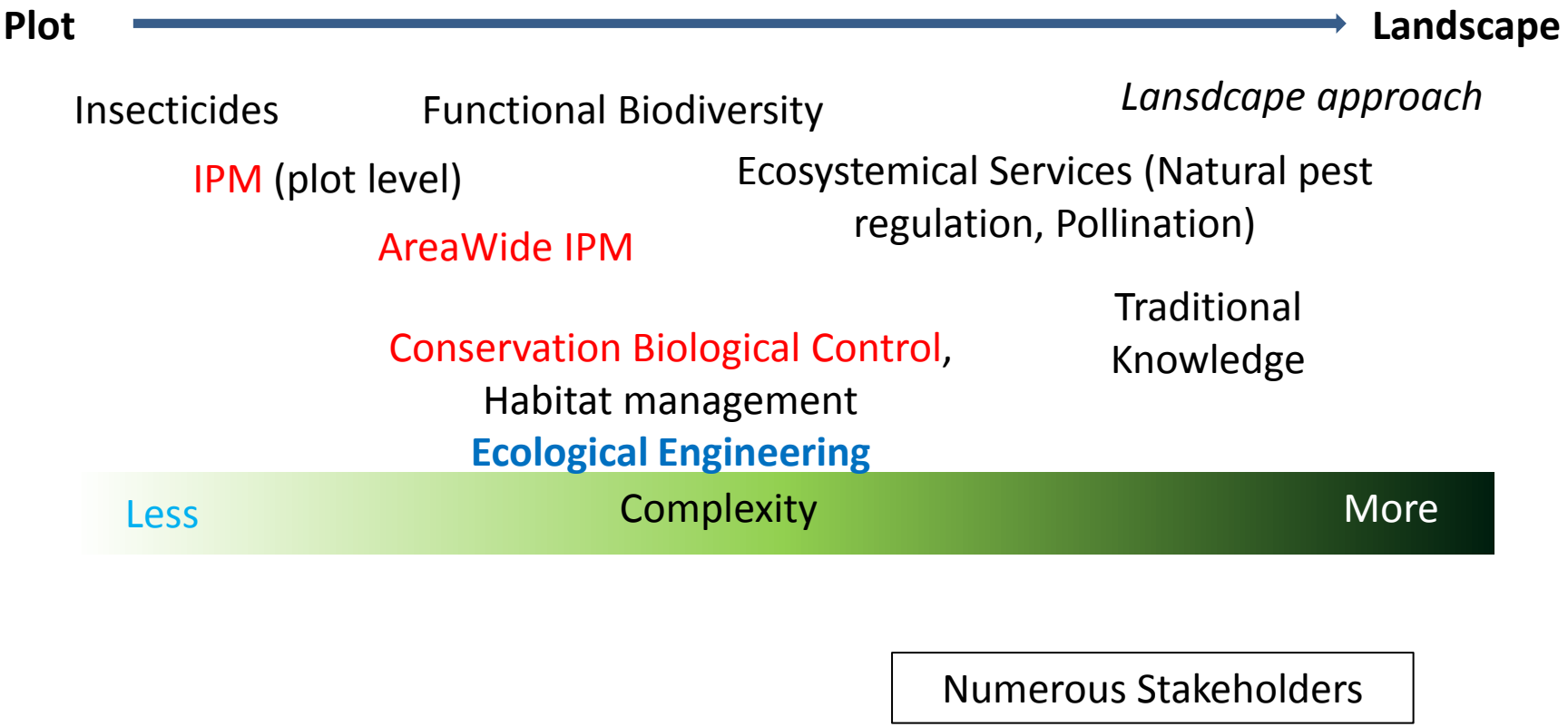
The long and challenging road for adopting some pest management concepts in sub-Saharan countries

Silvie P.

cirad

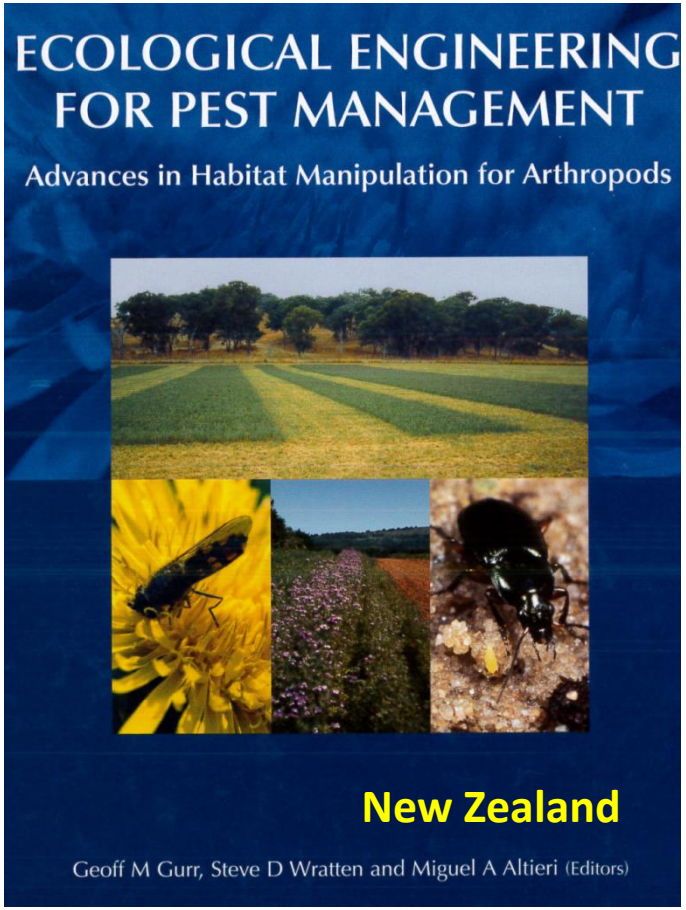
Institut de Recherche pour le Développement
FRANCE

From plot to landscape scale (Words and Concepts)



Ref.: DeFries *et al*., 2010. From plot to landscape scale: linking tropical biodiversity measurements across spatial scales. *Front Ecol Environ* 8, 153-160.

‘Chocolate-box’ ecology



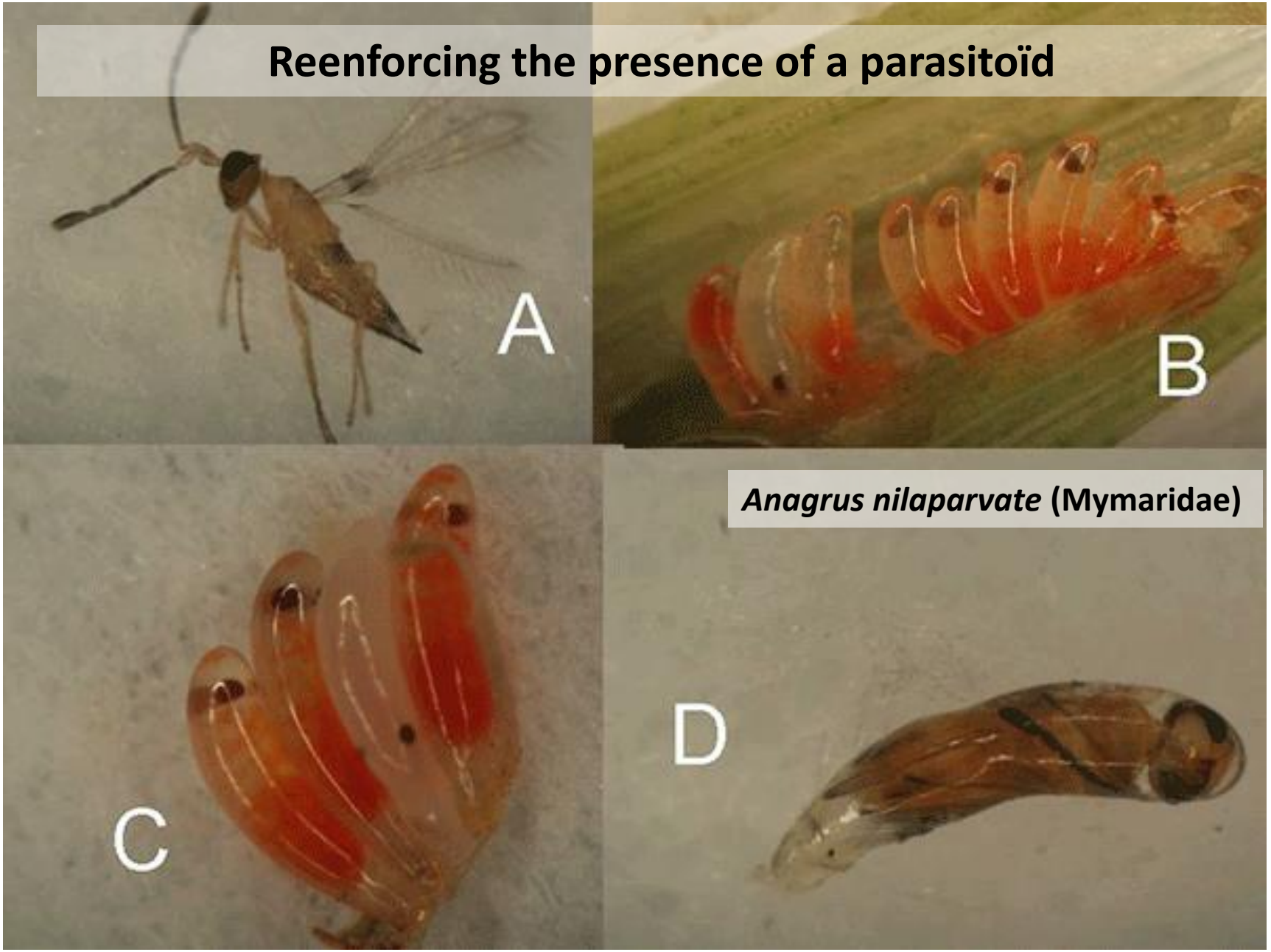
(Source: Tschumi *et al*. 2014)

Rice field margins management

Indramayu Regency, West Java (2012-2013)

