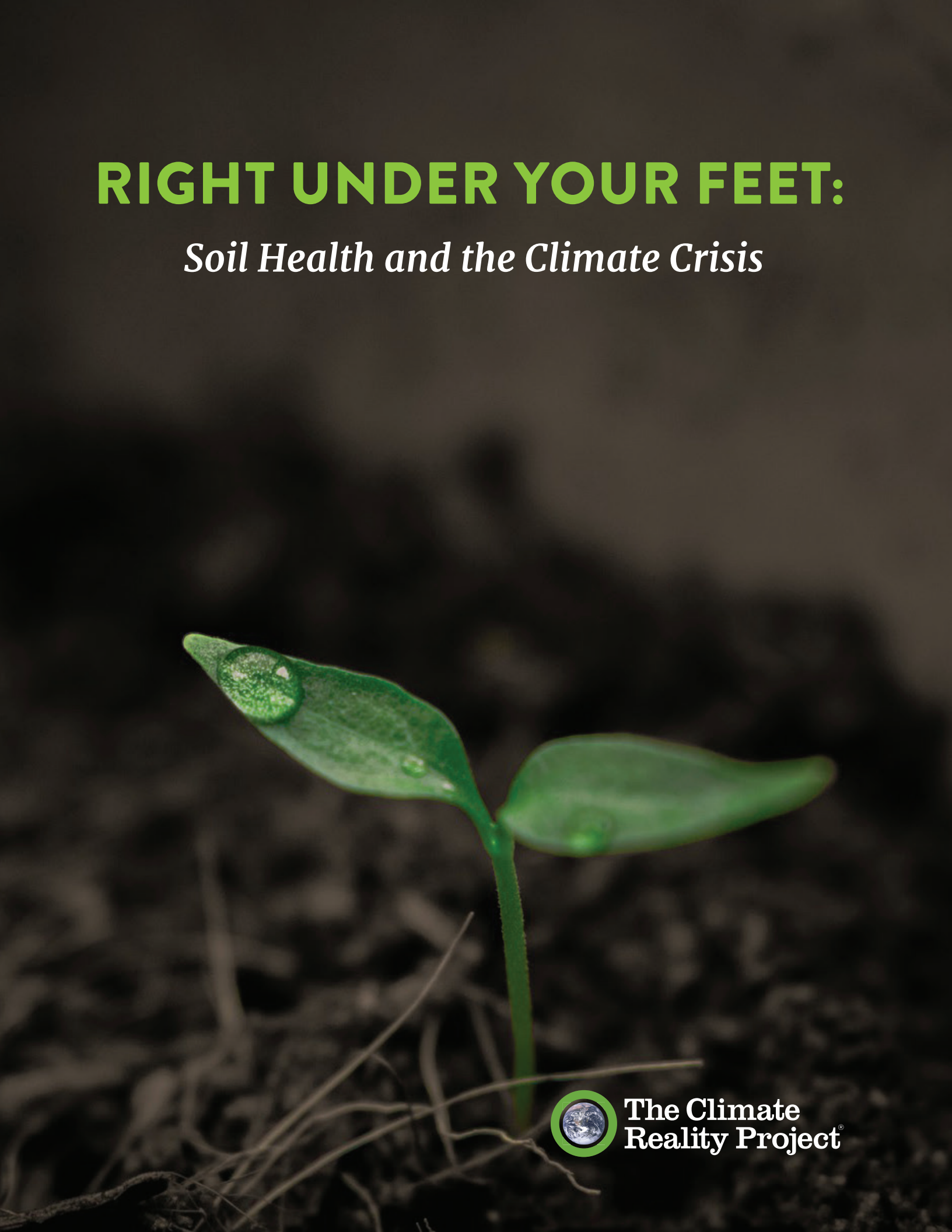
RIGHT UNDER YOUR FEET:

Soil Health and the Climate Crisis



The Climate Reality Project®

SOIL HEALTH AND THE CLIMATE CRISIS

When it comes to the consequences of climate change, some have a way of seizing the headlines.

