



# Modelling coexistence between GM and non-GM supply chains

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# Introduction

- General goal : assessing the feasibility of coexistence taking into account:
  - not only, the admixture risks at the field level,
  - but also, the admixture risks at the different stages of the chains from the upstream producers to the downstream consumers
- Empirical analysis of several supply chains (soybean, potatoes, wheat, maize...)
- Modeling for analyzing the impacts of various strategies and chain organization schemes





## Initial questions

How can the demand for non-GM products be supplied in a situation of coexistence, considering that the risks of admixture presuppose costly segregation measures?

How do public regulation and private decisions affect the characteristics of non-GM products supplied to consumers and affect the capacity of stakeholders to provide non-GM products compliant with the labelling threshold ?



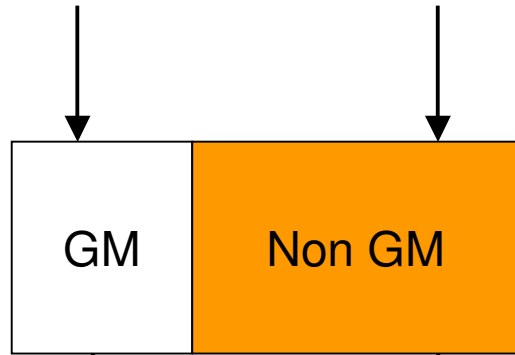


## Raw material

### Price differentiation

- GM pressure
- Labelling threshold
- Purity of non GM lots

**Supplier**



### Segregation costs

- Segregation efforts
- Internal GM pressure
- Labelling threshold

### Controls and tests

- Efficiency
- Costs

GM product

**Customer**

Non OGM  
Product

### Public liability rules

- Penalty costs
- Probability of controls

### Demand function

**Final**

Price differentiation GM/non GM

**Consumers**





## Previous works

- General Economic models: Moschini et al. (2008, 2005...); Giannakas et al. (2004....)
- Segregation costs: Bullock and Desquilbet (2002); Kalaitzandonakes et al. (2001)...
- Testing and segregating GM wheat: Wilson et al. (2005, 2007...)





# Simulation model description



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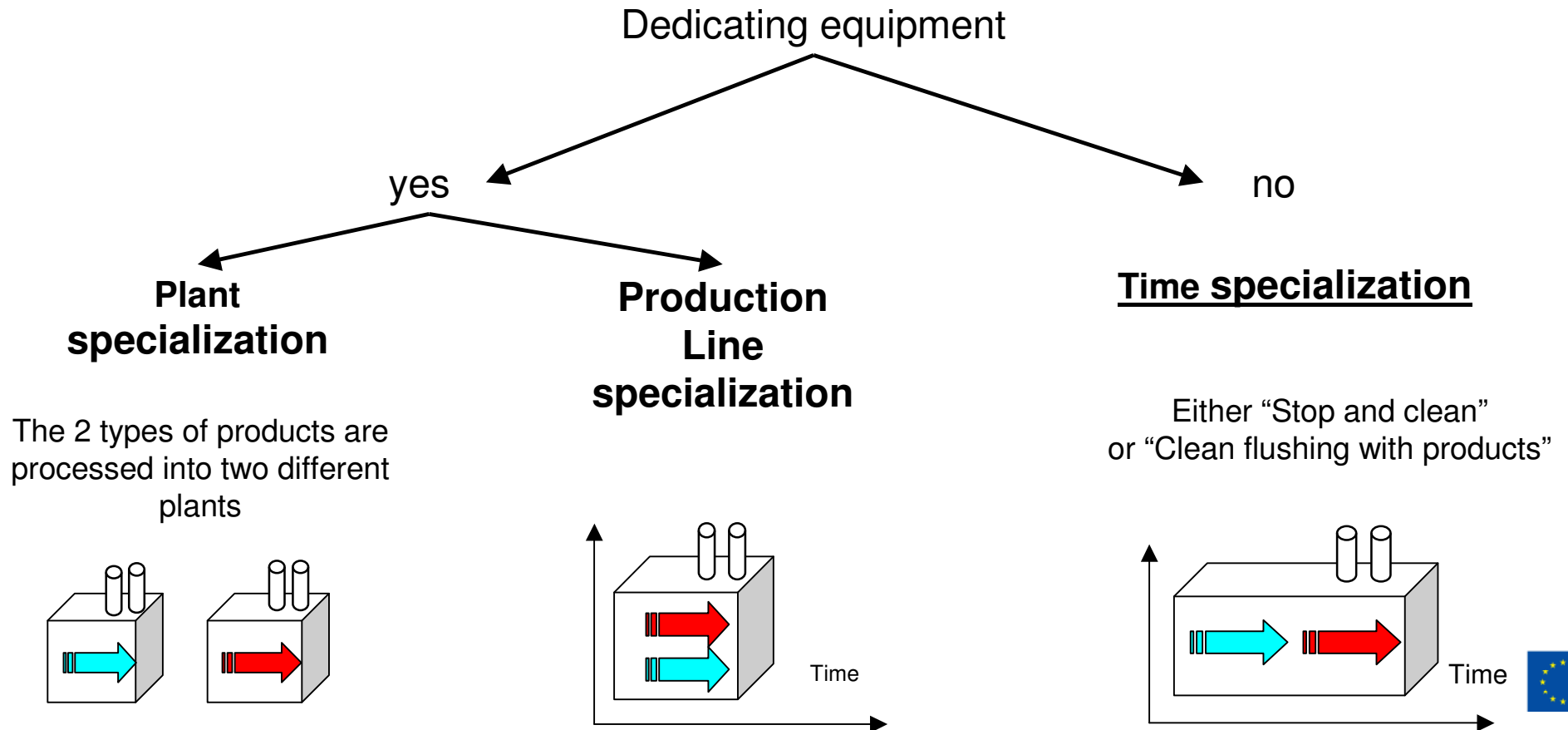
## Aims

- Risk analysis : the ability of the chain to guarantee to the consumers that the non GM product is compliant with the labelling threshold
  
- Economic analysis : comparison of the economic efficiency of several strategies about segregation, control and tests





