SOIL REGENERATION, CARBON STORAGE AND GARDENING by Bob Lawson

At the 2015 Paris Climate conference, the UK and most other countries signed up to the '4 in a 1000' initiative. The purpose of this initiative was to increase the soil carbon content by 4% per year.

How can we manage our plots and gardens to be productive, while improving soil structure, its water holding capacity and storage of carbon?

The soil contains a great variety of invertebrate animals, but since Darwin's time earthworms have been regarded as key organisms. They pull humus, compost etc which contains up to 8% carbon, into the soil and create burrows which help aeration and drainage and bring fertile soil to the surface. Two other vital types of organism are firstly bacteria which decompose the humus, releasing minerals for healthy plant growth, and secondly but less well known are mycorrhizal fungi. These fungi grow through the soil as fine hair like structures, the mycelium, which grow into the plant root structure and extend it many times over so reaching huge volumes of soil. They may also connect plants together. 90% of plants have these in their roots. The mycorrhiza grows using sugars that the roots release and the fungus mines the soil and can provide the plant with up to 80% of its nitrogen and 100% of its phosphorus as well as many micro-nutrients.

In healthy soils with added compost that normally has lowish carbon and nitrogen content, the mycorrhiza store carbon by making carbon containing polymers, with up to 40% carbon, that act as a sort of glue forming soil aggregates binding particles together. These stabilise the soil structure causing its crumbly nature and maintaining the fine spaces between the soil particles, so allowing water storage and greater circulation of air and minerals.

Intensive fertilizer led growing has increased yield hugely but with steep costs in environmental and soil damage such as lower worm and fungi populations and increased greenhouse gas emissions. Artificial fertilizers have also caused microbe genes to switch from using nitrogen in compost to using carbon compounds, so releasing it as the greenhouse gas CO2. They also destroy the porous nature of soil by narrowing the spaces so reducing its natural fertility, water holding capacity and productivity. This information was published in June 2020 by Rothamsted Research, based on 50 years of data with new research on soil structure and the genes of soil microbes. It can be read in full at http://bit.ly/3hkOATu

Suggested actions, based on this soil science. They are not original and could be added to.

1. Disturb the soil as little as possible, dig as little as you must. This causes less damage to soil structure, the mycorrhizal fungi, the earthworm count and enables soil microbes to fix carbon rather than release CO2 as the humus is decomposed.
2. Add compost to the surface. This is food for soil organisms, including worms, as they mix it in which improves soil structure, provides plant nutrients and helps store water.
3. Keep plants covering your soil as much as possible for as long as possible. This helps stop soil erosion, mineral leaching and soil compaction by heavy rain. It also makes more use of the plant's energy source, sunlight so there is more sugar to feed key mycorrhizal fungi.
4. Don't use peat, its extraction destroys a huge carbon and water store, and it seems wrong to use it when there are alternatives. As Timothy Walker a past Director of the 350-year-old Oxford Botanic Garden explained 'good plants were grown for centuries before the use of peat'.
5. Use a minimum of pesticides or artificial fertilizers which can harm pollinators, worms and other soil organisms as well as damage soil structure.

Feed the soil not just the plant/feed the soil and it will feed you. You will also improve the soils structure, increase its carbon content, so doing your bit towards limiting climate change.

SOIL REGENERATION / REGENERATIVE GARDENING by Bob Lawson

It has been estimated that 60- 70 % of soils in Europe are not in a healthy state. The NFU has reported that 10-15 % of our soils have no worms. This is for agricultural land, but gardens and allotments in total must cover a considerable area with many of the same problems.

Look after your soil microbes, fungi and invertebrates and your plants will thrive. Feed the soil not just the plant. You will also increase the soils carbon content, improve its structure and do your bit towards limiting climate change.

What you could do

These suggestions are based on scientific studies of soil. Of course, they are not original and other suggestions can be added:

1. Disturb the soil as little as possible, dig as little as you must.
2. Keep plants covering your soil as much as possible for as long as you can.
3. Add compost/humus to the soil surface whenever you can get it.
4. Try not to use pesticides or artificial fertilisers.
5. Plant seeds and annuals directly into the soil with a minimum of disturbance. In gardens try and use mixed plantings of perennials, shrubs and annuals, which means much of the soil is hardly disturbed.
6. Don't use peat.

Reasoning behind these suggestions:

1. Disturbing the soil to a minimum causes less damage to soil structure so it can hold more water and allow easier movement of soil nutrients and air. It also enables the soils microbes to fix carbon rather than release CO2 as humus is decomposed. Digging only when necessary e.g., Cropping potatoes, removing plant roots like cabbages and perennial weeds or just loosening crops like carrots, parsnips and leeks causes less soil damage AND on a personal level it helps ageing backs.
2. Keeping plant cover makes more use of the plant's energy source, sunlight, and releases sugars into the soil which feed the fungi that fix carbon compounds and help maintain soil structure. It also stops soil erosion, mineral leaching and soil compaction by heavy rain, which happens with bare soil.

   How can you increase plant cover?

   a. As one crop is harvested have a young replacement crop available.
   b. Multi cropping – grow quicker and slower growing crops together, or smaller areas of different crops.
   c. Or plants of different habits together e.g., Sweet corn with French beans.
   d. Grow crops interspersed with fruit bushes or trees or with pollinator or companion plants.
   e. Sow green manure.

   All these increase yield.
3. Adding compost is food for soil organisms, including worms, that incorporate it and improve soil structure as well as providing soil nutrients.

   As well as your own compost heap and well-rotted farm manure, sources are cut up plant material and non-harmful plant roots that will rot in the ground. Many plants do not resprout from the roots, cut them off at ground level and they add to the soil compost, without breaking up the soil structure. For example, non-seeding annual weeds, sweet corn, green manure and legume roots i.e., beans and peas also add organic nitrogen that has been fixed in root nodules.
4. Pesticides are very commonly non-selective, and many insecticides are artificial nerve poisons that can kill all invertebrates or in extremely low concentrations can affect insect behaviour. For example, neonicotinoids are accumulative in the soil i.e., are not biodegradable and increase in concentration year by year continuing to harm the soil ecosystem. Plants take them up in their roots and move them to their leaves and flowers where they are taken in by non-target insects e.g., bees, other pollinators and natural predators. They are now banned for outside use but can still be used on indoor grown plants.

   Artificial fertilisers damage soil structure by causing soil microbes to switch to using carbon compounds as their energy source so releasing CO2 rather than storing it and reversing the advantages of soil aggregates.
5. Perennials and shrubs, with small planting holes for annual or bedding plants or just surface disturbance for annual seeds cause minimum disturbance so maintaining soil structure.
6. Extraction of peat destroys a rare ecosystem which is a huge carbon and water store. In 2019 British horticulture used 2.9 million tons of peat which will decay and release large volumes of CO2 adding to global warming.

   It seems wrong to use peat just to make our gardening easier when there are alternatives. As Timothy Walker a past director of the 350-year-old Oxford Botanic Garden explained 'they managed to grow good plants for centuries before the use of peat'.