Global temperatures increasing steadily at their fastest rates in millions of years? Very scary. Glaciers calving and collapsing into the sea? Hard to miss. The Atlantic Ocean lapping down the streets of Miami? Front page news almost everywhere.

Others – like declining soil health – may be a little less immediately dramatic, but they can be equally impactful and even more far-reaching. It's not the sort of thing that inspires a telethon, but over time the toll of erosion, pollution, losses in organic matter, and other soil impacts of the climate crisis imperil a very basic human need – to eat.

The health and vitality of soil everywhere, from the smallest backyard garden to the largest Midwestern farm, plays an integral role in food production – and it's threatened by climate change.

CLIMATE CRISIS 101

Carbon pollution from burning fossil fuels is driving climate disruption and warming our planet. It's simple: the more carbon pollution in the air, the more the sun's energy gets trapped as heat. Which means things keep getting hotter. These rising global temperatures disrupt natural systems, leading to more and more extreme weather events like severe droughts, flooding, wildfires, and superstorms, among numerous other major impacts.

And we're all paying the price for it in lives, livelihoods, and water and food security.

THE STORY OF SOIL HEALTH IS REALLY ABOUT WATER

We're already beginning to see what a warmer future has in store for us – and it is not a pleasant sight.

The climate crisis has fundamentally altered the water cycle around the world. The result is shifting precipitation patterns and increased evaporation that in-turn cause more frequent severe rainfall events and more severe droughts. In many areas, rainfall has become either increasingly abundant or in desperately short supply, relative to longtime averages. It's a classic case of feast or famine.

TOO MUCH WATER

Extreme downpours can lead to runoff and erosion because the ground simply isn't able to absorb the precipitation at the rate it's falling, stripping healthy soil of key nutrients needed to sustain agriculture. In urban, suburban, and agricultural areas, this runoff can pick up pollutants from the landscape and carry them to nearby rivers and other waterways. In the most extreme cases, when a powerful downpour occurs in an area without adequate trees to hold the soil in place, a landslide can be triggered.

> Every kilogram of vegetables you grow yourself can reduce the dangerous emissions causing climate change by 2 kilograms, if you utilize household greywater and compost organic waste.
>
> **"The potential for urban household vegetable gardens to reduce greenhouse gas emissions."**
>
> *Landscape and Urban Planning, Volume 157, January 2017, Pages 365-374.* http://bit.ly/2ckfr4n

In coastal areas, sea-level rise may lead to increased groundwater salinization as the salty sea floods further inland. This will compromise the availability of fresh water, including that used for drinking and farm and garden irrigation.

Climate Change and the Water Cycle: Four Big Questions Answered

TOO LITTLE WATER

On the other end of the spectrum, less stable precipitation together with increased heat is causing increased desertification, leading to a complete loss of farm production in some areas. Frequent droughts and enhanced evaporation are not only killing off the vital living soil ecosystems necessary to grow healthy crops, they're also leaving less water to dilute even relatively common pollutants in reservoirs, streams and rivers, lakes, and wells.

It's easy to forget the profound impact the climate crisis has on every drop of H2O on the earth's surface. Water is the key factor in all agriculture. The success of family gardens, the livelihoods of farmers, and the availability of fresh, affordable food everywhere is directly threatened when our climate changes and water becomes either over-abundant or desperately scarce.

DON'T GET IT TWISTED

More than 97 percent of climate scientists agree that man-made climate change is a reality.

A CONVERSATION WITH AUTHOR CHRIS CLAYTON

"I think a big problem that people have when they talk about climate change is they don't emphasize enough the risks to food production, and I think that really shortchanges some of the arguments and the concerns down the road," says journalist and author Chris Clayton. "The idea that you could have millions of migrants moving all over the world because they can't eat, and the disruption and instability that creates doesn't get enough appreciation in the world."

Clayton is the agriculture policy director of DTN/The Progressive Farmer and the author of *The Elephant in the Cornfield: The Politics of Agriculture and Climate Change*, which examines the conflict in rural American farming communities over climate change.

