The Smart Farm

New Mexico

Supercomputing Challenge

Final Report

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Team #60

Manzano High School

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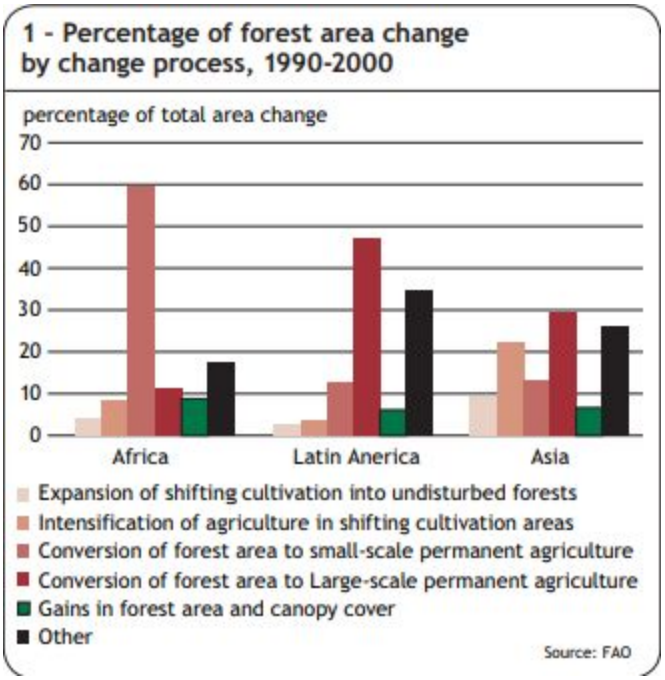
Abstract

The modern methodization of farming has led to positive and negative outcomes. Although modern farming has its own benefits on the production side, on the negative side, it has contributed to over-cultivation, land degradation, the exhaustion of soil—which leads to loss of arable soil. If these type of methods continue to be practiced, then eventually over time, there will be a limited resource of land and production of agriculture will decrease. Indoor vertical farming is the solution to this problem—through the practice of indoor vertical farming various benefits are achieved, for example, the ability to control temperature and farming all year round.

Vertical farm in A.P. Environmental Science class at Manzano High School.

Problem

Arable soil is the golden ticket of producing food. Arable soil is a type of soil that we are able to farm on but for a limited time. Once it's not arable, we must search for new lands to farm in and that's exactly the problem. Our world has little new lands to discover and that is why we are searching for alternatives. Our idea, Smart Farming, is the smart choice moving forward. Smart Farming is a way to use natural resources instead of products that negatively affect our environment. In other words, our team is finding what is better for our environment. In New Mexico and other parts of the world, people face the reality of cutting down natural habitats to make room for farms because of the increasing population that happens everyday. Lots of our foods come from these farms but in exchange, animals are losing their homes. We spray pesticides every year to kill off the bugs that eat our growing produce. Since we spray with these products, most people are unaware of how it's affecting our biogeochemical cycles.



Destruction of forests in different parts of the world caused by human interactions from 1990-2000.

