Grow Don’t Mow

Campus Food Production Research

Summer 2015 CES Research

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I. Introduction

In the fall semester of 2013 a group of students from the Environmental Planning class (Envi 302) created a proposal for the potential development of a campus farm on the piece of land known as Wire Bridge Farm. This parcel in Hopkins Forest has been farmed for decades, used mostly to grow silage corn and hay and to graze livestock.[1] The college acquired this land in 2003, but since the campus farm proposal, the college has decided to keep the land as it is now, in case any of the faculty want to conduct research on it in the future. In light of this decision, we are now considering whether a campus food production operation would be possible on a different plot of land that Williams College owns. To begin this project, Sarah Gardner, associate director of CES, spoke with Fred Puddester, VP of Finance and Administration, to determine what land was available. Four parcels were identified; a 1-2 acre piece behind Tyler house, 2 acres at the old piggery field, about 6 acres at a property on Cluett Dr, and about 8 acres on Potter Rd.

Increasingly, colleges and universities across the country are making sustainability part of their institutional missions. In order to not fall behind other peer institutions in this area, we recommend that Williams College reduce its environmental footprint by having its own campus food production operation. Furthermore, a campus farm fulfills four main sections of the Williams College mission statement[2]:

1. Ensures that *college operations are environmentally sustainable*
2. Aids in the *creation of a functioning community*

[1] Lucy Bergwall, Sara Clark, Eirann Cohen, and David Kruger, *Ephraim Williams Had a Farm* (2013).
[2] "Williams College Mission and Purposes," *Williams College Archives and Special Collections*, last modified April 14, 2007, http://archives.williams.edu/mission-and-purposes-2007.php.

3. Provides *direct engagement with human needs*
4. Instills in students *civic virtues including commitment to engage both the broad public realm and community life*

In addition to meeting the college's mission statement, a campus food production operation would improve the connections between Williams and the greater community by contracting a non-Williams employee and involving them in our daily lives. At the same time, it would provide a positive response to the increase in the student demand for local/sustainably grown food, as was shown by the student survey from the Fall 2013 Envi 302 project.[3]

A campus food production operation would provide a wide array of benefits for the college, its surrounding community, and the global community. On the campus level, a local food production system would increase student awareness of sustainability issues and promote land stewardship, provide new educational opportunities for environmental classes, and maintain the college's long-term financial stability. On the local community level, a farm would increase the percent of local food purchases—and thus create less pressure on faraway areas experiencing drought or deforestation—as well as stimulate the local economy through the creation of a new job. On the global level, a farm would reduce the college's contribution to climate change by reducing its carbon emissions and if sustainable practices are implemented, it would reduce the college's overall environmental footprint.

The goal of this project was to evaluate the parcels of land to determine possible courses of action that would lead to the creation of a campus farm. First we examined all unused parcels of land that the college owns and narrowed it down to four plots, Tyler, Piggery, Potter, and

[3] Lucy Bergwall, Sara Clark, Eirann Cohen, and David Kruger, *Ephraim Williams Had a Farm* (2013).

Cluett. Then we visited each of those four plots with Dave Fitzgerald from facilities and Jay Galusha, a local farmer. After those visits we narrowed it down even further to just Potter and Cluett. We also talked with Dining Services to determine what products had the largest capacity for growth in local purchases, and which ones would require the least amount of processing. We spoke to local farmers to determine which crops would be the most appropriate, and analyzed food purchase spreadsheets from Dining Services to establish sample profits and income estimates of different crop rotations. In the end we came up with various recommendations for future students to research and propose to the college.

II. Current Situation with Local Food Consumption, Goals, Benefits

Unlike 35 other colleges and universities, Williams College has not pledged to participate in the Real Foods Challenge: to achieve 20% "real food" in the dining halls by 2020.[4] This means that there is nothing forcing the college to improve their food options (by sourcing local, sustainable, perhaps organic products) other than scattered demands by student groups. However, the survey conducted by the 2013 Envi 302 class shows that students do want to see an increase in local foods and would be excited by the prospect of a campus farm.[5] Although the college has not signed the 20/20 challenge, a campus food production operation would be a way for us to remain competitive among other sustainability-oriented colleges. Additionally, not only would it meet growing student demand for local food, but it would also be a highly marketable asset for the admissions office.

[4] "Press and Success," *Real Food Challenge,* http://www.realfoodchallenge.org/press-and-success.
[5] Lucy Bergwall, Sara Clark, Eirann Cohen, and David Kruger, *Ephraim Williams Had a Farm* (2013).

The goal of a campus food production operation would be to first and foremost increase local food purchasing while bringing unused Williams College land into cultivation. These initial recommendations are somewhat conservative compared to other college farm operations. They do not rely on student workers or volunteers or any staff employed by Williams College. Instead, we propose a contract with an independent farmer who wants to meet Dining Services' needs. However, this project could be extended to meet many other criteria required by future faculty and students. It has the potential to become a working farm with educational opportunities for the Environmental Science or Biology departments to expand into. It could also be expanded beyond our starting plan to include other crops and animal products not mentioned in this report and students could become more involved through work-study arrangements or club participation.

In addition to decreasing our carbon footprint and increasing educational opportunities, the college's methods of handling food waste and compost could be improved upon through the addition of a campus farm. Currently, the college pays Allied Waste Service to haul the "compost" sludge to Holiday Brook Farm (about 24 miles away), where the sludge is properly composted and aerated to become workable compost after a few months. If the compost were to go towards the campus farm, the shorter distance means that the farm might be able to pick up the compost more often and have high quality fertilizer without having it turn into sludge first. Alternatively, instead of composting food waste on the farm site, it could be used to feed livestock like pigs that would produce animal products for the dining halls.

A campus farm would only produce foods that Dining Services already or plans to use. As a result, such an operation is restricted somewhat by Dining Services processing capabilities. Bob Volpi[6] and Executive Chef Mark Thompson made it clear that the Dining Services staff can only handle so much processing in the kitchens, and that the majority of their products are bought with this in mind.[7] Therefore, the crops or livestock that would be grown on a campus farm would have to be ones that require minimal processing or none at all. If processing was required, the produce would preferably be processed on site, at one of the empty dining halls on campus, or have to go to an outside facility to be prepared. Suggestions regarding processing will be detailed in Section V.

III. Parcels

Initially, four parcels were considered for this study: Tyler, Piggery, Potter, and Cluett. After an email correspondence with Rita Coppola-Wallace in Facilities on June 10, 2015, the Tyler property was eliminated from consideration due to construction plans that will divide the plot into small un-farmable pieces.[8] Upon visiting the piggery plot located at the base of the Mt. Hope estate with farmer Jay Galusha, it became clear that the land was almost completely in use by the Galusha's for hay, and the only piece available to us was about two acres. This did not seem large enough to support our vision for the campus farm, so the piggery plot was also eliminated from further evaluation. The remaining two plots, Cluett and Potter, are much more promising, and will be reviewed in detail below.

Potter Parcel

[6] Bob Volpi, interview by author, Williamstown, MA, June 18, 2015.
[7] Mark Thompson, interview by author, Williamstown, MA, June 25, 2015.
[8] Rita Coppola-Wallace, email message with author, June 10, 2015.

Located along Potter Road, this parcel has total area of 16.95 acres.[9] To the west lies a stream covered by forest. Most of the parcel, however, is arable land, totalling about 14-15 acres[10]. Wetland on this parcel is almost exclusively on the forested region (see Figure 4).[11] Besides the stream, there is no other water source on this site.[12]

In an email correspondence on July 13, 2015 with Fred Puddester, the Vice President for Finance & Administration and Treasurer of the college, it appears that there are no legal issues with using this land for agriculture.[13] According to an email correspondence on August 3, 2015 with Andrew Groff, Community Development Director of Williamstown, so long as we stay 100 feet away from any wetland, there are no foreseeable issues with farming this parcel.[14] Since the wetland is confined to the periphery of this parcel, this constraint does not appear to an issue. In a conversation with Sarah Gardner on June 19, 2015, we learned that Jim Sylvester, the farmer that used this land previously for haying and cattle grazing, has agreed to let the college use the northern half of the arable portion, which amounts to about 7-8 acres.[15] After this agreement was made, we conducted soil tests on this portion of the Potter parcel.

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[9] "Property Card," *Williamstown Board of Assessors*, last modified 2015, http://csc-ma.us/PROPAPP/display.do?linkId=2494332&town=WilliamstownPubAcc

[10] "Google Maps Area Calculator Tool," *DaftLogic*, last modified May 11, 2015, http://www.daftlogic.com/projects-google-maps-area-calculator-tool.htm.

[11] "CAI Query Manager Online Williamstown, MA," *Craigsonline*, http://www.caigisonline.com/WilliamstownMA/Default.aspx?Splash=True.

[12] Rita Coppola-Wallace, email message with author, July 14, 2015.

[13] Fred Puddester, email message with author, July 13, 2015.

[14] Andrew Groff, email message to author, August 3, 2015.

[15] Sarah Gardner in discussion with the author, June 19, 2015.

