SUMMARY OF RESEARCH QUESTIONS, APPROACH AND DATA COLLECTION METHODS

ConFooBio is an EU funded project focussed on the resolution of conflicts between food security and biodiversity conservation under uncertainty. Managing a specific natural resource often results in conflict between those stakeholders focussed on improving food security and those focussed on conservation. Such situations are increasing in intensity and scale and can be damaging for both biodiversity and human livelihoods. ConFooBio aims to develop new strategies to manage conflicts of this nature, showing how to achieve synergies that protect both biodiversity and secure livelihoods.

RESEARCH QUESTIONS

Conservation conflicts are complex and intractable and are often misleadingly framed as wildlife impacts, such as the damaging impacts of problem animals on farmlands, or the impacts of modern aquaculture on wild fish stocks. In reality they involve complex interactions between multiple stakeholders, who have conflicting interests, values and goals. Experimental games can inform the design of effective future interventions to mitigate such conflicts and help identify the conditions under which stakeholders in conflicting situations are likely to cooperate.

We conducted experimental games and questionnaire surveys with farmers to address the following research questions:

1. What are the effects of alternative management strategies on farmers' willingness to cooperate with conservation objectives?
2. What affects farmers' willingness to coordinate their actions at the landscape level?
3. How do farmers' socioeconomic characteristics and attitudes interact with the behavioural effects of alternative management strategies?

CONSERVATION CONFLICT CASE STUDIES

We worked in four countries to address three conservation conflicts case studies:

- ✓ ***Goose-agriculture conflicts in Scotland:***

In Europe, some of the most critical conservation conflicts relate to changes in land use, farming practices and policy. The introduction of agri-environment schemes, as well as the rapid increase in protected sites (such as Special Areas of Conservation under the EU Habitats Directive) and targeted actions for particular species (reduced shooting or changes in legislative protection) all have markedly increased the populations of a number of species of conservation concern, including greylag and barnacle geese. In addition, intensively managed grasslands have provided better foraging opportunities for geese and hence led to a rapid increase in their population size. For instance, greylag goose population (*Anser Anser*) in Europe has increased by more than seven times, from an estimated 120,000-130,000 individuals in the 1980s to around 960,000 individuals in the 2010s. However, while this super abundance of geese is seen as one of the major success stories of European bird conservation, they have caused significant agricultural damage to farmers and increasing social conflicts. Geese can cause agricultural damage to grass by reducing sward structure and causing soil puddling and compaction, but also to arable crops such as wheat by reducing yield. Across Scotland, goose management options vary across scales and have

no clear underlying basis. Conflict interventions are not driven by goose number or trends alone but are also strongly influenced by farmers' traits and other socio-political factors such as lobbying efforts.

- ✓ ***Elephant related conflicts in Gabon:***

In Gabon, as in many parts of Africa and Asia, elephants are an iconic and keystone species and symbolise wildlife conservation. The significant decrease in elephant numbers has raised concerns that the African elephants are on the path to extinction in the near future. Their protection has therefore attracted significant support from the global North. However, they are also perceived as problem animals imposing significant costs on livelihoods by rural residents living alongside them. Elephants not only destroy crops that peasant farmers depend on for survival, they also injure and kill people. In Gabon, food insecurity from crop losses as well as farmers' abilities to mitigate crop-raiding are further aggravated by rural exodus reducing local capacity to protect fields against elephants. Crop-raiding elephants are often killed in retaliation by farmers. Evidence suggests that competition for space with rapidly growing human settlements is a major driver of these elephant-related conservation conflicts. As conservation areas limit lands available for agricultural activities and increases the likelihood of elephant foraging on farmlands, land use changes resulting from conservation policies such as protected area establishment are also cited an important cause of such conflicts.

- ✓ ***Forest conservation-agriculture conflicts in Madagascar and Kenya:***

Madagascar supports an extremely rich biodiversity yet faces considerable threats from deforestation. Despite the tripling of the country's protected areas in 2014, covering 10% of the country's total land area, deforestation continues at an alarming rate and is driven primarily by conversion to agricultural lands. Those who directly use forest resources for agricultural purposes are often those that are most food insecure, and most reliant on forest ecosystem services. Farmers often have very few alternatives and have to resort to the short-term incentives of forest conversion for food production outweighing the long-term stability of forest resources. Madagascar has recently been identified as the country with the highest risk of conflict between food security and biodiversity conservation.

In Kenya as in many Sub-Saharan Africa countries, agriculture fuels the foundation of the economy contributing about 30 percent of gross domestic product. Smallholder farmers form much of the sector. In Kenya, the traditional agricultural system based on shifting cultivation practised earlier has become less common, and has over the years been replaced by modern small scale and large scale agriculture. However, in the advent of population increase in Kenya, more land is put under cultivation to meet the food demand. Loss of forest cover in order to avail land for agriculture (especially subsistence) in Sub-Saharan Africa is a popular practice, Kenya is not exempted.

SUMMARY OF THE DATA COLLECTED

- ✓ ***Experimental games:***

Experimental games offer a powerful approach to cut through the complex structure of conflicts and help identify the conditions under which stakeholders in conflicting situations are likely to cooperate. They are a cost-effective and low-risk approach to evaluate ex-ante the effect of policy interventions on stakeholders' decisions and disposition to cooperate.

