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A 3D-serious game for teaching the environmental sustainability of pig farming systems

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INRA SCIENCE & IMPACT

Context

- Animal production in the world (FAO, 2006)
  - Animal production has a significant contribution to the environmental impacts at world level
  - Consumption of animal products is expected to increase by almost 100%

  ⇒ Necessity to reduce the impact per unit product by more than 50%

- Different strategies for improvement
  - Improvement of animal's efficiency
  - Reduction of emissions from manure
  - Adaptation of livestock farming systems…

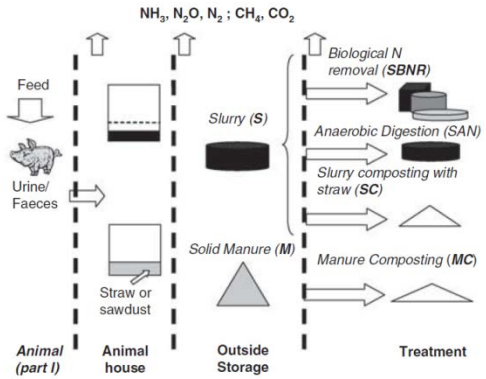
  ⇒ Different approaches at different scales : animal, feed, housing, manure management…

The environmental impact of animal production

- Complex to evaluate
  - Fluxes or concentrations : nitrates, ammonia, phosphorus, energy, water
  - Aggregated impacts : eutrophication, acidification, global warming, use of non renewable resources
  - Negative / Positive (biodiversity, carbon storage, land use…)

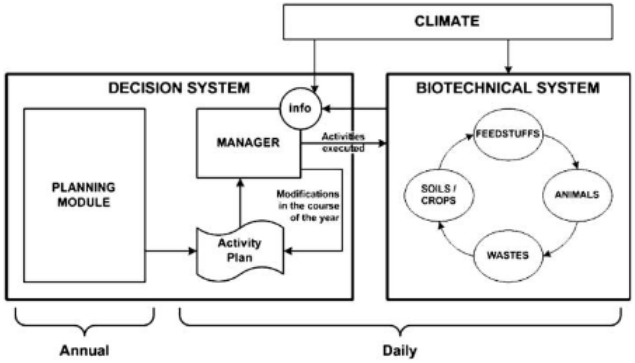
- Can be improved in different ways
  - Design of the whole system
    - Animal density per ha, recycling of nutrients…
  - Improvement of production process and practices
    - Animal performance, animal feeding and housing, manure management…

Different models available in the literature



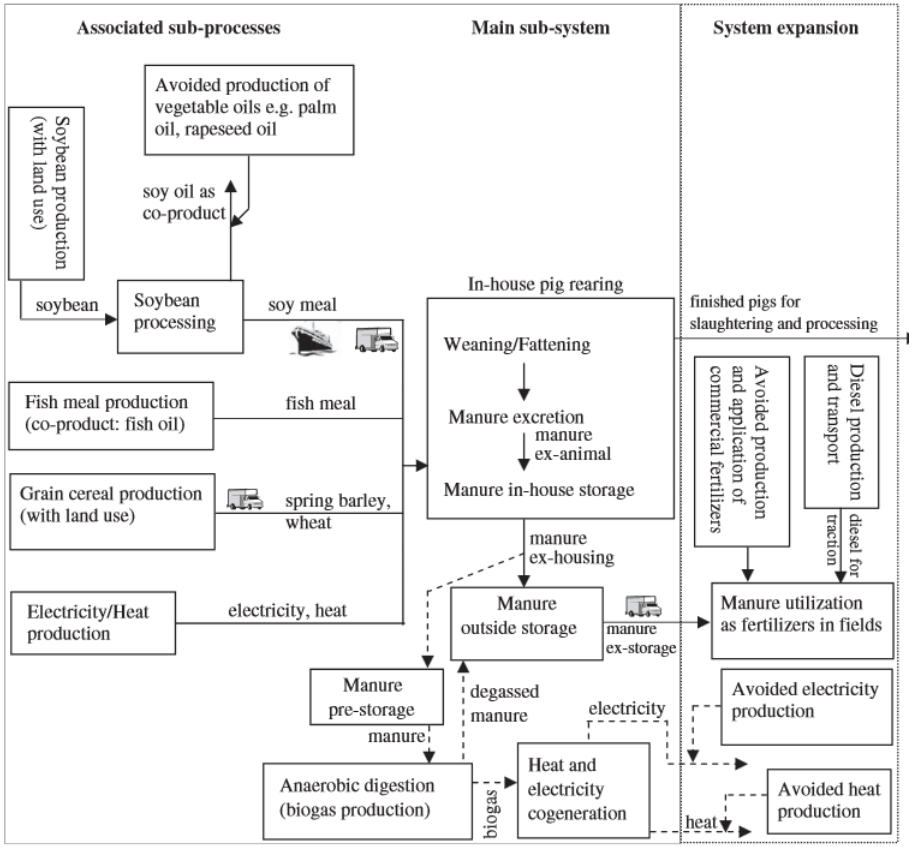
Pig unit models

(Rigolot et al. 2008)



Pig farm models

(Chardon et al. 2010)



Production chain models (LCA)