# GM / non-GM segregation



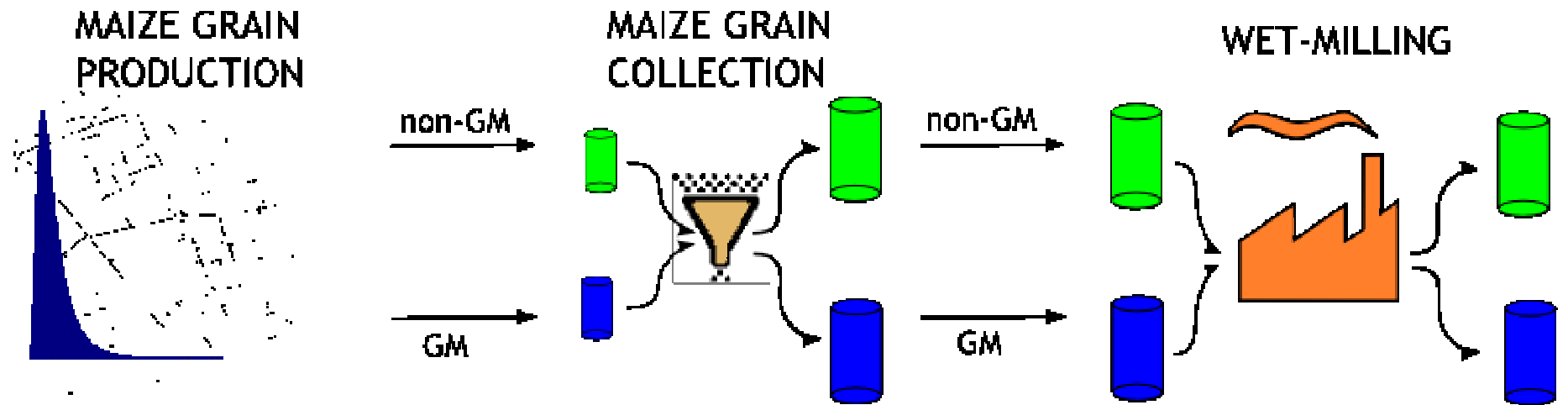
According to Le Bail et al., 2007







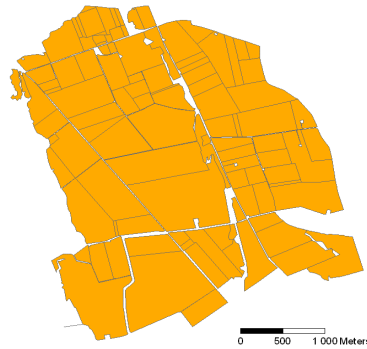
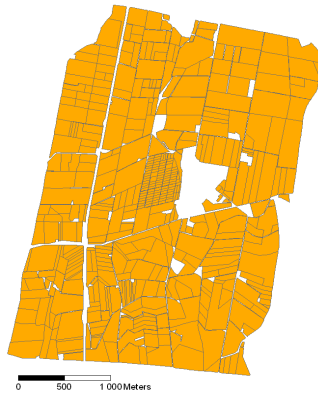
# General framework of the model



