Use of simulation models to improve individual and collective management of pig effluents in Grand-Ilet (Réunion Island)

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Using simulation models to improve the management of pig slurry in Grand-Ilet

(Reunion Island)

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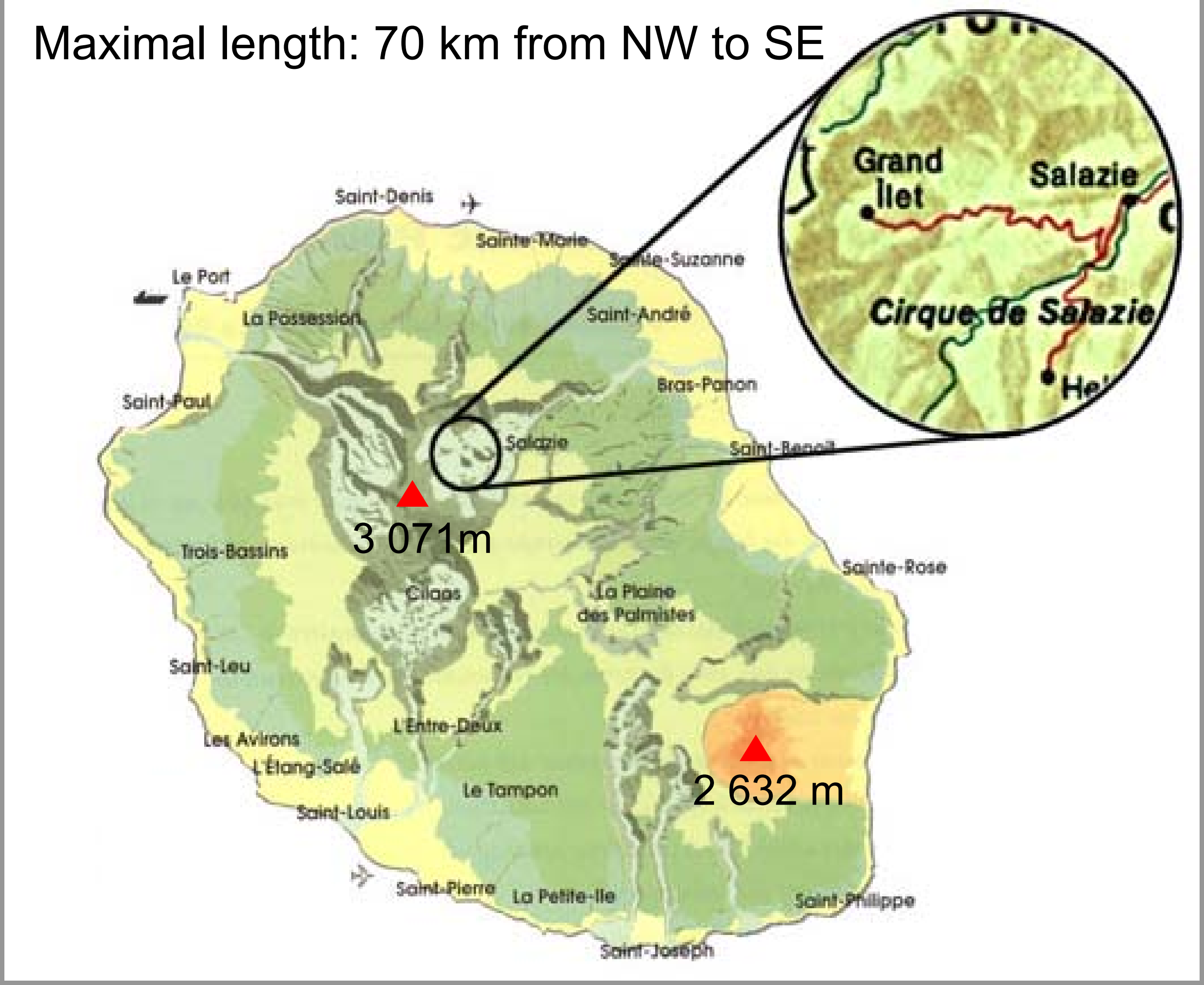
Reunion Is. & Grand-Ilet

Maximal length: 70 km from NW to SE



Too many pigs… too little land

- 51 farms
- 20 000 m^3/year slurry
- 100 tonsN/year
- 187 ha of which 75 ha cultivated

High N application: 1 300 kgN/ha/year

Great risk of pollution !
Prohibition threat

☞ **Support stakeholders design a collective management strategy for pig effluents**

