The UNEP Magazine for Youth

TUNZA

UNEP

for young people · by young people · about young people

Soil - the forgotten element

Earth: the living layer

Enriching soils, enriching lives

TUNZA
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Partners for Youth and the Environment

UNEP and Bayer, the German-based multinational involved in health care, crop protection and high-tech materials, are working together to strengthen young people's environmental awareness and engage children and youth in environmental issues worldwide.

A partnership agreement, originally signed in 2004 and renewed in 2007 and 2010, runs through 2013. It lays down the basis for UNEP and Bayer to implement the projects under the partnership. These include: TUNZA Magazine, the International Children's Painting Competition on the Environment, the UNEP Tunza International Youth and Children's Conferences, youth environmental networks in Africa, Asia Pacific, Europe, Latin America and the Caribbean, North America and West Asia, the Bayer Young Environmental Envoy Program and a photo competition, 'Ecology in Focus', in Eastern Europe.

The long-standing partnership between UNEP and Bayer has become a public-private partnership that serves as a model for both organizations.

Soil: did you know?

- An average soil sample is 45 per cent minerals, 25 per cent water, 25 per cent air and 5 per cent organic matter; the organic portion can rise to 10 per cent in a well-maintained garden soil.
- The mineral portion of soil is made up of weathered rock.
- Many soils have been transported over long distances by glacial movement, water flows and wind, settling far from their original 'parent rock'.
- Central and South American rain forests get most of their mineral nutrients from the Sahara, as soil dust from North Africa is transported across the Atlantic.
- It is the size of the mineral particles that gives the soil its texture, from very fine clay to coarse sand. Fine clay is used to make porcelain.
- Volcanic soil is among the most fertile on the planet.
- A healthy soil reduces the risk of floods and filters out pollutants from water.
- Red and yellow soils contain iron and are low in organic matter.
- Dark brown to black soils are high in organic carbon and are good for agriculture.
- Blue to purple soils suffer waterlogging.
- Rainforest soils contain little organic matter because the heat and humidity break it down too quickly for it to penetrate below the soil surface. This is why such soils degrade so quickly after deforestation, making them inappropriate for conversion to agriculture.
- Humus is organic matter that has reached a point of stability where it will break down no further if conditions do not change. A high humus content improves soil structure, promoting moisture retention and aeration.
- Bacteria and fungi secrete sticky substances that help bind the soil together.
- Soil classification is extremely complex: scientists have identified more than 10,000 soil types in Europe and more than 20,000 in the USA.

EDITORIAL

We live, all our lives, less than 25 centimetres away from extinction. For that is the average thickness of the thin dusting of topsoil that is all that stands between us and a barren planet, and on which we utterly depend. And yet we abuse it recklessly.

Every one of those centimetres can take 500 years to form, yet, neglected, it can be – and often is – eroded away in just a few years. Every year more than 24 billion tonnes of priceless topsoil are washed or blown away worldwide, as the land is overcultivated and overgrazed and trees and forests are cut down. About a quarter of the world's agricultural land, the United Nations reports, has already been degraded, and another 12 million hectares – an area the size of the African country of Benin – is lost to farming each year.

Desertification now threatens the livelihoods of more than a billion people in some 100 countries across the globe. It is at its worst in the drylands, where patches of desert erupt and grow like a rash on the face of the Earth. And it is no coincidence that about 80 per cent of the conflicts that have recently broken out around the planet are in arid areas where growing deserts are forcing neighbouring peoples to compete for the remaining fertile land.

And yet it is a forgotten crisis. Nearly 20 years ago – at the 1992 Rio Earth Summit – the world's governments agreed to a treaty to combat it, but have done little to put the treaty into practice. This autumn, when the UN General Assembly hosts a special one-day summit on the issue, will offer the best chance in two decades to bring the issue back to international attention. Governments must come to the table resolved, literally, to hold their ground.

DESERTIFICATION:
NOT ABOUT DESERTS

Design Pics/Still Pictures

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UNEP/Topham

The United Nations Convention to Combat Desertification, established in 1994, is the only international agreement that links environment, development and the promotion of healthy soils. TUNZA spoke to LUC GNACADJA, the Executive Secretary of the Convention, about an issue that affects us all.

The Convention to Combat Desertification is about more than just drylands, isn't it? Can you tell us how many people are currently affected by land degradation, and how much of the world's land is affected?

Indeed, and it is not about deserts either! Although it focuses on the drylands, which cover 41 per cent of the Earth where more than 2 billion people – or one third of the world population – live, all the people in the world depend on the drylands because they contain 44 per cent of the world's food production system and produce half of the world's livestock. Twelve million hectares of land are lost every year due to desertification. That's the size of my country Benin. The annual land lost could produce 20 million tonnes of grain. So the health of soil in the drylands is very important to the future of our entire global community. Put another way, land degradation directly affects 1.5 billion people whose livelihoods depend on degraded areas, but indirectly it affects every one of us in the world.

J. Sawalha/UNEP/Topham

Do you feel that climate change is the main driver of desertification?

Certainly it is one of the main drivers, but the reverse is also true: desertification is one of the main drivers of climate change. Climate change is known to bring extreme weather events such as prolonged and unpredictable droughts. The percentage of the Earth's land area stricken by serious drought has more than doubled since the 1970s, and there is a prediction that climate change will depress agricultural yields by some 15-50 per cent in most countries by 2050, given current agricultural practices and crop varieties.

I must stress that healthy soil can play an important role in climate change mitigation. Carbon sequestration in the soil serves a dual purpose: firstly, global warming can be mitigated significantly by removing atmospheric carbon dioxide and sequestering it in soil (if the soil is healthy that is!). Secondly, increased carbon in the soil has great value as a food-producing asset.

UNEP's forthcoming GEO (Global Environment Outlook) assessment suggests that population growth is a major driver of environmental change. Could you relate this to desertification?

Population growth is a serious challenge. It is estimated that there will be 9 billion people on our planet by 2050 and, to feed them all, we

need to increase our food production by 70 per cent in the next 40 years. That is a big ask. If we consider that 1.9 billion hectares of land worldwide have become degraded since 1950, the challenge is even greater. Behind that is another serious challenge: the risk of overexploitation. If the population grows in a starving world, humans are likely to overexploit and degrade the land more and more. In addition, we would lose the capacity of soil to sequester carbon, contributing negatively to climate change mitigation. Humans can be drivers of the problem but they can also be the solution. And the solution is feasible: land degradation can be reversed.

J. Salam/Still Pictures

Are modern, intensive farming practices a factor? And how does this relate to the rich world's levels of consumption?

Current increasingly intensive soil use is leading to significant land degradation. Mostly due to erosion, 24 billion tonnes of fertile soil disappear each year.

Virtually everyone in rich countries depends on the drylands for food. The wheat, rye, oats, barley and olives we eat or the cotton clothes we wear have their origins in drylands. But land degradation threatens not only the rich world's consumption but also global food security. Moreover, if the land is further degraded and becomes no longer productive, rural people will be forced to abandon their farms and migrate somewhere else in order to make a living.

All these things point to the importance of sustainable land management. Farming is needed to feed the ever-increasing population, but this can be done in a sustainable manner so that we no longer degrade arable land. Sustainable land management helps improve local livelihoods, reduce hunger, restore natural ecosystems and mitigate the effects of climate change.

Are you hopeful for the future? What do you feel are the key things that can be done?

Our generation could set humanity on the path to sustainable development or to self-destruction. The good news is we can still chose sustainability by making sustainable agriculture and forestry cornerstones of the green economy. In fact, two-thirds of the degraded lands offer restoration opportunities. Land degradation can be prevented, degraded lands reclaimed and drought mitigated using sustainable techniques for land and water. For that to happen, policy makers, governments, farmers, scientists and communities must work together.

Investment in sustainable land management is a local concern, a national interest and a global obligation. Thus it must be given priority at the local level to increase income, to improve food security and to contribute to poverty reduction; and at the national and global levels to help alleviate hunger and malnutrition, to reduce poverty, to protect the world's climate, to safeguard natural resources and ecosystem services, and in many cases to preserve cultural heritage.

There is a need to document and evaluate success stories and assess their impact on ecosystem services. Sharing success stories helps others take similar action for achieving their own goals, or for scaling up their practices. Moreover, there is a great need to clarify the impact of different sustainable land-management practices and adapt and optimize them under different conditions. And there is still a need to raise awareness of the causes, the context and the impacts of inappropriate resource use.

And lastly, how can young people in particular help fight desertification in their own lives?

Young people who are enthusiastic about nature and the environment can be front-line players in the collective fight against desertification. I have met many young people who have taken the time to teach themselves about desertification and how they can help drylands by fair trading, tree planting and saving energy. But I wish schools would teach more about desertification and sustainable development to help more young people understand the issues better and support the search for solutions.

Think about this – a drought can occur anywhere, whether in developed or developing countries. But in developed countries, drought doesn't kill people. What is happening now in Somalia and other East African countries would probably not happen in Australia. I invite young people to think why a drought implies famine in one place and not in another, and what would be the total cost of action now and that of inaction for our common future.

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Bayer


Lumbricus

Getting dirty


Lumbricus


Lumbricus

Every year at the Bayer Young Environmental Envoy conference in Leverkusen, a visit to a mobile laboratory and classroom powered by a photovoltaic roof is a highlight for the young environmentalists. Housed in a 7.5-tonne bus, the lab is named *Lumbricus*, meaning earthworm, and it demonstrates Ottmar Hartwig's enthusiasm for nature and environmental education – and a particular passion for soil. The TUNZA team thought our soil issue would be incomplete without talking to Ottmar about what he does, and why he thinks that educating young people about soil is a matter of urgency.