Soil test sent to and conducted by UMass Amherst showed that the parcel is lacking in the nutrients phosphorus and potassium, but is abundant in calcium and magnesium (shown in

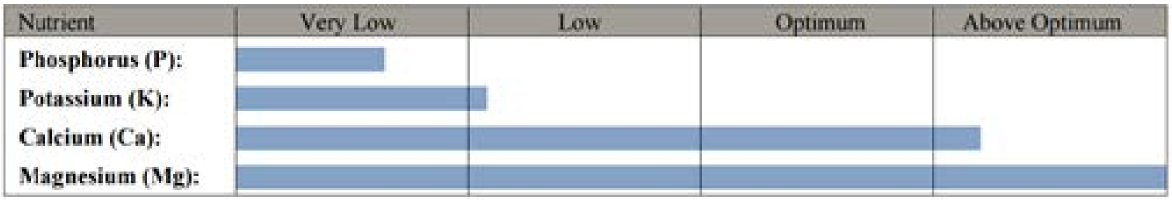

Figure 1).

Figure 1. Nutrient Content in Potter soil (Potter Sample 2)

Additionally, the results showed that the soil is not lacking in any specific micronutrient. However, the amount of manganese found exceeded the normal range found in soils. The amount of organic matter in the soil was found to be 7.8%. Finally, the pH averaged at 5.8 for the three samples. Soil amendment recommendations were requested for: beans, leafy greens, squash, lettuce, onions/leeks, tomatoes, basil, cucumbers/melons, and peppers. Figure 2 shows the amount of limestone, nitrogen , phosphorus (P2O5), and potassium (K2O) in pounds per acre recommended to amend the parcel's soil for each particular crop.

Crop	**Limestone**	**Nitrogen (lb/acre)**	**Phosphorus (lb/acre)**	**Potassium (lb/acre)**
Beans	3,000	50	100	75
Leafy greens	3,000	50-80	180	120
Squash	3,000	110-140	150	150

Lettuce	4,000	80-125	180	120
Onions/leeks	4,000	130-150	150	150
Tomatoes	4,000	140-160	180	150
Basil	3,000	115-130	120	75
Cucumbers/melons	3,000	110-130	150	120
Peppers	3,000	140	150	150

*note that the difference in limestone recommendation varies because three soil samples were sent, each differing in pH by 0.1 (ranging from 5.7-5.9)

Figure 2. Soil Amendment Recommendations for Crops (pounds per acre)

For more information regarding micronutrients, Cation Exch. Capacity, Exch. Acidity, Base Saturation, Scoop Density, Soil Organic Matter, Soluble Salts, and Nitrate-N, refer to the soil tests included at the end of this report in Appendix 2 and Appendix 3.

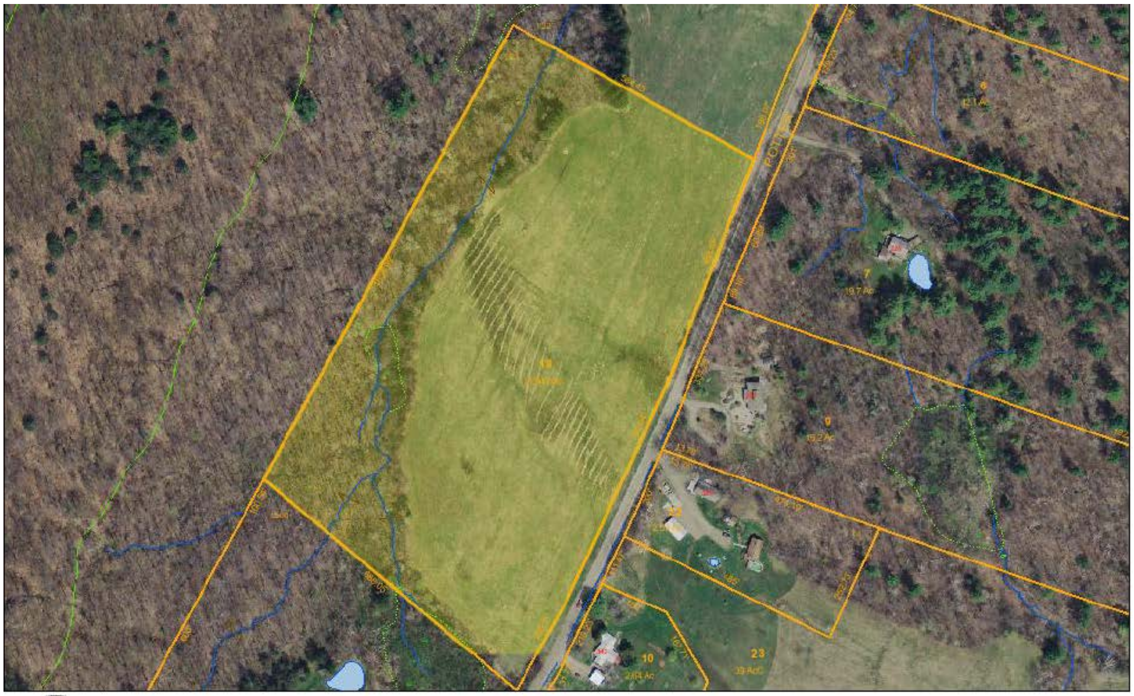

Figure 3. Potter Parcel (Aerial View)

Figure 4. Potter Parcel with Wetlands (shaded in dark green)

Cluett Parcel

Located along Cluett Drive, this parcel has a total area of 149 acres.[16] The southeastern portion of this parcel is hayed by Jim Galusha, however most of this parcel is forested. Wetland is concentrated in the northern portion of the parcel, as well as in the southern portion. (See Figure 8).[17] There is a stream that runs through the middle of the parcel, but otherwise there are no other water resources, as stated in an email correspondence with Rita Coppola-Wallace on July 14, 2015.[18] However, in terms of water resources, there is the possibility of drilling a well or to extend municipal water supplies since the parcel is located next to a residential area. Wetland on this parcel is concentrated almost exclusively on the forested part.[19]

In an interview with Fred Puddester on July 13, 2015, it appears that there are no legal issues with using this land for agriculture.[20] However, following a conversation with Jim Galusha on June 19, 2015, it was decided that manure should not be used on this land in consideration of Pine Cobble School located next to this parcel.[21] Although most of the cultivable land is used for hay production by Jim Galusha, there is a 2-4 acre portion at the bottom right corner that could be used if it was bush hogged. However, there is a larger approximately 6 acre portion at the northern section of this parcel that may be used if the land is cleared (for crop production) or if the brush is removed (for livestock rearing). It is this northern portion of the Cluett Parcel that we are examining in this report and conducted soil tests for.

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[16] "Property Card," *Williamstown Board of Assessors*, last modified 2015, http://csc-ma.us/PROPAPP/display.do?linkId=2493743&town=WilliamstownPubAc.
[17] "CAI Query Manager Online Williamstown, MA," *Craigsonline*, http://www.caigisonline.com/WilliamstownMA/Default.aspx?Splash=True.
[18] Rita Coppola-Wallace, email message with author, July 14, 2015.
[19] "CAI Query Manager Online Williamstown, MA," *Craigsonline*, http://www.caigisonline.com/WilliamstownMA/Default.aspx?Splash=True.
[20] Fred Puddester, email message with author, July 13, 2015.
[21] Jim Galousha in discussion with the author, June 19, 2015.

Soil test sent to and conducted by UMass Amherst showed that the parcel is lacking in the nutrients phosphorus and potassium, but is abundant in calcium and magnesium (shown in Figure 5).

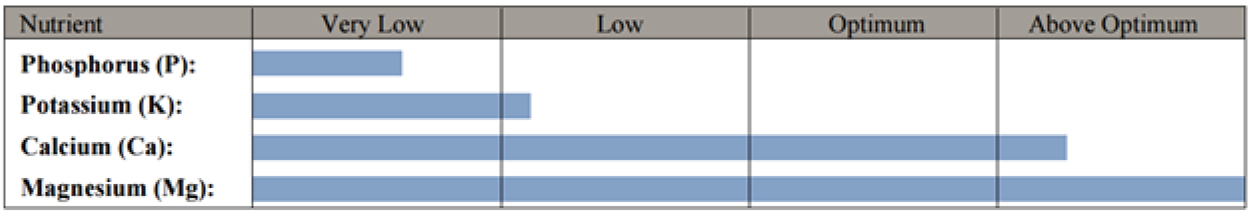

Figure 5. Nutrient content in Potter soil (Cluett Sample 2)

Soil amendment recommendations were requested for: beans, leafy greens, squash, lettuce, onions/leeks, tomatoes, basil, cucumbers/melons, and peppers. Figure 6 shows the amount of limestone, nitrogen , phosphorus (P2O5), and potassium (K2O) in pounds per acre recommended to amend the parcel's soil for each particular crop.

Crop	**Limestone**	**Nitrogen**	**Phosphorus**	**Potassium**
Beans	5000	50	100	75
Leafy greens	5000	50-80	180	120
Squash	5000	110-140	150	150
Lettuce	5000	80-125	180	120
Onions/leeks	5000	130-150	150	150
Tomatoes	5000	140-160	180	150
Basil	5000	115-130	120	75
Cucumbers/melons	5000	110-130	150	120
Peppers	5000	140	150	150

Figure 6. Soil Amendment Recommendations for Crops (pounds per acre)

Additionally, the results showed that the soil is not lacking in any specific micronutrient. However, the soil tests showed that both the iron levels and manganese levels exceeded the normal range. The amount of organic matter in the soil was found to be 8.2%. Finally, the pH averaged 5.4 for the three samples.

