# Transferring mycopesticides from the laboratory into the field: the importance of “enabling technologies”

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# Why biopesticides? (US EPA view)

Agents are:

- usually inherently **less toxic** than conventional chemical pesticides,
- relatively **specific**,
- decompose quickly, **avoiding pollution,**
- [compatible with] **IPM programmes …**

- “To use biopesticides effectively … users need to know a great deal about managing pests”.

http://www.epa.gov/pesticides/biopesticides/whatarebiopesticides.htm

# Mycopesticides: from laboratory to field…

Photo courtesy
Fizrul Indra

*"We achieved a high mortality with pathogen X in the laboratory …*

*… but when we tried it in the field, results were disappointing".*

LUBILOSA

# The concept …

**Entomopathogen**

*Metarhizium anisopliae* var. *acridum* (isolate IMI 330189)

**Formulation**

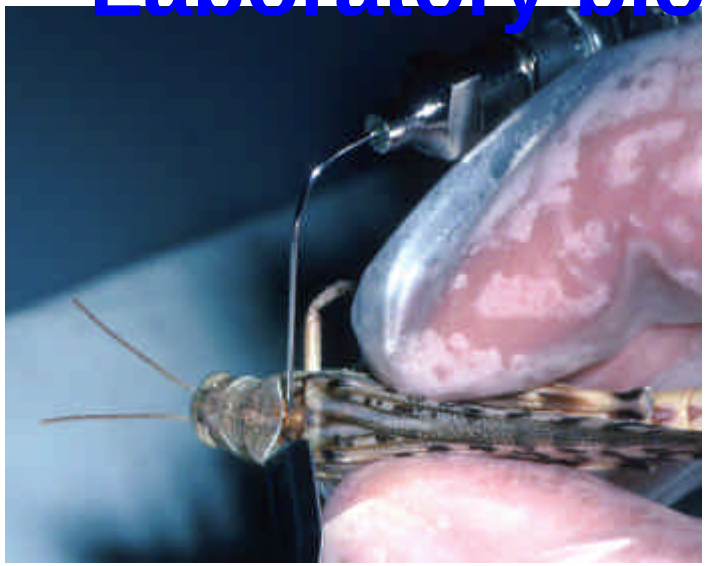
oil-based suspensions of aerial conidia

**Usual method of application**

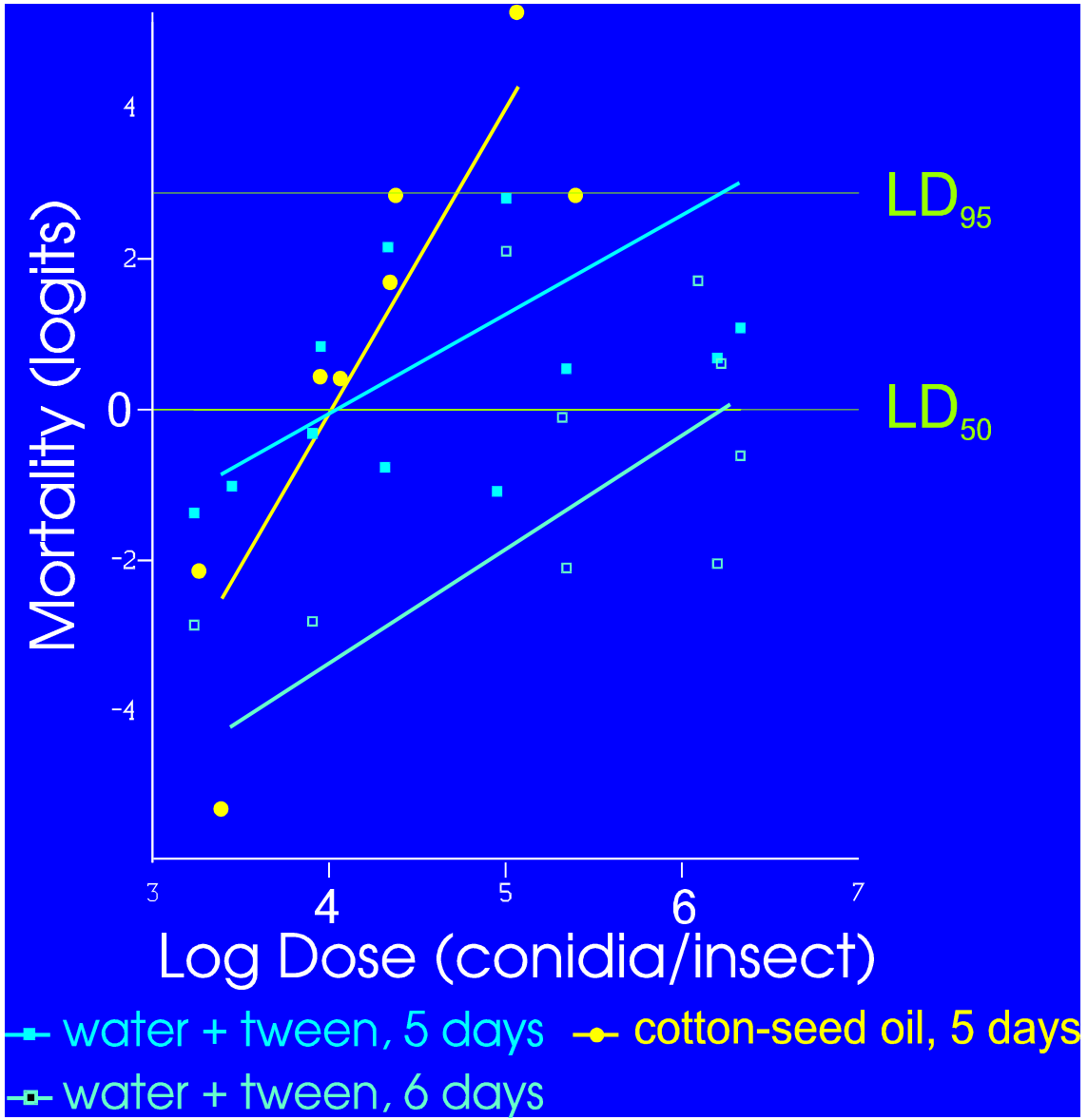
ultra-low volume (ULV)