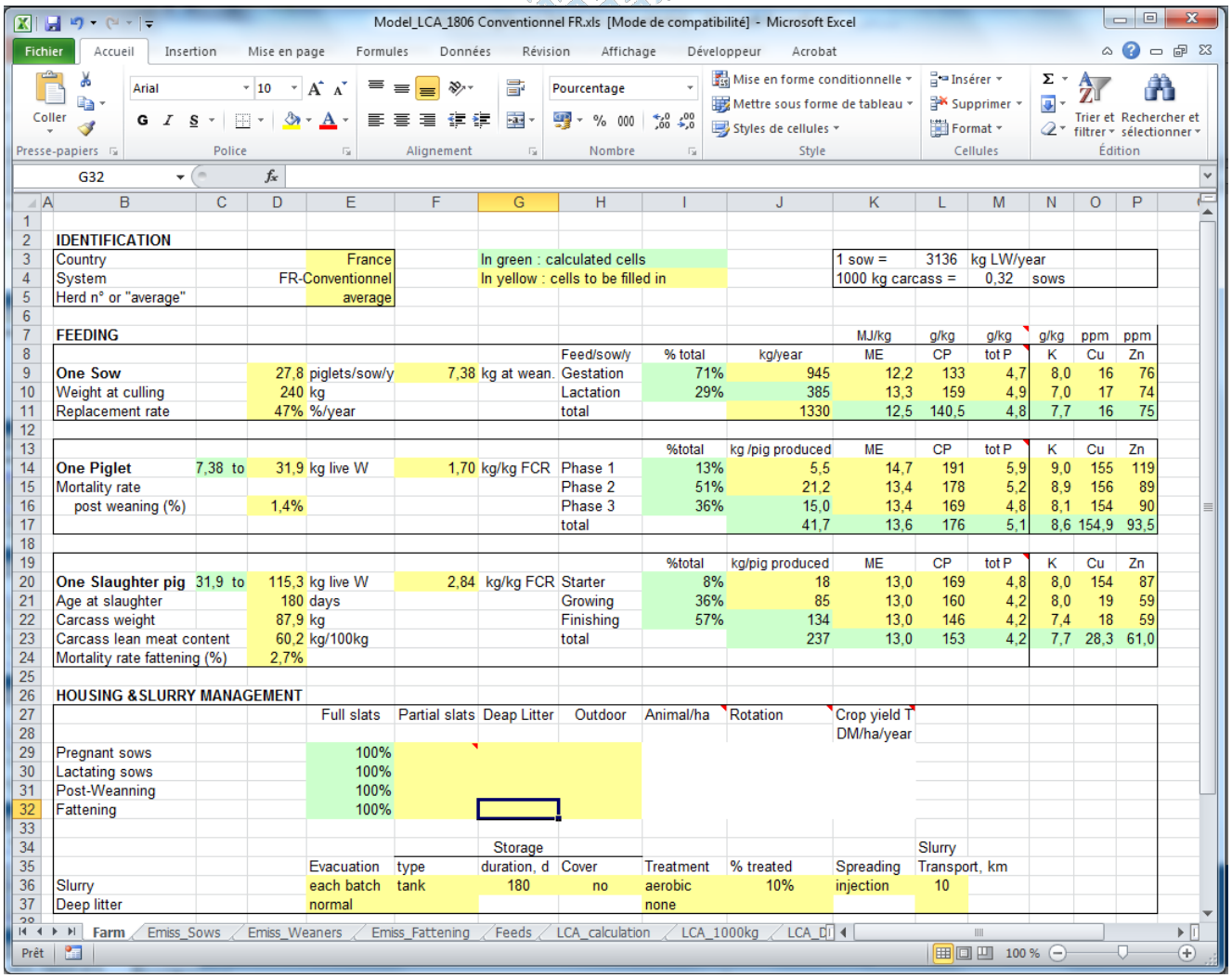
(Nguyen et al., 2010)

Different models available in the literature

- But they are difficult to understand and to teach
  - Complexity : too many equations and interactions…
  - Lack of realism : only numbers, no pig, no building, no manure…
  - Lack of attractiveness for the students : too conceptual & abstractive …

⇒ Develop a **3D serious** game using **a pig farm simulator** in order to facilitate the learning process

Objective : change interface from this !