For more information regarding micronutrients, Cation Exch. Capacity, Exch. Acidity, Base Saturation, Scoop Density, Soil Organic Matter, Soluble Salts, and Nitrate-N, refer to the soil tests included at the end of this report.

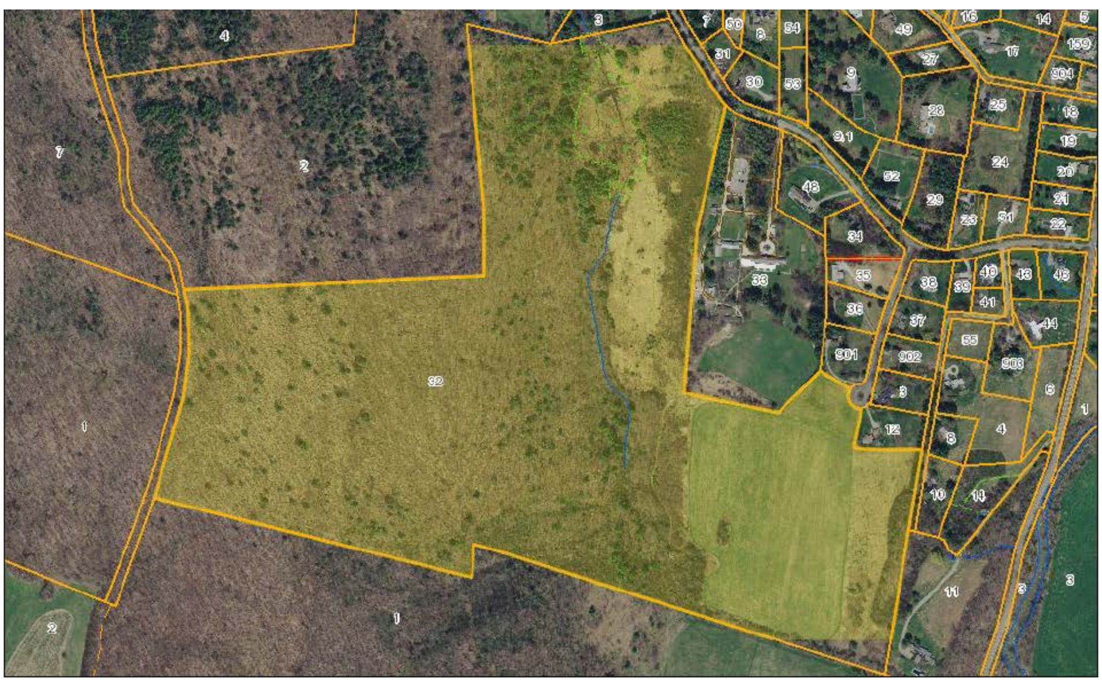

Figure 7: Cluett Parcel (Aerial View)

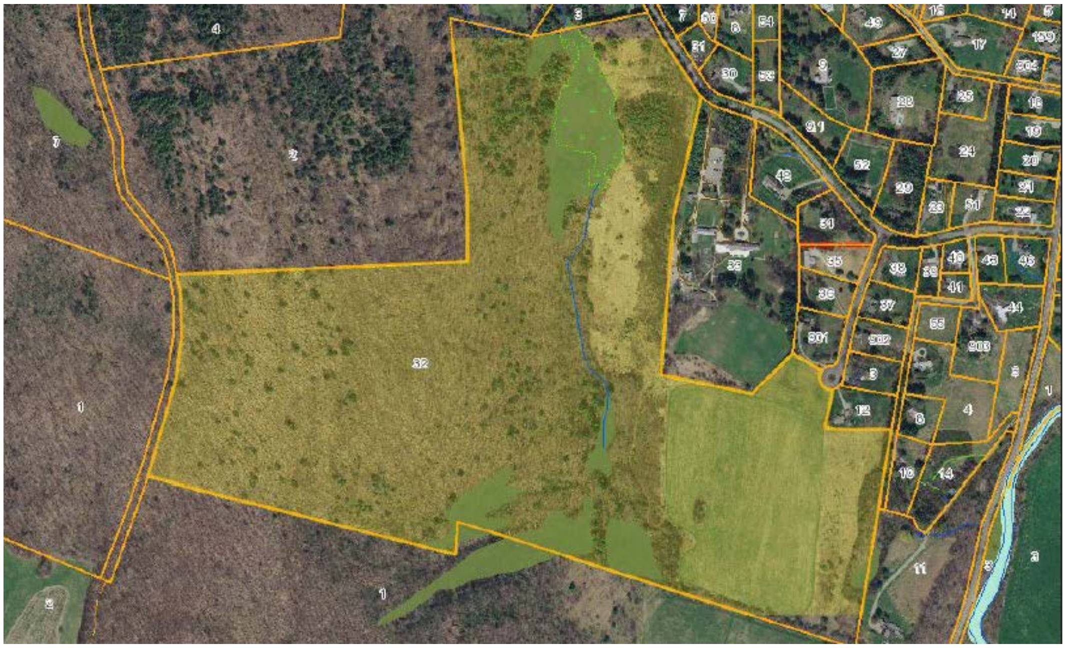

Figure 8: Cluett Parcel with Wetlands (shaded in dark green)

IV. Crops/Livestock

Besides crop production, another possible agricultural use of the college parcels is for livestock rearing, in particular chicken farming. The college goes through 10,605 dozen local free range extra-large fresh brown eggs a year or about 204 dozen per week.[22] The dining halls also rely on liquid eggs to a large extent, using about 38,220 pounds per year or 735 pounds per week.[23] In an interview with Chef Mark Thompson on June 25, 2015, Mark noted that a recent outbreak of avian flu in the Midwest, where the college primarily purchases its cage-free liquid eggs from, is anticipated to result in a shortage of the cage-free liquid eggs used in the college dining halls.[24] According to the Department of Labor, the cost of eggs increased by 84.5% in

[22] Diane's document
[23] ibid
[24] Mark Thompson, interview by author, Williamstown, MA, June 25, 2015.

June.[25] Furthermore, according to the USDA, eggs prices in New York rose from about $1.20 to $2-$4.50 a dozen from May to June.[26] An alternative, if the college wishes to maintain its current consumption of eggs, is to use whole eggs produced using college owned land to supplement this nation-wide shortage of eggs and to anticipate future shortages.

In order to raise chickens, different environmental and cost factors must be taken into account. At the very least, chickens require water, feed, shelter, and protection from predators.[27] Adequate water supplies may be a challenge without municipal water access, but streams and constructed facilities used to capture rain water may be alternatives. Shelter to protect chickens from weather events may come in the form of hoop-houses or more mobile shelters like moveable coops or "chicken tractors." Using a chicken tractor has the advantage of fertilizing the ground in the form of chicken urea and manure. Protection from predators is achieved by setting up an electric fence hooked up to a battery, which may or may not be solar powered. This takes care of most on-the-ground predators but may not be effective against hawks.

Hens, depending on the breed will lay one egg about every 25 hours. In order to maximize production, hens need at least 15 hours of "daylight," which may be simulated by using installed lights in the chicken coop. In order to keep chickens over the winter, heat lamps may also be used, but this requires some kind of electricity source. Eggs must be stored and maintained at 45°F (7.2°C).[28] See Section VI for costs regarding egg production.

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[25]Josh Boak, "Egg prices blowing up because of avian flu," *USA Today*, last modified July 15, 2015, http://www.usatoday.com/story/money/2015/07/15/producer-price-index-june-egg-prices/30187641/.
[26] Ben Axelson, "Could eggs hit $6 a dozen? Price set to surge if avian flu returns," *Syracuse*, http://www.syracuse.com/food/index.ssf/2015/08/egg_prices_increase_avian_flu.html
[27] Massachusetts Farm Bureau Federation, University of Massachusetts Extension, and the Massachusetts Department of Agricultural Resources, "Livestock & Poultry BMPs," (2008), 15-17.
[28] "Farmer's Markets," *Food Protection Program Policies, Procedures and Guidelines*, last modified April 30, 2013, http://www.mass.gov/eohhs/docs/dph/environmental/foodsafety/farmer-market-guidelines.pdf.

V. Other Campus Farms

There are many other colleges with campus farms, but the largest or most developed of those belong to technical colleges. Of course, those models would not fit with a liberal arts college such as Williams, so included below are some examples from some similar peer institutions. Even the models below are different from the one we're presenting though, because we don't want to rely on student/volunteer/staff labor, so they just show that this is a feasible goal with many ways to approach it.

1. Yale University

The Yale Food Project has a one acre farm that produces vegetables, herbs, berries, fruits, flowers, fiber and fuel crops.[29] They also have free-range laying hens and honeybees. During the school year, the farm is run by a staff of student interns, volunteers, and during the summer six student interns take care of the farm. It is utilized for coursework by professors and produce is sold at the local farmers market, used for farm events, sold to local restaurants, or donated to a hunger relief program.[30]

2. UMass Amherst

University of Massachusetts Amherst has a 12 acre farm, with 7 acres currently growing 39 different crops.[31] The produce is sold to a student-run cafe on campus, given to the dining halls, sold to their CSA members, sold at a farmers market, or distributed to Big Y supermarkets in the area. This all began as a student's independent study class, and then became a year-long class with a summer component. Unlike many other college farms, this one is certified organic.

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[29] "On the Farm," *Yale Sustainable Food Project*, last modified 2015, http://sustainablefood.yale.edu/farm-0.

