



SEVEN WAYS TO SAVE OUR SOILS



Introduction

The state of UK soils:

Our soils are degrading, and so, therefore, is the long-term ability for farmers to keep up food productionⁱ. Compaction and signs of surface run-off are visible in many fields, which can increase the risk of localised floodingⁱⁱ. Arable and horticultural soils are losing soil organic matterⁱⁱⁱ, a crucial component for farm health. Research suggests that while allotment holders are managing to secure soil health, farmers in the same area are losing soil nutrients and organic matter^{iv}.

Things need to change, and fast. All farmers and growers should have a common goal to protect, maintain and build their most vital asset - soil.

What is holding farmers back from looking after their own soils?

The problem is partly cultural. Farmers have come to see agro-chemicals as the main source of fertility and pest/disease control. This has led farmers not only to overlook the unintended consequences of agro-chemicals damaging soils, it has also diverted attention from soil health which should be at the heart of farm decision-making. The agrochemical industry has helped perpetuate this culture. It has also arguably diverted research from more innovative farming practices. In particular, there is an increasing realisation that soil life may be the key to crop productivity, but little research is being invested in this area and huge knowledge gaps remain – although new research is now being undertaken, for example by The James Hutton Institute on effective soil function⁷.

But it is more than just a cultural change that is needed. Many farmers are at the mercy of short-term leases and the pressure placed on them by their customers to compete with other global suppliers with lower overhead costs. As a consequence farmers are often forced to focus on the short-term. The result is short rotations, and high value but soil damaging crop systems with quick returns – this is not a way of farming that ensures future food production and healthy soils.

What about government soil policies?

Soil policies are not safe-guarding UK soils. In England, the recent changes to GAECs (Good Agriculture and Environment Conditions) will not prevent all damaging operations, let alone promote widespread positive management. For example, the requirement to maintain vegetative cover to protect soils over winter still allows maize stubble to count as adequate

soil cover, despite the clear evidence of soil damage linked to maize cultivation. Unless there is improved regulation, the UK government will not meet the target of all soils sustainably managed by 2030.

What action is needed?

Soil is a fundamental environmental resource and should be given the same level of protection as water and air. An EU Soil Directive would have helped achieve this, but for now at least, it is not on the table. So we believe the UK needs to act itself to save UK soils, while working constructively with EU partners to develop Europe-wide protection for our soils.

As a first step we believe this means committing to increasing soil organic matter levels. We present here our target for this and seven ways to achieving it.



Our target

The first target of the Soil Association's Soils Campaign is that we increase organic matter in UK arable and horticultural soils by 20% over the next 20 years. The UK government needs to commit to this target to restore UK soils to health.

How did we arrive at this target?

For years, scientists have known that there are simple steps farmers can take to increase soil organic matter. Organic farming practices achieve just that. A review of studies from all over the world demonstrates that organically managed soils have significantly higher levels of organic matter than those managed non-organically - in North-West Europe an average increase of 21%. While there have been only three studies in the UK, the differences found here for arable soil was 50%. The study also showed that these kinds of gains can be achieved even on farms which do not import organic matter from elsewhere; demonstrating that it is possible on a national scale^{vi}.

Meanwhile the best nationwide data available, the Countryside Survey, shows a different story for most of UK (non-organic) arable and horticultural farmland, with an ongoing downward trend apparent for soil organic matter levels^{vii}.

Reversing this decline in organic matter, and starting to increase it will be a challenge, but based on the experience of organic farming, our target for a 20% increase on existing levels in 20 years (so 1% a year) is realistic and sets out a great challenge to aim towards. Indeed, many farmers will be able to do better than this depending on their starting point and the available support.





What are the benefits of a 20% increase in soil organic matter (SOM)?

Increasing arable and horticultural soil organic matter levels by, on average, a fifth over 20 years would improve soil health considerably. It will lead to more fertile soils in the long-term and will provide a wealth of other benefits alongside. The benefits of an increase of a fifth in soil organic matter will depend on the existing levels, soil type and structure. The following are just approximate calculations to give an idea of the scale of benefits:

Water storage, floods and droughts

- Healthy soil reduces the risk of floods – storing as much as 3,750 tonnes of water per hectare, the equivalent of one and a half Olympic swimming pools^{vii}.
- For degrading UK arable soils which can contain as little as 1-2% soil organic matter in total, meeting our target (increasing these levels by a fifth in 20 years) would increase the water holding capacity by between 40-100 thousand litres per hectare or 4-10 litres per m².^{ix}.
- This means farmers can play a huge part in reducing the risk of localised flooding, at the same time as making their own farms more climate resilient – not only to floods, but also to droughts. This is vital considering that farmers are likely to face increasingly erratic weather in the future and increasing SOM may help reduce the annual variability in yields.

