

Communication and self-governance of
common-pool resources in dynamic
environments – supplementary materials

1 Experiment interface and instructions

We used Stella Architect to adjust the system dynamics (SD) model and design the interface. The interface is published on ISEE Exchange platform that allowed us to collect simulation and chat data as well. We recruited and qualified subjects from Amazon Mechanical Turk (MTurk). When these subjects, known as MTurk Workers, click on the experiment link, they will be redirected to the experiment landing page (Figure 1), where we provide guidelines to start an experiment session properly. We ask subjects to use their Worker ID as their experiment username (nickname), allowing others to recognize and report offensive behavior, particularly for communication treatments.

Another application of using Worker IDs is to find out users who leave the game in the middle of a session. It also helps us to prevent users attending a treatment session several times. Unfortunately, the process is not automated and should be done manually using Stella Architect and MTurk. A potential solution could be a feature in Stella that allows only certain usernames to start a session only for once.

The screenshot shows the experiment landing page interface. It is divided into several sections:

- Enter a nickname:** A text input field with a red circle '1' and 'Worker ID' next to it. Below it is a green 'Continue' button.
- Choose a session to join:** A section with a red circle '2' showing 'California - 2 roles available' and 'Green - 3 roles available'. Below are 'Create a New Session' and 'Join Existing Session' buttons.
- Waiting room for session: California:** A section with a red circle '3' showing 'To change roles, click on any unassigned role'. Below are four role buttons: 'Farmer 1 (3 available)', 'Farmer 2 (3 available)', 'Farmer 3 (3 available)', and 'Farmer 4 (3 available)'. A red circle '4' is next to the 'Ready to Start' button.
- Speakers on for game start notification:** A speaker icon and text with a red circle '5'.
- Use Your Worker ID as username:** A red heading and text: 'You are not allowed to use your worker ID twice for this HIT.' Below is an 'Enter a nickname' section with a text input field and a green 'Continue' button.

1. Enter your Worker ID for compensation and HIT approval. Do not join/start sessions with missing Worker IDs. Otherwise, the HITs will be rejected. You can use the survey link to enter your Worker ID as nickname before starting the game.

2. Join one of the available sessions or create a new one.

3. Choose one of the roles (e.g., Farmer 1).

4. Click Ready to Start and wait for others to join

5. Turn on your speakers. You will receive a sound notification when everyone joins. Check the game from time to time. Some workers using Safari report that they have problems receiving the sound notification (due to Safari privacy settings). **Create/join a session**

Tap 'Ready to Start'

Figure 1. Experiment landing page

After submitting their IDs, Workers should create a new session or join an existing one. Next, subjects must choose one of the available roles that are identical and wait until they match with others to start the experiment (Figure 2). This is the first waiting room. During our pilot experiments, we recognized that the waiting time could be as long as several minutes, and some subjects might start browsing the web and get distracted and do not realize that the experiment has started. To reduce these incidents, we ask subjects to turn on their computer speakers, to get a sound notification when a session starts.

Use Your Worker ID as username
You are not allowed to use your worker ID twice for this HIT.

Waiting room for session: Test Session
To change roles, click on any unassigned role

Required Roles

Farmer1 You (Test User 1) Ready to Start! | Farmer2 Waiting for player | Farmer3 Waiting for player | Farmer4 Waiting for player

Optional Roles

Leave | Cancel Ready to Start

Speakers on for game start notification

1. Enter your **Worker ID** for compensation and HIT approval. **Do not join/start sessions with missing Worker IDs. Otherwise, the HITs will be rejected. You can use the survey link to enter your Worker ID as nickname before starting the game.**
2. Join one of the available sessions or create a new one.
3. Choose one of the roles (e.g., Farmer 1).
4. Click Ready to Start and wait for others to join
5. Turn on your speakers. You will receive a sound notification when everyone joins. Check the game from time to time. Some workers using Safari report that they have problems receiving the sound notification (due to Safari privacy settings). **Create/join a session**

Tap 'Ready to Start'

Figure 2. First waiting room

The experiment starts when all roles are filled (Figure 3). We used images as much as we could to make the game more tangible to participants.



Figure 3. Start page

Although we have provided some of these guidelines on MTurk platform, we remind subjects not to use the browser's navigation buttons as it disrupts the flow of experiment (Figure 4).

Note:

Do not join a game where a worker has not entered their worker ID. We are sorry, and we can track those workers, block them, and report them to Amazon.

We kindly ask you to join another session. We are aware of these situations and will compensate you for your troubles.

Also, in case a player drops, please wait a few moments before leaving the game. Sometimes, a player drops because of their internet connection problem.

