Prediction of Green Chile

New Mexico

Supercomputing Challenge

Final Report

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Executive Summary

The goal of this project is to successfully model the heat of chile, using water and yield as our variables. With this program we have demonstrated that these variables do affect the pungency of the chile. With our program we have also verified that adding water to the chile field will reduce its overall pungency. Not adding water will also reduce the amount of money that the farmer needs to spend to create a good crop. We hope to distribute our results to our community's farmers so that they can grow the type of chile they need without wasting a large sum of money.

Introduction

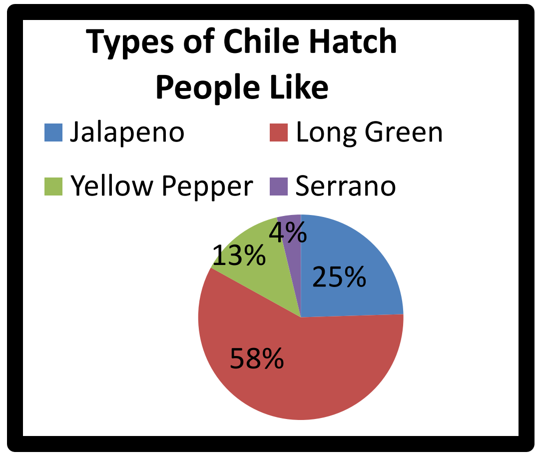

Figure 1

Our project is based on the consistency of the pungency of chile. For our project we conducted a survey at our local supermarket (shown in figure 1), Jims, asking Hatch citizens whether they liked Jalapeno, Long Green, yellow Pepper, or Serrano chile the most. With the survey results we found out that Hatch citizens like green chile the most, so we focused our project on green chile. There are many environmental factors that can make the pungency of chile inconsistent, for example, temperature, sunlight, and rain. There are also many man-made factors that can cause an inconsistency, for example, width of rows in the field, spacing of planted seeds, water added, and the type of chemicals added to the plant.

Objective

What we have done for our project is to create a program for chile farmers that could help them estimate the overall pungency and the water added for the last month before harvest. Since in a real life situation not all the chile in the field would be the same heat; we used two different equations to add the randomness of nature. We also made it possible for farmers to use our program to find the average pungency of the entire chile field. What we hope to achieve with this program is to help chile farmers create a consistent product that they would be proud to put out in the market.

Background

Living in Hatch all our lives, we have noticed that chile is an important part to our areas agriculture, so we have chosen to base our project on creating a computer simulation that can increase our community's use of agricultural technology. Many farmers work so hard to produce the chile of their desire and at the end be disappointed from not producing a consistent product.

While growing up in Hatch we have seen chile everywhere. When the world famous Chile Festival comes around once every year, chile is the main attraction and a great investment to our local chile businesses. Chile has been a big part of our culture. Many people in our families, as well as friends, have worked in the production of chile. Chile is a well known food product all around the world and is used for everyday products such as lipstick, pepper spray, crayons, thermal patches and Icy Hot. There has also been research done to try and use chile to fight cancers.

Hatch is known as the chile capitol of the world because it is among one of the biggest chile producing towns in Dona Ana and Luna County. Since 1994, Dona Ana and Luna County have been harvesting the greatest acreage in New Mexico (shown in figure 2).

Table 1. New Mexico chile pepper acreage harvested by county.

County	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Chaves	2,500	1,400	2,200	1,700	1,650	1,500	1,400
Dona Ana	***8,200***	***6,000***	***6,900***	***7,000***	***6,300***	***4,000***	***4,900***
Eddy	1,800	1,000	2,000	1,100	800	500	1,100
Hidalgo	2,300	2,200	3,100	2,600	2,500	1,250	2,600
Lea	1,200	1,100	1,000	900	800	1,000	700
Luna	***8,000***	***8,200***	***9,400***	***7,600***	***7,300***	***6,500***	***6,500***
Sierra	2,000	1,000	1,500	900	850	600	700
Socorro	400	300	600	350	400	200	300
Other counties	1,500	1,200	2,000	850	900	650	800
Total New Mexico	27,900	22,400	28,700	23,000	21,500	16,200	19,000

Source: New Mexico Agricultural Statistics, 1994-2000.