Water quality

- Healthy soil also protects underground water supplies by neutralising or filtering out potential pollutants. Increasing soil organic matter levels can improve this function^x.

Soil erosion

- Linked to this is the ability for healthy soil to reduce the risk of soil erosion. This occurs as increasing SOM levels reduce the amount of sediment and nutrients washed into rivers. Soil erosion by water has recently been highlighted as a major problem in Europe with the UK contributing 5% to Europe's total^{xi} despite occupying only 1% of Europe's land area. Research in Southwest England found farms had such poorly degraded soils that 4 out of 10 were visibly increasing surface run-off^{xii}.



Carbon sequestration

- Scientific debate continues on how much soil carbon can be sequestered through agriculture. It is likely to be considerable; the International Panel on Climate Change states that 89% of all agricultural emissions can be mitigated by improving soil carbon levels^{xiii}.
- An increase of 20% based on the UK average soil carbon density (using the best available data - the 2007 Countryside Survey) would suggest nearly 10 tonnes more soil carbon per hectare could be stored by 2035 – around 0.47 tonnes per hectare every year^{xiv}.
- This is a huge amount and estimates are likely to be more realistic if based on actual gains seen on farms. Organic farms in North-West Europe have on average around 20% more SOM than non-organic and demonstrate that meeting our target would result in major carbon gains. The recent meta-analysis found that organic farms (globally) store on average 0.27 to 0.45 tonnes more carbon in topsoil, per hectare per year^{xv}. Whilst carbon sequestration rates are known to decline in the long-term, these rates have been found to continue for at least 20 years - the most critical time for reducing emissions.
- Even if one takes the lower estimate of 0.27 tonnes more carbon stored in a hectare every year (the average sequestration rate found for zero-input organic farms), extrapolating this across the UK still



suggests that around 1.3Mt more carbon can be stored in UK arable and horticultural soils ever year^{xvi}. This is equivalent to the carbon sequestered annually by an area of forest three-quarters of the size of Wales, or to the emissions saved by taking nearly 1 million cars off the road^{xvii}. When you add the additional savings found in terms of reduced N₂O soil emissions and the increased methane uptake – as also found by a meta-analysis comparing organic and non-organic soils^{xviii} – the climate change mitigation potential of shifting arable and horticultural soils towards the standard seen on organic farms is even higher. It amounts to around 13% of current annual UK agricultural greenhouse gas emissions^{xix} – far exceeding the current target to reduce emissions by 6% by 2020^{xx}.

The Seven ways to save our soils

In order to meet the target for 20% more soil organic matter (SOM) in the next 20 years, we have set out seven key areas where we need action. Within each of these areas, there are a wide range of practical measures available to farmers. Given the pressures placed on farmers and land-owners; financial incentives and regulatory change, alongside changes in practice, will be needed.

We therefore propose both – practices and policies – that together could change the future of UK soils and safeguard future food production. Some of our suggestions may be more effective than others: some may be easier to implement. What is clear is that there is a wide range of opportunities available – and that currently, too few are being taken up.

1 Increase the amount of plant and animal matter going back onto fields

Soil organic matter is an essential element to healthy soils – achieving high levels is the key to soil health. Levels are low or declining on many UK farms - we urgently need to work together to reverse this trend by ensuring farms are recycling more plant and animal matter back into soils.

What practices are available to farmers?

- Learn about the additional benefits of animal manure and certified composts and use it in place of nitrogen based fertiliser wherever possible
- Bring livestock onto arable farm grass leys – utilise agri environment payments to fund grassland reversion.

What could government do to help?

- Commit to our target for 20% more soil organic matter in the next 20 years
- Stop subsidising practices that prevent this, such as planting maize without a protective cover crop (see our Runaway Maize report for more on maize and subsidised soil destruction.^{xxi})
- Increase farmer awareness about other additional benefits of farm yard manure and certified composts which increase its value above the value of its constituent parts.