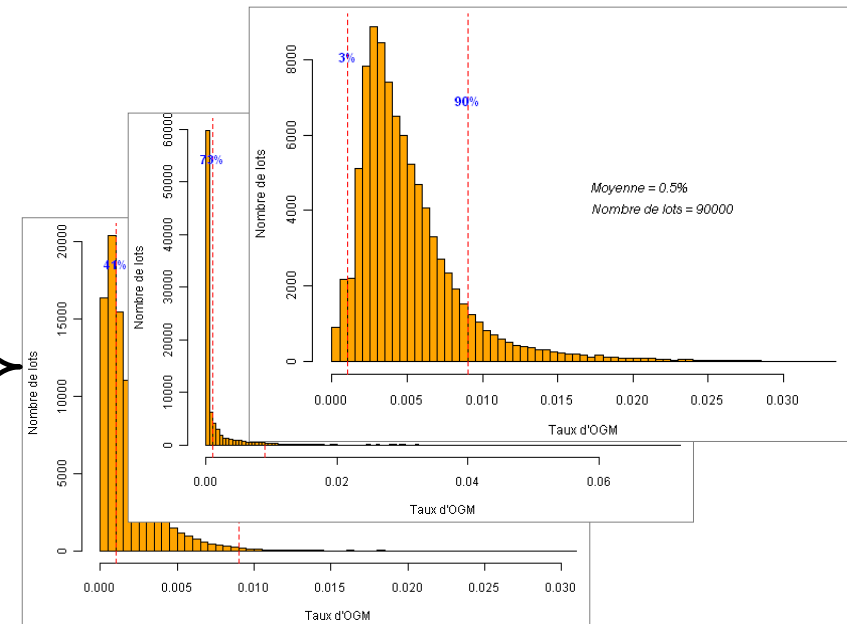


# MAPOD based simulations : initial admixture distributions in non-GM flows

2 regions

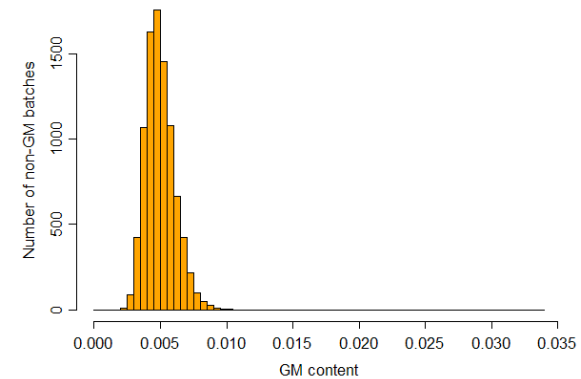
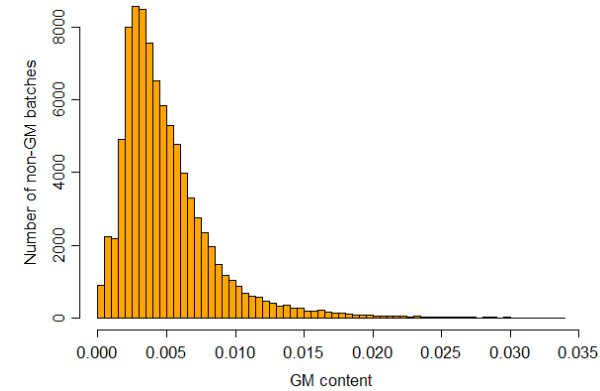
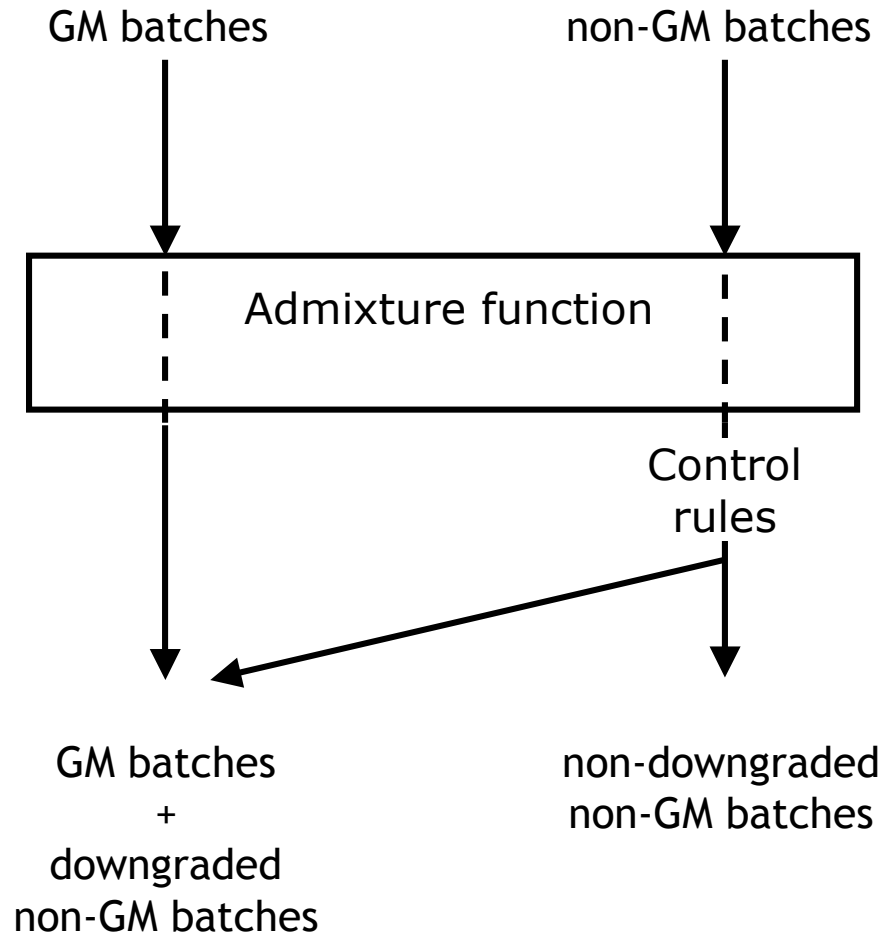


- Various % of maize fields
- Various % of GM/non GM fields
- Random allocation of the crops to the fields either with or without spatial constraints (isolation distance, clustering)





# Physical flows at each step of the chain



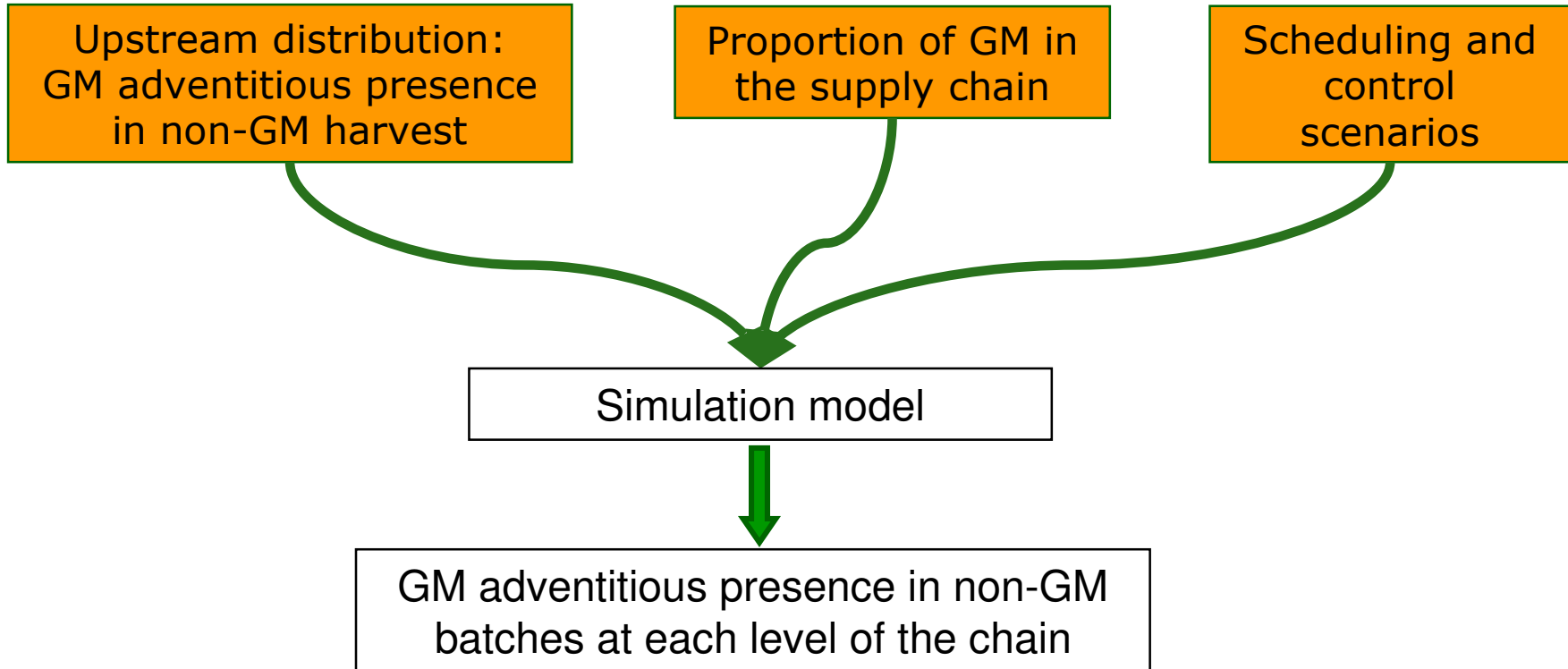


# Scenarios

Management  
of the non-  
GM batches

- Simple traceability (identifying batches from either GM or non-GM varieties)
- Simple traceability + automatic downgrading of non-GM batches (clean flushing with product)
- Simple traceability + PCR testing of non-GM batches at various levels of the chain







