SUSTAINABLE
SOILS
ALLIANCE

February 26 2021

Department for Business, Energy & Industrial Strategy
Greenhouse gas removals: call for evidence

The Sustainable Soils Alliance (SSA) was launched in 2017 to address the current crisis in our soils. Its aim is to campaign to restore UK soils to health within one generation by seeing soil health elevated to where it belongs as a priority alongside clean air and clean water. The SSA is a non-profit organisation (CIC number 10802764).

For further information, visit: https://sustainablesoils.org/

1. Do you give permission for your evidence to be shared with third party contractors for the purpose of analysis?
Yes
2. Do you agree that some greenhouse gas removal methods will be required to achieve the UK's net zero target by 2050? What are your views on the suitability and mix of different technologies in supporting the delivery of net zero?
o Yes. Emissions from the UK land use sector (calculated at 58 MtCO2e in 2017) have been cited as a major barrier to the UK meeting its net zero commitments under the Paris agreement by the Committee on Climate Change. The vital role of soils in carbon storage and sequestration and the potential to manage soils to increase carbon sequestration are well established, as acknowledged in the consultation (10 MtCO2e by 2050). o An estimated 9.8 billion tonnes of carbon are stored in Britain's soils. Indeed, globally soils store three times as much carbon as is contained in the atmosphere. Soil carbon sequestration can increase this amount but badly managed soil can be a major source of greenhouse gas emissions and the degradation of carbon-rich soils releases significant quantities of CO2. Healthy soils prevent carbon losses from soil erosion. o The estimated costs of soil degradation on GHG regulation in England and Wales is £440-820 million per annum (Graves et al., 2015). o Analysis of the longitudinal Countryside Survey reports that arable soils in Great Britain have lost significant carbon between 1978 and 2007. The British Society of Soil Science told a 2016 Parliament inquiry that if soils are not managed for carbon storage then climate change could be "heightened". Soils around the world have lost on average 26% of the carbon in the top 30 cm and 16% for the top 100 cm of soil. o The GHG removal potential of carbon sequestration should not be considered in isolation but rather in the context of all the productivity and ecosystem benefits – biodiversity, clean water, flood risk management etc. that increased soil carbon delivers. A holistic understanding of soil carbon's role and function is needed to ensure joined up policy-making and the alignment of economic interests (farmers and investors) that share a goal (soil improvement), but with different environmental outcomes in mind. o Wherever GHG removals are possible, they should not be considered as an alternative to reductions achieved within farming or elsewhere.
3. In relation to the GGRs listed in Figure 1 (except afforestation, habitat restoration and wood in construction), is there **new evidence** that you can submit in relation to any of the following: (i) technology readiness levels ● Although there remains scientific debate around realisable carbon sequestration from agricultural soils, the multiple productivity and **ecosystem benefits** from increasing carbon in these soils is undisputed. The

greatest potential for sequestration lies in the most depleted soils, in particular arable and grassland systems.

- There is also scientific consensus over certain **land management practices** that will increase organic matter and thus soil carbon. These include better crop and nutrient management (i.e. improving varieties, cover crops, crop rotations and optimising fertiliser use), reducing tillage intensity, varying grass types, improving animal stocking density and new methods, such as growing crops with deeper roots or roots more resistant to decomposition. Certain crops (C4) can be engineered to increase carbon fixation.
- Rapid evidence syntheses conducted by the NERC-funded iCASP and BBSRC-funded Resilient Dairy Landscapes projects in 2020 showed strong evidence across multiple studies and context for **soil carbon gains** arising from converting arable land to woodland, conservation tillage, hedges in arable land and organic amendments.
- Methods exist and are rapidly improving to measure, monitor and model carbon stocks and greenhouse gas emissions. In the past year, at least **three new standards** were developed for the monitoring, reporting and verification (MRV) of soil carbon sequestration, adding to a growing body of such standards:
  - CAR Soil Enrichment Protocol
  - VERRA Methodology for Improved Agricultural Land Management
  - FAO GSOC MRV Protocol
- **New technologies** and modelling approaches are being developed that can measure carbon and carbon flux with higher accuracy at low operational cost. These fall into three broad categories:
  - Modelling
  - Proxy measurements (e.g. sensors, imagery, spectroscopy)
  - Direct soil sample testing
- **Modelling and Proxy measurement** technologies are in development, potentially TRL 8, and likely to be very low cost to deploy over large land areas. They are already in use in the US to support carbon credit registration from agricultural soils in the Carbon Action Reserve registry. They have inherent challenges, none of which are insurmountable:
  - Uncertain accuracy of results may not satisfy stringent carbon market requirements, especially as markets evolve and regulations and buyer sophistication mature. However this is mitigated by reducing the issue of carbon credits to account for uncertainty, or retaining large buffer pools.
  - To convert modelled or proxy measures of carbon levels into carbon tonnage, soil density must be measured separately and applied to conversion calculations. To reduce costs standard conversion factors are often used instead but these take no account of different soil densities and can result in highly inaccurate carbon quantification.
  - Modelling and above-ground sensing/imagery technologies often only consider the top layer of soil and miss out the impacts at deeper levels. Arguably this could result in underestimating the carbon sequestered in soils but, again, increases uncertainty.
  - Both modelling and proxy measures require reference or calibration data for different soil types, climates and farming practices. The lack of such data for the UK highlights a need for significant research to fill the evidence gaps highlighted above.
- **Direct soil sample testing,** taking soil from the field and using combustion methods in a laboratory to give a direct carbon reading is still regarded as the most reliable 'gold standard' approach. The reference and calibration data required by modelling and proxy measures must come from this type of 'ground truthing'. The key barrier to deploying direct testing at scale is cost; a reputable soil carbon test, including bulk density assessment, typically costs around £25 per sample in the UK today.
- Technology is evolving rapidly to overcome this barrier. A good example is UK innovation company, Agricarbon, which is part funded by Scottish Enterprise and is developing a new **high-capacity, low-cost soil carbon and bulk density testing service** based on direct sample collection from up to 1m soil depth, and Dumas dry combustion analysis of the samples. Agricarbon uses robotics and industrial processing to significantly reduce the time and cost of sample preparation, while carbon analysis is still based on the best-in-class scientific instruments for elemental analysis. This will yield very high integrity soil carbon data but at a fraction of today's costs, to provide good visibility of soil carbon stocks for farming businesses and rapid accumulation of soil carbon data at a regional / national level.
- The relatively low cost of Agricarbon's service allows high sampling intensity (the pilots currently underway will average 3 samples per acre) and good resolution of carbon data at the individual field-level. The company aims to establish a global soil carbon certification service that will act as an affordable,