2 Improve soil health monitoring across the UK

Analysing soils is an essential first step to support effective decision making on soil health, but some farmers neglect to do this routinely.

What practices are available to farmers?

- Undertake routine soil analysis and take appropriate remedial action
- Test and monitor soil organic matter levels. Definitely do this if you are an arable farmer as you may be most at risk. Apps include the 'SOCiT App' and 'Farm Crap App'

What could government do to help?

- Ensure growers and arable farmers monitor soil organic matter; make it part of cross-compliance that farmers have to monitor and report on SOM levels on a representative area of their farms. Inserting this data on Basic Payment Scheme (BPS) application forms could help avoid RPA cross-compliance visits.
- Reward farmers doing more to improve SOM above the baseline for their soil type so it becomes something which farmers aspire to improve. Rewards could be through earned recognition for cross compliance for eligibility for the new Basic Payment to farmers, or through Agri environment prescriptions.



3 Encourage soil organisms – both those that build up soil and those that release nutrients

The current focus on chemical inputs began at a time when we didn't yet understand the importance of soil life. We are now realising how important soil biology is to farming. We need to learn how best to support this life in order to improve our ability to cope with floods and droughts and improve crop productivity.

What practices are available to farmers?

- Increase your own understanding; find out about innovative farmers carrying out farm trials or even consider taking part yourself. If there is nothing local to you, get in touch with the Soil Association
- Consider the unintended consequences of agrochemicals before making decisions on their use and consider ploughing less to reduce the physical impact on soil life
- If nothing else, increasing soil organic matter, through the other ways listed in this document, can improve your important soil biology
- Furthermore, there is a huge lack of research on the importance of soil biology and how it can be improved to benefit farmers. Lobby the government to fill this gap

What could government do to help?

- Address the gaps in chemical testing regulations so that unintended consequences on soil life are known before deciding on new pesticide approvals.
- Invest in R&D on the role of soil biology in securing crop productivity and carbon and water storage – and into how this is impacted by different chemicals and fertilisers, singly and in combination.
- Fund R&D into farming practices required to optimise these benefits.



4 Cover up bare soil with continuous plant cover

You can't see healthy soil – it is covered by plants. Plant roots hold soils together, reducing erosion, and allowing air to penetrate in spaces around roots. Roots also encourage healthier soil communities through plant-fungal interactions. But benefits spread beyond the farm – huge gains can be seen in terms of biodiversity, carbon storage, flood and drought control, and water quality.

What practices are available to farmers?

- Bring vulnerable land into permanent grassland under Agri environment options/ Ecological Focus Areas
- Where appropriate use cover crops, green manures and under-sown crops, with the added benefit of improving soil fertility

What could government do to help?

- Encourage more permanent grassland and support longer temporary leys, particularly on vulnerable soils.
- Introduce strict measures for management under cross-compliance. For example: maize stubble must not be listed as providing adequate soil cover.
- Fund research to help farmers choose the right cover crop for the right situation and advice to ensure knowledge exchange.



5 Bring more trees onto farmland

What practices are available to farmers?

- Plant/ allow trees to grow on vulnerable, steep sided fields and rough grazing
- Increase your understanding on the value of trees – for example speak to the Woodland Trust, or in Scotland to the Woodland Trust Scotland or Forestry Commission Scotland

What could government do to help?

- Create confidence amongst farmers about the benefits of agroforestry – fund research to quantify the benefits (for livestock shelter, a windbreak for crops and to improve farm climate resilience)
- Confirm that investing in agro-forestry systems will NOT reduce eligibility for Basic Payment Scheme (BPS)^{xxii}
- Utilise the agroforestry measure in the EU Rural Development Regulation by creating an agri environment Countryside Stewardship option for agroforestry



6 Reduce soil compaction from machinery and livestock

Soil compaction is a major problem in the UK – it can lead to increased surface run-off as well as drought stress, fewer grazing days, poor root growth and reduced yields overall.

What practices are available to farmers?

- Do a routine visual assessment to identify levels of compaction on farm and take remedial action
- A range of alleviation practices are available to reduce compaction risk:
 - Use lighter machinery
 - Adopt Controlled Traffic Farming (arable farmers)
 - Use correct tyre pressure
 - Reduce the number of passes
 - Try out reduced-till/ no till farming
 - Avoid over-grazing
 - Avoid trafficking over and grazing wet land

What could government do to help?