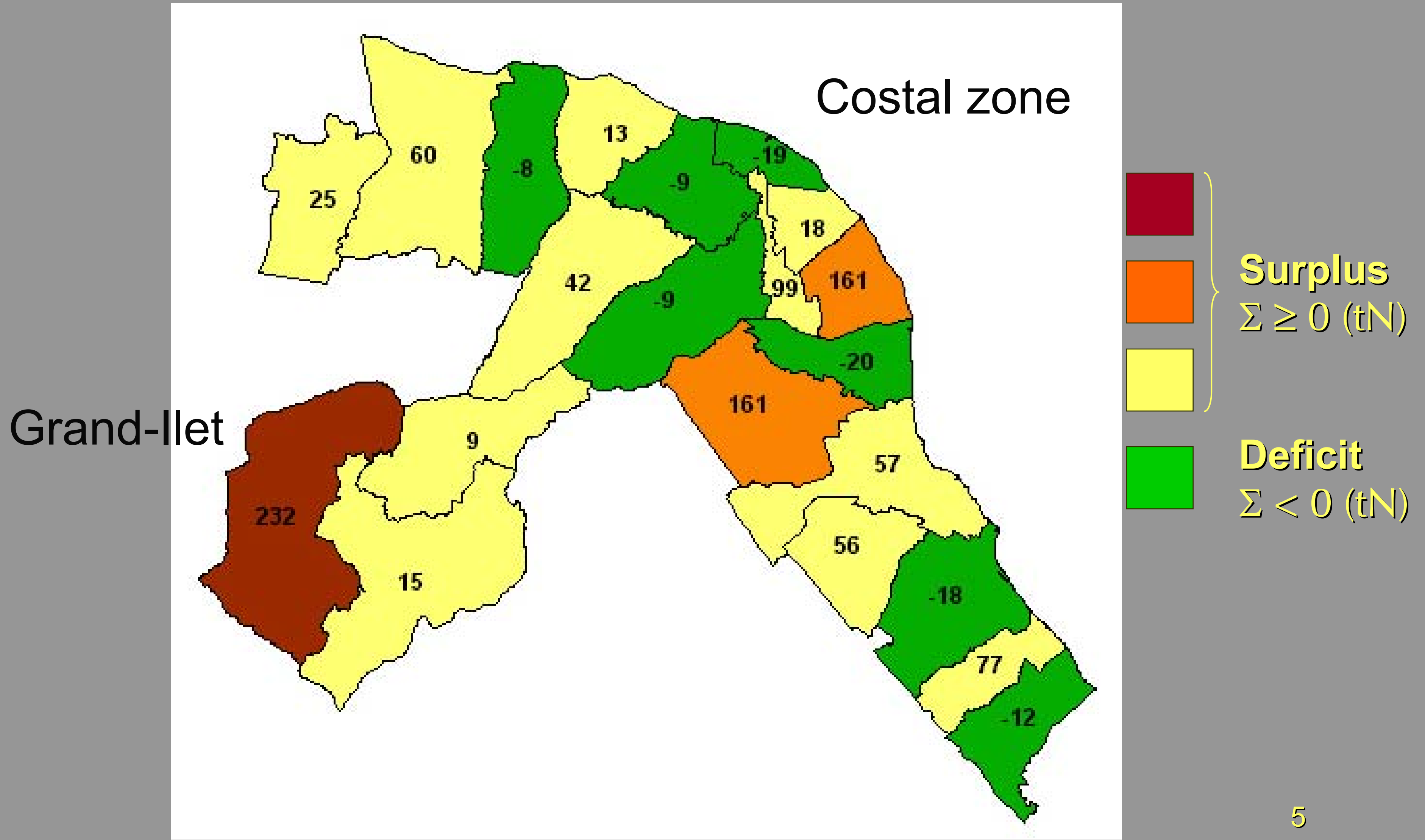
Decision 1

- Q1: Export effluents or treat them *in situ*?