independent assessor/certifier of soil carbon stock and flux, directly accessible to farm and landowners and agnostic to the carbon credit destination but accepted by the most stringent market operators. Combining Agricarbon certification with remote monitoring technologies (being developed by other innovations) that can remotely track the farming activities above ground, offers a clear and present path towards cost-effective and high integrity soil carbon project validation being pioneered in the UK.

- Agricarbon is currently piloting their service with a large UK farming cooperative and plans to publicise their work at the end of March 2021. The technology could be considered TRL6-7, in Validation stage, although the company is already generating revenue from the pilot projects due to high customer demand and has plans for rapid capacity expansion over 2021-2022.
- Another example of evolving technology is the NERC-funded **Dynamic monitoring, reporting and verification for implementing negative emission strategies in managed ecosystems (RETINA)** project which is developing a cloud-based platform that combines new development in sensor-based technologies with cloud-based model simulations to overcome major obstacles for implementing a monitoring, reporting and verification (MRV) system for land based negative emission technologies. This project would take the information from RETINA and translate it into a tradable commodity, e.g. carbon offsets.
- Whilst we are at TRL 8 for soil carbon management practices and modelling – and in many cases would argue that the new evidence emerging from these initiatives makes the case for soil carbon sequestration to be moved from TRL8 to TRL 9 – where work needs doing is on the accompanying **legal/technical issues** (additionality, permanence etc.). Again, these issues are not insurmountable.
  - **Additionality** is important to provide investors and Government with confidence that private investment in soil carbon is delivering benefits that would otherwise not have occurred. This issue has already been successfully resolved for soil carbon in peat soils under the Peatland Code, which applies four additionality tests (legal compliance, financial feasibility, economic alternatives and a barrier test) which could all be easily adapted for use in a Soil Carbon Code.
  - While **permanence** is a major concern for interventions designed to sequester and store carbon in agricultural soils, habitat banking is currently operating successfully with 30-year contracts to convert arable land to permanent pasture. The Peatland Code also operates successfully with 30-year contracts to reduce GHG emissions from peat soils. Following these precedents, there are already contractual models that could be used to provide the permanence needed for a UK Farm Soil Carbon Code.

(ii) scale-up potential (in the UK and/or globally)

- The scale up potential for soil carbon sequestration is well established – see the Royal Society Report UK (10 MtCO2e by 2050.) referenced in the Call for Evidence.
- Realising this potential will require willingness among **land managers** to engage. The NFU outlined farming's role in their publication 'Achieving Net Zero Farming's 2040 goal' (England and Wales) published in September 2019. They outline three pillars to achieving this. Pillar 2 (9 MtCO2e by 2050) is around increasing carbon storage in soils through measures 'such as hedgerows, woodland on farms, soil carbon practices, and peatland and wetland restoration'.
- A February 2020 DEFRA Farm Practices Survey revealed practices relating to greenhouse gas mitigation are widespread with 66% of farmers currently taking action to reduce GHG emissions from their farm. However, only 32% of farmers keep track of soil organic matter. This gap demonstrates a willingness among farmers to address GHG emissions, but a comparatively low awareness of the potential for soil carbon to contribute to this - 43% of farmers that don't measure SOM in their soils gave the reason it is 'not important enough to test for'.
- There are lessons for upscaling from existing carbon codes. A Woodland Carbon Guarantee was used to scale up private investment in the Woodland Carbon Code in England. A Peatland Carbon Guarantee is also being developed in Scotland by Finance Earth and NatureScot that could integrate impact investment as loans to cover the costs of capital works, with carbon finance then being released at five yearly verification points, with Government funding only used if carbon cannot be sold at a higher price on the market. A similar mechanism could be used to rapidly scale up investment in agricultural soil carbon after the introduction of a UK Farm Soil Carbon Code.

