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New challenges to crop pest management in traditional Central African agroecosystems under a changing climate

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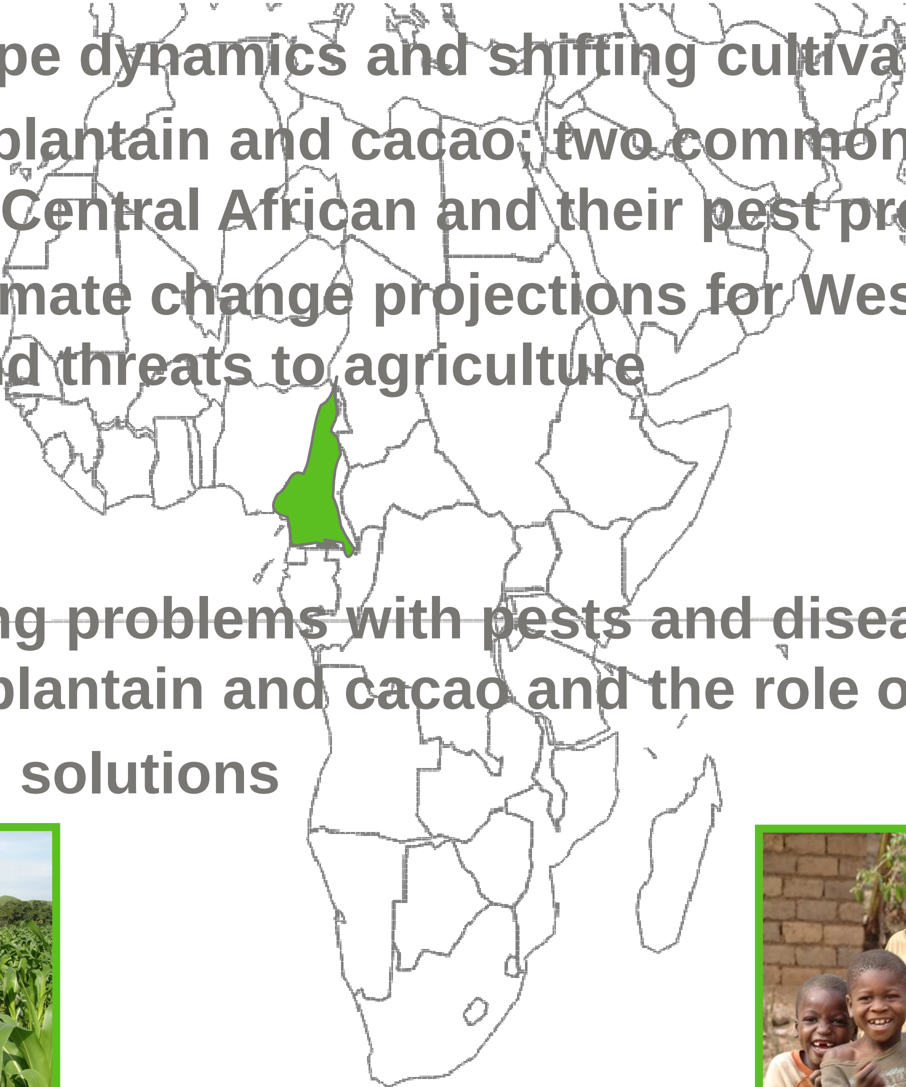
KNOWLEDGE FOR LIFE

Outline of presentation

1. Landscape dynamics and shifting cultivation
2. Banana-plantain and cacao: two common smallholder crops in Central African and their pest pressures
3. Some climate change projections for West and Central Africa and threats to agriculture



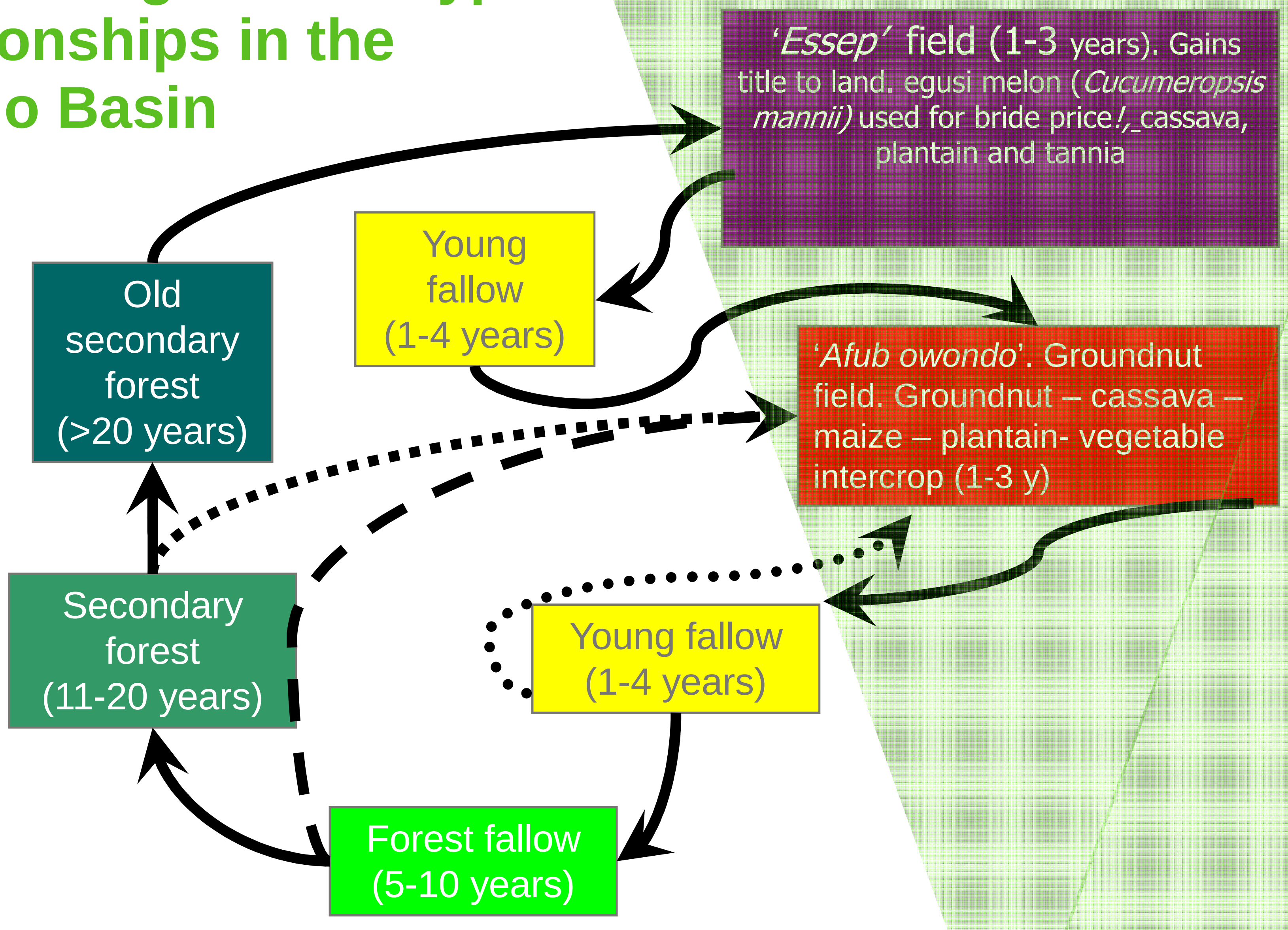
4. Escalating problems with pests and diseases of banana-plantain and cacao and the role of weeds
5. Potential solutions


