Preventing over-exploitation in a dynamic CPR game with heterogenous players: A comparison of awareness, communication and advice in the lab

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Plan

- Context and rationale
- Theoretical framework
- Treatments
- Implementation of the experiment
- Preliminary Results
- Conclusion and perspectives

Context & Rationale

In Tunisia, the complex terminal aquifer (Groundwater) is under the threat of overexploitation due to:

- High level of water use for irrigation
- Very low level of water recharge
- Inappropriate public policies for irrigation water management

>1 meter lowering of the water table/year

Institutional framework for irrigation water management

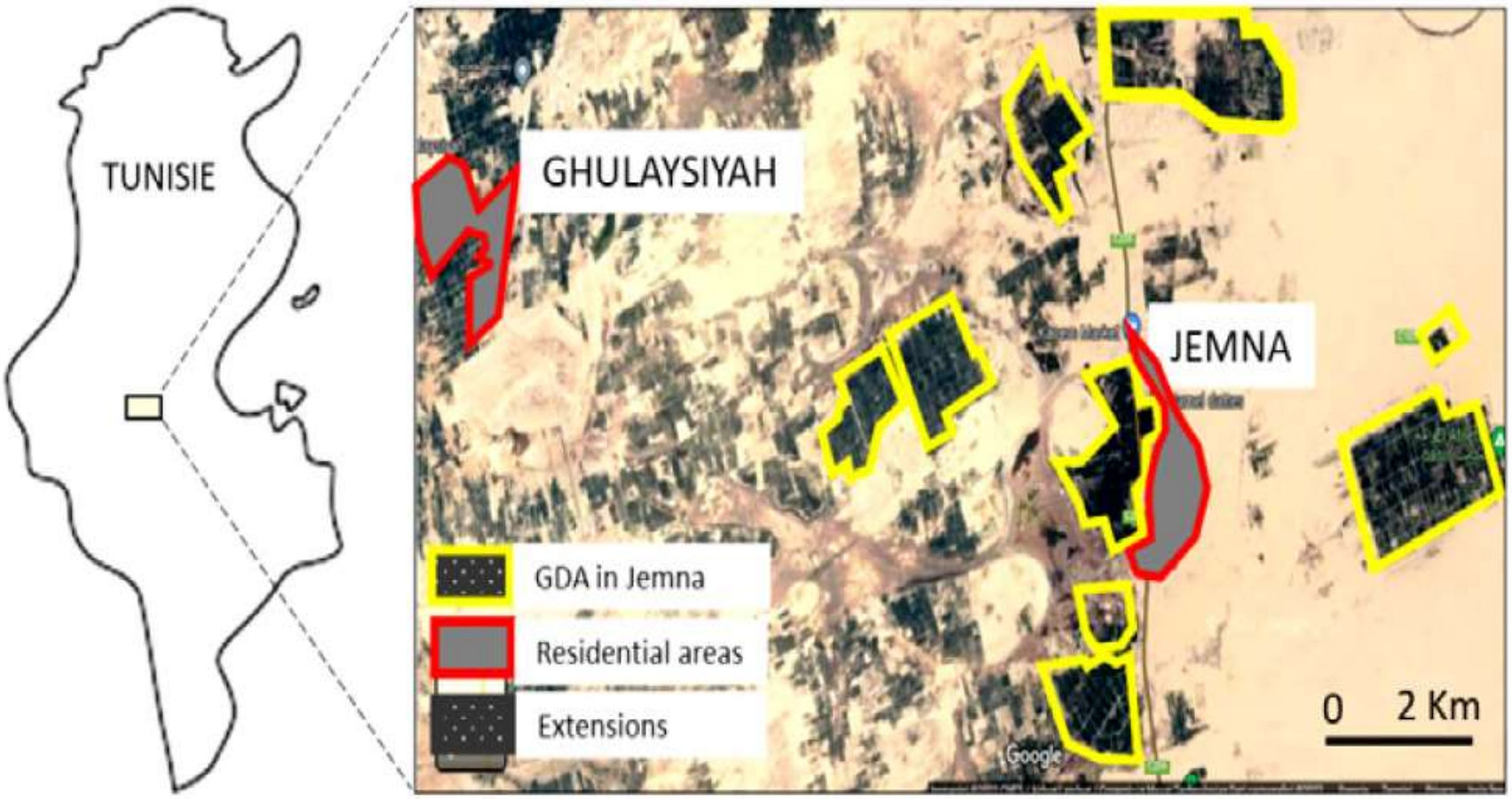
1. • **The Ministry of Agriculture and water resources**
2. • **The Regional Commission for Agricultural Development**
3. • **The Groups of Agricultural Development (GDA)**