(iii) costs per tonne of CO_2 removed, including any additional information about cost savings per tonne for removals "in bulk" (where possible, please provide evidence for cost breakdowns across the various elements e.g. capture costs, transport and storage costs)

- Given the nature-based nature of regenerative farming practices and comparatively little capital required to deploy them, costs per tonne of CO_2 removed through soil carbon sequestration could be relatively low. Experience from the US indicates that costs can be as low as $6 per tonne, with the potential to reduce this further – increased scale can lead to dramatic reductions in the cost to both implement and track practices.
- The cost/tonne of removals will be location/environmental conditions specific and dependent on farm-level management, while any estimate has to be able to separate incremental sequestration cost from general farm expenditure. The larger cost to farmers comes in the risks inherent in any practice change, often some consultancy required to adopt new systems successfully and some material, training and small capital costs.
- In some instances, e.g. for minimum tillage equipment or to cover new infrastructure. To support a move to mixed farming, capital costs will be greater.
- The cost of the infrastructure required to quantify and commercialise soil carbon can range from relatively low:
    - 10-15% fees charged by carbon removal marketplaces such as NORI (www.NORI.com)
    - 20% margins applied by 'vertically integrated' project developers with 'direct to customer' carbon offset sales (no live examples, several operators in development, at early stages)
    - To much higher costs of around 50-80% carbon income lost in fees to the global carbon registries VERRA and CAR.
- When considering cost, it is worth bearing in mind that investors are willing to pay significantly more for carbon removals/credits generated locally/in-region, especially when combined with clearly associated co-benefits such as biodiversity and food system security. Large volume corporate carbon-offset buyers have indicated willingness to pay £20-£30 per tonne for CO_2 removals from UK soils today (anecdotal, interviews with carbon buyers for Agricarbon and emerging carbon retailers targeting the UK market).

(iv) constraints to deployment;

- The lack of standard or protocol for monitoring, verification or reporting of GHG removals/soil carbon sequestration.
- The lack of a credible and liquid UK market for long term soil carbon credits.
- The low availability and expense of UK management and location specific modelling for GHG and soil carbon sequestration.
- The lack of cost-effective independent verification which is expensive if not carried out at scale.
- Behavioural barriers (willingness to change) among farmers, including low awareness of the importance of soil organic matter, concerns around contract length (required for permanence) and concerns that adoption of private schemes might compromise eligibility for Environmental Land Management.
- Costs of switching to soil carbon sequestering methods (perceived and real).
- Conflicting messages around the potential of different on-farm interventions and technologies based on single potentially conflicting studies (in the absence of evidence synthesis across multiple studies to provide a stronger evidence base).

(v) ability to verify removals, taking into account considerations of permanence of removal (i.e. how accurately can you measure the amount of CO_2 removed and stored by this method);

- As illustrated above (Technology readiness), there are three approaches to verifying removals: direct measurement of soil carbon via sampling, modelling soil carbon with spot checks to validate model outputs, or indicators and proxies e.g. remote sensing, colour/texture tests.
- Models exist that can calculate carbon sequestration in between measurement episodes. Standards exist and are being piloted in other countries by Climate Action Reserve and VERRA that combine measurement and modelling to quantify carbon sequestration to reduce the number of sampling points required and hence the cost.

(vi) lifecycle emissions for these methods in the UK (please specify any assumptions as part of this calculation, for example the carbon intensity of the electricity being used. If you are assuming a lower carbon intensity than the modern grid, why?);

(vii) wider environmental impacts and risks

- The role of soil carbon in underpinning a broad range of ecosystem services is acknowledged in the UN System of Environmental-Economic Accounting Experimental Ecosystem Accounts (SEEA-EEA, ref). The UK's Natural Accounting roadmap, based on SEEA-EEA guidance, includes both soil carbon sequestration and stock in its initial sets of accounts for 2016 (ONS, 2018).
- There are risks that soil carbon interventions and technologies do not have sufficient evidence, hence do not sequester or store the expected amounts of carbon, or lead to trade-offs with other ecosystem services. To avoid this risk, evidence synthesis is needed, and only interventions with a robust evidence base, across multiple projects, should be approved for integration into any future soil carbon market.
- To ensure payments for soil carbon do not compromise other ecosystem services, it would be preferable to design schemes to allow stacking of payments for multiple services, as has been successfully done in Landscape Enterprise Networks. By aggregating demand for multiple services, it is possible to design packages of measures including those that sequester and store soil carbon that provide multiple co-benefits including improved water quality, biodiversity, resilience to drought, and improved yields (see Reed et al, 2020).

4. Is there any evidence you would like to submit in relation to other nascent GGR methods not outlined in Figure 1? If so, please provide a clear description of the method and the evidence available in respect to the categories listed above, including deployment potential in the UK. If evidence is not available, please outline why and when it might become available. 5. What do you consider to be the main barriers to the development and deployment of GGRs?

N/A

6. What principles would you like to see included in a framework for incentivisation of greenhouse gas removals?

The Call for Evidence identifies six principles that should underpin future policy on GGR removal. In the case of soil carbon sequestration, the principles should be addressed via the creation of open access market infrastructure - an agreed 'carbon code' for UK farms and soils. A UK Farm and Soil Carbon Code would fund regenerative agriculture interventions that sequester and store soil carbon, contributing towards climate change mitigation whilst improving soil health, biodiversity, water quality and the resilience of the agricultural sector.

