



**INRAE**

## Teaching guidebook

*The Key to Soil: Unlock agroecological soil health management together*

The game *The Key to Soil: Unlock agroecological soil health management together* was created within the INRAE Ecodeveloppement research unit by Yann Boulestreau, with scientific support from Marion Casagrande and Mireille Navarrete, and mediation support from Emily Henry. The development of this game was supported by ADEME, the ACT department, and premature funding from INRAE as well as UMT SIBIO and ITAB.

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**Contact:** [lacledusol@inrae.fr](mailto:lacledusol@inrae.fr)

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# From a socio-technical analysis to an educational tool

The serious game *The Key to Soil: Unlock agroecological soil health management* together, based on a socio-technical analysis carried out by Yann Boulestreau in 2018, enables players to experience the most common barriers to agroecological transition. It focuses on the case of the management of soil-borne pests and diseases in sheltered vegetable systems in Provence, and the management of root-knot nematodes in particular. Based on this example, the role-playing game supports the exploration of original solutions through the coordination of several types of stakeholders to overcome the barriers encountered.

*The Key to Soil* was first used to share the results of Yann Boulestreau's socio-technical analysis, and to initiate the design of innovative strategies for overcoming the barriers to agroecological transition within the framework of his Ph.D. thesis. To this end, this serious game was used during workshops with stakeholders of the Provence vegetable production system (e.g., vegetable farmers, wholesalers, input suppliers, advisors, etc.).

Since then, *The Key to Soil* has been used many times in its original format, with a diverse audience of agronomy and environmental students at both undergraduate and Master's level, as well as a novice group of young adults at an ERASMUS summer camp. The highly positive feedback we received from the students demonstrated the game's ability to meet its educational goals. However, it was clear that the game's facilitation, as it stood, could not be appropriated by teachers other than the game's designer. This led us to develop a professional version of the game dedicated to training, which also includes a teaching kit. This version is part of an educational package for teachers working on the topic of agroecological transition.

*The Key to Soil* can be used to achieve various educational goals, as detailed in the following section. The aim of this guidebook is to provide teachers and other trainers who wish to make use of this original educational tool. For more detailed information on the rules of the game, a *Rulebook* is also available.

## An educational tool

The use of the game *The Key to Soil* supports an experiential learning approach (Kolb, 1984), in which experience is gained through play, fostering reflection through a debrief and conceptualization through a theory presentation. The teaching sequence consists of 2 to 3 sessions.

## Sessions

Session	Maximum duration	Description
<b>Session 0: Preparing students for the game session</b>	10 min.	Prior to the game session, the teacher provides the students with the materials they need to familiarize themselves with the game.
<b>Session 1: Game session + debrief</b>	2h	The teacher facilitates a game session. They then guide reflection on the barriers and levers to the agroecological transition that the student-players have just experienced.
<b>Session 2: Theoretical input (optional)</b>	2h	This session is optional and depends on the teacher's educational goals. It complements the game session with a course designed by the teacher.

**Facilitation tip:** *If you have the possibility to do so, run Session 1 a second time: the students will now be aware of the levers available. In the first round, the students will mainly notice the barriers, whereas during the second round, they will mainly notice the levers. This will enable them to gain a deeper understanding of both the barriers faced and the levers to overcome them. If this is not an option, organize an “innovation breakout” during the game session*

## Educational goals

*The Key to Soil* has two main educational goals. Depending on the teacher's objectives and the level of the players, other goals can be achieved. These are secondary (optional) goals.

Goals	Lens level	Public
Understanding the barriers to agroecological transition	Primary	All
Exploring ways to overcome these barriers	Primary	All
Identifying the stakeholders involved in the agroecological transition	Secondary (optional)	Novice
<b>Introduction to farm management</b>	Secondary (optional)	Intermediate
Introduce system agronomy concepts: cropping systems, production systems, agri-food systems, etc.	Secondary (optional)	Intermediate
Training to vegetable production systems and the agroecological management of soil-borne pest and disease	Secondary (optional)	Intermediate/Advanced

*Caption:*

**Neophyte:** no agronomic prerequisites or knowledge of the agricultural world

**Intermediate:** Good agronomic and agricultural vocabulary, good knowledge of the farming world

**Advanced:** Mastery of agronomic and agricultural vocabulary, in-depth knowledge of the world of agriculture, farm management, ecology, basic soil science, analysis and design of farming systems (mostly in arable crops).

## Aim of the game

For each role, the aim of the game is to make as much profit as possible, i.e., earn as many buns as possible.

# Session 0: Preparing the students

## Goal

This session introduces the game *The Key to Soil*. It familiarizes students with the rules of the game and their roles.

## Conditions

Components required

- 1 rulebook per student
- Game presentation videos (a version subtitled in English is coming soon)

Number of students

Whole class

## Course

**Max. duration:** 10 min.


The teacher emails each student the *Rulebook* to read before the game session, as well as the link to the tutorial video. They briefly introduce the format and goal of the next session, e.g., "The next session will take the form of a role-playing game called *The Key to Soil*, followed by a debrief to identify the barriers to and levers of the agroecological transition. Everyone has been sent a rulebook to read for next time".

They assign a role to each student. The students must read the general rules of the game and the information relating to their role.

## Assigning roles

The game lets students play one of 4 roles: vegetable farmer, input and equipment supplier, technical advisor, and wholesaler (marketer). There is only 1 profile per role, with the exception of the vegetable farmers. The 5 vegetable farmer profiles vary in terms of their cooperativeness, farm size, and approach to the soil.

Technical advisor



**KnowCulture**  
Technical advisor

You want to help vegetable farmers to implement the best practices while respecting their existing marketing channels, their outlets and the available inputs.  
You sell know-how to farmers and can collaborate with the input supplier to develop new know-how and inputs.  
You need to remind farmers who acquire new knowledge that they need the required inputs, service provision and/or equipment in order to implement the practice they just learned.