In Tunisia, the management of irrigation water (mainly in public areas) is **decentralized**. It is managed by the Regional Commission for Agricultural Development, which delegates the management to the several **Groups of Agricultural Development** of its operating area.

The Groups of Agriculture Development

The GDAs are **voluntary groups** with a civil personality created around an irrigated perimeter to allow users to manage their systems in an autonomous way **according to a given regulation**.

Case study of jemna oasis



Current status of irrigation water extraction : 3 types of extractors

A/ GDA members

B/ Non-GDA members
(Type 3) External

Operators who extract water from surface wells with land plots in extensions (new oasis)

Type (1)
GDA

Operators who extract from a common well (source of water)

Type (2)
MIX

Operators who extract both from the common well and surface wells with land plots in extensions (new oasis)

Theoretical framework

GOVERNING A GROUNDWATER COMMONS: A STRATEGIC AND LABORATORY ANALYSIS OF WESTERN WATER LAW

(ROY GARDNER, MICHAEL R. MOORE, and JAMES M. WALKER, 1997)

Function to be optimized

$$V_{(t)}(d_{(t)}) = Max_{xi} \sum_{i} B_{it} - C_{it}$$

With :

d_t depth to water at time t,

$B_{it}(x_{it}) = ax_{it} - bx_{it}^2$

$C_{it}(x_{it}, X_t, d_t) = [(d_t + AX_t + B)x_{it}]$,

Proposed solution

A **dynamic model** of Common Pool Resource extraction with **heterogeneous types of players.**

Modeling of the existing

- Take into account the different types of players (GDA-Mixed-External)
- Calculation of Nash equilibrium and optimal solution
- experiments (in the lab (France and Tunisia) and in the field (Tunisia)

Treatments

Propose and test "new approaches " of water management policies

- T0 (Baseline) players can exploit the CPR without regulation
- T1 (Simulator)
- T2 (Simulator + Communication)
- T3 (Simulator + Expert Advice)

} **policies**

Implementation of the experiment (1)

All players perform two sequences of the extraction game

7 periods

Training sequence (baseline)

7 periods

T0 Baseline

T1 Simulator

T2 Simulator + Communication

T3 Simulator + Expert Advice

Implementation of the experiment (2)