The Code will be open access to all farmers and robust enough to be adopted by operators of carbon offset registries, carbon capture incentive schemes (offsets, payments for ecosystem services and environmental investment products). To provide the necessary levels of integrity and consistency, the principles should be reflected as follows:

1. *Making sure removals are verifiable and quantifiable;*

- The development of a successful code hinges on the accurate, verified and affordable measurements of soil carbon and net greenhouse gas emissions from the farm as a result of adopting regenerative farming practices.
- Quantification – It is essential that GGR projects, be they woodland, soil-based or operating within another ecosystem are constantly monitored. This will allow metrics and emissions factors to be updated and improved over time, increasing scientific understanding of, and confidence in, the whole project. It will also ensure that suppliers of GGR are actually delivering removal/avoidance of CO_2e, increasing buyer confidence in (and engagement with) the market.
- Verification – A quality check is a critical component to ensuring that farmers implement regenerative agriculture practices and project proponents accurately calculate the benefits.

2. *Instilling confidence in investors;*

- Permanence: Carbon sequestration is reversible. To retain stored carbon, practices must either be continued or maintained to retain the carbon in the soil over an agreed period of time e.g. the Peatland Code and habitat banking negotiate 30 year contracts with landowners. If included in the Environment Bill, Conservation Covenants could be used to provide further assurance to investors that land use or management will not be reversed, leading to loss of carbon.
- Saturation: When a sequestering practice is adopted, carbon storage typically increases, but at a diminishing rate through time until it plateaus at a new steady-state equilibrium. Consequently, only a finite amount of sequestration is possible in a particular location. The validation of any project should include assessments of current soil carbon to assess the amount of carbon likely to be sequestered and stored via any intervention. UK soils are generally carbon depleted, however, meaning in most cases saturation is some way off.
- Additionality: Carbon sequestration rewarded via a code must be additional to what would have occurred anyway under business-as-usual conditions. This might be established according to at least one the following additionality tests:
    1. 'Common practices' (the prevalence of an activity in the surrounding area), 'economic alternatives' (the cost of practices would be otherwise unaffordable and so would not be economically viable on that land at that time),
    2. 'Financial feasibility' (the project would not be possible without additional carbon finance, over and above existing incentives e.g. from ELM), and
    3. 'Legal' (over and above an existing regulatory baseline).

  Whatever approach is taken, it needs to be rigorous but also realistic if the market is not to be narrowed unnecessarily. This is especially true when it comes to gauging against 'common practices'. For example, farmers might have implemented regenerative practices for a few years and abandoned them (because of lack of incentive), while it would be counter-productive to penalise farming communities that are early adopters of more sustainable farming practices.
- Leakage: Investors need reassurance that any activities they incentivise do not result in, for soil carbon, CO2 or GHG increases elsewhere - in another location, time, and/or form of GHG. This might be 'market shifting leakage' or 'activity shifting leakage'. This is typically built into standards and protocols and would be enforced via contracts .
- Transparency: For any GGR market to operate effectively, transparency is key. This is true of pricing, auditing, verification, administration of the relevant carbon standard(s), and with regards to principles such as additionality and permanence. Without transparency, suppliers and buyers of carbon products will be disincentivised from engaging in the market, leading to low uptake and poor GGR results.
- Independent Verification: It is important that credible verification is undertaken by an independent 3rd-party (e.g. UKAS or ISO). The institutions that administer carbon standards cannot be the only organisations responsible for ensuring compliance, transparency and quantification of GGR. Again, this will improve the integrity of any GGR market and its perception of legitimacy amongst buyers.
- Double-counting: rules need to be established to avoid separate market players claiming the same carbon offset. This is an issue across the carbon markets; for soil carbon sequestration in the UK, there is a need for "farm gate" carbon accounting principles to be developed.

3. *Attracting innovation;*

- Technology use by farmers is changing rapidly and innovative farmers are already implementing farm management systems to track their application of fertilizer, yield, pesticide application, and a host of other parameters at the sub-meter level. This information can also be used to quantify the increase in carbon in the farmer's soil. A Farm and Soil Carbon Code will encourage farmers to use and expand the use of these farm management systems.
- New sensors are being piloted that can provide high-accuracy and real-time decision data for cost-effective carbon removal, storage, and management.
- New technology solutions are becoming available that integrate airborne-satellite remote sensing, process-based modelling, deep learning, field-level sensing, and high-performance computing. This technology will allow for the calculation of carbon flux in the soil.
- New simple, transparent financial products, facilitated marketplaces and trading platforms to enable landowners and investors to participate in soil carbon sequestration markets. These need to embed emerging offset principles and guidance, (underpinned by a Farm and Soil Carbon Code) embodying the features set out in section.

4. *Ensuring value for money;*

- Value for Money (investor): This needs to be a key principle within any framework for incentivisation of GGRs where private sector investment is targeted. Public funding can be unpredictable, dependent on the priorities of specific administrations and the fiscal realities of their tenure. It is essential that private sector investment is encouraged and not out-competed, to ensure a consistency of investment in the market that is independent of the priorities of individual government administrations.
- Value for money (farmer): Currently, there is no practical way for a farmer to earn soil carbon credits. While protocols do exist, they are either too costly to be adopted, not rigorous enough to be valuable or too complicated to administer. There are currently two carbon markets for the UK land use sector, the Woodland Carbon Code and the Peatland Code, however neither enables investment in farm soil carbon sequestration.