Solution

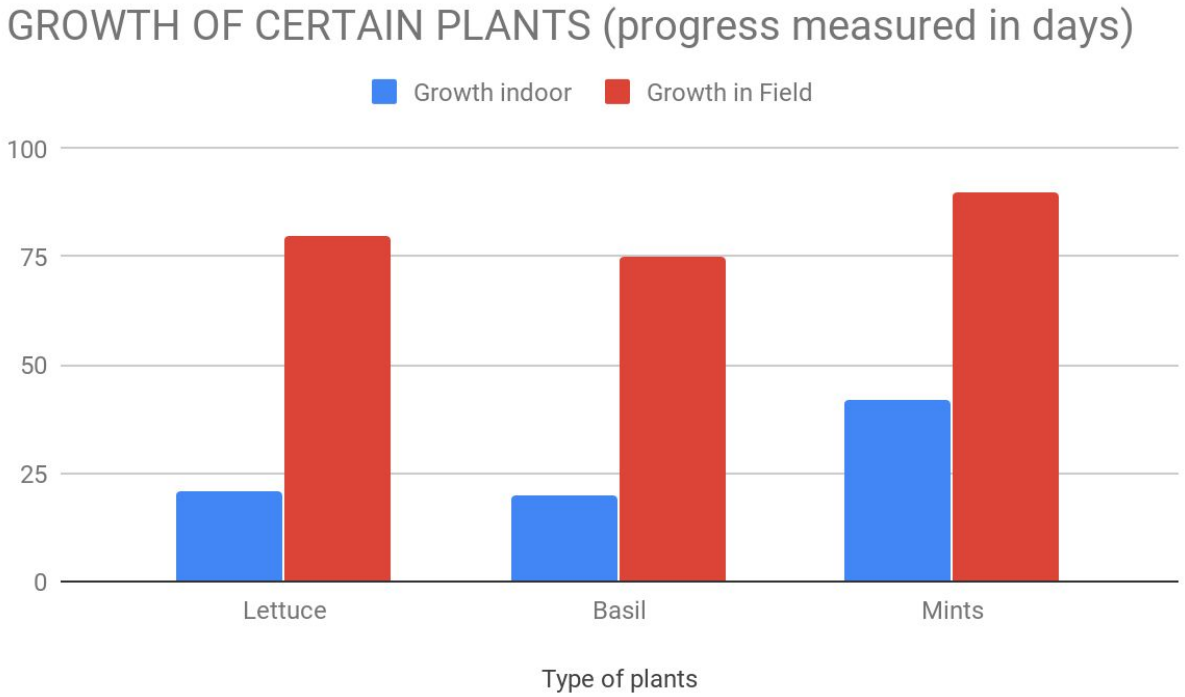
Starting a group project is easy, the difficult part is to unify the ideas flowing out of everyone. In the beginning we had various ideas on how we were going to generate and represent our data. We were worried about things such user interface or how to make it look pretty, some of these ideas were simulation running on game engines or with in games themselves. Our first attempt of the simulation was to use blender to simulate fluid dynamics to see how the polluted water would make to our natural water sources. We were told that was a bad idea and we needed to go simpler. Our judges suggested we try something like spreadsheet simulation. We toned our ideas to align with with the judges perspectives. Our final form of simulation was using spreadsheet program to predict how the data would look. We are making use of the auto solve and forecast functions alongside many other tools present in most spreadsheet programs. Using a small dataset we are using the forecast function to predict how fast the plants grow in a vertical farm compared to a traditional farm. This is a good way to show efficiency of vertical farming and it was one of the ideas pitched to us by our judges during our interim presentation.

Benefits of vertical factory farms versus other methods

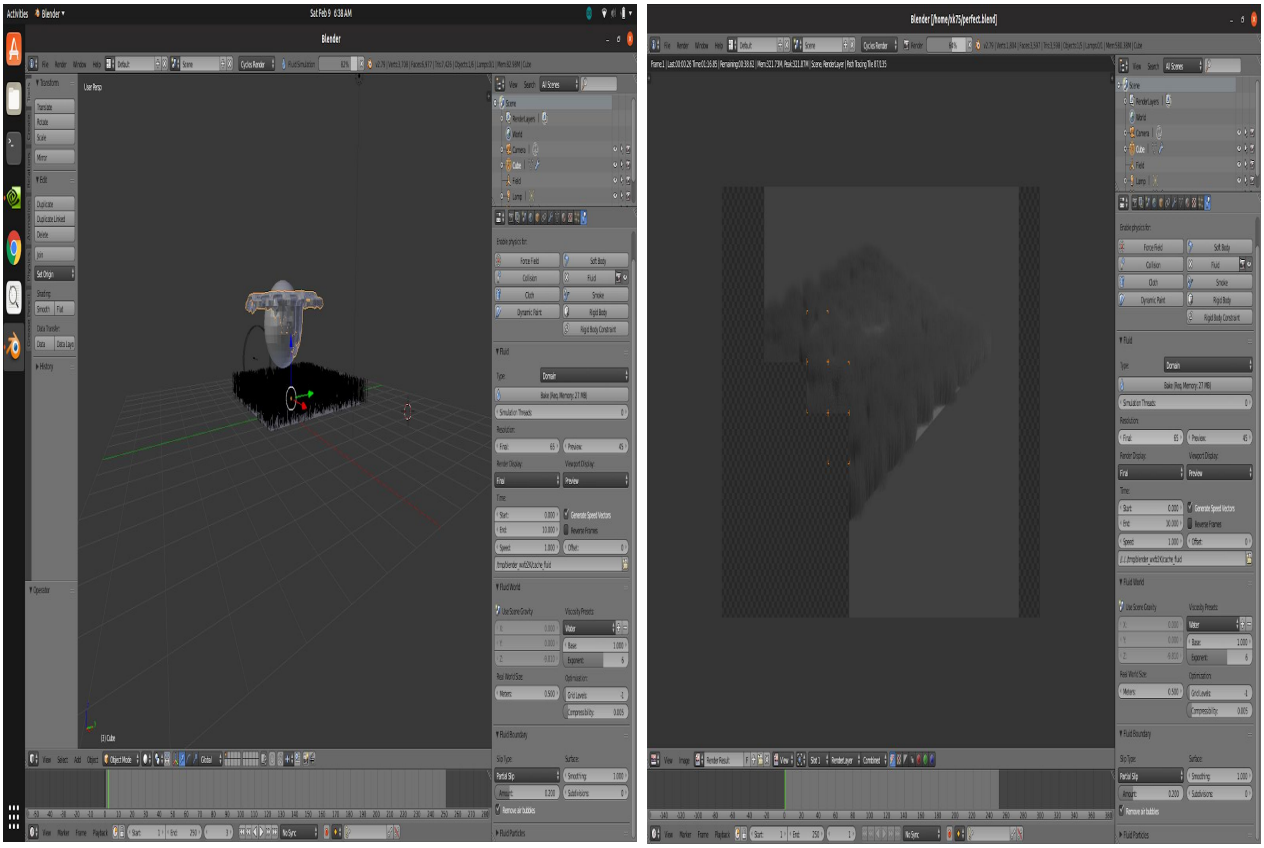
	Outdoor	Greenhouse	Vertical farm
Growth cycle	70 days	40-50 days	20 days
Water consumption per crop	35 l	15 l	1,5 l
Number of crops per square meter	18	25	250-300
Crop cycles	Seasonal	Seasonal	All year
Pesticides / Herbicides	Often	Less often	None
Location	Open field	Open field	Anywhere
Post harvest handling	High	Medium	Low