Farmers traditionally crop fields after clear felling and burning old forest fallows. After one cropping phase, they abandon the land to fallow to avoid weed invasion and soil fertility decline

Who deforests?

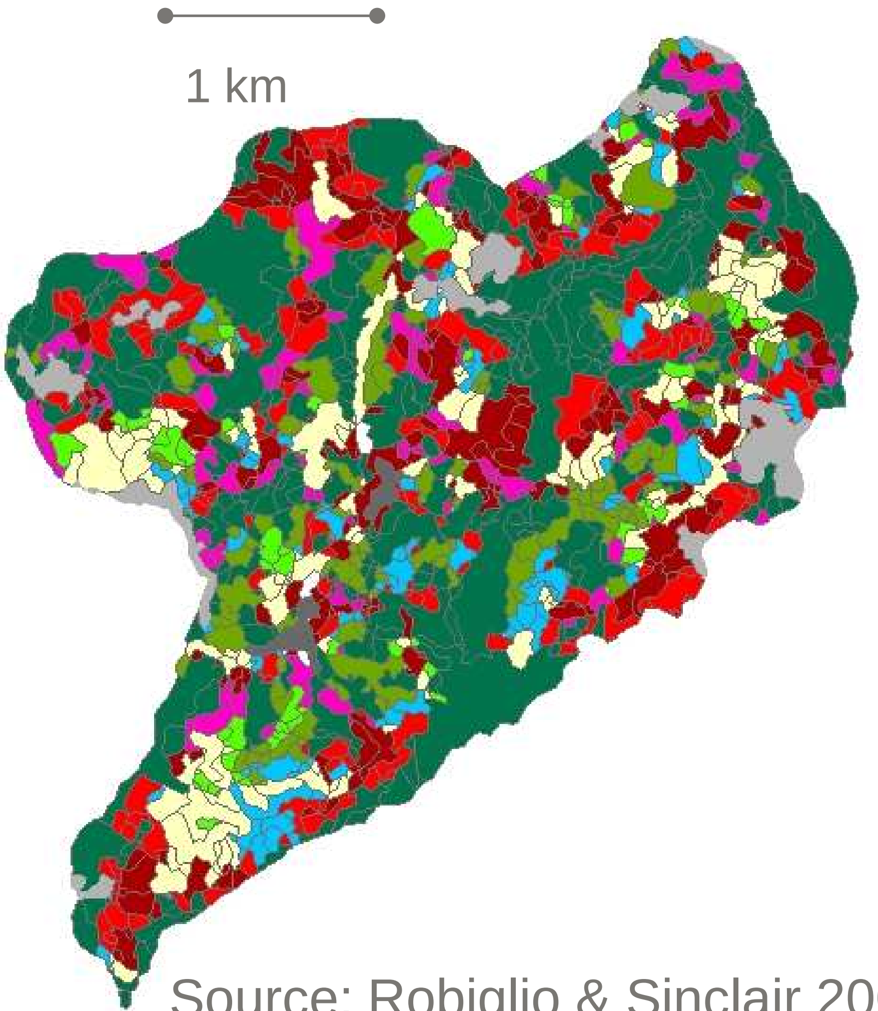
"*In Cameroon & DR Congo : deforestation is smallholder driven*" (IIED 2006)

Fallow length / field type relationships in the Congo Basin



Source: adapted after Brown 2004

Landscape Mosaic in southern Cameroon



Source: Robiglio & Sinclair 2007

- Primary forest
- Secondary forest
- Perennial crops: Cacao, oil palm
- Food crops in
- short fallow and
- long fallow cycles

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Banana-plantain: a staple and major cash-crop in Central Africa

- Most important food cash crop staple
- Cultivated in ‘*esep*’ long fallow fields intercropped with mélon (*Cucumeropsis mannii*), tannia, macabo; after a fallow >10 y.
- Without fertilizer, pesticides or herbicides
- Weeding twice per year with machete

Pest pressures of banana-plantain

2. Black Sigatoka *Mycosphaerella fijiensis*

3. Weevils.

Cosmopolites sordidus.

1. Root nematodes

Radopholus similis

Meloidogyne spp.