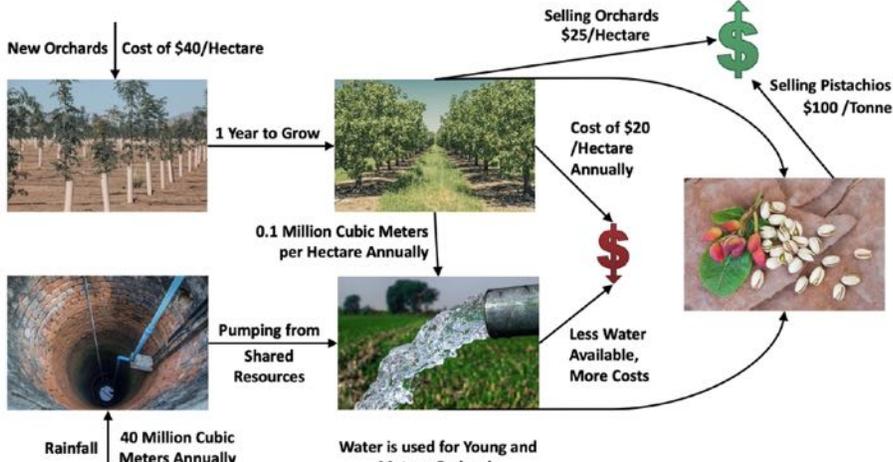


The image shows two screenshots from a game interface. The left screenshot is a 'Waiting room for session: Session1'. It has a title bar that says 'Not a Worker ID - Do not join the game'. Below the title, it says 'To change roles, click on any unassigned role'. There are four role buttons: 'Farmer0' (A31P9910Z2PC8F, Ready to Start), 'Farmer1' (A1NLP669W885IV, Ready to Start), 'Farmer2' (Jack, Ready to Start), and 'Farmer3' (You /A2MUGP9C89V73M). Below these are 'Optional roles' with two 'Worker ID - OK' buttons. At the bottom are 'Leave' and 'Ready to Start' buttons. An orange arrow points to the 'Farmer2' button. The right screenshot shows a 'Player dropped...' error message in a red-bordered box. The message says: 'Player Jack (Farmer2) is no longer connected to the game. You will be able to continue the current game but you will not be able to start a new game.' A green 'Next' button is at the bottom right.

Figure 4. Reminder not to use browser's navigation buttons

Although only qualified users, who have passed the qualification test, can attend the experiment, we show the instructions again before the main dashboard.

Orchard Management Game



The flowchart illustrates the game's mechanics. It starts with 'New Orchards' which cost '\$40/Hectare' and take '1 Year to Grow'. 'Rainfall' provides '40 Million Cubic Meters Annually'. 'Pumping from Shared Resources' provides '0.1 Million Cubic Meters per Hectare Annually'. 'Water is used for Young and Mature Orchards'. 'Selling Orchards' yields '\$25/Hectare'. 'Selling Pistachios' yields '\$100/Tonne'. 'Cost of \$20/Hectare Annually' is associated with mature orchards. 'Less Water Available, More Costs' is a consequence of water usage. The diagram includes images of an orchard, a well, and pistachios. At the bottom, it says 'Summary of the instructions' and has 'Back' and 'Next' buttons. 'Page 1 of 5' is in the bottom left corner.