Model_LCA_1806 Conventionnel FR.xls [Mode de compatibilité] - Microsoft Excel

	IDENTIFICATION															
	Country			France		In green : calculated cells				1 sow =	3136	kg LW/year				
	System			FR-Conventionnel		In yellow : cells to be filled in				1000 kg carcass =		0,32	sows			
	Herd n° or "average"			average												
	FEEDING									MJ/kg	g/kg	g/kg	g/kg	ppm	ppm	
							Feed/sow/y	% total	kg/year	ME	CP	tot P	K	Cu	Zn	
	One Sow		27,8	piglets/sow/y	7,38	kg at wean.	Gestation	71%	945	12,2	133	4,7	8,0	16	76	
	Weight at culling		240	kg			Lactation	29%	385	13,3	159	4,9	7,0	17	74	
	Replacement rate		47%	%/year			total		1330	12,5	140,5	4,8	7,7	16	75	
								%total	kg /pig produced	ME	CP	tot P	K	Cu	Zn	
	One Piglet	7,38 to	31,9	kg live W	1,70	kg/kg FCR	Phase 1	13%	5,5	14,7	191	5,9	9,0	155	119	
	Mortality rate						Phase 2	51%	21,2	13,4	178	5,2	8,9	156	89	
	post weaning (%)		1,4%				Phase 3	36%	15,0	13,4	169	4,8	8,1	154	90	
							total		41,7	13,6	176	5,1	8,6	154,9	93,5	
								%total	kg/pig produced	ME	CP	tot P	K	Cu	Zn	
	One Slaughter pig	31,9 to	115,3	kg live W	2,84	kg/kg FCR	Starter	8%	18	13,0	169	4,8	8,0	154	87	
	Age at slaughter		180	days			Growing	36%	85	13,0	160	4,2	8,0	19	59	
	Carcass weight		87,9	kg			Finishing	57%	134	13,0	146	4,2	7,4	18	59	
	Carcass lean meat content		60,2	kg/100kg			total		237	13,0	153	4,2	7,7	28,3	61,0	
	Mortality rate fattening (%)		2,7%													
	HOUSING & SLURRY MANAGEMENT															
				Full slats	Partial slats	Deap Litter	Outdoor	Animal/ha	Rotation	Crop yield T DM/ha/year						
	Pregnant sows			100%												
	Lactating sows			100%												
	Post-Weanning			100%												
	Fattening			100%												
						Storage							Slurry			
				Evacuation	type	duration, d	Cover	Treatment	% treated	Spreading	Transport, km					
	Slurry			each batch	tank	180	no	aerobic	10%	injection	10					
	Deep litter			normal				none								

Farm | Emiss_Sows | Emiss_Weaners | Emiss_Fattening | Feeds | LCA_calculation | LCA_1000kg | LCA_D

Prêt

100 %

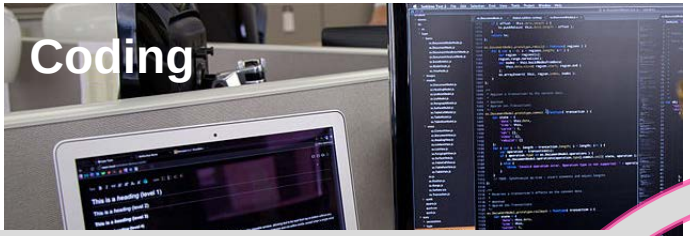
… to this !

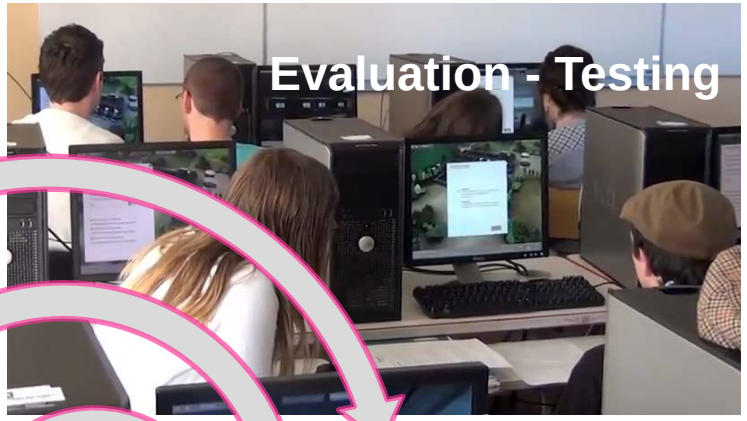
Approach used to develop the tool

- Build a multidisciplinary team
  - Scientists and engineers from research & development (French network "*Animal production and environment*")
  - Teachers in animal science and agriculture
  - Specialists in the use of new e-technologies for teaching & learning
  - A company specialized in 3D image, cartoons and serious games
- Define of the target public
  - Students in agriculture : from high school to university
  - Training of technicians and farmers
- "Agile" software development methodology
  - collaboration between self-organizing, cross-functional teams
  - iterative and incremental development
- Involve sponsors, and future users
  - ...