They also allow the identification of patterns in thinking and behaviour among stakeholders that can inform the implementation of larger-scale studies or larger modelling efforts. They are particularly useful for investigating sensitive or socially unacceptable behaviour that would be difficult to uncover with traditional survey techniques.

We developed three extensions of NonCropshare, a coordination game for insect-based ecosystem services (https://ccl.northwestern.edu/netlogo/) to account for specific structural factors relevant to each of the three-conservation conflict contexts. The games were designed as a public good game framed around farmers' land use decisions in a digital farming landscape. The game parameters were not based on empirical data but were logically selected based on game theoretic principles. However, they were calibrated to reflect a realistic range of potential costs and benefit scenarios.

The games were played in a workshop setting using 8-inches tablet computers. Participants were placed into groups of four households, each participant represented one household and was endowed an equal share of land in the game, a total of 9 lands and was asked to choose one land-use option in each cell. The games were interactive and simulate participate decision situations over time. Each experimental game session consists of six to nine rounds, analogous to agricultural years in which participants make land use decisions. Communication between participants was permitted in all the sessions. Participants all played the baseline set-up for three rounds and then played the treatments (alternative management strategies) in a random order in at least six rounds.

In Goosebumps (Appendix 1 - figure 1) and the elephant games (Appendix 1 - figure 2), crop-raiding animals are scattered in the landscape and decide where to go based on the "attractiveness" of the land use options. Each land use has a 'weight' assigned to it, with bigger weights meaning higher probability of attracting animals. Sacrificial crops or habitats have a 'neighbourhood effect' of adding to the weight of any square around them to reflect spillover effects. In each round, there are four options available to participants in each cell: 1) farm; 2) farm and scare wildlife off cells using non-lethal methods (e.g. physical or biological barriers); 3) farm and shoot animals in the cell (lethal control); and 4) lease the cell for wildlife conservation (i.e. provide elephant or goose habitats). Each option has different costs and benefits and is assigned different parameter settings.

In the Sharedspace game (Appendix 1 - figure 3 and figure 4), participants decide whether to farm the land cells or keep the forests / fallow in each round. Returns to farming (crop yield) depend on the conditions of the lands. Farming the cell brings some yields while conserving the forests or fallowing the land boosts crop yields to neighbouring cells through ecosystem service provision (e.g. pollination, soil restoration, watershed protection, landslide prevention). The game protocols are in Appendix 1.

- ✓ ***Household questionnaires***

The games were accompanied by a short questionnaire survey of 15-30 minutes to collect data on households' characteristics and attitudes. Key information gathered from the surveys are:

- Socio-demographic data,

- Basic land holding data and land used in the past year (recall period),

- Housing and assets,

- Social and human capital

- Interpersonal and institutional trust,

- Equity attitudes,

- Attitudes towards different conflict management strategies

The surveys in Gabon, Madagascar and Kenya were administered through in-person interviews with respondents. The surveys in Scotland were completed by participants themselves on tablet computers. All surveys were designing with KoboToolbox, a free and open source software used on android platforms (https://kf.kobotoolbox.org).

SAMPLING PROCEDURE AND DATA COLLECTION

Study sites and villages were selected in collaboration with local partners in each country to capture variation in farmers' exposure to conservation conflicts and their reliance on agricultural income. Our unit of analysis is the household. The game instruction protocol was extensively piloted in nearby localities, prior to the game implementation. The research ethics committee of the University of Stirling approved this study (GUEP286), and all research and field assistants administering the games received ethics training before carrying out fieldwork. We explained to participants that the aggregated results would be published but would not be linked to household identity or village-level information.

- ✓ ***Goosebumps in Orkney Scotland:***

We invited all willing farmers on Orkney islands off the north western coast of Scotland (table 1) to take part in the games. We surveyed both farmers on the mainland as well as the smaller isles. The participants were thus not randomly selected but the sample summary statistics (age, source income, size of arable land and education) were consistently representative of the farming community in Orkney. Each game participant represented one farm. In total, we conducted 21 games sessions with 84 farmers across 17 locations in Orkney. The games were piloted in June 2018 and administered in August and October 2018.

- ✓ ***Elephant game in Gabon:***

The sample size and study sites were chosen in consultation with the National Park Agency in Gabon to cover a range of exposure to crop raiding and reliance on agriculture. We run the games in two rural areas of Gabon (Table 1). One of these encompassed eight villages (140 households – 35 games) in the buffer zone of Lopé National Park established in 2002 (National Park villages) and the other rural area included ten villages (120 households – 30 games) within production forests situated between Lope and Ivindo National parks (logging villages) (table 1). Negative interactions between local farmers and forest elephants, *Loxodonta cyclotis,* are widespread in both sites. Due to the low number of households within each village, we did not randomly select participants but instead invited all willing participants present in each site to participate in our study. The games were extensively piloted in nearby villages in February and March 2018 and administered in April and May 2018.

- ✓ ***Sharedspace game in Madagascar and Kenya:***

In Madagascar, we conducted 68 game sessions with 272 small-scale farmer households living in rural villages in and around Mangabe protected area (IUCN protected area category VI with sustainable use of natural resources) managed by the environmental organisation Madagasikara Voakajy. The games were piloted in January 2018 and administered in July and August 2018 in Madagascar. In Kenya, the sample consists of 100 smallholder farmer households (25 game sessions) living near Mount Forest Kenya National Park, data was collected in May 2019. These study populations were plausible targets of future payments for ecosystem services interventions which often complement more traditional tools such as protected area and community-based conservation approaches.

