



# Simulation of Bollworm Damages on Cotton

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# Context : Pests & Cotton in West Africa...

**Bollworms :** variability in infestation (date, population)  
**Crop Management :** rainfed conditions, low input (NPK, chemicals)

*Helicoverpa armigera*



*Spodoptera littoralis*



*Earias biplaga*



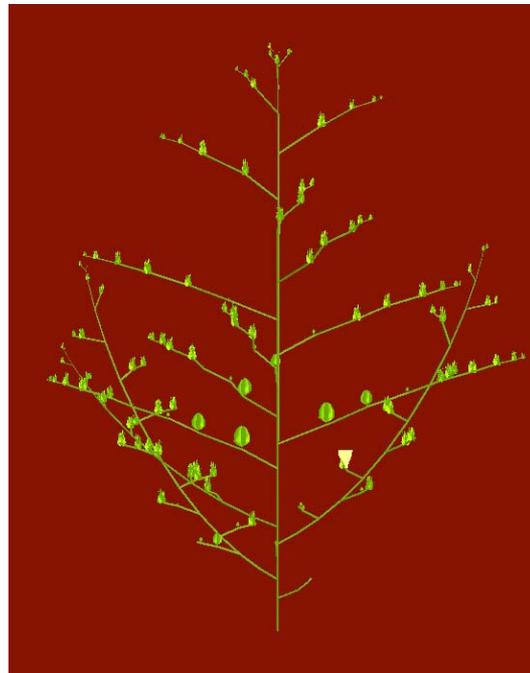
*Diparopsis watersi*



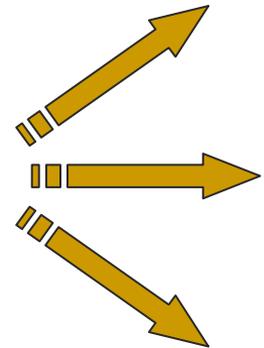
## Crop characteristics :

- Undetermined growth habit
- Adaptation to environmental conditions (density, etc.)  
→ High architectural plasticity

+



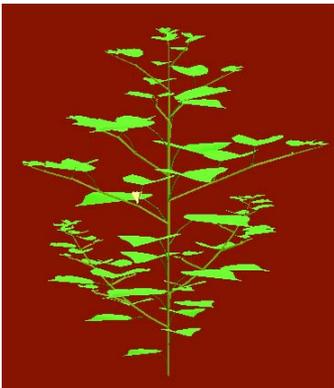
= Yield ?



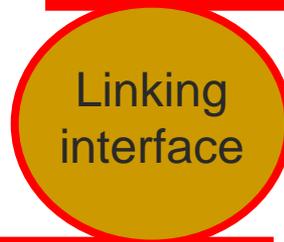
# Methodology

## Crop and Bollworm model linkage

Crop Model  
(Gossym)



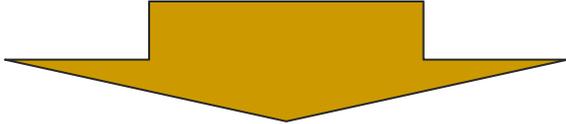
Buds & fruits  
availability



Bollworm model  
(Cobold)



Damages



Yield  
+  
rotten cotton

# COBOLD

## Simulation of bollworm population and injuries (CIRAD)



### Model Input

- Air temperature (2m)
- Nb of larvae per larval instars and species

### Laws included (hourly time step)

- Larval instar duration =  $f(T^{\circ}\text{C})$
- Voracity : fresh matter consumption per larval instars (regardless organ type)
- Fresh matter consumed =  $f(\text{organ fresh mass, larval instar})$
- Feeding preference : stochastic per fruit type
- Organ shedding : rules based on observations
- Mortality table due to natural enemies

Bibliography

Lab. experiments

Field experiments

Bibliography

# GOSSYM

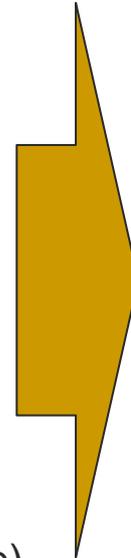
## Cotton Crop Model (USDA-ARS)