Pratylenchus goodeyi (at altitude)

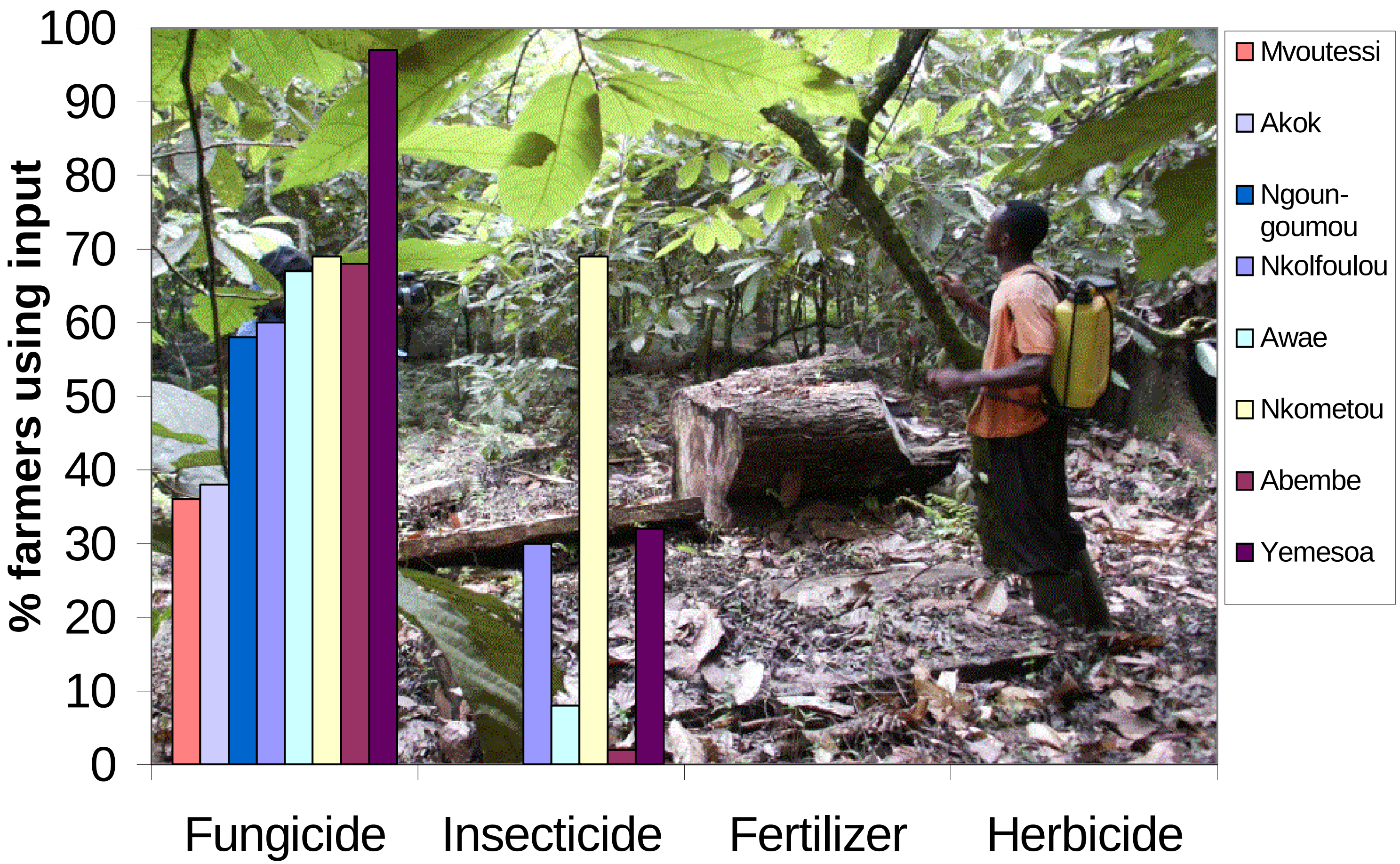
(Helicotylenchus multicinctus)

Smallholder cacao and pest pressure

- Cocoa, of S. American origin, is grown throughout the humid Tropics
- World production ~ 3.5 million tonnes p.a.
- More than 70% of world production is from the coastal zone of West/Central Africa where it is grown by smallholder farmers
- In Africa, blackpod (*Phytophthora palmivora* and *P. megakarya)* are major biotic constraints
- Global yield loss to blackpod alone ~ 0.5 million tonnes p.a.

P. megakarya infection of cherelle   cocoa grown under forest shade

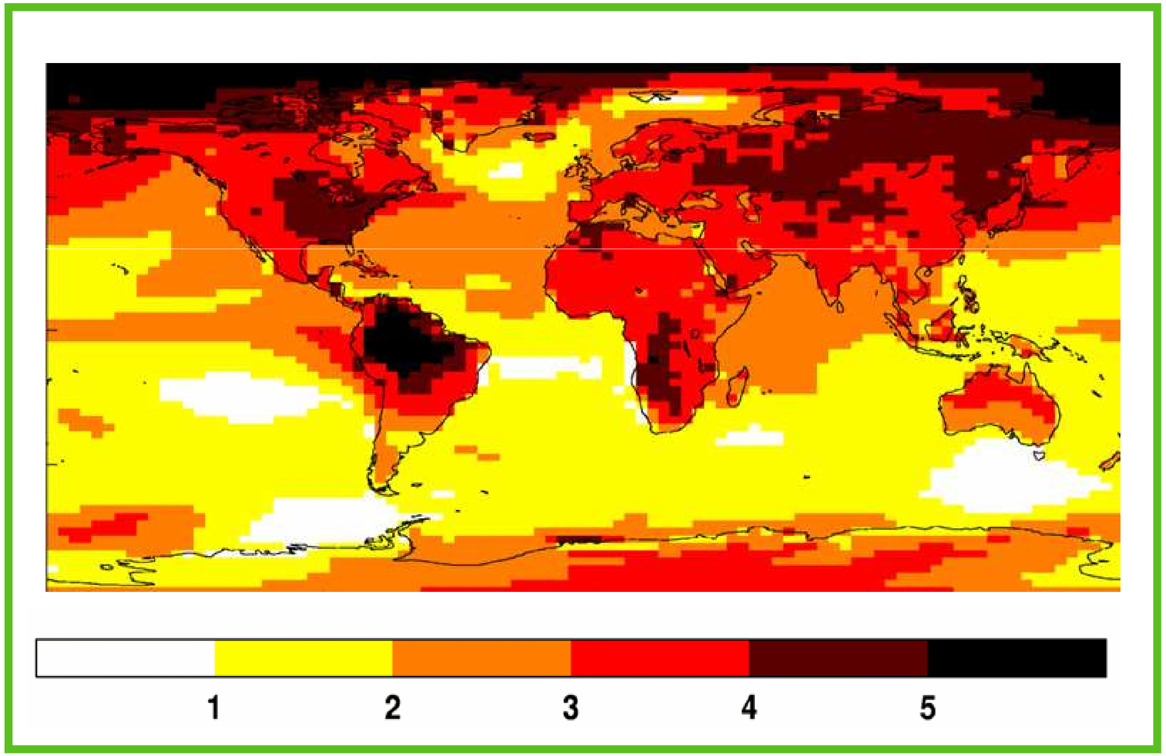
- *P. palmivora* is cosmopolitan, yet *P. megakarya*, a ‘new-encounter’ pathogen of cocoa, was first identified in Nigeria (*Brasier & Griffin 1979*).
- *P. megakarya* has moved from an African host to cocoa (*Holmes et al 2003*)
- Common in Nigeria and Cameroon, it has recently spread to and become extensive in Ghana
- Currently in an invasive phase, *P. megakarya* is spreading west from Ghana through Côte d’Ivoire (*Kebe et al 2002)*
- While phytosanitary harvesting & pruning can minimise yield losses from *P. palmivora,* these measures alone result in negligible yield in *P. megakarya-* infected areas *(Opuku et al 2000*)