Figure 5. Instructions page 1

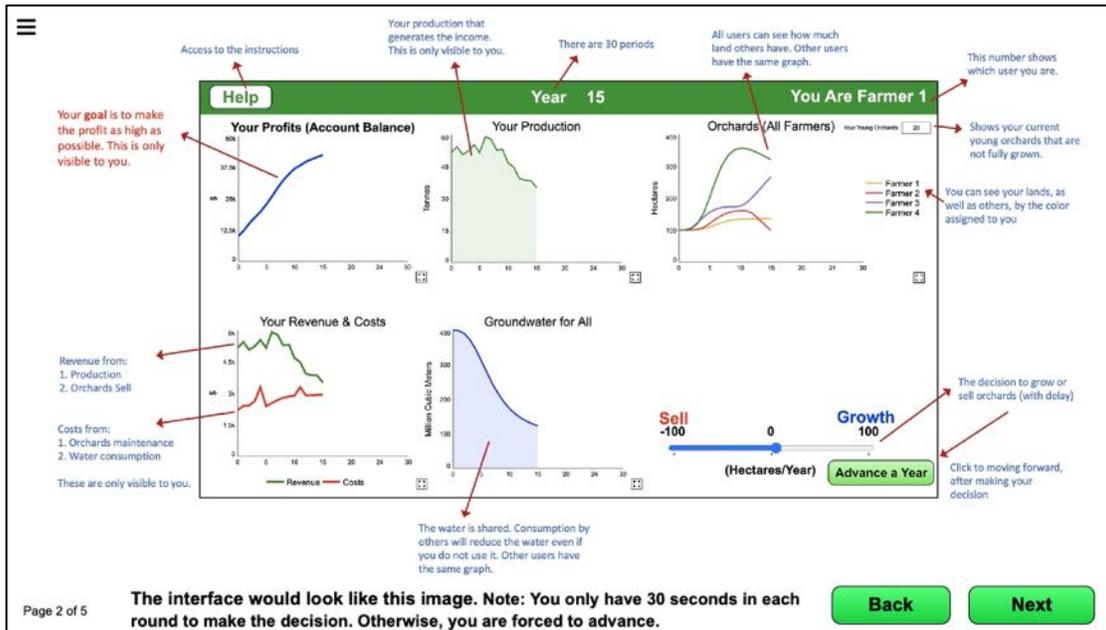


Figure 6. Instructions page 2

Orchard Management Game

Information and Instructions

Please carefully read the instructions below.

There are **four players**, including you, in this experiment. You will take the role of a pistachio orchards manager in an online simulation environment. The goal is to assess your ability to manage your (simulated) orchard and profits. You will be paid based on your profit at the end of the simulation, consisting of **30 years (periods)**. The training round does not affect your compensation.

Your Goal

Your goal is to maximize your profits (your bank account balance). Your account balance is revenue minus costs. You will start with a budget of approximately \$10,000. You can increase your profits if you have more orchards, consequently more production and revenue. Everything you produce will be sold for \$100/Tonnes. **This pistachio price is fixed.** You can also earn money if you sell your existing orchards. However, orchards and water costs decrease your profit. Every year, you will pay \$20 for maintenance for each hectare you have, and you will pay for the water consumed for irrigating the orchards. You will pay a one-time \$40 for each hectare you grow.

Each hectare of orchards (that produce pistachios) requires 0.1 million cubic meters of water per year. Each hectare of young orchards (while do not produce pistachios until they are fully grown) requires 0.05 million cubic meters of water per year. The groundwater resources are shared among all farmers. If there is less water available, it is more difficult to extract water from the ground and the cost of water rises, which means you need to pay more for water to irrigate your orchards. If there is no water, there cannot be any pistachio production.

Note that you cannot invest and increase your orchards when you have negative profits (account balance). Moreover, you cannot sell orchards more than what you already have. For example, if you have 50 hectares of orchards and you decide to sell 100 hectares, you will only get paid for the 50 hectares.

Page 3 of 5

Back Next

Figure 7. Instructions page 3

Orchard Management Game

Governance Decisions and Profits

As a manager, you make only one decision each year:

Orchard Growth/Sell:

Every year, you can adjust the orchard growth between -100 and 100 hectares per year. A positive number means orchard growth, while a negative number indicates orchard sell. You will start with 100 hectares of orchards. You will be charged \$40 per hectare you grow whereas you will receive \$25 per hectare you sell to the government.

It takes **1 year** to increase or discard a hectare of orchards.

How Much and When Will you Be Paid?

Besides the survey, which pays to qualified users, your compensation for completing the second part of the experiment consists of three parts:

1. **Fixed payment:** You are guaranteed a fixed payment, shown on the MTurk instructions, for completing the simulation.
2. **Effort Bonus:** You will be paid an additional bonus between **0 and \$0.5** based on your efforts during simulation. The effort is estimated based on your deliberation times and thoughtful exploration of the decisions.
3. **Performance Bonus:** You will be paid an additional bonus of **\$1 if you have the highest profit at the end of the experiment.**

**** Performance bonus may have been higher than \$1 depending on the game you joined.**

Page 4 of 5

[Back](#) [Next](#)

Figure 8. Instructions page 4

Orchard Management Game

You can chat with other participants during the game. You can use this opportunity to come up with strategies that can help you have more profits.

Quality chat participation can lead to a \$0.5 bonus on top of the previous payments (up to \$2).

Page 5 of 5 You will have access to the instructions during the simulation.

[Back](#) [Advance to the Game](#)

Figure 9. Instructions page 5

As we mentioned earlier, sometimes it is possible that a player does not realize that a session has started. To prevent having inactive/unaware subject during the experiment, we designed another waiting room before the main dashboard to make sure that all subjects are ready to start the game (Figure 10). During this time, subjects would receive multiple notification sounds, alerting them that they must pay attention to the experiment.