* LUtte BIologique contre les LOcustes et les SAuteriaux

# Laboratory bioassay



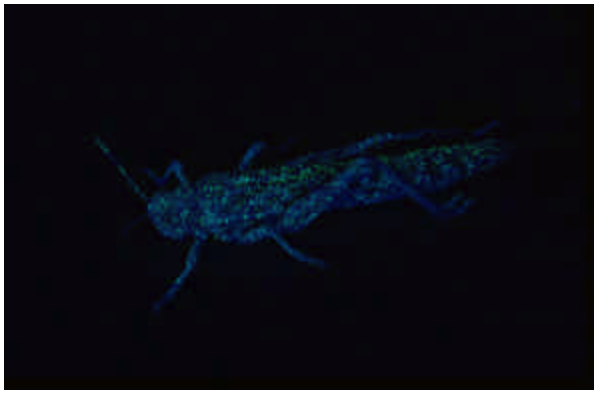
*Schistocerca gregaria* adults topically treated with two formulations of *Metarhizium* (isolate IMI 330189) 30°C, 35% RH



# Laboratory to field …

Investigating modes of action

- Direct contact
- **Secondary pick-up**
- Secondary cycling (horizontal transmission)



# ‘Green muscle’: application tests

Laboratory to field:
use of large (9 x 3 x 3 m) cages to determine efficacy and dose transfer mechanism

