**Team Activity: Gaming Ag N Cycling**

**Learning Objectives**

1. Gain an understanding of how local management can influence soil health, and local and regional water and air pollution.

2. Understand about trade-offs among crop productivity, management factors, and N cycling.

**Access the N Model**

Open the model that you have previously downloaded onto your laptop.

Otherwise, using only **ONE** laptop per Team, access the model from the Cloud, following the instructions at: <https://www.nrem.iastate.edu/nmodel/how-run-model>

Note: If too many people use the model in the Cloud, the model slows & stalls out.

For this activity, use the model in ‘**Interactive**’ Mode.

Attach one laptop per Team to a wall monitor, so that the Team can work together.

**Play the Four Games:**

Teams will compete to see which Team obtains the best outcome, depending on the Goal.

We will follow the procedure below, playing the game 4 times, with **a single, but different goal each time**:

 **i.** Income (Production) oriented: Manage for the highest income (yield)

 **ii.** Soil Conservation: Manage for the greatest increase in Soil Organic N and Soil Carbon stocks

 **iii.** Nitrate Reduction: Manage for the lowest nitrate flow to the Gulf of Mexico

**iv.** Integrative approach: Manage for the highest Crop yield possible while keeping nitrate run-off to Stream <10 ml, obtaining the best profit possible and maximizing Soil Organic Nitrogen.

We will start with Goal 1. You will have 7 minutes for each Goal for steps 1-4.

1. Work with your Teammates to develop a plan for attaining the Goal, e.g., highest income. For each of 10 years, decide which parameter settings (Crop, Fertilizer, and Management) will yield the best result. This will likely require multiple model runs of the 10-yr sequence.
2. For each year of the model run, record the parameter settings and the outcome for the goal of interest, e.g., income. Do this on a separate piece of paper. Copy the Final Report sheet (generated by the model at the end of 10 years) into a Word doc, using the Fn Print Screen buttons. Save this Word doc as ‘N model outcomes\_Team X’, and upload it to Canvas at the end of class.
3. Compare Results from all your model runs for this Goal. Record in the Table below the data for the best result that your Team obtained across all Final Reports for this Goal.
4. All Teams will report simultaneously their best outcome by displaying their 10-year Summary Page. On a small whiteboard, also post your best outcome for the Goal, e.g., highest Income achieved.
5. We will follow with a class-wide discussion about how you met the goal. Be prepared to discuss the ecological principles that guided your choice of parameters for achieving each specific goal. Also, report other aspects, e.g., revenue earned, how many badges for soil conservation you earned, and how many penalties for nitrate pollution.
6. The Team who wins receives 1 extra credit point.

**Tables**

 **Your best outcome:**

**Goal i**: Manage for the highest Income.

 **Total 10-yr income**: $206,521

 **Notes**:

|  |  |  |
| --- | --- | --- |
|  | Parameter | Outcome |
| Year | Cropping System | Fertilizer | Mgmt | Income |
| 1 | Corn | 180 in spring | Tilled | -$18,138 |
| 2 | Corn | 180 in spring | Tilled | $107,471 |
| 3 | Corn | 180 in spring | Tilled | -$13,197 |
| 4 | Corn | 180 in spring | Tilled | $71,837 |
| 5 | Corn | 180 in spring | Tilled | -$22,670 |
| 6 | Corn | 180 in spring | Tilled | $34,510 |
| 7 | Corn | 180 in spring | Tilled | -$19,886 |
| 8 | Corn | 180 in spring | Tilled | $21,578 |
| 9 | Corn | 180 in spring | Tilled | $70,279 |
| 10 | Corn | 180 in spring | Tilled | -$25,263 |

 **Soil carbon stocks**: Increased by 1 Mg/ha

 **Nitrate to streams**: >10 ppm in 10 out of 10 years; 386 kg/ha over the 10-yr period

 **Ecological reasoning for your choice of parameters**: Adding fertilizer to an N-demanding crop would cause it to grow more, and produce more yield. Planting a highly profitable crop such as corn and fertilizing it to produce a higher yield should maximize income. We could have increased the N level to 270 kg/ha, but in preliminary model runs, we found that productivity did not increase above 180 kg/ha. We chose corn because it brings a high price.

