7.3 Phase 1 Final Report

WP7 – Project Management & Phase 2 Planning

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Executive Summary

NIAB has planned a multi-site demonstrator to support the BEIS Biomass Feedstocks Innovation Programme. Specifically, this multi-site approach will support:

- The trialling of Phase 2, Lot 1 innovations in a range of locations across the UK.
- The trialling of different Phase 2, Lot 1 innovations in conjunction with each other to identify instances of greater cumulative impact.
- The showcasing of the BEIS programme, engaging with stakeholders across the UK biomass sector, sharing data and information and promoting the increased production of biomass feedstocks in the UK.

The basis for supporting those Phase 2, Lot 1 innovations associated with 2nd generation energy crops (primarily miscanthus) and short rotation coppicing will be a demonstration platform at over 70 sites across the UK. This will encompass more than 3,500 experimental plots for these crops to sit alongside NIAB's existing national trials programme. The sites will cover a full range of climatic conditions and soil types. This will allow for independent testing and demonstration of those relevant Phase 2, Lot 1 innovations as well as providing significant value for promotion of biomass feedstocks across the agricultural sector.

NIAB has also identified over 30 sites with existing energy crops for demonstration of technologies requiring a mature crop. These sites will be used for additional analyses including carbon Life-Cycle Analysis (LCA), biodiversity assessments and soil measurements.

For those Phase 2, Lot 1 innovations looking at other biomass options including algae, forestry and semi-wild crops, NIAB will assess these technologies using analogous approaches to those outlined above. Carbon LCA and where appropriate, assessments of environmental impacts will be conducted. NIAB, together with partner organisations will also provide a platform for Knowledge Exchange and raising of stakeholder awareness.

NIAB has carried out an exercise to identify those Phase 2, Lot 1 projects it feels will best support the BEIS programme aims but it is understood that this will have no bearing on the projects selected for Phase 2 funding. As such, NIAB is able to work with any successful Lot 1 projects.

Contents

1. Background

1.1. Energy crop production

It is estimated that in 2021, there are approximately 10,000 ha of energy crops being actively cultivated in the UK. To achieve the Government's ambitious Net Zero targets, the Climate Change Committee (CCC) recommend that this number will need to increase by over 700,000 ha by 2050[1]. In order to address this challenge, technical innovation, coupled with legislative reform will be required to overcome the barriers to increasing domestic supply.

The Sustainable Bioenergy Feedstocks Feasibility Study[2], contracted by BEIS, identifies Short Rotation Coppice (SRC) willow and miscanthus as the two most common energy crops grown to date in the UK, with the latter suggested to be in the majority. Although other 2nd generation energy crops, and SRC species exist, a considerable knowledge base has been established in both of these crops, so building on previous understanding in these crops will accelerate innovation and adoption to meet the CCC's 2050 recommendation.

The perennial nature of these crops makes them different to many annual crops grown by farmers. However, they have several appealing qualities, such as minimal fertiliser and management requirements, and a ~20 year life span, benefitting the soil from reduced tillage and increased organic matter deposition. In addition to the sequestration of carbon, both of these energy crops have been shown to benefit biodiversity, water quality and reduce flood risk.

1.1.1. Issues

Our work in Phase 1 of this project has identified the following significant issues that are currently preventing the widespread uptake of willow and miscanthus as biomass crops.

- Lack of independent agronomic support – UK growers are usually heavily reliant on their agronomists for advice and support in selecting and growing all crops. Currently there are a limited number of agronomists with experience with these crops. What information is available is mostly from organisations with commercial interests in the sector. NIAB provides independent advice to the sector and is relied upon for in-season support across all the mainstream crops by farms covering approximately 65% of the UK cropped area.
- Local markets for material produced – At present there are only a small number of commercial power generation facilities that use miscanthus or willow feedstock within their fuel mix. The mass and bulk of the crop means that processing and/or end-users need to be local to growers in order to minimise transport costs. Engagement with energy producers and other potential users is a key element of the NIAB knowledge exchange programme.

[1] CCC (2020) Sixth Carbon Budget report https://www.theccc.org.uk/publication/sixth-carbon-budget/
[2] Ricardo Energy & Environment (2020) Sustainable Bioenergy Feedstocks Feasibility Study final report for BEIS ED12678, April 2020.