Figure 2

Research

For our project we have chosen four main variables to research. The four variables are Capsaicin, spacing of seeds, temperature, and water. Within our research we have found many facts and secrets to growing chile.

While researching on chile facts we came across Pete Domenici. In 1983 Pete Domenici was an American Republican politician. He served six terms as a United States Senator from New Mexico. He had the longest tenure in the state's history from 1973 and 2009. Pete Domenici could not understand how the United States spelled chile as chili, so he stated that the dictionary was wrong. In 1983, Pete Domenici made it official by putting it in a Congressional Record that the vegetable chile is spelled as chile, not chili.

Producing chile is a long term growing process it takes 120 days or about 18 weeks maximum for the chile to be ready for harvest. According to the New Mexico State Chile Pepper Institute, chile farmers are not supposed to plant chile in the same field more than three to four years. Also a good harvest is about seven to ten tons per acre.

The number one variable of growing chile is capsaicin, with the research we have done we have found out that there are different levels of capsaicin (shown in figure 3) depending on the heat you want your chile to be. Capsaicin is also measured in Scoville Heat Units, SHU.

Capsaicinoid Name	Abbrev.	Typical relative amount	Scoville heat units
Capsaicin	C	69%	15,000,000
Dihydrocapsaicin	DHC	22%	15,000,000
Nordihydrocapsaicin	NDHC	7%	9,100,000
Homodihydrocapsaicin	HDHC	1%	8,600,000
Homocapsaicin	HC	1%	8,600,000

Figure 3

The spacing of seeds is another variable in calculating the heat of chile. The most common row width is 36 to 40 inches and a narrow row spacing, 32 inches, can result in a higher yield which increase the pungency of chile. Also, a good standing includes single plant, or clumps of no more than three plants, uniformly spaced 10 to 12 inches in the row of a 40 inch bed for a plant population of 13,000 to 15,000 plants per acre.

In the chile production the seed or plant does not grow if the temperature is below 60°F or above 90°F. When temperature rises above 90°F after several flowers have set and chile's are developing the growing process may stall. This may cause a split in the chile setting continuum and it's called a split set. An early yield is determined by the chile's developing before the onset of hot water. Delay in chile set can reduce the yield causing the pungency to decrease.

Water is also a variable in the pungency of chile. To get a good chile produce farmers have to irrigate the field 5 to 7 weeks before planting and they have to plant the chile seeds before the soil dries. Chile is a shallow rooted crop and needs 4 to 5 acres- feet of water between plowing and harvest. The water has to be applied on a 5 to 7 day schedule before rains and after rains begin, extend the interval to 7 days or more, depending on the rainfall amount. Also farmers are not supposed to water the field if there is a high risk of rain.

The four variables, capsaicin, spacing of seeds, temperature, and water, is our main goal for our program. We do not have enough information to plug in all the variables at one because this project is a long term project for now we have decided to work with yields per ton and pungency which is measured in Scoville Heat Units, SHU . For our research we found experiments done by New Mexico State Chile Institute. The data we have found was done between the years of 1977- 1981. We were not able to use the data from year 1981 because of its lack of detail.

For the yields and tons part of our programming we used figure 4 to estimate and calculate what equation we would use for our programming. We plotted the information from figure 4 and we added two different best fit curves to create the equation as shown in figures 5 and 6.

Table 2. Green chile yields[1] as influenced by irrigation treatment

Year	Treatment	Water Applied[2]	Yield[3]	C.V.
	% of control	*cm*	*tons/ha*	*%*
1977	60	35.2	2.5c	36.0
	70	37.2	3.7bc	36.0
	80	39.5	5.6b	20.0
	100	45.1	11.8a	20.3
1978	80	38.1	11.0d	5.2
	100	44.2	14.2c	8.7
	120	50.3	16.3b	11.1
	140	56.4	19.1a	6.7
1979	80	53.1	13.0b	30.9
	100	57.9	18.8ab	26.5
	120	63.0	18.1ab	12.5
	140	65.0	22.8a	40.7
1980	80	62.1	18.8b	12.3
	100	70.1	28.1a	5.4
	120	79.9	30.2a	14.8
	140	88.6	28.9a	12.2
1981	**Unused Data**			
	140	109.0	33.6a	10.7