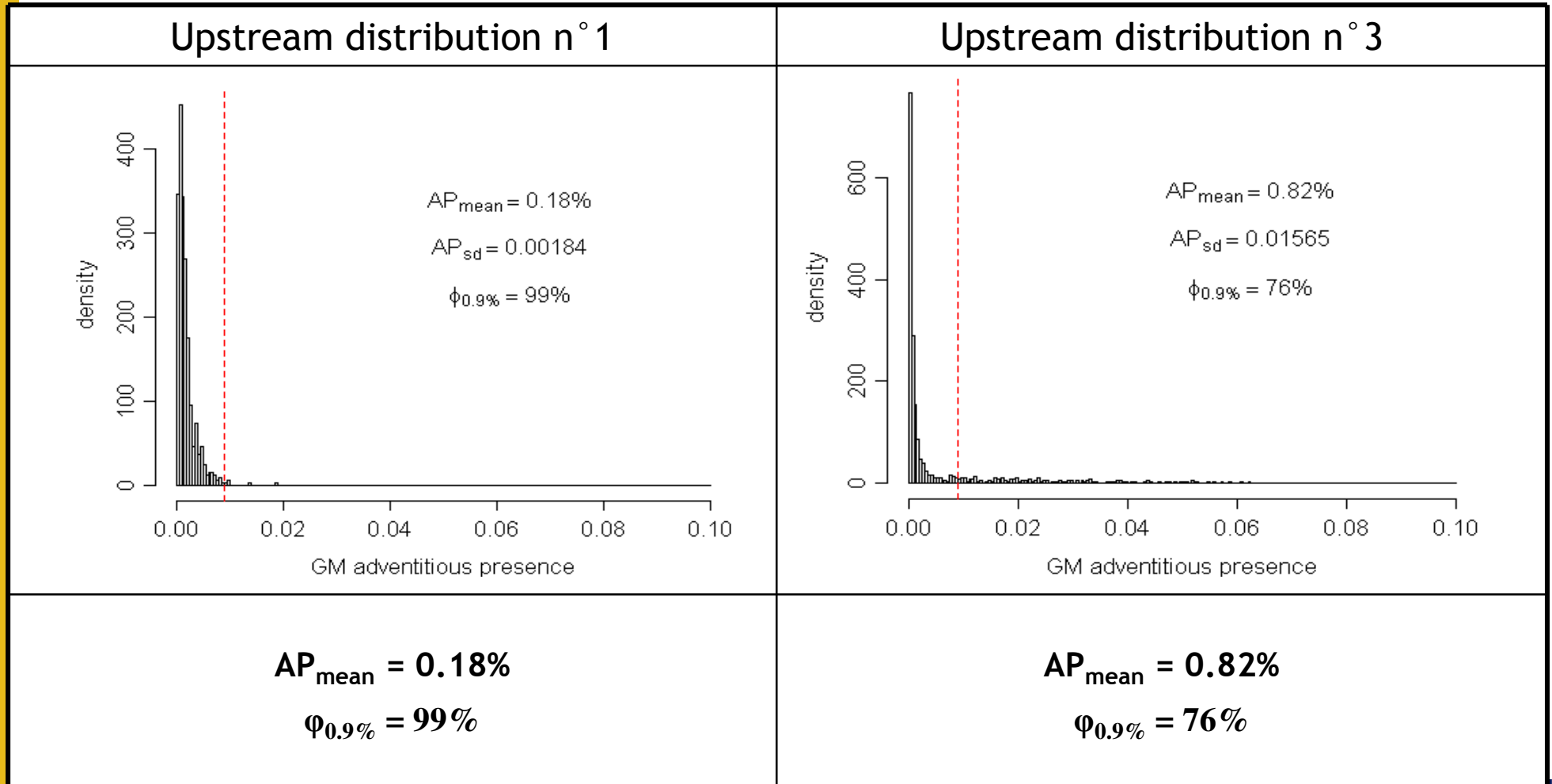
# Simulations carried out



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# Upstream distributions from MAPOD





# Output data

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- Number of non-downgraded non-GM batches
- Mean GM rate in the non-downgraded non-GM batches
- Proportion of non-downgraded non-GM batches compliant with the threshold (0.9%) at each step of the chain







# Simulation results

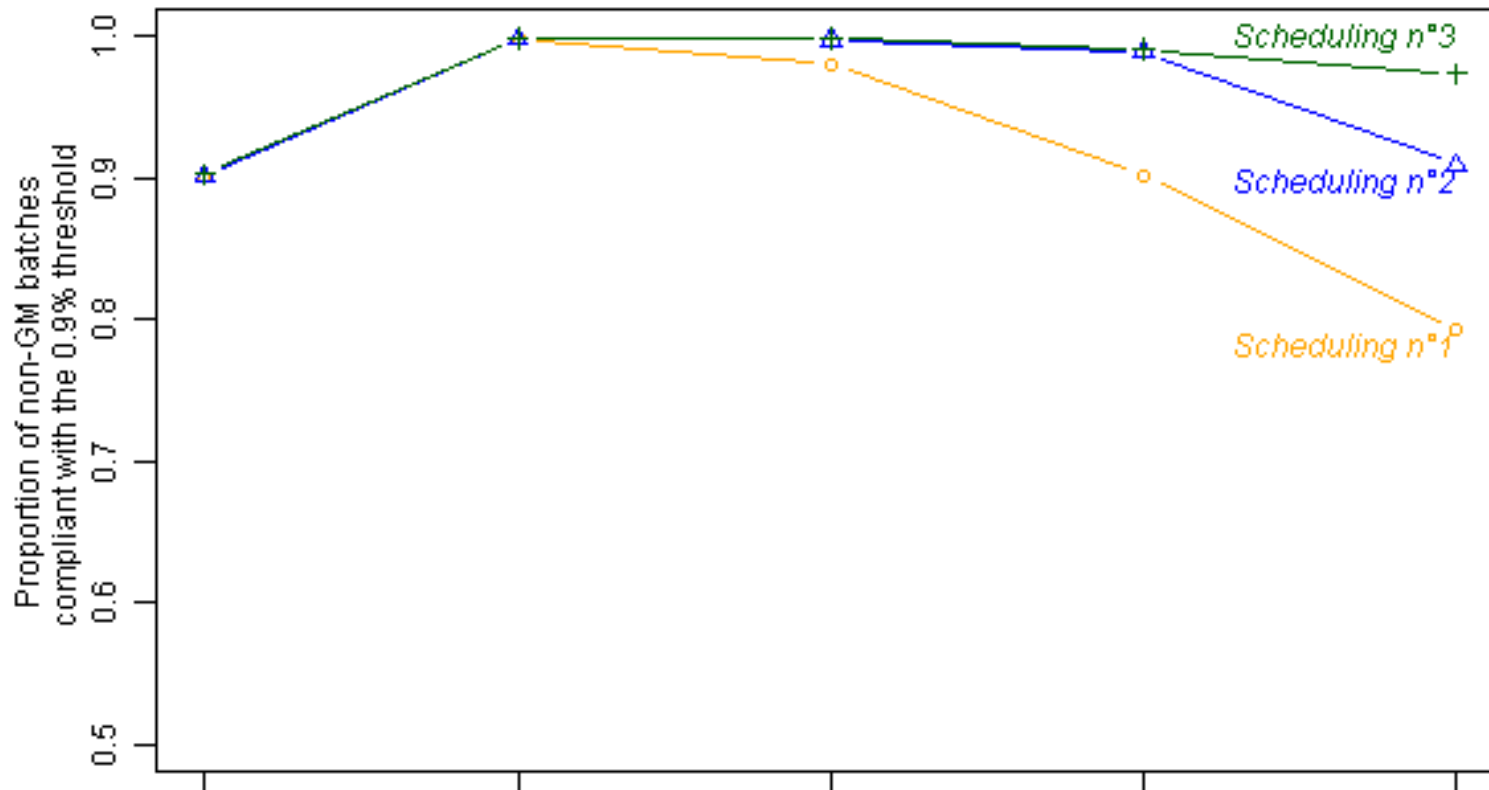
The chain organization, from the upstream producers to the downstream stakeholders, plays a crucial role in maintaining / improving the non GM product compliance with the labeling threshold