Table 1: List of study sites and GPS locations of the biggest administrative centre

COUNTRY	STUDY SITES	LONGITUDE	LATITUDE
SCOTLAND	Orkney	58.984656	-2.958999
GABON	Lope National park villages	11.610143	-0.107274
	Logging villages	12.66405	-0.880883
MADAGASCAR	Mangabe protected area	48.1681	19.0342
KENYA	Mount Forest villages	37.303456	0.054598

We dedicated sufficient time to the practice rounds before starting the treatments to ensure sufficient comprehension and to desensitise the subject of killing of elephants or forest conversion to agriculture. To gain participants' trust and increase the credibility of the game features, we invested considerable time and effort in emphasizing the neutrality of the research and ensuring anonymity. Participants were allowed to ask questions at any time and facilitators were trained to respond to questions by emphasizing the rules of the games and not providing suggestions. The use of images and verbal explanations allowed accessibility to illiterate or innumerate participants.

Appendix A: Game protocols

Goosebumps:

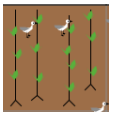
[First set up the seating, preferably forming a circle, ask participants to read information sheet and consent form, record participants' name ID, write their identifier codes on the score recording sheet, set up tablets, and put in player identifier]
Hello, and thank you for being here today.

Today we are going to play a game about land use decision making. You'll play in groups of four, and each player will have an equal share of the land in the game, a total of 9 squares. Your participation is voluntary, but we would really appreciate if you stay for the full session as the game can't run without all four participants. The games and the accompanying questionnaire should take about 60-90 minutes.

Do you consent to continue? If at any time you find that this is something that you do not wish to participate in for any reason, you are of course free to leave whether we have started the game or not.

In each of those squares, you can do one of four things:

1 2 3 4

1. Farm the square for private business

2. Farm the square for private business and scare geese away using scaring techniques (includes shooting as a method to scare geese away)

3. farm the square for private business and shoot geese to reduce their numbers

4. Provide disturbance free feeding areas for geese (goose habitats)

Each of the you will take responsibility for land use decisions on a 3x3 grid-cell section (farm) of a 6 x 6 grid-cell agricultural landscape as shown in the following figure. The white coloured number on each square is the number of geese (figure 1).

Each of these four options has different benefits and costs. Let me introduce each of them in turn.

Farming the square (options 1, 2 and 3) brings a yield of +4. Providing goose habitats brings no yield. scaring brings a cost of -1 while shooting -2.

We are going to play a few rounds per game session – rounds can be analogous to years. In each round, there are a certain number of geese in the landscape. When geese land on farmed cells (options 1, 2, 3), they cause damages and decrease your farm yield. This is described in the second line in the above figure ("goose damage"), the amount of goose damage on each farmed square depends on the number of geese in that square.

You don't need to memorize this – you can use this sheet as a reference while you play the game [hand out sheet now].

At the start of each round, geese decide where to land based on the "attractiveness" of the four options. Goose habitats (the fourth option) is the most attractive option, that is geese are much more likely to be drawn to a goose square (option 1) than on lands farmed for private business (options 1, 2, 3). Therefore, goose habitats can reduce agricultural damages across the landscape by drawing geese from other places. However, goose habitats may increase the amount of goose damage in farmlands that immediately surround them by bringing more geese close to them in the landscape. Put simply, goose habitats may make things better for some farms but worse for really close farms.

Now, if you decide to scare geese on a given cell, then some geese will leave the cell and reorient in other cells. The number of geese at the start of each round varies with shooting efforts and the goose population growth rate (the more you shoot, the less geese there are).

In some of the game sessions that we are going to play today, a subsidy and/or bonus is given for every goose habitat in the landscape. In another game session, the subsidy will offset the cost of the scaring technique, i.e. the cost of the scaring option (option 2) becomes zero.

You can cycle through the choices for each square by clicking on the square itself, and we'll practice that in a minute. When you've decided, you can click 'Confirm' and wait for the other players to confirm. Once everyone has confirmed, the round is over and the "score" (i.e., the total points earned) is calculated for each cell based on your choices in and around the cell, and the process is repeated in the next round.
You will make decisions simultaneously on your land squares and will see at the end of each round what has happened across the whole landscape, what yields are achieved in each square, and what score is earned by each player.
One other note – you can change any of the 9 squares to any of the two land use choices you like, in each round.

So just to review –Farming brings a yield of +4. Scaring techniques bring a cost of -1 and shooting costs -2. Goose habitats bring no yield, but they may decrease goose damage across the landscape by keeping geese away from farmlands. However, farmlands that are directly surrounding these goose habitats may attract more geese and hence be negatively impacted.

Let's look now at the game screen and see how this all fits together.

This is a screen shot from the first turn for Player 1, in the bottom left quadrant. The identifiers of the other three players are shown over their quadrants, which are lighter in colour, and can't be modified by Player 1.