Your personal goals :

- Support vegetable farmers in making the maximum profit.
- Make yourself a maximum of profit = earn a maximum of «Buns».

## Input and equipment supplier



### Intranzur Input supplier

Your company holds at the same time the activities of seed producer, producer of plant protection products, nurseryman, equipment provider and distributor of all kinds of inputs.

You need to remind farmers that they need the know-how to use the inputs and equipment you provide.

**Caution:** one of the vegetable farmers has plots that count double. You must therefore charge him double the price for each input he buys (except for unlimited use equipment).

Your personal goal: To make maximum profit = to earn a maximum of 4 Buns

## Wholesaler



### VeggieLand Wholesaler

You buy your products from vegetable farmers according to 3 criteria:

- Your existing markets,
- The quality you require,
- The price.

The price indicated on your board is only a "reference price". You are free to negotiate. But beware of time: if you haven't bought by the end of the round, you will have nothing to sell...

Your personal goal is to make as much profit as possible = earn as many "Buns" as possible.

## Vegetable farmers



### Cyril Langlon Vegetable farmer

You are a large vegetable farmer. All your plots count double. For each input, plantlet or seed you would like to use on a given plot, you have to buy and place two of the same input or plantlet/seed cards on this plot. You also harvest double on each plot.

You see the soil as a living system that needs to be healthy for your crops to produce well.

You don't want to cooperate with other farmers.

Your personal goal: make the most profit = earn the most "Buns"



### Thomas Legoupil Vegetable farmer

For you, soil is simply a growing medium that can be disinfected and adapted to your plants' growth needs

You don't want to cooperate with other farmers.


Your personal goal is to make as much profit as possible = earn as many "Buns" as possible.



**Joséphine Rivière**  
Vegetable farmer

For you, soil is simply a growing medium that can be disinfected and adapted to your plants' growth needs.


Your personal goal is to make as much profit as possible = earn as many "Buns" as possible.



**Frédéric Chambaud**  
Vegetable farmer

For you, the soil is a living system that needs to be healthy for your crops to produce well.

Your personal goal is to make as much profit as possible = earn as many "Buns" as possible and nurture the life in the soil.



**Sophie Langlais**  
Vegetable farmer

For you, the soil is a living system that needs to be healthy for your crops to produce well.

Your personal goal is to make as much profit as possible = earn as many "Buns" as possible and nurture the life in the soil.

There must be at least one student per profile. A maximum of 3 students can play the same profile together. In this case, they must make decisions as a team. The instructions on the profile cards **must** be followed as long as no other rules are set (see the "Events" section below).

*Facilitator's tip: To ensure that the instructions have been received and read by the students, send the email at least one week prior to the game session. Roles should be assigned randomly, either face-to-face (by drawing cards) or remotely (by sending a pre-filled table).*

## Session 1: Game session and debrief

### Session conditions

#### Components needed

##### *For the game*

- 1 rulebook for each profile played
- 9 game boards
- Game cards and boxes (57 know-how cards, 199 plantlet/seed cards, 110 equipment/input cards, and 90 harvest cards)
- 1 fine erasable whiteboard marker per profile played
- 500g dried white beans and 500g dried red beans for the buns, to be used as change
- 1 calculator per vegetable farmer profile played + at least 1 calculator for each of the other roles (optional)

##### *For the facilitator*

- 1 *educational guidebook*
- 1 *rulebook*
- 1 printed *game leader sheet* (attached)
- Slideshow "*Facilitating The key to the soil*"
- 1 video projector (with audible sound output for the whole class)
- 1 computer
- 1 notebook or paper + a pen for note-taking (optional)



Number of students  
8 to 20 players.

Up to 27 players can be accommodated by an experienced facilitator.

**Facilitation tip:** for a group of more than 20 students, we recommend splitting the class into half-groups for this session.

## Setting up the game

### Preparing the room

Before starting the session, the room and the game components must be prepared. This avoids wasting time during the session. Room preparation takes about 20 minutes.

Each role has its own table or island of tables. Some characters need to be side by side to facilitate communication. For example, the advisor and supplier tables will always be in close proximity. The same applies to the wholesaler and the global market. The vegetable farmers' island should take center stage.

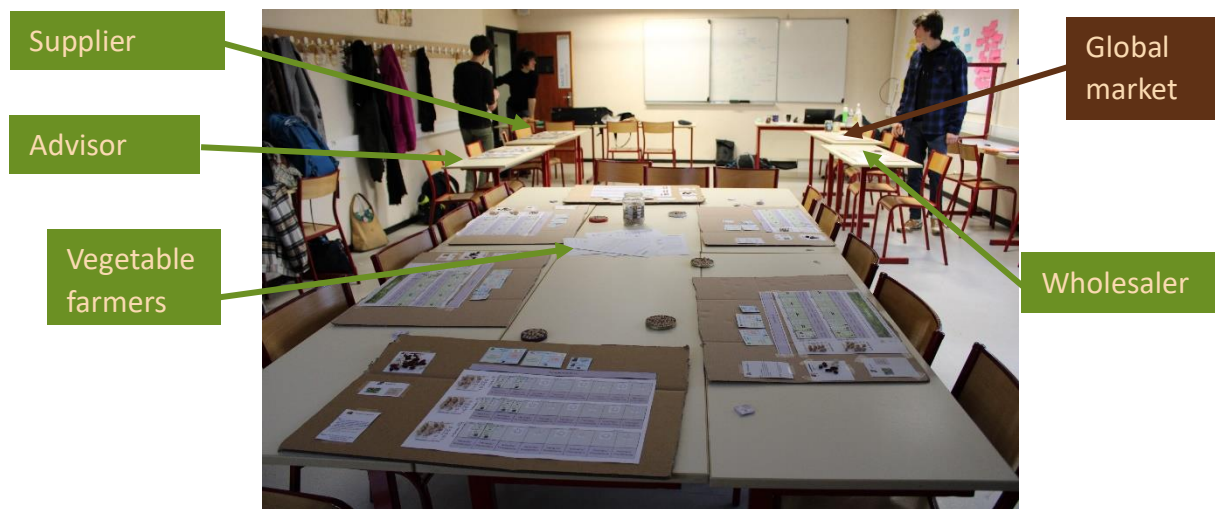


Table and island layout

**Facilitation tip:** To make it easier to move around, make sure that there's enough space between the islands.

### Board preparation

#### Technical advisor

1. Place 30 buns in the purse on the technical advisor's board
2. Place the technical advisor's catalog near the board
3. Place the box of know-how cards on the table, facing the advisor.
4. Place the box of blank know-how cards on the table, facing the advisor.

