: Cucumbers

Upscaling: Hot peppers

NAMDEVCO: 24,690 sets of 100 sold in 2013 at Norris Deonarine Market

Complete pollinator absence: Reduction to 5,703 sets of 100 peppers

Loss of **TT$674,418.24 (US$105,378)** (2013) for sales from this market alone

- In cucumbers, the smallest size group of pollinators appears to make the largest contribution, which notably excludes *Apis mellifera*
- Hot pepper pollination seems to be equally supported by small and medium sized insects
- Higher dependency of all three crops than cited in previously published literature

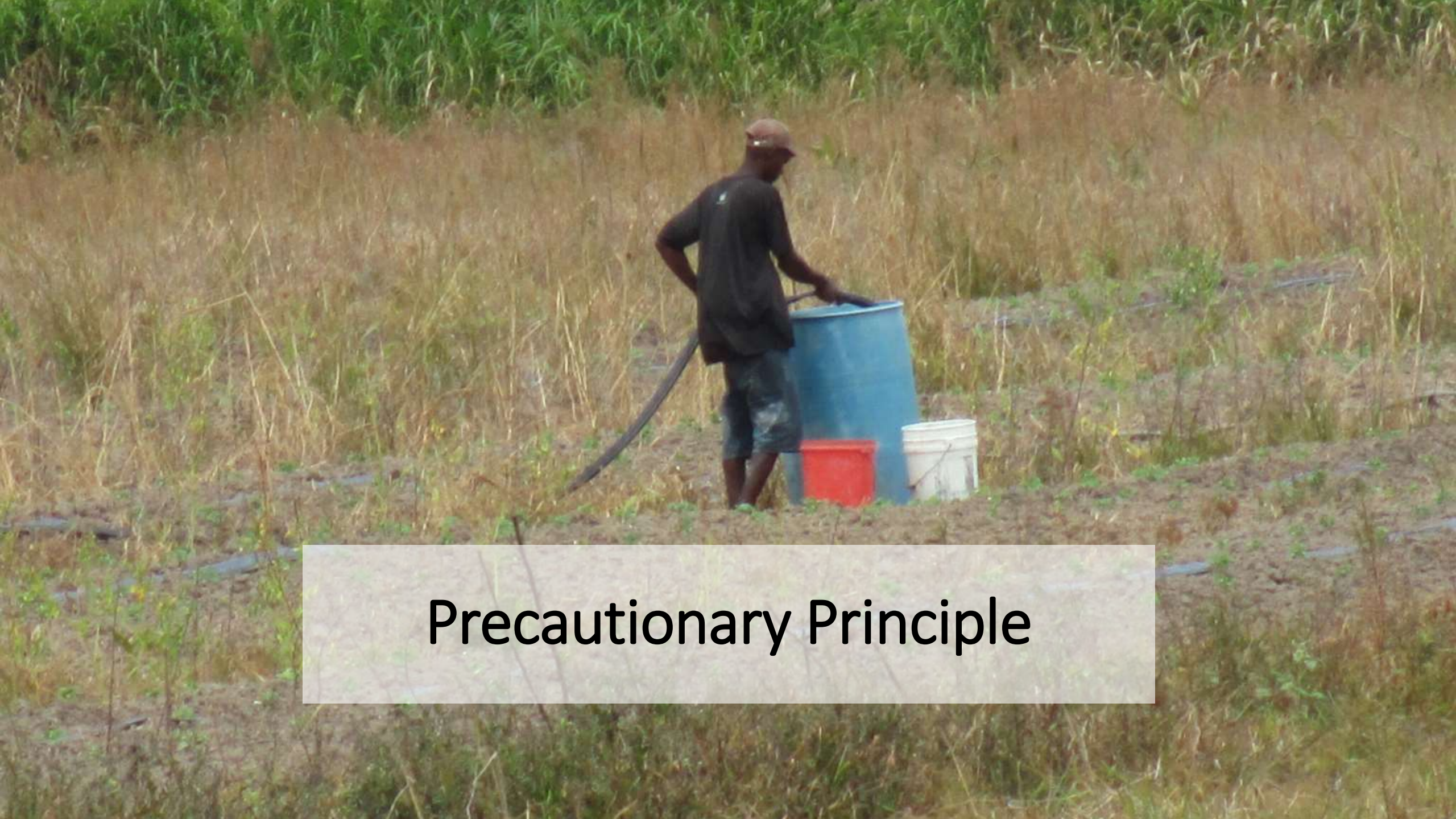
Agapostemon sp

- Results contradict Morse and Calderone's estimates (cucumber dependence on Apis mellifera - 0.9)
- In absence of smaller pollinators, *Apis* bees may provide a buffer and make up for the lack of other pollinators

Xylocopa sp on bodi flower

What can we do?

Given the high dependency on insect pollinators, national initiatives should focus on the **education of farmers**, including the need for pollinator conservation and the use of **sustainable farming practices**, and the formulation of **policies** to protect and manage pollination services.



