Science AMA Series: I'm Claire Horrocks, a Soil Scientist! Soil matters. Fact! Poor land management can damage soils. I'm working in Colombia and Kenya to develop methods to assess and improve soil health under tropical grasslands. AMA!

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Abstract

Hi reddit! I became a scientist because I wanted to make a difference. I had prepared myself for a life of numbers, statistics and working in a lab. Never did I imagine that I would be travelling to places like Colombia and Kenya, and getting to meet other researchers from around the globe who are also pretty keen to make a difference. But this is exactly what I am doing in my current role as a Newton Fund (http://www.newtonfund.ac.uk/) Postdoc at Rothamsted Research (http://www.rothamsted.ac.uk/) . The human population is growing and feeding everyone whilst limiting environmental damage is a huge challenge we face. Key to tackling the problem is understanding and managing soil. Soil is amazing and complex! It has many essential functions, including regulating water flow and water quality; storing carbon so less of it reaches the atmosphere as the greenhouse gas carbon dioxide; and supporting above and below ground biodiversity, which includes the plants we rely on for food. I am working in collaboration with scientists at the Centre for Tropical Agriculture (https://ciat.cgiar.org/) in Cali, Colombia and Nairobi, Kenya, to understand how growing different combinations of plants effects soil function in grazed grasslands. This will help us determine the best plant varieties and farming practices to ensure farmers in the tropics grow grass to rear healthy livestock, and produce sufficient nutritious food with less damage to the environment. Read more about my work and find out what life as a globe-trotting soil scientist is like in a recent blog entry (http://www.rothamsted.ac.uk/day-life-research-scientist/day-life-dr-claire-horrocks). My fingers are tired now from all the typing so I am going to head off but I have really enjoyed answering all the questions and reading some of the great discussions that have developed. Sorry I couldn't respond to all the comments I will try to pop back later to answer some more , bye for now. Claire

the WINNOWER

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CLAIRE_HORROCKS R/SCIENCE

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In general, what's the worst thing farmers do to the soil and what should be done instead?

thedetox

This is a good tillage debate, no till agriculture is an area by group at Rothamsted are very interested in there are certainly benefits in terms of increasing organic matter content of soil, so storing more carbon and reducing leaching of nitrogen and other nutrients. Also the effects of tillage can be very long lasting and it can take decades or even hundreds of years for a tilled soil to start to show similar physical chemical and biological properties that resemble those of a never tilled soil. However some times tilling is necessary to establish a crop and remove weeds. Developing optimal tillage regimes and improving reduced till techniques is a key area of research in soil science, improving our understanding of tillage and the effects will be a key focus to ensure sustainable food production in the future.

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What do you think of the regenerative agriculture techniques proposed by Alan savoy https://youtu.be/vpTHi7O66pI

bee_rad

Lots of people seem interested in these ideas, Alan savoy proposes herd management strategies focused on short periods of intensive grazing with very high sticking density and then moving the herd on. This idea has received varying degrees of support and criticism in the scientific literature and other forums. Some of the hypotheses he proposes are certainly worth testing, in-fact different herd management regimes and 'mob' grazing is something that we are looking into in my group. I think in short we need to do more studies, most of the controversy has stemmed from a lack of scientific evidence to support claims for and against the techniques proposed by Savoy. But the whole point of science is to hypothesize then carry out research to find answers, the debate has been useful in provoking interest and encouraging researchers and farmers to consider different grazing options, which cant be a bad thing. The key now is to get the data to investigate the ideas more. Watch this space!

Hi Dr. Horrocks! Thank you so much for doing this AMA. I work in a developing country in Asia where agriculture is the primary source of livelihood for many. A lot of farmers in rural areas engage in slash-and-burn farming which results to widespread deforestation. Apart from proper land-use planning and management, what sustainable farming techniques or practices that are relatively easy and cheap for the farmer to adopt can you suggest? Or if you can suggest some resources I can go through, that would also be much help. Thank you!