He puts the stakes of the climate crisis on agriculture and food production into stark relief.

"Nobody has to live in a beach city, but everybody has to eat. You know? And if our population is growing as everybody says it's going to be growing – 9.6 billion people by 2050. That's two-and-a-half billion more people than now," Clayton goes on to explain. "How are you going to feed them in a more volatile weather climate? Every single year, every single day. And when that year hits where food production in two or three bread baskets around the world is short a little bit – 10 percent here, 15 percent there – the risk of political instability becomes huge."

JUST 1 DEGREE MAKES A MAJOR DIFFERENCE

A 2017 study projects rising temperatures and increasing extreme weather events could reduce global production of maize, wheat, rice, and soy by 9 percent in the 2030s and up to 23 percent in the 2050s.

THE ELEPHANT IN THE CORNFIELD

The Elephant in the Cornfield details the divide within the farming community about the climate crisis. The farming community relies on science and scientists in nearly every aspect of its work, from testing things like water quality and soil nutrient holding capacity to developing crop quality parameters and proper fertilizers (and so much more). But because of divisive politics and financial concerns, climate denial is pervasive. Indeed, the debate is so fraught that even farmers who might be described as climate crisis realists refuse to so much as say the words "climate change."

But the impact of the crisis is becoming harder and harder for farmers and market gardeners to ignore – whatever their politics may be.

"We already see it. You see guys now in Canada growing more corn, which was almost unheard of some time ago, growing soy beans. Crop production continues to move further north as we move along, so then it really raises questions like, 'What are you going to grow in Texas when the climate changes that dramatically?'" Clayton asks. "You're really left with fewer number of crops and you have less water to irrigate with."

The biggest threat to agriculture from climate change, he explains, is its impact on **precipitation patterns and water quality**.

"You just don't grow anything without water – that's pure and simple. I was down in Texas in 2011, when they had the drought down there. And you're talking weeks upon weeks of hundred-degree temperatures. It was hard to irrigate because the winds were 25 miles an hour; the water would just evaporate coming out of the pivot," he says. "So you would see these

fields, and I couldn't understand, I saw these dry fields where nothing had happened, and I realized they had planted in the spring and nothing came up. It was just a pure, empty dryland field."

He says **soil health** has been one way some government agencies have been able to discuss climate change without wading too far into the charged discourse.

"They don't talk about climate change; they talk about soil health. And they talk about converting from tillage to no-till practices. To building the organic matter in the soil over time. When you till, you're releasing the carbon into the air, and it's like a massive rush for the plant," Clayton explains. "I've heard a few soil scientist guys I know describe it as you're literally setting the house on fire to grill your meat."

As Clayton lays out, turning to no-till practices – and keeping carbon in the soil – gives farmers a better long-term approach. "**[C]arbon sequestration** does so many different things that we don't really talk about. The biggest problems we have environmentally in agriculture is water quality – nitrates and phosphorus leaching into the water supply. If you are sequestering carbon in the soil, you're not disturbing the soil. You're building organic matter; the more organic matter you have in the soil, the more water-holding capacity you have, so your nitrates and phosphorus are leech-less."

TALKING ABOUT CARBON SEQUESTRATION

Most people know carbon as one of the building blocks of life and a part of carbon dioxide, the primary greenhouse gas driving the climate crisis. But carbon doesn't have to remain a gas in the atmosphere – and while ocean acidification has brought a lot of attention to carbon dioxide being absorbed by the sea, it can also be reabsorbed into the soil.

When plants photosynthesize, they take carbon dioxide from the air and – using the sun's energy, water, and nutrients from the soil – transform it into carbon the plant uses to grow leaves, stems, and roots. The excess carbon created through this process is transported down the plant and is stored in the surrounding soil. This carbon in the soil is known as **soil organic carbon** and it feeds microbes and fungi, which in turn provide nutrients for the plant. Soil organic carbon is the main component of soil organic matter, providing more structure to the soil and allowing it to store more water.