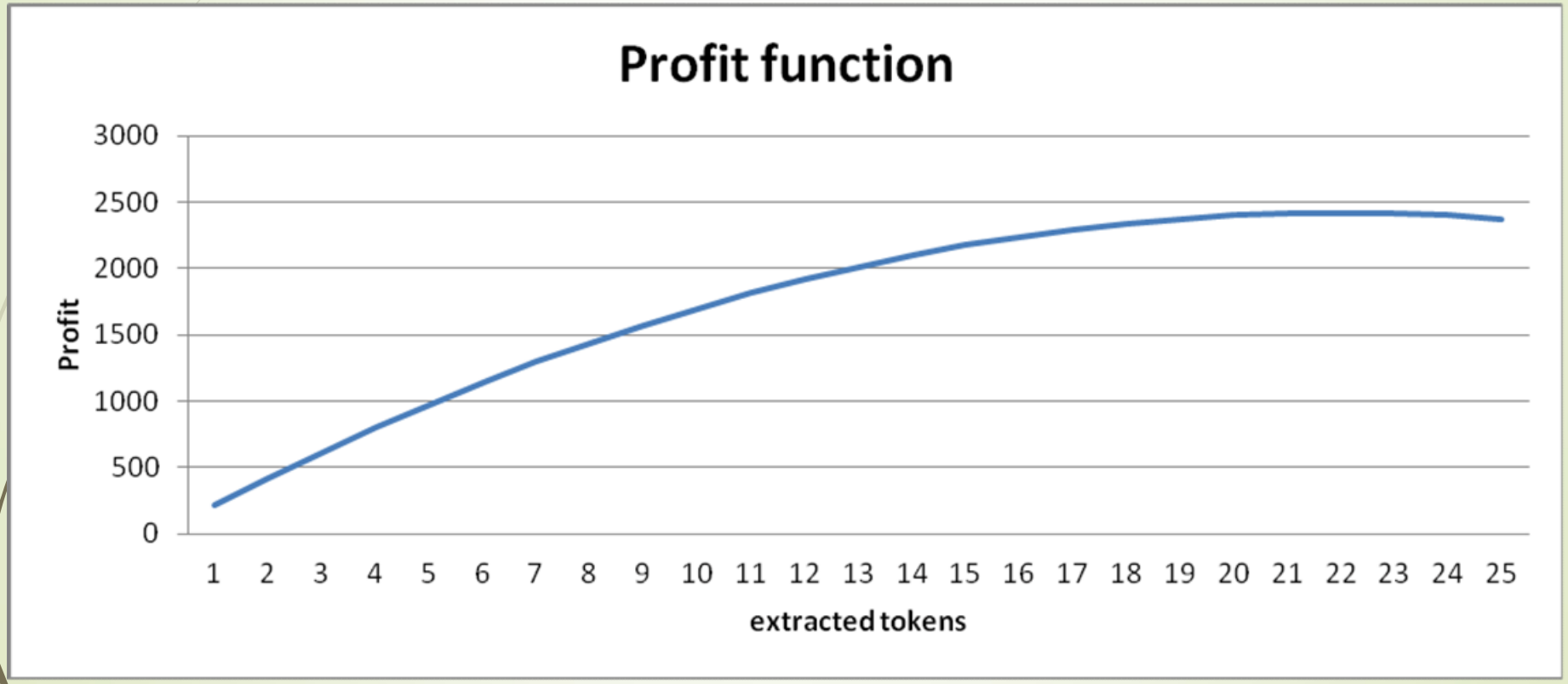
Decision

T0 : Baseline treatment

- **GDA type:** No decision to make: at each period they automatically extract 1 token.
- **Mix Type:** Their extraction consists of an automatic part (1 token) and a variable part (0 – 24 tokens)
- **External type:** can extract any number of tokens between 0 and 25 in each period.

Implementation of the experiment (3)

Your profit will be calculated based on this formula: $B_{it} = 220x_{it} - 5x_{it}^2$



Implementation of the experiment (4)

