Teacher’s Guide to Using the Scratch Project, *Virtual Farm v.2*, to Teach Principles of Microeconomics

Jean K. Rosales, Ph.D.
Economics Department
The University of North Carolina at Greensboro
Contact:  jkrosale@uncg.edu

This lesson uses the Scratch project, *Virtual Farm*, to expose learners to basic principles of microeconomics through game play.

*Virtual Farm* is available at MIT’s Scratch site, [scratch.mit.edu](http://scratch.mit.edu), at the address [http://scratch.mit.edu/projects/RetsamEmag/1251801](http://scratch.mit.edu/projects/RetsamEmag/1251801). It requires that Java or Flash be installed on the user’s computer to run the program, but does not require any other downloads.

Teacher’s Overview:
Students should play the Virtual Farm game until they have earned at least $100,000. Once they have completed that task, they should write a game manual, explaining how to play the game and outlining best strategies for earning money at various stages of the game. Once the manuals are complete, the teachers should lead a discussion of student strategies and use those to analyze the economic decision-making underlying the recommended actions. It might be worthwhile to have the whole class play the game together while discussing best strategies and concepts. The decision rules can be used as reference points in teaching economic principles.

Economic Principles Illustrated:
- Choice
- Opportunity cost
- Scarcity
- Budget constraint
- Use of resources
- Idle resources
- Diminishing returns
- Return on investment
- Profit
- Time as a resource

Game Play:
It might be best to have students work in pairs to facilitate note-taking. One student can be given the task of operating the game, while the other takes notes on what decisions were made. Materials needed at this stage:  *Note Taker’s Worksheet* (p. 11)

*Initial allocations*: As the game begins, the player is allocated four plots of land and $300, posted in the upper right corner of the game area. Clicking the choice bar, labeled “Click for items”, allows the player to click on one of eight investment options available.
The choice bar identifies the cost of each item (dollar figure with a red background) and the price at which the item can eventually be sold (dollar figure with yellow background). The player clicks on the desired item and plants it in any available plot. The appropriate amount of money will be deducted from the player’s account.

*Planting vegetables:* If a vegetable is chosen, the game will display the vegetable growing until it is mature enough to be harvested, at which point the player clicks on the vegetable to harvest it. The selling price of the vegetable will be added to the player’s account, and the plot of land will become available for additional planting.

**WARNING:** Once the player has planted all four plots, buying a fifth crop will bring up the message “Sorry, not possible.” The game will freeze. The only solution is to start the game over by clicking the green flag in the top right corner.

*Raising livestock:* If the balance in their accounts allows, players may choose to raise livestock (chicken, cow, pig, or sheep). Payments from selling the products of livestock are posted to the player’s account periodically throughout the life of the animal, rather than only at “harvest time” like the vegetables. Players can raise multiple animals at a time, but “buying” a second animal of the same type (for example, two cows) does not earn additional money. It does, however, deduct the purchase price from the account.

Note that the cow and the pig, unlike the other animals, require grazing land, so one of the plots is taken out of production for the life of the cow or pig and cannot be planted with cash crops during that time.

**WARNING:** If the player attempts to plant a fourth crop while a cow or a pig is being raised, a notice “sorry, not possible” will appear and will prevent the player from taking any other actions. The only solution is to start the game over by clicking the green flag in the top right corner.

*Awards:* Players periodically receive awards acknowledging their good performance in the game. They do not add to the players’ account balance and do not affect game play.

*Farmer’s Market:* The game board will periodically display a new picture and notice for the “Farmer’s Market.” Player-based game play halts while the farmer’s market is in operation. The farmer’s market deposits additional funds in the player’s account. It appears randomly and up to five times during a game.

*End of Game:* The player should continue to play the game until he/she has earned at least $100,000. This will take most players between 10 and 15 minutes.
Writing the Game Manual:

After the students have successfully played the game, they should write a manual for the game, which should include directions on the best strategies for making money quickly. Provide students instructions for developing the game manual (Game Manual Instructions, p. 12) and the table illustrating the cost and sales price for each commodity to help them recreate their game play (ROI Table, p. 10). Suggest the following as questions to be answered in the manual:

- Which crop should a player buy first? Why?
- What is the best vegetable to grow? Why?
- What is the best animal to raise? Why?
- Is there a general rule to follow when making the decision about which crop or animal to invest in?
- Are there any crops or animals you should avoid buying?
TEACHER’S WALKTHROUGH – DO NOT DISTRIBUTE

After students have completed their manuals, you should walk through the game with them. Project the game so everyone can see it and designate a student to operate the game based on the group’s decisions. If it isn’t possible to project the game, have the students re-start the game on their own computers, but tell them not to make any moves on their own but to wait until the group has made a decision.