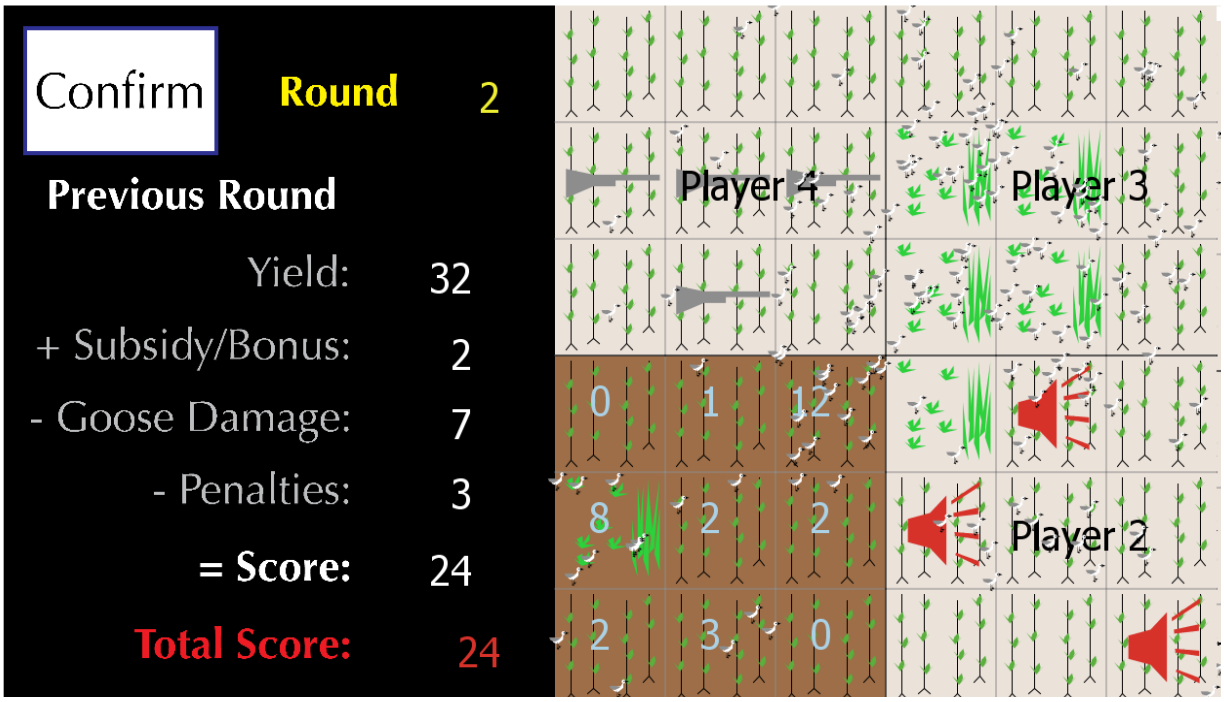


Figure 1: Bottom left corner of the landscape is active player, actions taken by other players in previous turn are visible. The white coloured number on each square is the number of geese. The scores of the active player in previous round is shown in the left-hand side of the panel.

After I have finished the explanation, we will play a short practice game to help you to understand the process.

PRACTICE [GP]

We'll just play a few short rounds now so that you get comfortable with the rules of the game. I'll walk you through the first turn so you can see how it goes, and you can ask me questions during your turn or between rounds. I encourage you to use the practice session as an opportunity to explore different options and see what happens. Feel free to discuss with others, but please do keep your screen to yourself.

[walk through a 5-round practice game]

Got it? *[answer any follow-up questions]*

Ok, let's move on to the experiment.

We are going to play four different games [the order will be randomised across groups], each one of which will differ a little bit, and might change a bit from what we've done in the practice.

Now, as you make your decisions, we'd like you to maximize your utility (or to do well) by trying to earn points. Please remember that there are different ways to earn points, either by playing individually or as a team working together. Most importantly, we want your decisions to reflect what you would do in real life.
Ok, let's begin.

[Each game group will play four treatments – the order being randomised. Thus, the four treatments can be introduced in a way that does not depend on other treatments having been played first]

T1: Baseline

In this game, the settings are just like they were in the practice. There is no subsidy from providing goose habitats. You are allowed to discuss the game with the other players for about one-minute at the beginning of each round, but please keep your screen to yourself. This game will last at least 6 rounds.

T2: Flat rate subsidy: a subsidy *X* is drawn randomly at the beginning of the game and held constant during the game

In this game, you are being offered a subsidy for each square of goose habitat in your land. You'll receive a subsidy which will add to your total score. You are free to discuss the game with other players for about one-minute at the beginning of each round but keep your screen to yourself. This game will last at least 6 rounds.

T3: Scaring support:

In this game, the settings are just like they were in the practice. There is no subsidy from providing goose habitats. However, you will get some financial support with the use of non-lethal scaring techniques, the support will offset the cost of -1, i.e. the cost of the non-lethal scaring techniques becomes zero. You are allowed to discuss the game with the other players for about one-minute at the beginning of each round, but please keep your screen to yourself. This game will last at least 6 rounds.

T4: Agglomeration Bonus - Using same subsidy level as in T2

In this game, you are being offered a subsidy for each square of goose habitat in your land. You'll receive a subsidy which will add to your total score. In addition, you will also get an additional bonus of 1 point for every goose square that has at least one goose square next to it. You are free to discuss the game with other players for about one-minute at the beginning of each round but keep your screen to yourself. This game will last at least 6 rounds.