- Future disease and pest pressure – One of the attractive features for growers of energy crops is the low level of nutrients required and their low susceptibility to disease and pests. Experience with other crops suggest that as the cultivated area increases this will likely increase leading to a need for new varieties, improved agronomic understanding or increased inputs. Monitoring for pests and disease together with provision of advice for management is a part of NIAB's activities for all major UK crops.
- Long term climate risk – Perennial energy crops are expected to be economically viable for as long as 20 years. Crops planted today will experience significant changes in climate with increased likelihood of extreme weather including drought, flooding and prolonged periods of both high and low temperatures. When making long term decisions with regards crop and variety selection it is important that growers have as much information regarding performance of crops across a range of climates as possible. The approach NIAB is taking in planting trial crops across the UK will help provide the required data.

1.2. NIAB

The NIAB Group is the UK's fastest growing crop science organisation, having trebled in size over the past decade through a strategic programme of investment, merger and acquisition.

Founded in 1919, and with a longstanding international reputation for expertise in plant varieties and seeds, today NIAB's scientific capabilities span the crop improvement pipeline; from underpinning research required to develop higher yielding more climate resilient crops through to the extensive trials data, agronomy expertise and advice needed to ensure these advances are transferred effectively onto farm.

NIAB is at the forefront of the application of genetics, physiology, soil science, precision agronomy and data science to improve the yield, efficiency and resilience of crop production across the arable, forage and horticulture sectors.

Unlike other RTOs in the agricultural sector NIAB works directly with growers and their agronomists providing independent, science-based advice to support both long-term planning and in-season decision making. NIAB is unrivalled in the sector as a trusted source on on-farm guidance to farmers. Of specific relevance to this project NIAB has extensive experience in:

- Managing national trials and demonstration programmes – NIAB manages 130,000 plot trials from its 13 regional centres across the UK every year.
- Running world class demonstration facilities – including the NIAB Innovation Farm, the WET Centre and NIAB's Concept Vineyard.
- Working with willow, miscanthus and hemp – NIAB has worked with these crops for over 20 years including writing the DEFRA report - "Assessing biomass miscanthus and short rotation coppice willow and poplar varieties: the way forward"

- Delivering trials for the industry – NIAB has 2,500 industry members for whom it runs a substantial annual field trials programme.
- Working closely with growers and industry stakeholders – from small arable farms to the largest global agrifood companies.
- Delivering high quality trials data – NIAB's trials team has ORETO accreditation and provides the data underlying all of the UK's major crop National Lists.
- Developing novel crops into field-ready commercial opportunities – NIAB understands the difference between experimental results and commercial field performance.
- Developing ongoing commercial funding streams for long term studies – The NIAB Concept Vineyard, NIAB's Farming Systems Research at Morley and the long term Sustainable Trial in Arable Rotations (STAR) programme in Saxmundham are all industry funded.

2. Phase 2 project plan

A full project plan for Phase 2 of the NIAB Multi-Site Biomass Crop Demonstrator has been prepared. The core programme will be able to be carried out as planned. There is however an issue with regards demonstration of the individual technologies selected for Lot 1, Phase 2 funding. Which projects are selected will not be known until after the NIAB proposal is submitted. As a result it is not possible to provide full detail at this point though it is made clear the nature of the activities anticipated and their approximate timing.

2.1. Timelines

A Gantt chart showing the main activities within Phase 2 of the project is provided at Annex 2.

2.2. Project management

The nature of the project is that there will be a number of concurrent workstreams throughout the three years that it runs. It is also the case that at the time of contract award there will still be a large degree of uncertainty with regards which Lot 1 projects will have received Phase 2 funding. These factors mean that while most of the project is expected to develop as planned and described in this document there will be a requirement for the application of Agile methodology that can rapidly mitigate emergent issues and take advantage of arising opportunities. In addition, the Agile approach to development of the project will mean that where issues arise the delays caused will only be minimal with other elements of the project being able to continue at pace.

The Project Management team are very familiar with the existing plan, the various stakeholders, both internal and external to NIAB, and the overall aims that BEIS has for the programme.

Supporting them are experienced NIAB managers, each expert at delivering major projects within their areas. It should be noted that while the proposed Multi-Site Demonstrator

programme is large it is by no means unusual in terms of scale, complexity or nature for NIAB and will sit alongside our other national crop demonstration programmes.

2.2.1. Team

NIAB has put together a strong and experienced team to deliver the Multi-Site Demonstrator programme. Each of the key areas will be led by an existing member of NIAB's staff with support from their internal teams. Where there is a need for specialist expertise that is not available within NIAB we have identified resource that is world-leading in that area and able to support the project. In these instances, we are pairing the external resource with internal members of the team to ensure both the seamless delivery of the project and the development of skills and expertise within NIAB.

NIAB has all the main positions within the project covered by existing resource.