5. *Being technology neutral;*

- A future Farm and Soil Carbon Code would include any technology or intervention for which there is robust evidence of effective GGR.
- It would also be trading-platform neutral, providing opportunities to verify GGR directly to landowners, or via intermediaries, either in isolation or in combination with payments for other ecosystem services in parallel with other standards/protocols where additionality criteria can be met (e.g. alongside habitat banking) in layered schemes such as Landscape Enterprise Networks where demand for multiple services is negotiated and integrated at the outset.

6. *Making a wider economic contribution.*

- The size of both voluntary and compliance markets is expected to grow significantly in the coming years, but to contextualise the former, projects predicted to sequester 4.7 million tonnes CO2e over their growing lifetimes were financed through the UK's 'Woodland Carbon Code' in 2019-2020. With each tonne retailing at between £5-£15, this illustrates the current size of the voluntary carbon market for woodland carbon alone, a market severely constrained by the availability of suitable land for planting.
- In contrast, agricultural land covers 17.7 million hectares in the UK and conservative estimates put the sequestration potential of this land at approx. 1CO2e ha-1 per year. With carbon offsets currently retailing at between £10-£20 in the voluntary market, and the trend for rising prices showing no signs of abating, the potential is there for the UK's farmland to absorb private investment in the region of £200M - £750M per year for carbon sequestration alone.
- Tapping into compliance markets offers even greater potential, and thus our 'Farm and Soil Carbon Code' will meet all the necessary criteria of offset schemes such as the aviation sector's 'Carbon Offsetting and Reduction Scheme' (CORSIA). Recent research by the environmental think-tank 'Green Alliance' suggests that airlines alone will be looking to "invest between £4 billion and £18 billion per year in offsets between now and 2035" through CORSIA. If even a fraction of that investment is channelled into the UK's carbon offset market it will ensure the market for 'Farm and Soil Carbon' is not constrained by a lack of demand.
- Covid-19 has raised political and public awareness of the importance and resilience of global food supply chains, the vulnerability of these chains to sudden shocks and their exposure to international developments beyond our control. This in turn raises the importance of increasing self-sufficiency, especially when it comes to food production – for which healthy soils are critical, and increased soil organic matter the most important indicator.
- A soil carbon marketplace will not only unlock a critical revenue stream for investment in soil, but will also help embed new, widespread appreciation and awareness of soils that will start with farmers but resonate with the financial markets, corporations and the general public. It will herald an understanding that soil is a critical, non-renewable asset that is vital for long-term human, environmental and economic health.
- Unlocking this potential will require standardisation and regulation, so that investors have confidence in the integrity of the 'product' they are buying. The key to achieving this integrity lies in the generation and widespread adoption of a carbon standard for UK farms.

7. What specific policy mechanisms could the government consider to incentivise (a) innovation and (b) initial deployment? Could any of the policy options outlined above be designed in a way that stimulates investment in innovation, including pilots and demonstrators for less mature technologies?

There is substantial appetite on both the demand and supply side for a Farm and Soil Carbon Code, but there is currently no standard against which projects can be registered and verified. Several regional ecosystem markets now operate in the UK and encourage farm-scale interventions that enhance soil carbon. However, without a an agreed protocol, they cannot quantify or verify soil carbon changes or market carbon benefits to investors.

We have recent examples of government behaviour that incentivised the innovation necessary for the development of the Woodland Carbon Code and Peatland Code. This included the support and buy-in of relevant government departments (e.g. DEFRA), funding (for research, engagement and pilot studies), public endorsement of the codes, etc. Replication of these behaviours would likewise incentivise and support efforts to develop another domestic carbon standard in the UK, for farms and agricultural soils.

Building on Reed et al (2020) and work by Finance Earth for NatureScot, and innovations proposed by Farm and Wildlife Advisory Group (FWAG) we propose 6 specific policy mechanisms that could enable public funding to leverage private finance for GGR from soils (for details of options 2-6, see Table 3 in Reed et al, 2020):

1. The creation of a Soil Carbon Guarantee, using impact investment to pay for capital works where necessary. This would be on a 30 year repayable loan basis where the landowner does not have their own capital to invest. The Government would set a floor price per tonne of carbon via reverse auction so floor prices can repay project costs and loans, with carbon available for sale at five-yearly verification points, which can be sold for the floor price, or at a higher price if the carbon market allows.
2. Funds delineation – the use of public investment to fund a discrete menu of 'value-added' components within a package of nature-based solutions.
3. Trigger funds – setting up government funding that only 'triggers' when a certain level of private sector funding is achieved.
4. Establishing fund-matching/co-investment as a default principle.
5. Using a transparent cost-benefit matrix to target public sector funds.
6. Creating integrated systems for public-private implementation such as county-wide or catchment area-based green bonds that allow private investors to participate in coordinated, landscape-scale natural solution implementation plans administered by appropriate local/regional public bodies.

(b) initial deployment?

The government could fund feasibility studies and pilot a Farm and Soil Carbon Code, in the same way it did for the Peatland Code. It could make use of public agencies (Natural England, Environment Agency) to increase awareness of and engagement with a nascent 'Farm and Soil Carbon Code and its pilot projects.

Could any of the policy options outlined above be designed in a way that stimulates investment in innovation, including pilots and demonstrators for less mature technologies?