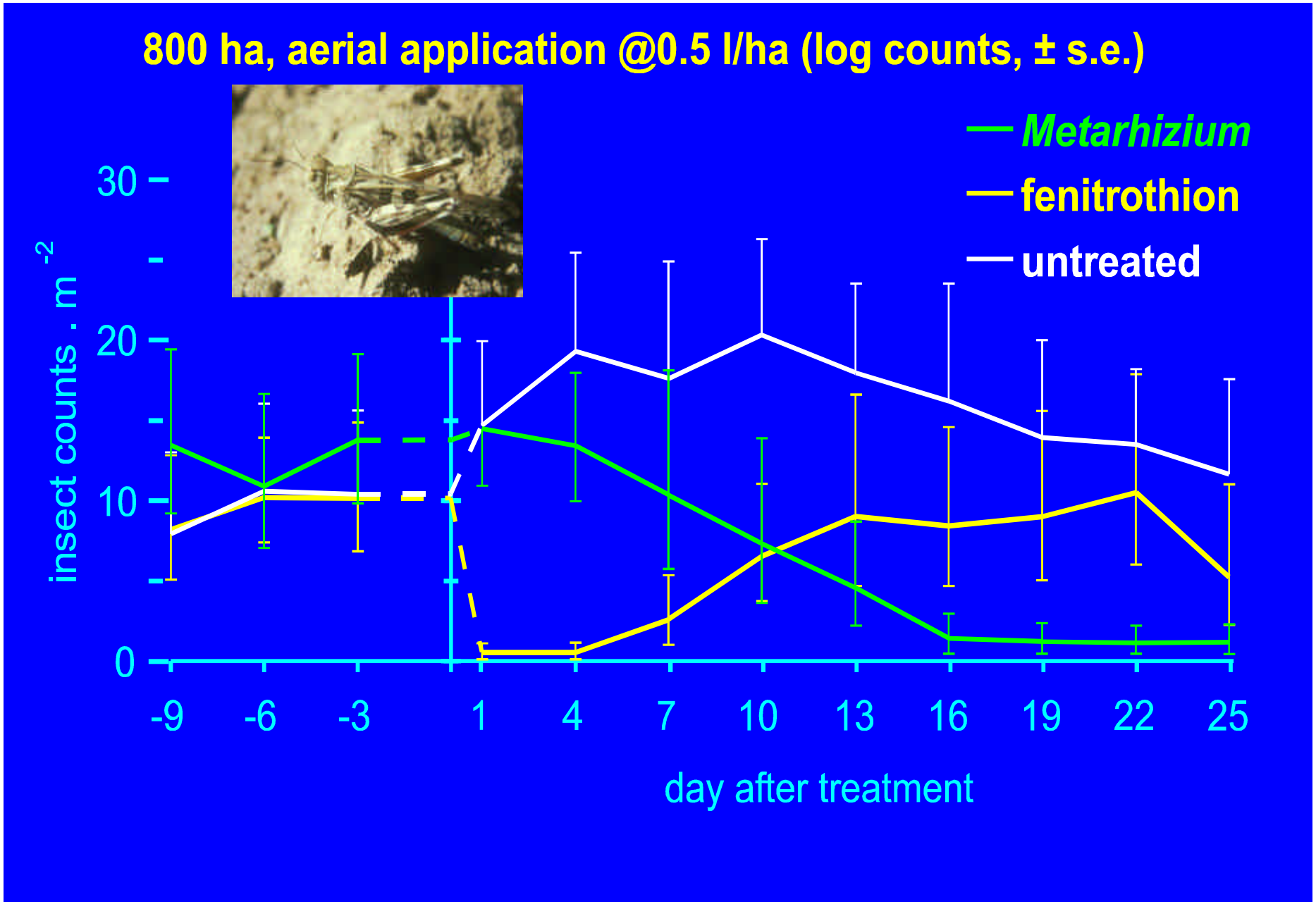
‘Ulvamast’

E.N.S.

# Aerial application

Oil-miscible flowable Concentrate (OF) poured into aircraft tank

# Field trial: *Oedaleus senegalensis*, Niger



# After 15 years of LUBILOSA …*

… and £10.2 M (€ 15 M) …

what have we really learned about developing new mycopesticides?

… a personal view …

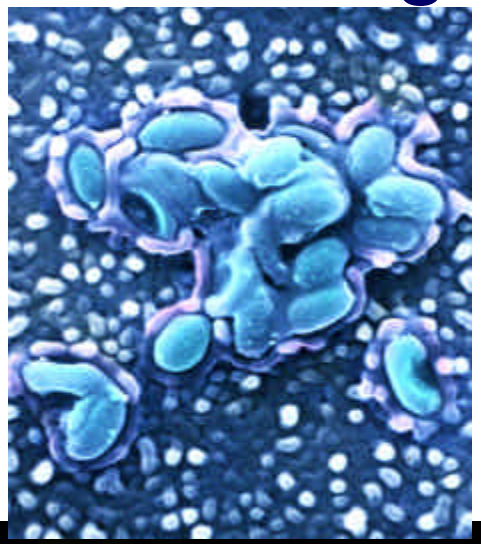
* sponsored by: CIDA, DfID, DGIS, SDC, USAID
implemented by: CABI, CILSS, GTZ, IITA, IPARC

www.lubilosa.org

# 1. The importance of working with appropriate isolates

*Metarhizium anisopliae* var. *acridum* (genus re-classified)