Reported input use on cocoa farms in eight surveyed villages in southern Cameroon.

Some climate change predictions

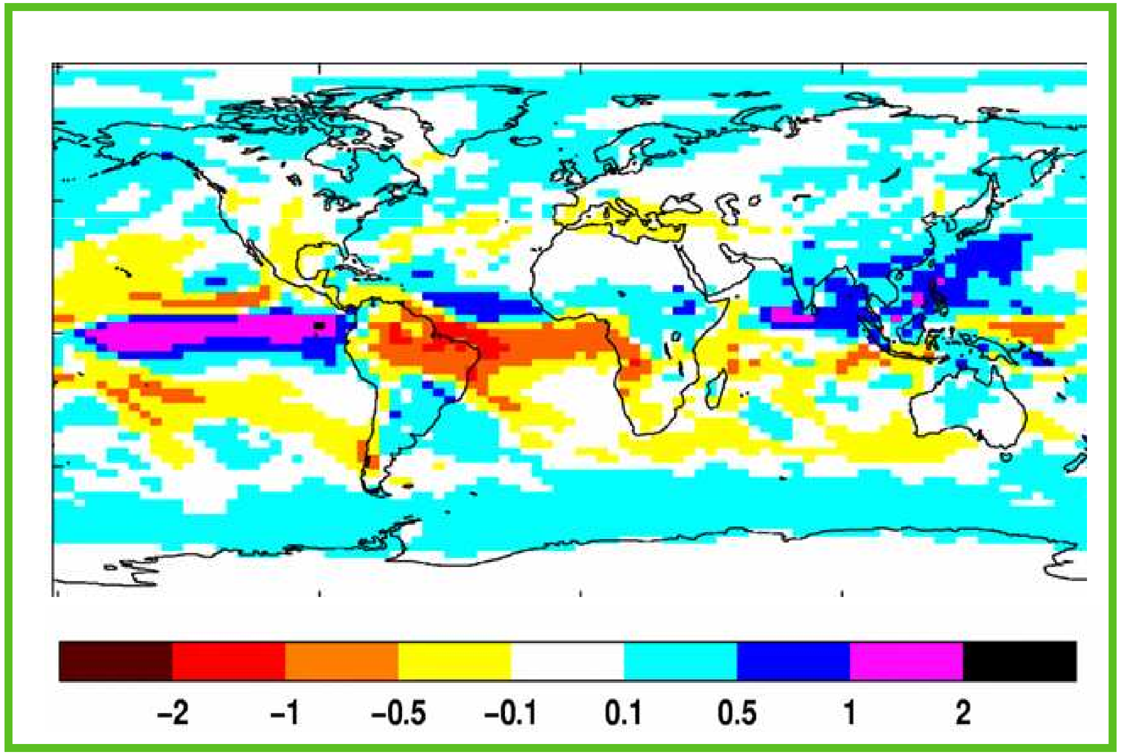
- Increases in global average surface temperatures of 1.1- 6.4 ℃ during 21st century *(IPCC 2007)*
- 3-4 ℃ increase in central Africa



Simulated temperature changes by 2080 (ºC) compared with 2000 (Betts 2005)