The other very important application of the second waiting room is to make sure that all subjects see the main dashboard at the same time. Also, past this point, subjects are ensured that other participants are actively engaged with the experiment.

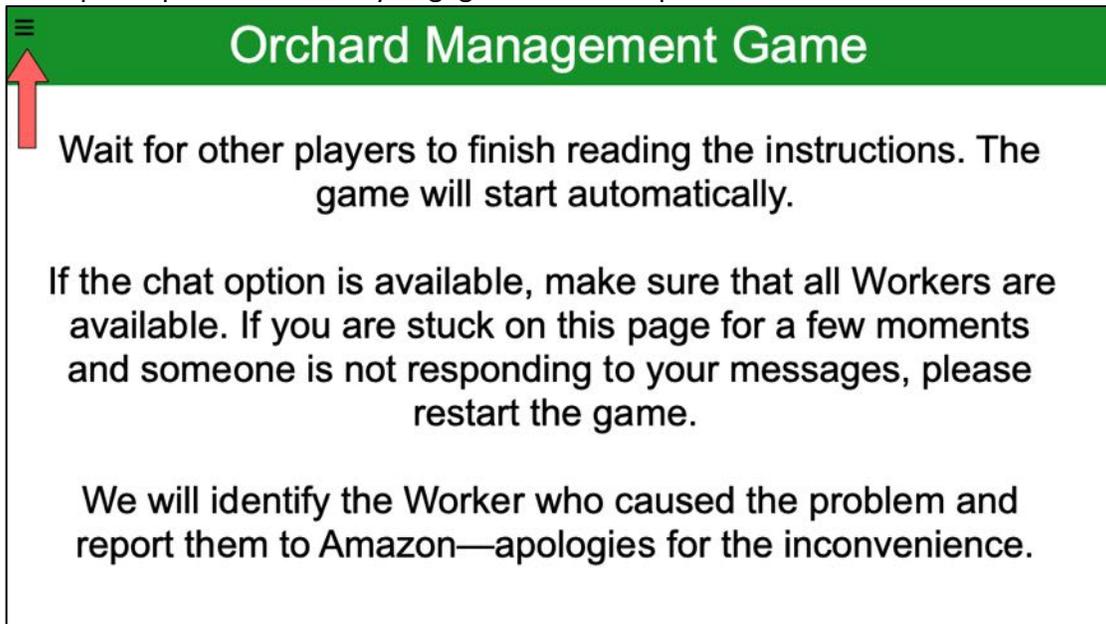


Figure 10. Second waiting room

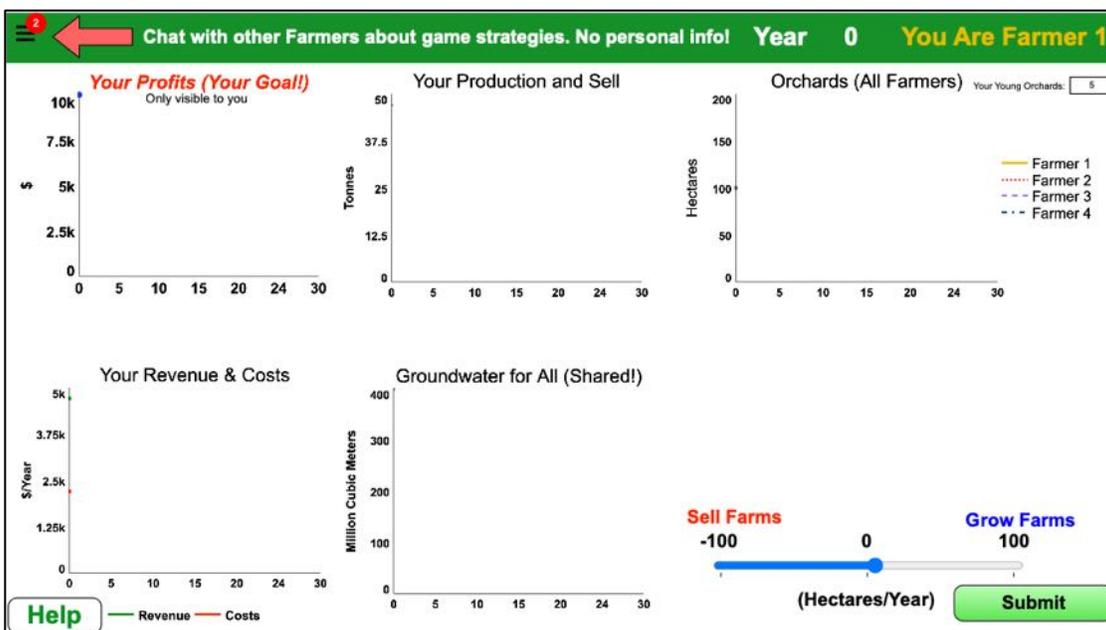


Figure 11. Main dashboard at start. Users receive a badge notification when they receive a message.

