Cattle Conundrum

New Mexico

Supercomputing Challenge

Final Report

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Team 16

Centennial High School

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Executive Summary:

The climate of our planet is changing, and rapidly. With more greenhouse gasses being produced, harmful UV radiation is being trapped within the earth's atmosphere. This is causing our climate to steadily increase in temperature. One of the more harmful greenhouse gasses is methane. One big contributor of methane are dairy cows. One dairy cow alone produces almost 800 liters of methane in only one day. Since New Mexico has 340,000 dairy cows, over a million liters of methane is released into our atmosphere every day. We decided to create a model to simulate the production of methane by cows. We did research to find out the amount of methane produced by a single cow on a daily basis, and also to find out about the amount of energy from food needed for a cow to produce a given amount of methane. We put all of this information into a model which shows how methane "clouds" form when cows consume food energy and included variables for number of cows and initial number of clouds present in the atmosphere. Running our model led us to the conclusion that cows' methane production can definitely be detrimental to the environment, and that as the number of cows in an environment increases, the effect on the environment increases drastically. While we cannot say for the certain what the direct effect of all of this methane would be (due to dissipation of methane due to wind and other factors), we have concluded that reducing the number of dairy cattle in our area would undoubtedly have a positive effect on our local environment and

the global climate. Whether or not these positive effects would outweigh the negative side effects of lowering our cattle supply we have not yet determined.

Problem

The goal of our project is to determine the amount of methane a certain number of cows produce in a certain period of time. Part of that includes finding various ways to reduce the methane production in order to reduce the threat of climate change. While brainstorming at the beginning of our project, the topic "cows" came up. We chose this project because we live relatively close a dairy farm. New Mexico's climate is already hot, and with climate change, we could get hotter. Methane is a very potent greenhouse gas and is more efficient at trapping radiation than carbon dioxide. According to the EPA, over a 100-year period, the comparative impact of methane on climate change is over twenty times greater than carbon dioxide. Likewise, methane's lifetime in the atmosphere is 12 years. Cows produce methane while the food in their stomachs ferment and interact with microbes, and the cows release the gas through burps and farts.

Description

In the beginning of our project, our idea was too broad. We originally wanted to measure the amount of methane and determine various ways to convert the methane into fuel. We realized our project was too broad, as well as difficult to program. With the help of LD Landis, we managed to narrow down our idea, and focus on what, exactly, we needed to do. We decided to focus on the diet of an average 1,400 pound cow and how a different diet can affect the cow's methane production. According to the Food Animal Education Network at Purdue University, one single dairy cow consumes 50 pounds of feed every day. In a study by the North Carolina Cooperative Extension Service, a 1400 pound cow produces 46.4 ft^3 of biogas per day, with 27.84 ft^3 of that being only methane. When converted to liters, a single 1400 pound cow produced 788.34101 liters of methane per day. We researched the contents of a cow's diet at a local dairy farm, but were unable to get information. Instead of looking at what our local dairy cows eat, we decided to research and try to interview local dairy farm owners. However, we had some difficulties contacting local farmers. We decided instead to research what different foods for cows produce the most methane gas in cows. According to LandLearn NSW, grains produce less methane in a cow's stomach than the grass that the usually eat. However, producing grain creates more carbon emissions. In addition, the milk produced by dairy cows is negatively affected once grain concentrations exceed 50% of the cows diet. Short-term additives like medium fatty chain acids can be added to reduce methane emissions from cows. However, such additives are too expensive to be used in commercial livestock. With the information we had, we developed a model to represent our findings in NetLogo. In the code, we programed a background to look like a pasture where cows would graze. We then programed turtles

to represent cows. As the cows ate, their energy level would increase. In the code, we also have clouds in the sky we programed. As the cow's energy increases, so do the clouds in the sky. After a certain amount of time, the sky becomes covered by the clouds, and eventually the screen.