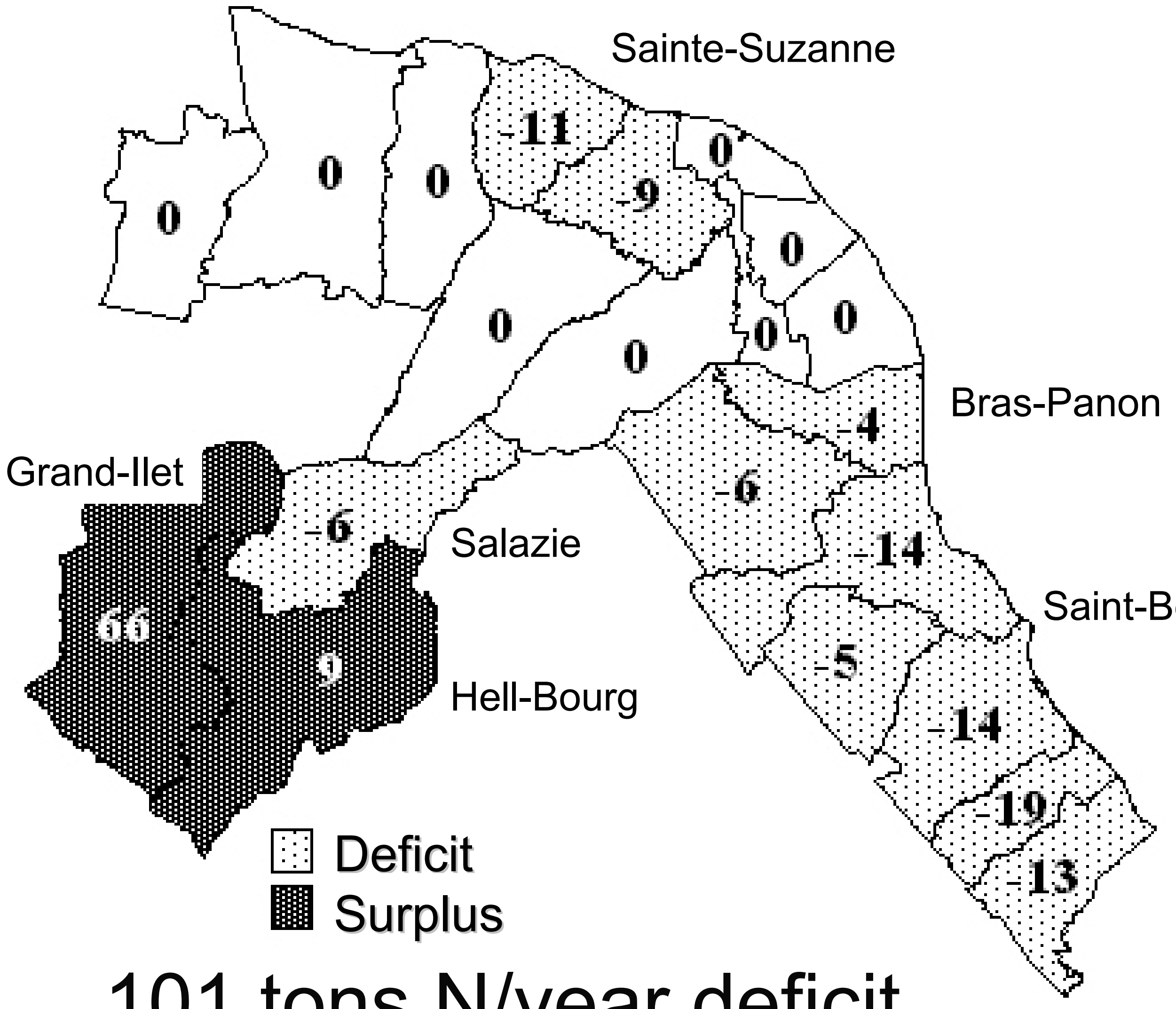
☞ By using a GIS:

- ☞ assess the nutrient balance in the area
- ☞ identify suitable spreading areas

Balance of N from liquid manure



Balance of N from solid manure



101 tons N/year deficit

Decision 2

- A1: Treating effluents *in situ*

- Q2: Which treatment process?
  - size?
  - cost?

☞By using the Macsizut spreadsheet with the stakeholders

Choosing a treatment with Macsizut

- 11 treatment plants combining 12 processes:
  - Centrifugation
  - Nitrification-denitrification
  - Filtration
  - N stripping and acid washing
  - Dehydration
  - Composting
  - …