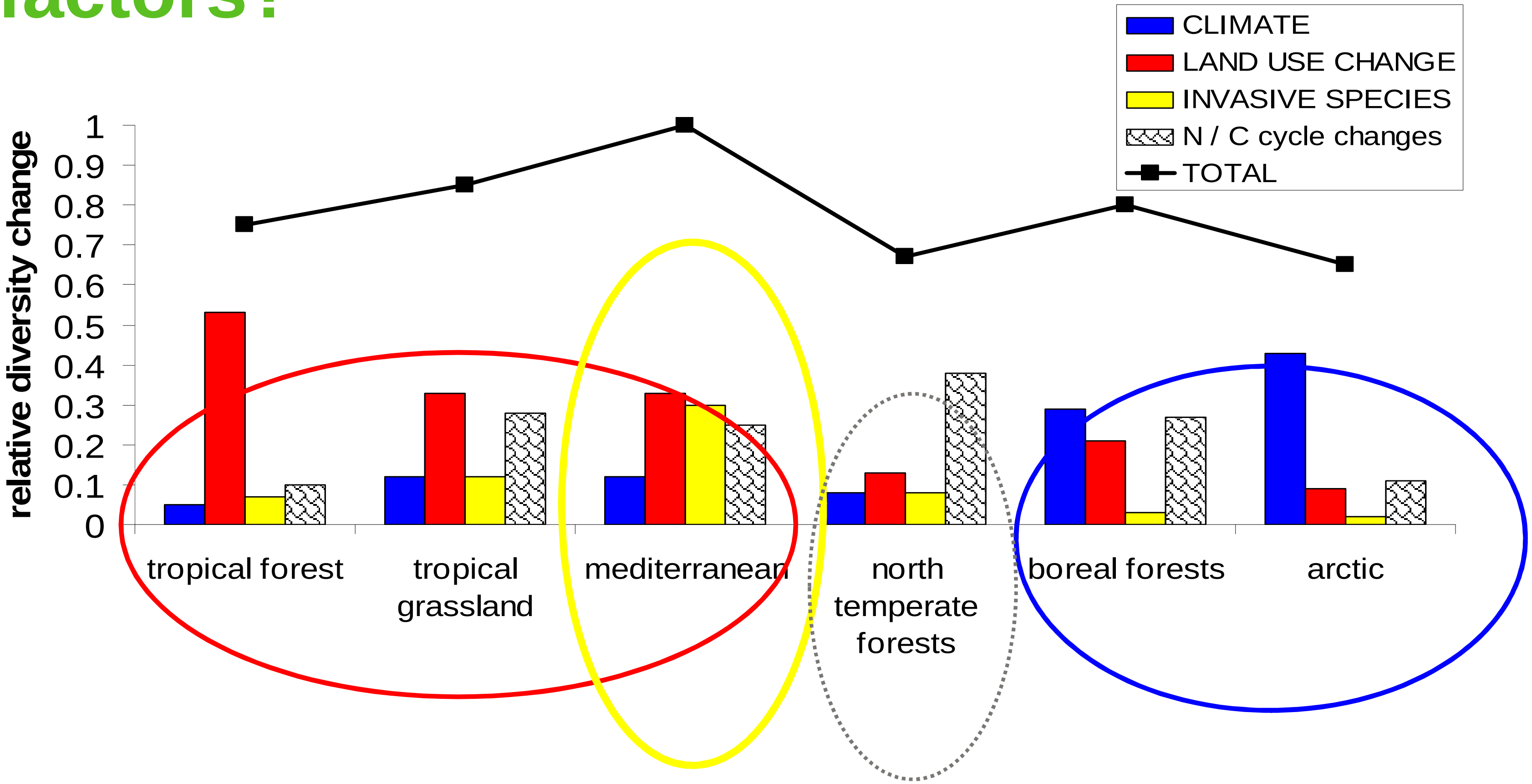
Some climate change predictions

- Increases in global average precipitation and vapour pressure *(IPCC 2007)*
- Slight reduction near Central African high rainfall coast, otherwise increase

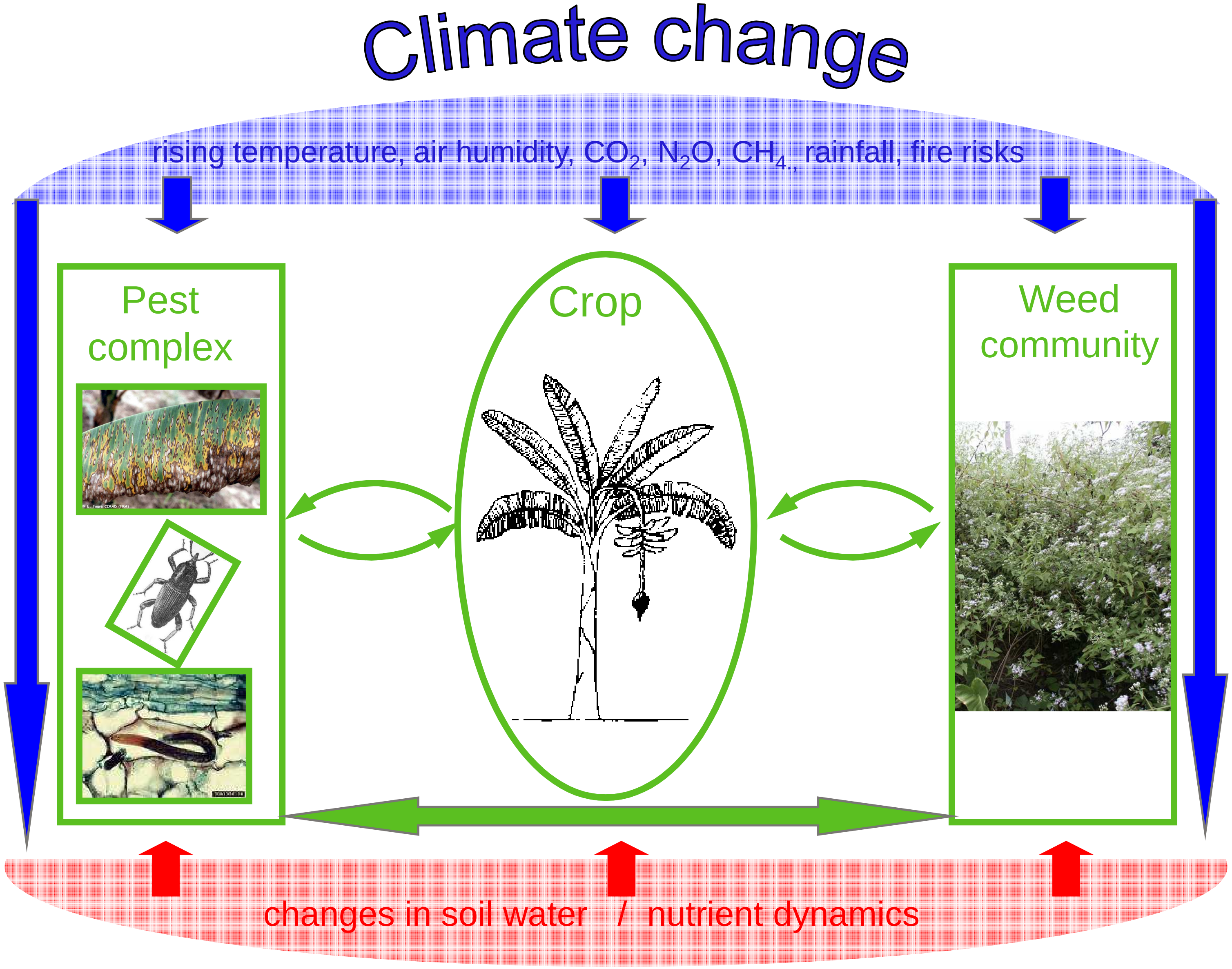


Predicted precipitation changes by 2050 (mm day^{-1}) (Betts 2005)