AudiWanKenobi

Hello, this is such a complex issue, slash-and-burn has been practiced for thousands of years and on a small scale can be sustainable as small areas that area given enough time to regenerate between cultivation periods can be repeatedly re-used. However the problems come when the same piece of land is used again to soon and the nutrients and organic matter can not recover. I have not yet worked in slash-and-burn systems directly but would always advocate wherever possible returning organic matter to the soil, this helps maintain soil structure and stability, retain nutrients and supports a healthy soil microbial community to drive vital nutrient cycles. It is worth looking at the work published through the international centre for tropical agriculture https://ciat.cgiar.org/ and other Cgiar centres, Cgiar is collaboration of global agricultural research institutes working in developing countries http://www.cgiar.org/

Is it possible to have high yield crops (by today standards) without the use of fertilizers and in a sustainable way? I mean, by proper use of fallowing, crop rotation, etc. If so, would it be true for many places or just for outstanding soils?

Svankensen

This is a key question in sustainable development, in fact many would say it is the central issue of sustainable intensification, so to address it completely and provide a definitive answer is difficult. In short fertilizers pesticides and other chemicals were responsible for major increases in productivity during the last millennium however the environmental and financial costs of these means that in an ideal world we would reduce their use. This is particularly important in countries like Kenya and Colombia where many farmers cant afford to buy in fertilizer. Certainly there is great potential to minimize the need for example for synthetic nitrogen fertilisers using bacteria that naturally draw

nitrogen form the air and fix it into the soil. Also where possible returning organic matter and residues to the soil to replenish organic matter and nutrients. Improved management and selection of suitable crops and cropping regimes for a given climate and soil can have very impressive effects, the key is matching the plant and regime to the soil and climate and working to improve the soil so that even 'poor' or unhealthy soils can be productive with minimal artificial fertilizer input. Also the quality and nutritional content of the food needs to be considered not just yield. The more we understand about soil ecosystems and feedbacks the closer we can get to achieving this goal on a global scale.

What group of farmers/people have you found most open to trying new techniques or returning to older/less damaging farming practices? What group has been the most difficult? Having worked for a time with a US water district in the Houston, TX metro area, we struggled horribly with getting across even basic soil biology to the average suburbanite homeowner. It was discouraging how resistant to knowledge some were.

LianeP

We work with farmer groups in the UK and have frequent farmer visits to Rothamsted Research to encourage increased knowledge exchange engagement between farmers and scientists, I am always impressed with the level of interest and enthusiasm, likewise and sciences festivals I have attended, although this is a self selecting group as by electing to be part of farmer groups and visit festivals they are likely to be open to new ideas. The best experience I had was in Kenya where a local farmer had set up a farmers group for local small holders to share knowledge and work with local scientists. These farmers were rightly proud of how they had increased yields by adopting push-pull technology and fostered a real spirit of cooperation working with scientists in a two way dialogue, their enthusiasm and success lead more farmers to join the group.

A futuristic vision of agriculture sees the development of hydroponics and aeroponics to feed the world population in an ecological manner.

This pretty much shifts the debate to studying direct assimilation of nutrients instead of a blend of biological, environmental and human factors.

- do you see hydroponics and areoponics as viable and competitive solutions to prevent further damages to ecosystems and still feed the world?
- is there a direct translation of what you learn and your experience into improving those "futuristic" technologies?

thbb

I saw an interesting program where they visited a salad farm under ground in central London whether all the crops were grown without soil. One of my main areas of research is into soil ecosystem services, i.e the various functions that soil provides which benefit humans and the wider environment. Food production is one of these and it is true that food production can be supported without soil by growing plants in liquid solutions that provide all the resources they need. Clearly in some situations and for certain crops this can and does work however on a global scale I still see conventional agriculture as being the main source of food production as the costs and need to import nutrients to these systems means they will not be possible for the majority. My work with soil has shown how complex it is and the great potential to use natural soil processes to increase the sustainability of production, and in doing to increase the ability for soil to perform other roles, e.g. carbon storage, maintenance of biodiversity, water retention. Having started out in plant sciences I certainly appreciate the use of developing alternative ways to grow crops but still believe the best chance lies in

understanding the more natural systems better and leaning how to optimize them.

How much can and will climate change affect soils?

FreekyFreezer

Climate change will definitely affect soils, for one it will effect the type of plants that grow and the rate of plant growth, which will alter the rate at which organic material (plant matter) is added to the soil and the rate at which nutrients are removed. Soils are also ecosystems in their own right supporting complex communities of living organisms ranging from the ones we can see like earthworms to the ones we cant like bacteria, as with all ecosystems changes in temperature and rainfall which we see with climate change will effect these communities. Soil could also affect climate change. Soil is an important store of carbon and nitrogen both of these elements can form greenhouse gases which contribute to climate change including (carbon dioxide methane and nitrous oxide). Soil conditions like temperature and moisture affect the rate these gases are released, so the response of soil could provide a feedback or feed-forward affect on climate change

Hi Claire, I'm also a soil scientist, and would like to extend an invitation to/r/soil should you be so inclined.