Elephant game:

[First set up the seating, preferably forming a circle, read consent form, record player names write their identifier codes on the score recording sheet, set up tablets, and put in player identifier]
Hello, and thank you for being here today.

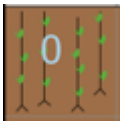
Today we are going to play a game about land use decision making. You'll play in groups of four, and each player will have an equal share of the land in the game, a total of 9 squares. Your participation is voluntary, but we would really appreciate if you stay for the full session as the game can't run without all four participants.

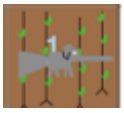
We are offering some gift items to thank you for your participation in today's experiment which should take about 90-120 minutes. In addition, the content of the gift items will depend on your management decisions in the game, which we will explain in a moment.

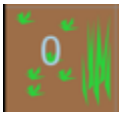
Do you consent to continue? If at any time you find that this is something that you do not wish to participate in for any reason, you are of course free to leave whether we have started the game or not.

In each of those squares, you can do one of four things:

1 2 3 4







1. Farm the square for your private business

2. Farm the square for your private business and use non-lethal deterrent methods to scare elephants away

3. Farm the square for your private business and kill elephants found marauding on your farmlands

4. Lease your farm plot for elephant conservation (zones dedicated to elephant conservation or" elephant habitat").

Each of the you will take responsibility for land use decisions on a 3x3 grid-cell section (farm) of a 6 x 6 grid-cell agricultural landscape as shown in the following figure.

Each of these four options has different benefits and costs. Let me introduce each of them in turn.

Farming the square (options 1, 2 and 3) brings a yield of +4. Providing elephant habitats brings no yield. Non-lethal scaring brings a cost of -1 while lethal scaring costs -2.

We are going to play a few rounds per game session – rounds can be analogous to years. In each round, there are a certain number of elephants in the landscape. When elephants land on farmed cells (options 1, 2, 3), they cause damages and decrease your farm yield. This is described in the second line in the above figure ("elephant damage"), the amount of elephant damage on each farmed square depends on the number of elephants in that square.

You don't need to memorize this – you can use this sheet as a reference while you play the game [hand out sheet now].

At the start of each round, the default land use options on all 36 grid cells are farmlands (option 1). Elephants are randomly distributed across the landscape with an equal chance. If you decide to scare elephants on a given cell, then some will leave the cell and reorient in other cells based on the attractiveness of the three options. Elephant habitats (the fourth option) is the most attractive option, that is elephants are much more likely to be drawn to an elephant square (option 1) than on your farmlands (options 1, 2, 3). These habitats contain some palatable crops and can therefore reduce agricultural damages across the landscape by drawing elephants from other places. However, elephant habitats may slightly increase the amount of elephant damage in farmlands that immediately surround them by bringing more elephants close to them in the landscape. However, rest assured that the neighbourhood effect of the habitat is small enough and may only marginally significantly affect the yield of adjacent farmlands. Put simply, elephant habitats may make things significantly better for some farms by keeping elephants at bay.

The number of elephants at the start of each round equals 18 and decreases with lethal scaring efforts (the more you shoot, the less elephants there are left). Please note that non-lethal and lethal scaring techniques are not 100 % effective, just like in real life, so you may try to deter elephants, but they might still raid your farm, likewise, you may attempt to kill them, but some will survive. We have set the games so you will success at killing an elephant 8 out of 10 times, using deterrent techniques however only works 3 out of 10 attempts.

In some of the game sessions that we are going to play today, a subsidy and/or bonus is given for every elephant habitat in the landscape. In another game session, the subsidy will offset the cost of the non-lethal deterrent method, i.e. the cost of the non-lethal deterrent option (option 2) becomes zero.

You can cycle through the choices for each square by clicking on the square itself, and we'll practice that in a minute. When you've decided, you can click 'Confirm' and wait for the other players to confirm. Once everyone has confirmed, the round is over and the "score" (i.e., the total points earned) is calculated for each cell based on your choices in and around the cell, and the process is repeated in the next round.

You will be permitted a period of discussion (one minute) before you make your individual decisions at the beginning of each round. You will make decisions simultaneously on your land squares and will see at the end of each round what has happened across the whole landscape, what yields are achieved in each square, and what score is earned by each player. Although you can observe individual players' decisions, you won't be able to match decisions to the individual.
One other note – you can change any of the 9 squares to any of the two land use choices you like, in each round.

So just to review, farming brings a yield of +4. Scaring techniques bring a cost of -1 or -2. Elephant habitats bring no yield, but they may decrease elephant damage across the landscape by keeping elephants away from farmlands.

Let's look now at the game screen and see how this all fits together.

This is a screen shot from the first turn for Player 1, in the bottom left quadrant. The identifiers of the other three players are shown over their quadrants, which are lighter in colour, and can't be modified by Player 1. The white coloured number on each square is the number of elephants.

Figure 2: Bottom left corner of the landscape is active player, actions taken by other players in previous turn are visible. The grey coloured number on each square is the number of elephants. The scores of the active player in previous round is shown in the left-hand side of the panel.

After I have finished the explanation, we will play a short practice game to help you to understand the process.

Practice

We'll just play a few short rounds now so that you get comfortable with the rules of the game. I'll walk you through the first turn so you can see how it goes, and you can ask me questions during your turn or between rounds. I encourage you to use the practice session as an opportunity to explore different options and see what happens. Feel free to discuss with others, but please do keep your screen to yourself.