### KnowCulture Technical advisor




You want to help vegetable farmers to implement the best practices while respecting their existing marketing channels, their outlets and the available inputs.  
 You sell know-how to farmers and can collaborate with the input supplier to develop new know-how and inputs.  
 You need to remind farmers who acquire new knowledge that they need the required inputs, service provision and/or equipment in order to implement the practice they just learned.

Your personal goals :

- Support vegetable farmers in making the maximum profit.
- Make yourself a maximum of profit = earn a maximum of «Buns».

  
Soil infestation level

  
Know-how

  
Winter

  
Single-use service/input

  
Summer

  
Equipment for unlimited use

  
Harvest

  
Plantlet/seed

  
Quality

1



= 1  
= 5 =


Start : 30 buns

Advisor's board

<i>Type of know-how</i>	<b>Price (buns)</b>	<b>Know-how</b>
<i>Cash crops</i>	10	<ul style="list-style-type: none"> <li>- Scallion <i>Italia</i></li> <li>- Lamb's Lettuce <i>Tender</i></li> <li>- Melon <i>Sucor</i></li> <li>- Lettuce <i>Sucor</i></li> <li>- Lettuce <i>Amarum</i></li> <li>- Tomato <i>Sucor</i></li> </ul>
<i>Service crops</i>	5	<ul style="list-style-type: none"> <li>- Trap sorghum</li> <li>- Oat-vetch biomass</li> </ul>
<i>Techniques</i>	5	<ul style="list-style-type: none"> <li>- Application of fermentable organic matter</li> <li>- Steam disinfection</li> <li>- Chemical fumigation</li> <li>- Tool cleaning</li> <li>- Solarization</li> </ul>

*Input and equipment supplier*

1. Place 60 buns in the purse on the supplier's board
2. Place the input and equipment supplier catalog near the board
3. Place the box of plantlet, input, and equipment cards on the table facing the supplier.
4. Place the box of blank plantlet, input, and equipment cards on the table facing the supplier.












### Intranzur Input supplier

Your company holds at the same time the activities of seed producer, producer of plant protection products, nurseryman, equipment provider and distributor of all kinds of inputs. You need to remind farmers that they need the know-how to use the inputs and equipment you provide.


**Caution:** one of the vegetable farmers has plots that count double. You must therefore charge him double the price for each input he buys (except for unlimited use equipment).



Your personal goal: To make maximum profit = to earn a maximum of « Buns

 Soil infestation level	 Know-how
 Winter	 Single-use service/input
 Summer	 Equipment for unlimited use
 Harvest	 Plantlet/seed
 Quality	

1

→

 = 1

 = 5 = 

Start : 60 buns

Supplier's board

<b>Price (buns)</b>	<b>Plantlets/seeds/inputs/equipment</b>
1	<ul style="list-style-type: none"> <li>- Solarization sheet</li> <li>- Disinfectant for tools</li> <li>- Trap sorghum seeds</li> <li>- Biofumigant sorghum seeds</li> <li>- Vetch-oat biomass seeds</li> </ul>
2	<ul style="list-style-type: none"> <li>- Plantlet Lamb's lettuce <i>Tender</i></li> <li>- Plantlet Melon <i>Sucor</i></li> <li>- Plantlet Lettuce <i>Sucor</i></li> <li>- Plantlet Lettuce <i>Amarum</i></li> <li>- Plantlet Tomato <i>Sucor</i></li> </ul>
3	<ul style="list-style-type: none"> <li>- Plantlet Scallion <i>Italia</i></li> <li>- Biocontrol product</li> <li>- Fermentable organic matter</li> <li>- Spreading service</li> </ul>
10	<ul style="list-style-type: none"> <li>- Steam disinfection service</li> <li>- Chemical fumigant</li> </ul>
30	<ul style="list-style-type: none"> <li>- Bundling machine</li> <li>- Spreader</li> </ul>

*Vegetable farmers*

1. Place the starting number of buns in the purse on each vegetable farmer's board
2. Place piles of blank harvest cards on the farmers' island.

**Joséphine Rivière**  
Marionnaud

Préparez-vous à jouer ! Ce jeu est conçu pour être joué par un groupe de personnes. Il est adapté pour être joué par un groupe de personnes de tous âges.

**Central de la récolte et du niveau d'infestation**

Le jeu se joue sur un plateau central de 12 cases (3x4) et un plateau de plantation de 12 cases (3x4).

Les règles de jeu sont les suivantes :

- Chaque joueur dispose de 12 cases de plantation.
- Le jeu se joue sur un plateau central de 12 cases (3x4) et un plateau de plantation de 12 cases (3x4).
- Le jeu se joue sur un plateau central de 12 cases (3x4) et un plateau de plantation de 12 cases (3x4).
- Le jeu se joue sur un plateau central de 12 cases (3x4) et un plateau de plantation de 12 cases (3x4).

Temps :

Le jeu se joue sur un plateau central de 12 cases (3x4) et un plateau de plantation de 12 cases (3x4).

Année 0, Année 1, Année 2, Année 3

Vegetable farmer's board

Wholesaler

1. Place 300 buns in the wholesaler's purse
2. Place crops purchased in Year 0 in the corresponding box. Crops purchased in Year 0 are completed crop cards. Place 5 pre-filled harvest cards, each indicating 12 boxes of lettuce harvested, in the matching slot.