- Raise awareness of the impact that compaction has on overall performance of crops/livestock and on how to avoid, identify and tackle soil compaction. Emphasis should be given to taking the correct action at the right time e.g. not when the soil is wet
- Strengthen measures designed to prevent soil compaction, needed to meet GAEC conditions. For example: make avoidance/treatment of compaction a GAEC standard in its own right (currently in England compaction only causes non-compliance if it causes soil erosion over more than 1ha (or a 20m strip along a watercourse).



7 Design crop rotations to improve soil health

The current fashion in farming for simple arable crop rotations, financial pressures and the increasing trend for short-term tenancies all put pressure on farmers to make short-term decisions. The result is a drop in UK food diversity, weeds which we can no longer control and soils which are being stripped of their nutrients and organic matter. To reverse this we need to ensure farmers are able to design diverse, long-term crop rotations that our soils need.

What practices are available to farmers?

- Many high value crops cannot be grown sustainably in a short rotation, such as potatoes and carrots. Design a longer crop rotation which avoids these problems. Focus on financial margins over the course of a whole rotation, not annual margins
- Carefully design your crop rotations with more crops varieties and longer gaps before going back to the same crop. Put more emphasis on crops that help protect soils and that build soil organic matter such as legume catch crops.
- Grow crops with different rooting depths to take advantage of the soil's varying nutrient profile
- Where possible include temporary leys in your rotation, used for grazing by livestock

What could government do to help?

- Introduce requirements on tenants and land owners to ensure soil health is not degraded during tenancies.
- Use BPS codes to promote longer and better rotations as part of GAECs. As an example this could be used to ensure maize / potatoes are grown no more than 1 year in 5 on the same field.
- Support mixed farming, for example by giving a scoring uplift to mixed farmers applying for middle tier agri environment agreements.
- Invest in R&D to investigate the impact of the increasing trend for short-term land rental and contract farming agreements on the long-term health of soils.





Support organic farming

Organic farms already practice all seven ways to save our soils. Given that our 20% target for soil organic matter uplift is largely based on the average difference between organic and non-organic farms, every farm we encourage to convert to organic production will be a huge boost in reaching this target. Support for organic should therefore be prioritised by all the governments in the UK through, for example: enhanced funding for organic production research; better knowledge transfer and better funding support for organic farming itself in recognition of the public goods organic farming provides. There should be a long-term aim to increase the proportion of organic farmland in the UK. While increases in UK organic farmland do need to be driven by the market, growth is potentially being curtailed at present by a lack of support for organic despite a growing demand for organic products.

Summary

- Urgent action is needed to address the state of UK soils. Current government policies are not enough.
- In particular, we need to commit to increasing soil organic matter levels in UK arable and horticultural soils – by at least 20% on existing levels in the next 20 years.
- This will have multiple far ranging benefits, and can be achieved if both farmers and the government address the following seven areas:
 1. Increase the amount of plant and animal matter going back onto fields
 2. Improve soil health monitoring across the UK
 3. Encourage soil organisms – both those that build up soil and those that release nutrients
 4. Cover up bare soil with continuous plant cover
 5. Bring more trees onto farmland
 6. Reduce soil compaction from machinery and livestock
 7. Design crop rotations to improve soil health
- Organic farms already practice all seven of these areas, with soil health being at the very heart of organic practices. Increased support for organic farming should therefore be a key part of the solution and will go some way to meeting our soil organic matter target.