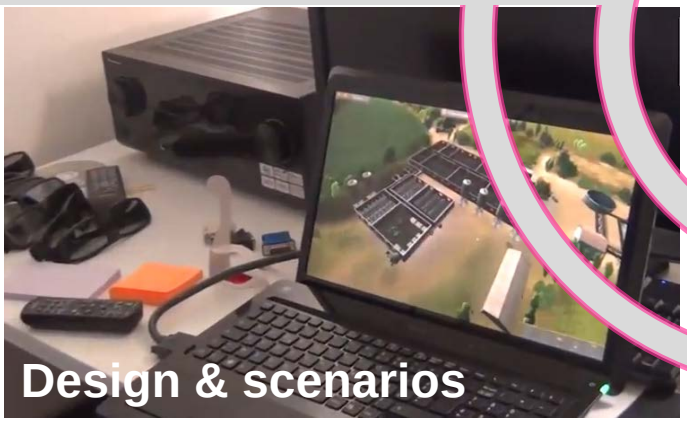
20 participants and sponsors

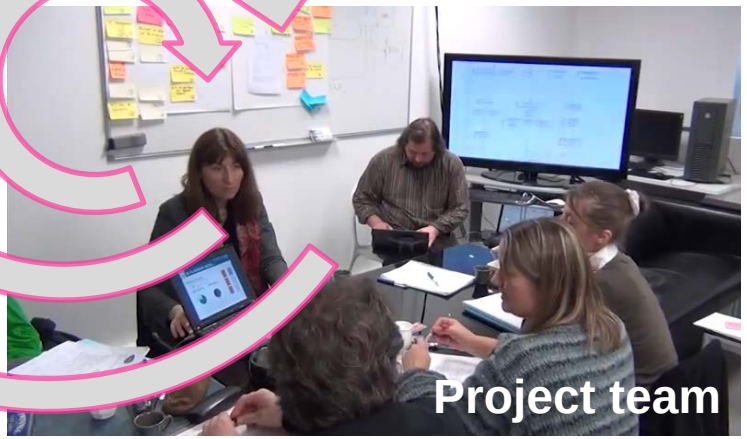
Methodology of development





- 8 iterative « sprints » (3 weeks each)
- A new version produced every 2 sprints





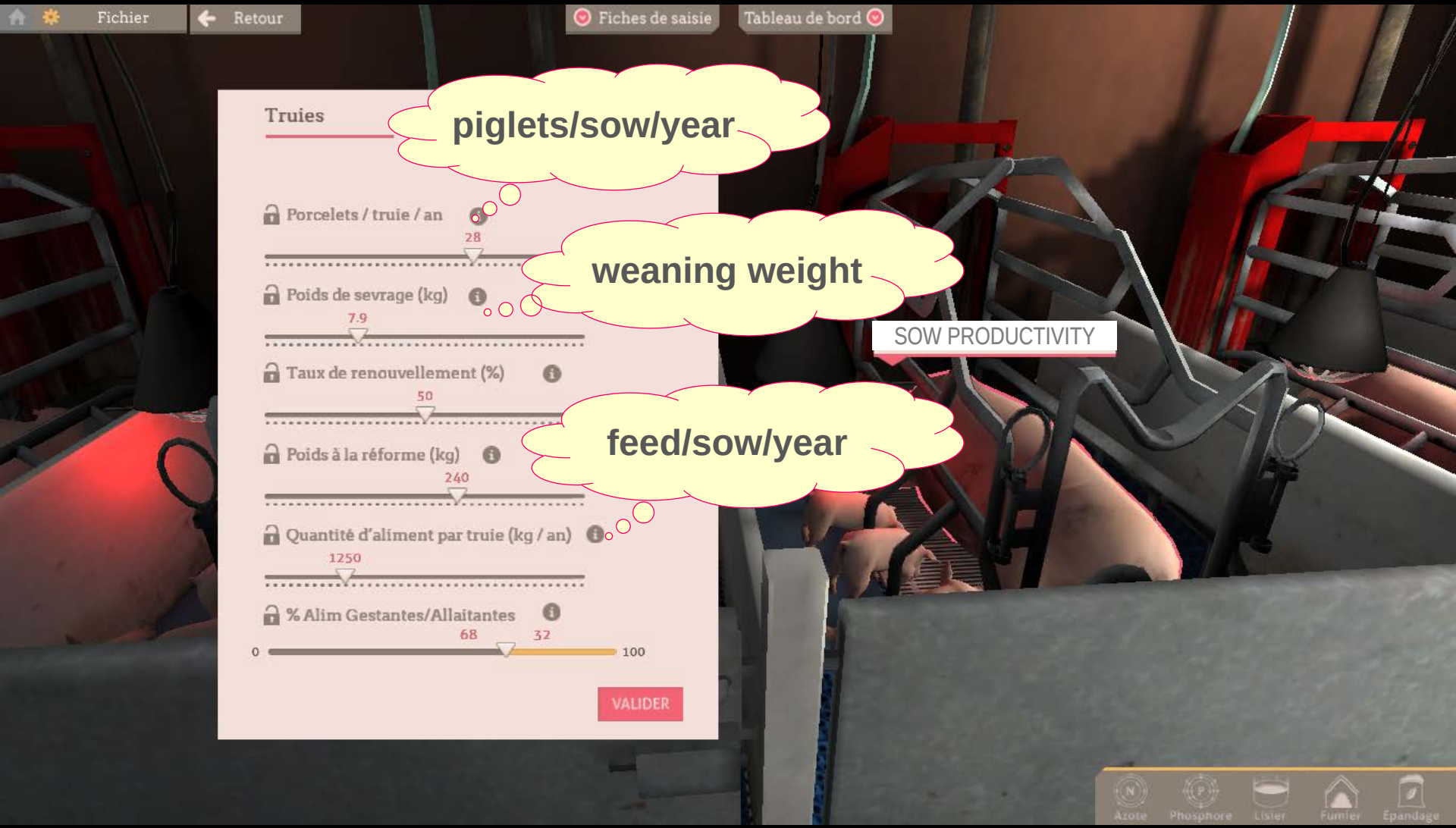
A look to some input interface

- Description of animal performance
  - “Touch” the sow to check performance
- Description of housing
  - “Touch” the floor to change housing of post-weaning piglets
- Description of feeds
  - “Touch” the feeder to check feed composition for fattening pigs
- Manure management
  - “Touch” the slurry storage to add aerobic treatment of 50% of slurry