Figure 4

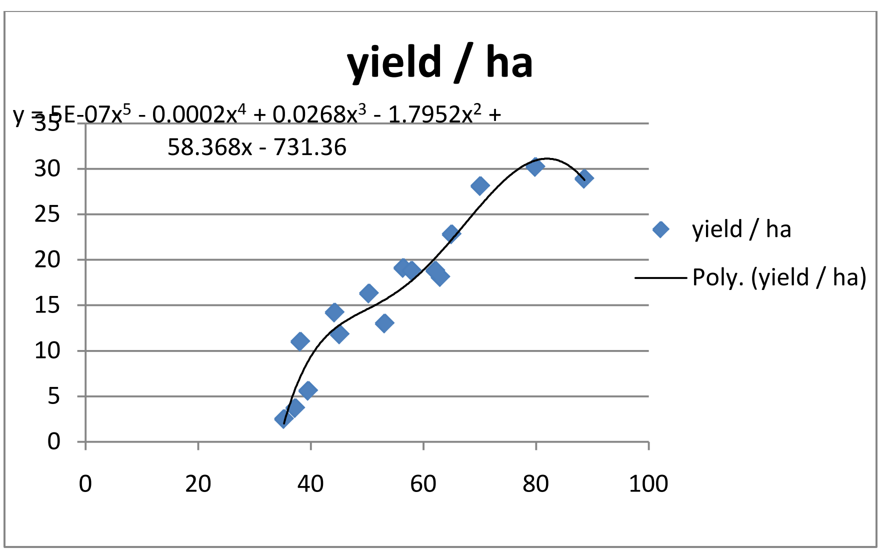

Figure 5

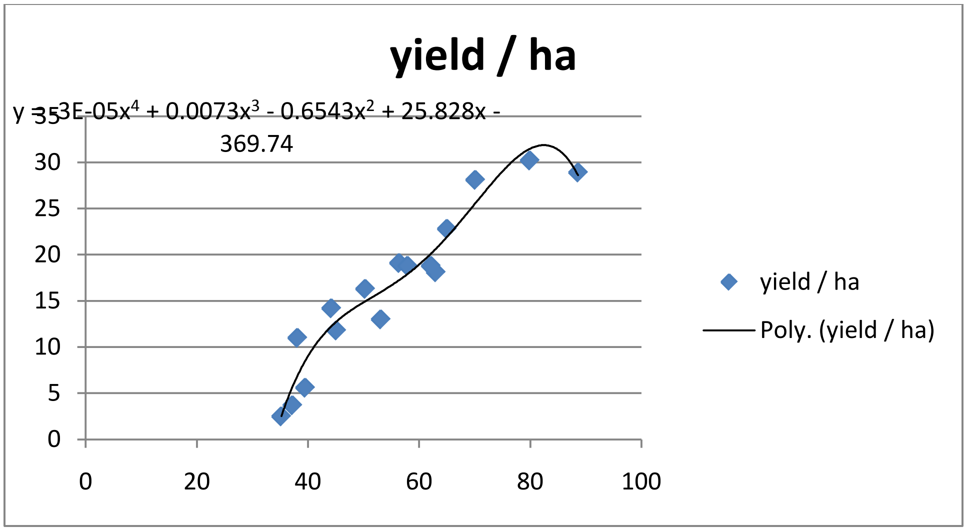

Figure 6

For the pungency part of our programming we used the information from figure 7 to calculate and determine what equations we will be using. We had very limited data to determine the pungency but we calculated an estimate amount.

Table 5. Pungency, in heat units (1 heat unit is 1000 Scoville), for green chile harvested September 2, 1980, August 13, 1981 and September 13, 1981[1].

Year	Treatment	Water Applied[2]	Pungency[3]	C.V.
	% of control	*cm*	*heat units*	*%*
1980	80	62.1	1.33a	31.4
	100	70.1	1.33a	16.8
	120	79.9	0.68b	33.0
	140	88.6	0.90ab	22.2
1st harvest–August 13, 1981	60	53.6	1.20a	39.0
	80	61.0	0.85a	41.1
	100	67.3	0.83a	40.1
	120	72.4	0.94a	28.5
	140	80.0	0.75a	42.6
2nd harvest–September 13, 1981	60	66.3	2.55a	18.3
	80	75.9	2.25a	20.0
	100	86.1	2.43a	30.1
	120	93.6	2.60a	55.6
	140	109.0	1.85a	34.9

Figure 7

Note:

The data for 1981 was only cut out on the yields per ton part for our programming. It was used for the pungency part because it was very detail and a big part. They information used for yield per ton did not affect they SHU measurements.