# 2. The importance of developing appropriate technologies



# 3. The importance of product development:

- (socio) economics
- registration, marketing, stewardship

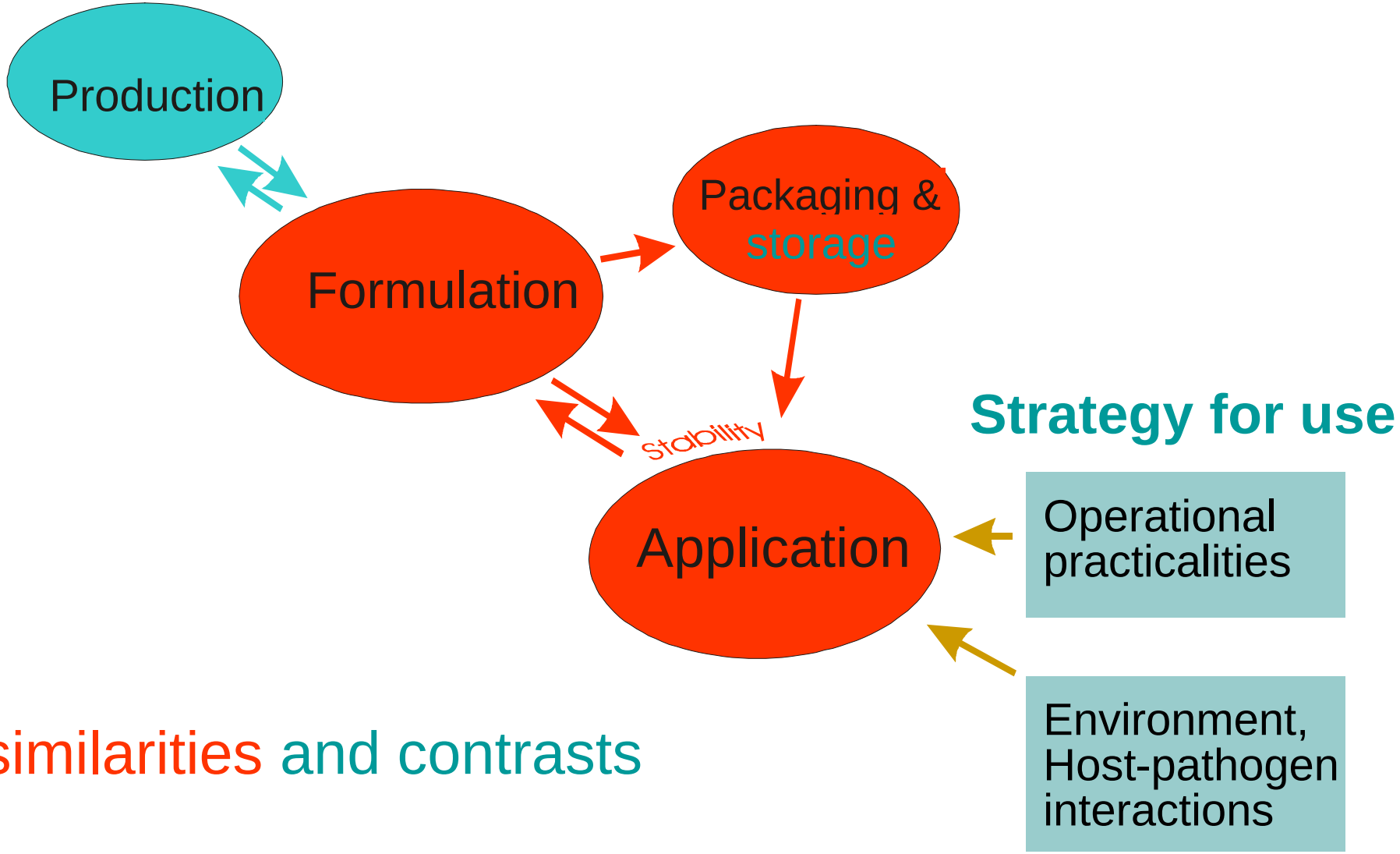

- Biopesticides are (or should be) specific (low impact on natural enemies and environment)
- Typically small (niche) markets
- Typically developed by small-medium sized enterprises (not agrochemical majors)
- Registration package - the most valuable asset?