[30] "The Yale Farm," *Yale Sustainable Food Project*, last modified 2015, http://sustainablefood.yale.edu/farm/yale-farm.

[31] "The Farm," *Stockbridge School of Agriculture*, http://stockbridge.cns.umass.edu/SFE-farm.

3. Duke

Duke University has a one acre farm that was founded in 2010 that produces food for the dining hall and CSA members.[32] They employ a full time farm manager and a full-time recent graduate as a Farm Fellow. More importantly their mission is to "inspire and empower the Duke community to catalyze food system change."[33] Although the farm is one acre, half of it is in cultivation or cover cropped, and the other half has a hoop house, one greenhouse, and four beehives. They encourage farm and classroom integration to spread food awareness beyond the people working there and offer work-study positions for student apprentices.

4. For other examples of campus farms see the Envi 302 paper from 2013

IV. Crops/Chickens

In order to decide on appropriate crops for a startup farm we talked to Dining Services about what crops they use the most and which ones have the largest potential for local purchasing. This was supported by food purchase spreadsheets that showed how much of each product was consumed in one fiscal year. Then we talked to various local farmers to learn about which crops grow best in the area and which ones require the least amount of manual labor. To start off, we thought it would be best if the crops needed only minimal labor and machinery so that there would be fewer obstacles and less upfront investment.

VI. Finances

1. Potter Parcel

[32] "Home," *Duke Campus Farm*, http://sites.duke.edu/farm/.

[33] "Duke Campus Farm: Five Year Strategic Plan," last modified February, 2015, http://sites.duke.edu/farm/files/2015/02/Duke-Campus-Farm-Strategic-PlanfinalPDF.pdf.

Conventional Soil Amendment Costs (per acre)

Crop	Nitrogen	Phosphorous	Potassium	pH	Total
Leafy Greens (kale, collard greens, spinach, bok choy, swiss chard, arugula)	$27.5	$111.6	$51.6	$67.50	$258.2
Lettuce	$44	$111.6	$51.6	$67.50	$274.2
Green Beans	$27.5	$62	$32.25	$67.50	$189.25
Squash (butternut, green, yellow, acorn, etc)	$60.5	$93	$64.5	$67.50	$285.5
Onions	$71.5	$93	$64.5	$67.50	$269.5
Leeks	$71.5	$93	$64.5	$67.50	$269.5
Tomatoes	$77	$111.6	$64.5	$67.50	$320.6
Basil	$63.25	$74.4	$32.25	$67.50	$237.4
Cucumbers/melons	$60.5	$93	$51.6	$67.50	$272.6
Peppers	$77	$93	$64.5	$67.50	$302

Figure 9: Potter Conventional Soil Amendment Costs

The conventional soil amendment costs in Figure 10 are based on the results and recommendations from the soil test results. There were no deficiencies in micronutrients, so only macronutrients would have to be added to the soil. The pH would have to be increased from 5.7 to 6.5, and the conventional method is through the addition of limestone. However, depending on what type of limestone is used, dolomitic or calcitic limestone, it also increases the amount of magnesium and calcium (respectively) in the soil. Both calcium and magnesium are already higher than the optimal range, so increasing those might be counterproductive for increasing yield. The final decision about pH improvement method would have to take this into account. Alternative soil amendment products might be a better way to raise the pH without raising calcium and magnesium levels. A local farmer, Win Chenail, obtains his lime from Whitman's feed store in Bennington, VT. The prices for pH amendment shown above (Figure 10) are based on the price they offer bulk calcitic limestone for, which is $45 per ton.[34] This fee estimate also includes spreading services, and is likely to change a little based on the transportation distance. The price for the limestone without spreading services is $40-$42 per ton, which is such a small difference that it makes more sense to pay for the spreading too. According to Kathy Whitman, the lime they sell is calcitic but has some magnesium added as well.

The fertilizer costs in Figure 10 are estimates based on prices obtained from CaroVail Inc. in Salem, NY. The retail prices for NPK per pound are $0.55 for nitrogen, $0.62 for phosphorus, and $0.43 for potassium.[35] The prices listed are based on the minimum amount of fertilizer that the soil tests indicated (ex: Nitrogen 50-80 lbs/acre; calculation was done using 50 lbs/acre). The company also does custom fertilizer blends based on soil test results at the same price per nutrient per pound, so that might be a good option for when the farmer decides on exactly what crops they want to grow. CaroVail also offers fertilizer spreading services, which is about $10 per ton.

Alternative Soil Amendment Costs

[34] Kathy Whitman phone call with author, August 6, 2015.
[35] CaroVail sales representative, phone call with author, August 6, 2015.

Some alternatives to conventional fertilizers are wood ash, bone meal, potash, fish bone meal, granite dust, manure, or cover crops. From our research it seems that steamed bone meal is the best alternative, both because it offers the highest percentage of nitrogen and phosphorus and because it is available at Whitman's Feed Store in bags of up to 50 lbs for $50. Steamed bone meal has 18-24% P and 0.7-7% N, with a release rate of 2-4 months. [36] The best source of K seems to be manure from either cattle (most K) or poultry. Sources for manure and poultry would have to be researched further.

If we wanted to use a cover crop, Whitman's Feed Store sells white clover at $2.50/lb and red clover at $4.50/lb. Clover is a good cover crop to return nitrogen to the soil before and after other vegetable crops. We focused on white and red clover because they are perennial cover crops, which fix more nitrogen per acre than other cover crops because of a longer growing season.[37] Other cover crops, such as peas and buckwheat, could also be explored, but would need further research.

Clearing the land

Since the land was hayed in recent years by Jim Sylvester, all that is on the land now are tall meadow grasses. To start farming the land would have to be mowed and plowed, something that could probably be done by Jim Galusha or by renting a tractor from another farmer. The process is a little more complicated for the Cluett parcel.

2. Cluett Parcel

[36] "NITROGEN-PHOSPHORUS-POTASSIUM VALUES OF ORGANIC FERTILIZERS," *OSU Extension Service*, http://extension.oregonstate.edu/lane/sites/default/files/documents/lc437organicfertilizersvaluesrev.pdf.
[37] John Jennings, "Value of Nitrogen Fixation From Clovers and Other Legumes," *University of Agriculture Division of Agriculture*, http://www.uaex.edu/publications/pdf/FSA-2160.pdf.

Figure 10: Conventional Soil Amendment Costs (per acre)

Crop	Nitrogen	Phosphorous	Potassium	pH*	Total
Leafy Greens (kale, collard greens, spinach, bok choy, swiss chard, arugula)	$27.5	$111.6	$51.6	$112.5	$303.2
Lettuce	$44	$111.6	$51.6	$112.5	$319.7
Green Beans	$27.5	$62	$32.25	$112.5	$234.25
Squash (butternut, green, yellow, acorn, etc)	$60.5	$93	$64.5	$112.5	$330.5
Onions	$71.5	$93	$64.5	$112.5	$341.5
Leeks	$71.5	$93	$64.5	$112.5	$341.5
Tomatoes	$77	$111.6	$64.5	$112.5	$365.6
Basil	$63.25	$74.4	$32.25	$112.5	$282.4
Cucumbers/melons	$60.5	$93	$51.6	$112.5	$317.6
Peppers	$77	$93	$64.5	$112.5	$347

* pH is significantly higher than Potter because the pH of Cluett was lower, 5.5.

Clearing the land

Option 1: Sarah Gardner reached out to local farmer Jim Galusha for an estimate of what it would cost to clear the Cluett parcel. Part of the parcel is sloped and wooded, part of it is wetland, and then there are about 10 arable acres. However, these 6 acres are covered in high grasses, underbrush, and small to medium-sized trees. Jim Galusha assessed the property and said that it would cost about $2000 per acre to clear it. He said that there were two options; first he would mow it, then go through with a bulldozer with a root rake (which doesn't remove the topsoil), and then leave the debris in a big pile in a corner of the property to decompose. The other option would be that after bulldozing he could make wood chips out of the debris, but that would be a lot more expensive than $2000 per acre. After bulldozing and clearing the debris he would plow and disk the field, a total of about $2000 for the whole parcel. He recommended planting winter rye for the first year to prepare the soil.

Option 2: If the Cluett parcel is not cleared in the next few years it will grow into a densely wooded area, which is much less valuable to the college than 6 acres of well-maintained arable land. The more time that elapses the more expensive it would be to clear the land.

Figure 11: Crops and Associated Costs

Crop	**Purchasing potential (May-Nov)**	**Costs of seeds per acre**[38]	**Estimated selling price(per lb)**	**Estimated profit (per acre)**	**Additional associated costs**	**Notes**
Kale	$2,898.37	$57.66*	$2.00	$23,942.34		
Collard Greens (conventional)	$559.50	73.70	$1.52 per ct	N/A		Not worth growing (NWG)
Spinach (conventional)	$16,632.61	356.25	$8.00 (local price) *1.95**	$95,643.75 or $23,043.75		Labor intensive to pick
Lettuce (spring mix)	$47,021.92 (includes all lettuces)	$38.35	$8.42 (local price) $2.80**	$202,000 or $67,100	Hoop house/green house for season extension	Limited growing season w/o hoop house

[38] "Vegetable Seed Planting Guide," *Harris Seeds*, https://www.harrisseeds.com/storefront/download/vegseedplantingguide.pdf.