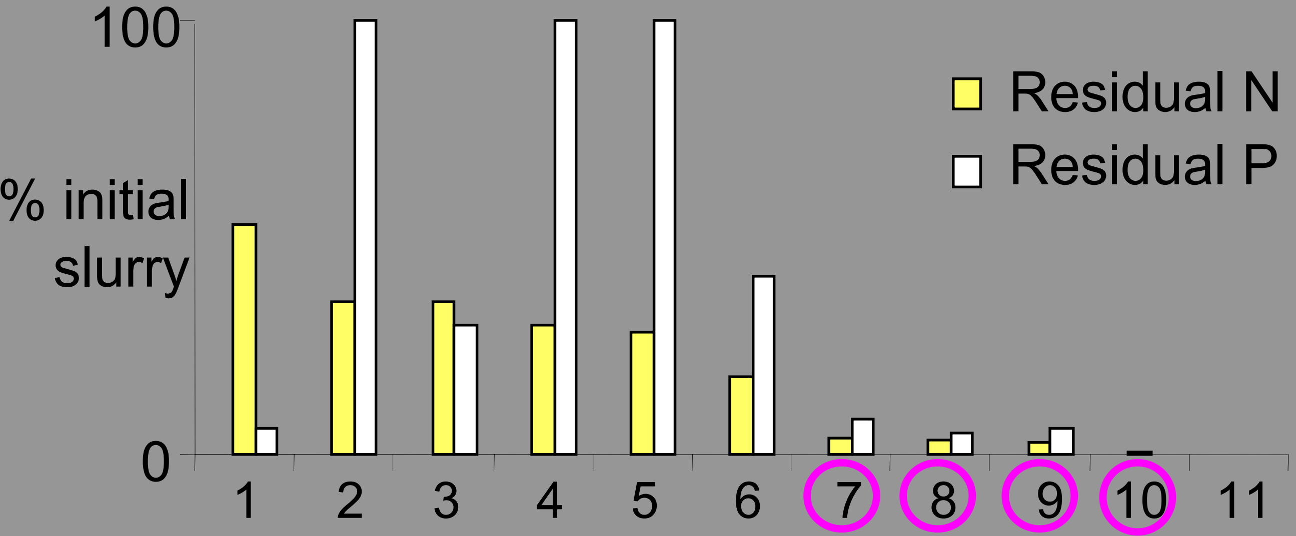
Selection criteria 1

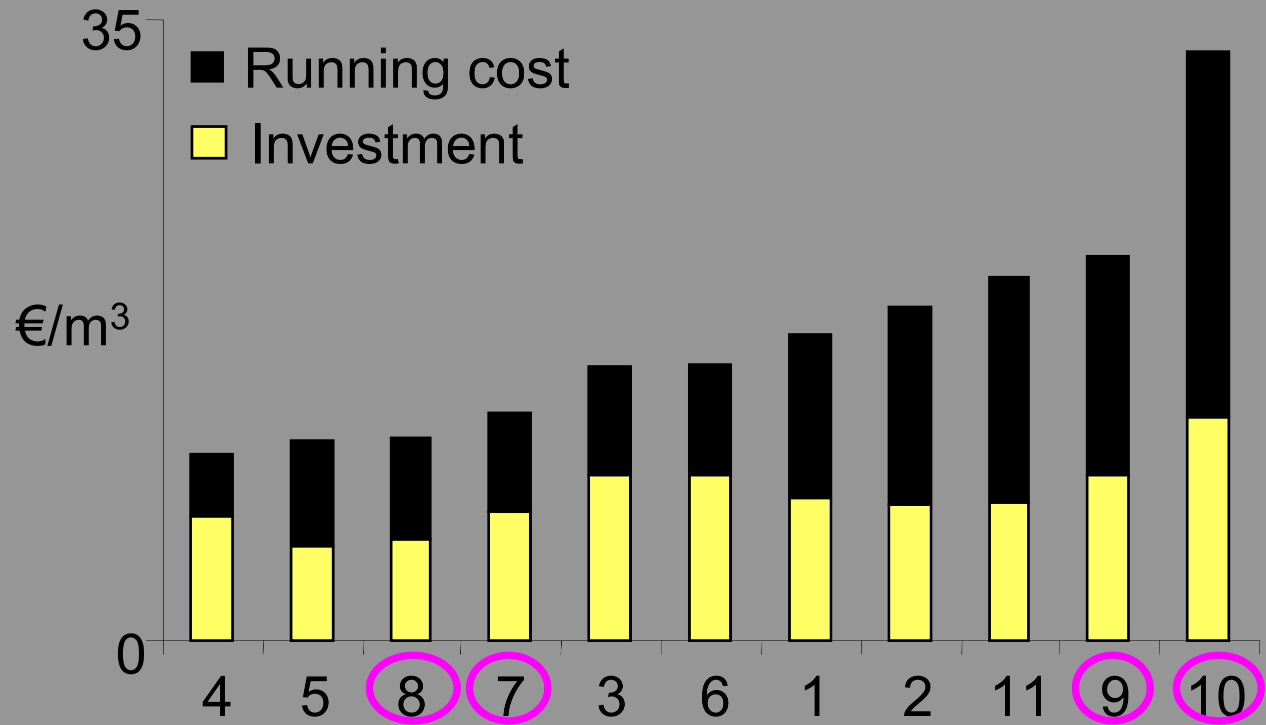
	Farmers	Cooperatives	State authorities
1			Water authority approval
2	No by-product to manage on farms	Minimal by-products to manage	Minimal by-products to manage
3	Most treated liquid phase	Most treated liquid phase	Most treated liquid phase
4	Low cost	Low cost	Low cost

Selection criteria 2

	Farmers	Cooperatives	State services
5		Preserve fertilizing elements	
6	Low energy consumption	Low energy consumption	Low energy consumption
7	Easy maintenance	Easy maintenance	
8	Minimal ground occupation		Minimal ground occupation
9			Coupling with biogas production

Macsizut outputs





☞ Most cost-effective: **#8 centrifugation + nitrification-denitrification**

Discussion support

NDN-SP "Val'Epure"