Source: plant hoppers Project (Asie) http://ricehoppers.net

Reenforcing the presence of a parasitoïd



***Anagrus nilaparvate* (Mymaridae)**

http://ricehoppers.net

Weeds and bugs in rice field margins

Japon

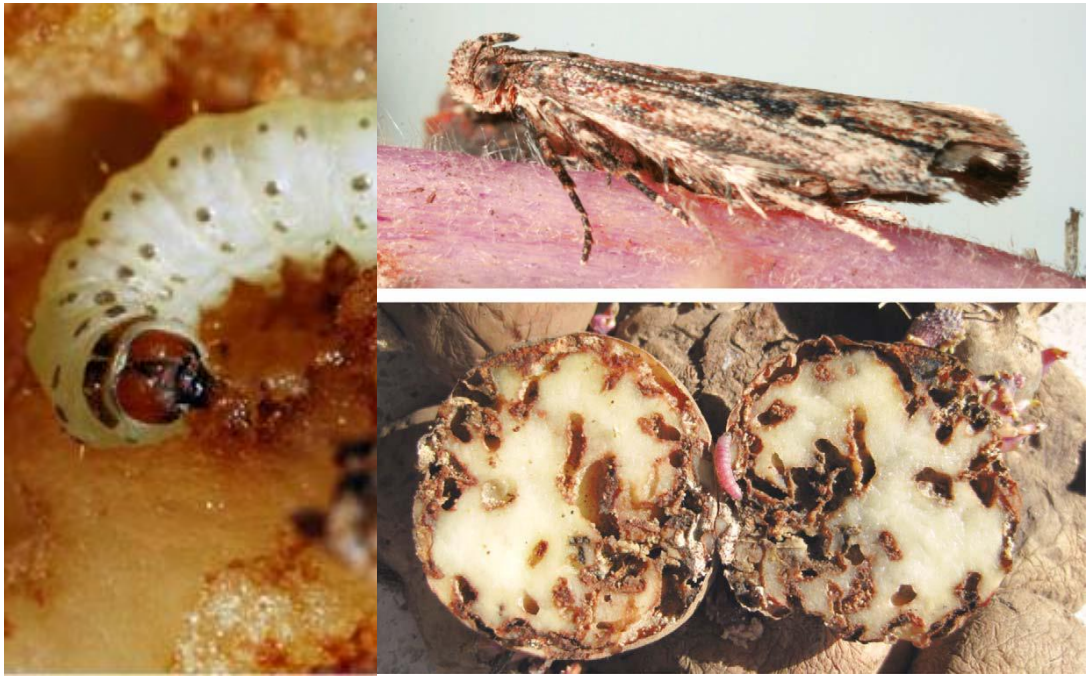
Miridae targeted (rice): ***Stenotus rubrovittatus***, ***Trigonotylus caelestialium***

Source: Yasuda *et al.,* 2011. Comparison of the effects of landscape composition on two mirid species in japanese rice paddies. *Appl Entomol Zool* 46, 519- 525.

See also…Takada *et al*., 2012, *Biological control* 60, 169-174

Effet de l'altitude et du paysage (1 km à la ronde)

Columbia Biological model : ***Tecia solanivora*** (Gelechiidae)/potato



Source: Poveda et al., 2012. Landscape simplification and altitude affect biodiversity, herbivory and Andean potato yield. *Journal of Applied Ecology* 49, 513-522.

What's going on in Africa ?

IPM and Cotton pest management

Crop Protection 43 (2013) 157–165

Contents lists available at SciVerse ScienceDirect

Crop Protection

journal homepage: www.elsevier.com/locate/cropro

Review

Threshold-based interventions for cotton pest control in West Africa: What's up 10 years later?

Pierre Jean Silvie [a,b,*], Alain Renou [c], Samuel Vodounnon [d], Gustave Bonni [e], Moïse Obayomi Adegnika [e], Omer Héma [f], Patrick Prudent [g], Julie Sorèze [g], Germain Ochou Ochou [h], Mamoutou Togola [i], Djibril Badiane [j], Abdoulaye Ndour [k], Pikassalé Komlan Akantetou [l], Bassarou Ayeva [l], Thierry Brévault [a]

Crop Protection 30 (2011) 1370–1375

Contents lists available at ScienceDirect

Crop Protection

journal homepage: www.elsevier.com/locate/cropro

Short communication

Manual topping decreases bollworm infestations in cotton cultivation in Mali

Alain Renou [a,b,*], Idrissa Téréta [c,1], Mamoutou Togola [c,1]

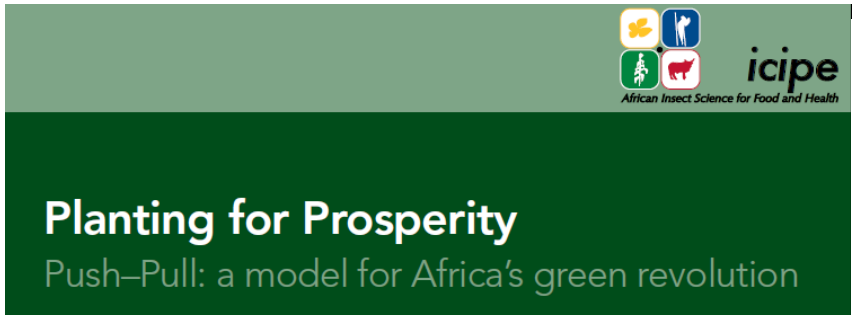
[a] CIRAD, UPR SCA, F-34398 Montpellier Cedex 5, France
[b] CIRAD, BP 1813, Bamako, Mali
[c] IER, CRRA de Sikasso, BP 16, Sikasso, Mali

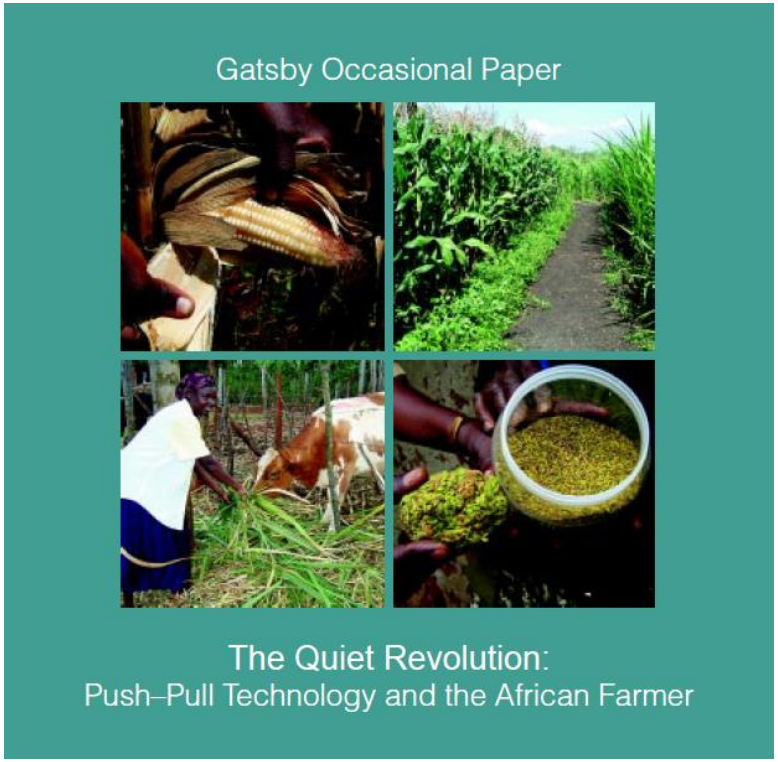
FIRST STEPS TOWARDS "GREEN" COTTON IN MALI

Alain Renou, CIRAD, BP 1813, Bamako, Mali. Tel: 223 78 41 76 24; Fax: 223 221 87 17; E-mail: alain.renou@cirad.fr or renou@afribone.net.ml, Mamoutou Togola, Idrissa Téréta and Thierry Brévault, IER Cotton Entomology and CIRAD UR Annual Cropping Systems, outline the decreasing use of insecticide in cotton thanks to ongoing dissemination of threshold-based spraying programmes amongst smallholders in Mali

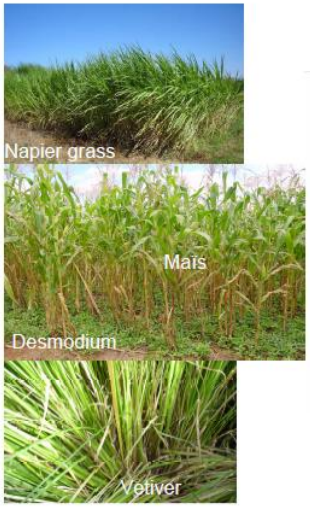
Outlooks on Pest Management – August 2012

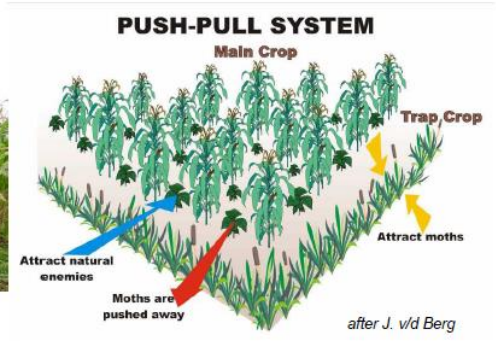
Maize : the push-pull concept…





Le système « push-pull » en Afrique de l'Est & australe (Khan et al.)