↪ 2 mechanisms to consider : admixture between GM and non-GM products & admixture between non-GM products (+/- dilution)





# Probability of compliance according to the scheduling of batches (Upstream distribution 3)



Upstream distribution n°3,  $\mu=0.5\%$ ,  $\sigma=0.0032$ , 10% of GM in the supply chain, Simple traceability

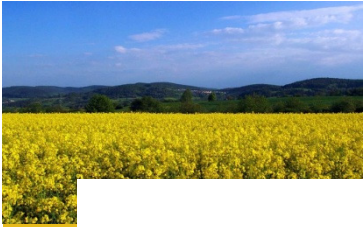




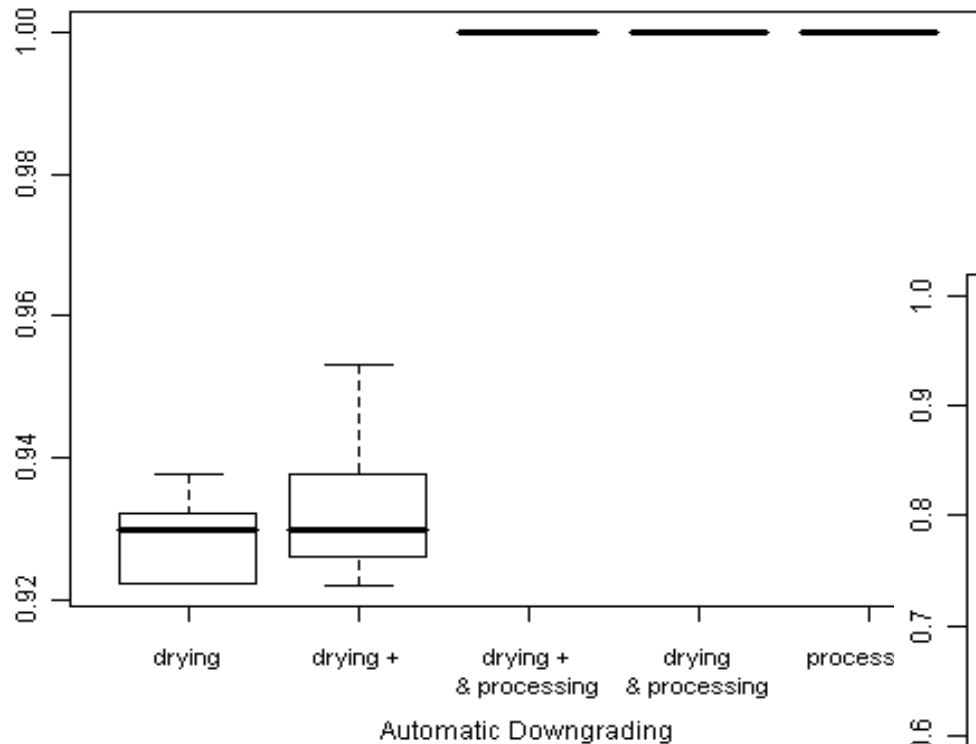
## Probability of compliance according to the GM proportion in the chain (Upstream distribution 3)

	Proportion of GM in the supply chain	10%	50%
Probability of compliance of non GM batches	<i>Field</i>	90.1%	
	<i>Collection</i>	99.8%	
	<i>Storage</i>	100%	
	<i>Starch</i>	92.8%	63.2%