### Model Input

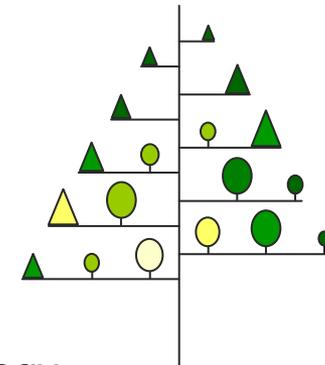
- Soil characteristics (H<sub>2</sub>O + MO)
- Climate (T°C, radiation, rainfall ...)
- Cultural practices (planting, irrigation, fertilizer ...)

### Biophysical Processes (daily time step)

- Photosynthesis
- Phyllochrone (leaves + fruits)
- Partitioning rules (vegetative vs reproductive)
- Shedding rules (physiological)



### Average plant “pseudo”-architecture

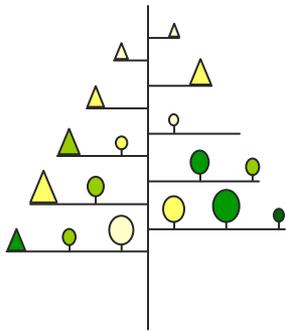
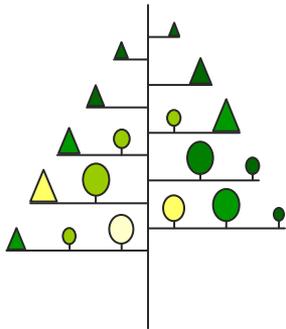


- Topology
- Each position characterized by
  - △ ○ a status : bud, fruit
  - ... □ a dry mass
  - a % of presence

# Linkage, a complex operation...

Inducing coincidence of organization levels ...  
 Example : fruit representation

Gossym



Numerical  
 derivation

Resource :

Collection of reproductive organs



Cobold



Numerical  
 integration

Organ consumption per position :

- damages → mass
- shedding → number

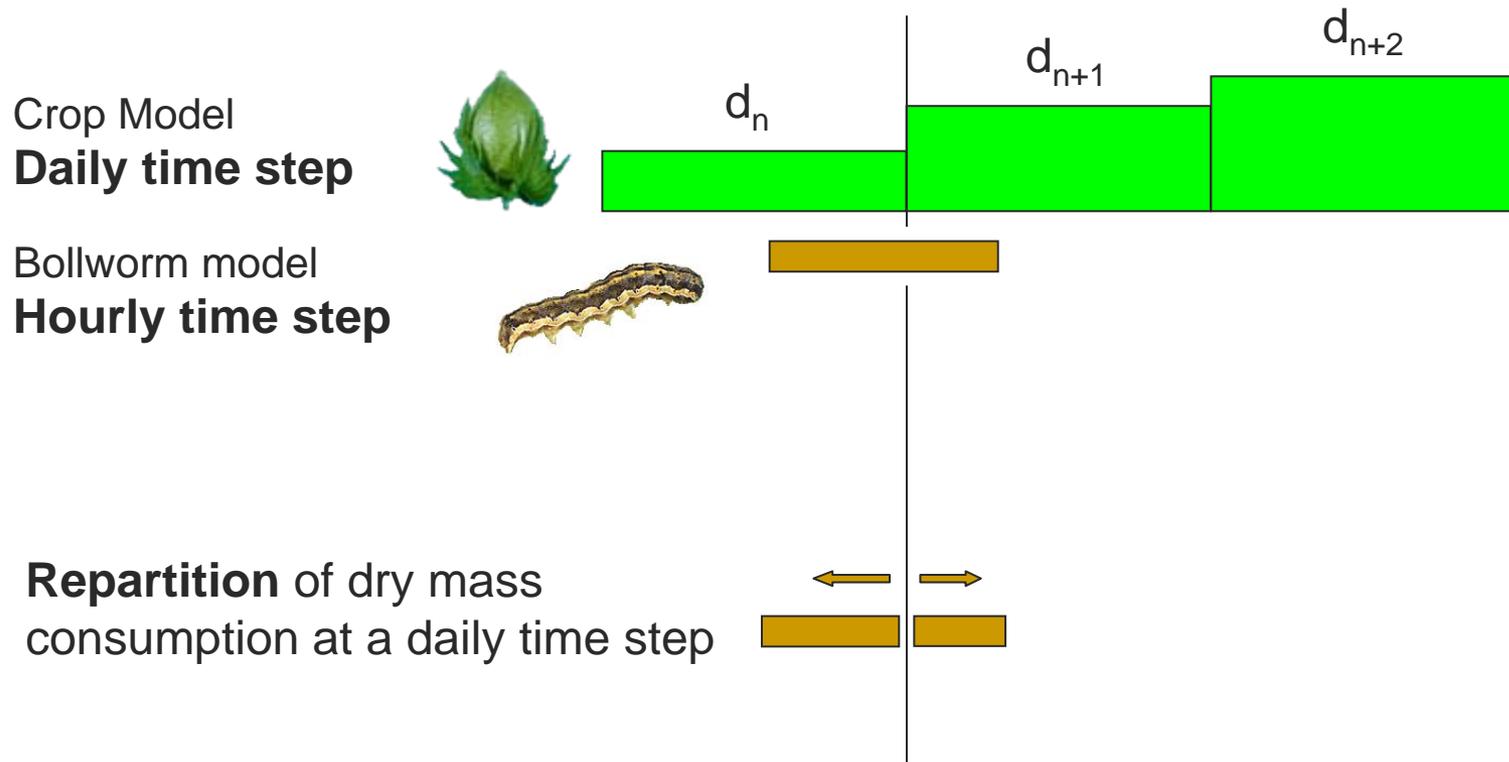
		status : bud, fruit
		dry mass
		% of presence

