



Field Trials for Assessment of Control Measures Against Cacao Pod Diseases

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Assumptions: Disease Management and Rational Pesticide Use (RPU)

- **Long term solutions**
 - breeding programme: tolerant / resistant varieties
 - search for “classical” biological control agents
- **Medium term solutions**
 - breeding programme: improved varieties
 - development of novel, stable, reliable biopesticides, and their delivery systems (5 years)
- **Short term (“cocoa price hike” scenario)**
 - re-evaluation of chemical fungicide options (2 years)
 - quality control and delivery of existing biopesticides
 - provision of resource materials on known techniques (including best cultural and spraying practices)

RPU: Practical, Safe, Economic Environmentally-sound, Solutions

- RPU is a sub-set of Integrated Pest Management (IPM). It is about maximising efficacy against the true biological target and minimising side effects;
- There are at least 3 RPU tactics:
 - * use of more specific agents (biological or chemical),
 - * spatial targeting (usually better application),
 - * improved timing of applications (with monitoring);
- Biology-based solutions (e.g. Biopesticides) are preferred, but an open-minded approach is taken to chemical agents provided they are: safe to operators, economic and have a tolerably low environmental impact;
- RPU is absolutely not about the promotion of pesticides.

Working Definition of the Term 'Biopesticide'

Used strictly for living microbial control agents (MCAs) that:

- are specific as individual products and thus confer some environmental (or marketing) advantage (in contrast to most but not all chemicals),

and
- have a limited period of activity - and usually are used with standard pesticide application techniques (unlike most classical biological control agents).

Scenarios

“Method works in the Lab
but not in the Field.”

“Recommendation works well
on the Research Station
but not in Farmers’ Fields.”

“On-farm Research showed
that the technique was effective
but when the Project ended,
the method was abandoned.”



Comparison of Research Station Trials (“Scientific”) and On-farm Trials (“Participatory”)

- We assume that true on-farm trials are participatory by definition.
- Industry-style (demonstration) trials are not presented here.

Scientific Versus Participatory Trials

- Scope → when to use which (trial) ?
- Objectives → what can be achieved ?
- Design → how to get started ?
- Management → how to run them ?
- Risk → what is acceptable ?
- Cost → what (not) to budget ?
- Impact → what's in it for stake-holders ?

Scope

Scientific

Participatory

Farmer

knows

doesn't know

knows

doesn't know

Scientist

knows

doesn't know

⇒ **Scientific trials have wider scope than participatory ones.**

Objectives

Scientific

- Hypothesis testing
- Gain scientific knowledge
- Testing novel methods that may need further development
- Understand interactions, whether method works or not
- **mechanistic understanding**

Participatory

- Hypothesis testing
- Explore practical options
- Training
- Development
- Find functional solution, whether mechanism understood or not
- **functional understanding**

⇒ **Participatory trials have wider objectives than scientific ones.**

Trial Design

Scientific

Participatory

Design

- May be complex, e.g. Factorial

- Simple, e.g. randomised blocks or split plot

Controls

- Always with controls: untreated (e.g. water) may include positive (inoculated plots)

- Usually absolute, **never** positive often includes standard (known methods)

Edge Effects

- Undesired Use of “net plots”

- Desired because more realistic

Uniformity

- High

- Low

Replication

- Variable

- High

Management & Risk

Scientific

- By scientist(s): small team may be sufficient.
- Better access to previous scientific work
- Vertical communication.
- Risk can be (and often is) taken.

Participatory

- By farmer, rural developer, extensionist & scientist.
- Multidisciplinary team required.
- Horizontal, mutual communication.
- Risk avoidance is priority: farm produces family livelihood.