'How did I come to spend my days on an ecobus? Maybe it was all the gardening I did with my father in the 1960s, or the wildlife shows of the era – from Jacques Cousteau to Bernhard Grzimek to David Attenborough. And my love of nature prompted me to study biology and geography at Cologne University.

'But as far as I'm concerned, you can't learn without getting your hands dirty. One thing I always say is: "If you want to learn to swim, you have to go into the water. If you want to learn about ecology, you have to go into nature – at least once!" In my years of teaching, I've observed that young people are increasingly losing direct experience of nature – not just plant growth or insect metamorphosis, but even bad weather! So for many of our students, collecting invertebrates in steep forest soil or digging to discover different soil layers in a muddy riverbank, under a lot of weeds, is a new experience.

'Which brings me to soil. The local and global importance of natural soils is a favourite theme of mine, and, according to the International Union of Soil Sciences and the German Soil Science Society, a subject that's too often ignored in the classroom. Yet soil, along with water, is fundamental for life on the planet, and is connected to agriculture, afforestation, water production, water storage and filtration and biodiversity. Under natural circumstances it takes 10 years to produce 1 millimetre of soil, and it takes a minute to destroy it: we are losing fertile soil at an alarming rate, and I fear the loss of productive soil worldwide will give rise to major social and political problems.

'But when young people come to *Lumbricus*, soil is not always a favourite subject: they think it's just dirt! We teach them that soil is actually an ecosystem with a bundle of important processes and many helpers. The methods we use to get children close to soil differ according to age group and interest. For the little ones, we offer a microscopic look at the soil inhabitants. Older pupils drill into soil to obtain a "soil-sausage", so that they can observe different soil layers. More mature students might analyse a soil sample's pH to determine acidity. In the end, every team presents its results and documents it digitally for further use back in the classroom.

'These lessons give only a glimpse of soil science to children, but it's a subject well worth teaching. In our humble ecobus – named after the worms who do such an important undercover job for the world – we have reached more than 70,000 young people, and plan to keep going. We know we're making an impact: we've seen some of the documented results of *Lumbricus* outings persist in school classrooms for years. But best of all is when pupils from years past return as adults, now young teachers themselves, bringing their own pupils to learn about nature by digging in.'

Youth action: saving our soils

There are many things young people can do to improve soil right where they are. Browse our compost guide (see page 15) for ideas and see what methods might be right for you. In the meantime, be inspired by these examples promoting soil improvement and sustainability, led by young people from the UNEP-partnered Bayer Young Environmental Envoy (BYEE) and Volvo Adventure young environmentalist programmes.

Haneesa Zahidah, Malaysia, BYEE 2010

As president of the green team at my university, I was looking for something sustainable that ordinary people could do. That's when I found out about Takakura composting, a well-structured yet straightforward method that I thought would work for Malaysian households, as it's time-efficient and suitable for the tropics. Invented by Japanese scientist Koji Takakura, this method of composting takes a maximum of 26 days to produce compost, less than a third of the usual time.

You start by making fermentation solutions with sugar and salt. The sugar solution consists of water, brown sugar and fermented soy (known as *tempeh* in Malaysia); the salt fermentation solution consists of water, vegetable scraps and/or fruit peels, and salt. These are left for five days to ferment.

When the solutions are ready, they're mixed with a combination of rice husk and bran and left for five days in a cardboard box, until a layer of white mould forms. Then the mixture is ready for scraps. A small plastic or wicker container lined with cardboard is filled with the mixture to about the 60 per cent level, and chopped vegetable and fruit scraps are added. It is covered with cloth, and stirred daily, and more scraps are added until the container is full. The compost is then transferred to a sack and left to mature for two weeks.

Takakura is a particularly good method for any country that produces rice, as the husk and bran are only used for chicken feed or otherwise thrown away. In 2010, I introduced Takakura composting at my university, gathering organic waste from the cafeteria and setting up a small composting site at the Faculty of Architecture. In two months we produced about 50 kilos of compost, used for landscape gardening on campus. I've now begun a training project at a school in a neighbouring state; they intend to use their compost in their science garden.

I plan to carry on promoting composting as a waste management system in more schools and institutions while giving away compost samples; seeing, touching and smelling soil helps people realize how valuable composting can be.

Haneesa Zahidah


Haneesa Zahidah


Volvo Adventure

Büyük Kolej team, Turkey
Oxygen Instead of Waste, Volvo Adventure 2011 Finalist

Between 1980 and 2005, 40 million tonnes of trash were thrown into the 100-hectare Ankara Mamak City Dump without proper care. Closed since 2005, the dump threatened to pollute groundwater and still gives off bad smells. In our research, we learned that waste can destroy the structure of soil, pollute groundwater and produce harmful toxic gases.

Today, 60 per cent of the area is piped to extract methane, but the remainder lies idle. We decided to create a forest there. With the support of our parents, school, and engineers who advised us on soil structure and what trees to plant, we started a campaign to inform the public. We raised enough donations to plant 4,000 saplings. Then local government joined in and planted 15,000 saplings. Ultimately, we aim to plant 400,000 trees on the site, preferably cedar, the most appropriate for the climate. Our success will improve the soil, rehabilitate habitat for living organisms, and create a park in which children will be able to play.

Youth action: saving our soils **Youth action:**

M. Edwards/Still Pictures

Kennedy Mbeva, Kenya, BYEE 2010

We're always looking at modern solutions, looking to the future. But what if we look back? In May 2010, I read about how farmers in Burkina Faso re-greened degraded land simply by laying stones to capture moisture. It's a simple, inexpensive project and involves the community. I decided to take it to Yatta, an arid area in eastern Kenya, where they grow maize and beans mainly for subsistence. Their land has been degraded due to deforestation and poor agricultural practices, leading to soil erosion.

The project, still in its pilot stage, involves laying rows of fist-sized stones in rows called *cordons pierreux* or *diguettes* along contours, retaining rainwater and preventing topsoil from eroding. In front of these stone lines, we will dig 30-centimetre holes into which the water will percolate. The holes will be filled with cow, goat and chicken manure to attract termites, which break it down and help create fertile soil. We will then plant these holes with indigenous trees, such as *Prunus africana* and species of the genus *Aningeria*, as well as fruit trees, so that eventually the lines of stones will be transformed into lines of trees – a forest that will help stabilize the soil and further draw down moisture.

We are just begining to lay our stones, and the residents are eager to give it a try. It's a long-term project based on trial and error, and depending on the results we will seek more support, both financially and from the Kenyan government. It'll take at least three years, but it's worth the wait.

Jerry Lee, Malaysia, BYEE 2010

I present an interactive, mobile environmental education exhibition to young people in Malaysia to promote the recycling of sewage sludge and treated effluent. In Malaysia, we are running out of landfill space to accommodate sewage sludge. But we also have the technology to treat sewage so that the end products are safe to reuse: sewage sludge has massive potential as a fertilizer for both food and non-food crops, particularly in oil-palm plantations. It can also be formed into bricks and used as a building material.

Currently, Malaysia pays little for its water, so we tend to waste our tap water, sourced from reservoirs and groundwater. Using treated effluent – wastewater that has been processed to remove pathogens and pollutants such as heavy metals – for gardening and landscaping helps conserve tap water supplies.

The main problem is that the public thinks that sewage products are dirty; that they're unsafe. But research shows that they're not. Ironically, Malaysian farmers tend to use a much more hazardous fertilizer, a mixture of peat soil and chicken dung, which harbours *E. coli*, salmonella and other dangerous bacteria.

I begin my presentation by stressing the importance of environmental conservation (if I advertised it as about sewage no one would come), then present the biosafety and reuse aspects of treated sewage products. So far, I've managed to complete 12 campaigns in all the residential dormitories in my school. My interactive exhibition fits into two or three cars, so can be taken on the road. I love nature, and don't want to see more of Malaysia's environment being destroyed for the sake of landfill. Instead, why not use – and save – what we already have?

The Green Team

T. Claudius/BIOSphoto/Still Pictures

Shalmali Tiwari, team Green Battle, India

Volvo Adventure 2011 finalist

In India, government-run schools in rural areas provide a midday meal, but students only eat a little and throw the rest away. In our village, food and agricultural waste used to be thrown directly into drains outside buildings, blocking them and causing pollution and disease.

At school, we learned about vermiculture as a solution for turning organic waste into fertilizer, and asked our municipal agricultural department about it. They came to train us, and offered us earthworms free of cost. So we dug three square pits, each measuring a cubic metre, lined them with pebbles, and added a mixture of matured cow dung and earthworms. We asked the food workers to throw food waste in, and organized other students to collect other village wastes.

The earthworms excrete castings, rich in nitrogen and phosphorous. We don't grow vegetables ourselves, but we use some of the worm castings at school in our flower beds, which are now green and beautiful. We also sell a lot to farmers and villagers, using the profits to buy things for school, such as fencing or gates.

This project has cleaned up our village; many villagers have even taken up vermicomposting in their own homes. And in the last three years, we have promoted the method to 26 schools.