**VeggieLand**  
Grosbelle

Préparez-vous à jouer ! Ce jeu est conçu pour être joué par un groupe de personnes. Il est adapté pour être joué par un groupe de personnes de tous âges.

**Central de la récolte et du niveau d'infestation**

Le jeu se joue sur un plateau central de 12 cases (3x4) et un plateau de plantation de 12 cases (3x4).

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Temps :

Le jeu se joue sur un plateau central de 12 cases (3x4) et un plateau de plantation de 12 cases (3x4).

Année 0, Année 1, Année 2, Année 3

**Cabette**  
Quatre trimestre : 2 bac, Quatre volume

**Melon**  
Quatre trimestre : 2 bac, Quatre volume

**Salades**  
Quatre trimestre : 1 bac, Quatre volume

**Tomates**  
Quatre trimestre : 1 bac, Quatre volume

Wholesaler's board

Global market

The global market is not assigned a player. It has an unlimited supply of buns. Leave the remaining stock of buns next to the global market board. Place an opaque white A3 sheet of paper on the board

to hide all future evolutions of market prices from the players over the course of game. For each sale, the facilitator uncovers the corresponding year.

### *Banking and public policy*

The bank and the public policy maker have no board: these roles are performed directly by the facilitator at the request of the other players (e.g., to get a bank loan). The facilitator uses the remaining stock of buns placed next to the global market when needed (e.g., to loan money). The bank can provide loans to all roles at a non-negotiable 10% interest rate. The loan must be repaid after 1 year (i.e., two rounds of the game). The public policy maker can provide subsidies for certain practices, equipment or inputs. They can establish taxes and bans on certain inputs.

### Preparing the facilitation material

1. On a computer, download the facilitation presentation: *Key\_for\_soil.ppt*.
2. Connect and switch on the projector.
3. Launch the presentation and make sure everything works. Ensure the sound is audible throughout the room.

## Position and role of the game facilitator

The game facilitator is the teacher or any other agroecology facilitator mobilizing this educational tool.

First, the facilitator prepares the room for the game. During the game, they take on the role of the game master, keeping time and letting the players know when they have reached the end of a stage.

They also ensure that the rules of the game are followed. They answer questions about these rules, and correct any mistakes, while letting the players decide for themselves what to do. If a student is stuck (e.g., they are out of buns or one stage behind), the facilitator proposes solutions (e.g., a bank loan).

At the same time, the facilitator encourages the players to innovate by thinking beyond the initial rules of the game. They make sure that the innovations created by the students are realistic.

Finally, the facilitator must also take notes on actions they observe during the game that fit in with their educational goals. This will make it easier to return to these points during the debrief. For example, this could involve situations that illustrate the barriers to transition (e.g., a vegetable farmer's refusal to buy diversification crops) or levers (e.g., vegetable farmers sharing equipment).

**Facilitation tip:** *If there is more than one facilitator, the "main" facilitator should ensure that the game runs smoothly, answer questions, and tailor the game based on the players' ideas (e.g., by playing the bank, or creating a new market or inputs at players' request). The co-facilitator(s) should remind the players of time limits, observe and take notes for debriefing, answer questions, and collect the "running costs".*

*When the class is too large, one or two students can co-lead with the teacher.*

## Course of the session

### Session breakdown

Step	Name	Max. time
1	Introduction	10 min.
2	Test round	14 min. (<= 20 players) 18 min. (> 20 players) +5min. to reset the game

<b>3</b>	Game session	45 min. (<= 20 players) 58 min. (> 20 players)
<b>4</b>	Debrief	30 min.

The times shown above are guidelines for the maximum time to allocate to each step. These times may vary depending on the pace of the group.

### Step 1: Introduction

The purpose of this brief introduction is to remind the participants of the session's goal.

Assign students to the seats corresponding to their roles. Launch the slideshow *Key\_for\_soil.ppt* and present it. Make sure that all students have read and understood the key rules of the game before starting the game. Don't spend time explaining the rules in detail, as they can only be fully understood by playing.

### Step 2: Test round

The first season played is a “test round”, to familiarize the students with the rules. The facilitator carefully observes the game, answering questions and correcting students. The students are given more time than is normally allocated to the game for this “test” season. At the end of the season, the boards are restored to their initial state (number of buns, know-how, plot cover from the summer season of Year 1).

### Step 3: Game session

The game is played over 6 rounds. Each round corresponds to a season (summer or winter).

Each round is split into two stages:

1  
S  
E  
A  
S  
O  
N

### Stage 1: Land use and cover

1. Each **vegetable farmer** chooses which practices and which crop to use on each of their plots. But be careful! These choices will influence the development of soil-borne pests and diseases. This pressure will have an impact on the harvest.
2. To gain access to new practices, each farmer will have to acquire new know-how from the **technical advisor** in return for payment in buns.
3. Depending on the choices made, the **vegetable farmers** purchase plants, seeds, inputs and equipment from the **suppliers**.
4. As for the **wholesaler**, they must sell their purchases from the previous season on the global market.



Choice of practices



Purchase of know-how



Purchase of equipment and inputs

### Stage 2: Harvesting and sales

1. Each **farmer** calculates the impact of the crops and other practices (biofumigation, tool disinfection, etc.) they decided to implement for that season on the level of soil infestation by soil-borne pests and diseases.
2. The **vegetable farmers** harvest their crops. The quantity harvested is influenced by the level of soil infestation and the nature of the crop. The yields of pest-resistant crops are not affected by the level of infestation!