Lettuce (romaine)	$47,021.92(includes all lettuces)	$3494.78	$1.88**	$41,625	Lettuce chopping machine, $400	Same as above
Bok Choy	$278.79	N/A	$1.30**	N/A		NWG
Swiss Chard	$1,044.57	$261.00	$2.14	$25,419		NWG
Arugula	$7,812.28	N/A	$4.60	N/A		
Green Beans	$5,644.89	$451.50	$1.89	$14,670	Low labor, no processing required	
Squash (butternut, green, yellow, acorn, etc)	$14,268.79	$118.17	$1.50	$44,881.83	Squash peeler ($10,000)	
Onions (convnetional)	$33,497.01	$754.98	$2.00	$79,245.02	Curing facility (barn)	
Leeks	$563.22	$754.98	n/a	n/a		NWG
Tomatoes(organic)	$73,491.06	$72,625	$1.27	$-34,525	Tomato cages/trellis system (greenhouse?)	Organic tom. seeds are extremely expensive
Tomatoes (conventional)	$73,491.06	$18,200	$0.94**	$10,000	Tomato cages/trellis system	Very labor intensive, very prone to disease
Basil	$894.30	N/A	$10	N/A	Drying shed	NWG
Cucumbers	$9,300	$211.60	$0.96	$18,988.4		Machine harvest yields half the amount of hand picking

Peppers	$17,617.78	6209	$1.50**	$23,791		

*Non-organic seeds because Harris Seeds doesn't offer them
**Non-local price of crop per pound

The crops shown above were chosen with advice from Win Chenail and Bill Stinson about which ones were least labor intensive and would grow well in the area. Our vision includes not having to rely on immigrant labor or student volunteers, hence the criteria for low-labor crops. Crops were deemed “not worth growing” if they had low purchasing potential, seed costs surpassed profits, or information for the chart was not found. Crops with information “not available” were deemed such if adequate counts could not be calculated from Dining Services spreadsheet or if Harris Seed company did not sell the seeds. Prices used to calculate the selling prices were based on local prices of produce currently purchased by Dining Services when it did not differ too greatly from that of non-local purchases. For cases where the local vs. non-local prices differed greatly, both prices were included to show a range of possible selling prices for the crop.

Management

The campus farm that we envision would not be certified organic but would use organic practices whenever possible. If it turns out otherwise, then there would be additional costs associated with pesticide, fungicide, herbicide use. One option for farm management would be to have the land managed by a farmer under a contract with the college that would allow the farmer to use the college land for free in exchange for their food-growing services. The college could ask the farmer to dedicate a certain percentage or amount of their total yield to Dining Services (sold at fair market prices) and the remainder they could sell to other buyers. Alternatively, Dining Services could promise to buy everything they produce. This amount could be adjusted after the season depending on how well it goes for both parties. Since the land offered to ther farmer would most likely be a lot greater than the amount of land actually needed to grow the food that Dining Services needs, the farmer could be allowed to use the rest as they see fit in order to sell more produce to other restaurants or at the farmers market. When equipment is needed the farmer could either rent or hire someone else to till/plow the land.

A second option for farm management would be to have the college lease the land at a low price to an interested farmer and enter a contract where the farmer has more control over what they grow, and the college promises to buy certain produce from them. The food production operation that we envision is aimed at young passionate farmers that are eager to coordinate their production with Dining Services. This could perhaps be a recent agricultural school student or a Williams alum interested in setting up a farm in the area. The selling point would of course be the fact that Williams can offer land to use for free or at a low price, an important consideration for someone who cannot afford their own land.

Chickens

The following is a table estimating the costs of raising hens for two years. This table assumes that one bird needs 10 pounds of feed the first 10 weeks and 1.5 pounds of feed per week following the initial period. (1 bird: 10 lb + 1.5 lb/week x 94 weeks = 151 pounds of feed per bird. 100 birds x 151lb = 15,100 pounds of feed or 302 50lb bags).[39] The price of the feed

[39] "How Much Feed Does a Chicken Need," *Nutrena*, last modified 2015, http://www.nutrenaworld.com/knowledge-center/poultry/how-much-does-a-chicken-eat/index.jsp.

was based on what was offered at Whitman's Feed Store in North Bennington, VT at the time of the study.[40]

Replacing all large white fresh eggs

	Unit	**Amount**	**Price**	**Total**
Chicks	Per chick	82	2.81	230.42
Feed	50lb bag	248	16.10	3992.8
Heat bulb	Bulb	3	7	21
Total recurring costs				4244.22
Housing start up costs				2250
Feeder & water dispenser startup costs				225
One-time cost				**$2,475**

Figure 12: Egg operation costs to replace the number of fresh large white eggs currently consumed every 2 years, about 2,640 dozen eggs

*Price of chicks was derived from Murray McMurray Hatchery website.[41] All other costs, excluding price of feed, were based on a model provided by the University of Maryland Extension.[42]

Replacing half of all liquid eggs

	Unit	**Amount**	**Price**	**Total**
Chicks	Per chick	894	1.40	1251.6
Feed	50lb bag	2700	16.10	43470

[40] Whitmans Feed Store representative, phone call with author, August 6, 2015.
[41] "Buff Oprington," *Murray McMurray Hatchery*, https://www.mcmurrayhatchery.com/buff_orpingtons.html.
[42] "Raising Your Home Chicken Flock," *University of Maryland Extension*, last modified 2010, https://extension.umd.edu/sites/default/files/_docs/Raising%20Your%20Home%20Chicken%20Flock_FINAL_0.pdf

Heat bulb	Bulb	36	7	252
Total Recurring Costs				44973.6
Housing start up costs				26,820
Feeder & waterer startup costs				2682
Total Start Up Cost				**$29,502**

Figure 13: Egg operation costs to replace half the amount of liquid eggs currently consumed every 2 years, about 28,665 dozen eggs.

*Prices were based on the same sources as the previous table. It was assumed that 1 pound of liquid eggs is the equivalent of 9 whole eggs.[43]

Medium sized chicken operation (300 chickens)

	Unit	Amount	Price	Total
Chicks	Per chick	300	1.40	420
Feed	50lb bag	906	16.10	14,586.6
Heat bulb	Bulb	12	7	84
Other Costs				15,090.6
Total Cost				
Housing start up costs				9000
Feeder & waterer startup costs				900
Total Cost				**9,900**

*Prices were derived from same sources as previous two tables.

[43] "Frequently Asked Questions," *Sunny Fresh,* http://www.sunnyfresh.com/cb/sf/Resources/Information/FAQ/index.jsp.

Figure 14: Egg operation costs to have a medium sized chicken operation, about 300 chickens or 9,625 dozen eggs produced over two years.

Crop Rotations

In the interest of being more sustainable with fertilizer/pesticide/herbicide/fungicide inputs and to build a resilient farming operation, we advise crop rotations to be integrated into any future farm plan. Based on a crop rotation that is comprised of four groups of crops (as well as chickens): leaf or flowering crops, fruit crops, root crops, and legumes, we have come up with three possible crop rotations that utilize the crops that have the most local purchasing potential, as found in Figure 11. In addition, we have estimated the total amount of money that a farmer would earn to cover labor costs, pesticides/herbicides/fungicides, transportation, processing, machines, and any other associated costs.

Example crop rotation and profits:

1. One acre of romaine lettuce, half an acre of peppers, quarter acre of onions, one acre of red clover, 82 chickens: $43,500+$9,000+$20,000+$1,800=$74,300
2. Two-thirds acre of lettuce (spring mix), quarter acre of squash, quarter acre of onions, one acre of red clover, 82 chickens: $46,000+$14,000+$20,000+$1,800=$81,800

Further Research

For future research we recommend looking into a couple of additional things. First and foremost, it might be very helpful to look into the possibility of including pigs in the food production operation. Pigs could help clear the brush at a site like Cluett, and would be able to live on Cluett without clearing the tree stumps from the property, reducing the cost of land preparation by Jim Galusha. They could also help with the college's compost, an additional point for further research. Instead of giving the compost to Holiday Brook Farm, the compost could be taken to this new farm, and properly turned and aerated for use as fertilizer on the land. It could also be fed to the pigs, almost completely eliminating the need (and cost) for feed.

To mention briefly, further research should also include looking into building costs for things such as chicken coops or an onion storage shed/barn, and also if Facilities could be payed to build such things. Before commencing the project there should also be some thought or cost analysis of what happens when things go wrong, for example if a crop fails or the chickens all get killed by a predator. In such instances, the contract between the college and the farm should make sure that despite any of these setbacks, the farmer could still make a living.

Additionally, if chickens are included in the operation, there would need to be a way to get water to the properties. Cluett could possibly be connected to city water, since it is in a residential area, but Potter would have to either use the stream, or have a rain catching system. Looking further down the line, the next person to take on this project should also look into processing logistics. Pigs would have to be sent to a slaughterhouse in the area, possibly the same one Kim Wells sends his pigs to. Chickens would also have to be sent to a processing plant after two years, when they stop laying. With vegetable crops, there is a possibility that the empty dining halls at Williams College could be used for some simple processing. According to Jeff Kennedy, the Williamstown health inspector, the college has kept the unused kitchens licensed, and as long as one person in the kitchen is ServSafe certified, the farmer could use either Greylock or Dodd dining hall to process their products. Such a space would be extremely useful for simple things such as washing and trimming lettuce, peeling squash, and also perhaps increasing the storage/freezing space for summer crops. Bob Volpi mentioned that he thought the kitchens needed additional certifications in order to function in this capacity, but to clear this up there should be further communication with Mr. Kennedy and Mr. Volpi.