Case study

Lower Smite Farm

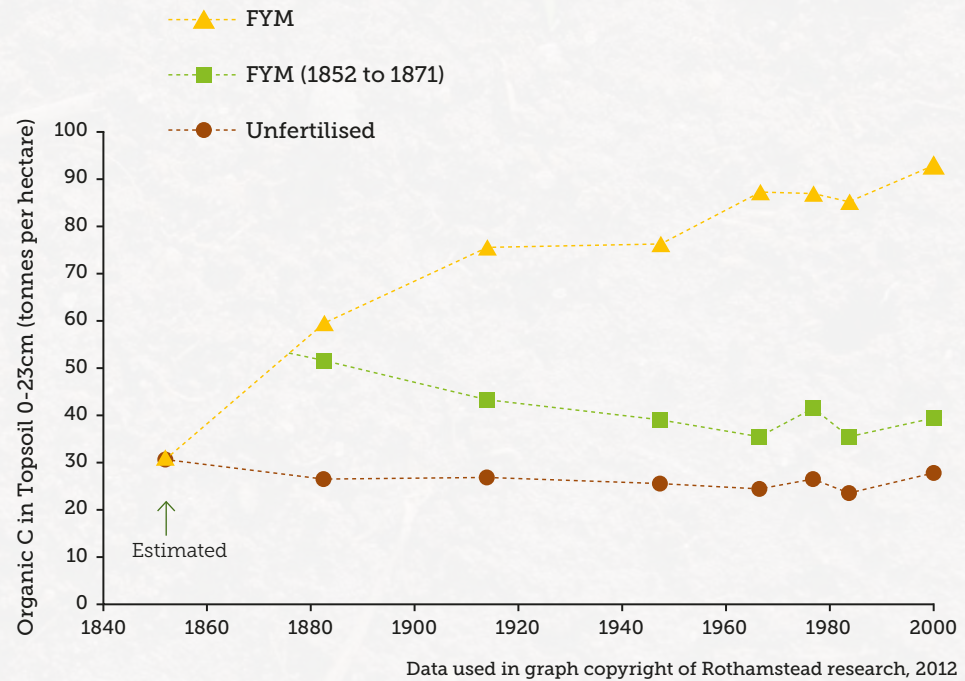
Lower Smite Farm is run by the Worcestershire Wildlife Trust and is managed by Caroline Corsie. Percentage soil organic matter levels were low on the farm to begin with – around 2.5% across the farm – but this is typical of many arable soils in the UK and reflects the lack of grassland breaks or green manures in many arable rotations. Caroline has been using green manures and winter cover crops to improve the soil fertility of the farm and over 5 years she has managed to increase soil organic matter levels by 20% across the farm. The use of green manures and cover crops has also created rich pollinator habitat. Caroline trades forage cuts of cover crops, green manures and hay for neighbours farm yard manure – a rich and often hard to obtain resource for the farm - and occasionally uses household waste compost. The work undertaken by Caroline has shown that degraded soils can be improved but it takes time, resources and an openness to try new techniques. Lower Smite is an excellent example of what can be achieved and is a valuable resource for other farmers trying to improve their soils in Worcestershire.



Case study

Rothamsted Long-term Hoosfield Experiment

A long-term trial was initiated by the Rothamsted Research Centre in 1852 and carried on for 164 years – an incredibly long time for a field trial. The purpose was to look at the effects of different practices and cropping systems on soil organic matter and yield. The data from this Hoosfield Spring Barely field trial provides an interesting insight into the impact that applying animal manure can have on soil organic matter levels. For un-fertilised sites, soil carbon – an indication of organic matter levels – has stayed reasonably steady. On sites where farmyard manure has been applied annually however, levels have increased dramatically to around triple what they were originally. What is more, these increases have continued without plateauing, far exceeding the 20 years of gains usually expected. The experiment also found that if manure is no longer applied, levels will soon drop again, but the benefits from the manure are still clear 130 years later.



References

ⁱ Defra 2009 Soil Strategy for England - 'Our soils have degraded over the last 200 years due to intensive agricultural production. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69261/pb13297-soil-strategy-090910.pdf

ⁱⁱ WPalmer, R. C. and Smith, R. P. (2013) 'Soil structural degradation in SW England and its impact on surface-water runoff generation', *Soil Use and Management*, **29**: 567–575 <http://eureferendum.com/documents/sum12068.pdf>

ⁱⁱⁱ Countryside Survey Soil Report from 2007 http://www.countrysidesurvey.org.uk/sites/default/files/pdfs/reports2007/CS_UK_2007_TR9-revised.pdf

^{iv} Edmondson et al (2014) 'Urban cultivation in allotments maintains soil qualities adversely affected by conventional agriculture', *Journal of Applied Ecology*, <http://agris.fao.org/agris-search/search.do?recordID=US201400138533>

^v Research on soil at the James Hutton Institute <http://www.hutton.ac.uk/research/groups/environmental-and-biochemical-sciences>

^{vi} Gattinger et al (2012) 'Enhanced top soil carbon stocks under organic farming', *PNAS*, **109**(44): 18226–18231
Research Institute of Organic Agriculture (FiBL), Switzerland October 2012 <http://www.pnas.org/content/109/44/18226.full>