[walk through a 4-round practice game]

Got it? *[answer any follow-up questions]*

Ok, let's move on to the experiment.

We are going to play four different games, each one of which will differ a little bit, and might change a bit from what we've done in the practice.

Now, as you make your decisions, we'd like you to maximize your utility (or "do well") by trying to earn points, and that's where the gift items come in. At the end of the session, we'll record the score for each player on the paper and pick one of the four games that you played randomly and look at the highest score. The gift items (content and number) that you will each receive equally will be based on that highest score.

Please remember that there are different ways to earn points, either by playing individually or as a team working together. Most importantly, we want your decisions to reflect what you would do in real life.

Ok, let's begin.

[Each game group will play 4 treatments; the order is randomised across groups. Thus, the four treatments can be introduced in a way that does not depend on other treatments having been played first.

G1: Baseline treatment:

In this game, the settings are just like they were in the practice. There is no subsidy from providing elephant habitats. You are allowed to discuss the game with the other players at the beginning of each round, but please keep your screen to yourself. This game will last at least 6 rounds.

G2: Flat Rate Subsidy: A subsidy from *X* points (drawn randomly at the beginning of the game and held constant during the game)

In this game, you are being offered a subsidy for each square of land that you lease as elephant habitats. You'll receive a subsidy which will add to your total score. You are free to discuss the game with other players at the beginning of each round but keep your screen to yourself. This game will last at least 6 rounds.

G3: Support for deterrents

In this game, the settings are just like they were in the practice. There is no subsidy from leasing plots for elephants. However, you will get some support for deterring elephants from your farmlands, the support will offset the cost of non-lethal deterrent methods. You are allowed to discuss the game with the other players at the beginning of each round, but please keep your screen to yourself. This game will last at least 6 rounds.

G4: Agglomeration payment

In this game, you are being offered a subsidy for each square of elephant habitat in your land. You'll receive a subsidy worth X points which will add to your total score. In addition, you will also get an additional bonus of 1 point for every elephant square that has at least one elephant square next to it. You are free to discuss the game with other players at the beginning of each round but keep your screen to yourself. This game will last at least 6 rounds.

Shared space game:

[first set up the seating, preferably forming a circle, read consent form, record player names write their identifier codes on the score recording sheet, set up tablets, and put in player identifier]
Hello, and thank you for being here today.

Today we are going to play a game about land use decision making. You'll play in groups of four, and each player will have an equal share of the land in the game, a total of 9 squares. Your participation is voluntary but we would really appreciate if you stay for the full session as the game can't run without all four participants.

We are offering some gift items to thank you for your participation in today's experiment which should take about 60-90 minutes. In addition, the content of the gift items will depend on your management decisions in the game, which we will explain in a moment.

Do you consent to continue? If at any time you find that this is something that you do not wish to participate in for any reason, you are of course free to leave whether we have started the game or not.

In each of those squares, you can do one of two things:

1 2

1. Farm the square for your private business

2. Leave the forest/fallow land as is

Each of the you will take responsibility for land use decisions on a 3x3 grid-cell section (farm) of a 6 x 6 grid-cell agricultural landscape as shown in the following figure.

Each of these two options has different benefits and costs. Let me introduce each of them in turn.

You don't need to memorize this – you can use this sheet as a reference while you play the game [hand out sheet now]. Forth

At the start of each round, the default land use options on all 36 grid cells are forest/fallow lands (option 1). If you decide to farm on a given cell, then you will get a yield of +12, but if you choose to farm the same cell in two consecutive rounds, the yield goes down to +10 on the third and onward rounds. However, to get the fertility of a cell back to +12, you will have not to cultivate the cell for two consecutive rounds. Leaving the forest/fallow land as is brings no yield. However, the neighbouring farmed cells will gain more yields of +1 from the ecosystem services from the forest/fallow land.

In some of the game sessions that we are going to play today, a subsidy (of different amounts) and/or bonus is given for every forest/fallow land in the landscape.

You can cycle through the choices for each square by clicking on the square itself, and we'll practice that in a minute. When you've decided, you can click 'Confirm' and wait for the other players to confirm. Once everyone has confirmed, the round is over and the "score" (i.e., the total points earned) is calculated for each cell based on your choices in and around the cell, and the process is repeated in the next round.

You will be permitted a period of discussion (one minute) before you make your individual decisions at the beginning of each round. You will make decisions simultaneously on your land squares and will see at the end of each round what has happened across the whole landscape, what yields are achieved in each square, and what scores are earned by each player. Although you can observe individual players' decisions, you won't be able to match decisions to the individual.
One other note – you can change any of the 9 squares to any of the two land use choices you like, in each round.

So just to review, farming brings a yield of +12. Farming for two consecutive rounds reduces yield to +10, and to get the yield back up to +12, the cells will need not to be farmed for two consecutive rounds. Leaving forest/fallow lands bring no yield but they increase yield in the adjacent cells by +1.

After I have finished the explanation we will play a short practice game to help you to understand the process.

PRACTICE [GP]

We'll just play a few short rounds now so that you get comfortable with the rules of the game. I'll walk you through the first turn so you can see how it goes, and you can ask me questions during your turn or between rounds. I encourage you to use the practice session as an opportunity to explore different options and see what happens. Feel free to discuss with others, but please do keep your screen to yourself.