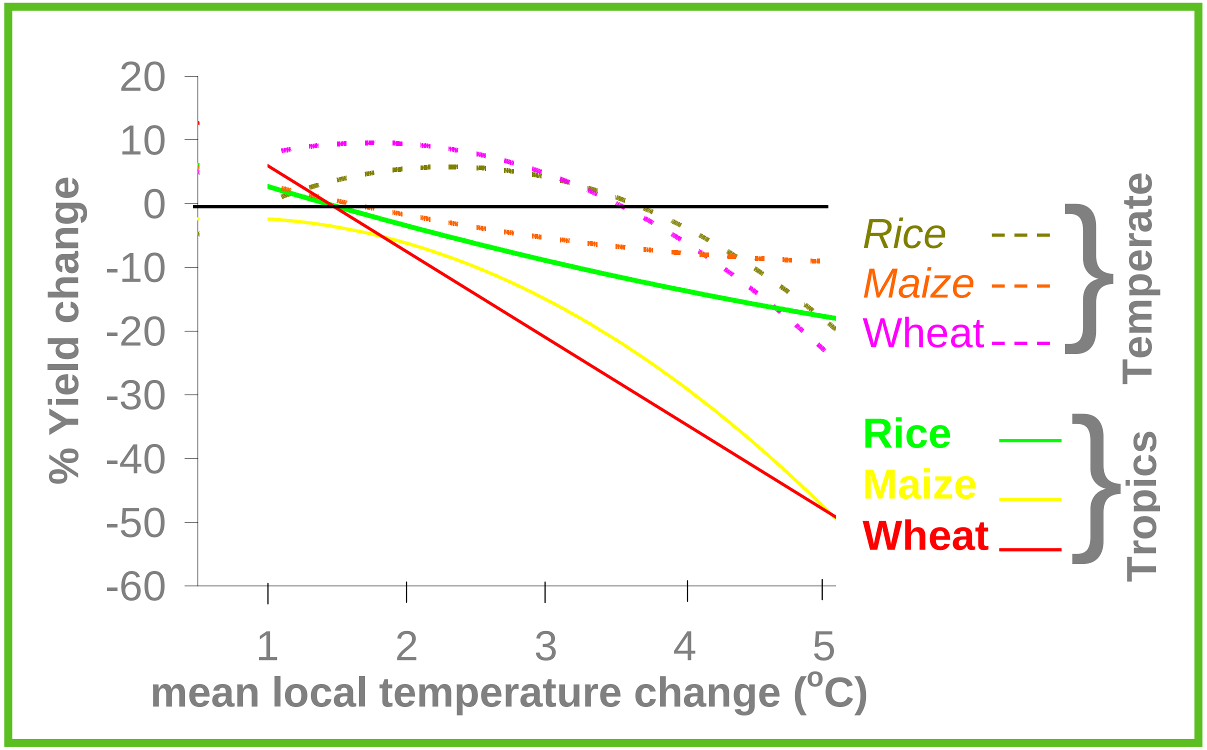
Some consequences: how will climate change interact with other factors?



Predicted species changes by 2100 & drivers. Assumes no interactions between factors. *adapted from Chapin III et al (2000)*


Climate change
rising temperature, air humidity, CO2, N2O, CH4., rainfall, fire risks
Pest complex
Crop
Weed community
changes in soil water / nutrient dynamics

Effect of higher temperatures on crop yields



adapted from IPCC (2007), summarising 69 studies. No adaptation.

< 3 ^{o}C increase → higher yields in temperate zones

> 3 ^{o}C increase → lower yields in temperate zones

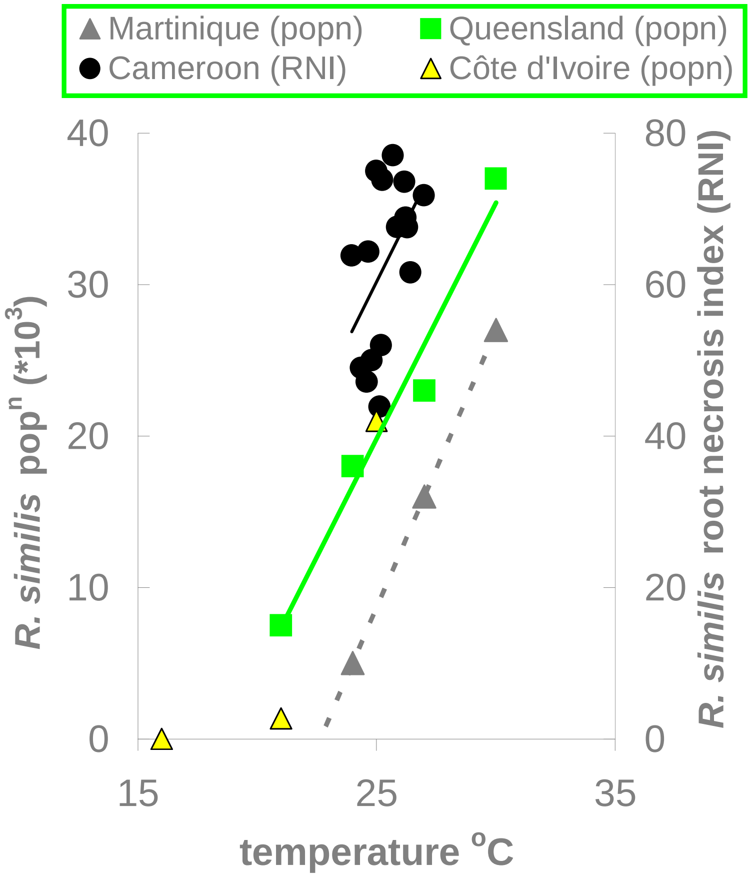
Any increase → lower yields in tropics

Predicted crop yield declines in the Tropics

- Climate change will alter pest / crop / soil dynamics
- Ranges of some pests may expand to higher altitudes & latitudes
- More extreme climatic disturbances will create opportunities for pest colonisation and establishment. Increasing destructiveness of tropical cyclones over the past 30 y (Emanuel 2005)

Forest – savannah transition zone yet little forest remaining. Large scale fires during the dry season (December – February)

More damage by *Radopholus similis* at higher temperatures



Data adapted from Fallas & Sarah 1995, Pinochet et al 1995, Norgrove & Hauser unpubl

Temperature effects on *R. similis* populations and root necrosis index. Data from a field study in Cameroon and controlled lab studies elsewhere. Treatment means presented. All data significant at $P<0.05$

- Higher temperatures lead to higher reproductive rates, more root necrosis and yield losses

Banana pests spreading to higher altitudes previously free of them?