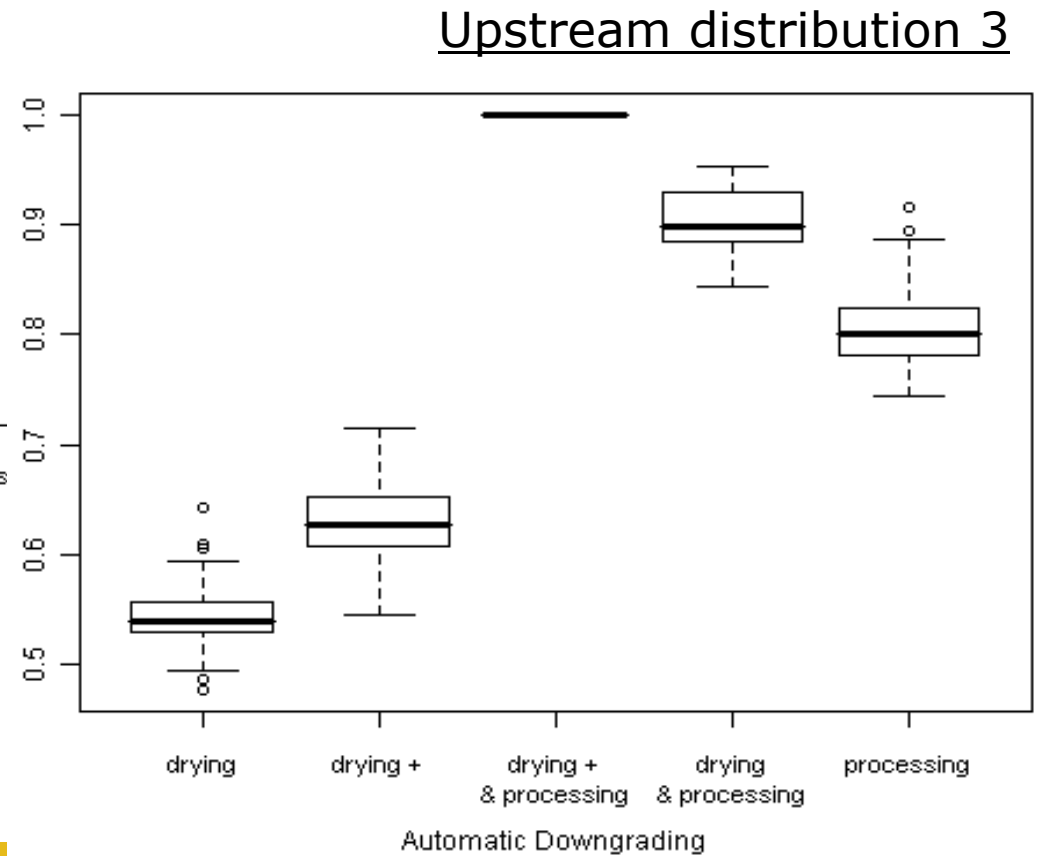




# Probability of compliance of non GM batches according to the chain strategies



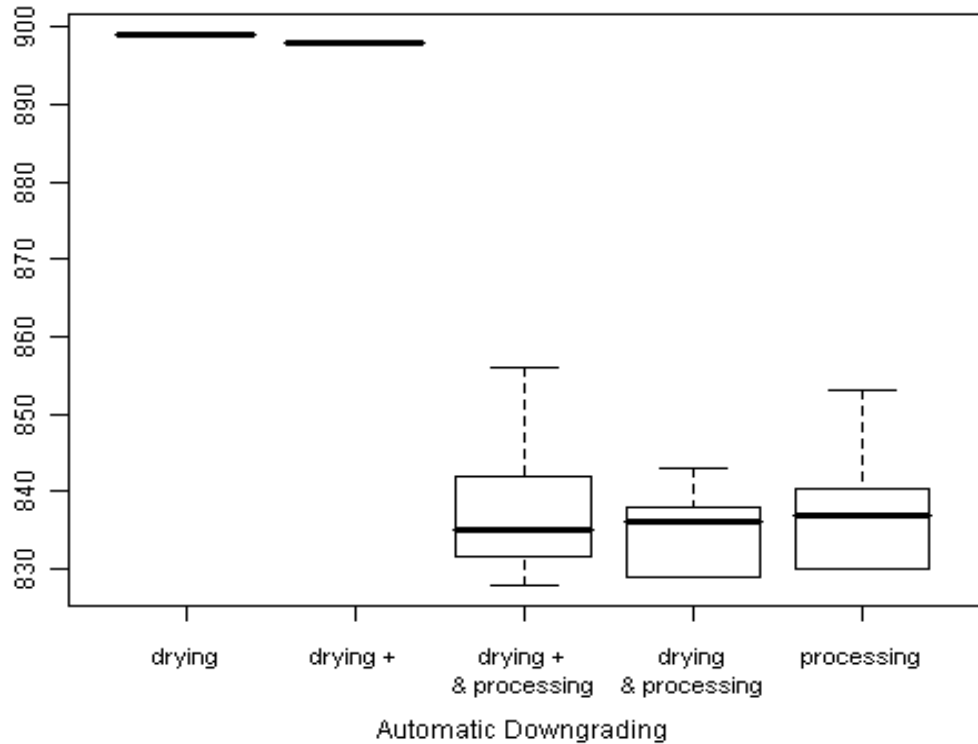
Upstream distribution 1



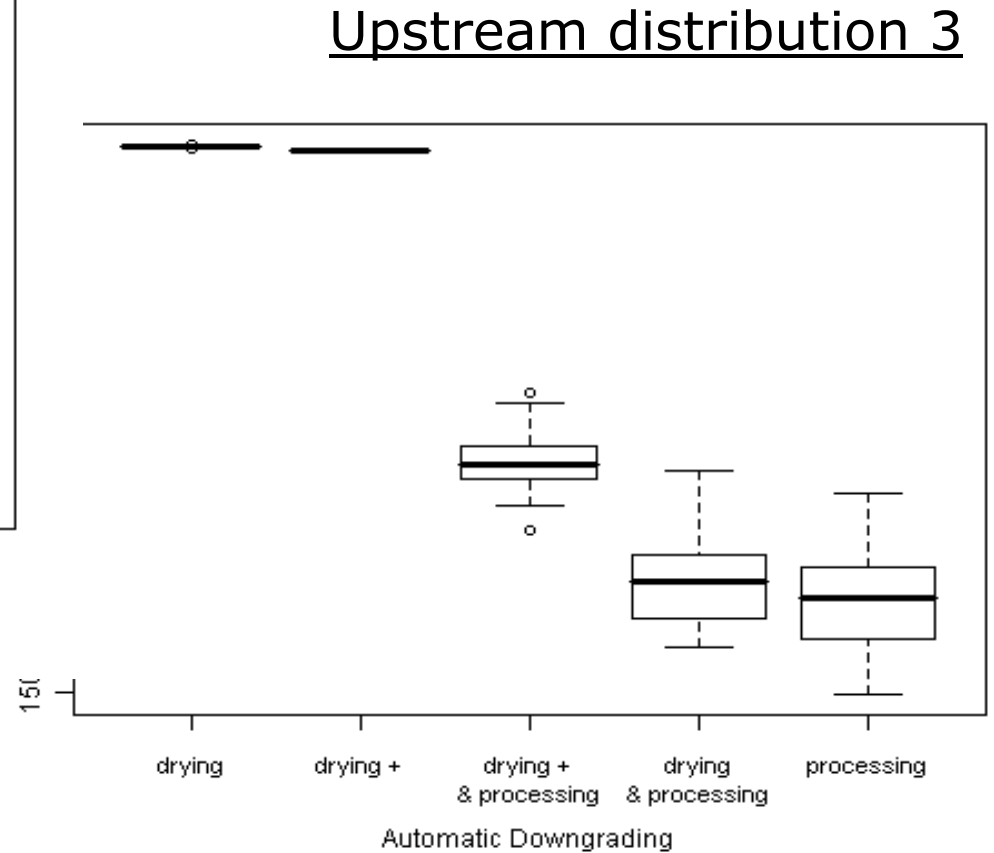
Automatic Downgrading