Victoria Rogers and Michael Stevenson, Northern Ireland

Think Globally, Eat Locally, Volvo Adventure 2011 2nd prize winner

Our project, Think Globally, Eat Locally, at East Belfast's Grosvenor Grammar School, encourages people to lower their carbon footprint by growing our own vegetables. Inspired by our biology teachers, we decided to establish an active vegetable garden to grow produce for school departments, like science and home economics, and to supply our canteen with local, in-season ingredients.

As part of an earlier waste reduction initiative, we'd already been making our own vermiculture compost from organic waste generated at school, collecting it from small green bins in the staff room and in the home economics classroom. Using this compost, we'd grown some vegetables for our biology labs – including giant pak choi to feed our lizard! Then two things fell into place. First, our new school site was under construction nearby, making it easy to request space for a proper garden. The builders even helped us set up the 12 raised beds we needed, made of recycled plastic. Second, we'd won £500 (about $800) in another environmental competition, which funded the purchase of soil and seeds.

We decided to plant vegetables such as carrots, potatoes, onions, beetroot and spinach that would be harvestable before the summer holidays begin, as well as herbs. The canteen staff are particularly keen to try new recipes when using our produce. Teachers ask about the herbs and how to grow certain vegetables, while pupils ask how to cook certain foods. The garden brings the community together.

Next we helped the nearby primary school to start their own veg patch. We wanted to give each child something to take home, so we made grow bags from recycled fabric, each containing seeds of an easy-to-grow vegetable, instructions and identification tags.

It's been a success so far, and we hope to expand, running workshops for our community and other interested schools.

Think Globally, Eat Locally

In defence of Spain

Central defender Carlos Marchena, who currently plays for Villarreal CF and Spain, has won almost every honour football has to offer. FIFA U-20 World Cup (1999), a silver medal at the 2000 Olympics; the Spanish League (2001-02 and 2003-04), the Copa del Rey (2007-08), the UEFA Cup (2003-04) and the UEFA Super Cup (2004), all with Valencia CF; and the UEFA European Football Championship (2008) and the FIFA World Cup (2010) for Spain. At the end of 2010 he played his 50th consecutive undefeated international match – a record. Earlier this year, he was also named Drylands Ambassador to the United Nations Convention to Combat Desertification (UNCCD). TUNZA managed to catch up with Carlos in between his international duties and pre-season training.

TUNZA: You have been amazingly successful as a footballer, winning almost every honour worldwide, in Europe and in Spain. Have you always also had an interest in the environment?
CM: Being a footballer is a profession that needs full-time dedication, leaving very little free time. But I have appreciated nature since I was a boy and have always been interested in its cycles and the delicate balance that supports the environment.

TUNZA: You come from Andalusia in southern Spain and grew up near the Coto Doñana National Park. Did your early life give you an affinity with the natural world?
CM: I come from Las Cabezas de San Juan, a town near Seville. Spain in general, but Andalusia in particular, is suffering from the effects of desertification. Much of Las Cabezas' economy is sustained by cotton, vegetables and cereal farming; in fact, my father used to grow cotton and wheat. So the well-being of Andalusian families like mine is closely related to the state of the soil. If the soil is degraded, the economy of the people in my town – like that of all inhabitants of drylands – is at risk. In fact, for some time now, the number of farmers in the area has been falling.

TUNZA: The history of Andalusia is one of great agricultural production thanks to careful water management, initially by the Moors. Did that, too, give you a particular understanding of drylands?
CM: Drylands set the scene for my childhood and adolescence. And it was a wonderful setting. I was with people who worked and lived on the land. I do remember problems with drought and years of poor productivity – we have always suffered from water shortages, especially in the summer. I remember a big tanker coming to deliver water to all the families...

But over the years I have learned that drylands aren't necessarily negative. They create the most beautiful landscapes and a very pleasant climate. But almost half of Andalusia is arable, so conservation depends on its good management. And thanks to many thousand-year-old soil management techniques – including those introduced by the Moors, now known as traditional knowledge – it is possible for us to enjoy this land and its wonderful ecosystems and work it in a sustainable way, without degrading it.

TUNZA: Could you tell us about your concerns about desertification?
CM: My profession has allowed me to travel all over the globe and visit wonderful places, including very different ones from those of my childhood. I was shocked to find that so many of the countries suffering from poverty also suffer from desertification, but then I learned that this is no coincidence – most of the world's dryland populations are in developing countries. I also realized that many of these countries

are far worse off than we are in Spain. I don't mean to say that desertification is not a serious problem for us: 35 per cent of Spain is at risk of desertification and this increases to 75 per cent if you consider the characteristics of our climate. However, there are various techniques to combat desertification that also help to reduce poverty. I am firmly convinced that, united, we can transform our concerns into specific action to reverse the processes of soil degradation.

TUNZA: Do you feel that desertification is really about climate change, or have other factors had a major influence?
CM: The effects of climate change on drylands are complex and its impact uncertain. Desertification is a phenomenon involving water shortage and soil degradation. Productivity suffers, reducing people's capacity to live off the land and increasing the levels of poverty. This leads to overexploitation of resources and the forced migration of at least some of the people. Though it is true that desertification is a response to a combination of natural factors (exacerbated by climate change), it is also a response to human factors, such as forest fires, poor agricultural methods, rural exodus or the unsustainable exploitation of water resources.

And the relationship between climate change and desertification is not just one-way. The soil can act as a powerful instrument to fight climate change. About 20 per cent of the carbon dioxide produced by humans is captured by the soil. Conversely, erosion reduces the soil's capacity to sequester carbon and actually emits it to the atmosphere.

TUNZA: Do you think that desertification will become a big issue for your homeland and its people?
CM: Economic development and the industrialization of Spain during the second half of the last century happened so fast that the environment has been destabilized. The fight against desertification now requires decisive action by the public sector. If measures such as early warning and monitoring are to be effective, the issue must be prioritized both on the world agenda and as a matter of public awareness, working closely with those who actually use the land. Much has already been achieved, both at institutional and scientific levels, but there is still much to be done. Spain plays a vital role in the UNCCD, for which I am an Ambassador.

TUNZA: How can we all help? Do you have a particular message for our readers, the youth of the world?
CM: I think a good start would be to realize that desertification is a serious problem, a sign of unsustainable land management. People who are aware of the enormous value of the soil, who sustain and nurture it, can promote initiatives to preserve it, and can raise people's awareness that preserving the soil means preserving their future. Responsible consumption is an important part of this. I would also like to see policy makers take full account of collective opinion. In fact, only if we remain united and are aware of the causes of desertification will we be able to reverse the process.

Desertification has far-reaching consequences; it is a global problem affecting all countries without exception. The young people of the world not only have a vital role to play – they are the key to the future.


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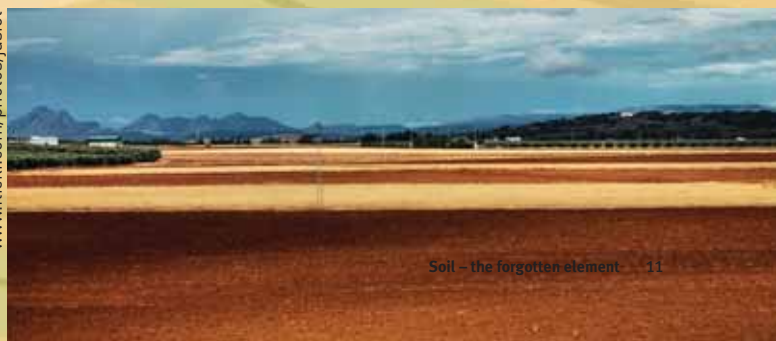
UNCCD


Jörg Bandell


UNCCD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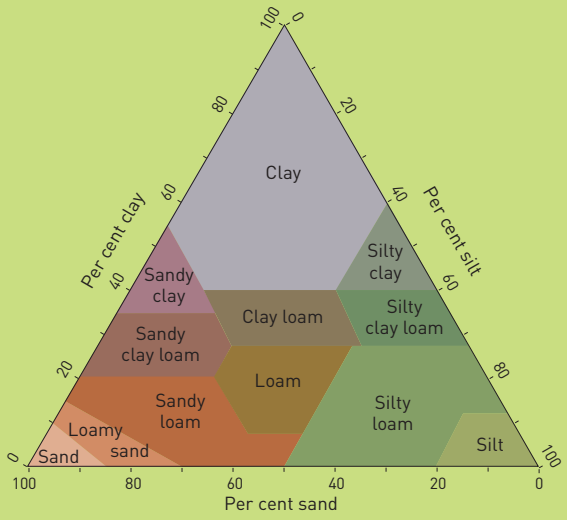
Earth: the living layer

Most of the land surface of the planet is covered in a layer of soil – ranging from only a few centimetres to several metres thick. It is made up of inorganic matter (mineral and rock particles), organic matter (decaying plants and animals), living organisms, many of which are microscopic, and air and water.

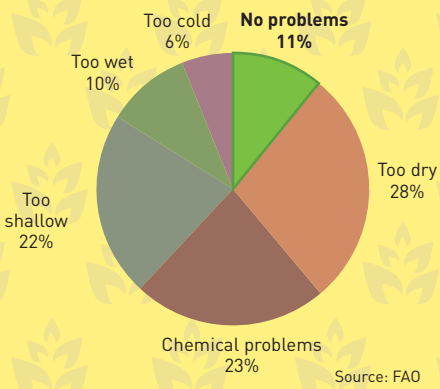
Soil forms as parent rock (bedrock) crumbles over time, and air and water get between the particles, causing further chemical and physical changes. Plants then take root, binding the soil particles together, attracting animals and organisms like moulds and fungi, and protecting the soil from being blown or washed away. Soil texture depends on the size of the particles that make it up, ranging from very coarse sandy soils which are highly aerated and drain quickly, through silty soils to very fine clay, which drains poorly and can rapidly become waterlogged. A loamy soil – including particles of all sizes – is best for growing plants.