Cost of tokens

- Base cost : the cost of the first token extracted during this period

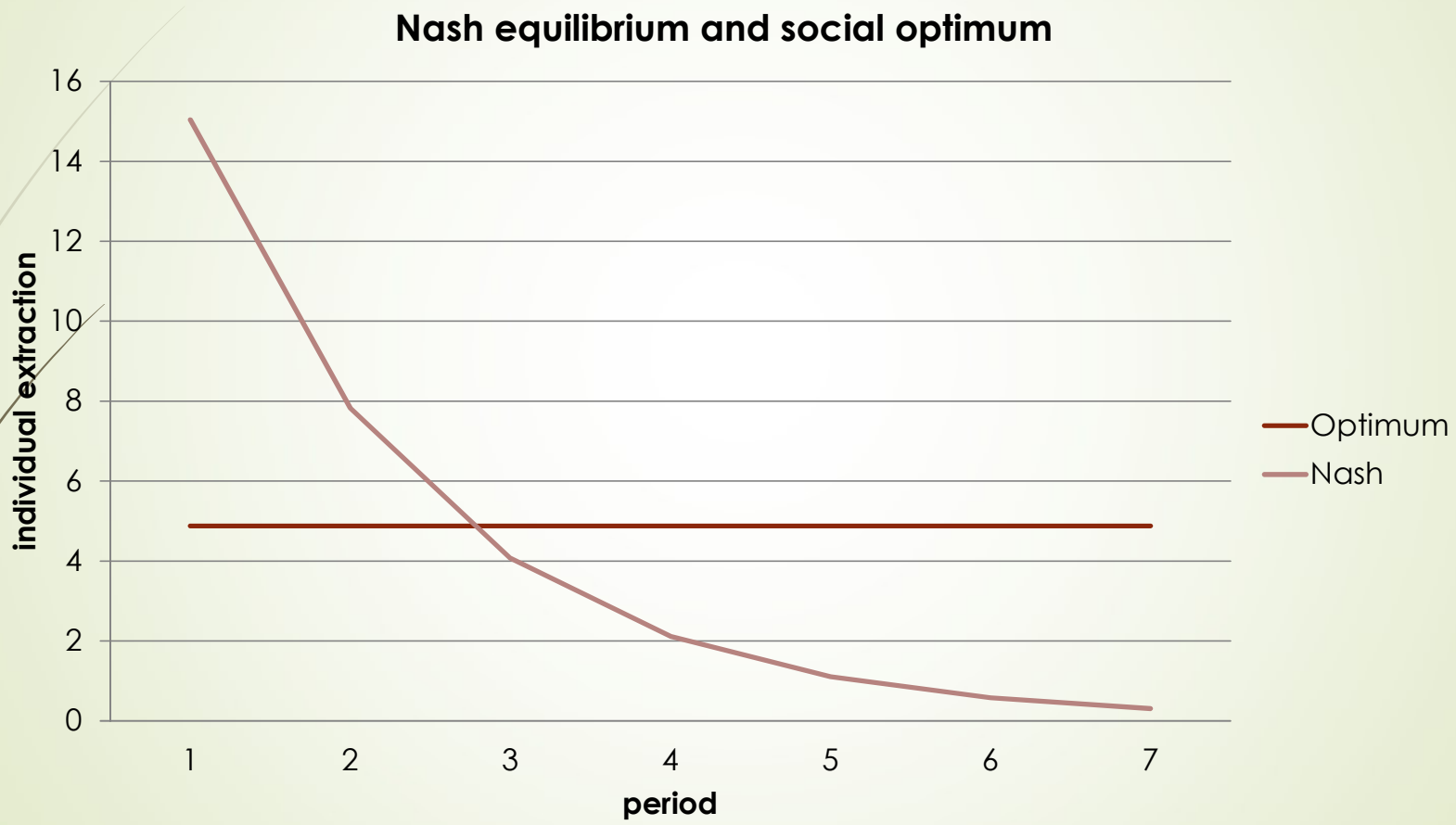
- Each additional token extracted will cost **1 ECU** more than the previous token.

- The cost of your tokens is equal to the average of extracted tokens x number of tokens you have extracted

- When you move from one period to the next, the base cost of the new period will be equal to the cost of the last token of the previous period + **1 ECU**