2.2.2. Sub-contractors

NIAB will be using the following organisations to deliver elements of the programme. Agreements subject to success in securing Phase 2 funding are in place. Depending on the Lot 1 selection process additional sub-contractors will be used. These have been identified and agreements for support have been developed.

2.3. Risk management

NIAB has a robust and well established approach to active risk management. The processes are compliant with ISO9001 and ensure that the risks are proactively managed, and issues mitigated through a risk register. Throughout the Phase 1 activity a live risk register has been maintained and updated. A snapshot of this risk register has been provided as deliverable WP7.2 – Risk Register at regular intervals throughout the project. A review of risks specifically relevant to Phase 2 is included in Annex 3 of this document.

Once the initial round of workshops with Lot 1 suppliers is completed a risk workshop will be held to identify and review all technical, commercial and managerial, and environmental risks arising from the interactions with the Lot 1 projects.

The register will be actively maintained by all workstream leads and updated with new risks as they are identified. Risk will also be a standing agenda item on project meetings and changes reported to BEIS on a monthly basis.

2.4. Quality assurance

The NIAB Quality Management System (QMS) which will form the basis of a QMS for the project including activities of the sub-contractors. NIAB is accredited to ISO 9001 and currently operates to ISO 9001:2015 standard. NIAB is also ORETO (certificate 351) accredited for efficacy trials of any chemical treatments.

2.4.1. Audit

NIAB's QMS requires a process of internal audits. These are carried out by a team of 20 trained auditors who operate under the guidance of the NIAB Quality Manager. For the purposes of this project the audits would be annual.

It is expected that each audit will result in a number of minor areas for improvement and areas of outstanding practice. These will be shared within the project (and more widely within the BEIS programme where appropriate) in order that lessons can be learnt across all elements. In the unlikely event that an audit identifies an area of major concern this will be immediately flagged to both BEIS and the Project Advisory Board and dealt with as a performance management issue and also a potential area for performance improvement.

2.5. Project controls and governance

The basis of the project governance structure is a peer-to-peer approach overseen by a Project Advisory Board composed of NIAB staff, BEIS representatives, industry representatives and subject matter experts. The Chair will be Stuart Knight, NIAB's Deputy Director. The Programme Advisory Board will exist to provide advice relating to the strategic direction of the project and the wider role that the NIAB consortium will have in supporting the development of the biomass sector. It will look at any potential re-direction of effort and resource within the programme as well as identifying the strategic implications of the project results. It will also provide high-level guidance with regards trends and threats to the sector that might impact the project. The BEIS PMO and the NIAB Project Manager will be invited to observe meetings of the Project Advisory Board except where the discussion relates to their own performance when they will be asked to leave the meeting.

It should be noted that the remit of the Project Advisory Board is purely advisory and any decision to change elements of the project must be taken by the Contractual Governance Group and agreed by BEIS and the NIAB Project Manager.

The Project Advisory Board will be reviewed once the successful Lot 1 suppliers have been identified. If appropriate additional members will be co-opted to the Board to provide experience and expertise in specific fields.

2.5.1. Independence

NIAB is completely independent of all commercial entities in the energy crops sector. This is vital for ensuring that the data and guidance arising from the multi-site demonstrator can be relied on by growers and other industry stakeholders.

2.6. Reporting

In a complex programme such as the NIAB multi-site energy crop demonstrator accurate and timely reporting of progress, issues, opportunities and risks is essential for smooth delivery. BEIS have indicated in their requirements for project reporting which form the basis of the reporting timescales that NIAB will work to.

2.6.1. KPIs

The KPIs to be used for this project will be agreed with the BEIS PMO at the Project Kick-Off meeting. The dashboard will also contain project milestones that are coming up in the next quarter or have passed in the previous quarter. These will be colour-coded to indicate the likelihood of issues arising with regards timelines or quality.

2.6.2. Monthly reports

Short summary reports will be prepared prior to monthly calls with the BEIS appointed Project Monitoring Officers. These reports will include a summary of:

- Progress in month against delivery plan and project milestones
- Activities planned for upcoming month
- Areas where BEIS support is requested
- Key live risks and changes in the risk register
- Safety and environmental issues arising

It should be noted that the live KPI dashboard will also be available to the BEIS PMO.

2.6.3. Quarterly reporting

Quarterly reports will be prepared containing the information usually in the Monthly Reports and a snapshot of the full set of KPIs. Included will be:

- Financial information including spend to date and forecast against budget
- Key lessons learnt

2.6.4. Stages gate reviews

It is understood that BEIS will require stage-gate meetings on a 6-monthly basis to assess progress, costs, risks, and spend against the original project plan for the NIAB multi-site demonstrator. NIAB will support these as required with any information needed that isn't in the quarterly reports.