A few simple questions:

Do you have any soil profile pictures from the countries you are studying in?

What species are you investigating and why? what are the trade offs, if any in using these species?

What soil quality parameters are you trying to improve?

How long do you expect it to take to see serious improvement in the soil?

Monolithic_Zebra

some good questions and thanks for the invite! I don't have any soil profile pictures, plenty of field work ones though. In Colombia I am currently working on Brachiaria grasses, and making comparisons with Panicum, CIAT Colombia has a Brachiaria breeding program the varieties produced are hugely variable and there are always trade offs when selecting which variety to grow, for example some of the cultivars are very hardy and can survive drought (which happens frequently in Colombia) and do well in the vast plains (Llanos) of Colombia requiring little input in terms of fertilizer and irrigation from farmers but the hardiest ones have a creeping growth habit which means they would be less useful for farmers in Kenya who tend to practice cut and carry farming, meaning the cattle don't graze the grass, instead it is cut by hand and carried to the cattle, so taller more tufty species like panicum are preferred. One of the aims of my work is to understand more about the tradeoffs and the effects of the different grasses. At the moment I am looking at aggregate stability and soil organic matter content, increasing aggregate stability is key to reducing erosion a major problem in many areas. One problem with studying soil is that some management actions can take many years to show an effect, in some cases the legacy of former management or mismanagement can last decades if not hundreds of years, particularly if we want to restore for example more natural or semi natural systems on former intensive arable sites for example. However even some improvement in soil health can make a big difference to farmers so small increases in organic matter by adding compost for example may show an effect in one or two years.

Hey! can you run us through a few of the differences between the way the US grazes, and the way

they graze in Kenya? can you point out some cultural differences as it pertains to raising meat?

what challenges do you face there, that you wouldn't face in the US?

What guidelines differ from the general rules we use in the US? (about time, intensity, duration, and frequency).

blot101

I am based in the UK so my experience in US agriculture is limited. However I am sure that the farms that I will be working on in Kenya are very different, the farmers I visited are generally small scale subsistence farmer, primarily producing food to support the family with only a small amount sold for profit. The farms are tiny, less than 1 hectare, and the work is done by hand, for example with grass cut with Machete. In the UK farms are normally in the order of hundreds of ha I imagine in the US farms are generally larger still. In Kenya farms will have only one or two cows for milk, a fodder crop or grass for the cows and some beans or something for the family to eat. The cows I saw weren't grazed the farmers cut the fodder crops and carried them to the cows who were tethered or in stalls. Working in Kenya is very different to in the UK and other temperate areas due to the climate, the heat can be exhausting and the problems of drought more severe. Also access to farms knowledge exchange is hard as you are dealing with some many farmers in remote rural areas, who may only speak the local language. However I was really uplifted by the farmers we did meat who were engaged and really keen to try new methods and learn how to improve their productivity

What soil best management practices can be implemented to combat climate change? I assume this is dependent on the type of soil. Also, what can be done for soil as places urbanize. Can structural soil be used in the capacity to combat climate change?

HalfRho

One major way to use soils to help combat climate change is through increasing carbon storage as organic matter in soils. Carbon that is stored within the soil is not adding to the atmospheric concentrations of the greenhouse gases carbon dioxide and methane. Nitrogen management is also key as nitrogen can be lost from the soil as nitrous oxide a greenhouse gas that is nearly 300 times as powerful as carbon dioxide. Waterlogging can increase methane and nitrous oxide emissions whereas tillage can lead to increased break down of organic matter releasing soil stored carbon as carbon dioxide.

We have very few soil scientists where I live. I was told very recently to go back to school to get educated as a soil scientist because it's going to be a major concern. We have a lot of farm land outside the major cities. I'm wondering what kind of further education I would need. I already have a bachelor's in environmental science from a university.

tiny_little_planet

I started off studying Natural Sciences in particular plants, I then got interested in soils later in my career through studying a PhD when I realized how essential soils are to plant growth and to underpinning ecosystems. So from my experience a masters or PhD in soil science can certainly be a way in. In the UK the British Society of Soil Science offers a qualification to be a chartered soil scientist http://soils.org.uk/chartered-status which is another way.