Conclusion

This report shows that there are many ways a campus food production operation could be configured. The final decisions would have to be made by the farmer in conjunction with the college to assess how much each party is willing to put into the project to see it come to fruition. We found that at each step of the founding process the farm could go in many directions. Although at first we thought that we wanted to be able to grow one or two crops in large quantities to produce enough to provide for dining services everyday uses, we have found that it might be more profitable to make a diversified farm. This would help the farmer have a more stable income that can withstand price drops, crop failures, weather related incidents, etc, better than a monoculture. A diversified farm would also have more educational value for students for future integration with classes.

Appendix 1: Crop Costs

Crop	pounds Yield per acre	Pounds of seed per acre	Cost of seeds per acre	Cost of seeds total (8 acres)	Current price paid by D.S./lb (local)

Beans (organic)	4 tons or 8000	70	5.25/ 5 pounds * 70 = 451.50	3612	1.89
Leafy Greens	6 tons or 12,000				
Arugula			$ 164.8/lb		4.59
Bok Choy					1.30 (not local)
Spinach	6 tons or 12000	15	47,500*15*25/50,000 seeds=356.25	2850	8.00 or 1.95 (not local)
Swiss Chard (organic)	12,000	4.5	25,000*4.5*23.20/10,000=261	2088	2.14
Collards	6 tons or 12000	5	14.74*5=73.70	589.60	?
Kale (conventional)	6 tons or 12,000	3	19.22/lb * 3=57.66	461.28	2
Squash (organic)	15 tons *2000=30,000	2.25	2.25*52.52/pound=118.17	945.36	1.50
Lettuce (spring mix) (conventional)	12 tons or 24000 lbs	1	38.35/lb * 1 =38.35	306.8	8.42
Lettuce (romaine) organic ***	24000	1	82.23/10000 seeds*425,000=3494.78	27,958.2	1.88 (not local)
Onions/Leeks (conventional)	20 tons or 40,000	3.5	65.65 /10,000seeds * 115,000=754.98	6039.8	2
Tomatoes (organic)	15 tons or 30000	2	20.75 / 100 seeds *350,000=72,625	581,000	1.27
Tomatoes (conventional)	15 tons or 30000 lb	2	52/1000 seeds * 350,000=18,200	145,600	.94
Basil	?	?	?	?	?

Cucumbers/melons	10 tons or 20000	2.5	84.64/lb * 2.5 = 211.6	1692.8	.96
Peppers (conventional)	10 tons or 20,000	2	221.75/5000 seeds * 140,000=6209	49,672	1.5

https://www.harrisseeds.com/storefront/download/vegseedplantingguide.pdf

Appendix 2: Potter Soil Test Results

Soil and Plant Tissue Testing Laboratory
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161 Holdsworth Way
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Amherst, MA 01003
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e-mail: soiltest@umass.edu
website: soiltest.umass.edu

Soil Test Report

Prepared For:
Michael Ding
2710 Paresky Center
Williamstown, MA 01267

md9@williams.edu
563-794-7416

Sample Information:
Sample ID: Potter 1

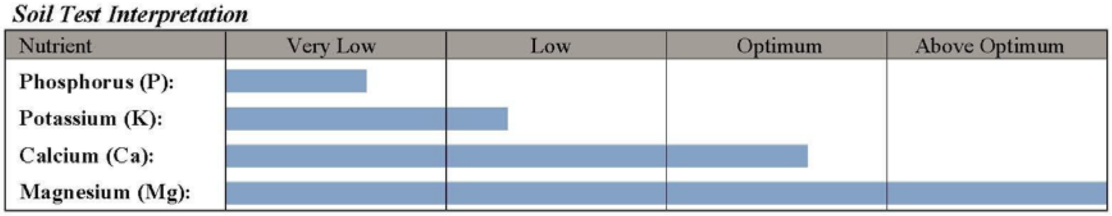
Order Number: 15897
Lab Number: S150713-331
Area Sampled: 8 acres
Received: 7/13/2015
Reported: 7/16/2015

Results

Analysis	*Value Found*	*Optimum Range*	*Analysis*	*Value Found*	*Optimum Range*
Soil pH (1:1, H2O)	5.8		**Cation Exch. Capacity, meq/100g**	14.0	
Modified Morgan extractable, ppm			**Exch. Acidity, meq/100g**	5.1	
Macronutrients			**Base Saturation, %**		
Phosphorus (P)	1.2	4-14	Calcium Base Saturation	47	50-80
Potassium (K)	65	100-160	Magnesium Base Saturation	15	10-30
Calcium (Ca)	1326	1000-1500	Potassium Base Saturation	1	2.0-7.0
Magnesium (Mg)	265	50-120	**Scoop Density, g/cc**	0.83	
Sulfur (S)	14.0	>10	**Optional tests**		
*Micronutrients **			Soil Organic Matter (LOI), %	7.8	
Boron (B)	0.2	0.1-0.5	Soluble Salts (1:2), dS/m	0.10	<0.6
Manganese (Mn)	10.8	1.1-6.3	Nitrate-N (NO3-N), ppm	21	
Zinc (Zn)	1.6	1.0-7.6			
Copper (Cu)	1.0	0.3-0.6			
Iron (Fe)	6.0	2.7-9.4			
Aluminum (Al)	46	<75			
Lead (Pb)	1.7	<22			

* *Micronutrient deficiencies rarely occur in New England soils; therefore, an Optimum Range has never been defined. Values provided represent the normal range found in soils and are for reference only.*

Soil Test Interpretation



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Recommendations for Beans: Dry/Snap/Lima

Limestone (Target pH of 6.5)	Nitrogen, N		Phosphorus, P2O5	Potassium, K2O
		lbs / acre		
3000	50		100	75

Comments:

-Calcitic limestone is acceptable since soil magnesium level is sufficient.
-A sidedressing of 30 lb nitrogen per acre at prebloom may extend harvest period and increase yields, especially on sandy soils. Machine harvested beans are unlikely to need sidedressing.
-DO NOT exceed a total of 80 lb. N per acre plus K2O as a preplant. Incorporate if necessary.
-Consult the New England Vegetable Management Guide for more information regarding timing and placement of amendments.

References:

New England Vegetable Management Guide http://www.nevegetable.org

Recommendations for Leafy Greens

Limestone (Target pH of 6.5)	Nitrogen, N		Phosphorus, P2O5	Potassium, K2O
		lbs / acre		
3000	50 - 80		180	120

Comments:

-Consult the New England Vegetable Management Guide for more information regarding timing and placement of amendments.

References:

New England Vegetable Management Guide http://www.nevegetable.org

Recommendations for Squash

Limestone (Target pH of 6.5)	Nitrogen, N		Phosphorus, P2O5	Potassium, K2O
		lbs / acre		
3000	110 - 140		150	150

Comments:

-Calcitic limestone is acceptable since soil magnesium level is sufficient.
-Total N and K2O in the band should not exceed 5.5 lb./1000 ft of row. Banded P2O5 may not be of benefit in warm soils.
-Consult the New England Vegetable Management Guide for more information regarding timing and placement of amendments.

References:

New England Vegetable Management Guide http://www.nevegetable.org

General References:

Interpreting Your Soil Test Results http://soiltest.umass.edu/fact-sheets/interpreting-your-soil-test-results

For current information and order forms, please visit http://soiltest.umass.edu/

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Soil Test Report

Prepared For:
Michael Ding
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Williamstown, MA 01267

md9@williams.edu
563-794-7416

Sample Information:
Sample ID: Potter 2

Order Number: 15897
Lab Number: S150713-332
Area Sampled: 8 acres
Received: 7/13/2015
Reported: 7/16/2015

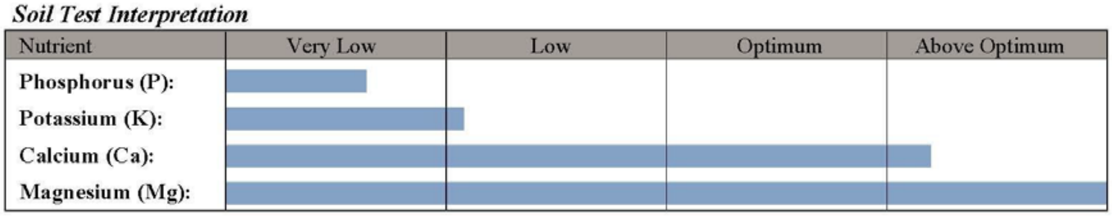
Results

Analysis	*Value Found*	*Optimum Range*
Soil pH (1:1, H2O)	5.7	
Modified Morgan extractable, ppm		
Macronutrients		
Phosphorus (P)	1.3	4-14
Potassium (K)	54	100-160
Calcium (Ca)	1598	1000-1500
Magnesium (Mg)	233	50-120
Sulfur (S)	12.2	>10
Micronutrients *		
Boron (B)	0.2	0.1-0.5
Manganese (Mn)	11.2	1.1-6.3
Zinc (Zn)	1.4	1.0-7.6
Copper (Cu)	0.7	0.3-0.6
Iron (Fe)	4.9	2.7-9.4
Aluminum (Al)	33	<75
Lead (Pb)	0.9	<22

Analysis	*Value Found*	*Optimum Range*
Cation Exch. Capacity, meq/100g	15.4	
Exch. Acidity, meq/100g	5.3	
Base Saturation, %		
Calcium Base Saturation	52	50-80
Magnesium Base Saturation	12	10-30
Potassium Base Saturation	1	2.0-7.0
Scoop Density, g/cc	0.86	

* *Micronutrient deficiencies rarely occur in New England soils; therefore, an Optimum Range has never been defined. Values provided represent the normal range found in soils and are for reference only.*

Soil Test Interpretation



UMass Extension

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Recommendations for Lettuce

Limestone (Target pH of 6.5)	Nitrogen, N		Phosphorus, P2O5	Potassium, K2O
		lbs / acre		
4000	80 - 125		180	120

Comments:

-Calcitic limestone is acceptable since soil magnesium level is sufficient.
-Over-application of nitrogen on fertile soil can result in very rapid growth and tipburn.
-Consult the New England Vegetable Management Guide for more information regarding timing and placement of amendments.