Carbon can remain stored in soils for thousands of years – or it can be quickly released back into the atmosphere through farm practices like plowing and tillage, where soil is prepared for planting by mechanical agitation methods such as digging, stirring, and overturning.

NO-TILL FARMING IS PLANET-SMART FARMING

One way to sequester carbon is to practice "no-till farming," which eliminates manipulation of the soil for crop production.

When combined with **cover cropping** – the use of noncash crops like clover (great for bees!) or small grains to protect soil from erosion, weeds, pests, and diseases; decrease nutrient loss; and improve soil fertility and biodiversity between periods of regular crop rotation – no-till farming has numerous potential benefits for gardeners, farmers, and the planet, according to Clayton.

"When you layer the two issues together – no-till practices and cover cropping – you're really building organic matter. You're putting a shield over your soil to protect it from the driest times, [and] you're also putting a sponge in the soil that protects it when there's heavy rains," he says. "So the two practices together just build organic matter, store carbon in the soil, but they have so many other benefits. They add nutrients to the food because now you have all that organic matter breaking down. Then you also have the water quality benefits. … If you can do anything that benefits water quality, you are creating leaps ahead in terms of environmental practices for agriculture."

"NO-TILL FARMING" EXPLAINED

At its most basic, no-till farming is the practice of growing crops without disturbing the soil through tillage or plowing. Plowing and tillage, be it of a backyard garden or a thousand-acre farm, dramatically erode soil — both were key factors behind the "Dust Bowl" in the 1930s – and release large amounts of carbon dioxide into the atmosphere.

No-till farming has many climate benefits. It locks up more carbon in the soil and dramatically cuts back on fossil-fuel use in farm operations (less plowing/tilling means fewer reasons to gas up the tractor). As soil organic carbon levels increase, so does the amount of nutrients that the soil can hold, meaning less petroleum-based fertilizers and run-off into local water bodies. The practice also would help gardeners and farmers deal with extreme weather like drought since soil rich in soil organic matter retains water better than tilled ground.

According to a study published in the *International Journal of Agricultural and Biological Engineering (IJABE)*, "Society gains from [no-tillage systems] on both large and small farms by:

- much-diminished erosion and runoff;
- less downstream sedimentation and flood-damage to infrastructure;
- better recharge of groundwater, more regular stream-flow throughout the year, and the drying of wells and boreholes less frequent;
- cleaner civic water supplies with reduced costs of treatment for urban/domestic use;
- increased stability of food supplies due to greater resilience of crops in the face of climatic drought; and
- better nutrition and health of rural populations, with less call on curative health services."

MOVING FORWARD

Asked what it will take to get farmers on the same page as climate scientists, Clayton is pragmatic.

"More green markets, more financial opportunity," he says. "When the opportunity outweighs the cost… you know, farmers, in general, are businessmen – they're small businessmen – so when they figure out there's an opportunity versus a cost, they're going to jump on it more.

"Farmers are just like anybody else – they don't like to change. Office workers, we hate it when we have to update our software system. Think about if you have to change your work practices and what you do; it's kind of the same challenge for farmers," he continues. "'I've been farming one way for 30 years and you want to come and tell me that I've got to do it differently.' Nobody likes to hear that. And that's part of the challenge they're facing. People just don't like to change unless you find that what you're changing to makes you a whole lot more money or is a lot simpler. And no-till and cover cropping really is a whole different kind of management practice for people, so they have to rethink things quite a bit."

SO WHAT'S THE PROBLEM?

Experts list mindset (traditions and prejudices), how-to knowledge, availability of appropriate machines, and adequate policies to promote adoption as the main barriers no-till farming practices must prevail over in order to be broadly successful. And they stress that the responsibility for overcoming these challenges falls not just to farmers and gardeners but to politicians and public administrators.

"With adequate policies to promote conservation agriculture/no-till, it is possible to obtain what is called the triple bottom line," IJABE writes, "**economic, social, and environmental sustainability, while at the same time improving soil health and increasing production.**"

IMPROVING SOIL HEALTH

THERE'S PLENTY YOU CAN DO

FOUR TIPS TO IMPROVE THE HEALTH OF YOUR SOIL RIGHT NOW

The USDA Natural Resources Conservation Service (NRCS) outlines a few climate-smart techniques that will improve the overall health of your soil. The overriding theme? If you take care of your soil, it will take care of you.