Soil textures



Source: FAO/CUP

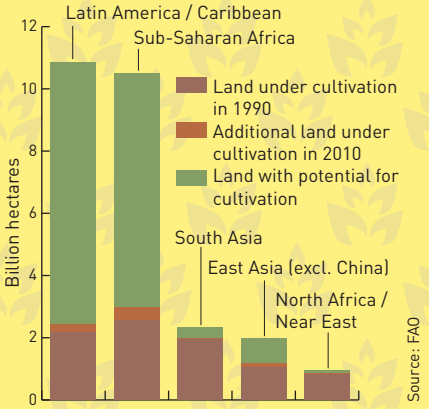
The suitability of soil for agriculture
% of total land area



Source: FAO

Soils vary in their fertility and ability to hold water and nutrients in the right amounts for agriculture. According to the FAO, only 11 per cent of the world's land area has soil that can be farmed without need for improvement. The rest is too wet, too dry, too shallow, too cold or chemically unsuitable, or just too steep. Most of the land that is best suited for agriculture is in the northern hemisphere – North America, Europe, Russia and China. Worldwide, only about a third of all potentially cultivable land is in use, but this proportion varies from region to region.

Cultivated areas and land reserves in the developing world



Land suitability for cultivation

Source: FAO

Soil degradation

In regions where there is plenty of moisture and organic matter – such as prairies – a few centimetres of soil can form in 50 years; in cold or dry regions it can take thousands of years. But it takes very little time for it to become degraded. Erosion – by wind or water – is by far the commonest cause of soil loss, and is most likely to occur where there is no vegetation to hold the soil in place. Clearing forests, overgrazing, cultivating crops on steep slopes, or in very large fields with no windbreaks, can all lead to erosion. This has a severe impact on the role of soil in ecosystem health, such as its ability to act as a filter for pollutants, its role in the hydrological and nitrogen cycles, its carbon storage capacity and its ability to provide a habitat for biodiversity.

Even the richest soil rapidly loses nutrients when it is put to work for food production. Traditionally, land was kept healthy through the addition of organic fertilizers like animal manure and plant waste, which both supplied nutrients and maintained the soil structure. With intensified farming in the 20th century, people increasingly turned to mineral fertilizers to improve crop yields. Used in the correct quantities alongside careful maintenance of soil structure, such fertilizers contribute greatly to food production without harming the soil. Their overuse, however, and the attendant problems of contaminated waterways, exhausted land and soil erosion, has led in recent decades to a resurgence of interest in traditional organic farming methods.

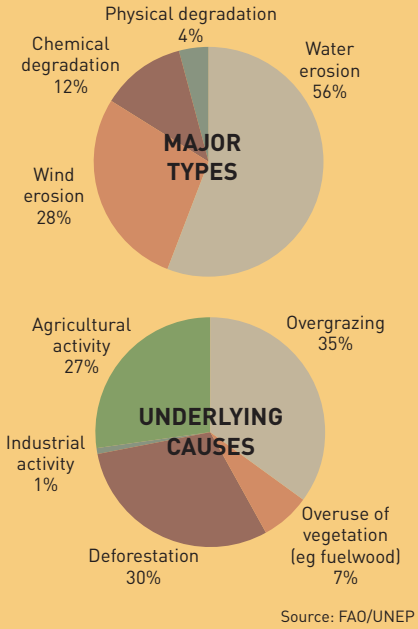
In many regions of the world, the problems that emerged with the intensive use of chemical fertilizers have been compounded by poorly managed irrigation. Irrigated cropland is far more productive than rain-fed cropland, and accounts for more than a third of the food we produce. In China, for example, more than 40 per cent of arable land is irrigated. However, irrigation combined with poor drainage can lead to a build-up of salts in the soil that renders it unproductive, and many hundreds of thousands of hectares of arable land are lost to waterlogging and salinity every year.

Looking after what we have

It might seem as though we have vast untapped soil resources for crop production, but most of the land that is not currently cultivated is either forests or wetlands, which provide other valuable ecosystem services; is set aside for other uses, including conservation; or would require massive inputs to become productive. So it's vital that our cultivated land is properly looked after. Much can be done.

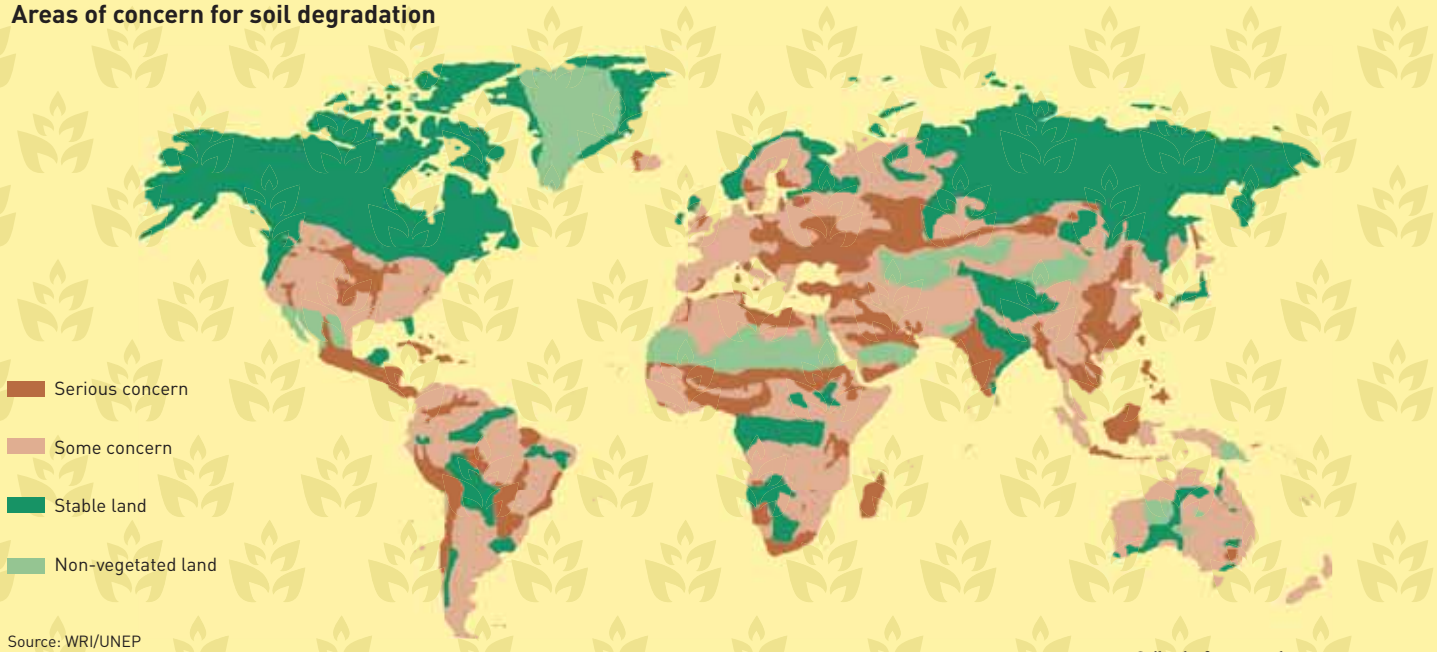
Ploughing around the contours of hills (instead of vertically) prevents heavy rainfall from washing away soil, as does the maintenance of wooded areas that hold the rain and reduce surface water runoff. The planting of windbreaks and building of embankments also prevent wind erosion. Increasingly, attention is also turning not just to keeping the soil where it is, but to maintaining its biochemical balance. This means taking an integrated approach to farm productivity and biological diversity. It means understanding soil-plant-water requirements and suiting the type of crop to the type of soil and the local climate. It means maintaining wooded areas adjacent to croplands, and it means rotating crops and restricting grazing animals so that land has time to recover.

Major types and causes of soil degradation



Source: FAO/UNEP

Areas of concern for soil degradation



Source: WRI/UNEP

Black soil, black gold

The world is getting warmer and drier, and soils less fertile as populations grow. What if we could improve soil productivity to feed more people, sequester carbon AND protect the atmosphere from more greenhouse gas emissions? The answer may be in biochar, the secret treasure that has lain hidden in the Amazon's ancient *terra preta*, or black earth, for thousands of years.

M. Steinmetz/VISUM/Still Pictures

Map source: www.gerhardbechtold.com

The discovery of black gold

For hundreds of years, explorers scoured the central Amazon rainforest for signs of an ancient civilization known as El Dorado, a legendary kingdom of gold. One Spanish explorer, Francisco de Orellana, crossed the Amazon river in 1540 and reported densely populated stretches of complex societies along its banks, enjoying land as fertile as Spain's. But subsequent explorers found no sign of these settlements. This seemed to make sense: the existence of such a civilization defied logic, as the Amazon's soils are well known to be too poor for the intensive agriculture needed to sustain large populations.

But in August 2002, a group of archaeologists who set out to find El Dorado did find signs of civilization in the Llanos de Mojo at the edge of the rainforest, in Bolivia. Dense islands of forest dotted the area, and within these strange forest islands were mounds, some up to 18 metres high, full of domestic implements, bones and large urns, suggesting these forests were human settlements. They then found fields raised to protect crops from yearly flooding while taking advantage of water as natural irrigation. These fields were big enough to grow crops – including cotton, dye and staple foods like maize – for thousands of people, a sure sign of civilization.