Absolutely, pilots provide a great opportunity for engagement, scientific analysis and stakeholder feedback and should be undertaken as part of the development process of a Farm and Soil Carbon Code. We agree with the conclusions of the Vivid Economics report (2019) which calls for support pilots for immature land-based GGRs (soil carbon sequestration, biochar, and enhanced weathering) to establish their environmental impact and potential for negative emissions.

With that in mind, we are concerned that proposed ELM tests and trials and pilots do not appear to be prioritising mechanisms that stimulate private capital, i.e. by using public funds to catalyse private investment.

8. How could government best contribute to establishing optimum market conditions for GGRs to be developed and deployed at a large scale?

The evidence from the voluntary carbon markets that currently exist around the Woodland Carbon Code and Peatland Code is that the role of government is best suited to promoting these markets and publicly endorsing them, but not attempting to distort their prices or oversee day-to-day operation.

We see a clear role for government in enabling the evolution of a Farm and Soil Carbon Code as follows:

1. Design public funding schemes (e.g. Nature for Climate Fund and ELM) in a way that leverages – rather than squeezes out private finance. To achieve this, we would draw attention again to the six options proposed under question 7. ELM (and equivalent schemes in Wales, Scotland and NI) should provide clear messaging to the landowning community that farms that adopt projects under the Code would also be eligible for ELM. A good example of such an explicit approach to public/private synergies is the new Peatland Strategy from DEFRA, (announced 25/2), which is going to fund landscape-scale peatland restoration through the 'Nature for Climate Fund' in a competitive process that favours projects which can demonstrate 'value for money' by having secured some private sector investment through the Peatland Code.
2. Increase access to government-controlled/influenced data sources, vital to the development of new tools, technologies and farm innovations. These could include anonymised RPA data on natural and farmed habitats, OS data, Soil Maps and others. This is important because soils are not uniform and the potential to achieve net carbon transfer from soils varies greatly across landscapes reflecting natural factors such as climate, topography, biological activity and geology as well as historical land use and management. Land managers will need to know the baselines for their own land to be able to make informed decisions about managing for net carbon sequestration.
3. Promote a consistent approach to the monitoring, reporting and verification of net carbon transfer through the creation of a robust MRV framework that would be applicable for any given agricultural field in the UK using the latest tools and technologies. This would include evidence from biogeochemical modelling to illustrate how net soil carbon transfers will change with management for any given field: How much soil carbon could be stored? How far can greenhouse gas emissions be reduced? How long before this area reaches its maximum limit for net carbon transfer?
4. Fill the knowledge gap (through R&D investment) where more data is needed e.g.:
    - Sequestration potential on arable and improved grasslands.
    - How to ensure that management for soil carbon sequestration does result in a net transfer of carbon (or carbon equivalents) from the atmosphere into soils, addressing the interplay between soil carbon stocks and greenhouse gas emissions from soils, including non-carbon gases (N_2O). This should lead to practical advice on management options that will deliver and maintain net soil carbon sequestration in any field for a given management regime.
    - Evidence on the effects of buffer strips in and around grass fields on soil carbon. In contrast to our understanding of above-ground hedgerow function, little is known about how hedgerows affect the below-ground soil systems and health.
    - The impact of Agroforestry on soil health. Specifically more data is urgently needed from temperate agroforestry systems to draw reliable conclusions, as most studies are from tropical and subtropical areas.
5. A clear regulatory baseline: Any financial support for soil management practices, whether public or private, needs to be underpinned by a well-resourced and enforced regulatory baseline, currently the 8 Farming Rules for Water. We would like to see these rules strengthened to include measures previously under cross-compliance that have benefited climate change mitigation (e.g. measures to minimise soil erosion and establishing buffer strips along watercourses). These should be mandated irrespective of whether farmers are in receipt of public money.
6. A maturing market for soil carbon sequestration will be assisted by a stable, transparent and high market value for carbon. Government should provide clear policy signals on longer term market prices for carbon trading and/or carbon taxes, to supplement existing collateral such as BEIS guidance on short term carbon trading projections and long term Social Cost of Carbon. Green Book rules for public investments provide strong signals, but should be supplemented by fiscal and public infrastructure policy interventions (biodiversity net gain is an existing example) as well as consistent messaging to markets on its future intentions and expectations (for example on the introduction and trajectory of a carbon tax).
7. Government should promptly and assertively implement forthcoming recommendations of the Taskforce on Scaling Voluntary Carbon Markets and those of other formal reports relevant to soil carbon such as the Dasgupta Review. Government leadership should be visible and backed by funded policy commitments, ideally prior to COP26.