The main dashboard (Figure 11) includes several graphs that report information only visible to each subject (i.e., profits, production, and revenue/costs) and information shared among participants (i.e., orchards and groundwater). When subjects make their decisions in each round, they should click on the 'Submit' button and advance to the next round. Subjects would get a badge notification when they receive a message.

The chat box allows users to broadcast or send direct messages to each other (Figure 12). Graphs are updated in after each period (Figure 13).

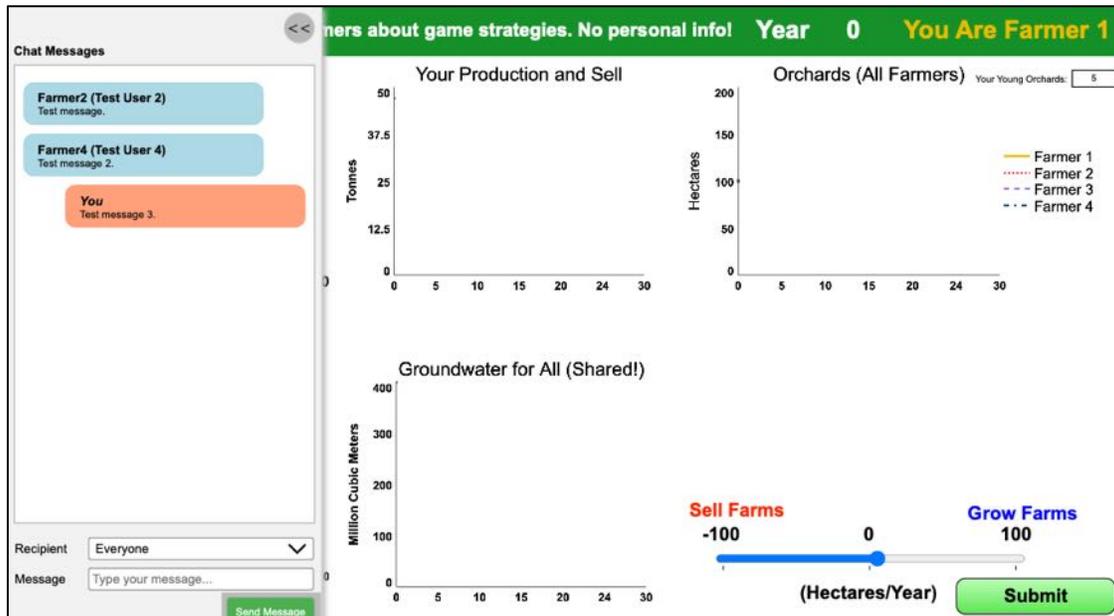