# Enabling technologies …

## … in the public domain (P)

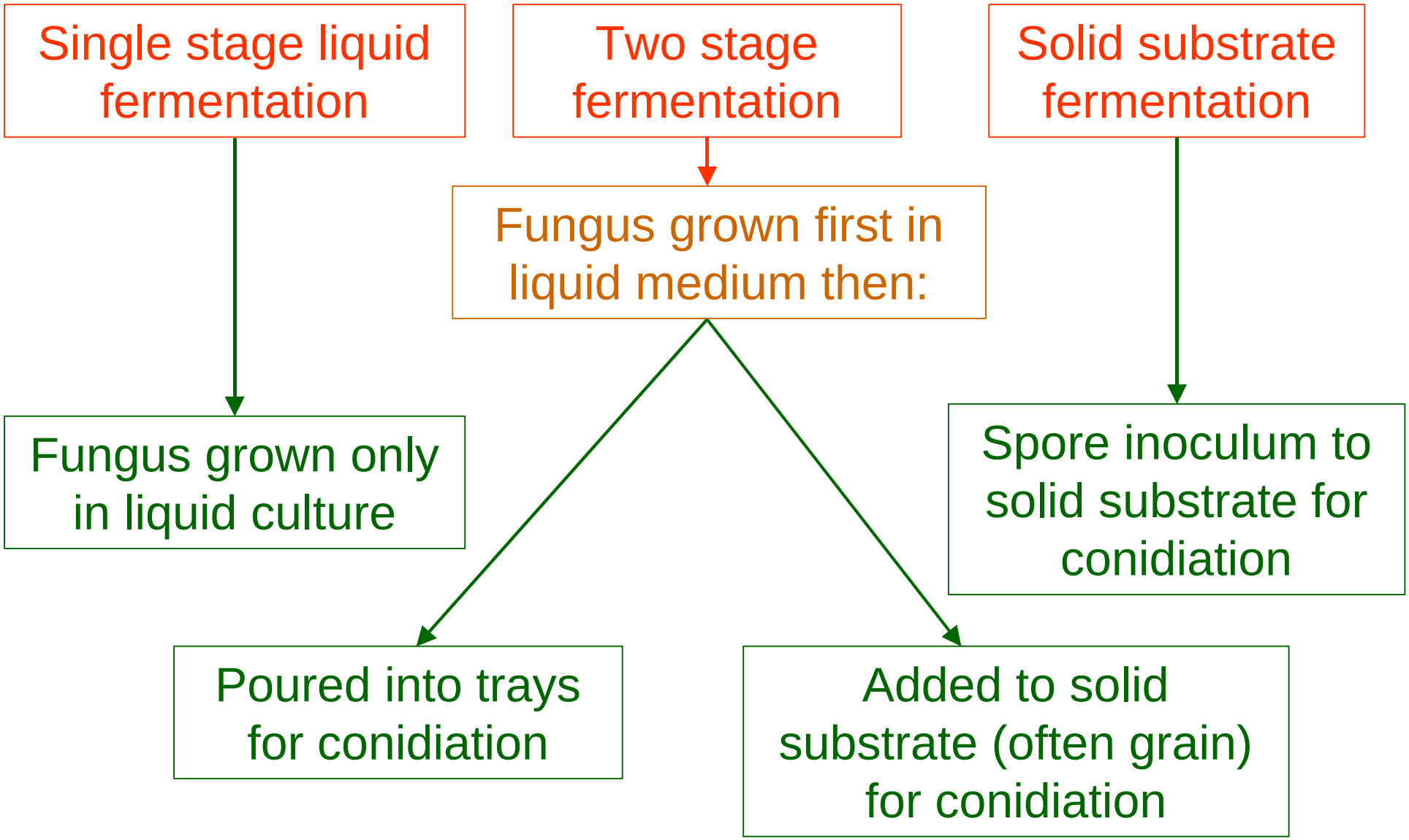
| | |
|---|---|
| Identification of virulent fungal isolates | ➢ P |
| Mass production systems: | |
| pilot | ➢ P |
| commercial | ➢ X |
| Spore separation and packaging | ➢ P |
| Storage techniques and models | ➢ P |
| Formulations (oil-based) | ➢ (partial) |
| Application methods | ➢ P |
| Field testing techniques | ➢ P |
| Registration and licensing | ➢ X ! |

# Parallels with chemical pesticide development




similarities and contrasts

# Mass production options



# A commercial system
## (Sylvan Industrial SSF)

Double cone blender

Mixing inoculum

# Production options

- **Capital intensive** production systems
  - Require high degree of engineering
  - Expensive to set up
  - Can be cost effective, but require large market/product range

- **Labour intensive** production systems
  - Can produce high quality products
  - Relatively cheap to set up
  - Good for small markets
  - **Ideal for product development**