SOURCE: Urban Crops

Efficiency example of vertical farms gotten from Urban Crops



Bottom: failed blender model. Top: Graph generated by our model, shows the period of growth.



Results of Our Study

Our research included the different kinds of methods of farming that we can possibly use to solve our problem. We also interviewed a local farmer, Minor Morgan, who gave us his input about traditional, conventional, and smart farming. His information included the variables of cost, energy efficiency, carbon footprint, and the types of pesticides we use. A few ideas that we learned during our research about our Smart farm is that growing indoors is more efficient because it is in a controlled environment. In an indoor environment there are no seasons that can yield or slow down the growth of the farm due to the fact that there are no harmful weather effects that can hinder the growth in any way. The method of farming that we used indoors in our schools smart farm is vertical farming. Keep in mind all our methods used at school is indoors. Vertical farming is a way to save space rather than the conventional farming where it is all on land. As we start to farm vertically there are variables that are pros to smart farming such as efficiency in growing the plants, less cost for manual labor, and overall better for the environment. Vertical farming includes methods such as aeroponics and hydroponics. We found that both ways are beneficial to our environment because they produce less energy, or in other words a carbon footprint in the environment. Our goal is to find better ways of farming and we think aeroponics and hydroponics is the solution due to the fact that it doesn't need arable land, meaning that we don't need soil, and it is water-based. In our research we found the similarities between Minor Morgan's farm and smart farming techniques. One of them being that they both meet the criteria of being aware of what kind of carbon footprint is produced and a difference between the two is only the fact that one is vertical while the other is on a land.

Examples of organic farming from Minor Morgan's farm (North Valley Organics)

Mycorrhizal fungi, it is a symbiotic fungi that attaches itself to roots of plants, it is used by Minor Morgan to help his plants get better nutrition and grow efficiently.

Conclusion

Farming is an aspect of life that we depend on. That is a lesson our team learned during our research. In the past, human impact on farming had negative effects because the standard practice involved pesticides that spawn algae blooms and destroying habitats for soil that is arable causing animals to become near extinct or becoming entirely extinct. If the farming population continues to concoct conventional farming methods, not only will the United States will suffer the consequences but the whole world will be affected as a whole. Our group approached the contemporary issue with a safer and efficient method. These methods include farming without soil, farming vertically, farming in a controlled environment, and overall these methods save more space in our shrinking environment. Currently we are calculating the growth time of plants based on the growth time of plants from our data set. Our next step in furthering our model is to be able to calculate the product yield per square foot. Our team will continue to experiment with more coding to simulate results that are favorable.