Move to the farrowing room

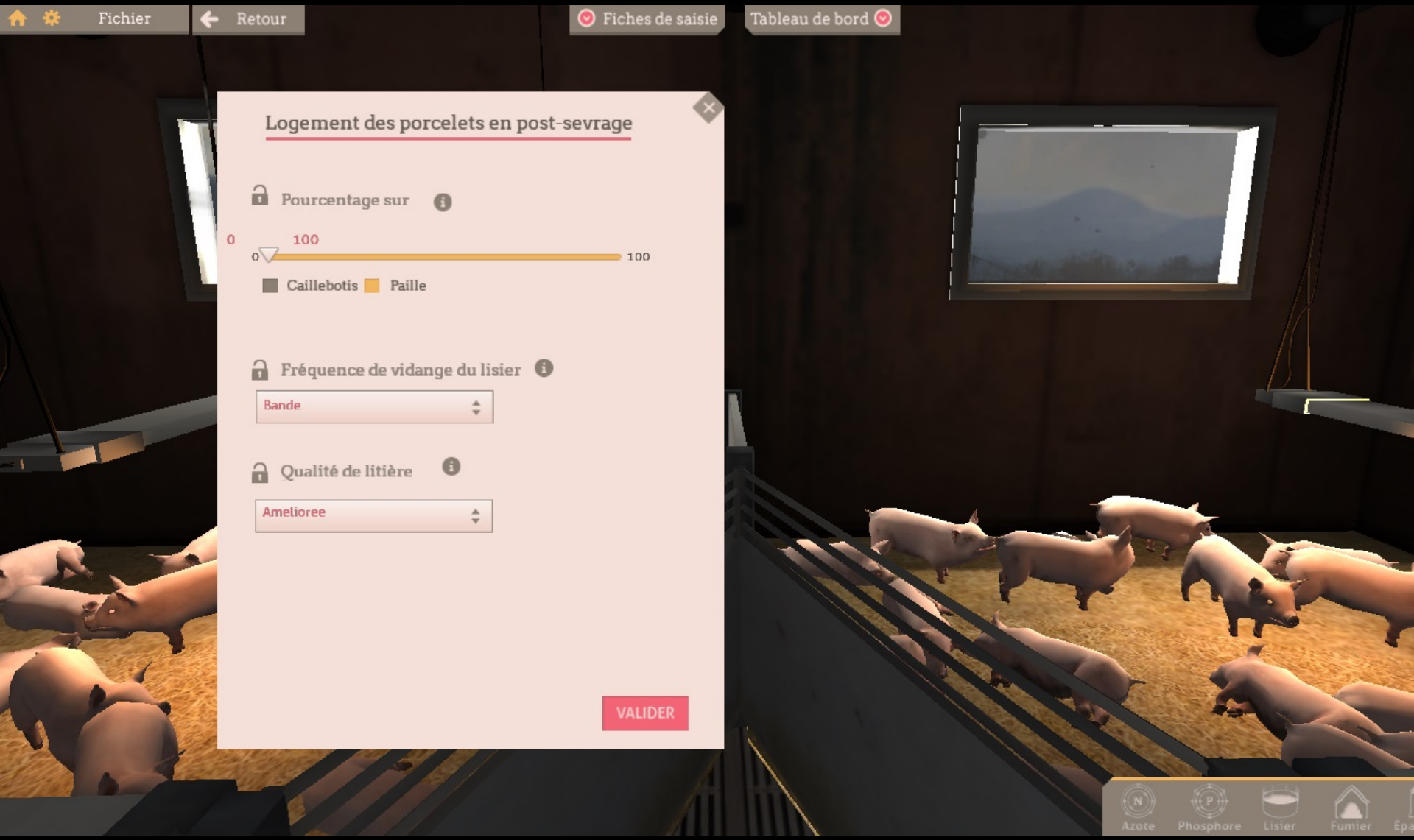
=> Check sows productivity

=> Change sows performance



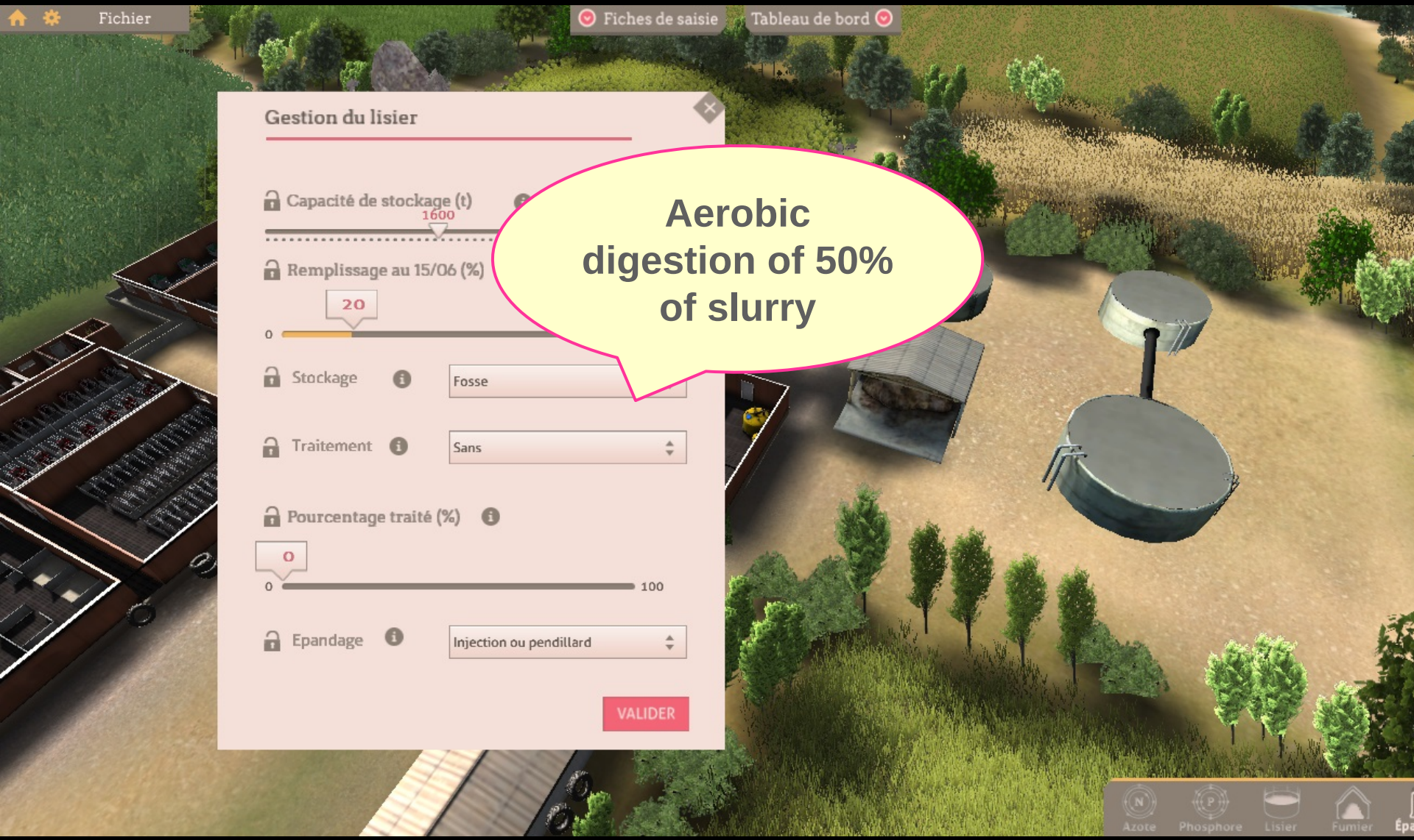
=> Change housing of post-weaning piglets

