No-Till Practices and Banana Cropping Systems: How Mechanization Can Contribute to a Sustainable Banana Production in the French West Indies?

Presented by Tran Quoc Hoà
CIRAD
GUADALOUPE & MARTINIQUE

- TROPICAL CLIMATE: Rainfall => from 1300 to 6000 mm, average Temperature = 28-30 °C
- Andosols, Ferrallitic soils, Vertisols...
Main exporting countries (Cavendish Banana) in 2016

- Equateur: Exported tons (20e) - Surface = 5 700 ha - Nb Producers = 380 - Exportation = 200 000 T
- Guatemala*: Exported tons (13e) - Surface = 2 040 ha - Nb Producers = 190 - Exportation = 64 000 T

Sources: Cirad

Latin America
INDUSTRIAL (Cavendish) BANANA ISSUES

**ENVIRONMENTAL**
- Decreasing soil & water pollution due to chemical inputs
- Biodiversity conservation

**SOCIETY**
- Reconciliation between Society & Agriculture
- Quality of life & food quality improvement

**PRODUCERS**
- To maintain/increase productivity and to decrease production costs in order to generate higher profits

**RESEARCH & DEVELOPMENT**
- Food security
- Better understanding of agroecological processes in order to promote sustainable agriculture & biodiversity
SUSTAINABLE BANANA PROJECT IN THE FWI

3 MAIN OBJECTIVES

- Funded by EU since 2008
- Partnership between CIRAD
  French Technical Institute
  Banana Producers Organization

- To design innovative banana cropping systems and to provide support for their dissemination in order to reduce the use of pesticides;

- To monitor and to control emerging diseases (Black Leaf Streak);

- To create resistant banana hybrids to emerging diseases.
WEEDS
DEGRADED SOILS
Herbicides
Chemical fertilizers
Loss of mineral nutrients
Fungicides
BLACK SIGATOKA
Ploughing & Chemical fertilizers
DEGRADED SOILS
Soil erosion & compaction
Conventional intensive (Cavendish) banana cultivation

Mycosphaerella fijiensis

Fusarium oxysporum f. sp. Cubense Tropical Race 4

Panama TR4

Radopholus similis

Pratylenchus coffeae

Cosmopolites sordidus

NEMATODES

WEEVIL BORER

Nematicides

WEEDS

Herbicides

Radopholus similis

Pratylenchus coffeae
Example of conventional banana cropping system & practices in the FWI

Main agronomical constraints

- Weed dissemination
- Low soil fertility improvement
- Ineffective soil sanitation

Banana (5 years) / Fallow / Banana (5 years)

Chemical and/or mechanical destruction

Spontaneous fallow (6 to 12 months)

Soil TILLAGE

Planting on bare soils

5 years

Soil fertility degradation

Weed pressure
Part 1
Cover Crops: a Key Component in the No-Till Banana Cropping Systems

Arachis pintoï + Bananas (Guadeloupe)
Multifunctionality of cover crops

Above ground

- SOIL Protection
- SOIL Organic Matter
- SOIL Structure

Below ground

- N Fixation
- Nutrients recycling
- PESTS CONTROL
- SOIL Biological Activity
- WEED CONTROL
- Nutrients recycling
Nematodes Regulation

=> 2 processes

1st - Sanitation during fallow period

- Installation of cover crops non-host of banana nematodes;
- Allelopathic effect.
Multiplication rate of nematodes (Radopholus Similis) according to species

Log du taux de multiplication

NON-Host Species

Host Species

Crotalaria sp.

Dorel et al. 2016
Producers use *Crotalaria sp.* during fallow period for the biological nematodes control
2nd - Enhancing nematodes predation

Comparison of free-living soil nematodes communities:

Bare soil vs with cover crops
Cover crops increase predators populations

=> Positive effect on biodiversity and food webs

Djigal et al. 2011
Weevil borer control

In soil litter, general predators contribute to weevil borer control:

- Ants
- Earwigs...
Cover crops increase predators abundance

*Solenopsis geminata*

Captures of ants

5 times more ants in plots with cover crops

Mollot et al. 2012
Predators increase the predation rate of weevil borer eggs

2 to 7 times more predation in plots with cover crops

Mollot et al. 2012
Weevil borer control by *Brachiaria decumbens* (Guadeloupe) + pheromone traps
Which specie is the best for banana?

Above ground

Soil protection

Soil Organic Matter

Soil structure

Soil protection

Soil Biological activity

Below ground

Weed control

N fixation

Nutrients recycling

Nematodes control
ALL OF THEM!

ADD species according to their COMPLEMENTARITY
=> Increase the functional biodiversity

Soil protection

Weed control

Soil Organic Matter

N fixation
Nutrients recycling

Soil structure

Nematodes control

Soil Biological activity

ALL OF THEM!
Brachiaria R. + Crotalaria S. during fallow period (Guadeloupe)
Crotalaria

• ORGANIC NEMATICIDE
• N Fixation
• Drainage (Tap Root System)

Brachiaria

* High vegetal biomass production (C, SOM)
* Biological ploughing
* Nutrients recycling (biological pump)
Various cover crops-based banana cropping systems in the FWI

Conventional Cropping systems
1- Natural fallow
2- Banana on bare soils

Innovative CS I
1- Natural fallow
2- Banana on bare soils
3- Banana + perennial LIVING COVER*
   * A. pintoï + Crotalaria sp.
   * D. heterocarpon + Crotalaria sp.
   * Arachis + Desmodium + Sesbania sp.
   * C. cajan + Desmodium
   * N. wightii, P. phaseoloides
   * Drymaria cordata...