- At the beginning of the game, players have only $300. They can plant one pumpkin (cost: $300) or one tomato (cost: $200).
  - Decision rule: They should plant the pumpkin because the sales price they will receive ($400) is greater than the sale price they would earn for the tomato ($230).
  - Economic concept: **Per unit profit** – the pumpkin cost more but the profit on the pumpkin is higher. Profit is defined as selling price minus cost. The selling price for the pumpkin is $400; its cost is $300, which gives us a profit per pumpkin of $100. In contrast, the tomato cost less, $200, but its selling price was only $230, so the profit per tomato is $230 minus $200 equals $30.
  - Economic concept: **Opportunity cost** – The students’ decision to plant the pumpkin meant they had to give up the opportunity to plant the tomato, their next best available option. The cost of that forgone opportunity was $30 – the income from the sale of the tomato that they had to give up in order to plant the pumpkin. Ask students why they decided to plant the pumpkin instead of the tomato. Their answer should be that the pumpkin brought in more money, making it the preferred alternative.

- Students will have planted one crop and will have three unused plots of land. Ask
  - Economic concept: **Idle resources** – the three unused plots represent idle resources – resources that could have been used to produce more crops but weren’t. Ask students why they didn’t plant anything on the other plots of land. They should tell you they didn’t have any money left to buy additional crops.
  - Economic concept: **Budget constraint** – students were unable to plant additional crops in the unused land because they are working with a budget, the size of which limits their purchases.
  - DISCUSS whether it is good or bad to have idle resources. Students should conclude that leaving the land idle was bad because it could have been producing more crops and earning more money. The group should conclude that it is good to maximize the use of all resources when possible.
  - NOTE: This discussion can be referred to when teaching the concept of production possibilities frontiers/curves. Leaving the land idle can be depicted as operating inside the frontier.

- In the second round, the students have a budget of $400 – the original money they began with plus the $100 profit they earned from growing and selling the
pumpkin. They now have enough money to plant another pumpkin or to plant two tomatoes. What should they do?

- Economic decision: They should plant the pumpkin. The pumpkin would cost $300 and earn $100 profit. The two tomatoes would cost $400 and earn $60 (2 times $30) profit.

- Economic concept: Return on investment -- Deciding whether to plant one pumpkin or two tomatoes involves the concept of return on investment, the amount of profit earned compared to the cost of purchasing the good. It is calculated as profit divided by cost. Recall that profit is calculated as selling price minus cost, so the profit from planting a pumpkin is $400 (selling price) minus $300 (cost) = $100, and the return on the investment for the pumpkin is $100 (profit) divided by $300 (cost) for a return on investment of 0.33. The return on investment for two tomatoes is $460 (selling price of two tomatoes) minus $400 (cost of two tomatoes) = $60 (profit). Divide $60 (profit) by cost ($400) to get 0.15. Since 0.30 is greater than 0.15, the pumpkin has a higher return on investment and is the better choice. NOTE that the return on investment for one tomato (($230 – 200)/200 = 0.15) is the same as the return on investment for two tomatoes -- the ROI will be the same regardless of the quantity of goods you invest in.

Return on investment (ROI): (Selling price minus cost) divided by cost

ROI for one pumpkin: ($400-$300)/$300 = 0.33

ROI for two tomatoes: ($460-$400)/$400 = 0.15

ROI for one tomato: ($230-$200)/$200 = 0.15

NOTE: You might want to have the class calculate and fill in all the ROIs on the ROI Table (p. 10) for all of the crops and animals at this point or you can have them fill ROIs in as the game progresses.