[walk through a 3-round practice game]

Got it? *[answer any follow-up questions]*

Ok, let's move on to the experiment.

We are going to play five different games, each one of which will differ a little bit, and might change a bit from what we've done in the practice.

Now, as you make your decisions, we'd like you to maximize your utility (or "do well") by trying to earn points, and that's where the gift items come in. At the end of the session, we'll record the score for each player on the paper and pick one of the five games that you played randomly and look at the highest score. The gift items that you will each receive equally will be based on that highest score.

Please remember that there are different ways to earn points, either by playing individually or as a team working together. Most importantly, we want your decisions to reflect what you would do in real life.

Ok, let's begin.

[Each game group will play 5 treatments; the order is randomised across groups. Thus, the five treatments can be introduced in a way that does not depend on other treatments having been played first. Participants are free to discuss with others, but please do keep their screens to themselves)

I) Treatment T1: Individual property rights, no subsidy (6 rounds)

Each participant is endowed nine fallow forest patches (3x3 grid-cell section of the 6x6 grid-cell agricultural landscape) on which they can make land use decisions (figure 1). There are two main land use decisions available to each player, farm or fallow. No subsidy is offered for conserving fallow lands.

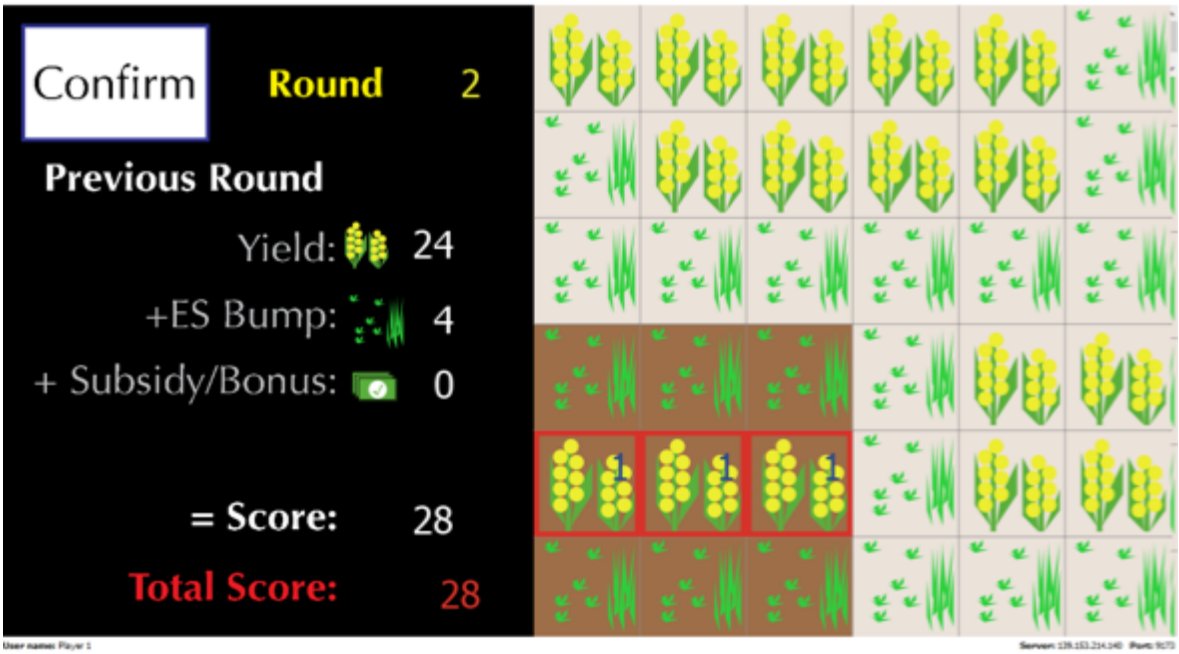


Figure 3: Bottom left corner of the landscape is active player with his nine land squares, actions taken by other players on their assigned lands in previous turn are visible. The scores of the active player in previous round is shown in the left-hand side of the panel.

II) Treatment T2: Individual property rights with subsidy (6 rounds)

Each participant is endowed nine fallow forest patches (3x3 grid-cell section of the 6x6 grid-cell agricultural landscape) on which they can make land use decisions. There are two main land use decisions available to each player, farm or fallow. A randomly assigned flat subsidy is offered to fallow lands. The same game procedure in T1 applies here.

III) Treatment T3: Common access (shared space) without subsidy (6 rounds)

All four participants can access any cells in the agricultural landscape, this mimic open access scenarios or situations where farmers collectively own and manage forested lands. Each participant can farm a maximum of 9 cells as in T1 in each round. No subsidy if offered for fallow forestlands.