Innovative CS II
1- Improved fallow*
   * Brachiaria sp. + Crotalaria sp.
   * Brachiaria sp. + C. cajan
   * Brachiaria sp. + S. guianensis
2- Banana Direct Planting on MULCH*

Innovative CS III
1- Improved fallow*
   * Annual: C. pascuorum, S. guianensis
   * Perennial: N. wightii, P. phaseoloides, A. pintoï + Crotalaria sp., D. heterocarpon + Sesbania sp....
2- Banana Direct Planting on LIVING COVER*

Innovative CS IV
1- Improved fallow*
   * Brachiara sp. + Annual legumes
2- Second perennial cover* on MULCH
   * Perennial legumes (Arachis, Desmodium...) + Annual legumes (Crotalaria, Sesbania, Cajanus, Centrosema...)
3- Banana Direct Planting on LIVING COVER*

Complexity gradient
Various cover crops-based banana cropping systems in the FWI

- Conventional CS
  - Chemical and/or mechanical destruction
  - Spontaneous fallow
  - Soil tillage

ICS II
- Improved fallow (Brachiaria sp. + Annual legumes)
- MULCH

ICS II
- Field leveling
- Soil compaction

ICS II
- Good soil fertility improvement and soil sanitation
- Soils are protected BEFORE banana plantation
- Easy to do

- After planting banana, mulch degradation leads to weed pressure increase
- Herbicides are required to control perennial grasses (Brachiaria)

Planting on bare soils

Direct Planting of Banana on MULCH
Various cover crops-based banana cropping systems in the FWI

- N supply, efficient weeds control
- Soils are protected before plantation
- Cover crops can be managed by mowing or rolling

- Biological tillage with legumes less efficient during fallow period
- Mechanization/labor required because of the cover crop management
Various cover crops-based banana cropping systems in the FWI

- Soils are permanently covered (before and after banana plantation)
- Efficient pests control (nematodes, weeds...), continuous soil fertility improvement
- High technicity and Know-How required
- Mechanization is highly required to sow and manage cover crops
Part 2: Adoption of No-Till Banana Cropping Systems
Monitoring: Adoption of No-Till Banana Cropping Systems

- **Annual surveys** (from 2012) among 570 banana producers in FWI for basic data

- **Qualitative interviews** (2017): perceptions of the advantages and limits of cover crops in banana cropping systems, constraints for adoption and dissemination, etc. => 109 interviews
Results

- Early stage of agro-ecological transition;
- Highest adoption levels are observed among largest-scale farms (access to mechanization);
- Adequate approach required in order to accompany medium and small-scale farms.

Source: UGPBAN, IT2, CIRAD
Results based on 109 interviews

**Producers’ Point of View…**

- **For the « No-Till » producers**
  
  *What are the main constraints for extension?*
  
  - Farm organization (Labor Availability, Calendar, production costs)
  - Lack of adapted equipments for cover crops management
  - Topography

- **For the “NON-Users”**
  
  *Why don’t you adopt these systems?*
  
  - Farm organization (Labor Availability, production costs...)
  - Technical issues (lack of knowledge, lack of equipment...)
  - Topography
  - No interest (not convinced, negative representation...)

Source: CIRAD, IT2
4 years ago...

LACK OF ORGANISATION...
Establishment of a “Task Force unit” dedicated to the support of the dissemination of No-Till systems.

- Organization and coordination of all the stakeholders and field operations.

⇒ Setting-up an enable environment
⇒ Technical innovations must be accompanied by organizational and institutional innovations
For being successful, adoption of such innovative systems requires a high level of integration: from the soil to the landscape, from research to private sector.
FALLOW with *Crotalaria spectabilis + Brachiaria sp.* (Guadeloupe)
FALLOW with Pigeon Pea + *Brachiaria sp.*
(Guadeloupe)
Rolling on *Crotalaria juncea* with a roller crimper before Banana planting (Martinique)
Crotalaria juncea + Desmodium ovalifolium + Bananas (Guadeloupe)
Crotalaria juncea + Desmodium ovalifolium + Bananas (Guadeloupe)
Direct seeding of Pigeon Pea on *Brachiaria sp.* + *Crotalaria sp.* residues (Guadeloupe)
Pigeon Pea + banana (Guadeloupe)
Sesbania sp. + Desmodium ovalifolium + Bananas (Martinique)
Sesbania sp. + Desmodium ovalifolium + Bananas (Martinique)
**Desmodium ovalifolium + Bananas**
(Martinique)
“Ace” buggy with mower (Martinique)
“Ace” buggy with mower (Martinique)
Management of the cover crop (*Panicum maximum* cv. Mombaça) before bananas planting (Martinique)
Bananas + *Gmelina arborea* + *Brachiaria D.* (Martinique)
Bananas + *Gmelina arborea* + *Brachiaria D.* (Martinique)

**Mowing Machine**

**Swathing Machine**
SWATHING machine for small tractor...
After 6 Weeks

Preparation of *Arachis repens* cuttings by banana producers (Guadeloupe)
Planting *Arachis repens* cuttings on brachiaria mulch with a modified vegetables planter (Martinique)
Or Kun Chroeurn!

Thank You!