Total Génie Civil FRF 6 303 411
Total Equipement FRF 1 010 627
TOTAL Investis. FRF 7 314 038
TOTAL Investis. € 1 115 018

	100% privé		**75% subv. - 25 % privé**		**60% subv. - 40% privé**	
	Avec amortis	Sans amortis	Avec amortis	Sans amortis	Avec amortis	Sans amortis
Charges amortis. (annuités+prov. amortis)						
Génie civil (6,5%, 15 ans)	31	20	8	5	12	8
Equipements (6,5%, 7 ans)	8	7	2	2	3	3
TOTAL	39	27	10	7	16	11
Charges de fonctionnement						
réactifs	0	0	0	0	0	0
énergie	19	19	19	19	19	19
main d'œuvre	11	11	11	11	11	11
maintenance	3	3	3	3	3	3
suivi annuel, bilan	1	1	1	1	1	1
TOTAL	35	35	35	35	35	35
Charges de collecte						
TOTAL	11	11	11	11	11	11
Coût FRF/m^3 de lisier traité	***85***	***73***	***55***	***53***	***61***	***57***
Rachat des co-produits						
TOTAL	2	2	2	2	2	2
Coût de revient FRF/m^3 de lisier traité	**82**	**71**	**53**	**50**	**59**	**54**
Coût de revient €/m^3 de lisier traité	**12,58**	**10,78**	**8,13**	**7,68**	**9,02**	**8,3**

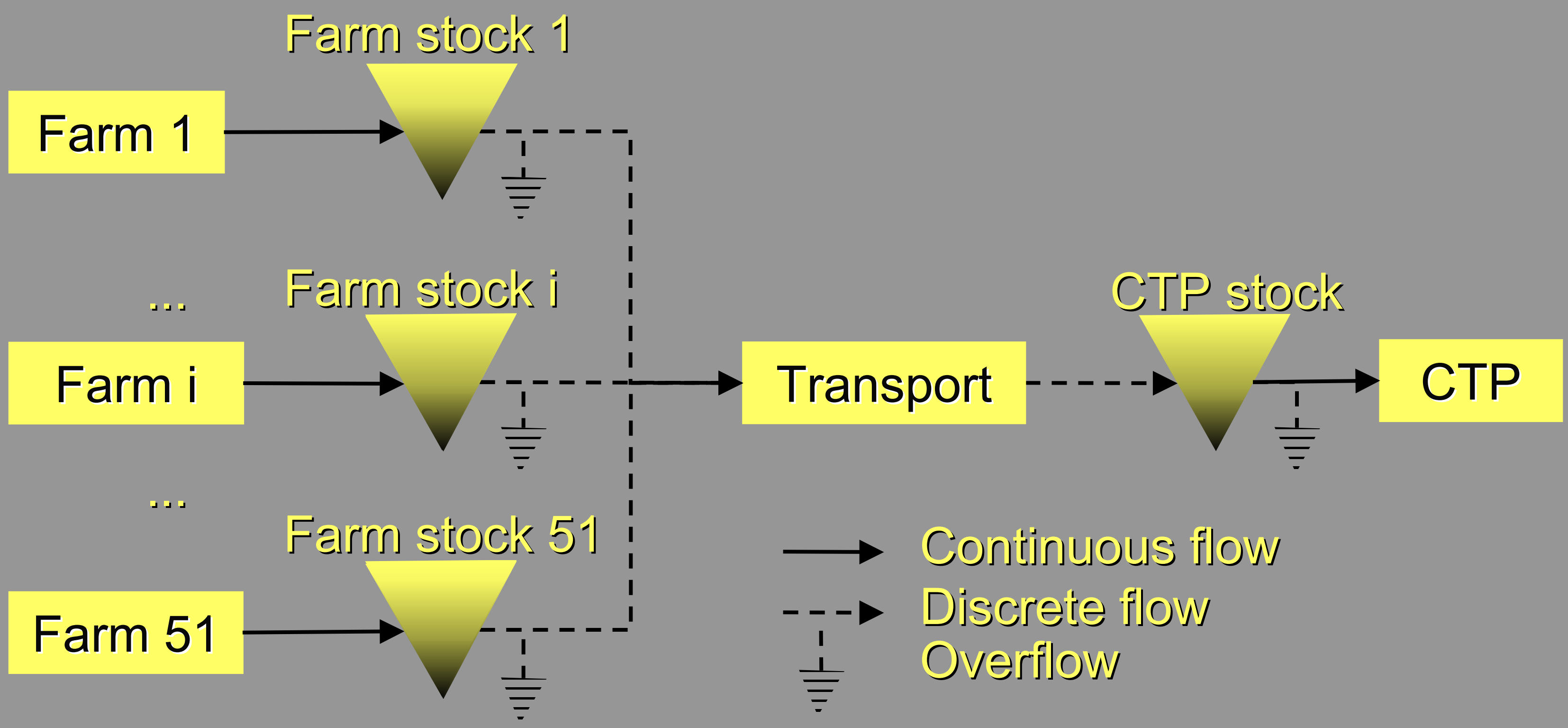
Decision 3

- A1: Treating effluents *in situ*
- A2: Centrifugation + nitrif.-denitrification