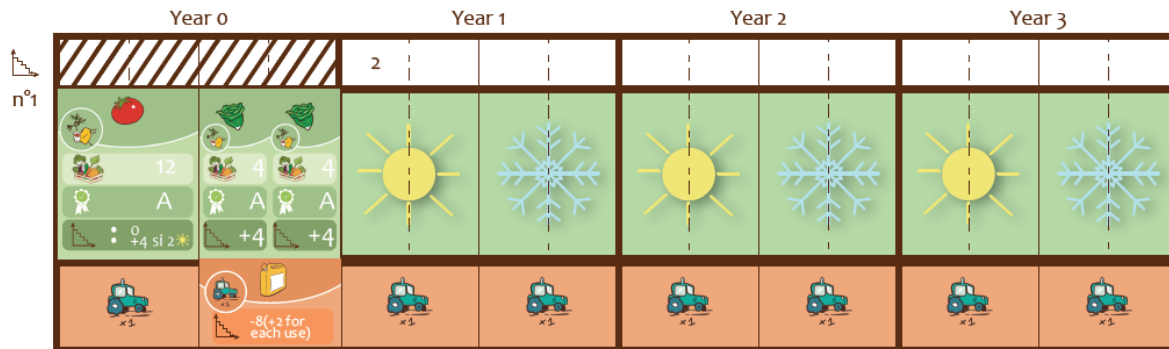


3. The **vegetable farmers** sell their crops to the **wholesaler**. However, the **wholesaler** is constrained by the demands of the global market: even if they do not know these requirements in advance, they can anticipate them and refuse to buy certain crops if they consider that these crops' quantity, quality or variety doesn't meet market criteria.
4. The **advisor** and **supplier** can create new know-how or inputs to sell to the **vegetable farmers**. They can also move around and communicate with the other stakeholders.

Next season

Each year is split into 2 seasons. There are therefore 3 game years. Year 0 has already passed. It allows players to learn about the vegetable farmer's previous practices on their plots.

PLEASE NOTE: The game starts in Year 1.



Year 0: On this plot, tomatoes were grown in summer, followed by two consecutive lettuce crops in winter. Chemical fumigation was carried out in winter. The soil infestation level at the beginning of summer in Year 1 is 3. Years 1, 2 and 3 will be completed according to the players' choices.

The number of seasons can be reduced to 5 if there is not enough time.

**Facilitation tip – "Innovation" break:** To encourage the players to develop innovative solutions, at the end of the 4<sup>th</sup> season (or the 3<sup>rd</sup> if you are only doing 5 seasons), you can take a break, either to do an initial debrief (Option 1), or to leave space for coordination between players (Option 2).

Option 1 – "Initial debrief": Carry out an initial debrief focusing on the barriers to changing practices that the players have already encountered (see "Step 4: Debrief", p. 17). For each barrier, ask the players how they could overcome it. Before resuming play, encourage them to try out the ideas discussed. The second debrief will focus on the results of these trials.

Option 2 – "Coordination break": Give the players a 5-minute break in the game. During this break, encourage them to communicate and coordinate with one another in order to overcome the barriers encountered during the first part of the game. At the end of this break, resume the normal course of the session.

*The facilitator's tasks during the game*

1. Launch the slideshow *Key\_for\_soil.ppt*. The slideshow guides players through the game and helps them keep track of time. It indicates the current stage of the game and displays the time remaining. Draw players' attention to these features of the slideshow, so that they can make good use of them during the game.
2. At the end of each year, the sheet of paper hiding the values on the Global Market board must be shifted to reveal the values of that year. Make sure that the wholesaler does not look at the new values before Stage 2 – "Harvesting and sales".
3. At the end of each year, collect operating costs:

Role	Amount (buns)
Advisor	40
Supplier	70

4. Upon request, provide loans at a non-negotiable 10% interest rate for all roles. Record each loan in the table on the *Facilitator's worksheet*.



5. Collect 50 buns for the creation of each new plantlet/seed, input/equipment or knowledge card. If the advisor and the supplier decide to pool their resources to create a knowledge card AND its corresponding plantlet/seed or input/equipment card, the joint cost is 70 buns for the 2 cards.
6. Collect 50 buns for each new value chain created by the wholesaler. Add the corresponding value chain to the Global Market if it does not already feature on it.
7. Three events occur during the game (shown in red on the slideshow). Announce each event to all players by reading out the associated text on the *Facilitator's worksheet* (see the Appendix).

### *Innovations*

Players can innovate and create their own solutions. To do so, they must ask the facilitator. The implementation of certain recurring innovations has been anticipated by the designers and is described below. The game facilitator should not communicate these solutions directly. However, they can point the players in the right direction, particularly when they notice that the students have questions or difficulties linked to these innovations (e.g., problems with accessing equipment, difficulties in selling to wholesalers).

#### Lending/leasing/pooling of agricultural equipment

Vegetable farmers can lend, lease or share equipment. Vegetable farmers taking advantage of this equipment sharing scheme should write the name of the equipment and the conditions under which it is made available (duration and price) on a blank piece of paper, then place it in the board area dedicated to equipment.

#### The transmission of know-how between farmers

Vegetable farmers can share their know-how with one another. To do so, they must follow the same steps as for agricultural equipment (see above).

#### Alfalfa plot

Some players have a plot of alfalfa. Two possible uses have been predefined:

- Those wishing to mobilize alfalfa biomass for fermentable organic matter under a greenhouse can generate 2 "Fermentable organic matter" cards per year. To use them, they will need the corresponding know-how and the spreader, or the associated service. On request, the facilitator will provide them with a signed voucher on a blank piece of paper, which the vegetable farmer can present to input suppliers to obtain the fermentable organic matter.
- Those wishing to convert this plot into a greenhouse can place their cards in this box. Converting this plot into a greenhouse will cost 20 buns. At the start of the game, this plot is healthy, i.e., with an infestation level of 0.

#### Direct-to-consumer

A Direct-to-Consumer board is available for the creation of a "direct-to-consumer" outlet at the initiative of one or more vegetable farmers. Vegetable farmers will sell directly to this outlet, using the board independently, in the same way that the wholesaler uses the Global Market board.