Scientific Field Trials: Requisites for Rigorous Evaluation

- High incidence of key target disease (artificially enhanced if necessary, but preferably not)
- Uniform stand of trees in discrete 2-3 ha. Blocks
- Good infrastructure (technical & administrative) with political stability
- Adequate funding

Example 1: a “Scientific” Trial

Mycofungicide Field Trial CATIE, La Lola, Costa Rica, 2000-01

Objective

To investigate delivery factors that may influence the effectiveness of agents to control frosty pod (*Moniliophthora roreri*) and other cacao pod pathogens.

Design

Factorial, completely randomised plots

Trial Factors

- 4 agents:
 - chemical standard: copper hydroxide @ 1.5 kg. a.i. / ha
 - *Clonostachys rosea* isolate 23 @ 1.7×10^{12} conidia / ha
 - *Clonostachys rosea* cocktail (5 isolates): same total rate
 - control (water only)
 - 2 Spraying techniques:
 - side-lever knapsack D2- 45 narrow cone nozzle
 - VLV Motorised Mistblower fitted with 'Micronex'
 - 2 formulations:
 - suspensions only
 - with adjuvant emulsifiable oil (2 l/ha 'Codacide')
 - 2 replicates
- TOTAL: 32 plots**

(10 applications: June 2000 - March 2001)

Application Techniques (examples)

- Directional hollow cone with pressure regulator
 - * how should it be used correctly?
 - * is it really reliable (even with minimal training) ?



- Mistblower fitted with rotary nozzle
 - * do improved yields warrant the (substantial) extra money?
 - * how much spray hits the true biological target?



⇒ **These issues should be resolved before expending farmers' time and resources**

Plot Lay-out: Managing Cross Contamination and “Edge Effects”

X	X	X	X	X	X	X	X	X	X	X	X	X	Plot size: 576 m ²	
X	X	X	X	X	X	X	X	X	X	X	X	X	(0.0576 ha)	
S	S	X	X	S	S	S	S	S	S	X	X	S	S	(1111 trees/ha)
A	S	X	X	S	A	A	A	A	S	X	X	S	A	
A	S	X	X	S	A	A	A	A	S	X	X	S	A	
A	S	X	X	S	A	A	A	A	S	X	X	S	A	
A	S	X	X	S	A	A	A	A	S	X	X	S	A	
S	S	X	X	S	S	S	S	S	S	X	X	S	S	
X	X	X	X	X	X	X	X	X	X	X	X	X	X	
X	X	X	X	X	X	X	X	X	X	X	X	X	X	
S	S	X	X	S	S	S	S	S	S	X	X	S	S	
A	S	X	X	S	A	A	A	A	S	X	X	S	A	

- 4 x 4 tree assessment zone (A)
- surrounded by 1 row of trees: sprayed but not assessed (S)
- surrounded by 1 row of unsprayed (guard) trees (X)

Participatory Field Trials

- Management by multi-disciplinary team
 - Participating farmers and their Cooperatives
 - Rural Developer (e.g. socio-economist)
 - Extensionist: native speaker
 - Scientist
- Hypotheses of common interest
 - Agents reduce losses from disease and increase yields
 - Agents perform effectively against a range of diseases and under variable environmental conditions (sites and seasons).