# ‘Green muscle’: early development

Coarse (300 ìm) sieving of substrate

# Early large scale ULV trials (E. Niger)

Application: the lower the volume rate, the greater the importance of quality

# The ‘MycoHarvester’ a “spin off”



ACIS

www.mycoharvester.info

2 stage process time consuming, expensive but …

# Aerial conidia are robust and effective

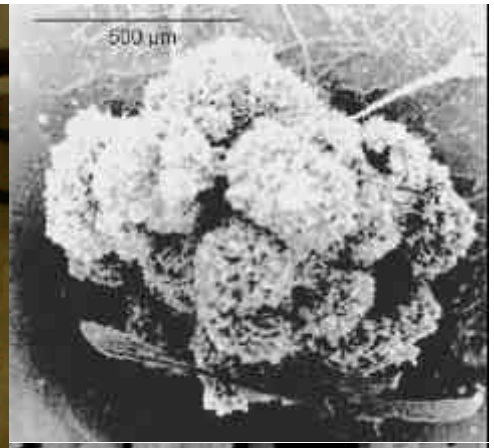
Originally:

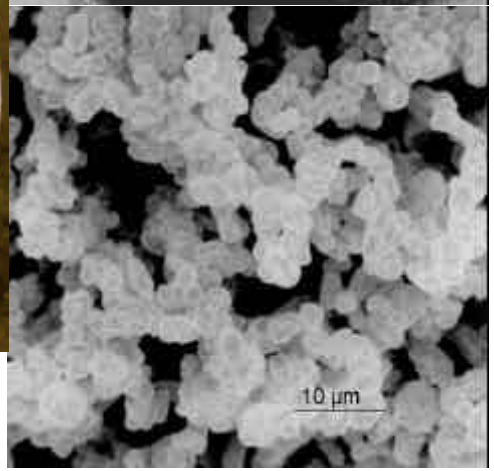
*Metarhizium*
*Beauveria*
*Paecillomyces*
*Nomuraea* spp.

have lipohilic (hydrophobic) cell walls …
… compatible with oil formulation.

# Scale-up: the MycoHarvester 3

- Processes >0.5 T substrate / day
- Proven for *Metarhizium & Trichoderma* spp.