# Number of final batches considered to be non GM



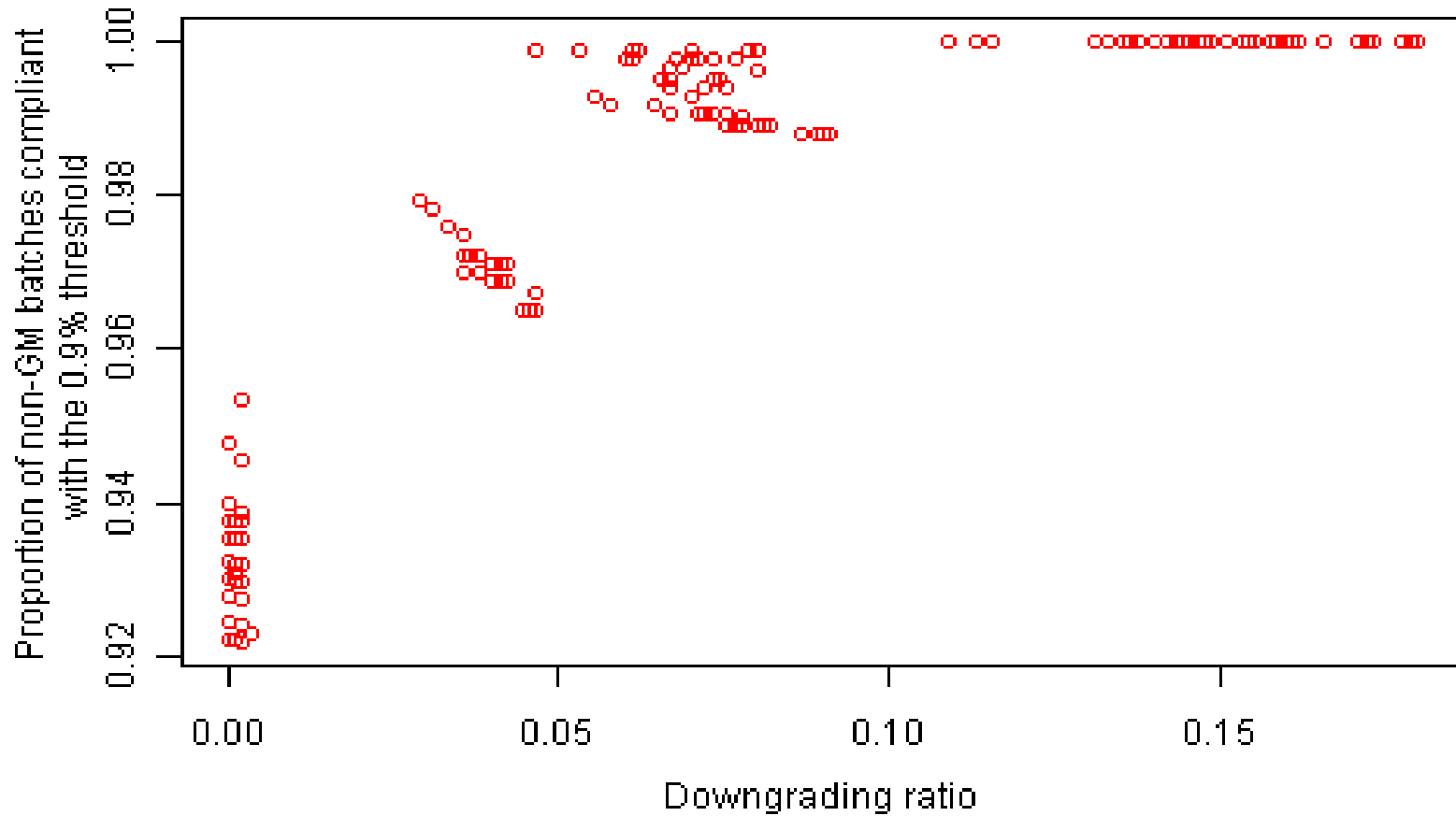
Upstream distribution 1





## Proportion of final non-GM compliant batches and downgrading ratio

*The greater the penalty cost, the greater the loss due to a low compliance probability*