**PLEASE NOTE:** The vegetable farmer(s) behind the creation of this direct-to-consumer outlet must decide which other farmers can sell to the outlet at the time of its creation.

#### Direct sales on the global market

Vegetable farmers can sell directly on the global market. To do so, during the sales stage, they must go directly to the Global Market board and sell according to the market criteria. These criteria mean

that only large vegetable farmers or a group of vegetable farmers should be able to sell on the global market.

#### Step 4: Debrief

At the end of the six rounds, start by asking "How do you feel?". The emotions expressed by the students (frustration, joy, etc.) will steer the discussion towards the problems they encountered during the game, while also helping everyone settle down again.

Tackle one problem at a time, inviting different players who encountered the same problem to express themselves. Help students make the connection between the problem encountered and the recurring barriers to transition (see the *List of learnings* in the Appendix). Asking about the realism of a situation experienced in the game can help draw the link between the situation and the barrier (or lever) encountered. For example, contemplating the realism of the difficulty of selling small quantities of vegetables allows for broaching the subject of economies of scale, which partly hinder crop diversification (Meynard et al., 2018).

Ask the students how they dealt with the barriers, and draw the link with generic levers (e.g., setting up equipment cooperatives to deal with problems of access to equipment). Ask all the players to imagine other solutions that have not been explored in the game, for example with the following questions: "How did you overcome this obstacle in the game? What could we do in real life?" Add to the suggestions if necessary. Finally, complete and guide the discussion based on the *List of learnings* and your educational goals.

**Facilitation tip:** *End each point with a clear sentence summarizing the barrier and the corresponding levers, then move on to a new point.*

*You can draw on the notes or observations of any co-leaders to highlight key moments in the game that revealed the barriers and levers to transition.*

## Session 2: Theoretical input (optional)

This session takes a closer look at the concepts covered in Session 1.

### Course

Max. duration

2 h

### Content

Theoretical contributions can be approached in two ways:

- Use experiences from the game to illustrate key concepts (e.g., cropping system, food system),
- Generalize the knowledge on barriers and levers gained from the game by comparing it with other case studies and/or generic scientific knowledge.

The subject and format of this session are not predefined. They will depend on the teaching goal and the level of the audience. For example, if the goal is to introduce different agronomy system concepts (cropping system, production system, agri-food system), it is possible to run a semi-interactive lesson. After defining the concepts, the teacher can ask the students which parts of the game represented a particular concept.

Each plot on a farmer's board and their farming practices correspond to the cropping system. The crop cards, positioned across the years, illustrate the sequence of crops. The equipment cards illustrate the components of the technical itinerary. The entire vegetable farmer's board represents the farm and is anchored in the production system. Finally, on a broader scale, all the roles (including the global market, the bank, and the public policy maker) and their interactions make up the agri-food system.

The teacher can base their theoretical input on the following *List of learnings* (see the Appendix). Yann Boulestreau's thesis, as well as the articles Boulestreau et al. (2021, 2022 and *submitted*), Belmin et al. (2018), Della Rossa et al. (2020), Guichard et al. (2017), Magrini et al. (2016), Meynard et al. (2017), and Meynard et al. (2018) can also support teachers in this theory presentation, particularly on the concepts of barriers and levers in agri-food systems.

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# Appendix

## List of learnings

### **Learning goals**

1. Make the players understand the barriers to the agroecological transition faced by farmers and their socio-technical environment, as well as the levers for overcoming them. Illustrate that some of these barriers go beyond the management unit of the farm, and depend on actors in the agri-food system other than farmers (represented here by the vegetable farmers).
2. Introduce knowledge on farm management.
3. Introduce the concepts of system agronomy: cropping systems, production systems, agri-food systems.
4. Provide training on vegetable production systems and the agroecological management of soil-borne pests and diseases.

Summary of the learning outcomes

Goal no.	Game features	Learning (generic knowledge)	Help with debriefing: follow-up questions and examples of levers
<b>Barriers to accessing agricultural supplies (upstream value chain)</b>			
1	<p><b>What the game shows:</b> Some vegetable farmers want to implement known agroecological practices, but don't have access to the corresponding inputs.</p> <p><b>How this is reflected in the game:</b> Some know-how cards are available without corresponding input cards.</p>	<p>Lack of access to certain inputs hinders the implementation of certain agroecological practices (e.g., the use of service crops).</p>	<p><b>Questions</b></p> <ul style="list-style-type: none"> <li>- Did you have any problems accessing certain inputs?</li> <li>- What could be the causes? <i>For example, vegetable farmers have problems accessing certain Sorghum varieties, as livestock farmers buy stocks before them (sowing earlier than in vegetable farming).</i></li> <li>- How did you overcome this obstacle in the game? How could you go about it in real life?</li> </ul> <p><b>Levers</b></p> <ul style="list-style-type: none"> <li>- Purchasing groups</li> <li>- Development of e-commerce</li> </ul>
1	<p><b>What the game shows:</b> Some equipment is too expensive for a vegetable farmer on their own.</p> <p><b>How this is reflected in the game:</b> The price of equipment exceeds most farms' initial budget.</p>	<p>Lack of access to certain types of equipment hinders the implementation of certain agroecological practices (e.g. manure spreader).</p>	<p><b>Questions</b></p> <ul style="list-style-type: none"> <li>- Did you have any problems accessing certain equipment? How come?</li> </ul> <p><b>Lever</b></p> <p>Equipment cooperative.</p>

### Barriers within the value chain (downstream value chain)

1

**What the game shows:** Minimum restrictions on sales volumes (for logistical reasons), as well as maximum restrictions (due to market constraints), limit specialization in main crops (e.g., tomatoes) or alternative crops (e.g., scallions). The volumes of demand for alternative crops are low, while those for main crops are high.

Prices, maximum volumes, and quality constraints are set by the global market and imposed on the wholesaler. They change from one year to the next.

Minimum quantity constraints are set by the wholesaler and the global market for logistical reasons.