Your gain = Your benefit - Cost of tokens

Theoretical predictions



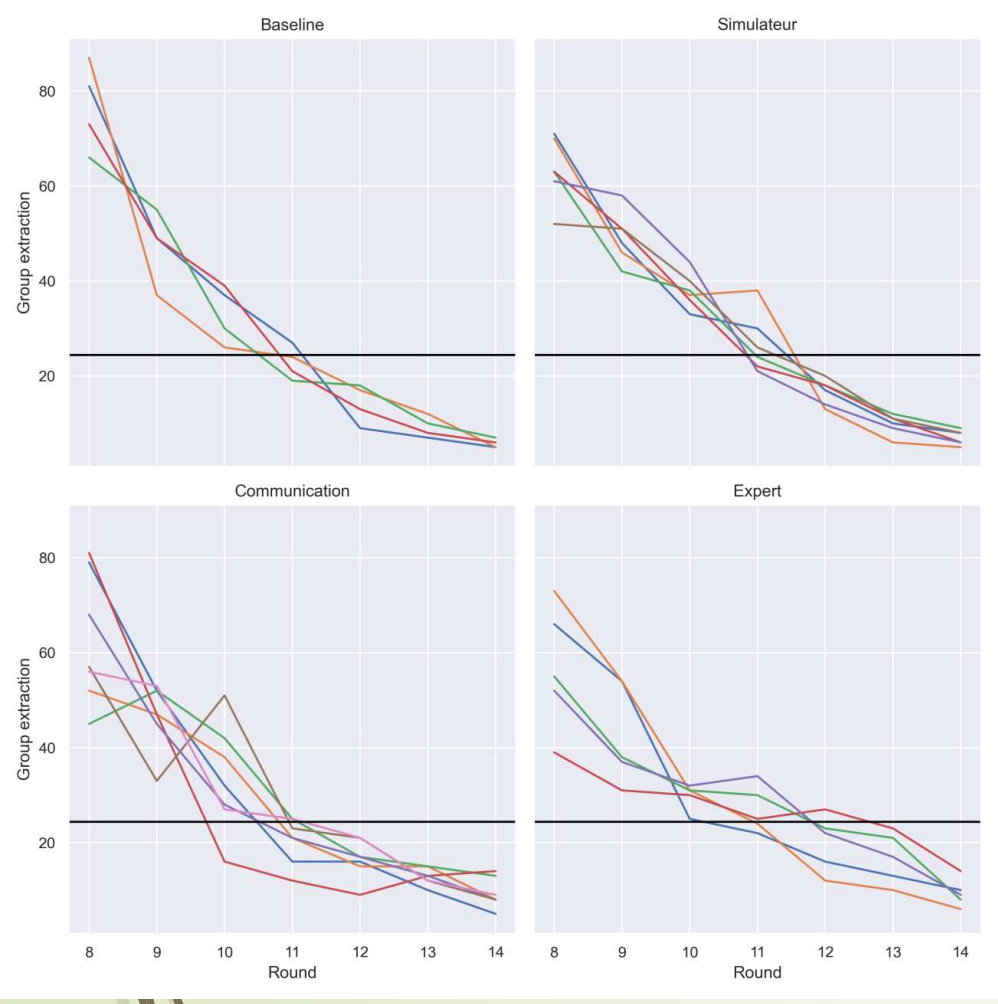
Preliminary Results (1)

Important

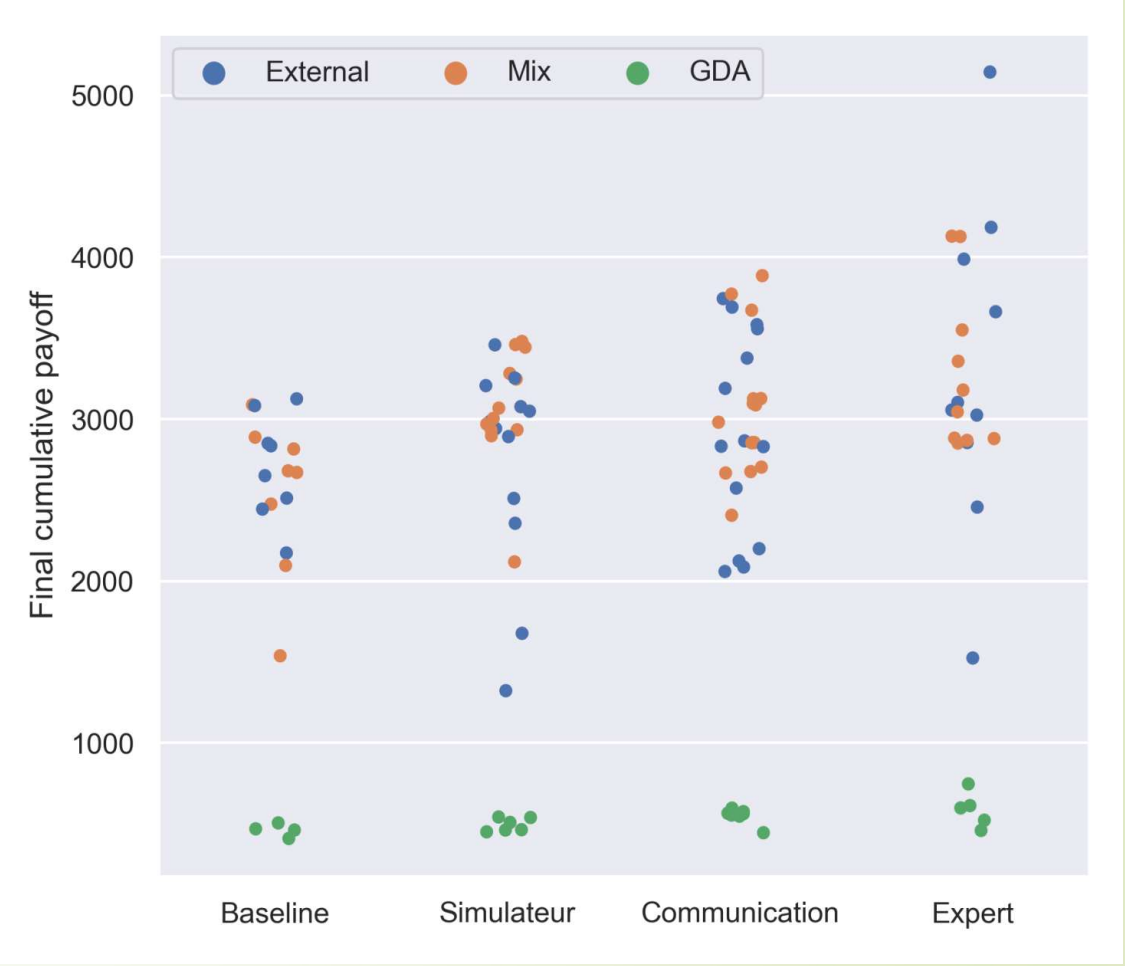
We designed this protocol in two sequences, the first sequence is **Training sequence (baseline) and the second sequence are the treatments.**