Example 2: Participatory Biocontrol Field Trials

Bocas del Toro, Panama, 2000-01

Objective

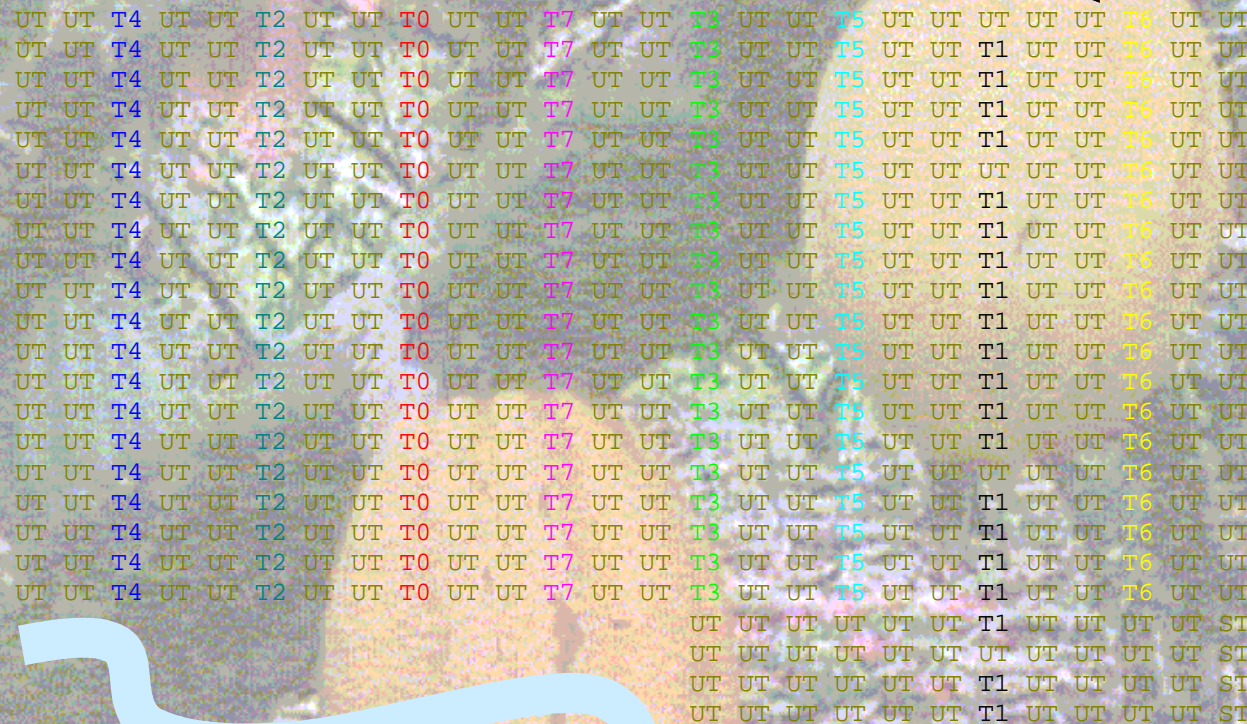
**To identify promising antagonist mixtures
for simultaneous biocontrol of moniliasis
and black pod (*Phytophthora* spp.).**

Design

Randomised blocks (RBD)

Participatory Trial Layout

Farm 1



Edge effects deliberately allowed.

Direction of slope

Adjustment for missing trees in T1

UT...Untreated

To...Control

T1 - T7...Antagonist treatments

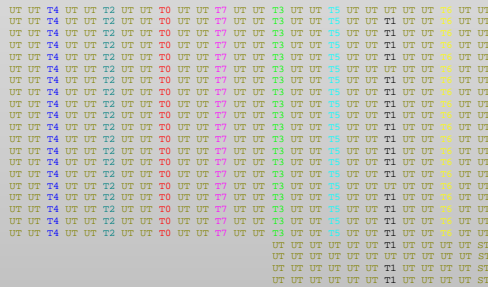
Stream at bottom of field

Participatory Trial Design

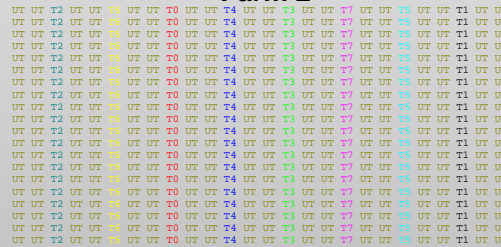
- Design
 - Comparison of antagonists with an absolute control: weekly removal of infected pods.
 - ⇒ Encourages farmer to practice diligent cultural control.
 - Experimental unit: 20 trees in rows, separated by two untreated rows.
 - Seven treatments plus absolute control.
- Edge Effects and Uniformity
 - Edge effects are smallholder reality and thus included.
 - Moderate uniformity within field: gradient (e.g. slope, proximity to stream and high humidity pocket) perpendicular to treatments for equal exposure.
 - Large variation between different fields.