But how had so many managed to settle in a place where soil was so infertile? Digging in gave the answer. Wherever greenery was lush, the earth beneath it was black: soil mixed with partially burned organic material called biochar. It is likely that these earlier inhabitants discovered biochar by accident, leaving organic waste to burn with other wastes in smouldering fires. Despite being abandoned for thousands of years, the earth here was still fertile and moist, and producing lush vegetation in the midst of an infertile rainforest.

What is biochar, and what does it do?

Biochar is formed by heating biomass such as wood, animal dung, leaves, bone or any other organic material in a low-heat (about 500°C), low-oxygen environment so that it burns but does not combust, a process called pyrolysis. Charcoal – biochar made from wood – is the best-known example.

It has long been known that ashes can help improve soil: many traditional farmers use slash-and-burn techniques to prepare fields for tilling, for example. And Japan has a tradition of amending soil with charcoal. But it wasn't until the *terra preta* discovery that scientists began to realize that biochar had so many startling and potentially far-reaching benefits.

First, biochar helps retain vital plant nutrients such as nitrogen, phosphorous, calcium and sulphur in the soil, much decreasing the need for fertilizers. Second, it absorbs and holds water, releasing it into the soil slowly. It provides a habitat for the microbes that live in soil and help plants grow. And because microbes live and die within the material, it helps increase its carbon content, allowing the biochar to regenerate itself. Biochar also helps raise soil pH, making it less acid and more alkaline. Besides increasing the availability of nutrients to plants, this guards against aluminium toxicity in the soil, which, while natural in clay-based soils in particular, inhibits plant growth and therefore limits crop production. Scientists have documented, in some cases, an 800 per cent increase in yield when soil is amended with biochar and other organic material.

Carbon sink

As if that weren't enough, biochar sequesters carbon. While slash-and-burn combusts organic material, releasing all the carbon into the air, pyrolysis fixes carbon in the biochar, where it remains inert for thousands of years. Biochar mixed into soil also helps it retain methane and nitrous oxide emissions, rather than letting them escape into the atmosphere.

This has great implications for closing carbon loops. If we were to make biochar from industrial by-products – including from forestry, agriculture and livestock, for example – we'd recycle material that would otherwise go to landfill where it would produce methane, or be incinerated, which is energy-intensive and produces emissions. At a smaller scale, scientists have calculated that if farmers who practise slash-and-burn instead prepare fields with slash-and-char, which requires a slow burn under a layer of straw and soil rather than an open fire, overall human carbon emissions would be reduced by up to 12 per cent.

The heat generated by creating biochar can be used for energy, making feedstocks do double duty as

Christoph Steiner/www.biochar.org

E. Parker/OSF/SpecialistStock

Christoph Steiner/www.biochar.org

biofuel. Even small households could create biochar by replacing traditional cooking stoves (which often emit harmful pollutants into homes) with pyrolysis-based stoves, which would provide heat for cooking as well as processing agricultural residues into biochar for gardening.

So what's the catch?

With all these benefits, it's no surprise that, when word about biochar first spread, it was hailed as a silver bullet to save the world from carbon emissions. But as with any solution, many questions need to be asked. First, where will the biomass needed to create enough biochar to fertilize fields and sequester substantial amounts of carbon come from? While agricultural and other organic waste is plentiful, it can be expensive and fuel-intensive to get it to processing facilities, and from there to fields. Systems must be worked out to distribute the biochar into fields, as well. Data on the effects of biochar on the field are still being gathered, and more needs to be done before implementation on an industrial scale. Research includes interactions between biochar, soil conditions, soil biodiversity and crops; the effects of various kinds of biochar feedstock and production methods; and distribution rates and methods.

But if we can really find a way to store carbon in soil for centuries while making nutrient-poor soils fertile, reduce the need for polluting fertilizers, conserve water and prevent desertification, this ancient technique may prove to be part of the solution to 21st-century problems!

A guide to composting

Making compost is a way of recycling organic waste into a nutrient-rich mixture that can be used to fertilize and improve soils the natural way. It replaces the need for synthetic fertilizers – saving you money and keeping synthetics out of your garden – and improves the soil structure naturally, encouraging microbes, worms and other soil fauna to live there.

Composting helps keep greenhouse gases out of the atmosphere: when compostable material is thrown into landfill it takes up space and, as the organic material decomposes, produces methane, a powerful greenhouse gas.

Making your own rather than using commercial peat-based composts also helps preserve peat bogs. These are rare habitats that are being harvested faster than they can regenerate. In addition, the bogs release carbon dioxide into the atmosphere when the peat is harvested.

Continued overleaf →

Gui Dan/www.flickr.com/people/42526397@N00

The wonder of Earth's worms

Known for his famous work *On the Origin of Species*, Charles Darwin's name may be most synonymous with gallant sea farers, giant tortoises or the beaks of finches. However, in 1881, the final book published by Darwin brought together over 40 years of research on one of his most loved and studied organisms – the earthworm. In *The Formation of Vegetable Mould through the Action of Worms with Observations on Their Habits*, published shortly before his death, Darwin's fascination for earthworms resulted in the first academic work to recognize the massive importance of these soil-dwelling creatures.

Earthworms (of which there are around 6,000 species worldwide, including the common earthworm, *Lumbricus terrestris*), provide a rich food source for many birds and other animals, forming a key component of food webs. Another essential role for these amazing annelids is the aeration, mixing and sediment reworking of soil – a process called 'bioturbation', which alters the physical and chemical nature of the soil. Their movement and formation of burrows churns up sediments, making them and their nutritious contents more accessible to plant roots and other soil-dwelling creatures, as well as enabling the percolation of water through soil.

Earthworms also increase soil fertility by pulling dead organic matter such as leaves into their burrows, digesting it and excreting worm castes, which are concentrated with nutrients. Castes may be up to 40 per cent richer in humus and five times richer in nitrogen than the upper 10 centimetres of top soil, as well as more abundant in many other minerals and chemicals released by the digestion of plant and animal matter. In good conditions, a single worm may produce around 4.5 kilos of castes a year, and it is estimated that there may be up to 432 worms per square

Continued from previous page

Can everyone compost?

Anyone with organic waste and some space can compost. There are many different methods so there is probably a solution that could suit you, as even small amounts of compost can be used to grow vegetables, herbs or flowers in a patio garden, on a balcony or in a window box.

How does it work?

Composting is simply the breaking down of organic material with the help of microbes, worms, fungi and insects, which turn it into a nutrient-rich plant growing medium. The basic compost heap starts with scraps of organic material of different sorts. Here are a few of the basics to get you started.

- Tough or woody plant materials – shrub and hedge trimmings, straw, shredded newspaper and bits of cardboard such as toilet rolls – that are slow to break down are called browns. They contain a lot of carbon. These should be shredded to small pieces to help encourage breakdown.
- Greens – things like vegetable and fruit scraps, grass, leaves, weeds, dead flowers and so on – are full of nitrogen and help rot down material quickly.
- What you *don't* want in this kind of heap is cooked food, dairy products or meat, which can attract pests, or packaging of any kind that won't decompose, such as plastics.

Containers for composting vary. They can be above-ground heaps covered with a tarpaulin, cardboard or a layer of newspaper to keep excess water out, mesh containers, bins with lids or below-ground pits. Most importantly, the bottom should be open and directly on the earth so that soil fauna can make their way into the waste.

Cool composting

For cool composting, simply pile and mix your organic materials into a heap or in a bin, and carry on adding more material to the top. When you run out of space, stop, and let it sit. Naturally occurring bacteria in your organic material will have started the decomposition process. It usually takes about a year to get compost from this low-maintenance process. In the end, you'll find brown crumbly compost in the bottom layers, which can be used in the garden. If there is still material that hasn't broken down, give it a stir, add moisture or dry material as needed, and leave it to mature.

Hot composting

If you've got more time to spend tending your heap, hot composting will get you results faster. The bacteria need air and water along with the food, so you'll need to keep the heap moist and aerated: adding water, grass cuttings, or vegetable waste when needed, or woody matter if it gets too wet, and stirring often. Keeping a lid on the bin or plastic sheeting over your heap will keep the compost at a high enough temperature to encourage bacteria, which eat the sugars and nitrogen in the fresh

D. Kurmaic

metre of soil – that's 432 million per hectare! It is therefore clear that these animals are major contributors to the chemical content and biological health of soil systems. Agriculturalists would do well to remember this, and should encourage conditions that favour earthworm multiplication and survival.

Darwin was the first person to theorize that earthworms play such valuable roles. By setting up experiments lasting 20-30 years, painstakingly measuring the natural movement and sinking of stones and stationary objects into the soil, he was also the first to realize that worms are at the heart of much environmental re-landscaping. He found 2,000-year-old Roman artefacts completely buried by castings and showed that worms could bury objects in some areas at a rate of 22 centimetres per decade.

Darwin stated of these creatures: 'It may be doubted whether there are many other animals which have played so important a part in the history of the world.' This view is shared by modern-day scientists such as James Lovelock, originator of the Gaia hypothesis, who suggests that the work required to keep the entire living planet system healthy 'is done for the most part by the denizens of the soil, the microorganisms, the fungi, the worms, slime moulds and the trees'.