Figure 12. Chat box and sample messages

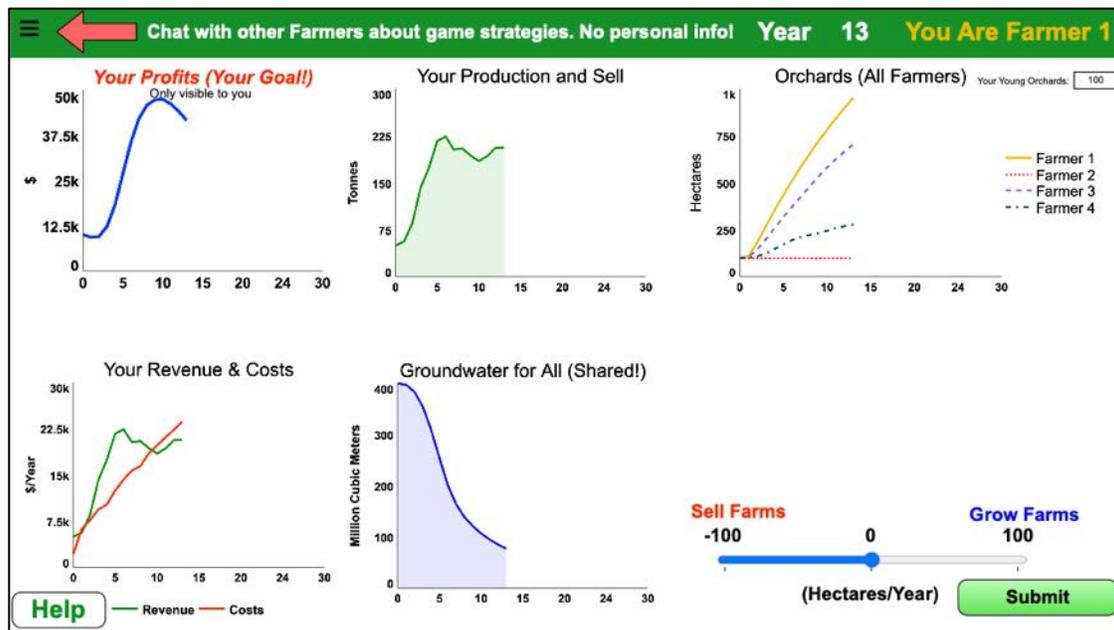


Figure 13. Main dashboard after a few periods

When simulation reaches the end, it automatically redirects all users to the survey code page. The code is randomly generated for each user, allowing us to match the performance and calculate the compensation. MTurk workers

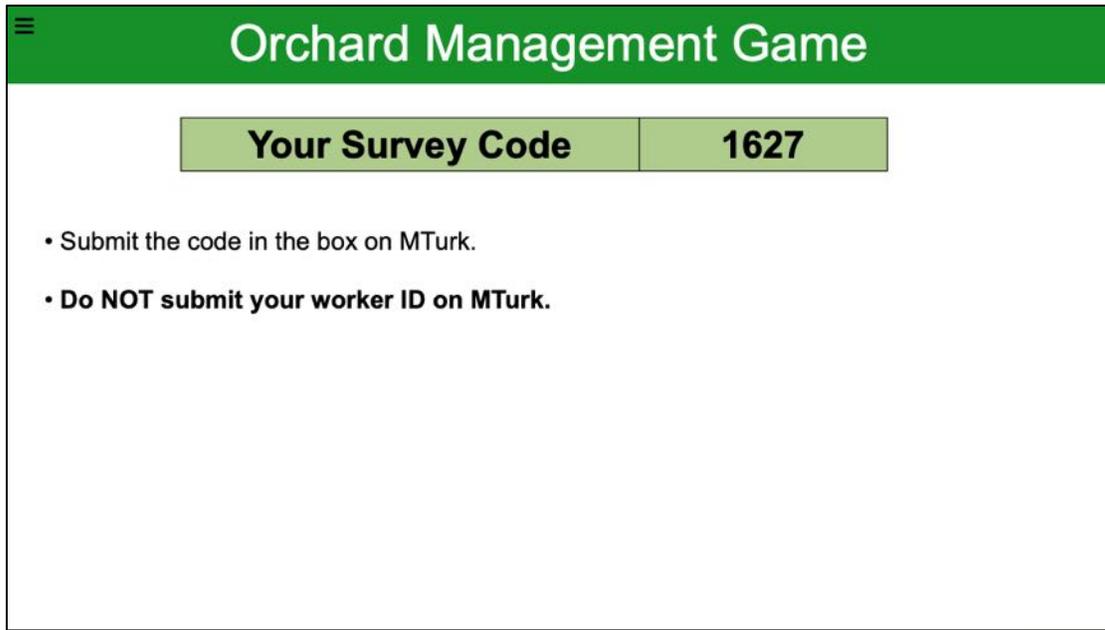


Figure 14. Randomly generated survey code

Subjects with negative balance cannot grow orchards anymore, the same as the traditional experimental designs on self-governance mechanisms (Figure 15).