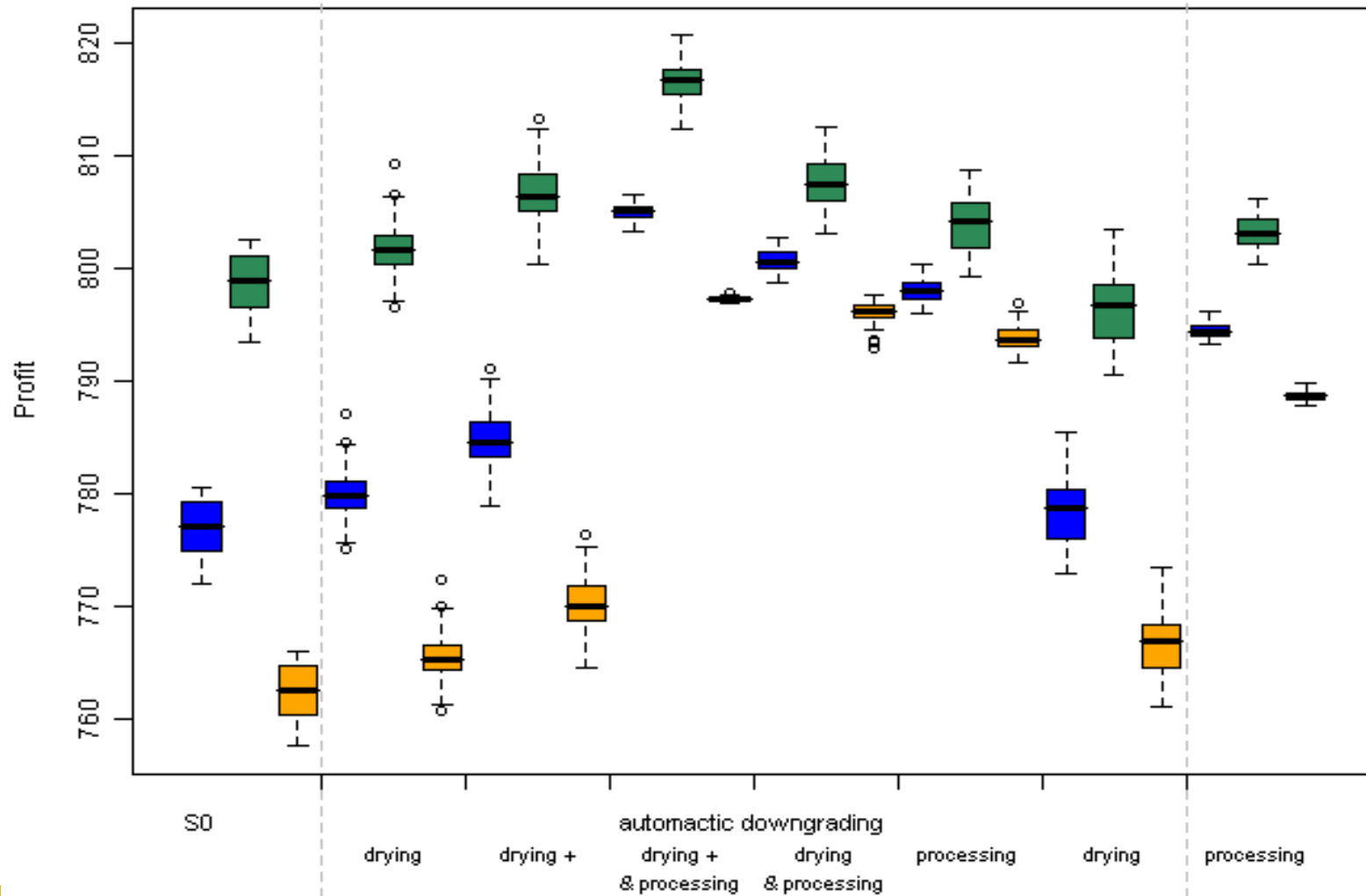


*The greater the non GM price premium, the greater the loss due to a large downgrading ratio*



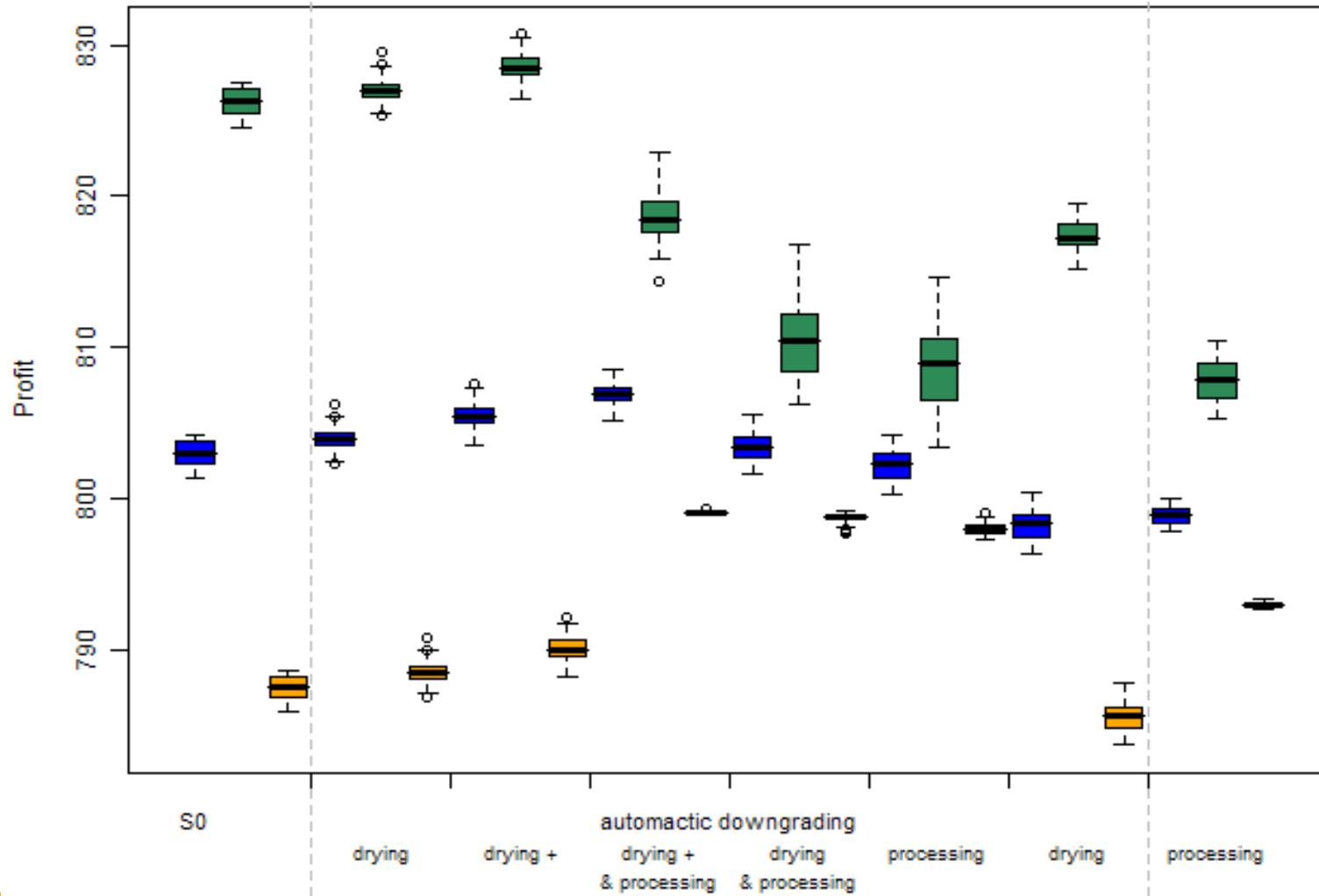


Upstream distribution 3; Penalty cost = 15%  
Non-GM price premium = 0 (yellow) ; 4% (blue); 10% (green)





Upstream distribution 3; Penalty cost = 5%  
Non-GM price premium = 0 (yellow) ; 4% (blue); 10% (green)







# Conclusion

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Research which gives some tools for chain organization design in order to manage the coexistence between GM and non-GM products

Downstream supply chain is crucial on the capacity to provide non-GM products (in spite of the variability of the upstream situations)

The capacity of stakeholders to provide non-GM products compliant with the labelling threshold depends on strategies (scheduling, control rules...)





The simulation supply chain model allows to test several management scenarios and compare various strategies

By using gene flow models, it is possible to estimate the adventitious presence of GM material in non-GM maize at the farm gate.

The WP2 results show that this information helps in the implementation of an automatic downgrading strategy and may therefore save further PCR testing.

This requires strict vertical organisation but can increase overall profitability





We discussed the trade-off between the level of compliance of the final product and the number of downgraded non-GM batches

This trade-off depends upon both the relative value of the penalty cost incurred as a consequence of non-compliance and the non-GM price premium in the marketplace.

Coexistence between GM and non GM products seems difficult to implement with “time specialization” when the GM pressure is high

From an economic point of view, it is only viable for low/moderate GM pressure and if there is a good balance between : non GM price premium and penalty cost





Thank you for your attention



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