- In the third round, students will have $500, the initial allocation of $300 plus $100 profit from round one and $100 from round two. What should they purchase?
  - Economic decision: They should plant one pumpkin and one tomato since they can afford to do both.
  - Economic concept: Diminishing returns -- Even though the tomato has a lower return on investment than the pumpkin, it still has a positive return. They do not have enough money to plant two pumpkins, but they do have enough money to plant one pumpkin and one tomato, which will bring in the maximum return they can earn given their budget. Two things are worth noting: once they have bought all the pumpkins they can with their budget, they have to move to the next most profitable commodity, the tomato. Their return will be less, but it will still be positive and worth doing. Note also that, by planting a second crop, they are making good,
productive use of an otherwise idle resource, the empty plot of land. Putting idle resources into production is a good decision, but it may depend on the return on investment of the alternatives.

- In round four, students now have a budget of $630. What should they do? That budget will allow them to plant:
  - Three tomato plants OR
  - Two pumpkins OR
  - One pumpkin and one tomato
  
  o Economic decision: Have students compare the ROI for each possibility. The ROIs are:
    - 3 tomato plants = \((690-600)/600\) = 0.15
    - 2 pumpkins = \((800-600)/600\) = 0.33
    - 1 pumpkin and 1 tomato = \((620-500)/500\) = 0.26
    
    The combination of the pumpkin and the tomato has a higher ROI than the 3 tomato plants but a lower ROI than the 2 pumpkins, so the 2 pumpkins is their best investment at this point, given their budget.

- In round five, the students have a budget of $830. They now have a third crop available to them – the potato, which costs $700 and has a selling price of $800. Should they plant a potato?
  
  o Economic decision: Calculate and compare ROIs for the three crops they have available:
    - ROI for tomato: \((230-200)/200\) = 0.15
    - ROI for pumpkin: \((400-300)/300\) = 0.33
    - ROI for potato: \((800-700)/700\) = 0.14
  
    - It turns out the potato has the worst ROI of all three crops.

It might be helpful to work through this problem from a couple of different perspectives to reinforce the intuition behind the choice of crops.

One potato costs $700 and earns $100 profit ($800 selling price minus $700 cost).

One pumpkin costs $300 and earns $100 profit ($400 selling price minus $300 cost).

Both crops earn the same profit, but the potato costs more than twice as much as the pumpkin.

One potato costs $700 and earns $100 profit.
Two pumpkins cost $600 and earn $200 profit.

The two pumpkins cost less and earn higher profit, so they are definitely the better investment.

* * *
From this round on, students will continue to earn profits and plant crops. When they have at least $2200 in their accounts, have them calculate the ROI for the new crop they can purchase, the watermelon:

ROI for watermelon: \( \frac{($3000 - $2200)}{$2200} = 0.36 \)

The watermelon has the highest ROI of all four crops and should be planted if the budget and the number of plots available allows.

If the budget does not allow students to plant additional watermelons, but they can afford to plant either pumpkins or tomatoes and they have land available, encourage them to plant as much as they can afford, since it will earn profits and avoid having idle resources.

The students will eventually earn enough money to be able to raise a chicken for $6000, which will earn them a total of $2000 profit ($8000 selling price minus $6000 cost).

For older students, it might be worthwhile to point out that, while the chicken earns more profit than any other choice available with the current budget, it does not have the highest ROI.

ROI for the chicken: \( \frac{($8000 - $6000)}{$6000} = 0.33 \)

Compare that to the ROI for the watermelon (0.36).

- **Economic decision:** Should students invest $6000 in a chicken or $4400 in two watermelons? The watermelons have a higher ROI and cost less than the chicken. On the other hand, the chicken does not take up any plots of land, leaving that resource available for additional crop planting.
- It is worth noting that, while the chicken has a very high ROI, it takes longer to earn the total $2000 profit from the chicken than it does to earn $800 per watermelon. The chicken ties up funds for approximately three rounds of play, so the students have to wait longer to get their money back.
- **Economic decision:** Should the students invest $6000 in a chicken or $4400 in two watermelons, given that the chicken ties up funds for three rounds?
  - **Economic concept:** **Time value of money** – Students have the following choices:
    - **Raise one chicken for three rounds of play:**
      Total profit over three rounds: \( ($8000 - $6000) = $2000 \)
    - **Grow one watermelon for each of three rounds of play:**
      Profit per round: \( ($3000 - $2200) = $800 \) per round
      Total profit over three rounds: \( $800 \) times 3 = \( $2400 \)
It turns out that the watermelon is the best investment of the students’ funds when calculating profit per round, given that the chicken ties up the funds for three rounds of play.