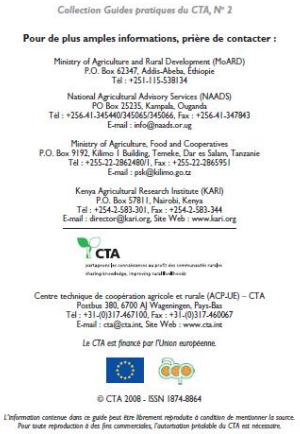


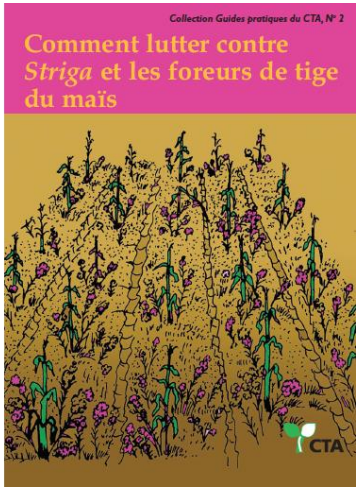
J. van den Berg, 2003

Busseola fusca

…became a paradigma, in some countries

To try is to adopt it !





http://www.push-pull.net/publications.shtml

Developing the landscape approach for crop pest management

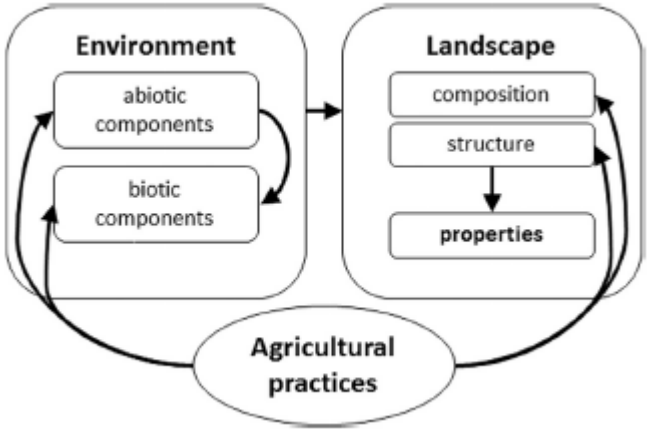
cirad

Hypothesis

Crop Protection 66 (2014) 53–60

DIVECOSYS: Bringing together researchers to design ecologically-based pest management for small-scale farming systems in West Africa

Thierry Brévault [a, b], Alain Renou [a], Jean-François Vayssières [c, d], Guillaume Amadji [e], Françoise Assogba-Komlan [f], Mariama Dalanda Diallo [g], Hubert De Bon [c], Karamoko Diarra [h], Abdoulaye Hamadoun [i], Joël Huat [c, k], Pascal Marnotte [a], Philippe Menozzi [a, k], Patrick Prudent [a], Jean-Yves Rey [c, j], Dieynaba Sall [j], Pierre Silvie [a], Serge Simon [c, f], Antonio Sinzogan [e], Valérie Soti [a, l], Manuele Tamò [d], Pascal Clouvel [a, *]



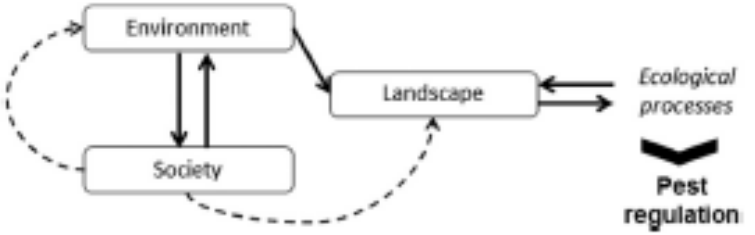


Fig. 3. Action and assessment framework based on concepts derived from landscape ecology (Burel and Baudry, 1999). Landscape configuration results from the dynamics of environment and society which has developed there (black arrows).

Biological models: cereal pests (stem and ear borers)

Sesamia calamistis, *Busseola fusca*, *Chilo partellus* (**maize**, Kenya)

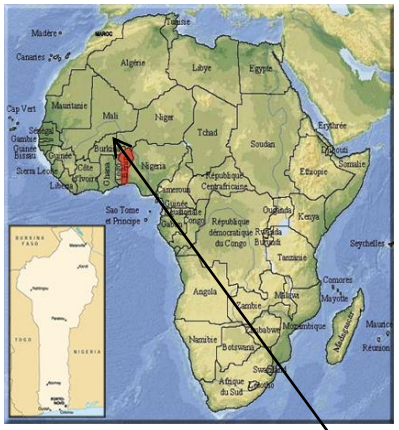
Sesamia calamistis, Mussidia nigrivenella (**maize**, Benin)
Coniesta ignefusalis (**sorgho**, Benin)
Sesamia calamistis, Diopsidae (**rice**, Benin)

Busseola fusca (Kenya)

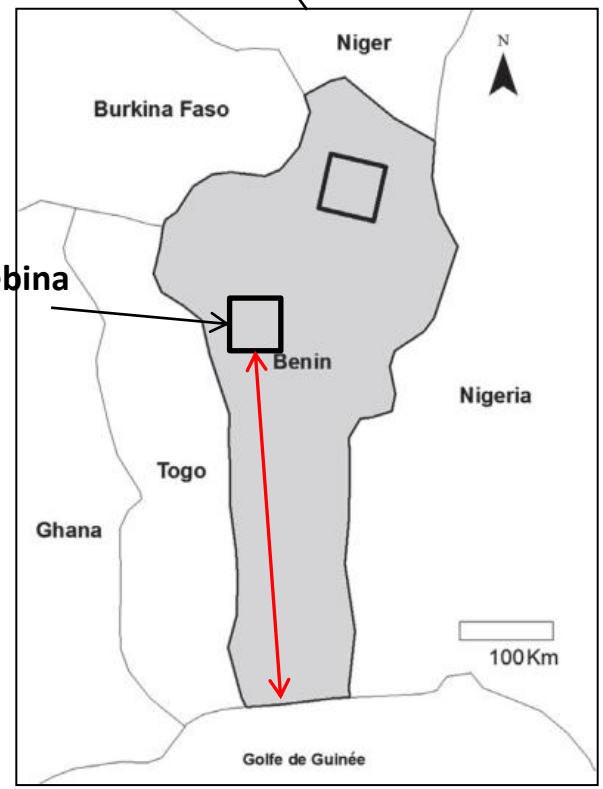
Coniesta ignefusalis (Benin)

Philodicus fraternus (Asilidae)
Preying *Diopsis thoracica (*Diopsidae*)*

Sites of studies



Bénin



Kenya

Challenge 1: the distances

The students: Aknowledgements (1)

2011/02/15 to 2011/07/31

Laure ANDRÉ (Istom)

Miren HARIGNORDOQUY (AgroParisTech)

Kenya

Bénin

2013/07/01 to 2013/12/15

Robin DRIEU (SupAgro)

Alexandre BOUCHER (Université Paris-Sud)

Djibril SAMA (Pélébina Village)

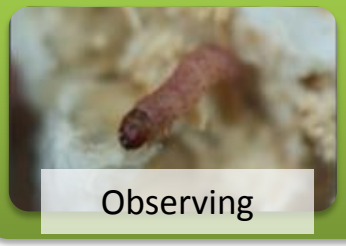
2014/02/02 to 2014/07/31

Main steps

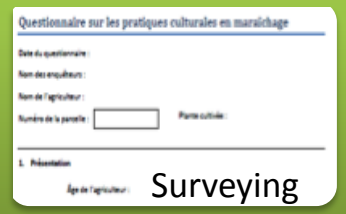
Communication (local communities)

Landscape parameters

Correlations ?



Infestation- biological regulation

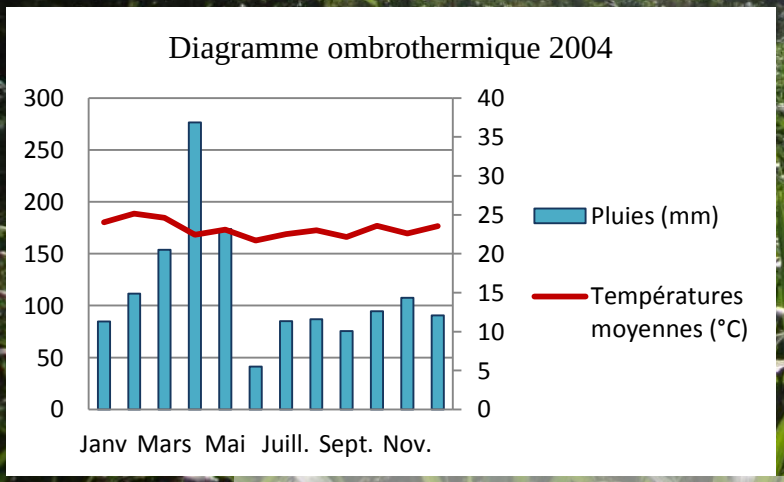


Farmers' practices and knowledge

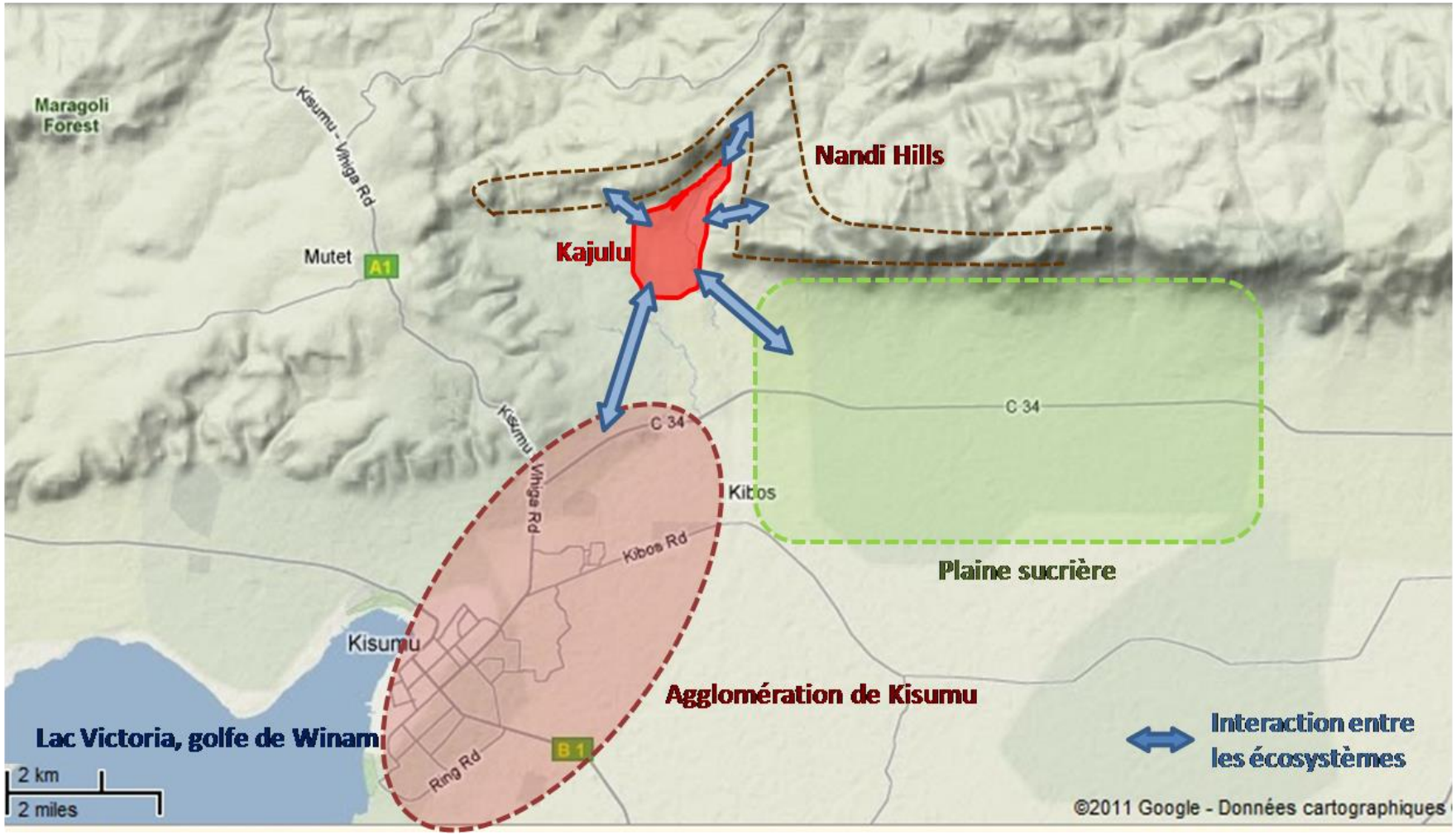
Kenya

Long rainy season
1000 inhabitants/km²
Challenge 2
Language : Luo

D. Birman, PhD. (2014/09/12). Approche compréhensive d'un agro-écosystème : contextes écologique, technique et social de l'action des agriculteurs Luo dans un territoire de l'Ouest Kenya (