1. MESS WITH IT LESS

The no-till practice described above is a great example of one way to farm or garden successfully while also minimizing physical disturbance of the soil. Over time, physical disturbance can result in the kind of bare or compacted soil that creates a hostile environment for important soil microbes. Beyond physical disturbances, be cautious about chemical or biological activities that also can damage long-term soil health. Misapplication of fertilizers and other soil amendments can disrupt the natural relationship between microorganisms and plant roots.

2. DIVERSITY, DIVERSITY, DIVERSITY

It's as true on the farm as it is at the office – diversity creates a better, more productive environment for everything it touches. Here, we're talking about biodiversity, which is key to the success of any agricultural system. The science here gets a little complicated, but getting down to the brass tacks, here's how it works: Different plants release different carbohydrates (sugars) through their roots, and various microbes feed on these carbs and return all sorts of different nutrients back to the plant and the soil. Planting the same plants in the same location can lead to a buildup of some nutrients and a lack of others. By rotating crops, and deploying cover crops strategically, farms and gardens can be more productive and produce more nutrient rich crops, while avoiding disease and pest problems.

3. LEARN TO LOVE THE RHIZOSPHERE

Every living plant maintains a rhizosphere, the area near the root where the concentrated soil microbial activity described above happens. It's the most active part of any soil ecosystem. "Healthy soil is dependent upon how well the soil food web is fed," according to the NRCS. "Providing plenty of easily accessible food to soil microbes helps them cycle nutrients that plants need to grow." Alternating long-season crops or a succession of short-season crops followed by a cover crop will build out a healthy and diverse rhizosphere environment for your plants – and you can make things even better for your plants and their root ecosystems with a healthy dose of fresh compost.

4. COVER IT UP

Bare soil is bad soil. And while finding a way to both allow crop residues to decompose so their nutrients can be cycled back into the soil and keeping the soil protected with cover is certainly a balancing act, it's an important one to figure out. Why? Because left exposed to the elements, soil will erode and the nutrients necessary for successful plant growth will either dry out or quite literally wash away. Additionally, the rhizosphere discussed above will starve and diminish without plants to feed it.

A STUDY IN SUCCESS: CALIFORNIA

California has long been at the forefront of the fight for state-level climate solutions, so it comes as no surprise that the state is part of a new movement that encourages climate-smart farming. Led by Governor Jerry Brown, the state has developed programs that place a financial incentive on the adoption of no-till techniques and other strategies to reduce agricultural emissions.

"California's cap-and-trade market — a way for polluters to mitigate their emissions by purchasing carbon 'offsets' generated by projects that reduce emissions — includes the agricultural sector, enabling farmers to get paid for climate-friendly practices," *Modern Farmer* writes.

In its 2016-17 budget, the state also allocated funds from its Greenhouse Gas Reduction Fund for a new incentive and demonstration program called the "**California Healthy Soils Initiative.**" The program, the first of its kind in the country, gives grants to farmers who take steps to build soil organic matter and reduce agricultural greenhouse gas emissions through carbon sequestration.

PROTECTING THE SOIL MEANS PROTECTING THE PLANET

The best news of all is that the same actions you take to keep your soil healthy also protect that planet. The sustainable conservation agriculture practices described above have a naturally lower carbon footprint than conventional farming. If you're employing low- or no-till practices you're using gas-powered tractors, rototillers, and cultivators far less. Crop rotation and cover cropping not only build healthy soil organic matter, it also acts as a method of carbon sequestration. And of course, thriving plants – the lungs of our planet – breathe in an awful lot of carbon dioxide from the atmosphere during photosynthesis. **It's a real win-win!**

LONG-HAUL SOLUTIONS

As we mentioned earlier, a rise of just a degree or two makes a major difference in crop yield. Think about it this way: What's the difference between 32 and 33 degrees or 211 and 212 degrees Fahrenheit on water? It either freezes or boils, respectively. Now, consider the farms that depend on reliable seasons and predictable, consistent temperatures and precipitation to grow specific crops in specific regions.