**Goal ii**: Manage for the highest Soil Carbon sssststocks.

 **Your best outcome:**

 **Soil carbon stocks increased by**: 25 Mg/ha

 Notes:

|  |  |  |
| --- | --- | --- |
|  | Parameter | Outcome |
| Year | Cropping System | Fertilizer | Mgmt | Stock of Soil Organic N |
| 1 | Alfalfa | 0 | No-till | 6441 |
| 2 | Alfalfa | 0 | No-till | 6660 |
| 3 | Alfalfa | 0 | No-till | 6852 |
| 4 | Alfalfa | 0 | No-till | 7052 |
| 5 | Alfalfa | 0 | No-till | 7263 |
| 6 | Alfalfa | 0 | No-till | 7449 |
| 7 | Alfalfa | 0 | No-till | 7655 |
| 8 | Alfalfa | 0 | No-till | 7865 |
| 9 | Alfalfa | 0 | No-till | 8023 |
| 10 | Alfalfa | 0 | No-till | 8255 |

* **10-yr income**: a loss, **-**$118,244
* **N flow to the stream**: 212 kg/ha over the 10-yr period.

**Ecological reasoning for your choice of parameters**: A perennial crop will have greater root biomass, which will contribute more to soil organic matter, Compared with an annual crop. Also, lack of tillage will reduce soil disturbance, thereby reducing soil organic matter decomposition.

 **Your best outcome:**

**Goal iii**: Manage for the lowest Stream N.

|  |  |  |
| --- | --- | --- |
|  | Parameter | Outcome |
| Year | Cropping System | Fertilizer | Mgmt | Stream nitrate conc (ppm) |
| 1 | Corn | 0 | No-till, cover crop & buffer strip | 9 |
| 2 | Corn | 0 | “ | 9 |
| 3 | Corn | 0 | “ | 9 |
| 4 | Corn | 0 | “ | 9 |
| 5 | Corn | 0 | “ | <8 |
| 6 | Corn | 0 | “ | <8 |
| 7 | Corn | 0 | “ | 9 |
| 8 | Corn | 0 | “ | <8 |
| 9 | Corn | 0 | “ | <8 |
| 10 | Corn | 0 | “ | <8 |

**# of years with <10 ppm nitrate in streams**: All 10 years!

**Note**s:

* **10-yr income**: a loss, **-**$496,507
* **Soil carbon stocks**: decreased by 6 Mg/ha

**Ecological reasoning for your choice of parameters**: Reducing N added to the system as fertilizer and planting corn (does not host symbiotic N fixation) will mean that the only sources of inorganic soil N would be mineralization of soil organic N and N fixation by lightning or free-living N fixers. Thus, adding zero fertilizer to corn would reduce N available to be leached to the stream. Cover crops and potentially, riparian buffer strips would take up soil inorganic N, and no-till methods would reduce soil organic matter decomposition; these three management practices could further reduce soil inorganic N stocks.

**Goal iv**: Manage to optimize income and soil organic N while reducing N in Streams.

**Your best outcome:**

|  |  |  |
| --- | --- | --- |
|  | Parameter | Outcomes |
| Yr | Cropping System | Ferti-lizer | Mgmt | Income | SON | Stream nitrate(ppm) |
| 1 | Corn | 90, Spring | No-till, cover, buffer | $6510 | 6217 | >10 |
| 2 | Corn | “ | “ | $54,499 | 6246 | >10 |
| 3 | Corn | “ | “ | -$29,783 | 6224 | 9 |
| 4 | Corn | “ | “ | $22,861 | 6213 | 9 |
| 5 | Corn | “ | “ | -$23,092 | 6189 | <8 |
| 6 | Corn | “ | “ | -$29,038 | 6175 | 9 |
| 7 | Corn | “ | “ | -$3993 | 6175 | <8 |
| 8 | Corn | “ | “ | $4492 | 6165 | 9 |
| 9 | Corn | 180, S | “ | $112,443 | 6159 | 9 |
| 10 | Corn | 180, S | “ | $9617 | 6155 | 9 |

 1**0-yr income**: $124,517 **Soil C decreased by**: 3 Mg/ha

**# of yrs <10 ppm nitrate**:

8 out of 10

**Ecological reasoning for your choice of parameters:**

Corn has the highest productivity in this climate. Reducing N fertilizer in most years reduces soil Inorganic N available to be leached, but it also reduces yield and detrital inputs that build soil organic matter. Use of cover crops, etc. would further reduce soil Inorganic N, and thus leaching to streams.