Bee Green Team

Georgia Tech
Unwanna Etuk
Rachel McBroom

Problem:

Pollinators are suffering abnormal annual population declines primarily due to habitat destruction and the effects of various pesticides. A third of the food we eat requires pollination, making them crucial for the environment and humans.

Proposed Solution:

Create "Seed Libraries" that provide free seeds in order to actively engage, educate, and assist communities to help restore natural habitats and pollinator populations by planting native, pollinator-attracting plants and using sustainable agriculture practices.

Additional Benefits:

Support wildlife responsible for pollinating plants by providing food and shelter; improve landscape, air, and water quality; create interest in and provide education about urban agriculture; and ultimately help the city meet Mayor Reed's Sustainability Goal of providing food to 75% of Atlanta within .5 miles by 2020.

Background Information:

Carbon sequestration is a naturally or artificially occurring process in which CO_2 is removed from the atmosphere and stored in solid or liquid form.[5] Plants sequester carbon through photosynthesis. The carbon-containing products, photosynthates, are transferred from active leaves (source) and into permanent structures.[20] Some leaks into the soil (sink), creating soil organic carbon (SOC) pools.[21] SOC pools play a major role in soil health maintenance and land-surface exchange of CO_2.[18] These carbon sinks contain about 3 times as much carbon as the carbon stored in all land plants, comprising about 20% of the global carbon stock.[14] The amount of carbon the pools can hold depends on soil quality and vegetation. Using sustainable agricultural practices, like no-till cultivation, organic fertilizers, and planting perennial crops, can improve soils' ability to store carbon.[11] Perennials require less disturbance of the soil, therefore limiting the release of carbon. They also tend to have a higher total root mass.[20] This allows for greater transport of carbon to the soil.

A total of 2,262 lbs CO_2 can be stored in the estimated total plant matter, most of which will ultimately be added to the soil as plants shed about 70% of their photosynthates.[19]

Calculations:

\# of packets × # of seeds × germination rate = # of plants
\# of plants × dry weight = total biomass
total biomass × 0.457* = total carbon
total carbon × 3.6663** = total CO_2

	Organic Cucumber 'Marketmore 76'	Organic Tomato 'Beefsteak'	Parsley 'Italian Giant'	Sweet Basil 'Italian Large Leaf'
[A] Packet count	250	250	250	250
[B] Seed count	23	70	400	160
[C] Germination rate[1]	0.8	0.75	0.6	0.6
[D] Total plants	4,600	11,250	60,000	24,000
[E] Dry weight	7.59 g[2]	12.92 g[3]	4.58 g[13]	8.46 g[14]
C sequestered	14,048.42 g 31 lbs	243,533.79 g 537 lbs	460,427.15 g 1,015 lbs	308,087.58 g 679 lbs

	Organic Cucumber 'Marketmore 76'	Organic Tomato 'Beefsteak'
[A] Total plants	4,600	11,250
[B] Fruit weight	0.7 lbs[6]	1.5 lbs[7]
[C] Harvest yield	17[15]	20[16]
[D] Travel distance[4]	Jalisco, MX: 1,749 mi	Sacramento, CA: 2,468 mi
[E] Avg. individual annual consumption	6.5 lbs[12]	12.87 lbs[9]
[F] Production/ transport C emissions[8]	0.46 lbs per lb of cucumber	0.66 lbs per lb of tomato
C emissions saved	3 lbs/yr per person	8.5 lbs/yr per person
C emissions saved (total fruit yield)	25,180 lbs	222,750 lbs

The estimated number of cucumbers and tomatoes produced can potentially save 247,930 lbs of CO_2 from being emitted through non-local production and transport. Considering the average annual consumption of an American, a total of 11.5 lbs of CO_2 per year per person who harvests their own fruits can be saved.

Calculations:

\# of plants × harvest yield = # of fruit
\# of fruit × fruit weight = lbs of fruit

	Bee	Butterfly
[A] Packet count	250	250
[B] Garden size	16 sq ft	20 sq ft
[C] Garden C seques.	0.368 lbs/yr	0.46 lbs/yr
[D] Total C seques.	92 lbs/yr	115 lbs/yr
	Lawn with grass stubble	
[E] Lawn size	16 sq ft	20 sq ft
[F] Lawn C seques.	0.16 lbs/yr	0.2 lbs/yr
[G] Total C seques.	40 lbs/yr	50 lbs/yr
Increase in C seques.	52 lbs/yr	65 lbs/yr

The pollinator gardens with perennial plants created could increase the sequestration of carbon in the soil by 169 lbs CO_2 per year.

Calculations:

garden size × 0.023*** × 250 = total sequestration per year in gardens
lawn size × 0.01**** × 250 = total sequestration per year in lawns

*Percent of carbon in a plant's dry weight[12]
**Ratio for CO_2 to C
***Cultivated perennial grass avg annual SOC accumulation (lbs/sqft/yr)[19]
****Lawn with grass stubble avg sequestration rate (lbs/sqft/yr)[18]

Our project, The Seed Library, became the first initiative to support Atlanta's Bee City USA commitment, which was designated by the City of Atlanta Mayor's Office of Resilience. With funding from the Captain Planet Foundation we purchased custom-designed seed packets to provide to the community.

Cost of seeds:

$930 for 1,500 packets

Current Status:

Two seed libraries have been established within the Atlanta-Fulton Public Library System.

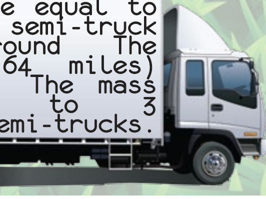
Scalability:

With the abundance of partnerships and support for Bee City USA Atlanta, there are many potential funding sources to continue and expand the project. The city hopes to create the seed libraries in more public locations, like libraries and schools.

Total Carbon Savings: 250,361 lbs per year

Carbon Equivalent:

Emissions are equal to a full semi-truck driving around The Perimeter (64 miles) 1,081 times. The mass is equal to 3 full-sized semi-trucks.



References:
[1] US Federal Seed Act. Sec. 201.31.
[2] Cikili et al. Soil-Water J. 2013, 2, 719.
[3] Esteban et al. IDESIA. 2016, 34, 25.
[4] Google Maps. 2017.
[5] Google Dictionary.
[6] USDA Food Composition Database.
[7] Allonsy. SFGate Home Guides.
[8] CleanMetrics. 2011.
[9] USDA Economic Research Service.
[10] Fisher. Post Carbon Institute. 2015.
[11] Ospina. Climate Institute. 2016.
[12] Kaiser & Ernst. Uni. of KY Cooperative Extension Service.
[13] Najla et al. Phys. & Mol. Bio. of Plants. 2012, 18, 133.
[14] Tzortzakis et al. The Sci. World J. 2012, 12.
[15] Shafeek et al. Res. J. of Agric. & Bio. Sci. 2013, 9, 114.
[16] Zuba et al. Hortic. Bras. 2011, 29, 50.
[17] Food and Agricultural Organization of the United Nations.
[18] Gebhart et al. J. of Soil & Water Cons. 1994, 49, 488.
[19] Zirkle et al. HORTSCIENCE. 2011, 46, 808.
[20] Majumder et al. Plant & Soil. 2007, 297, 53.
[21] Martinson. Appellation Cornell. 2010, 4.