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- *R. similis* is absent at the cooler high altitudes & latitudes. But is this changing?
- *R. similis* might replace the less damaging highland species, *Pratylenchus goodeyi* at higher altitude
- Black sigatoka is currently absent at higher altitudes where less damaging yellow sigatoka is present. This may change.

Higher humidity in cacao growing areas?

- Predicted higher temperature, humidity or rainfall in some parts of the humid tropics will exacerbate yield losses to fungal diseases

- Yet, above 26°C, *P. megakarya* growth is sub-optimal (*Brasier & Griffin 1979*) so aggressiveness might reduce as climate change advances

- Farmers use mainly copper-based contact fungicides but this strategy will become less effective if rainfall increases, as the product will be washed off

credit: Yonghachea

credits: Norgrove

Predicted expansion of Siam weed range

- *Chromolaena odorata* (Siam weed) is a serious weed from S. America, invasive throughout the tropics
- CLIMEX™ *(Sutherst et al 2007)* uses IPCC models plus precipitation, vapour pressure, & temperature data to predict climate change surfaces for global weeds, including Siam weed
- In West Africa, the range of Siam weed is predicted to expand east to Central Africa and beyond (*Kriticos 2007*)
- Biocontrol is contentious as many farmers perceive Siam weed positively as it outcompetes the more difficult-to-manage *Imperata* grass

Interactions with crop defoliators and disease

Z. variegatus on Siam weed credit: Cock

Z. variegatus credit: Cock

Z. variegatus on cassava (*Manihot esculenta)*

- Siam weed is an attractant for the African grasshopper *Zonocerus variegatus (Le Gall 2003)*
- It achieved pest status in 1986 and increases in *Zonocerus* populations are correlated with and attributed to increasing cover of Siam weed
- *Zonocerus* can transmit bacterial blight *(Zandianakou-Tachin et al 2007),* a serious disease of cassava, a main staple in the region

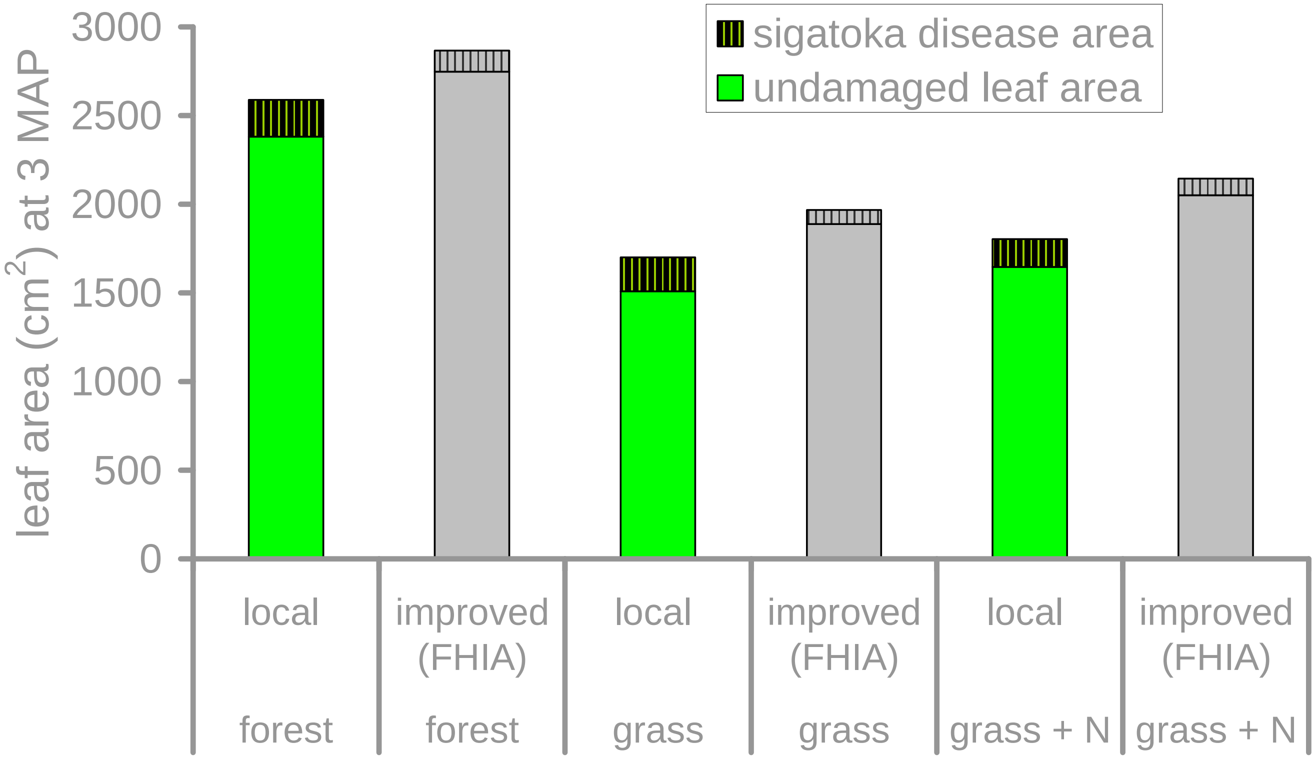
Adaptation to climate change impacts

CABI's Global Plant Clinic, through its rural plant clinics, promotes IPM to farmers including methods to reduce damage from *R. similis* and other nematodes.