Earthworms, as an essential part of the system, are crucial to the life and health of our planet's soils. Thus, they are crucial to the life and health of our planet's terrestrial ecosystems, a role that, as Darwin first realized, more than deserves our respect and gratitude.

By Luke Roberts, who is studying molecular and cellular biology at Imperial College, London.

organic material, generating heat. The more you stir your heap, the more these aerobic microbes will continue with their work, and the faster you'll have compost. Fungi, worms and insects will be attracted to your heap and will help break matter down further. When the heap starts to cool down – typically within two to three weeks – you'll have great compost.

With either method, in the end, you'll have dark brown, crumbly, earthy smelling material. This is best left for two months to mature before it's used.

Vermiculture

If you mainly have food scraps – vegetable scraps, egg shells, meat scraps and so on, wormeries are a good bet. Worms eat the food and process it, along with ingested soil, into a fine, mineral-rich compost called castings. Actually, these castings are so rich that you must mix them with normal soil before you use them for planting.

It's easy to make your own wormery out of a wide and shallow plastic box. Just poke holes in the bottom to allow more air in, then line it with shredded paper or leaves, lightly moistened, and add some soil and leaves to give the worms grit and bacteria.

Check with your local nursery for the best worms to use in your area – red wriggler earthworms (*Eisenia foetida*) are a popular choice; you'll need about 1,000 to get started if you are going to provide a decent amount of castings.

Now you can start feeding your worms with scraps, and sifting out the compost – actually worm castings – as it's being produced. Small wormeries can easily be kept indoors.

Wormeries also come in fancy stacked plastic structures. Worms in the bottom of the structure eat the food, leaving compost behind, and work their way up the trays as you add scraps little by little. Empty the castings from the tray and put it on top to continue feeding. The worms also generate some liquid – worm leachate – which is an excellent soil fertilizer, but you need to dilute it before use.

It's fine to feed some cooked food and meat scraps to your worms, but don't add citrus, salt, garlic or onions, and don't use fish, dairy, grass clippings, or anything too fatty or otherwise indigestible.

Leaf litter

Leaf litter is the simplest method yet: if you can collect deciduous leaves in the autumn and have some space in your garden, it's easy to make good compost called leaf mould with very little effort. Simply fill a bin or make a pile of fallen leaves, and sprinkle them with water. Leave the pile to itself, and fungi will break down the leaves. In about a year they will have turned into a dark-brown crumbly mulch that can be spread across soil to retain moisture and keep out weeds, or can be added to potting compost.

With thanks to the Cambridge University Botanic Garden.

Gifts for the mighty mud

Jemima and John Griffiths chose to leave their slick city life in Bristol, UK, to live sustainably, off-grid in the foothills of the Estrela Mountains of central Portugal. It has been a steep learning curve for them, surrounded by chickens and pigs, getting water from the spring, and generating power with solar cells. Here Jemima talks about her growing feelings for the soil that sustains them.

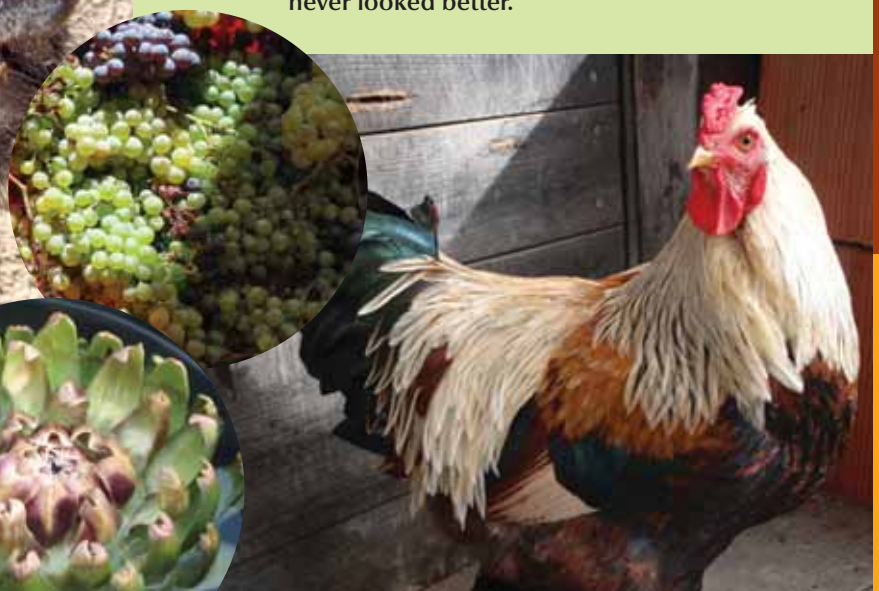
Last year I started a vegetable garden. I was a city girl with big ideas about self-sufficiency but little experience and no idea what I was getting myself into. But I soon became aware that my beloved plants seemed at their most content in dark crumbly soil that smelt rich and complicated. It might sound odd to describe mud as complicated. It's very easy to think of it as not much at all, but as I dug about I had a thought: soil is for us landlubbers (plants and animals alike), the ultimate source and destiny of life! Does that sound a bit mad? Let me explain.

The complicated part astounded me: in your average square metre of happy top soil there are likely to be thousands of different species and billions of tiny organisms playing a myriad of different roles. From bacteria to bugs the earth below our feet is a hive of activity, and these little creatures are busy making a meal of whatever reaches the ground – be it leaves falling or animals, large and small, dying. Quite literally, everything returns to the earth. I learned that this process of recycling matter builds a soil that nurtures what grows in it and, of course, what grows in it feeds us. Whenever you're out and about it's worth taking a minute to look beneath your feet and appreciate what's going on down there!

This led me to a feeling that we have a bit of a misconception in modern farming. There seems to be a desire to sanitize the soil – to rid it of all life: I suppose to leave a blank canvas for the crop we want to produce. The problem with this is that it's very difficult to replicate all those nutrients that a teeming underground life system will build. Artificial fertilizers may produce a bountiful harvest in the short term, but soil needs a varied diet, otherwise its quality is inevitably going to deplete over time. It seems to me that I should be supporting this complex ecosystem rather than battling with it.

I've learned to make as many offerings as I can to all those lovely organisms. Compost, manure from our pigs and ash from our stove contribute to the dark crumbly matter that my beans and tomatoes sink their roots into. It takes more effort to weed than to spray poisons, but there are ways around that. Soil organisms like to be covered in something and bare soil can quickly start to erode, so I thickly layer my garden with leaves raked up in the autumn. This 'mulch' allows me to stop weeds germinating by keeping the sun off rogue seeds that have wandered onto my soil. All my gifts, along with those leaves, eventually get dragged down by the earthworms to contribute to the feast! By working with nature rather than against it, I've found my plants have never looked better.

Photos: J. Griffiths



CHOICES

A rewarding experience

Allotments – small plots of around 250 square metres – have been a feature of European cities since the early days of industrialization. Typically, they are owned by municipalities, and rented for a small fee to city-dwellers who want to grow their own vegetables, fruits and flowers and raise chickens for eggs and meat. You might think that in today's industrialized world they were an outdated idea – far from it. TUNZA intern Emily Keal and her friend Lee Reid both spend time on the Reid family's allotment – and enjoy the fruits of their labour.

Chemical weedkillers and pesticides are in the armoury of the majority of farmers and land-owners fighting to keep pests and diseases at bay. But the solution to a problem can become a problem, which many feel is what's happened with food production today. There is an alternative, however, in the traditional allotments dotted around Britain. A look at the Reid's family allotment provides plenty of food for thought, and for the table! Everything from potatoes to melons is grown organically.

Norton, a small town in northeast England, is home to 160 allotments where people own chickens and grow their own fruit and vegetables. Dating back to the 1930s, these allotments provide a taste of old Britain with a new twist, as people seek to balance family budgets at a time of austerity by growing their own food. Other factors coming into play are to eat more healthily while helping the environment and avoiding the massively over-packaged products on supermarket shelves.

A virtuous circle is completed on the Reid's allotment by composting anything from leaves to teabags and even eggshells. Every year they rotate the crops using a different patch of ground to avoid pests and diseases and keep the best balance of nutrients in the soil. All the composted material is eventually returned to the soil to nurture it naturally for the next crop. As Steve Reid said, 'a lot of time and effort goes into the allotment, yet it's a very rewarding experience: everything we grow we eat'. Not only is their organically grown produce better for wildlife and the environment, it's also a lot healthier for the family!

With the current concerns about climate change, any reduction in the journeys taken by our food will reduce the effect we have on the environment. It has been estimated that the ingredients that make up the average family Christmas in the UK clock up about 77,000 kilometres, almost equivalent to twice round the world! These 'food kilometres' all contribute to our carbon footprint, so even growing some vegetables in the garden helps combat global warming. Vegetables produced by Steve and his wife Jane on their allotment only travel a short distance from plot to pot at their home, a matter of minutes away.

Mellowcat

Lucy Curtis →

Allotments are becoming more and more popular because of today's current climate, both environmentally and financially.

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Jackie Nilsson

If you're interested, follow the Reid's five basic principles for growing your own!