**How this is reflected in the game:** For each product, the Global Market board indicates market prices, the required quality, and the minimum and maximum quantities, all independent of player actions and non-negotiable.

The wholesaler, who represents traders in the broadest sense of the term, must respect these constraints. They are themselves subject to minimum quantity requirements in their purchases from the farmers.

Commercialization constraints lead to specialization in a small number of crops and hinder diversification in terms of species and varieties. These commercialization constraints stem from the global market, i.e., what consumers are buying. Traders try to anticipate this as best they can, so as to sell the greatest possible volume and make a profit margin.

#### Questions

- Have you encountered any difficulties in selling your products?
- Is this realistic?
- Where do these difficulties come from?

#### Levers

- Planning carried out with traders, taking into account soil conditions and diversification needs
- Diversification of consumer diets and therefore of crops  
*Example: Campaign to raise consumer awareness of the need to diversify their diet*
- Facilitating access to know-how for alternative crops

### Barriers linked to farm size

1

**What the game shows:** Larger farms are better placed, in terms of capital and disposable income, to invest in the development of alternative practices. They have sufficient production volumes to enable diversification.

**How this is reflected in the game:** The farms vary in size (2 to 6 plots) and start the game with different amounts of capital (30 to 90 buns).

The small size of some farms hinders their ability to implement an agroecological production system, for several reasons:

- Lack of income and capital to invest in new practices,
- Difficulties achieving sufficient production levels to diversify crops (see previous point).

Conversely, a larger farm size facilitates:

- Diversification;
- The opportunity to experiment on a small part of the farm;
- The ability to generate sufficient income to invest in innovation.

Ultimately, this constraint stems from the articulation between the diverse range of farm structures and the uniform upstream and downstream market constraints.

#### Questions

- Have you observed any differences between small and large farms?
- What are the causes of these differences?

#### Levers

- Cooperatives pooling capital, equipment, and farmer knowledge
- Expanding or reducing a farm's surface area sufficiently to switch to direct sales, if the market is there



Barriers to accessing new know-how			
1	<p><b>What the game shows:</b> Some vegetable farmers want to use inputs without having access to the knowledge they need to apply them correctly.</p> <p><b>How this is reflected in the game:</b> Some input cards are available without the corresponding know-how cards.</p>	<p>The lack of technical references and know-how available from technical advisors hinders the effective implementation of certain practices.</p>	<p><b>Questions</b></p> <ul style="list-style-type: none"> <li>- Did you have any problems accessing know-how?</li> <li>- What could be the reasons for this? (lack of technical references, vegetable farmers unable to access the advisory network independent from suppliers).</li> </ul> <p><b>Levers</b></p> <ul style="list-style-type: none"> <li>- Production of specific, dedicated knowledge</li> <li>- Expansion of advisory networks independent from suppliers (<i>not included in the game</i>)</li> </ul>
Cognitive barriers			
1	<p><b>What the game shows:</b> Some vegetable farmers don't cooperate with others, which limits their ability to develop certain initiatives. Some see the soil as a simple medium for crops, which hinders the implementation of practices that would help regulate pest pressure by increasing soil biodiversity and biological activity.</p> <p><b>How this is reflected in the game:</b> Each vegetable farmer's role card indicates how cooperative they are and their approach to the soil.</p>	<p><b>At farm and agri-food system level</b></p> <p>Vegetable farmers' lack of willingness to cooperate in some areas is holding back the implementation of certain agroecological practices (e.g., it is impossible to set up an equipment cooperative to share equipment that is too expensive for a single farm).</p> <p>Vegetable farmers' mental representations can also strongly influence their choices.</p>	<p><b>Questions</b></p> <ul style="list-style-type: none"> <li>- Why didn't some vegetable farmers want to cooperate in the game?</li> <li>- In reality, what drives this lack of cooperation? (competition, fear of betrayal, distance)</li> <li>- Are there any other aspects on your character card that slowed down your change of practice?</li> </ul> <p><b>Lever</b></p> <p>Cooperative structures that guarantee cooperation, while strongly and explicitly penalizing "profiteers".</p>

1	<p><b>What the game shows:</b> Vegetable farmers tend to follow the farming system "historically" established on their farm.</p> <p><b>How this is reflected in the game:</b> All players start with a history of the crops and inputs used in Year 0.</p>	<p><b>At operational level</b> The effects of fixation and path dependency: vegetable farmers tend to stick to the production methods they know, because they have invested time into mastering them by developing the necessary know-how. They have also invested money in equipment.</p>	<p><b>Questions</b></p> <ul style="list-style-type: none"> <li>- Why did some of you initially maintain historical practices?</li> <li>- Why did you subsequently change your practices?</li> </ul> <p><b>Levers</b></p> <ul style="list-style-type: none"> <li>- Training on the short- and medium-term consequences of conventional techniques</li> <li>- Training on the technical-economic assessment of different practices at rotation level</li> </ul>
<b><i>Time-resource barrier</i></b>			
1	<p><b>What the game shows:</b> The different actors face a lack of time to familiarize themselves with their options and make strategic decisions.</p> <p><b>How this is reflected in the game:</b> Timed game.</p>	<p><b>At operational level</b> Lack of time hampers the implementation of agroecological production systems by limiting the ability to acquire new know-how and to step back and reflect on strategic decisions (particularly the combination of agroecological practices).</p>	<p><b>Questions</b></p> <ul style="list-style-type: none"> <li>- Was the time allocated to each stage sufficient?</li> <li>- Why?</li> <li>- Is this realistic?</li> </ul> <p><b>Lever</b> Workforce cooperatives, guaranteeing access to available employees meeting the need in term of working times and competences.</p>