We present here the between results of the second sequence.

Preliminary Results (2)



extractions



Payoffs

Preliminary Results (3)

Treatment effect on cumulative payoff

	All treatment (1)	Expert (2)	Communication (3)	Simulateur (4)
treated	278.1***			
	(74.28)			
expert		356.4***		
		(91.11)		
Communication			259.6***	
			(85.16)	
Simulateur				209.9**
				(94.41)
N	1050	525	525	490
R^2	0.203	0.226	0.233	0.194

Note: The dependent variable is the cumulative payoff
All estimations include round fixed effect, group type
Standard errors in parentheses.
Statistical significance is denoted by: $^{*}p < 0.1, ^{**}p < 0.05, ^{***}p < 0.01$.

Preliminary Results (4)

Treatment effect on total extraction of the group

	All treatment (1)	Expert (2)	Communication (3)	Simulateur (4)
treated	-1.573***			
	(0.609)			
expert		-2.324***		
		(0.723)		
communication			-2.431***	
			(0.692)	
simulateur				0.265
				(0.809)
N	1050	525	525	490
R^2	0.831	0.842	0.872	0.828

Note: The dependent variable is the total extraction of the group
All estimations include round fixed effect, group type
Standard errors in parentheses.
Statistical significance is denoted by: $^{*}p < 0.1, ^{**}p < 0.05, ^{***}p < 0.01$.

Preliminary Results (5)

Treatment effect on Total extraction of the group by round

	All treatment (1)	Expert (2)	Communication (3)	Simulateur (4)
treatment*r8	-13.98***	-16.91***	-10.29***	-14.86***
	(1.551)	(1.768)	(1.786)	(1.976)
treatment*r9	-2.559*	-3.929**	-2.179	-1.429
	(1.551)	(1.768)	(1.786)	(1.976)
treatment*r10	0.292	-2.768	-1.018	5.286***
	(1.551)	(1.768)	(1.786)	(1.976)
treatment*r11	0.366	0.714	-4.411**	5.429***
	(1.551)	(1.768)	(1.786)	(1.976)
treatment*r12	4.025***	4.411**	2.036	5.857***
	(1.551)	(1.768)	(1.786)	(1.976)
treatment*r13	-1.776	0.0714	-2.429	-3.143
	(1.551)	(1.768)	(1.786)	(1.976)
treatment*r14	2.621*	2.143	1.268	4.714**
	(1.551)	(1.768)	(1.786)	(1.976)
N	1050	525	525	490
R^2	0.844	0.867	0.880	0.855

Note: The dependent variable is the total extraction of the group

Conclusion and prospects

- Our findings are promising: the expert advice treatment seems to be the most efficient
- Next steps:

1. Achievements of Lab experiments at INAT (240 subjects)

2. Experiments on the field with the farmers of jemna oasis (240 users of the resource)

Thanks for attention !