- **Soil preparation: digging and manuring.**
- **Weeding: removing weeds from soil.**
- **Composting: improving the soil by adding vegetable waste that has been broken down through natural processes.**
- **Sowing: placing seeds in soil and watering.**
- **Pricking out: transferring seedlings from the greenhouse to the plot when they are big enough.**

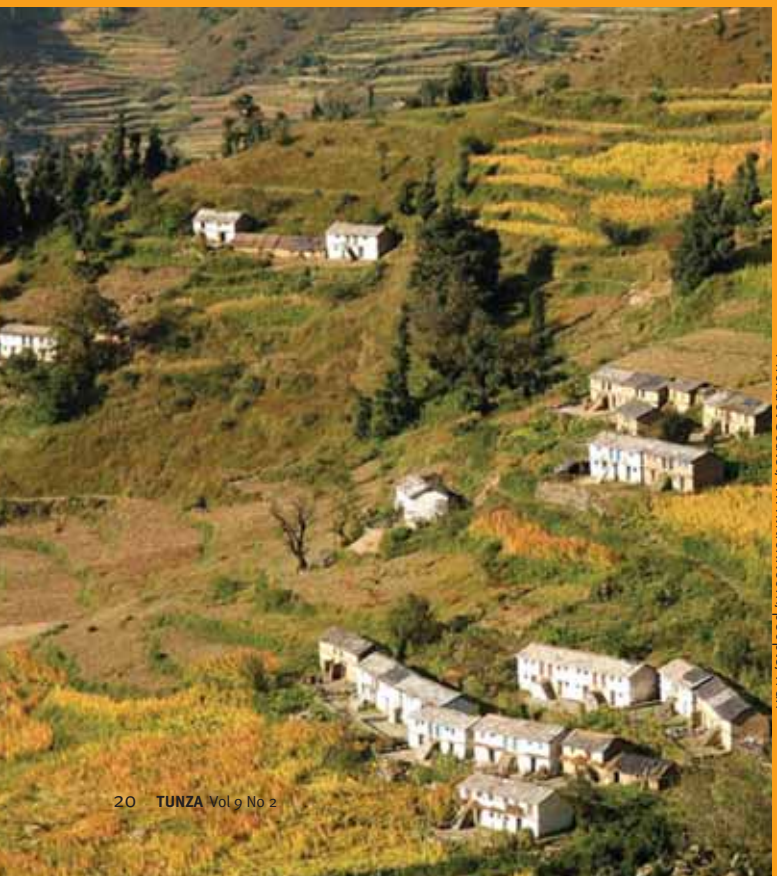
Enriching soils, enriching lives

Soil is a particularly important issue in mountainous areas – as topsoil can easily be washed away by rain. On common land, the challenge is to conserve soil so that forests and other vegetation can regenerate. On private land, the issue is to conserve soil and retain moisture for sustainable agriculture. TUNZA talks to V.K. Madhavan about his work to promote sustainable development in northern India.

African Renaissance

My organization, the Central Himalayan Rural Action Group (Chirag), works in around 200 villages in Uttarakhand, a state in northern India. We promote an integrated approach to development, focusing on such issues as health care, education, social forestry, soil, water conservation and especially sustainable agriculture. This may seem broad, but there's no silver bullet: we want to provide people with multiple opportunities to improve their lives.

On common lands, forests are an essential resource for these communities, who rely on them for fuel, fodder and leaf litter, which they use for animal bedding and compost. But they have been degraded over time due to excessive use and loss of a sense of community ownership. On a practical level, we help communities make contour trenches using mud, and plant fodder grasses in them. This provides people with an immediate incentive: within three months, the fodder is harvestable. After a year, communities see natural regeneration as soil and moisture levels improve – allowing trees, shrubs and other forest species to grow.



Michael Scalet/www.flickr.com/people/vran

In agriculture, the traditional method of composting in this region is to gather the leaf litter used for livestock bedding – which is soaked in animal waste – age it in mounds above the ground, and spread it on the fields. This compost is rich, but, unfortunately, it's not good enough. So to improve decomposition, we encourage farmers to do two things – make sure the compost is well aerated by stirring it; and prevent rainfall from getting into it. Both work better if the compost is in a pit rather than in an above-ground mound.

We also encourage the farmers to introduce effective microorganisms – a combination of beneficial yeasts, fungi and bacteria – into the compost. A start-up solution, which comes in one-litre bottles, is diluted and poured over new organic matter as this is layered on to the heaps. Over a period of time, the solution helps break down the compost enough to add worms, which further enrich the soil. The hope is that the microorganisms will also multiply in the fields, tilting the balance in favour of healthy soil microbes.

A third soil enhancer is *panch gavya*, a traditional method of soil improvement we've introduced from a different part of India, which involves using five things derived from cows. You mix together milk, clarified butter, yogurt, dung and cow urine in a pot, cover it in cloth and leave it for a few days. Once it starts to ferment, you dilute it with water and use it as a seed treatment or spray fertilizer, or for layering with compost.

All these organic methods have resulted in better yields and crop quality. The fact that we have 400 farmers using them on their own lands is testament to that!

Learning on the job

It all started in 2006, when Philip Wilkinson of the Wildlife and Environment Society of South Africa was working with the Department of Education in rural South Africa, introducing environmental studies into the curriculum. During long drives between schools, he and a colleague hit on an idea: sustainability commons, a place where communities could learn about sustainable technologies in a hands-on way. Schools, as places of learning and a community hub, were the perfect location.

Photos: African Renaissance

Rural schools in South Africa often lack municipal services such as reliable tap water, electricity or sanitation. All they receive is an annual sum from the Department of Education – often barely enough to cover costs – as well as basic food to provide the pupils with school lunches. Our idea, and then project, would serve three purposes: making a school as self-reliant as possible; educating the children and community about sustainable technologies; and proving to the municipality that sustainable technologies are implementable in rural South Africa. Any money saved would be reinvested in education.

We drew up a wish list of things that we would need to turn our idea into reality: wind and solar power, composting systems and a greenhouse, biogas digesters, and so on. Today, with the support of individuals, non-governmental organizations, the Chris Hani District Municipality and the Department of Education, these all exist at Three Crowns Junior School in the Eastern Cape, which has about 150 students.

Solar water heaters

Our solar water heaters are made of cheap black PVC piping normally used in irrigation lines and available almost everywhere. Recycled two-litre drinks bottles around the pipes add a layer of insulation and increase heating efficiency. The pupils use the hot water to wash their plates after lunch, and now we're building another heater to provide hot water to the kitchen.

Biological wastewater treatment

The wastewater from the biodigesters goes through a biological treatment facility to remove excess nutrients from the water that could have an impact on surface and groundwater quality. The algae grown in the system are used to feed the biodigester, or dried and applied as an organic fertilizer. We also plan to use this nutrient-rich water in a hydroponic system to grow plants and to raise fish.

Drip irrigation system

The pipes are made from recycled car tyres allowing water to soak directly into the ground, minimizing loss through evaporation.

Biogas

Two biodigesters produce gas by processing waste flushed from toilets, along with cattle manure and organic kitchen waste added three times a week. The gas is used to cook for the children – along with two solar cookers.

Worm farm

Our worms rapidly convert organic matter to vermicompost and worm leachate. Ten parts of water to one part of leachate is used to irrigate and fertilize. Leachate also serves as an insect repellent.

We brought in experts where needed – such as for establishing wind and solar energy, biogas and water treatment facilities – but on an everyday basis everything is built and run as part of the students' daily lives: they learn by doing. The kids grow vegetables, tend the worm farms, run solar cookers and help operate the biogas digesters, hot water heaters and irrigation system.

Based on this success, the project has spread to three more schools. Recently, our municipality budgeted nearly half a million dollars to roll out sustainable technologies in the community at large, which wouldn't have been possible without the participation of Three Crowns' students.

Here are a few of the technologies, from small-scale to advanced, that we are using at Three Crowns.

Greenhouse

The school built a greenhouse using two-litre drink bottles. This used up some plastic waste – there's no waste collection here. The school grows the seedlings, cuttings, shrubs and trees it needs here, and sells any extras to surrounding schools.

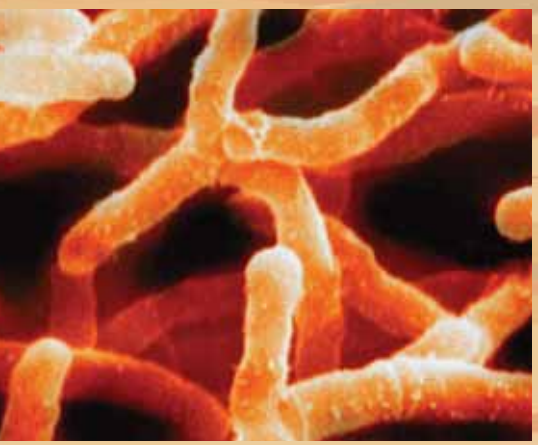
7 wonders of the soil

Acacia trees

In arid regions drought, overgrazing, intensive farming, mining and deforestation can turn once-fertile land into desert. One way to restore the soil is to plant trees, particularly those that 'fix' nitrogen by drawing it from the atmosphere and making it available to other plants. These trees are typically deep-rooted, helping to retain moisture in the soil, and also improve soil structure by providing leaf litter. Acacias are popular because they grow quickly and can thrive in harsh conditions. In Hawaii, *Acacia koa* establishes vegetation on overgrazed lands; in India, *Acacia nilotica* rehabilitates degraded saline soils; in Australia, *Acacia saligna* is re-greening sand-mining sites. The FAO's 2004 Acacia Project has already benefited 44 communities in six African nations by planting acacias in vulnerable farmland. The trees help restore soil fertility, provide fuelwood and fodder, shelter crops and are a source of gum Arabic, which is collected and sold to the food industry.