9. How might the role of government change over time to bring GGR technologies to market and encourage their deployment up to 2050?
• In the short term we see a role for the government/public sector in helping to jump-start private sector engagement with soil carbon and facilitating the transition to a place of heightened awareness of soils importance and where farmers and businesses price soil carbon into their activities. • This should be achieved through the promotion of routine SOM measurement and monitoring by farmers, greater enforcement of the regulatory baseline (including through greater investment in the relevant authorities), the generation of advice and guidance to improve soils appreciation and targeted payments for the protection and improvement of soils that leads to the delivery of public goods – including climate change mitigation. The government should look to provide land managers with long-term clarity and incentives to deliver change and promote and publicise technology deployment – showcasing examples of where this has been successful. • The government also has a role identifying and filling knowledge gaps as and when they emerge. For example: management practices which foster permanence in net soil carbon sequestration. All soils eventually reach a point where further carbon sequestration is limited (i.e. at or near “equilibrium”), and the time to reach this limit may be years or decades. The challenge will be adapting management to sustain higher soil carbon stocks and lower greenhouse emissions once this limit is reached – especially under a changing climate. Understanding the moving target of this equilibrium between now and 2050 will be a significant research challenge that should lie with the government. • In the long term, the aim should be to use public funding to create investor confidence and liquidity, rather than paying directly for public goods, for example via schemes like the Woodland Carbon Guarantee (applied to other markets). • Any 'Farm and Soil Carbon Code' must be designed to facilitate this transition and mesh with public sources of funding for climate mitigation on agricultural land. This will be achieved through close and constant dialogue with the four devolved UK governments, with the result that the carbon standard we create can sit alongside the new subsidy regimes (such as the Environmental Land Management scheme (ELM) in England).
10.Which factors should be considered when assessing the suitability of different policy options for businesses?
• International competitiveness: The global market for the storage of carbon in farmed soils is estimated to be c. $10tn. By way of example, Microsoft last year committed to including soil carbon sequestration among a portfolio of negative emission technologies it will use to remove by 2050 all the carbon the company has emitted either directly or by electrical consumption since it was founded in 1975. They have already started buying carbon credits from agricultural projects in the US and Australia. • The protocols that enable these transactions exist elsewhere in the world but cannot be applied effectively to UK soils. Establishing a UK farm and soil carbon code will unlock huge potential for more profitable sustainable farming, for a more resilient and high quality local food supply to UK communities and provide a robust, verified carbon offset option for businesses looking to invest in localised climate mitigation projects. • UK farmers will be put at a significant competitive disadvantage if they are unable to capitalise on this opportunity. At a time when farmer incomes are constrained, input costs are rising and post-Brexit trade and subsidy opportunities are uncertain, soil carbon sequestration could provide a vital, reliable, and long-term income source. • Finally, in addition to reducing GHG emissions, by funding the expansion of regenerative farming methods across the UK, a Code will help position UK farming internationally in terms of its sustainability credentials, with sustainability claims verifiable via independent audits funded via the Code.
11.Are there any existing business models in other sectors – such as power, industry, transport or land use – that could complement new schemes to incentivise GGRs?
12.Are price instruments or quantity instruments likely to be more effective in encouraging and sustaining deployment of GGRs? Or will a combination be required?
13.How far should a policy framework aspire to be technology-neutral between different GGR options?

14.Could wider support for GGRs have any unintended effects on the development and commercialisation of technologies in other sectors, and how could this be mitigated?
15.Are there any international examples that have proved effective at incentivising GGRs? Why were they effective, and are there any barriers to taking similar action in the UK? Are there examples of international approaches that have not worked well?
● The first methodology for a voluntary soil carbon market came out in 2012 and since then, a number of market mechanisms have evolved supported by national and regional governments and increasingly global corporations looking to offset or in-set their emissions elsewhere. They include the following codes and protocols: o GSOC MRV Protocol (Sept 2020) o Carbon Credits (Carbon Farming Initiative—Measurement of Soil Carbon Sequestration in Agricultural Systems) Methodology Determination (2018) o The Climate Action Reserve Soil Enrichment Protocol (2020) o GOLD STANDARD FOR THE GLOBAL GOALS Soil Organic Carbon Framework Methodology Version 1.0 Published January 2020 SDG: 13 Climate Action o NORI Croplands Methodology: Version 1.1, last updated: March 9, 2020 o Verified Carbon Standard Program - Verra Standard: · VM0017 Adoption of Sustainable Agricultural Land Management (SALM) o Verra - previous protocol o Bcarbon: Baker Institute Soil Carbon Working Group o BS EN ISO 14064-2:2019 Greenhouse gases - part 2: specification with guidance at the project level for quantification, monitoring and reporting of greenhouse gas emission reductions or removal enhancements o Soil Capital (Belgium / France) o West Country Rivers Trust o Healthy Soils for Healthy Food (2015) - Austria o Soil Value Exchange o Ecosystem Services Market Consortium ● As a critical step towards the development of a Farm and Soil Carbon Code, the Sustainable Soils Alliance is part of a consortium that is evaluating the applicability of these codes for the UK, including an assessment as to whether they fulfil the principles (permanence, saturation etc.) outlined in section 6. To find out more about this research, please contact Professor Mark Reed, Director of the Thriving Natural Capital Challenge Centre at Scotland's Rural College, Mark.Reed@sruc.ac.uk.
16.Should the government introduce a tax credit, and if so, how should this be designed? Should it be provided only for specific GGR technologies or a broad range of methods? Would multiple, specific rates be effective at incentivising as much investment as possible?
● The introduction of an economy-wide carbon tax will be essential before 2050, to encourage society's wholesale movement towards net-zero. Therefore, ensuring that the carbon products generated by GGR projects (e.g. soil-based carbon credits) are eligible to be used as offsets will be important.
17.Should participants from specific sectors with historical carbon emissions be eligible to apply for the credit or should the credit be economy-wide?
18.If the government were to introduce a GGR obligation scheme, which businesses and emitting sectors could this cover? How could such a scheme be designed to minimise competitiveness impacts and regressive passed-through costs (e.g. to consumers and bill-payers)?