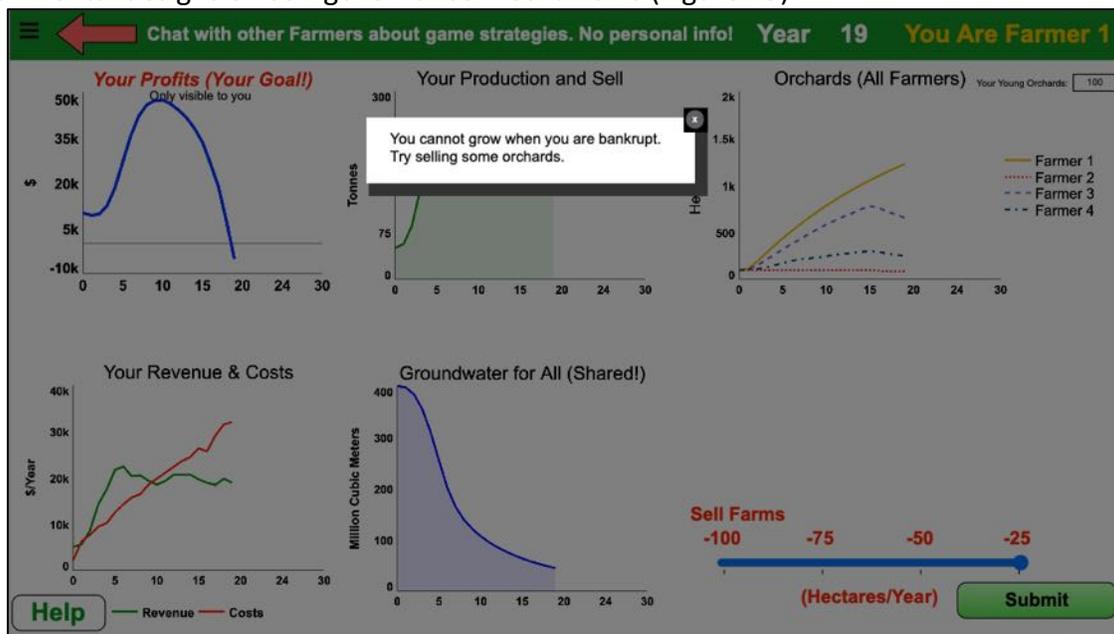


Figure 15. When subjects go bankrupt, they are not allowed to grow more orchards

To make our results comparable, we prevented a session to continue when a player drops ().

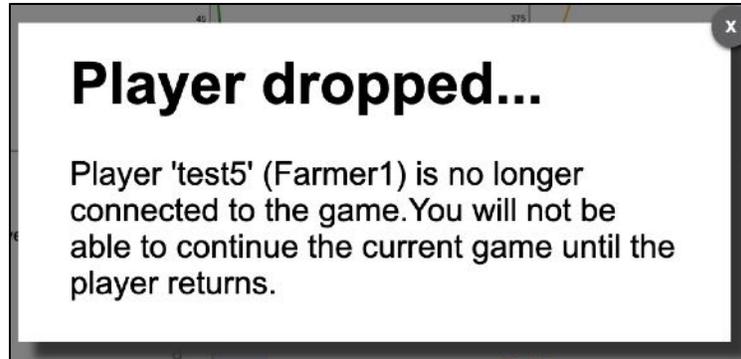


Figure 16. Subjects are not allowed to continue the session when a player drops

2 Demographics and qualification test

We used Stella Architect to design a demographics survey and qualification test. We show the structure we used for the qualification test (Figure 17). The demographics survey follows a similar logic, although no link is needed (Figure 18). Each decision in the interface corresponds to an auxiliary variable. In the figure below, each row relates to each question, shown in the interface (Figure 19). Right answers are connected to the test score variables, and the sum of the test score variables results in the final score. If the user final score is greater than a threshold, the user is qualified and will be redirected to the survey code page (Figure 20). Otherwise, the user is disqualified and cannot see the survey code page (Figure 21). Qualified subjects submit their code on MTurk, allowing us to invite them to the main experiment.

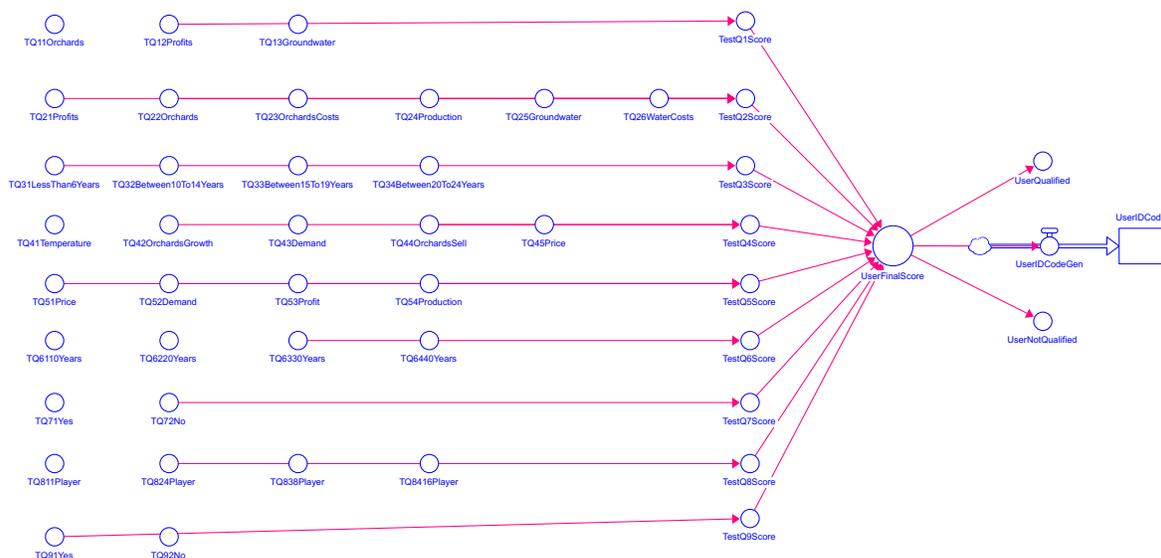


Figure 17. Structure for the qualification test

Orchard Management Survey

Demographics
 This survey is anonymous and your answer to these questions do NOT impact your qualification.