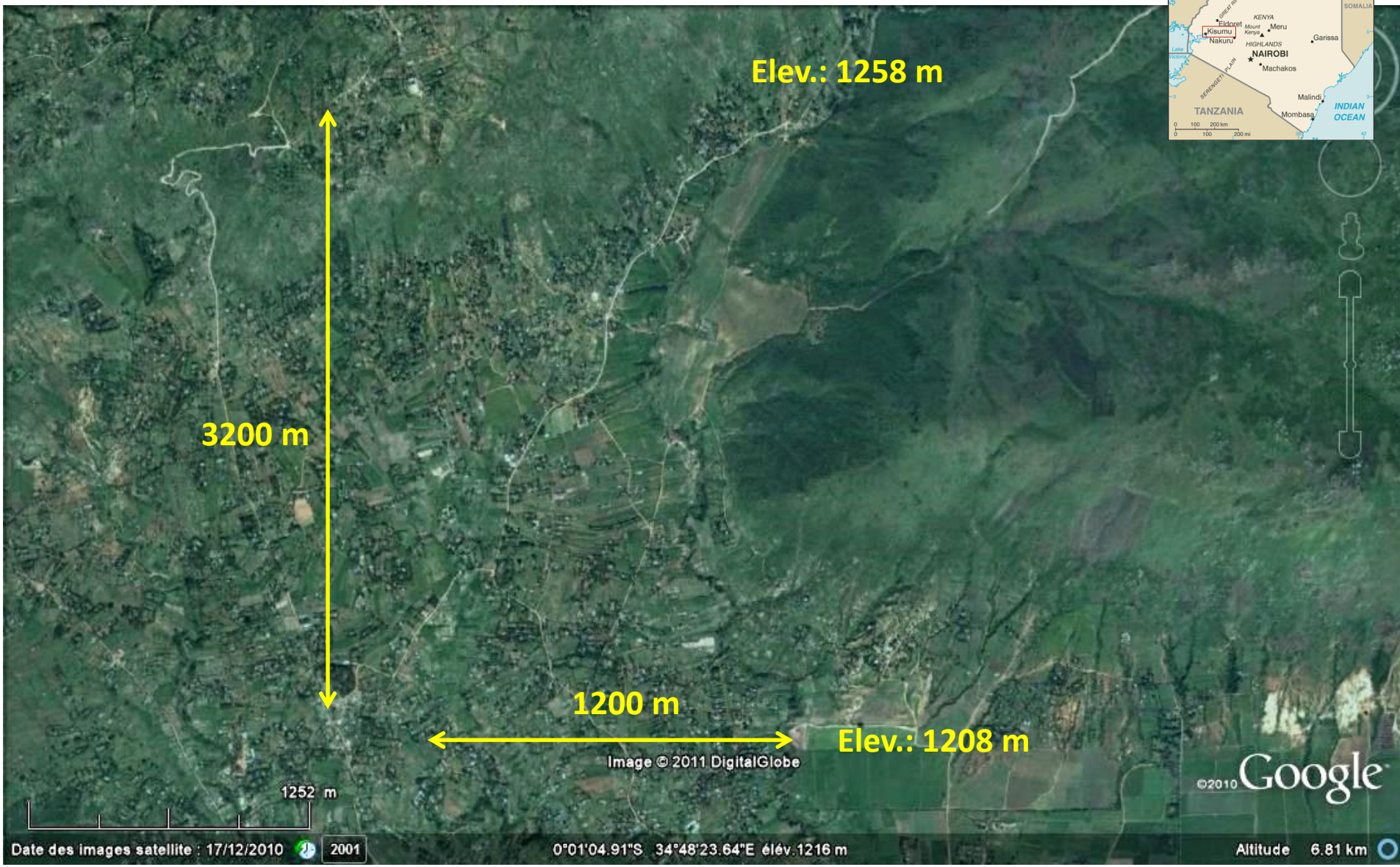


Kenya

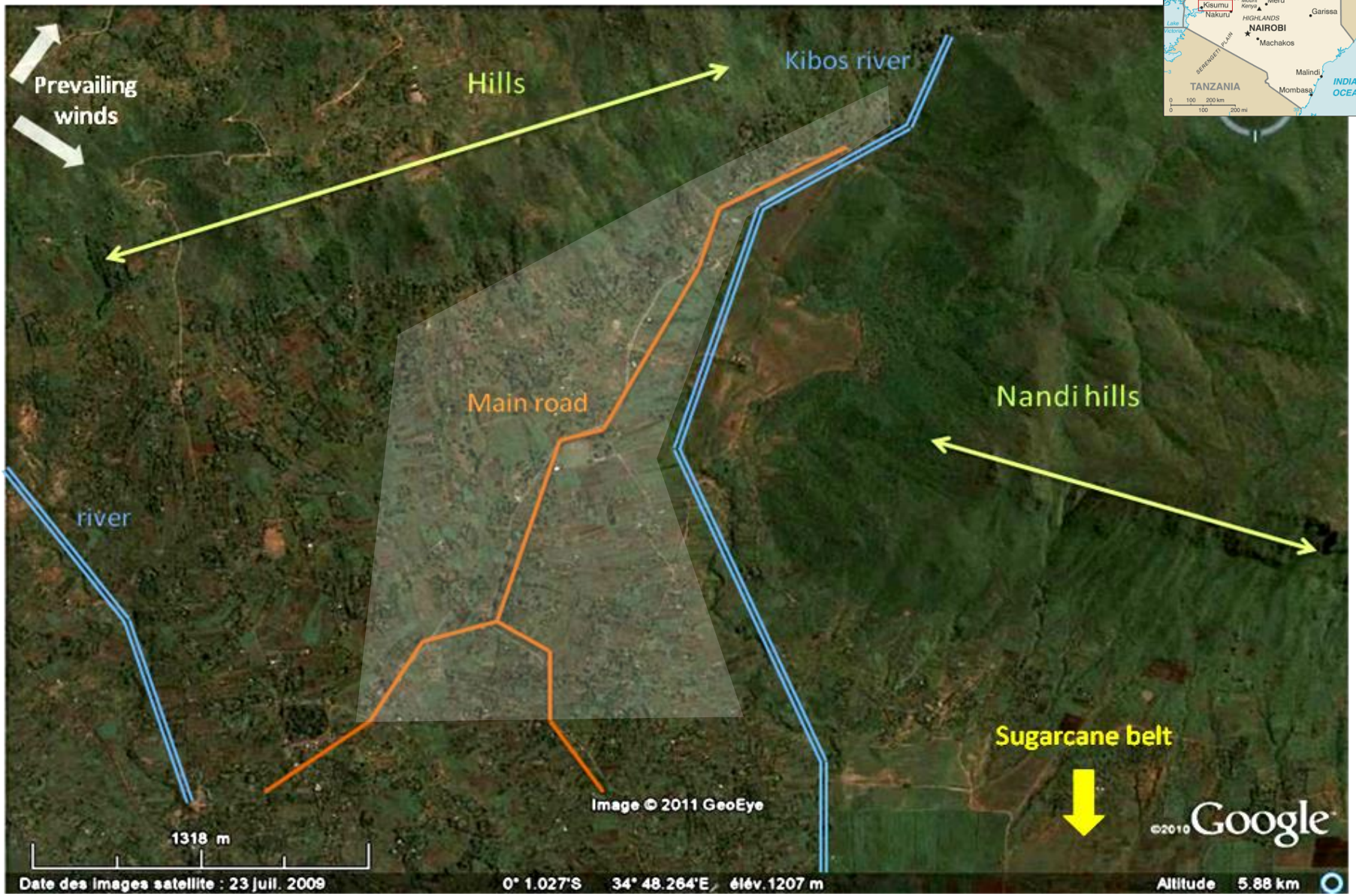

Maragoli Forest
Kisumu - Vihiga Rd
Mutet
A1
Nandi Hills
Kajulu
C 34
Kisumu - Vihiga Rd
C 34
Kibos
Kibos Rd
Plaine sucrière
Kisumu
Agglomération de Kisumu
Lac Victoria, golfe de Winam
Ring Rd
B 1
2 km
2 miles
Interaction entre les écosystèmes
©2011 Google - Données cartographiques