Math Model

While looking at all the different models on net logo we noticed that they all have a their own unique randomness. They thing they all have in common is the random function they put in there code. We have decided not to use the random function; we have used two different equations that can be chosen by the plant to determine the amount of SHU it will produce. By having several equations we will simulate a real life situation.

The equations we will be using for our programming are:

1. SHU1 = (-2.3035 * amount-of-water + 1037.9)
2. SHU2= (13.471 * amount-of-water)

Average SHU Equation

SHU Average per chile = (SHU + (-6.1952 * amount-of-water-added ^ 2 + 246.46 * amount-of-water-added - 827.92))

Stating Water

Yield in Ton per Hectare = ((0.0029 * amount-of-water-start ^ 2) + (0.1243 * amount-of-water-start))

Added Water

Yield in Ton per chile = yield + ((0.0029 * amount-of-water-added ^ 2) + (0.1243 * amount-of-water-added))

Each equation was found by using Microsoft Excel, we graphed a set of points and we added many best fit curves that calculated several equations. Each equation would give a different SHU depending on the amount of water added. This is also what will give us a randomization to our computer simulated chile field.

Programming

```
globals
[
yield
row
SHU1
SHU2
total-SHU
i
]
breed [ chilies chili ]
chilies-own [ SHU ]
to setup
  clear-all                                             ;; clears and resets all previous things within the world
    set SHU1  ( -2.3035 * amount-of-water-start + 1037.9 )
    set SHU2 ( 13.471 * amount-of-water-start )
    set yield ((0.0029 * amount-of-water-start ^ 2) + (0.1243 * amount-of-water-start))
    field
    rows
    while [ i < 909 ]
     [
      ask chili i
      [set total-SHU total-SHU + SHU]
      set i i + 1
     ]
    set i 0
end
to go
set yield yield + ((0.0029 * amount-of-water-added ^ 2) + (0.1243 * amount-of-water-added))
ask chilies
  [
```

```
  set SHU (SHU + (-6.1952 * amount-of-water-added ^ 2 + 246.46 * amount-of-water-added -
827.92))
  ]
   while [ i < 909 ]
     [
      ask chili i
      [set total-SHU total-SHU + SHU]
      set i i + 1
     ]
    set i 0
end
to field
ask patches
  [
    set pcolor brown
  ]
end
to rows
    ask patches
    [
      if (pxcor = 10 or pxcor = 20 or pxcor = 30 or pxcor = 40 or pxcor = 50 or pxcor = 60 or
pxcor = 70 or pxcor = 80 or pxcor = 90)
      [
        sprout-chilies 1
        [
          set shape "plant"
          set SHU one-of (list SHU1 SHU2)
          set size 1
          set color green
        ]
      ]
    ]
End
```

Results

The lack of our data has made our program unreliable. A lot of the information it provided to us was outdated. Many of the tools used were not up to technology like now. Over the summer we will conduct our own experiment that will provide us with our very own data. With more accurate and updated data on green chile, our program can be very reliable for chile farmers all around the world.

Conclusion

For our program we noticed that our data from our sources and our data from the program did not match. As we stated earlier this is because of a lack of sufficient and good quality data. One thing that we could do to improve the data is to conduct our own science experiment during chile growing season to accurately prove if the relationship between the amount of irrigation a field gets does have an effect on the pungency of the chile. Our youngest team member is willing to continue doing this project to help farmers even more. This was an awesome experience and we will be back next year.

Work Cited

Capsaicinoids. (n.d.). Retrieved from http://www.edinformatics.com/math_science/science_of_cooking/capsaicin.htm

Chile facts. (2006). Retrieved from http://www.chilitraditions.com/chilefacts.htm

Garcia, F. 1908. Chile Culture. New Mexico College of Agriculture and Mechanic Arts. Bulletin No. 67. 32 pp. (n.d.). Retrieved from http://aces.nmsu.edu/pubs/_h/h-230.html

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