References:

New England Vegetable Management Guide http://www.nevegetable.org

Recommendations for Onions, Leeks

Limestone (Target pH of 6.5)	Nitrogen, N		Phosphorus, P2O5	Potassium, K2O
		lbs / acre		
4000	130 - 150		150	150

Comments:

-Calcitic limestone is acceptable since soil magnesium level is sufficient.
-Onions and Leeks do not tolerate acid soil, especially in early growth stages. Liming may not be sufficient for this years crop.
-Consult the New England Vegetable Management Guide for more information regarding timing and placement of amendments.

References:

New England Vegetable Management Guide http://www.nevegetable.org

Recommendations for Tomatoes

Limestone (Target pH of 6.5)	Nitrogen, N		Phosphorus, P2O5	Potassium, K2O
		lbs / acre		
4000	140 - 160		180	150

Comments:

-Calcitic limestone is acceptable since soil magnesium level is sufficient.
-Consult the New England Vegetable Management Guide for more information regarding timing and placement of amendments.

References:

New England Vegetable Management Guide http://www.nevegetable.org

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Sample Information:
Sample ID: Potter 3

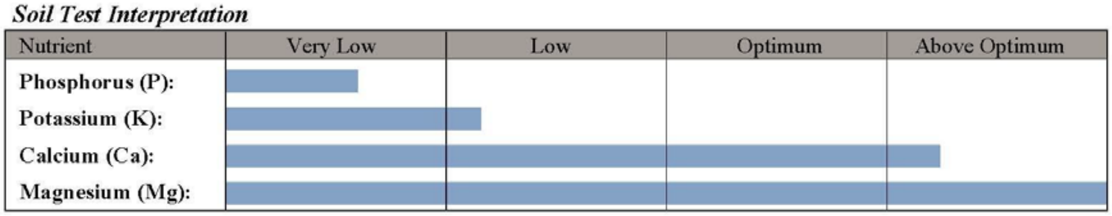
Order Number: 15897
Lab Number: S150713-333
Area Sampled: 8 acres
Received: 7/13/2015
Reported: 7/16/2015

Results

Analysis	*Value Found*	*Optimum Range*	*Analysis*	*Value Found*	*Optimum Range*
Soil pH (1:1, H2O)	5.9		**Cation Exch. Capacity, meq/100g**	15.1	
Modified Morgan extractable, ppm			**Exch. Acidity, meq/100g**	4.9	
Macronutrients			**Base Saturation, %**		
Phosphorus (P)	1.2	4-14	Calcium Base Saturation	53	50-80
Potassium (K)	59	100-160	Magnesium Base Saturation	13	10-30
Calcium (Ca)	1611	1000-1500	Potassium Base Saturation	1	2.0-7.0
Magnesium (Mg)	243	50-120	**Scoop Density, g/cc**	0.85	
Sulfur (S)	12.4	>10			
Micronutrients *					
Boron (B)	0.3	0.1-0.5			
Manganese (Mn)	10.5	1.1-6.3			
Zinc (Zn)	1.3	1.0-7.6			
Copper (Cu)	0.8	0.3-0.6			
Iron (Fe)	5.0	2.7-9.4			
Aluminum (Al)	36	<75			
Lead (Pb)	1.4	<22			

* *Micronutrient deficiencies rarely occur in New England soils; therefore, an Optimum Range has never been defined. Values provided represent the normal range found in soils and are for reference only.*

Soil Test Interpretation



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West Experiment Station

Recommendations for Basil

Limestone (Target pH of 6.5)	Nitrogen, N		Phosphorus, P2O5	Potassium, K2O
		lbs / acre		
3000	115 - 130		120	75

Comments:

-Although adequate fertility is required, excess nitrogen applications can cause post-harvest discoloration and reduced flavor. Basil benefits from a sidedress application of nitrogen after the first or second cutting.
-Consult the New England Vegetable Management Guide for more information regarding timing and placement of amendments.

References:

New England Vegetable Management Guide http://www.nevegetable.org

Recommendations for Cucumbers, Melons

Limestone (Target pH of 6.5)	Nitrogen, N		Phosphorus, P2O5	Potassium, K2O
		lbs / acre		
3000	110 - 130		150	120

Comments:

-Calcitic limestone is acceptable since soil magnesium level is sufficient.
-Total N and K2O in the band should not exceed 5.5 lb./1000 ft of row. Banded P2O5 may not be of benefit in warm soils.
-Consult the New England Vegetable Management Guide for more information regarding timing and placement of amendments.

References:

New England Vegetable Management Guide http://www.nevegetable.org

Recommendations for Peppers

Limestone (Target pH of 6.5)	Nitrogen, N		Phosphorus, P2O5	Potassium, K2O
		lbs / acre		
3000	140		150	150

Comments:

-Calcitic limestone is acceptable since soil magnesium level is sufficient.
-Consult the New England Vegetable Management Guide for more information regarding timing and placement of amendments.

References:

New England Vegetable Management Guide http://www.nevegetable.org

General References:

Interpreting Your Soil Test Results http://soiltest.umass.edu/fact-sheets/interpreting-your-soil-test-results

For current information and order forms, please visit http://soiltest.umass.edu/

Appendix 3: Cluett Soil Test Results

UMass Extension

Soil and Plant Tissue Testing Laboratory
203 Paige Laboratory
161 Holdsworth Way
University of Massachusetts
Amherst, MA 01003
Phone: (413) 545-2311
e-mail: soiltest@umass.edu
website: soiltest.umass.edu

Soil Test Report

Prepared For:
Michael Ding
2710 Paresky Center
Williamstown, MA 01267

md9@williams.edu
563-794-7416

Sample Information:
Sample ID: Cluett 1

Order Number: 16271
Lab Number: S150730-327
Area Sampled: 10 acres
Received: 7/30/2015
Reported: 8/7/2015

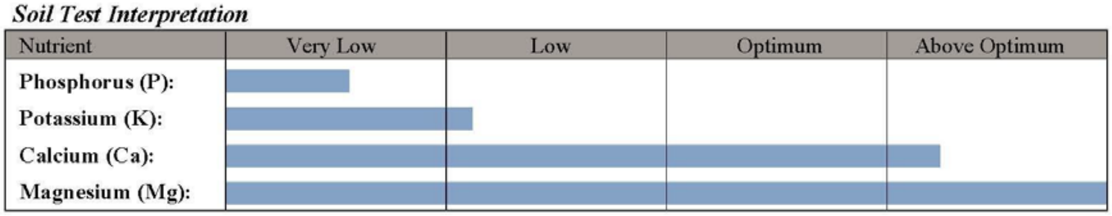
Results

Analysis	*Value Found*	*Optimum Range*
Soil pH (1:1, H2O)	5.5	
Modified Morgan extractable, ppm		
Macronutrients		
Phosphorus (P)	1.1	4-14
Potassium (K)	56	100-160
Calcium (Ca)	1617	1000-1500
Magnesium (Mg)	304	50-120
Sulfur (S)	16.3	>10
Micronutrients *		
Boron (B)	0.2	0.1-0.5
Manganese (Mn)	20.8	1.1-6.3
Zinc (Zn)	2.9	1.0-7.6
Copper (Cu)	1.7	0.3-0.6
Iron (Fe)	12.6	2.7-9.4
Aluminum (Al)	46	<75
Lead (Pb)	2.2	<22

Analysis	*Value Found*	*Optimum Range*
Cation Exch. Capacity, meq/100g	17.5	
Exch. Acidity, meq/100g	6.7	
Base Saturation, %		
Calcium Base Saturation	46	50-80
Magnesium Base Saturation	14	10-30
Potassium Base Saturation	1	2.0-7.0
Scoop Density, g/cc	0.78	
Optional tests		
Soil Organic Matter (LOI), %	8.2	
Soluble Salts (1:2), dS/m	0.13	<0.6
Nitrate-N (NO3-N), ppm	14	

* *Micronutrient deficiencies rarely occur in New England soils; therefore, an Optimum Range has never been defined. Values provided represent the normal range found in soils and are for reference only.*

Soil Test Interpretation



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Recommendations for Basil

Limestone (Target pH of 6.5)	Nitrogen, N	Phosphorus, P2O5	Potassium, K2O
	lbs / acre		
5000	115 - 130	120	75

Comments:

-Although adequate fertility is required, excess nitrogen applications can cause post-harvest discoloration and reduced flavor. Basil benefits from a sidedress application of nitrogen after the first or second cutting.
-Consult the New England Vegetable Management Guide for more information regarding timing and placement of amendments.