Kenya

Studied area



Description of the landscape



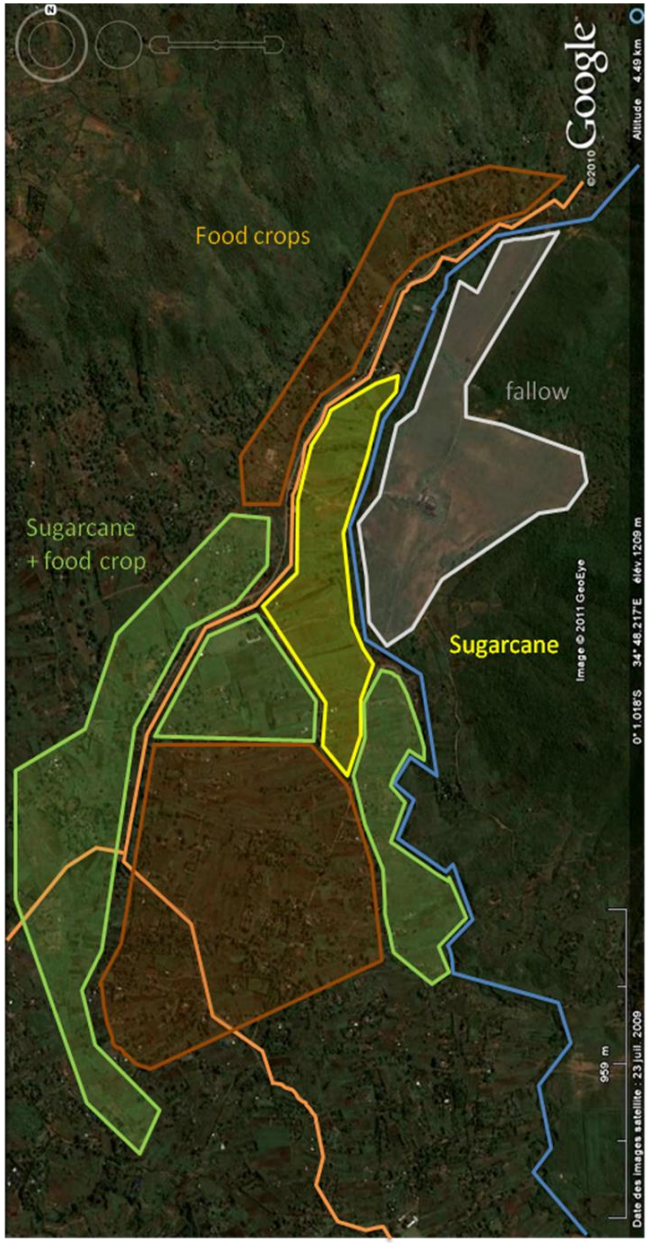
Landscape and field intercropping

Average field surface:
458 m² (64 – 1615)

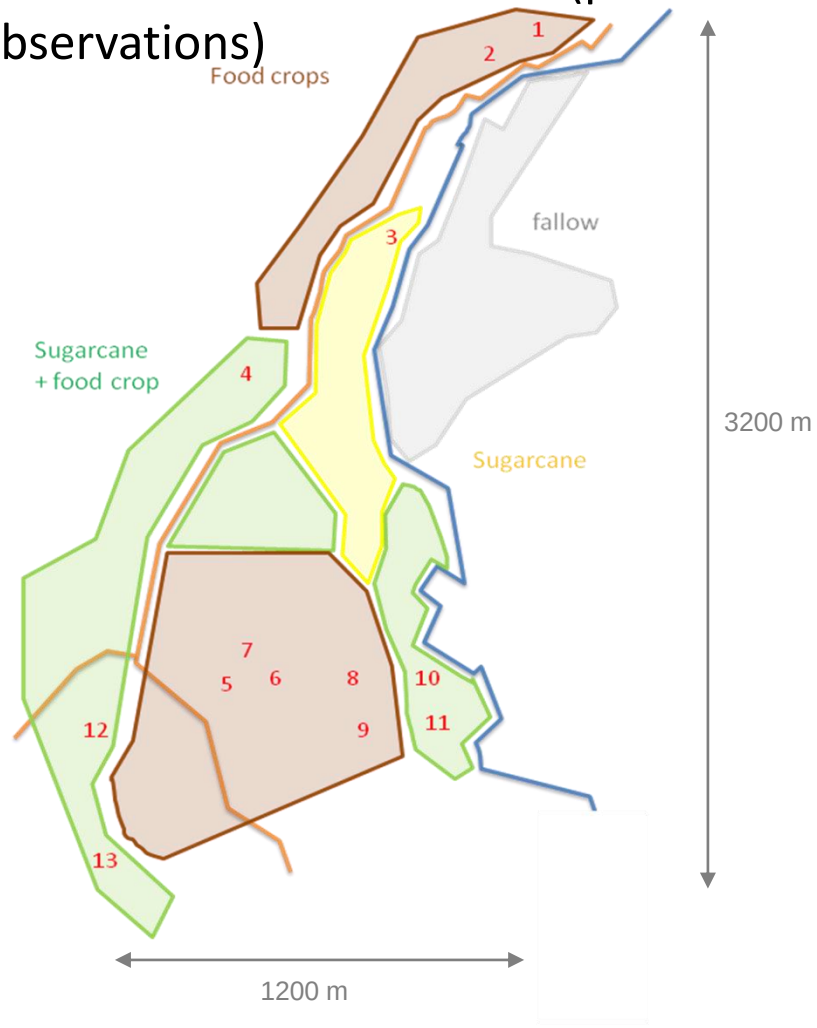
Crops = maize, cassava, beans, sorghum, peanuts

Challenge 3: mapping

Landscape and maize fields



13 Fields : regular observations
(4 weeks)
+ 14 more: one more week (ponctual observations)



Observations

CROP (maize)

- Weekly observations (4) on 13 regular fields *(+ 14, once*)
- 50 plants (10 pl. x 5 lines)/field (Overholt *et al*., 1994)
- Presence of eggs, Damage on leaves, Dead hearts, Exit holes
- Dissection of infested plants, collection of larvae or pupae
- Rearing on artificial diet (for adults or natural enemies)
- Identification of stem borers species

(Boaz Messyok, ICIPE; Bruno Le Rû, IRD)

WILD

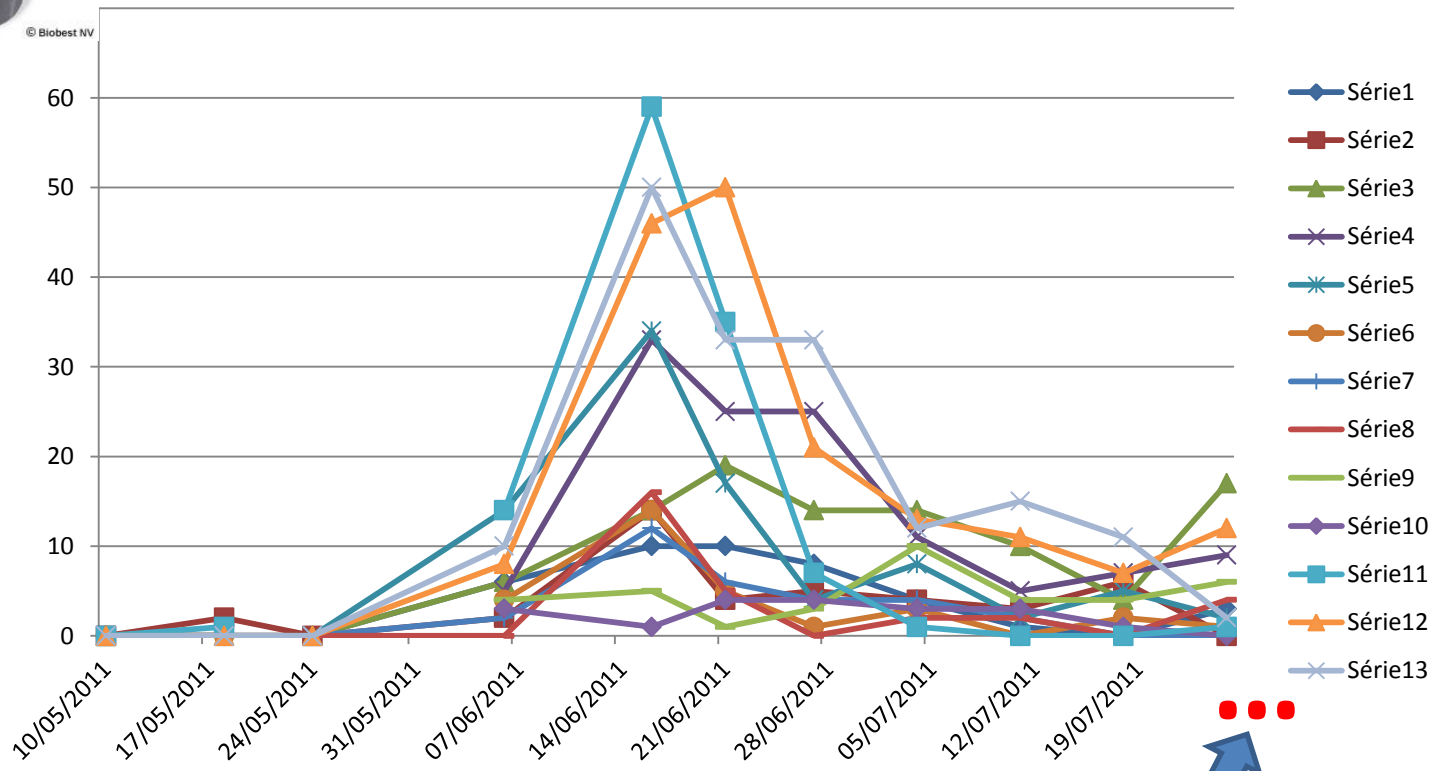
- Observations on wild grasses (B. Le Rû) (*1 day survey*)

Observations on cereals (maize)

Funnel trap
(*Busseola fusca*)

Results

Busseola fusca



Challenge: the duration of the study

Results

CROP

- Very low pressure of stem borers on the crop (0,8 attacked plant/field)
- *B. fusca* is the dominant species (52 larvae on 57 larvae and pupae reared)
  - *Chilo partellus* (2 larvae)
  - *Sesamia nonagrioides* (2 larvae) (next to a stream)
- Parasitoïdes: none
- No stem borer on Napier grass (*Pennisetum purpureum*)

WILD

- Few borers on wild grasses but no parasitoid:

  Sesamia nonagrioides, Sciomesa piscator on….

  Cyperus spp., *Brachiaria* sp., *Panicum maximum*

Challenge: the biological model (inter annual variability)

The farmers' perception

Knowledge about « kundi » (caterpillars)

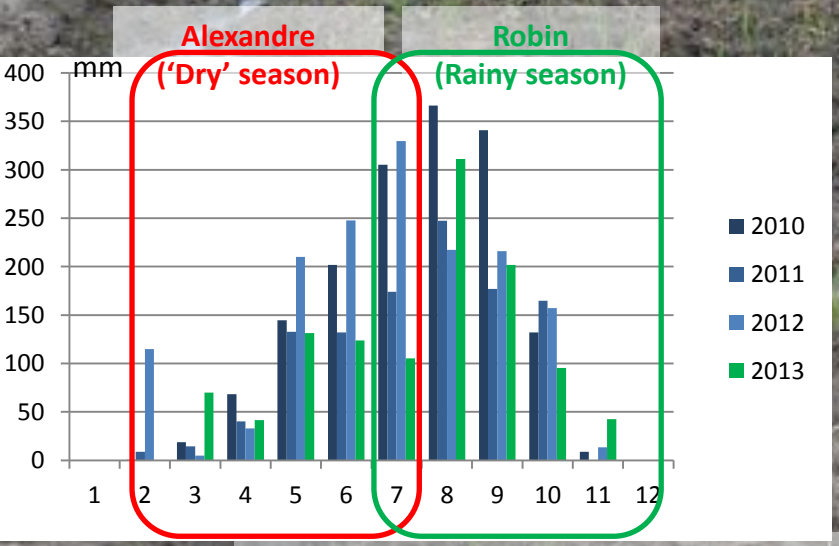
"Anyway, they are not considered as major pests unlike rodents, squirrels, baboons and birds that cause a lot of looses during sowing and before harvesting" (M. Harignordoquy, 2011 Report) .