^{vii} *The Countryside Survey found a decline in soil carbon density (and therefore soil organic matter) between 1998 and 2007* http://www.countrysidesurvey.org.uk/sites/default/files/pdfs/reports2007/CS_UK_2007_TR9-revised.pdf

^{viii} European Commission Joint Research Centre European Soil Portal – 'key facts about soil' http://eusoils.jrc.ec.europa.eu/projects/soil_atlas/Key_Factors.html

^{ix} 1% SOM = an additional 20,000 to 25,000 gallons per acre, or at least 225,000 litres per hectare. 0.2-0.4% increase (20% increase on 1-2%) = 45000 to 90000 litres. Based on Byrant L. (2015) Organic Matter Can Improve Your Soil's Water Holding Capacity http://switchboard.nrdc.org/blogs/lbryant/organic_matter.html

^x European Commission Joint Research Centre European Soil Portal – 'key facts about soil' http://eusoils.jrc.ec.europa.eu/projects/soil_atlas/Key_Factors.html

^{xi} Panagos et al (2015) 'The new assessment of soil loss by water erosion in Europe', *Environmental Science & Policy*, **54**: 438 – 447 <http://www.sciencedirect.com/science/article/pii/S1462901115300654#tbl0015>

^{xii} Palmer, R. C. and Smith, R. P. (2013) 'Soil structural degradation in SW England and its impact on surface-water runoff generation',

Soil Use and Management, **29**: 567–575 <http://eureferendum.com/documents/sum12068.pdf>

^{xiii} An estimated 89% of the global potential for agricultural greenhouse gas mitigation would be through carbon sequestration. Smith P et al, (2008) 'Greenhouse gas mitigation in agriculture'. *Philosophical Transactions of the Royal Society of London Series B Biological Sciences* (2008) **363**: 789-813

^{xiv} The Countryside Survey 2007 found the average soil carbon density in Great Britain's arable and horticultural soils in 2007 to be 47.3t C/ha. <http://www.countrysidesurvey.org.uk/outputs/soils-report-from-2007>

^{xv} Note this is based on global figures. Based on the average difference in carbon sequestration rates between organic and non-organic farms, found in the Gattinger et al (2012) global meta-analysis of comparative studies <http://www.pnas.org/content/109/44/18226.full>

^{xvi} Taking the total croppable area of the UK as 4.8m ha, (https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/355868/structure-jun2014final-eng-18sep14.pdf) – an increase of 0.27 mega tonnes of carbon per hectare would mean an increase of around 1.3 million (1296000) tonnes of carbon.

^{xvii} Based on the USA's Environmental Protection Agencies Greenhouse Gas Equivalencies Calculator - <http://www.epa.gov/cleanenergy/energy-resources/calculator.html>

^{xviii} A global meta-analysis found organic farms emit the equivalent of 492kg CO₂e less N₂O and take up an additional 3.2kg CO₂e of methane per ha per yr on average: Skinner et al (2014) 'Greenhouse gas fluxes from agricultural soils under organic and non-organic management - A global meta-analysis' Sci. of the Total Env. <http://www.ncbi.nlm.nih.gov/pubmed/24061052>

^{xix} Based on the croppable area of the UK as 4.8m ha https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/355868/structure-jun2014final-eng-18sep14.pdf and total current agricultural emissions of 53.7 m CO₂e https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/449266/agriclimate-6edition-30jul15.pdf

^{xx} https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/449266/agriclimate-6edition-30jul15.pdf

^{xxi} Farnworth, G. & Melchett P. (2015) 'Runaway Maize: Subsidised Soil Destruction' <http://www.soilassociation.org/LinkClick.aspx?fileticket=DSJZR8S7YU4%3d&tabid=2445>

^{xxii} The new scheme is an improvement, but it should be clarified that agroforestry is compatible and that land with trees is eligible when logical conditions are met.

Image credits

P1 Natural Resources Conservation Centre
p5 Wye and Usk Foundation
& Brian Boucheron
P7 Charles Sainsbury
P10 The Permaculture Association
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P13 Jason Miller & Colette Kessler, Pierre USDA Natural Resources Service
P11 Richard Croft
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Thanks to
Trevor Mansfield, Liz Bowles,
Tim Bevan, Ben Raskin, Emma
Hockridge, Lillian Kelly, Lyn
White, Peter Melchett and
Ruth Semple

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