Acknowledgements

Sharee Lunsford

We would first like to thank Ms. Lunsford. She has provided many resources that has helped our team move forward with new ideas. Ms. Lunsford has also edited our interim report, making key changes that strengthened our paper. When our team is also tired and not focused, Ms. Lunsford will always pull our group from procrastinating into being productive. Our team would not have got far if it wasn't for Ms. Lunsford. Thank you for being there when our team needed you the most.

Kaley Goatcher

Our team met Kaley Goatcher ─ a system engineer, during the Supercomputing Kickoff last year. Discussing farming practices with Ms. Goatcher gave our team clarity and a main focus to work towards to. Thank you Ms. Goatcher.

Minor Morgan

Mr. Morgan has been a great help to our team. He made our team think outside of future farming. Proving that traditional farming is still efficient if it is done in a certain method. Mr. Morgan has also taught us the biology aspect of farming. Terms such as microbes and bacteria appears often throughout our project and it was because of how Mr. Morgan So our team are forever grateful to Mr. Morgan.

Patty Meyer

Ms. Patty is a huge contributor throughout our current Supercomputing run. Not only does she provide us with multiple resources to utilize but she also is willing to spend her free time in order for us to progress. When our team was meeting with Mr. Morgan, she drove all five of us to discuss our project with him. Thank you very much Ms. Patty.

Stephen McGuinness

Mr. McGuinness is the inspiration for why our team started this project. A teacher at Manzano High School, he raises the awareness of how current farming practices are destroying Earth's environments and its habitats. Mr. McGuinness is also responsible for creating the first successful Smart Farm in Manzano High School and his success keeps on growing. Our team is truly proud to be part of his successful run on improving farming practices. Thank you Mr. McGuinness.

Kurtis Griess

Kurtis is our leader. He has got us to compete in the Supercomputing Challenge for the past two years. Our first year was very successful and it was because of his guidance. Kurtis has edited our papers, both interim and final, he has also introduced to people who relates to our research, and he helped organize our team such as funding for our entry to the competition. Our team will always be thankful for Kurtis,

Karen Glennon

Every Monday, our team must make the trip down to Jackson Middle School where all the nearby teams meet. Everytime our team would step foot into the lab, snacks are provided, the Monday Morning Memo is always addressed, and our poster and paper is checked at all times. Ms. Glennon is responsible for all of this. Ms. Glennon makes sure that our project is up to date and not lagging behind. Thank you very much Ms. Glennon.

Individual Significant Achievements

Alex Phommachack

Being a first year participant in the Supercomputing Challenge I've learned many skills and got to know new people in the program. I really enjoyed the research stages in our project because it helped us work together as a team and assign each other roles which we soon fulfilled. With our topic being about smart farming I learned more methods and the variables that affect farming as a whole. While writing our final report I realized how many things we have done and accumulated which makes me feel great about myself of how much work and time that we put into our project.

Nigone Phommachack

For the past two years, the Supercomputing Challenge has made me expand my skill set . The two years I've spent on this challenge is by far two of the best years of my life. Working with my team and mentors has made me develop my leadership, teamwork, and communication skills. I've learned how to code, something I never thought I would do, although I still have a long way to go until I become decent at it. I will cherish the good times I've had during our Supercomputing Challenge runs.

Naomi Ramos

I enjoyed working with my team. I contributed to the team by helping conduct research from the smart farm located at our school and taking a tour with Minor Morgan's farm. I helped

with the presentation as well by creating certain slides and presenting them. The executive summary of this final report was done by me. I liked our topic that we focused on this year, I learned many new concepts, I was unaware that certain methods of farming are harming the environment. I didn't even know vertical farming was even an effective solution.

Manoj Subedi

This is my second year participating in the Supercomputing Challenge, it has been a fun experience for the past two years. Some of the best things I have learned while participating in the challenge are team dynamics, leadership, research, and alongside many other skills. The skills I have learned here will be something that I will be proud of for a long time to come. The experience is not just about what I have learned, it is also about the journey. I have had a lot of fun working with my group, getting to know my group a little better each time we come together to work on the project. This is my final journey- this has been a fun ride- and I have learned a lot from it.

Jerrel White

What I have learned from this experience is that the world has different ways to farm but the world as a whole should provide food for their people which is best used the right way. The more healthy way is what we want for this project . I learned that plants under certain conditions can change based on those condition that you give it. In a way a plant might not be able to grow on a sandy area but if we are able to change it in a conditioned area we can grow anything. What I have contributed to our team is the research but my research was not just based on a smart farm but more just farming in a whole.

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