### Levers surrounding the coordination of players in the agri-food system

1	<p><b>What the game shows:</b> Innovative solutions, often involving collaboration between players, can remove many of the barriers to changing practices.</p> <p><b>How this is reflected in the game:</b> The facilitator encourages players to think outside the box and create innovative solutions. Blank cards and boards enable the game to be quickly adapted to the solutions proposed by players.</p>	<p>Many levers stem from collaboration between players. For example, this includes joint production planning by vegetable farmers and wholesalers, taking infestation levels on plots and market capacities into account when choosing crops (e.g., to avoid 2-3 vegetable farmers saturating the market with resistant crops). Another example is equipment cooperatives to facilitate access to equipment.</p>	<p><b>Questions</b></p> <ul style="list-style-type: none"> <li>- What solutions did you develop to overcome the difficulties you faced?</li> </ul>
<h3>Crop-rotation concept</h3>			
2	<p><b>What the game shows:</b> The vegetable farmer makes key farm management decisions, under constraints of budget, time, and soil-health constraints. They choose the crop rotation, the investments (time and money) to make to acquire new resources, and the collaborations to pursue.</p> <p>Each decision has an impact on their yields, their ability to market their production and the evolution of their soil's health (which in turn influences future yields). They face unforeseen events (e.g., variations in the purchase prices of their products and inputs).</p>	<p>The farmer allocates production resources (time, capital, inputs) in order to obtain produce and ensure the renewal of their production resources (in this case, the health of their soil).</p> <p>They make strategic decisions (e.g., investment in specialized equipment for a given crop), tactical decisions (e.g., which crop to grow in a given year), and technical decisions (e.g., which input to use to control root-knot nematodes).</p>	<p><b>Questions</b></p> <ul style="list-style-type: none"> <li>- What have you learned about running a business?</li> <li>- What are the constraints involved?</li> <li>- What informs a farmer's decisions?</li> </ul>

**How this is reflected in the game:** Through the immersion in the vegetable farmer's role and board.

**System agronomy concepts**

3

**What the game shows:** Players experience:

- The construction of cropping systems,
- Production system management (see previous point),
- Interactions between stakeholders in the agri-food system.

The game highlights the difference between the "conventional" approach to pest management (seeking total elimination through the use of biocides with low selectivity) and the agroecological approach (combining practices based on known ecological processes to keep the pest population below an acceptable threshold).

**How this is reflected in the game:** As the game progresses, vegetable farmers have to build up a rotation and apply (a set of) techniques for the different crops. They pilot their production systems to obtain a commercializable harvest. Crops, inputs, know-how and harvests are represented by cards that the vegetable farmers place on their boards and/or exchange with other players for buns.

The *agricultural systems* concepts are interrelated:

- The cropping system;
- The production system;
- The agri-food system.

It is recommended to cover these concepts during the theoretical input session.

This can for example involve using photographs of the different levels of the game: the vegetable plot on which the cropping systems are built; the Vegetable Farmer board on which the production system is built; and the whole game with the different interacting roles representing the agri-food system.

To increase interactivity, ask the class to match each photograph with the corresponding level.

### Concepts surrounding the agroecological management of soil-borne pests and diseases

4

**What the game shows:** *The Key to Soil* involves the following roles:

- Provence vegetable farmers selling to long value chains,
- A supplier of inputs and equipment for vegetable production,
- A vegetable-farming technical advisor,
- A vegetable wholesaler,
- A downstream value chain (the "global market")
- The bank and the public policy maker

The game highlights the interactions involved in buying, selling, advising, and conflicts and collaboration between these different roles.

Players experience the management of vegetable systems and soil-borne pests in the following ways:

- Vegetable farmers: By making technical decisions for vegetable operations faced with soil-borne pest and disease problems (see Goals 2 and 3);
- Advisor: By providing vegetable farmers with technical advice;
- Input supplier: By selling inputs and equipment for the management of soil-borne pests and diseases;
- Wholesaler: By buying vegetables from farmers whose harvesting and choice of crops are influenced by the soil pest pressure.

**How this is reflected in the game:** The different roles and their possible actions in the game correspond to the agri-food system

*The Key to Soil* allows players to work on the following skills:

- Designing and adopting an agroecological management strategy to tackle soil-borne pests and diseases;
- Providing technical advice and support to vegetable farmers, following an agroecological approach;
- Selling and creating inputs, equipment or services that support the agroecological management of soil-borne pests and diseases.

Also to be included in the theoretical inputs, if this is part of the targeted educational goals.

stakeholders with the greatest influence on the choices of practices made by vegetable farmers.

Each plot has a soil pest pressure indicator represented by a token to be placed on a scale from 1 to 16. The higher the pressure, the more the yield of susceptible crops is affected. All the growers' technical decisions influence this pressure indicator to a degree shown on the corresponding input and know-how cards.

# Facilitator's worksheet

## Operating expenses

To be collected at the end of each year.

<b>Technical advisor</b>	40 buns
<b>Input and equipment supplier</b>	70 buns

## Creation of cards, value chains and new greenhouses

Objects	Know-how	Equipment, input	Know-how + equipment or input	Channel	New greenhouse
<b>Applicant role</b>	Technical advisor	Supplier	Consultant and Supplier	Wholesaler	Vegetable farmer
<b>Price (buns)</b>	50	50	70	50	40 (20 on alfalfa plots)

A plot of alfalfa can be valorized in the form of 2 free "Fermentable organic matter" cards per year. To use these cards, however, a player needs to have a "Application of fermentable soil amendment" knowledge card, and either be equipped with a spreader or use a spreading service.

The wholesale lamb's lettuce channel opens with a reference price of 1 bun and a minimum quantity of 5 lettuces.

## Events

Event no. 1 (summer of Year 2): A new national regulation bans the use of chemical fumigation. The input supplier must remove it from their box.

Event no. 2 (winter of Year 2): All vegetable farmers can cooperate. Vegetable farmers whose card indicates that they do not wish to cooperate can now ignore this indication.

Event no. 3 (summer of Year 3): The price of the steam disinfection service has risen with the price of fuel. The input supplier must set the price of steam disinfection cards at 30 buns.

## Loans

Role	Loan amount	Year and season of repayment at 10% interest rate