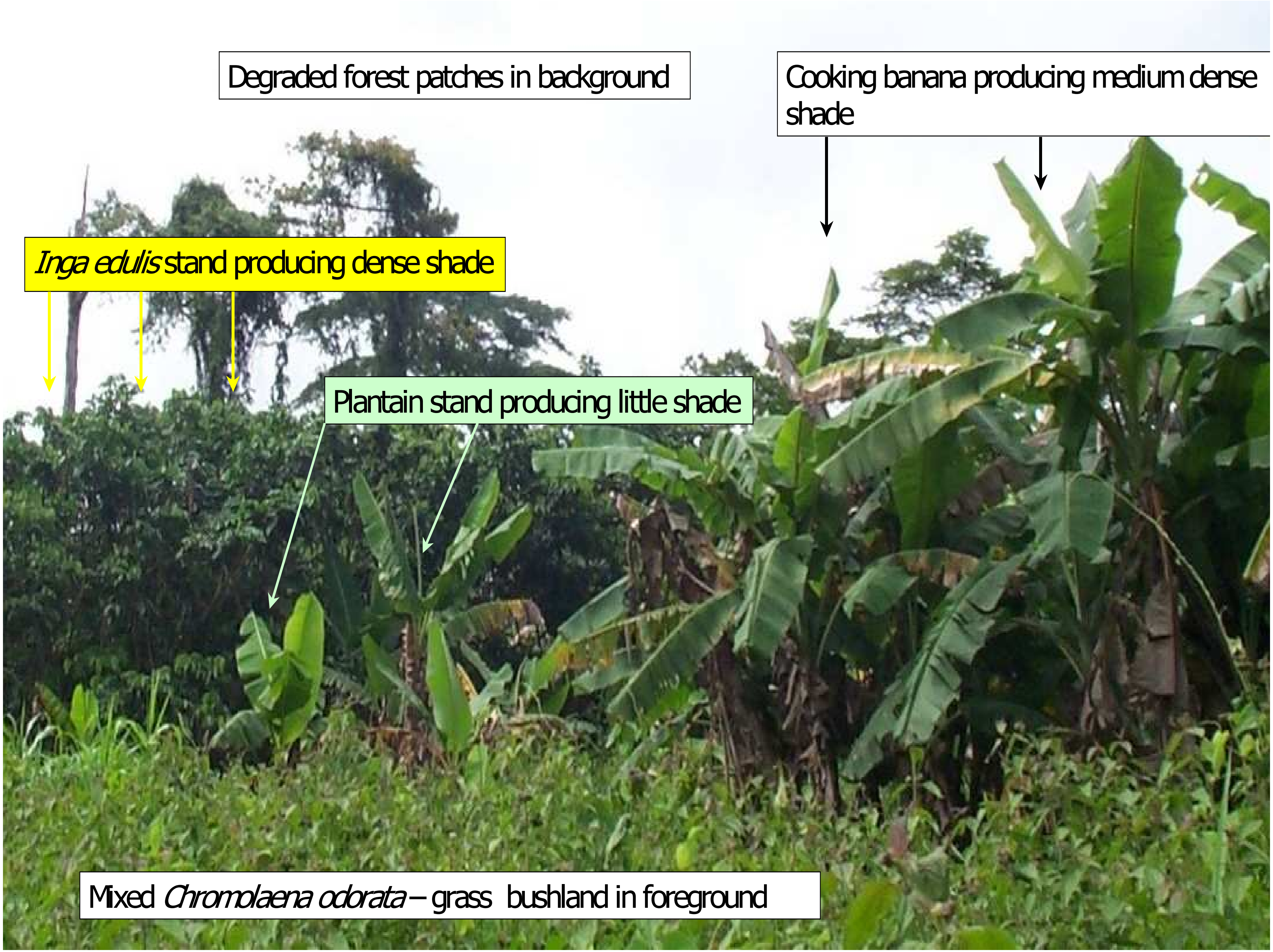
These include:

- Using clean planting material, such as suckers that have been immersed in hot water to kill nematodes, tissue culture plantlets or carefully pared suckers (removal of roots and outer infected tissue)
- Removing all plant parts from old fields, using crop rotation or leaving land fallow for at least 3 years

Tolerant varieties to manage disease threats under climate and land use change



Black sigatoka disease on local and improved plantains at 3 MAP young plantains as affected by land use system and N-amendment (Norgrove unpubl.)


Degraded forest patches in background
Cooking banana producing medium dense shade
Inga edulis stand producing dense shade
Plantain stand producing little shade
Mixed *Chromolaena odorata* – grass bushland in foreground

Novel biocontrol agents in cacao

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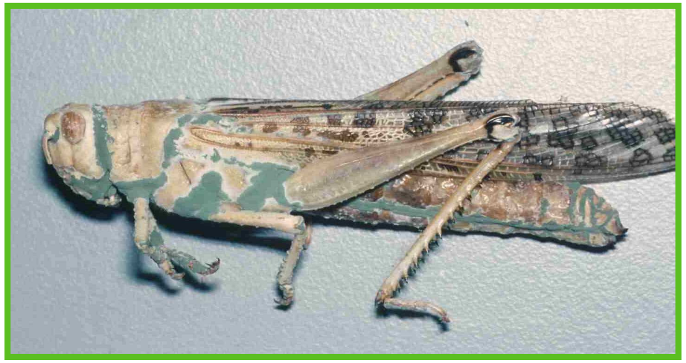
- Promote more effective control methods to farmers, including rational fungicide use, improved sprayers and spraying techniques (*Bateman 2004*)

- Novel control methods. *Trichoderma* endophytes are plant symbionts. They can protect their hosts from diseases through various mechanisms: competitive exclusion, antibiosis, induced resistance and mycoparasitism

- *Trichoderma* spp. that exhibit these properties and colonise cocoa tissue are being collected, isolated & screened for potential as biocontrol agents (*Holmes et al 2004*, *Bailey et al 2008*)

Managing *Z. variegatus*

- Green Muscle® can be used to control *Z. variegatus, Schistocercia gregaria,* the desert locust and other hoppers
- Green Muscle is an environmentally-friendly mycoinsecticide of *Metarhizium anisopliae* var. *acridum* developed by the collaborative LUBILOSA project comprising CABI, IITA, GTZ & CILSS/ AGRHYMET..
- Commercialised by Biological Control Products SA (Pty) Ltd, South Africa



Desert locust infected with Green Muscle ®

Conclusions and further work

- Climate change impacts are case-specific. Need to be understood by referring to existing data or conducting new fundamental research
- For African cacao, need new methods such as biocontrol agents to compensate for reduced efficacy of contact fungicides under greater precipitation.
- For bananas, greater pest problems require more stringent cultural control methods or use of tolerant varieties.
- In 2009, CABI will be using altitudinal transects, to mimic impact of changing temperatures in Cameroon, central Africa to study the effects on invasive weeds.

Thanks to CABI colleagues (Greg Masters, Keith Holmes, Emma Thompson, John Bridge, Matthew Cock) and Prosper Yonghachea (University of Hohenheim)

Thank you for your attention!