Precautionary Principle

Private citizens

- [ ] Plant flowers
- [ ] Start kitchen gardens
- [ ] Provide pollinator habitat

Farmers

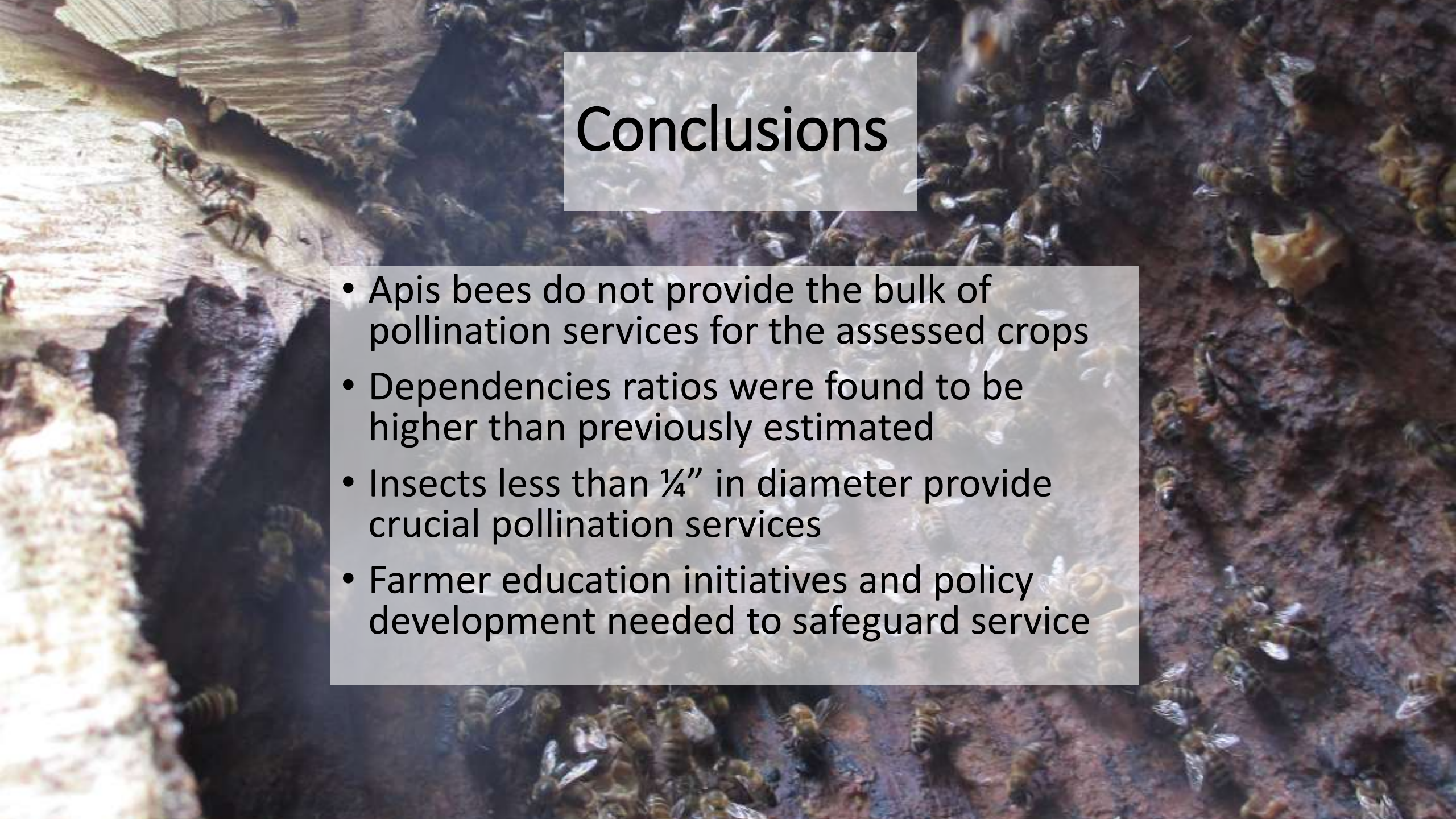
- [ ] Observe and record insects!
- [ ] Multicropping
- [ ] Plant non-crop flowers in between crops
- [ ] Spraying: low wind, high temperature, low dew conditions
- [ ] Plant hedgerows
- [ ] Provide pollinator habitat – nest boxes, bare ground, wooden stacks
- [ ] Use alternative pest control methods
- [ ] Leave portion of land unplanted

Researchers

- [ ] Pollinator surveys
- [ ] Further investigation of effects of landscape, abiotic conditions, pesticide effects on pollination provision
- [ ] Lobbying – decreasing gap between science and policy

Government

- [ ] Farmer education initiatives
- [ ] General population education initiatives
- [ ] Restriction of pesticide use
- [ ] Subsidies for pollinator friendly farms
- [ ] Development of pollination strategy and policy
- [ ] Pollination surveying and monitoring



Conclusions

- Apis bees do not provide the bulk of pollination services for the assessed crops
- Dependencies ratios were found to be higher than previously estimated
- Insects less than ¼” in diameter provide crucial pollination services
- Farmer education initiatives and policy development needed to safeguard service

Thank you!