Mark A. Wilson

Actinomycetes

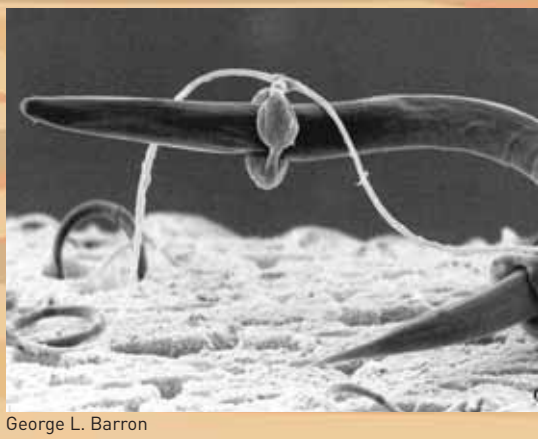


Graham Colm/en.wikipedia/CC

A spoonful of soil can contain as many as a billion bacteria. We often think of them as 'germs', but these single-celled organisms are crucial to soil and human health. Different kinds do different jobs. One important group, actinomycetes, is helpful in a multitude of ways: decomposers break down such tough materials as tree bark and are responsible for that freshly turned earth smell. *Frankia* sp., the nitrogen-fixing actinomycetes, work with nitrogen-fixing host plants to accumulate atmospheric nitrogen, which plants can't use in its gaseous form. This symbiosis allows the plants to thrive while building nitrogen-rich soil in which other plants can grow. And it was an actinomycete bacteria that provided us with streptomycin, the first-ever antibiotic remedy for tuberculosis, isolated by Dr Albert Shatz in 1943. We still use these bacteria today to produce antibiotics such as erythromycin and tetracycline, proving that our obsession for killing 'all known germs' with disinfectants may be somewhat misguided!

Nematodes

There are probably at least a million different species of nematode living everywhere from the surface of the soil to the roots of plants. These microscopic worms eat everything from fungi to bacteria to insects, larvae and plants, and live either independently or as parasites on host insects, plants and animals. They can consume 6.5 times their own weight daily, and along with earthworms are important in recycling organic matter into fertile soil and helping to distribute nutrients: both bacterial- and fungal-feeding nematodes release large amounts of nitrogen into the soil. Not all nematodes are welcome – the one that causes trichonosis in pigs can make us ill too, and plant-feeding nematodes can be devastating to crops. However, some insect-eating species are valued as natural pesticides, and nematodes in turn provide food for small insects and even for fungi. The fungus *Arthrobotrys anchonia*, for example, forms a constricting ring of cells that traps a nematode as it passes through!



George L. Barron

Dung beetles

Rafael Brix/GNU-FDL

The humble dung beetle relies almost exclusively on faeces, playing a crucial role in keeping the soil fertile and lowering levels of the greenhouse gas nitrous oxide. There are around 10,000 species of dung beetle, everywhere in the world except Antarctica, and ranging from 0.2 to 17 centimetres long. There are three types: rollers make balls of faeces, sometimes 50 times their own size, and roll them into burrows; tunnellers dig below the dung; while dwellers live and breed within it. In the process they fertilize and improve the soil: rollers and tunnellers drag and bury dung up to 60 centimetres underground, distributing nutrients, aerating soil and helping water to percolate through. This also sequesters carbon and reduces the nitrous oxide – a greenhouse gas over 300 times more powerful than carbon dioxide – emitted by manure. New Zealand plans to import and release 11 species of foreign dung beetle in order to manage livestock waste and reduce greenhouse gases.

Water bears

The tiny and incredibly hardy water bear is often found in the film of water in soils, but can survive anywhere – ocean sediments, below the Antarctic ice, in mosses, in boiling hot geothermal springs, even outer space. Also known as tardigrade or moss piglet, the water bear does resemble a bear, but has eight legs and is only about the size of a full stop. Its segmented body has a brain, a digestive system (it mainly feeds on plants or bacteria, though some are carnivorous) and sexual organs, and it is prey to nematodes, amoebas and other tardigrades. Scientists are studying the water bear's ability to enter a state of metabolic standstill – called cryptobiosis – in the face of environmental stressors such as lack of water or oxygen, low temperatures and radiation, sometimes for as long as 120 years. It may hold clues to the preservation of tissues, cells and vaccines without refrigeration.

http://tardigrade.acnatsci.org

Cellular slime moulds

Bruno/Columbus/Wikimedia CC

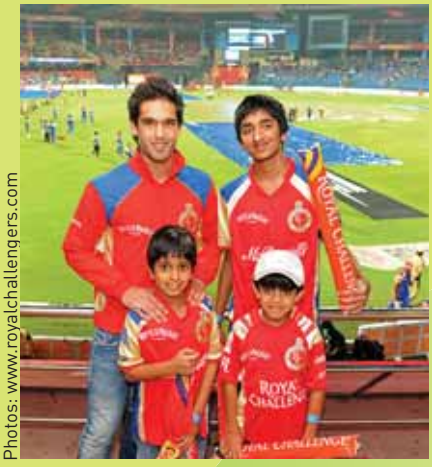
Neither plant nor animal nor fungus, *Dictyostelium discoideum* is a cellular slime mould, a microscopic amoeba that normally lives independently in the soil, eating decaying vegetation, fungi and bacteria, and helping to maintain the balance of microflora. What makes it fascinating is its ability to turn from a single-celled organism into a multi-cellular body: when there isn't enough food or temperatures become too low, the microscopic cells swarm together to form a single, slug-like – and often brightly coloured – blob. This blob moves towards warmth and light, sometimes harvesting bacteria from one place and carrying it to a more suitable location. When ready to reproduce, it shape-shifts into a plant-like structure with a stalk, which lifts a spore head high enough for spores to be scattered for germination. The slime mould's ability to live as both an individual and communal organism is of interest to biologists studying organ and tissue development.

Mycorrhizal fungi

Every handful of soil can host thousands of fungi species, of which there are at least a million. Best known for breaking down organic matter, fungi make nutrients available for other organisms. Among the most important are mycorrhizal fungi living in symbiosis with more than 90 per cent of the plants on Earth, surrounding and penetrating their roots. The fungi absorb sugars from the plants while spreading filaments further out into the soil than plant roots can reach, absorbing water and nutrients that they make available to the plant. We eat some of their fruiting bodies – chanterelles, truffles and porcini. Scientists recently found evidence that mycorrhizal fungi played a key role in enabling early land plants to green the Earth in the early Paleozoic era, more than 470 million years ago, thus shifting the atmospheric balance of the planet towards the oxygen-laden air on which life on Earth now depends.

Strobilomyces/GNU-FDL

TEAM SPIRIT



Photos: www.royalchallengers.com

In India, cricket is more than a game and can inspire people to take collective action. The Indian Premier League (IPL) team Royal Challengers of Bangalore understood this and reached out to its fans and the wider public with its Go Green initiative. When TUNZA spoke to RCB owner Sidhartha Mallya, we started by asking what lay behind the campaign.

'Climate change and global warming are the most critical issues facing humankind, and we at RCB believe we all must act now – not just at governmental and corporate levels, but all of us. Small actions and lifestyle changes by many people will add up and make a significant difference.

'RCB began Go Green in 2010 with a number of activities including car pooling for fans coming to matches, waste separation at stadium and its disposal through recycling and composting, collaboration with the Bangalore Metropolitan Transport Corporation for additional buses, and a carbon footprint calculator on the RCB website (http://www.royalchallengers.com/go-green). These actions helped reduce emissions, but RCB has decided to become the first carbon-neutral cricket team in the world.

'Our carbon neutrality won't be achieved by buying carbon credits that seemingly "wash away" emissions. We launched a unique fan-driven initiative through which RCB fans each make small environmentally friendly changes in their daily lives, and pledge their emission reductions to RCB. The RCB green team is not just the 11 players on the field, but includes more than 100,000 fans, each of whom is contributing in his or her own way. This is a democratic green campaign of the fans, for the fans and by the fans, and they are the real heroes.

'Our green campaign, which is guided by NextGen, an energy and environment consulting firm, has two basic aims: to raise awareness and to get people to make lifestyle changes. For example, our sapling initiative in schools, colleges and communities doesn't involve a mass planting. Rather we give saplings to individuals – students, teachers and others – to plant and tend. So far, 10,000 saplings have been planted across Karnataka State. Our objective is not just to plant trees and generate emission reductions, but to change people's mindsets.

'Similarly we don't just promote the use of energy-efficient light bulbs, we make them easily available at a 35 per cent discount. We also urge all RCB fans to travel by bus on Bus Days – the 4th of every month – as a symbol of commitment to sustainable public transport. And our solar water heater initiative, which emphasizes the need to use renewable energy, runs renewable-energy-themed contests on social networks and encourages RCB fans to use solar water heaters. So far, 338 have pledged their emission reductions from the use of solar water heaters.

'Personally, I've taken many of the green lessons learned with RCB back to my family business life. Our companies take great care managing and mitigating our environmental impacts through, for example, conserving water by recycling effluent and process water; using biomass, rice husk, in the boilers; and managing waste, achieving zero discharges at some plants. I strongly believe that for long-term success, economic growth needs to be environmentally responsible and sustainable.

'As global citizens it is our responsibility to ensure that, at an individual level, each one of us does our bit and takes steps to preserve the planet. Join us in our green initiatives. As we say, "RCB is Game for Green ... are you?"'