=> Change housing of post-weaning piglets



=> Check feed composition of fattening pigs

=> Change manure management



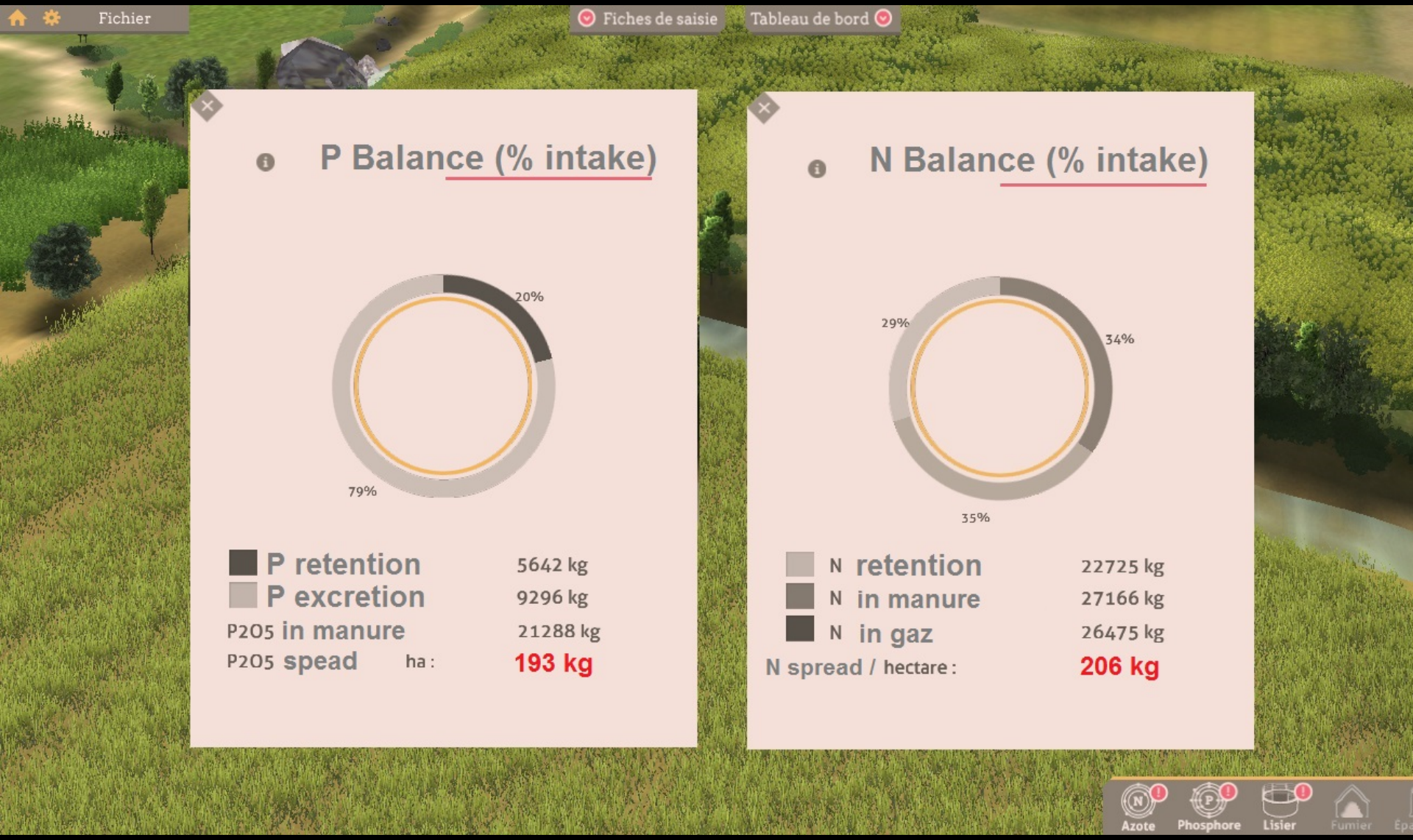
=> Change manure management

A look to some outputs

- Real time dashboard
  - Red lights => environmental situation of the farm
- Nutrient balance
  - N and P balance
- N-gaz emissions
  - Per type of gaz
  - According to location of emission
- Environmental evaluation by Life Cycle Assessment
  - Global warming
  - Eutrophication