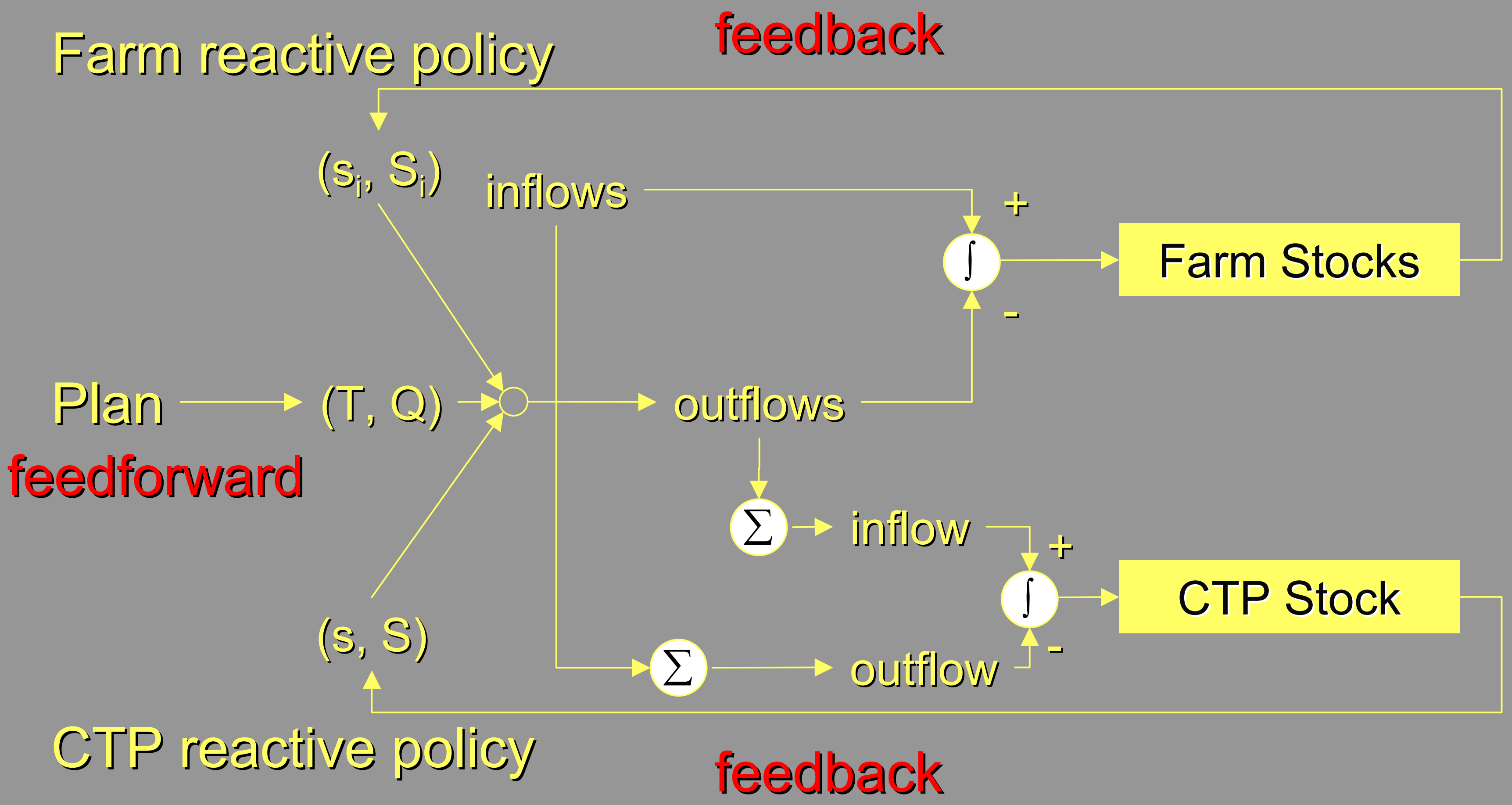
- Q3: What supply policy for the plant?
  – when should a delivery be done?
  – how much should be delivered?
  – transport means?
  – workforce?
  – cost?