1. What is your age group?
 Under 18 18-24 25-34 35-44 45-54 55-64 65-74 75-84 85 or Older
2. What is your gender?
 Male Female
3. What is your highest level of education?
 Less than high school High school graduate Some college 4-year degree Professional degree Doctorate
4. How much professional experience do you have working in the agriculture sector (e.g., manager, engineer)?
 None Less than 1 year 1-3 Years 3-6 Years More than 6 years
5. What is your current employment status?
 Student Homemaker Retired Unemployed Working Part-time Working Full-time
6. How much is your annual gross income?
 Under \$10,000 \$10,000-\$20,000 \$20,000-\$30,000 \$30,000-\$45,000 \$45,000-\$60,000 \$60,000-\$80,000 \$80,000-\$120,000 Over \$120,000

[Submit and Go to Instructions](#)

Figure 18. Demographics survey

We regularly checked different forums, such as TurkerView, where MTurk Workers exchange information about the MTurk tasks and made sure that they do not share the answers to the qualification test.

Orchard Management Qualification Test

Instructions

Qualification Test
 Right answers to these questions qualify you for the main experiment.

1. What variable are you trying to maximize in the orchard management simulator?
 Orchards Profits Groundwater
2. Which graphs would you see in the user interface of the experiment? Select all that apply
 Profits Orchards Orchards Costs Production Groundwater Water Costs
3. How long will it take to fully grow your orchards?
 Less than 6 years Between 10 to 14 years Between 15 to 19 years Between 20 to 24 years
4. What decision do you control in the experiment? Select all that apply
 Temperature Orchards Growth Demand Orchard Sell Price
5. Final value of which factors determine your compensation? Select only one
 Price Demand Profit Production
6. How long does the simulation last?
 10 Years 20 Years 30 Years 40 Years
7. Does the price change in the simulation?
 Yes No
8. How many players are will be in the simulation, including you?
 1 Player 4 Player 8 Player 16 Player
9. Does water consumption by others affect the water available to you?
 Yes No

[Submit](#)

Figure 19. Qualification test

Orchard Management Survey and Qualification

Congratulations! You are qualified.

Your Code	0
-----------	---

Thank you for participating in this survey.

Please submit the generated code on MTurk so that we can compensate you.

We will post other HITs regularly to ask you to attend the original experiment.

You can now close the browser page.

Figure 20. Survey code page visible by qualified users

Orchard Management Survey and Qualification

Unfortunately, you did not qualify. Thank you
for participating in this survey.

You can attend the survey again using the original link.

Figure 21. Disqualified users do not receive a survey code

3 Demographics

Statistics on the data from the qualification test are shown below.

Table 1. Age vs. Qualification

	Qualified		Total
	No	Yes	
Age			
Under 18	2	0	2
18 - 24	180	72	252
25 - 34	1,081	462	1,543
35 - 44	710	324	1,034
45 - 54	297	174	471
55 - 64	178	76	254
65 - 74	48	32	80
75 - 84	2	2	4
85 or Older	3	1	4
Gender			
Female	1,040	590	1,630
Male	1,461	553	2,014
Education			
4-year Degree	1,434	596	2,030
Doctorate	29	21	50
High School Graduate	162	95	257
Less than High School	5	3	8
Professional Degree	508	200	708
Some College	363	228	591
Experience			
None	336	547	883
Less than 1 Year	323	142	465
1-3 Years	994	243	1,237
3-6 Years	573	115	668
More than 6 years	275	96	371
Employment			
Homemaker	119	71	190
Retired	64	40	104
Student	45	33	78
Unemployed	65	49	114
Working full-time	1,827	778	2,605
Working part-time	381	172	553
Income			
Under \$10,000	208	144	352
\$10,000-\$20,000	275	128	403
\$20,000-\$30,000	392	156	548
\$30,000-\$45,000	430	201	631
\$45,000-\$60,000	569	221	790
\$60,000-\$80,000	370	151	521
\$80,000-\$120,000	209	90	299
Over \$120,000	48	52	100