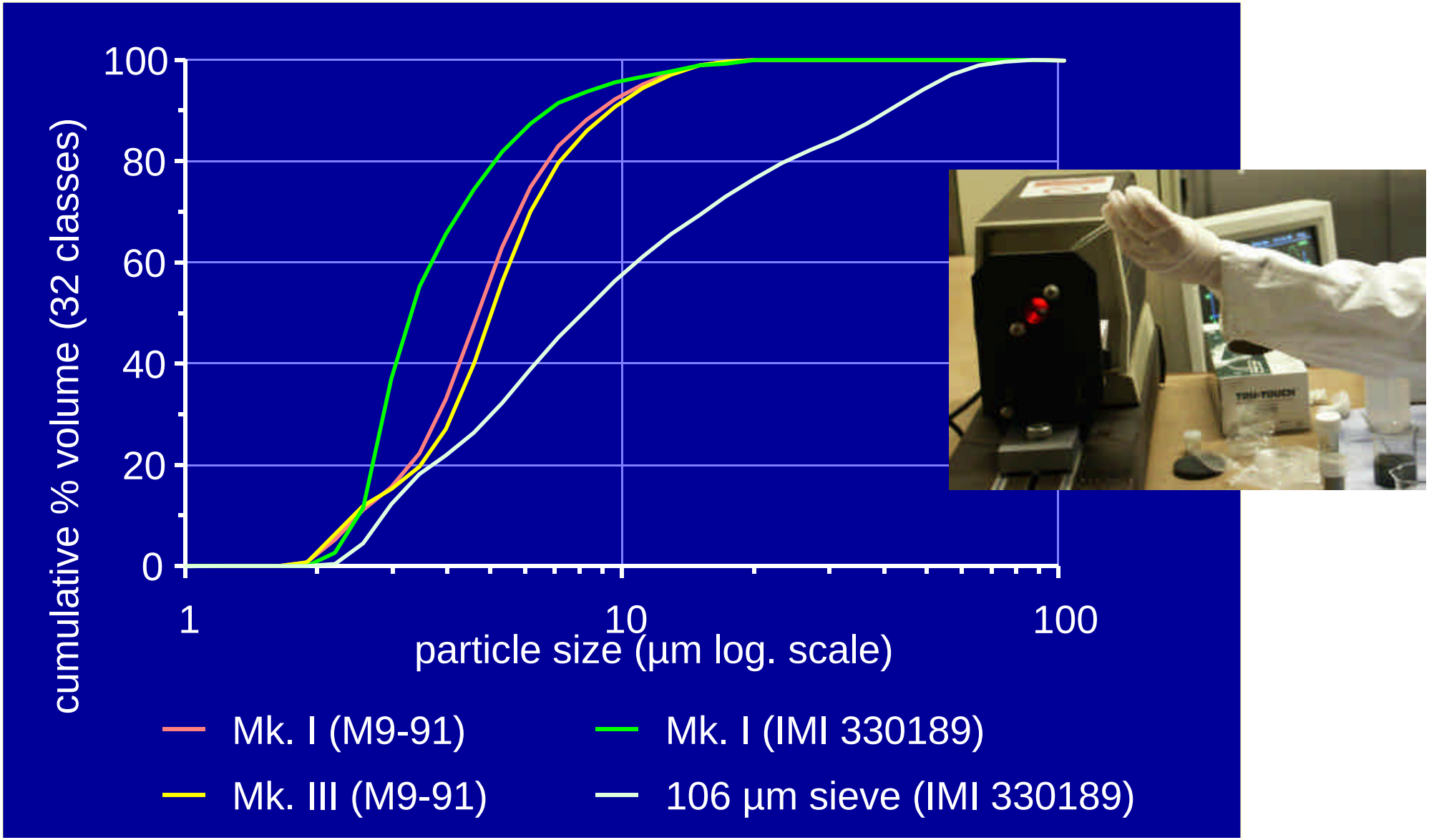



*T. stromaticum*

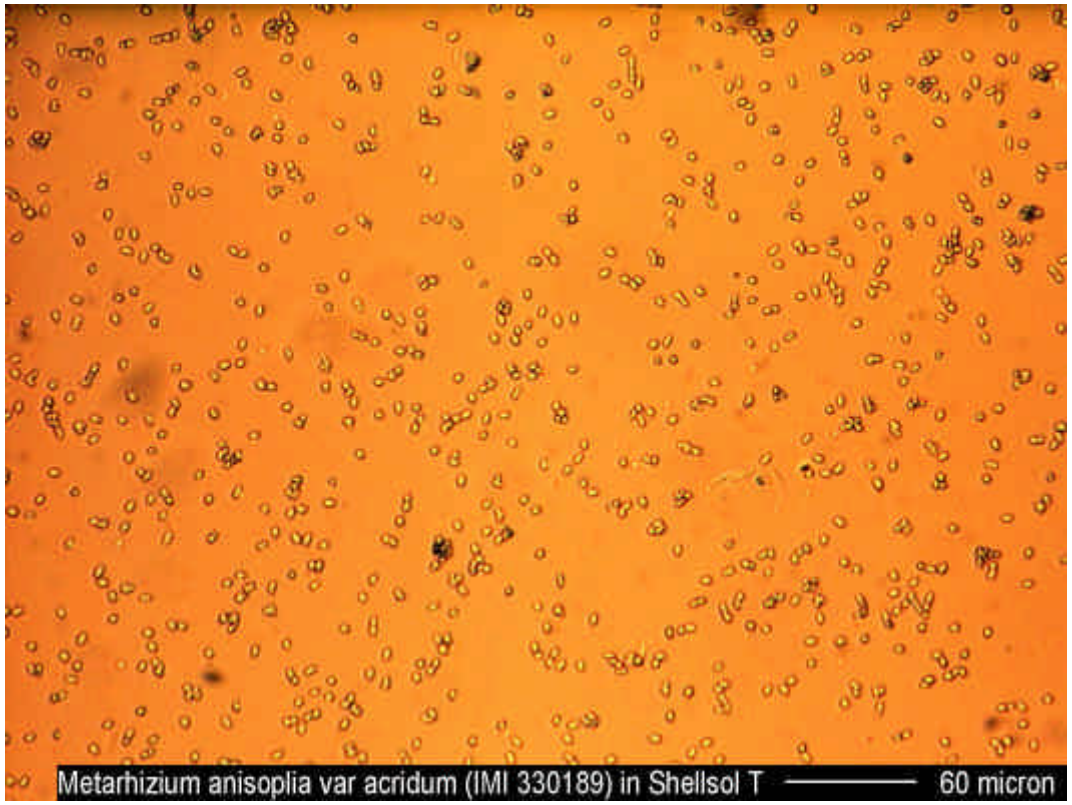
# QC: includes particle sizing

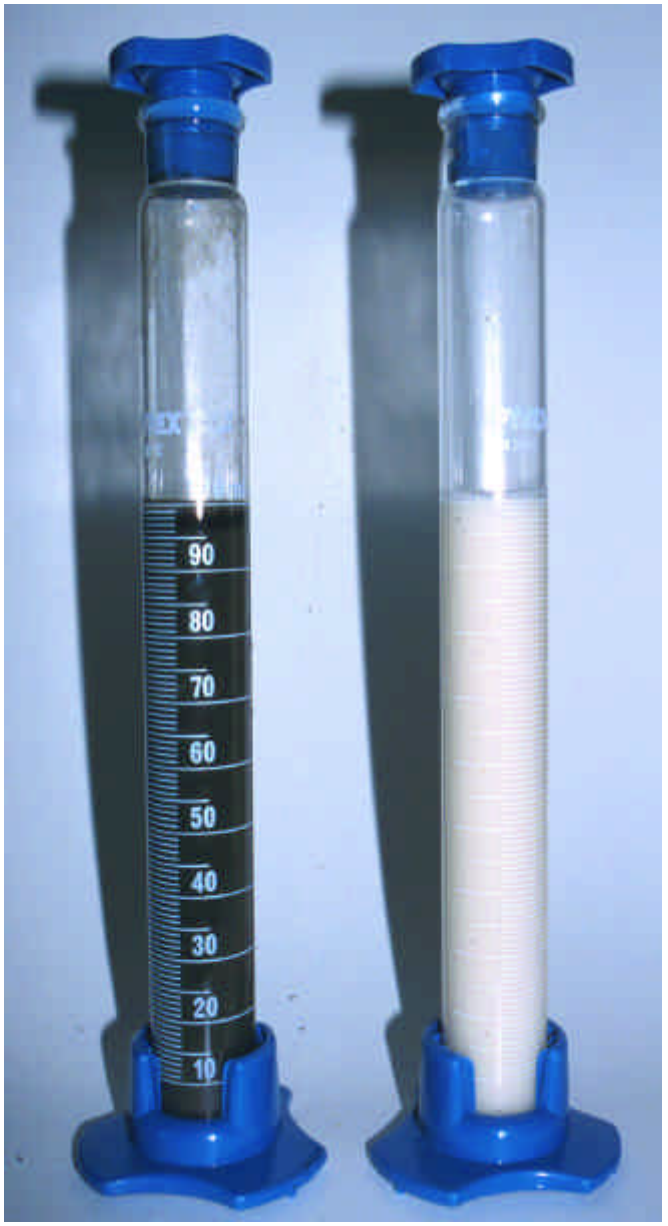
(e.g. *Metarhizium* conidia 'MycoHarvester' extractions)



# Stable suspensions

for reliable ULV spraying:
and subsequently
emulsifiable formulations for
MV / HV application



# Drying, Packaging and Shelf life

Moisture analyser

Bag sealing machine

# Shelf life: storage model

$$\log_{10} s = K_E - C_w \log_{10} m - C_H t - C_Q t^2$$

m moisture content (m.c.: % wb)

$K_E$ (6.3) absolute longevity extrapolated from value of log10 s at 1% m.c.

$C_w$ (3.06) describes effect of m.c. on longevity

$C_H$ (0.00176) and $C_Q$ (0.000703) describe the effect of temperature on longevity

t temperature

Hong *et al*. (1998…)

# Packaging, viability indicator

Tri-laminate foil sachets

10 years at 4$^{o}$C?

# If we knew then what we know now…
## …*e.g.* cost of application

100 g ‘Green Muscle’ = 5 x $10^{12}$ conidia …

… costs approximately $20 to produce
Chemical locust insecticides approximately $10/ha
‘Green Muscle’ works well at 100 g/ha …

… if only we had done more trials at 25 g/ha ?
(with high quality material)

Hindsight is a wonderful thing!

# Opportunities? (*e.g.* cocoa)

- Invasive species: *e.g. Moniliophthora*
- Difficult to control
- *Trichoderma* spp. for reducing inoculum pressure

# Impact of EU/91/414 on commodities

- Mycoinsecticides as substitutes for withdrawn chemical insecticides?

# Conclusions:

- Biopesticide products and delivery systems require a level of sophistication with parallels to chemical pesticide development
- Constraints: biopesticide development linked to enthusiastic scientists in research establishments and SMEs (rarely supported by strong lobby groups or major companies) …
- “Enabling technologies” available for development of control agents (sometimes new to science);
- Lab to field: need good “prototype products” in place before large-scale field testing.

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