- At some point in the game, students will have far more money available than they can use to plant watermelons, given the limited plots of land available. At that point, it makes sense to raise a chicken (or other livestock) because they will earn some profit even though the chicken has a lower ROI than the watermelon.

NOTE: The pig is never a good investment. The pig costs $10,000 and only returns $8,000, so students lose money when they raise a pig.

* * * *

The cow and the sheep both have good ROIs.

ROI for the cow is \((20,000 - 12,000)/12,000 = 0.66\)

ROI for the sheep is \((40,000-25,000)/25,000 = 0.60\)

The cow has a slightly higher ROI than the sheep, so it is the best investment overall of all the crops and livestock available.
## TEACHER’S VERSION OF TABLE COMPARING ROI

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Selling price (A)</th>
<th>Cost (B)</th>
<th>Profit (A – B)</th>
<th>ROI (A – B) B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tomato</td>
<td>$230</td>
<td>$200</td>
<td>$30</td>
<td>0.15</td>
</tr>
<tr>
<td>Pumpkin</td>
<td>$400</td>
<td>$300</td>
<td>$100</td>
<td>0.33</td>
</tr>
<tr>
<td>Potato</td>
<td>$800</td>
<td>$700</td>
<td>$100</td>
<td>0.14</td>
</tr>
<tr>
<td>Watermelon</td>
<td>$3000</td>
<td>$2,200</td>
<td>$800</td>
<td>0.36</td>
</tr>
<tr>
<td>Chicken</td>
<td>$8,000</td>
<td>$6,000</td>
<td>$2,000</td>
<td>0.33</td>
</tr>
<tr>
<td>Cow</td>
<td>$20,000</td>
<td>$12,000</td>
<td>$4,000</td>
<td>0.66</td>
</tr>
<tr>
<td>Pig</td>
<td>$8,000</td>
<td>$10,000</td>
<td>-$2,000</td>
<td>-0.25</td>
</tr>
<tr>
<td>Sheep</td>
<td>$40,000</td>
<td>$25,000</td>
<td>$15,000</td>
<td>0.60</td>
</tr>
</tbody>
</table>
TABLE COMPARING RETURNS ON INVESTMENT

Remember:
Profit = Selling price - Cost
ROI = (Selling price – Cost)/Cost

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Selling price (A)</th>
<th>Cost (B)</th>
<th>Profit (A – B)</th>
<th>ROI (A – B)/B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tomato</td>
<td>$230</td>
<td>$200</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pumpkin</td>
<td>$400</td>
<td>$300</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Potato</td>
<td>$800</td>
<td>$700</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Watermelon</td>
<td>$3000</td>
<td>$2,200</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chicken</td>
<td>$8,000</td>
<td>$6,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cow</td>
<td>$20,000</td>
<td>$12,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pig</td>
<td>$8,000</td>
<td>$10,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sheep</td>
<td>$40,000</td>
<td>$25,000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
NOTE TAKER’S WORKSHEETS

Students’ names: ____________________________________________

Page ______

As you make each purchase, note what you bought and how many you bought. You can use the comment column to make notes about why you decided to buy that item.

<table>
<thead>
<tr>
<th>WE BOUGHT:</th>
<th>NUMBER:</th>
<th>COMMENTS:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
INSTRUCTIONS FOR DEVELOPING GAME MANUAL WITH STRATEGIES

Now that you’ve played Virtual Farm, you will have noticed that the game does not have a game manual available to explain how to play it and it does not have any suggestions on the best strategies to use for winning the game.

Your task is to write a game manual and strategy guide for Virtual Farm.

Some of the questions your customers will want you to answer are:

1. How do I start playing the game?
2. What should I buy first? Why?
3. How should I decide which crops or animals to raise?
4. Should I try to keep all of the plots of land planted? Why or why not?
5. What happens if I try to buy more of a crop when I already have all four plots of land planted? What should I do?
6. The game won’t let me plant on the fourth plot of land when I raise a cow. Why? What should I do?
7. What’s the best overall strategy for planting vegetables?
8. What’s the best overall strategy for raising livestock?
9. What’s the best overall strategy for making money?

Good luck and have fun.