If we keep burning fossil fuels without making any real efforts to cut emissions, we could see surface temperatures on Earth warm by more than 7.2 degrees Fahrenheit (4 degrees Celsius) by the end of this century. Put as plainly as possible, this would transform the planet in ways that undermine its capacity to support a large and thriving human population.

But it doesn't have to happen this way.

ACT ON CLIMATE NOW

Ready to make a difference for the future of our planet?

1. REACH OUT TO YOUR REPRESENTATIVES

Contacting your elected officials' offices is a useful way to communicate your opinions on the climate crisis, especially when an action (such as a vote) is pending. It's unlikely you'll speak directly to the official, but their staff tracks the number of calls they receive on various topics, and most legislators do pay attention to communications from their constituents.

The US Capitol Switchboard can be reached at (202) 224-3121. An operator will connect you directly with the office of the US senator or representative you request. Visit your state and local government websites for contact information for your state senators and representatives, who you may find more receptive to your concerns about soil health and its impact on food production. Be sure to call often!

2. WRITE A LETTER TO THE EDITOR

The opinions section of a publication is one of the most valuable places to discuss the climate crisis. By writing a letter to the editor, your insights and opinions on the topic will be out there for hundreds or even thousands of people to read. It's an incredible tool for reaching and educating the public. And influencers, including business leaders and elected officials, pay attention to opinion pieces, which function as a direct line to local voices.

Be sure to keep it short and sweet, and make it personal, explaining why taking climate action to protect soil health is important to you. Check out our *I Am Still In Action Kit* for tips and examples on writing an effective letter to the editor.

3. TALK TO FRIENDS AND FAMILY

When you talk, your friends and family listen. Whether it's at the grocery store, the local carnival or county fair, or over lemonade at a family picnic, discussing the reality of the climate crisis is your chance to change minds and ensure the people you care about know what is happening to the planet – and what they can do about it.

Focus on the things that matter most to your friend or family member. If you know someone who values their garden or farm as a resource for fresh food, income, or even just as a fun, therapeutic place to show off their green thumb, emphasize the facts in this e-book. For more about the science of the climate crisis, visit the Climate Reality website.

4. ENCOURAGE YOUR COMMUNITY TO GO 100-PERCENT RENEWABLE

Taking local action is one of the most effective ways that you can support climate solutions. Help demonstrate the robust demand for clean energy by encouraging your community, university, or local business to commit to transition to 100 percent renewable electricity.

Learn how with our *100% Committed* Renewable Electricity Roadmap.

5. SIGN UP TO LEARN MORE FROM CLIMATE REALITY

To change everything, we need everyone. That's why we need your help to continue the fight for climate solutions to protect healthy, happy farms and gardens everywhere. Click here to sign up to receive regular updates on the latest climate science and all the ways that you can take climate action.

A global challenge needs a global solution. Wherever you are, whatever you do, and whatever time you have, you can do something right now to bring us one step closer to a future without carbon pollution. One where we can provide our booming world population with fresh, healthy food grown in a sustainable soil ecosystem.

Happy planting!

The Climate Reality Project®

Founded and chaired by former US Vice President and Nobel Laureate Al Gore, The Climate Reality Project is dedicated to catalyzing a global solution to the climate crisis by making urgent action a necessity across every level of society.

Today, climate change is standing in the way of a healthy tomorrow for all of us. But we know that practical solutions are right in front of us. We can create a healthy, sustainable, and prosperous future by making a planet-wide shift from dirty fossil fuels to clean, reliable, and affordable renewable energy. At Climate Reality, we combine digital media initiatives, global organizing events, and peer-to-peer outreach programs to share this good news with citizens everywhere and build overwhelming popular support for policies that accelerate the global transition to a clean energy economy.

To learn more, visit www.climaterealityproject.org.