# Linkage, a complex operation...

2/3

Inducing coincidence in time, space and energy...

Example : fruit consumption



# Linkage, a complex operation...

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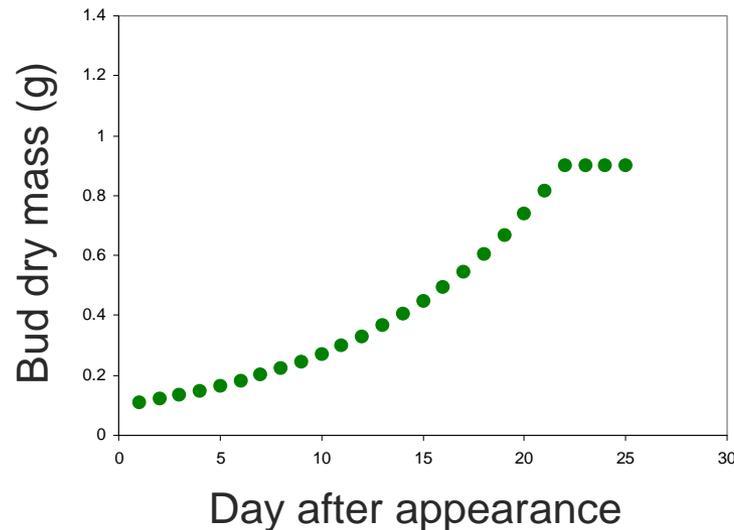
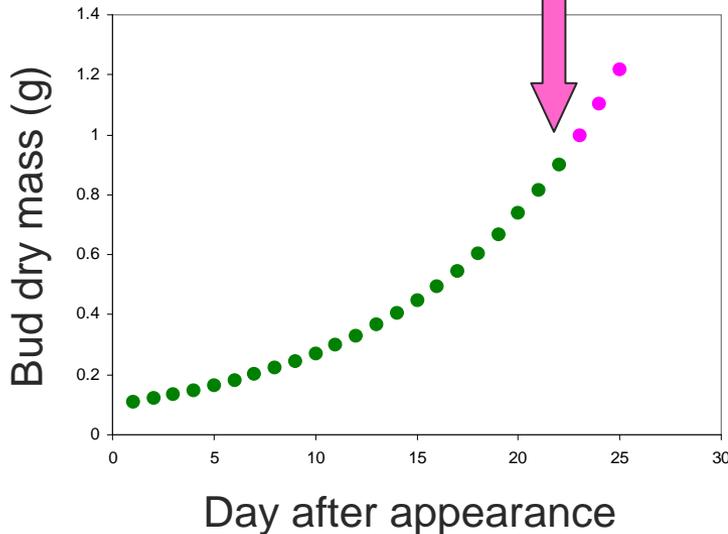
Inducing coherence of modelling options...