References:

New England Vegetable Management Guide http://www.nevegetable.org

Recommendations for Cucumbers, Melons

Limestone (Target pH of 6.5)	Nitrogen, N	Phosphorus, P2O5	Potassium, K2O
	lbs / acre		
5000	110 - 130	150	120

Comments:

-Calcitic limestone is acceptable since soil magnesium level is sufficient.
-Total N and K2O in the band should not exceed 5.5 lb./1000 ft of row. Banded P2O5 may not be of benefit in warm soils.
-Consult the New England Vegetable Management Guide for more information regarding timing and placement of amendments.

References:

New England Vegetable Management Guide http://www.nevegetable.org

Recommendations for Peppers

Limestone (Target pH of 6.5)	Nitrogen, N	Phosphorus, P2O5	Potassium, K2O
	lbs / acre		
5000	140	150	150

Comments:

-Calcitic limestone is acceptable since soil magnesium level is sufficient.
-Consult the New England Vegetable Management Guide for more information regarding timing and placement of amendments.

References:

New England Vegetable Management Guide http://www.nevegetable.org

General References:

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website: soiltest.umass.edu

Soil Test Report

Prepared For:
Michael Ding
2710 Paresky Center
Williamstown, MA 01267

md9@williams.edu
563-794-7416

Sample Information:
Sample ID: Cluett 2

Order Number: 16271
Lab Number: S150730-328
Area Sampled: 10 acres
Received: 7/30/2015
Reported: 8/7/2015

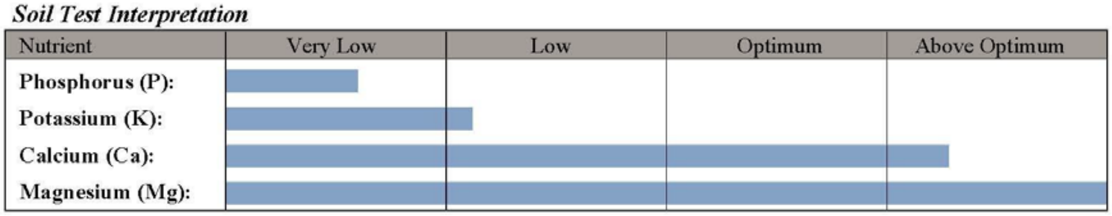
Results

Analysis	*Value Found*	*Optimum Range*
Soil pH (1:1, H2O)	5.4	
Modified Morgan extractable, ppm		
Macronutrients		
Phosphorus (P)	1.2	4-14
Potassium (K)	56	100-160
Calcium (Ca)	1636	1000-1500
Magnesium (Mg)	286	50-120
Sulfur (S)	15.4	>10
Micronutrients *		
Boron (B)	0.2	0.1-0.5
Manganese (Mn)	21.1	1.1-6.3
Zinc (Zn)	2.7	1.0-7.6
Copper (Cu)	1.8	0.3-0.6
Iron (Fe)	13.4	2.7-9.4
Aluminum (Al)	48	<75
Lead (Pb)	2.4	<22

Analysis	*Value Found*	*Optimum Range*
Cation Exch. Capacity, meq/100g	17.2	
Exch. Acidity, meq/100g	6.5	
Base Saturation, %		
Calcium Base Saturation	48	50-80
Magnesium Base Saturation	14	10-30
Potassium Base Saturation	1	2.0-7.0
Scoop Density, g/cc	0.77	

* *Micronutrient deficiencies rarely occur in New England soils; therefore, an Optimum Range has never been defined. Values provided represent the normal range found in soils and are for reference only.*

Soil Test Interpretation



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West Experiment Station

Recommendations for Beans: Dry/Snap/Lima

Limestone (Target pH of 6.5)	Nitrogen, N		Phosphorus, P2O5	Potassium, K2O
		lbs / acre		
5000	50		100	75

Comments:

-Calcitic limestone is acceptable since soil magnesium level is sufficient.
-A sidedressing of 30 lb nitrogen per acre at prebloom may extend harvest period and increase yields, especially on sandy soils. Machine harvested beans are unlikely to need sidedressing.
-DO NOT exceed a total of 80 lb. N per acre plus K2O as a preplant. Incorporate if necessary.
-Consult the New England Vegetable Management Guide for more information regarding timing and placement of amendments.

References:

New England Vegetable Management Guide http://www.nevegetable.org

Recommendations for Leafy Greens

Limestone (Target pH of 6.5)	Nitrogen, N		Phosphorus, P2O5	Potassium, K2O
		lbs / acre		
5000	50 - 80		180	120

Comments:

-Consult the New England Vegetable Management Guide for more information regarding timing and placement of amendments.

References:

New England Vegetable Management Guide http://www.nevegetable.org

Recommendations for Squash

Limestone (Target pH of 6.5)	Nitrogen, N		Phosphorus, P2O5	Potassium, K2O
		lbs / acre		
5000	110 - 140		150	150

Comments:

-Calcitic limestone is acceptable since soil magnesium level is sufficient.
-Total N and K2O in the band should not exceed 5.5 lb./1000 ft of row. Banded P2O5 may not be of benefit in warm soils.
-Consult the New England Vegetable Management Guide for more information regarding timing and placement of amendments.

References:

New England Vegetable Management Guide http://www.nevegetable.org

General References:

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Soil Test Report

Prepared For:
Michael Ding
2710 Paresky Center
Williamstown, MA 01267

md9@williams.edu
563-794-7416

Sample Information:
Sample ID: Cluett 3

Order Number: 16271
Lab Number: S150730-329
Area Sampled: 10 acres
Received: 7/30/2015
Reported: 8/7/2015

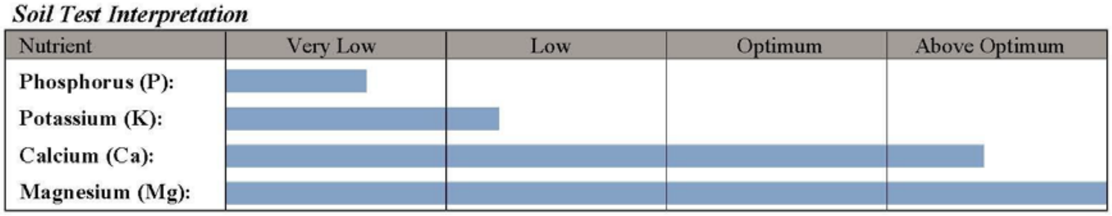
Results

Analysis	*Value Found*	*Optimum Range*
Soil pH (1:1, H2O)	5.3	
Modified Morgan extractable, ppm		
Macronutrients		
Phosphorus (P)	1.3	4-14
Potassium (K)	61	100-160
Calcium (Ca)	1720	1000-1500
Magnesium (Mg)	312	50-120
Sulfur (S)	17.7	>10
*Micronutrients **		
Boron (B)	0.6	0.1-0.5
Manganese (Mn)	23.1	1.1-6.3
Zinc (Zn)	3.0	1.0-7.6
Copper (Cu)	1.8	0.3-0.6
Iron (Fe)	13.8	2.7-9.4
Aluminum (Al)	51	<75
Lead (Pb)	2.4	<22

Analysis	*Value Found*	*Optimum Range*
Cation Exch. Capacity, meq/100g	18.6	
Exch. Acidity, meq/100g	7.3	
Base Saturation, %		
Calcium Base Saturation	46	50-80
Magnesium Base Saturation	14	10-30
Potassium Base Saturation	1	2.0-7.0
Scoop Density, g/cc	0.82	

* *Micronutrient deficiencies rarely occur in New England soils; therefore, an Optimum Range has never been defined. Values provided represent the normal range found in soils and are for reference only.*

Soil Test Interpretation



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Recommendations for Lettuce

Limestone (Target pH of 6.5)	Nitrogen, N	Phosphorus, P2O5	Potassium, K2O
	lbs / acre		
5000	80 - 125	180	120

Comments:

-Calcitic limestone is acceptable since soil magnesium level is sufficient.
-Over-application of nitrogen on fertile soil can result in very rapid growth and tipburn.
-Consult the New England Vegetable Management Guide for more information regarding timing and placement of amendments.

References:

New England Vegetable Management Guide http://www.nevegetable.org

Recommendations for Onions, Leeks

Limestone (Target pH of 6.5)	Nitrogen, N	Phosphorus, P2O5	Potassium, K2O
	lbs / acre		
5000	130 - 150	150	150

Comments:

-Calcitic limestone is acceptable since soil magnesium level is sufficient.
-Onions and Leeks do not tolerate acid soil, especially in early growth stages. Liming may not be sufficient for this years crop.
-Consult the New England Vegetable Management Guide for more information regarding timing and placement of amendments.

References:

New England Vegetable Management Guide http://www.nevegetable.org

Recommendations for Tomatoes

Limestone (Target pH of 6.5)	Nitrogen, N	Phosphorus, P2O5	Potassium, K2O
	lbs / acre		
5000	140 - 160	180	150

Comments:

-Calcitic limestone is acceptable since soil magnesium level is sufficient.
-Consult the New England Vegetable Management Guide for more information regarding timing and placement of amendments.

References:

New England Vegetable Management Guide http://www.nevegetable.org

General References:

Interpreting Your Soil Test Results http://soiltest.umass.edu/fact-sheets/interpreting-your-soil-test-results

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