"Push-pull strategy elaborated by ICIPE was introduced to young farmers during "farming courses" at school. Some farmers also learned about it in various seminaries.
Nevertheless, they are experiencing it for a short time, so they cannot tell if there is a changing or not in stemborers infestation on maize field."
(M. Harignordoquy, 2011 Report) .

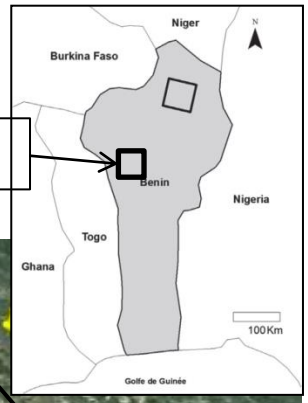
Bénin

Rainy season

Two seasons
50 inhabitants/km²
Languages : Yom, Kotokoli, Dendi



Bénin



Pélébina Village

Studied area

Elev.: 410 m

200- 700 m

Elev.: 436 m

2500 m

© 2013 Cnes/Spot Image

Google earth

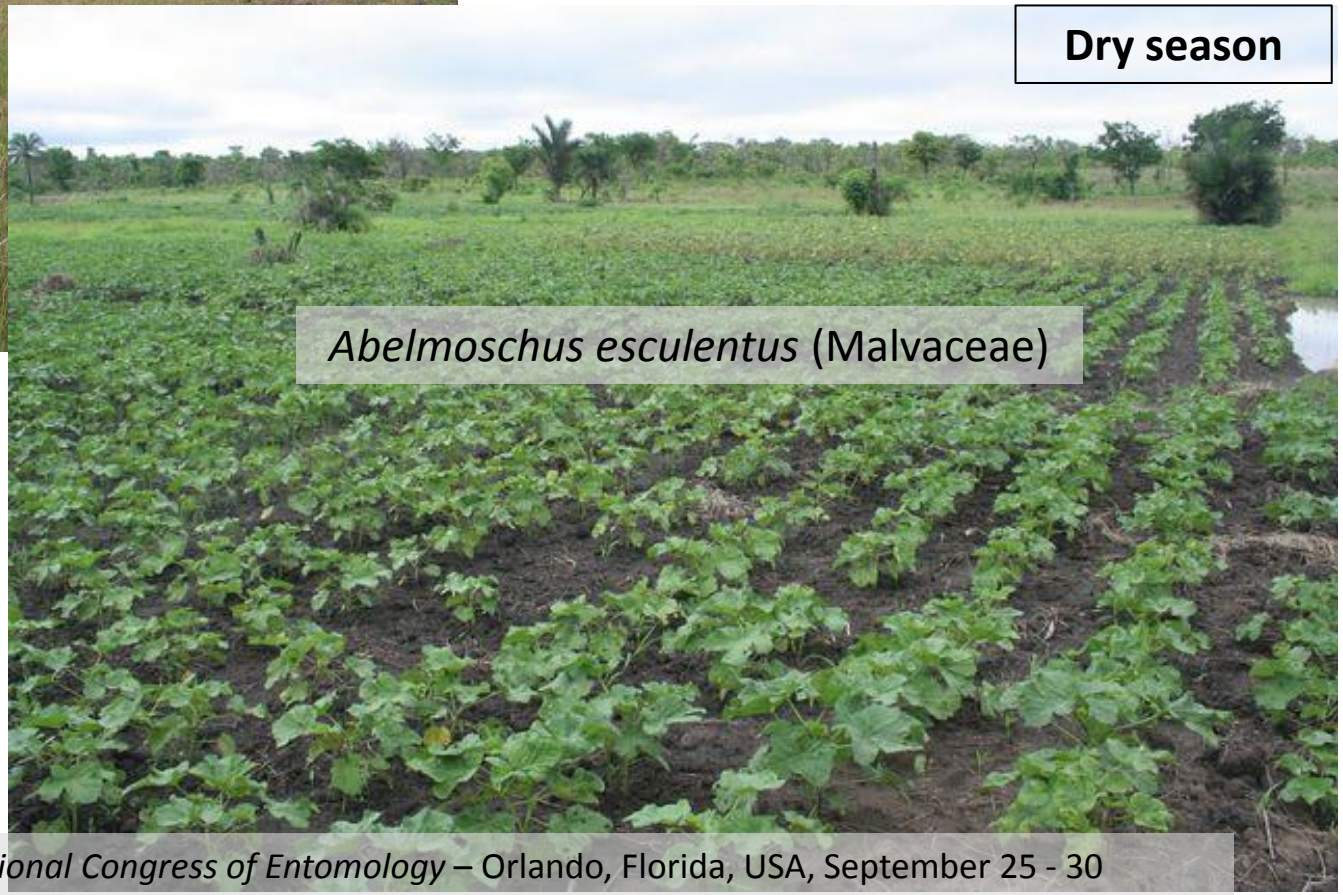
Bénin

End of rainy season

Bénin

End of rainy season

Dry season

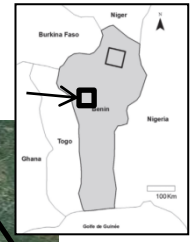


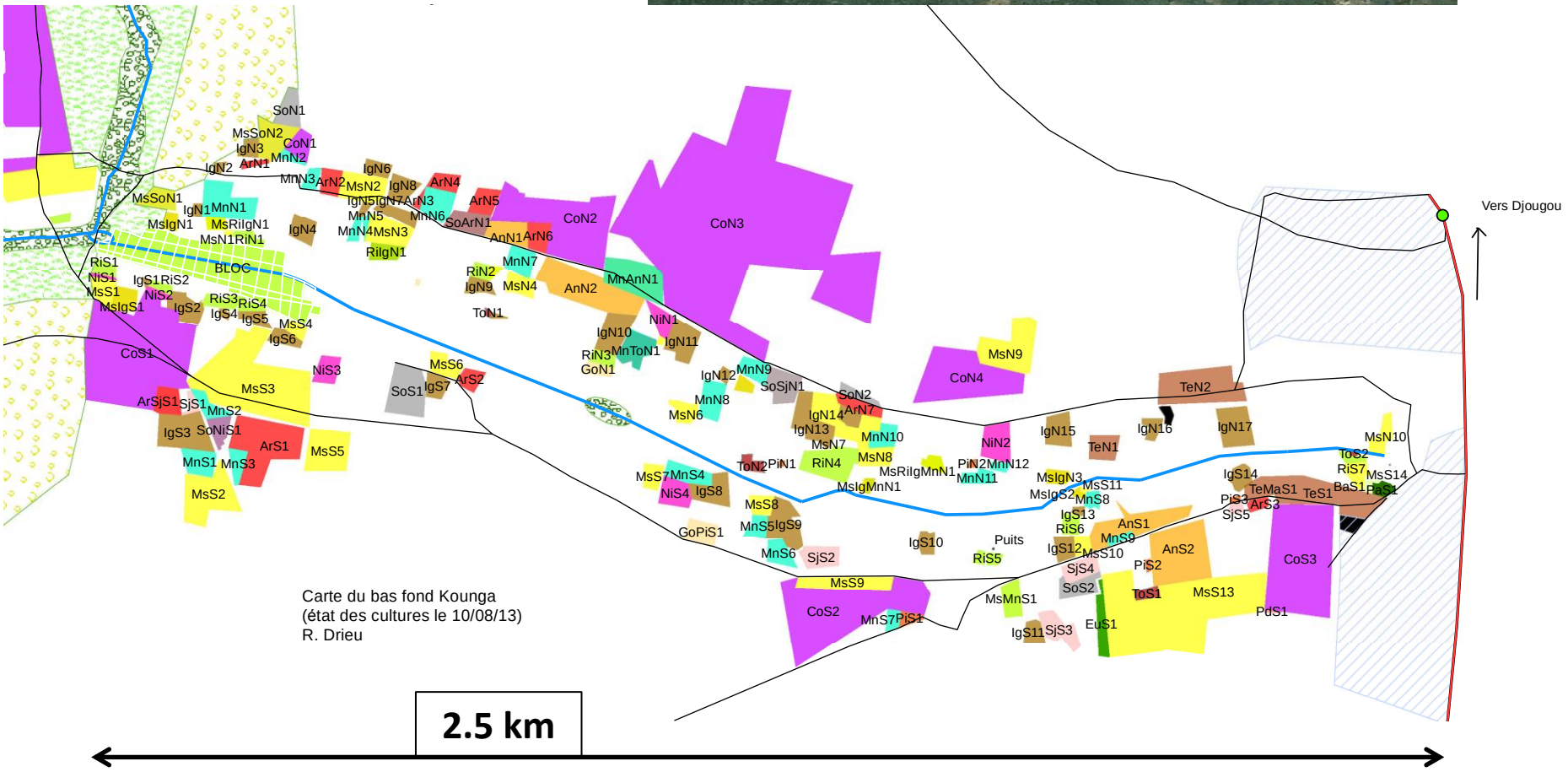
Abelmoschus esculentus (Malvaceae)