Example : bud mass exponential growth



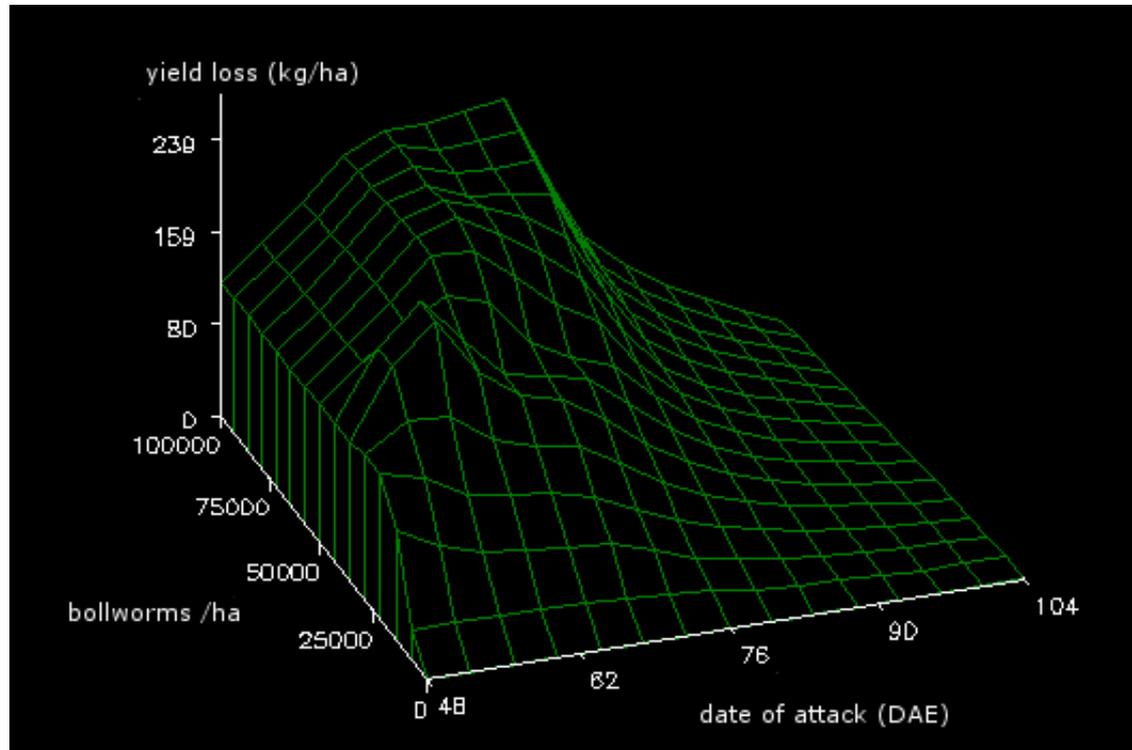
Sensitivity to flowering date :

- **low** on crop model (negligible)
- **high** on damage simulation



# Results

Example : simulation of yield loss ...



Maroua experimental station, Cameroun, 2004

# Perspective

## Towards a DSS...

### **Actual Status :**

- Validation of COBOLD is under progress with on-station trials
- publications : laws already published, COBOLD architecture submitted

### **COBOLD is the core of a future DSS :**

- Aim : allow the adjustment of economic injury levels according to :  
weather (mainly rain), sowing dates, evolution of seed cotton and  
chemical prices
- End-users : technical advisers (cotton companies)