☞By using the Approzut dynamic simulation model with the stakeholders

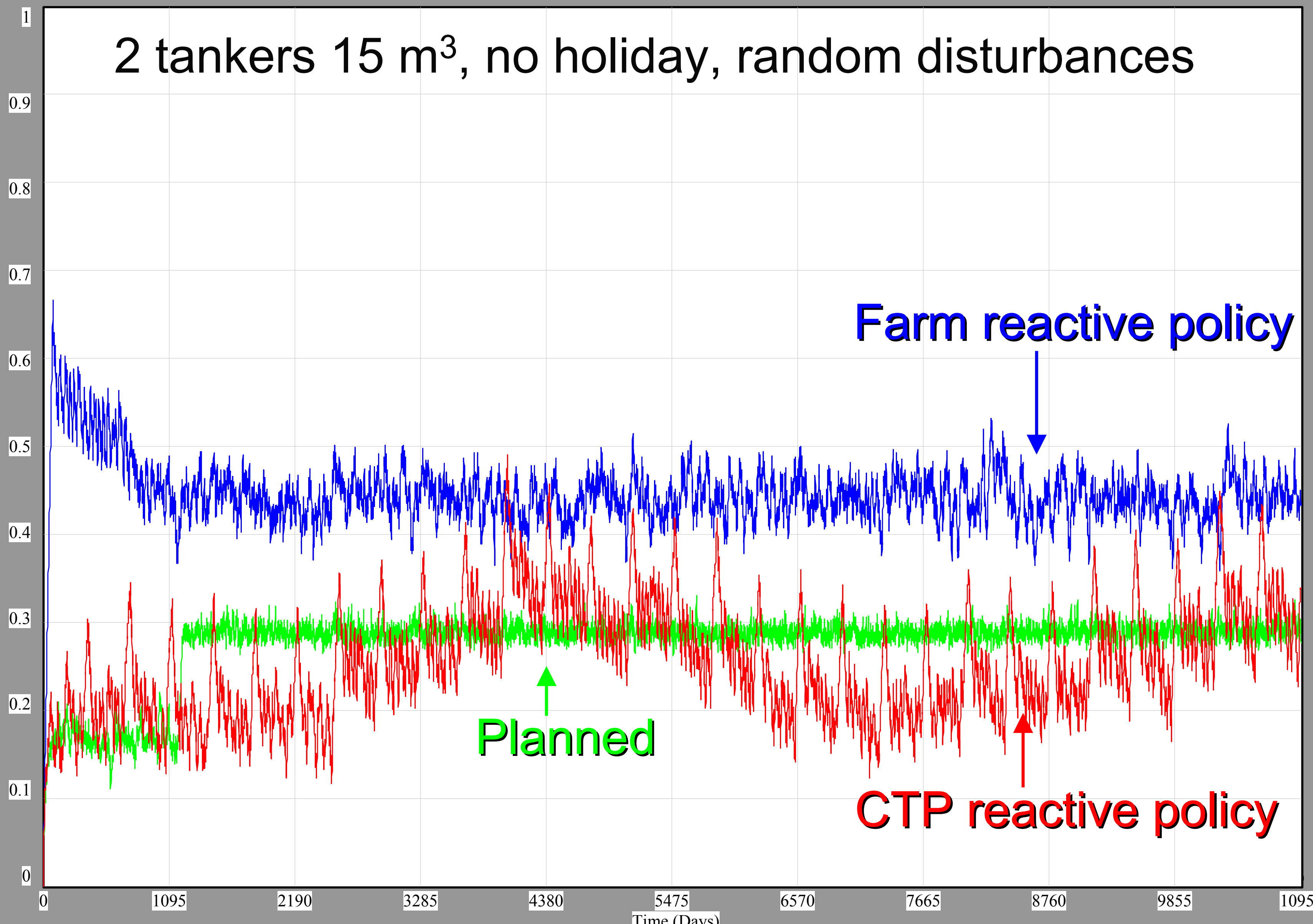
Supply chain outline



Approzut model outline



Scenario simulations



Policy comparison

- No overflow → reactive policies
- Efficiency (amounts, work time, kms) → *same*
- Slurry shortage → no holiday
- Overtime work → no holiday
- Robustness → no holiday, farm reactive
- Field implementation → planned?

Policy choice

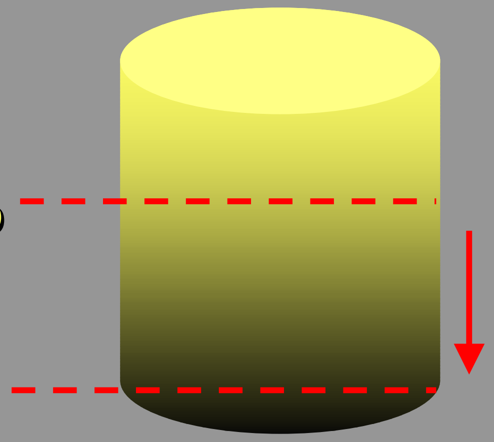
- Farm reactive policy best

When?

from stock level $s_i = 65\%$

How much?

down to level $S_i = 0$



- Priority rule: fuller-nearer-smaller first
- No holiday
- 2 full-time drivers + 1 part-time
- Information about stock levels

Decision 4

- A1: Treating effluents *in situ*
- A2: Centrifugation + nitrif.-denitrification
- A3: No decision yet

- Q4: How to evaluate the whole supply chain?