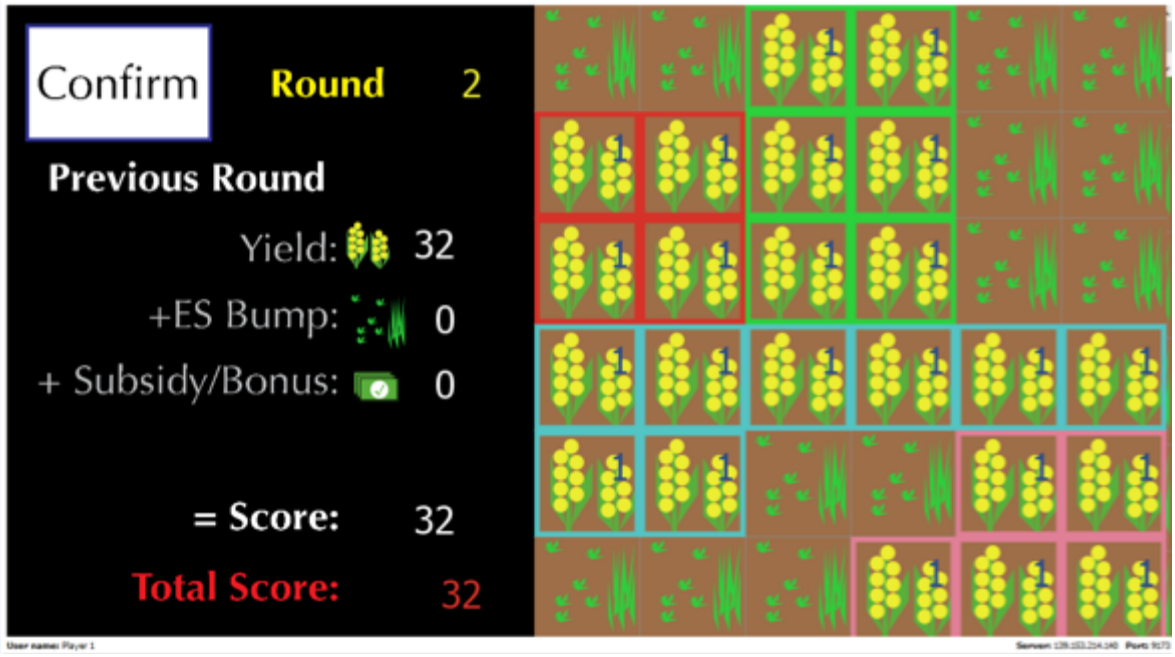


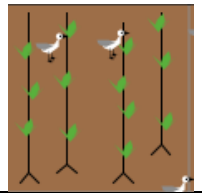
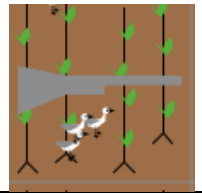
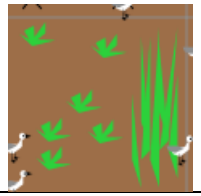
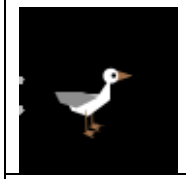
Figure 4: The players are colour coded. The red-coloured squares represent the lands farmed by the active player. The green squares are fallow lands shared by all four players. The scores of the active player in previous round is shown in the left-hand side of the panel.

IV) Treatment T4: Common access (shared space) with subsidy (6 rounds)

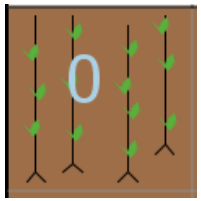
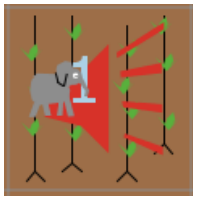
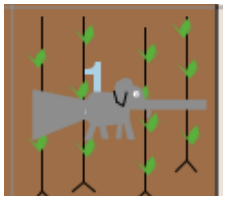
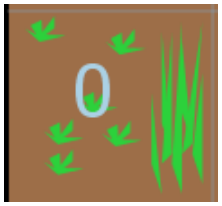
All four participants can access any cells in the agricultural landscape. A randomly assigned flat subsidy is offered to fallow lands and is shared equally by the four participants.

V) Treatment T5: Agglomeration bonus (6 rounds)

Each participant will be endowed nine land squares as in T1 and T2 and is offered a bonus in addition to the subsidy for every fallow land that has at least fallow land next to it.

HANDOUTS GOOSEBUMPS	1. FARM 	2. FARM AND SCARE GEESE 	3. FARM AND SHOOT 	4. GOOSE FEEDING AREAS 
YIELD 	4	4	4	0
SUBSIDY 	0	0	0	VARIES
DAMAGE 	Increases with goose number	Increases with goose number	Increases with goose number	0
PENALTIES 	0	-1	-2	0

SCORE = YIELD + SUBSIDY – GOOSE DAMAGE - PENALTIES

HANDOUTS ELEPHANT GAME	1. CULTIVER 	2. CULTIVER + REPOUSSE 	3. CULTIVER + ABATTAGE 	4. ZONES POUR ELEPHANTS 
Production 	4	4	4	0
Subvention 	0	0	0	Varie
Dégâts 	-2 par éléphant	-2 par éléphant	-2 par éléphant	0
Pénalités 	0	-1	-2	0

SCORE = PRODUCTION + SUBVENTION - DEGATS - PENALITES

HANDOUTS SHAREDSPACE GAME	1. FOREST LANDS / FALLOW LANDS 	2. FARMLANDS 	
		MORE FERTILE	LESS FERTILE
YIELD 	0	12	10
ECOSYSTEM SERVICES 	-	+1 FOR NEIGHBOURING FARMLANDS	+1 FOR NEIGHBOURING FARMLANDS
SUBSIDIES 	VARIES	0	0

SCORE = YIELD + ECOSYSTEM SERVICES + SUBSIDIES