19.What other regulatory approaches could government explore to incentivise GGR deployment?
● Currently, policies relating to soil management include the 8 Farming Rules for Water and BPS cross-compliance rules (GAEC 4, 5, 6) which include providing minimum soil cover, minimising soil erosion and maintaining the level of organic matter in soil. These rules (GAEC) are very weak, with no obligation to measure, no baseline data for existing soil carbon stocks in the majority of farms, and no mechanisms to establish either compliance or breach. These rules stand to fall once the transition period from the EU CAP comes to an end. ● To improve soil protection and incentivise GGR deployment, we have urged Defra to integrate them into the FRfW to develop an integrated set of baseline standards. This might include: o The creation of evidence-based guidelines on soil carbon levels using existing soils data and reflecting regional variability (history, current use, inherent characteristics etc.). This could potentially incorporate threshold figures below which soil structural stability will suffer a significant decline – and where urgent remediation is needed. Such guidance would produce SOC range data for individual soils using an approach developed in Europe and tested in Scotland. (Reference 1 and reference 2). o We would like to see Carbon/Soil Organic Matter added to the list of tests currently required under the Farming Rules as part of a baseline standard. Currently, the legal requirement is for farmers to test their soil pH, Nitrogen, Phosphorus, Potassium, and Magnesium levels, on cultivated land, a minimum of every 5 years, and we would like to see soil organic matter added to this list. ● Soil carbon loss is often greatest on vulnerable soils where farming, especially horticulture, is most intensive (e.g. on fenland peat soils). The problem is exacerbated by the fact that the land is often farmed on very short tenancies (sometimes less than 1 year), where there is no incentive for improving/protecting land management practices. We have called on the government to changes the tenancy regime to encourage long-term tenancies, as they are likely to result in a greater willingness to improve the environmental performance of the soil, e.g. via the design of diverse, long-term crop rotations needed to restore healthy soil balance. ● Embedding a soil carbon regulatory baseline and monitoring would be a critical step towards driving soil understanding and appreciation throughout land management. Regular, consistent soil testing is the critical gateway to understanding soil's role and functions. It generates a positive feedback mechanism whereby farmers see that their soils are changing and that their practices are having an effect – motivating them to make continued improvements. ● It would also send a clear message about the importance of soil carbon as the critical indicator of soil health – for productivity benefits as well as public goods - biodiversity, climate change, and water storage and filtration.
20.What are the merits and risks of introducing payment schemes for GGRs, potentially involving up-front grants or payments for each tonne of CO_2 stored? Which GGRs would be suitable for a payment scheme?
● In section 6 we have outlined some of the critical principles that should underpin any payment scheme for GGR through soil carbon sequestration. These should mitigate many of the inherent risks in such a scheme for both buyer and seller. When it comes to up-front costs – especially capital costs, we see a role for impact investment loans under the Guarantee approach outlined above. Under these terms a 30 year repayable loan would be available to landowners that don't have their own capital to invest.
21.Could a contract scheme be effective in incentivising GGRs such as DACCS and BECCS? What would be the main challenges and limitations of such a mechanism, and how could it be designed to maximise its effectiveness?
o N/A
22.What could a cap and trade scheme for negative emissions look like, and which sectors would you propose to be included in such a market?
o N/A

23.The costs of different GGR technologies vary significantly. How could a cap and trade system address these differences? How could a cap and trade system be used to incentivise initial investment in any future emerging GGR technologies over a long-term trajectory?
o N/A
24.What role can government play in encouraging more companies to make voluntary commitments to invest in GGR technologies in the UK? To what extent can this support innovation in, and deployment of, these technologies?
25.What are your views on the government's intention to coordinate deployment of GGR technologies such as DACCS and BECCS in line with our stated CCUS ambitions, and how could we best do this?
26.What principles would you wish to see in any accreditation scheme for negative emissions? How should the government regulate this? Any evidence relating to best practice of existing negative emissions MRV is welcomed.
We would draw your attention to the answers provided in section and 6, and the underlying message that an accredited UK Farm and Soil Carbon Code is the critical instrument for verifying soil carbon changes and market carbon benefits to investors. Reflecting the lessons learnt from effective MRV employed in carbon sequestration projects around the world, the following principles should be reflected in any UK scheme: 1. The ability to aggregate multiple farmers into a single project so as to maximise reach/scope while keeping cost and administrative burdens manageable. 2. If a calculation methodology is used (rather than soil sampling) it should not require specialized training. This means that any models used should be robust and easy to run with government datasets for climate and straightforward data from farmers. 3. Verification of the project should use a sampling approach and not require the auditor to visit every field every year. Wherever possible, as much data as possible should be verified through a desk audit. Site visits should be limited to a sample to check overall project implementation. 4. Integrated farmer IT systems should be used where possible to reduce the burden of collecting data and increase its accuracy. 5. Remote sensing, IoT, and machine learning should be used to the maximum extent possible.
27.What are the most significant barriers to developing a robust monitoring, reporting and verification system for GGRs?
Cost: For other agricultural offset protocols, the cost of verification has been 50% of the development cost. This has hindered the implementation of practices and development of projects. The cost is driven by the requirement to visit all farms, the rerunning of calculations and models and the review of large volumes of data. By reducing the number of site visits and using farmer IT systems that have been independently validated or validated by the government (using the principles outlined in the previous question), the cost of verification can be dramatically reduced.