☞By using the **Biomas** multi-agent system to **simulate transfers at territorial scale**

Biomas multi-agent system

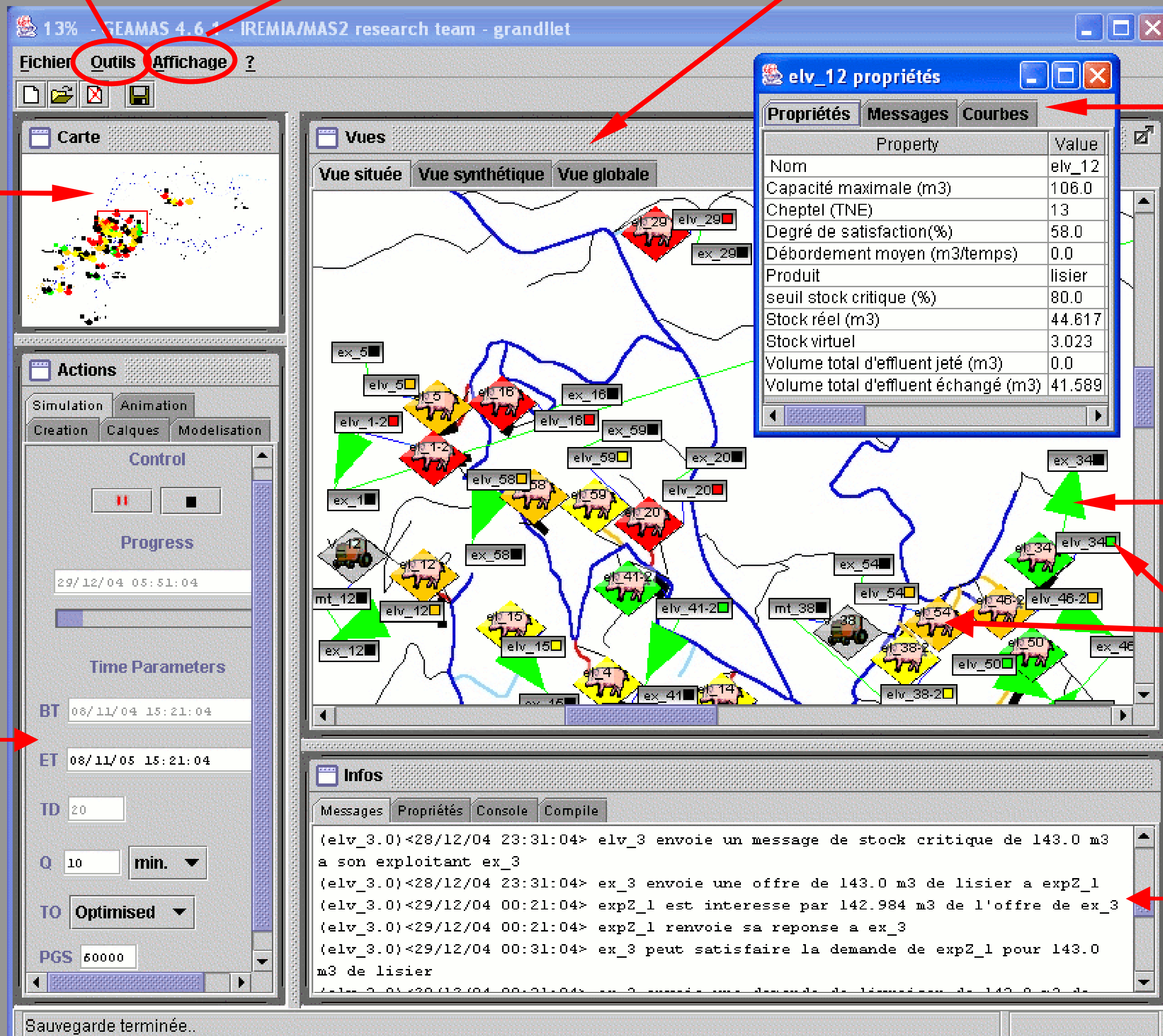
Analysis tools

Parameter menu

Situated view

Mini map

Agent inspector



Exchange intensity

Qualitative state

Simulation control

Messages

Conclusions-Prospects

Choose a treatment process
MACSIZUT

Evaluate the whole supply chain at territorial scale
BIOMAS

Choose a supply policy
APPROZUT

- Devise a methodology of simulation-based decision-making with the stakeholders