Mapping the lowland

GPS device

Software ArcGIS





Carte du bas fond Kounga
(état des cultures le 10/08/13)
R. Drieu

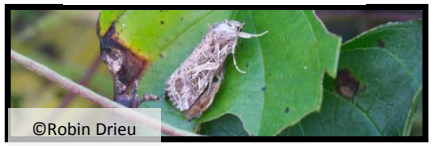
2.5 km

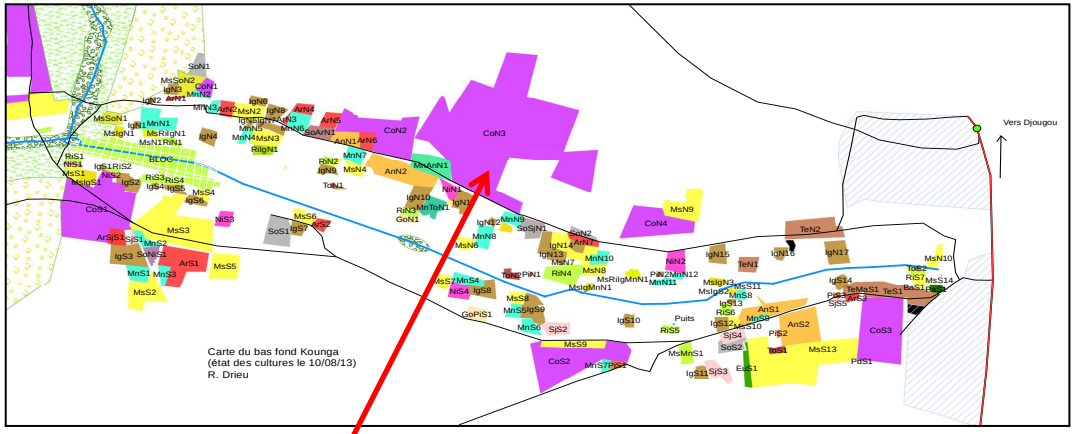
Mapping the lowland

Rainy season

August, 2013

S. littoralis



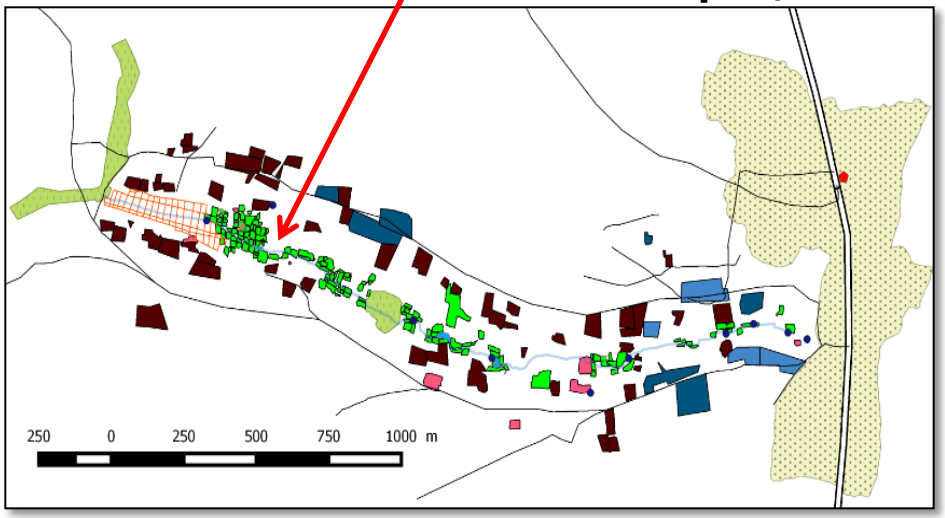


Source: R. Drieu

Dry season

H. armigera

April, 2014



Source: A. Boucher

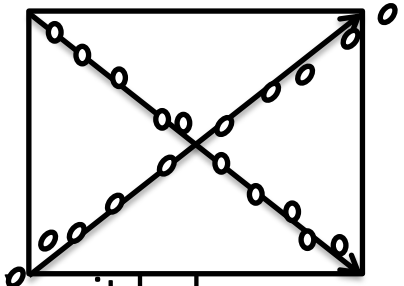
cotton

gombo

(A. esculentus)

Observations (Rainy season)

CROP (cereals: maize, sorghum, rice)



- Observation on maize fields
- 50 plants (2 x 25 plants/diagonal)/field
- Damage on leaves, stems, ears (maize, sorghum), exit holes
- Rice: 10 ‘pockets’ are observed on each diagonal
- Dead hearts and white panicles (rice)

Challenge: Impossible to destroy sane plants !

- Dissection (infested ears, dead hearts)
- Collection of larvae or pupae for…
- …Rearing on plant

Challenge: rearing in good conditions !

- Identification by taxonomists (B. Le Rû, IRD/ICIPE)

Observations (Dry season)

WILD

- Observation on wild grasses (Poaceae, Cyperaceae) (12 fallows)
- Targeted sampling (Le Rû *et al*., 2006a,b):

  50 stems/plant species (5 stems/10 sites/fallow)
- Sweeping net (20/fallow/date of observation)
- Dissection of infested ears, collection of larvae or pupae
- Rearing on plant

CROP (*A. esculentus* mainly)

- Maize: 25 young plants/diagonal (beginning next rainy season)

Results

CROP

- Maize : low pressure of stem borers
  - **Before harvest** damages observed **up to 50% for the ear (highly variable)**
  - **After harvest**, **7% of stem** are infested on average, **36% of the ears** contain a borer.
- Sorghum: High presence of *Coniesta ignefusalis (*end of rainy season)
- Rice : Presence of Diopsidae (Diptera) more than expected Lepidoptera
- Parasitoïds: one (*Xanthopimpla* sp.)

  obtained from a nymph (maize)

Results

WILD

- Few borers on wild grasses

Challenges:

- **rearing in good conditions**
- **identification of caterpillar and host plant!**

- No parasitoid in the stems but Hymenoptera pollinators
- Parasitoïds: sweeping net

Many challenges and questions

- **Sociological aspects : participation of local communities**
  - Destroying plants ?
  - Getting the farmers involved…perception of insect damages ?

- **Technical constraints for mapping:**
  - Obtaining a good satellite picture (cloudy weather)
  - Mapping small diversified plots (field margins, intercrops, trees…)

- **Technical (entomological) constraints:**
  - Bad rearing conditions
  - Lack of pheromones for important pest species
  - Taxonomical Expertise (entomological, botanical)

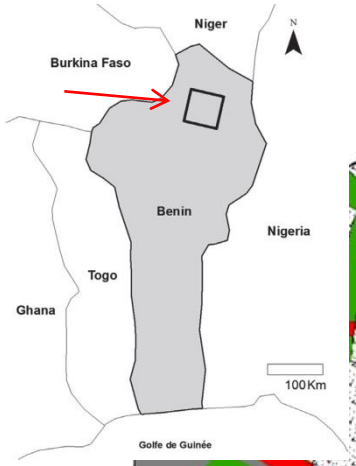
- **Methodological aspects:**
  - Duration of studies (and funding) (Bill, where are you ?)
  - Is the correlational approach a good (statistical) method ? Correlation is not causality.

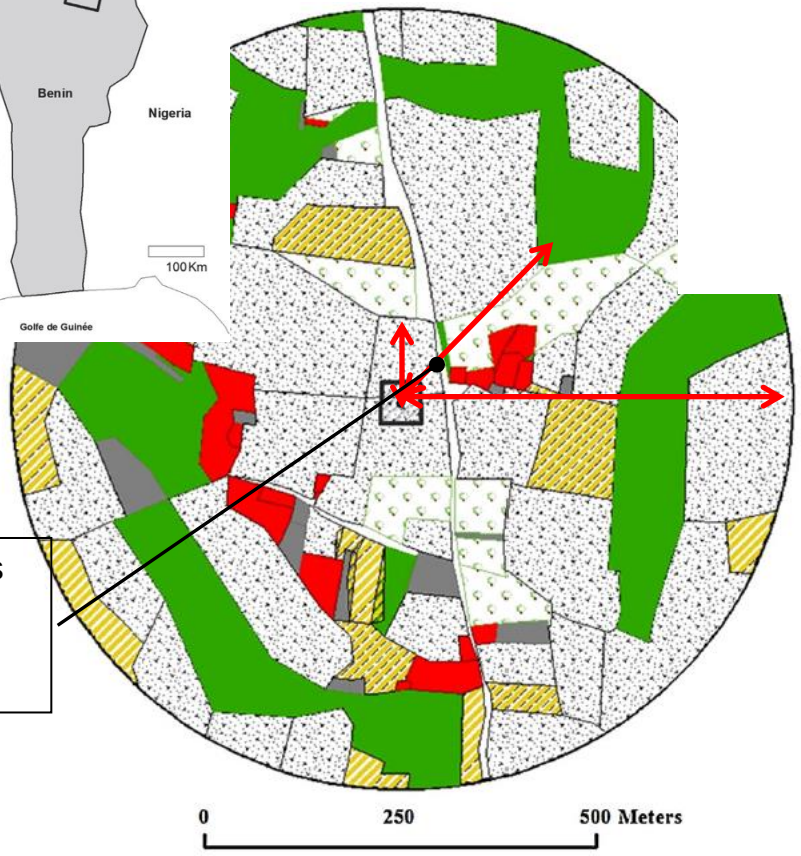
For these reasons, landscape scale pest management approach is still in its infancy in sub-Saharan Africa….

…However, some experimentation exist in Africa !

Benin (Kandi)

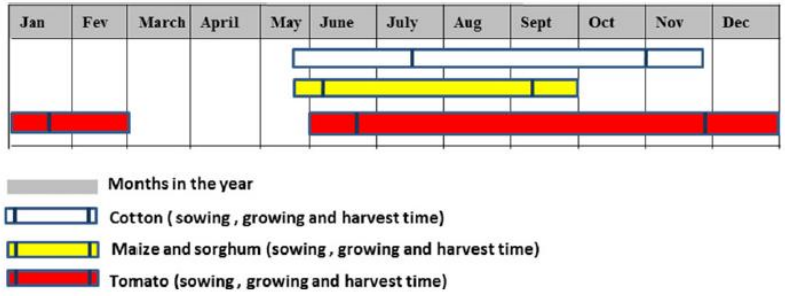
Biological model: *Helicoverpa armigera*/cotton





Radius
100 m
250 m
500 m

Cultural calendar of the four major host plants of *H. armigera* in Northern Benin



- The trapping point = Piège lumineux (18h30- 20h30)
- The selected cotton field

Land cover
- Cotton
- Maize
- NV = Végétation naturelle
- Other
- Sorghum
- Tomato

37 champs: 17 (2011) + 20 (2012)

$$H = \sum P_i \log P_i$$

Tsafack *et al.*, 2013, 2015

cirad

In this congress

Senegal

Biological model: *Heliocheilus albipunctella*/millet

D3743 Tree-crop agroforestry systems promote natural control of the millet head miner, *Heliocheilus albipunctella* **Thierry Brévault** (thierry.brevault@cirad.fr)[1,2], Ahmadou Sow[2,3], Ibrahima Thiaw[4,5], Gérard Delvare[1] and Valérie Soti[1,4], [1]CIRAD, Montpellier, France, [2]BIOPASS, Dakar, Senegal, [3]Université Cheikh Anta Diop, Dakar, Senegal, [4]Centre de Suivi Ecologique, Dakar, Senegal, [5]Université Gaston Berger, Saint Louis, Senegal