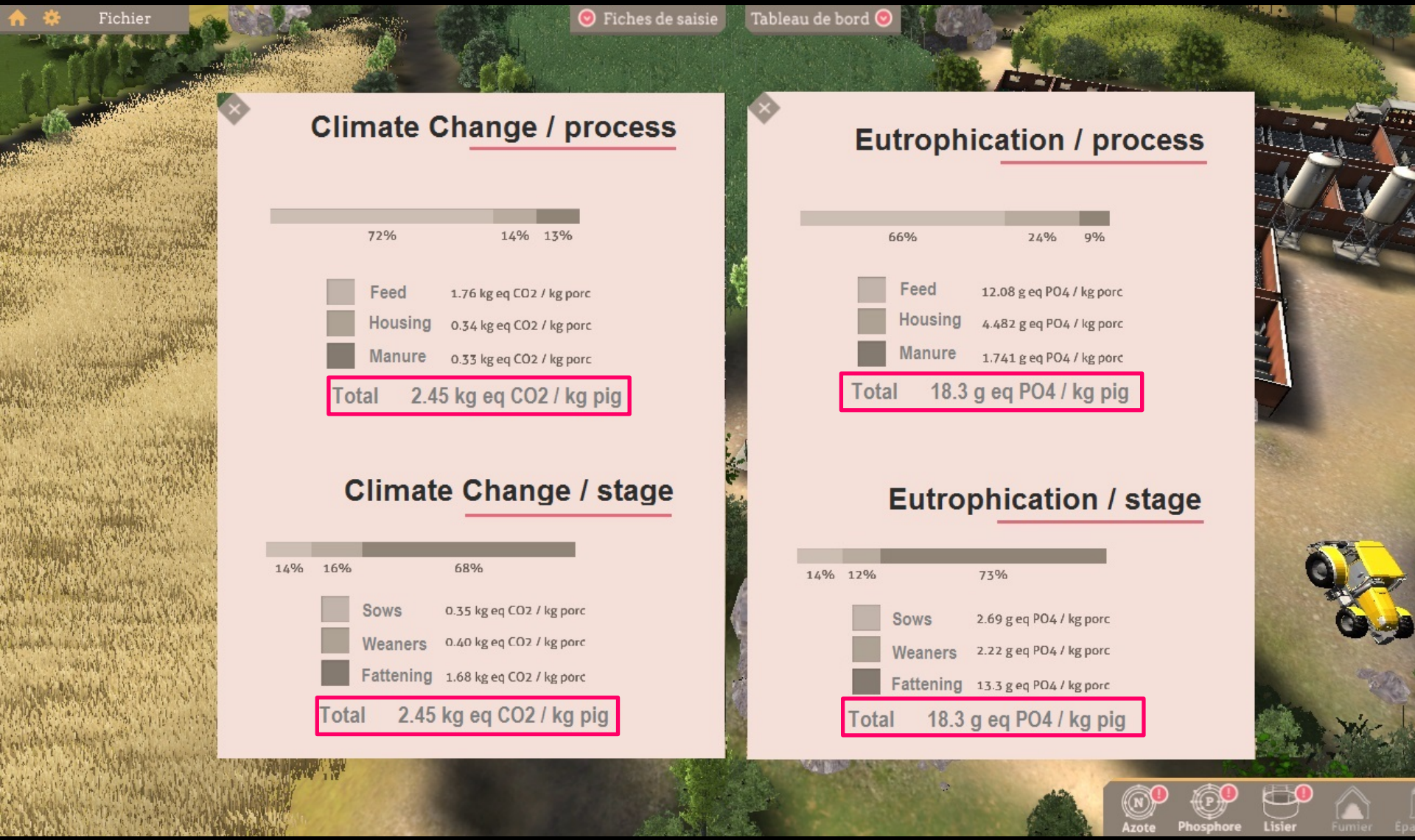
Real-Time dashboard

N and P balance



N-gaz emissions

Environmental evaluation by LCA

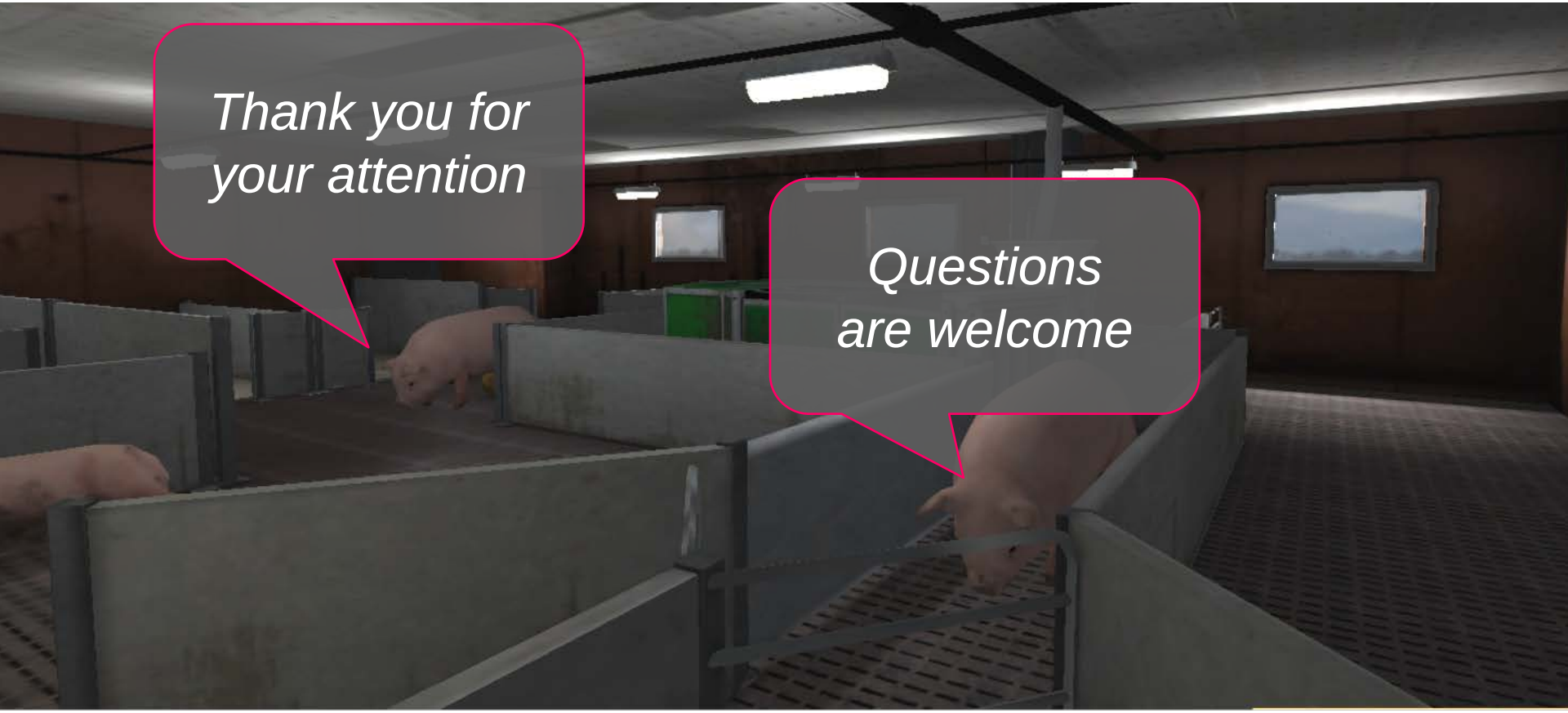


Strategies of use

- Predefined scenarios
  - A given objective with limited possibilities
  - ⇒ A first approach adapted to self learning
- Scenarios defined by the teacher to address specific topics *e.g.*
  - Restore an appropriate N or P balance by improving nutrition
  - Adapt size of storage to crop rotation
  - Evaluate the effect of housing (litter *versus* slatted floor) on global warming impact of pig production
  - ⇒ The teacher define a starting point (a farm configuration) and an objective to reach
  - ⇒ He can lock some inputs to guide the solution
- "Real life" simulation
  - Evaluation of environmental impacts of a real farm
- "Free" utilization

Conclusion and perspectives

- A motivating project
  - Innovative approach for most of the participants
  - A good way to favor cooperation between research, development and education
  - Well received by the sponsors
- Serious game approach
  - Very attractive for the students / intuitive learning
  - A way to make complex models accessible for teaching
  - A good way to learn new concepts
- Perspectives
  - Diffusion of the software and large scale evaluation
  - Platform for teachers to share examples of courses
  - Extension to other animal productions (dairy, poultry)


Thank you for your attention
Questions are welcome