Lay-out of Sites

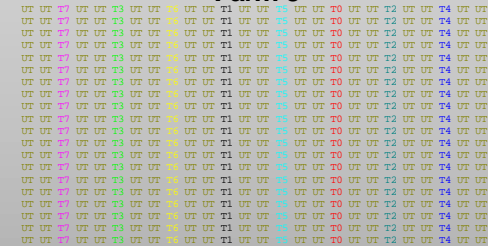
Farm 1



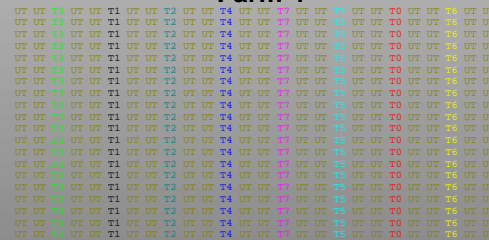
Farm 2



Farm 3



Farm 4



Strategic locations in territories of Kuna, Ngöbe-Bugle and Teribe Indians

The Participatory Approach



**Mixing of
biocontrol
agents: a group
learning
experience**



Farmer to farmer training



Trial Evaluation

Data Recording

- Data are recorded weekly by experienced field personnel:
 - * **CONSISTENCY IS CRUCIAL**
 - technical assistants in scientific trials,
 - extensionist and farmer in participatory trials.

- The following data are recorded per experimental unit, i.e. 16 and 20 trees, respectively:
 - * number of moniliasis-infected pods (M); these are distinguished into symptoms and signs (sporulation)
 - * number of *Phytophthora*-infected pods (P)
 - * healthy, mature pods harvested (H)

Statistical Analysis

Your trials can only be as good as your statistical analysis and interpretation of results.

Calculations

- Total number of pods $T = M + P + H$
- Moniliasis incidence: $= M / T \times 100\%$
- Black pod incidence: $= P / T \times 100\%$
- Percentage healthy pods: $= H / T \times 100\%$

Note: Percentages tend to follow the binomial distribution, counts the Poisson distribution. Therefore, you have to perform a test of normality and probably transform your data prior to analysis of variance.

Analysis of Variance

(Normally Distributed or Transformed Data)

Factorial (Example 1)

<u>Source of Variation</u>	<u>SS</u>	<u>df</u>	<u>MS</u>
Agent		3	
Sprayer		1	
Formulation		1	
Agent * Sprayer		3	
Agent * Formulation		3	
Sprayer * Formulation		1	
Agent * Sprayer * Formulation		3	
Error		16	
Total		31	

Randomised Block Design (Example 2)

<u>Source of Variation</u>	<u>SS</u>	<u>df</u>	<u>MS</u>
Treatment		7	
Farm		3	
Error		21	
Total		31	

Implementation & Training

Scientific

- Not an integral part of approach
- Feedback rarely takes place
- Usually done by third party (if any)

Participatory

- Mutual exchange of experiences; learning by doing.
- Feedback and adaptive research part of process.
- Integral part by consequence, but participatory research is Research, not Technology Transfer.

Inferences for Implementation

- ⇒ Low adoption rates common, BUT often designed to investigate truly novel (high risk) approaches
- ⇒ Second-hand information from top-down approach

- ⇒ Entire team discovers practical solutions
- ⇒ Automatic implementation

Priorities and Conclusions

- √ Continuing need for “lab to field” development of MCAs and application techniques for all agents,
- √ Need to identify the most efficacious chemical and biological fungicides in order to:
 - provide “stop gap” control measures
 - act as “standards” for future MCA trials
- √ Contrast between participatory and “scientific” objectives (and therefore methods): both have their place in promoting improved disease control.