A solution for mapping ? Unmanned Aerial Vehicle (drone)

Wheat crop hit by army worms

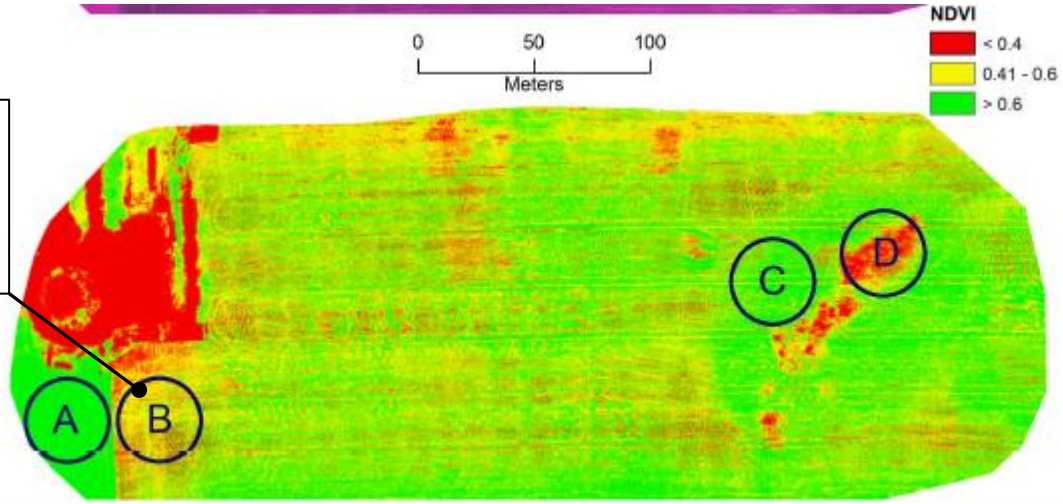


Figure 7. The top image is a mosaicked infrared color composite map (NIR, red, green-no enhancement) of a wheat field located in Verner, ON, Canada (80°5′50″E, 46°22′35″N) that was stricken by army worms and lodging taken on July 31, 2013. The bottom image is the corresponding NDVI derived map. The A indicates a healthy non-infested alfalfa field, the B indicates a section of the wheat crop hit by army worms, the C shows an area of lodging and D indicates a rock outcrop.
doi:10.1371/journal.pone.0112894.g007

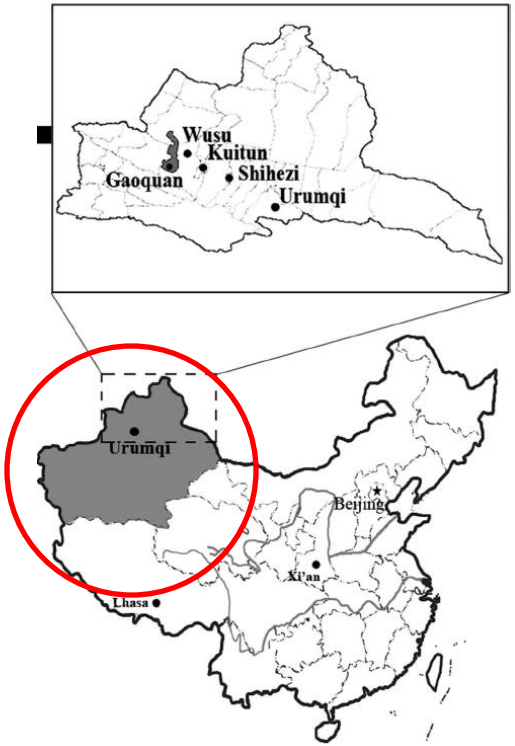
Applications of Low Altitude Remote Sensing in Agriculture upon Farmers' Requests– A Case Study in Northeastern Ontario, Canada

Chunhua Zhang[1]*, Dan Walters[2], John M. Kovacs[2]

Hope is inspired by other experimentation in the World

Biological model: *Helicoverpa armigera*/cotton

Northwestern China



Lu et Baker, 2013

Spatio-temporal dynamics of *H. armigera*

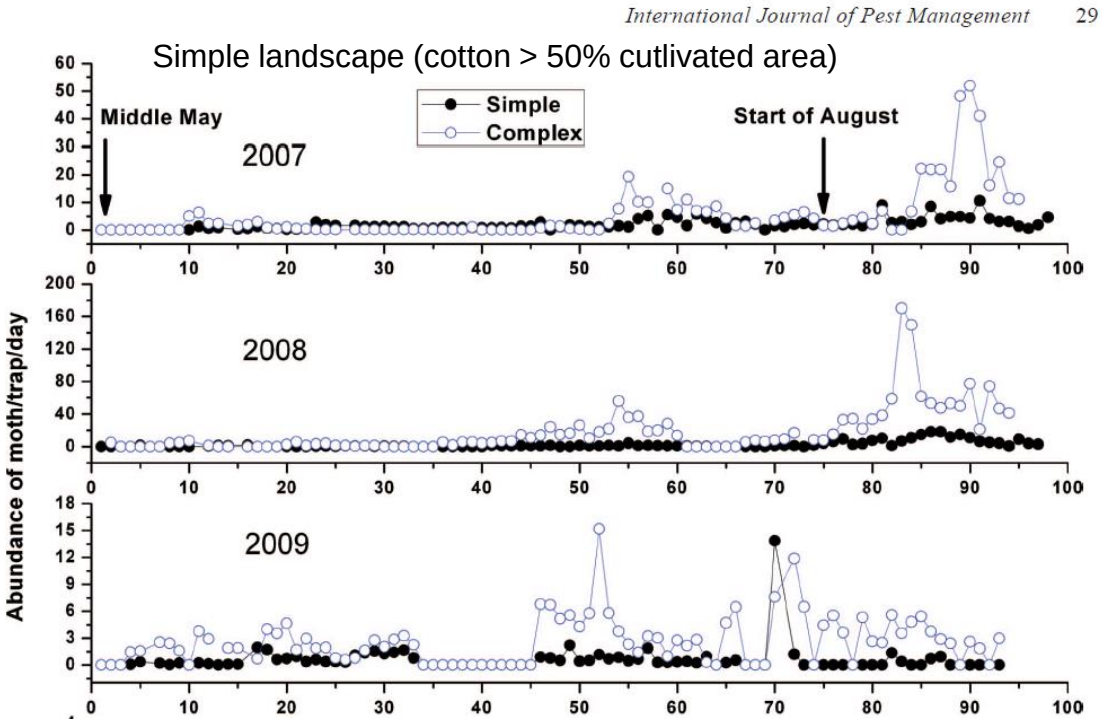


Figure 3. Average numbers of adult *Helicoverpa armigera* captured in light traps in simple and complex farming systems in northern Xinjiang in 2007, 2008, 2009 and 2010. Note different scales used for *y*-axes for individual years. Days are counted from 15 May.

Hope is inspired by other experimentation in the World

North China Plain

Biological model: *Trichogramma chilonis*/*Helicoverpa armigera*/cotton/maize

Cotton	Maize
23 localities (12 in 2012, 11 in 2013)	33 localities (2012 to 2014)
Sentinell eggs (48h in the field)	> 50 000 eggs
0-25,8% (mean: 5,6% parasitism)	0-38,8%

Liu *et a*l., 2016 a,b

Hope is inspired by other experimentation in the World

Biological model: *Aphis gossypii/N.E./*cotton

North China Plain

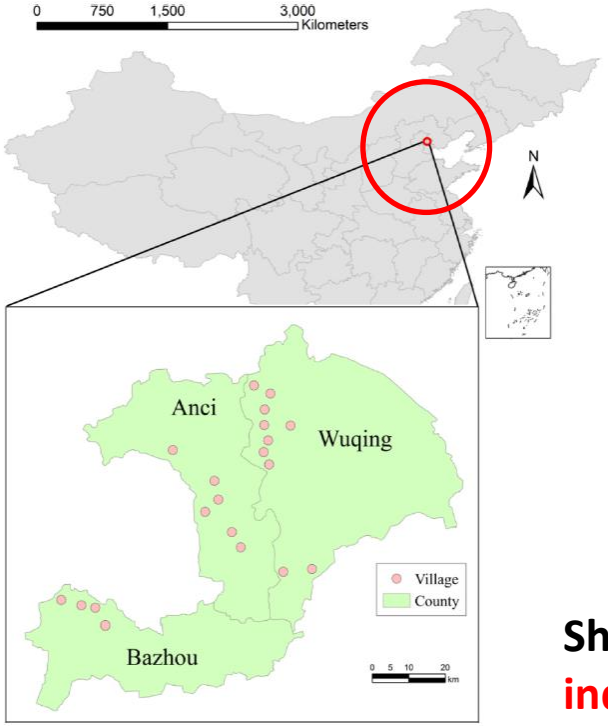
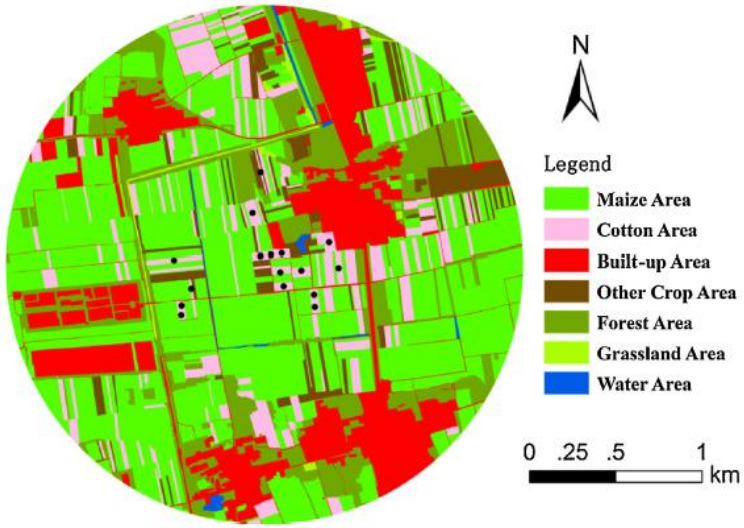


Fig. 1. Study area and the locations of the 20 villages in three counties studied.

Zhou et al., 2014

Natural enemies of cotton aphids



Shannon and Simpson diversity indices are not good indicators to explain the relationship between the land use and the density of the aphids' natural enemies.

The growers: Aknowledgements (2)

African Insect Science for Food and Health

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Discussion