Results

In the course of this project, we discovered how vast the effect of the methane is on a small pasture. We also discovered that the lifespan of methane in the atmosphere is 12 years. Even though the methane is dispersed, it is still there. The more cows concentrated in a single area, the more methane produced. Our code clearly displayed this fact, considering that the screen was completely covered with methane gas before the code was finished running. Our model shows the correlation of the amount of feed the cattle eat and the amount of methane gas released into the atmosphere. This model clearly shows the buildup of methane in the air. We have two buttons, one that sets up the program, and another that starts it. We also have two sliders that change the number of cows and clouds in the program. With five cows, the screen turns completely white after approximately one minute. With ten cows, the time decreases to approximately forty-five seconds, and with fifty cows,

it is reduced to thirty seconds.

Conclusions:

We can conclude from this project that cows are detrimental to the environment and contribute to global warming. Through our research, we know what cows produce more of the greenhouse gas methane than most people are aware. We also learned exactly how much grass and hay food energy it takes for cows to survive and thus to create the methane they produce. Our model shows that as the number of cows increases, the amount of methane in the atmosphere also directly increases. Thus, the more cows present, the more greenhouse gases present. Though our research shows that methane from cows has a much smaller impact on the environment than transportation and industry, we feel that it plays a significant role in our community and would like to see measures taken to reduce the number of cows in our dairies or to further research into food types that might reduce the amount of methane produced by cows.

Recommendations

If we were to further this model, we would like to quantify the amount of methane produced, or the size of the clouds using a monitor. We would like to be able to adjust the amount of methane

produced based on different production rates due to different food types. We would also like to do more research into finding out the dissipation rate of the methane, and how it contributes to the environment locally and as a whole, as well as factors that can eliminate or reduce methane already present in the atmosphere.

There are several things that we would do differently the next time in general. One thing we would definitely do would be having everyone on the team learn how to program. That way, we could finish the code quickly and work on the code even if a team member is gone. We would also learn how to program earlier into the competition. We did not start the actual program until late into the year. Another thing that we would do next time would be staying on task and not procrastinating. During meetings, we would often get distracted. Because we were distracted, we put off working on our project. Another problem we came across was contacting local dairy farm owners to learn how much the cows are fed, as well as how many cows they own.

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APPENDIX A: (Code)

```
globals [grass]breed [cattle cow ]
```

```
breed [cloud methane]
cattle-own [energy]
to setup
  clear-all
  setup-sky
  setup-grass
  create-cattle  cattleslider [set size size * 5]
  ask cattle [set color brown]
  ask cattle [ setxy random (min-pxcor - 10) random (max-pxcor + 10) ]
  ask cattle [setxy  random (min-pycor - 15 ) random (max-pycor - 30)   ]
  create-cloud cloudslider [set size size * 2]
  set-default-shape cloud "cloud"
  ask cloud [set color white ]
  ask cloud [setxy random (min-pycor + 1) random (max-pycor + 10) ]
  ask cloud [setxy random (min-pxcor - 15) random (max-pxcor + 1) ]
  reset-ticks



end
to setup-sky

  ask patches [if ( pycor < 0 ) [ set pcolor scale-color green (random 5000 + 40000) 0 100000  ]]
end

to setup-grass
  ask patches [if ( pycor > -1 ) [set pcolor scale-color blue (random 500 + 40000) 0 100000 ]  ]
  set grass count patches with [pcolor = green]
end
to eat-grass
  ask cattle [
          if pcolor = green [
          set pcolor black
          set energy energy + 10

          ]
  ifelse show-energy?
          [ set label energy ]
          [ set label "" ]
  ]

end
```

```
to go
  ;365= numbers of days in a year
  move



end
to move

  ask cattle [

          repeat 365[ ask cattle  [right random 180
          forward 1
          set energy energy + 15.77
          eat-grass
          ask cloud [set size size * 1]
          grow-cloud
          wait .25

  ]

]]

end
to clone
  if (energy > 10)
  [hatch 1
          [set energy 0
          ]
  ]

end

to grow-cloud
  if (energy > 10)
  [ask cloud [set size size * 1.003]
  set label size
  set label ""
  ]

end
```

;make clouds grow with methane