2.6.5. Final reporting

NIAB will prepare draft and final reports on the project including their assessment of the Lot 1 innovations and the wider programme. These will be available in November 2024 and February 2025 respectively.

2.6.6. Site visits and events

It is hoped that the PMO and the BEIS team will visit some of the sites that are being used for delivery of the project. Where possible we will aim to coincide the site visits with either Knowledge Exchange or Innovation Demonstration events taking place to maximise the value to the team. The dissemination events required by BEIS will be included in the KE programme.

3. Innovation selection

While the core of NIAB's programme relates to short rotation coppicing and 2nd generation energy crops we will where possible support the evaluation and demonstration of any projects selected including those relating to semi-wild, algae and forestry innovations.

We have carried out an evaluation of each innovation project against a set of criteria in order to determine which innovations are best supported by NIAB's approach and which will have the biggest impact on the targets that BEIS has for the sector.

Full details relating to the innovation selection process has been provided previously in deliverables WP 2.1 – Selection Criteria and WP 2.2 – Innovation Selection. The criteria are provided in Annex 1.

4. Coordination plan

NIAB has had extensive conversations with the Lot 1 suppliers with regards how they could be supported by a multi-site demonstrator programme. The timing of this report relative to the conclusion of the Lot 1, Phase 1 projects means that there are limitations on the detail available regarding the Lot 1, Phase 2 project proposals and timelines. As mentioned previously, BEIS has not yet selected the successful Lot 1, Phase 2 projects. As such, the plan for coordinating NIAB's activities with those of the Lot 1 suppliers has been developed in principle but will need to be updated once clarity on selection and the details of the proposed programme are available.

4.1. Lot 1 supplier coordination

To develop an over-arching programme plan within which the multi-site demonstrator can provide support the following steps will be taken:

4.1.1. Communication

Key to the success of the NIAB demonstrator programme is open and timely communication with the Lot 1 suppliers. NIAB's independence of commercial interests in this sector allows for straight-forward sharing of information and plans once BEIS's selection has been finalised.

Within the first month following contract announcement it is proposed to have an initial ½ day workshop with each successful supplier to get details with regards the:

- Top-level timescales for their project.
- Timing of opportunities for physical demonstration of innovations.
- Nature of infrastructure required for physical demonstrations.
- Knowledge exchange requirements and ambitions.
- Key risks associated with their delivery programme.
- Expectations that they have of the Multi-Site Demonstrator.
- Opportunities for demonstration of synergies with other Lot 1 suppliers.

Following this initial workshop, we will put in place a regular quarterly call with each supplier to both coordinate ongoing activities and review changes to the points listed above. In the planning of specific demonstration events or activities the communication will be more regular as required.

4.1.2. Programme level workplan

Following the initial workshops outlined above NIAB will create a programme level workplan detailing the timescales for the Lot 1 projects and mapping them against the Multi-Site Demonstrator activities. This will allow for the identification of both risks and opportunities for the programme relating to the timelines and activities of each of the Lot 1 suppliers.

The programme level workplan will also allow for the finalisation of the timing of on-site demonstrator events with external audiences. These timings and the activities that need to be carried out (logistics, etc.) ahead of the events will be shared and agreed with the Lot 1 suppliers.

4.1.3. NDAs

Where necessary, NIAB will enter into Non-Disclosure Agreements (NDAs) with individual suppliers. These will follow one of NIAB's standard corporate templates depending on the number of entities involved.

5. Demonstrator locations

The aims of the demonstrator programme are to determine the impact of climatic and edaphic variation on the growth and feasibility of energy crops as a biomass feedstock, and to demonstrate and evaluate Lot 1 innovations.

The NIAB Multi-Site Energy Crops Demonstrator will run three programmes at the national scale, each targeting a distinct project area to be addressed. These programmes include Core, Satellite, and Existing Trials, with specific requirements being outlined below.

Further detail relating to the site selection process can be found in deliverables WP1.1 – Site Long List, WP 1.2 – Site Short List and WP 1.3 – Other Energy Crop Sites.

5.1. Site specification

5.1.1. Core sites

Plot scale replicated trials are a core part of NIAB's annual operation. The goal of the Core sites is to:

- Provide an independent platform for statistical validation and evaluation of Lot 1 innovations.
- Evaluate energy crop species and varieties.
- Provide five regional centres for demonstration and showcasing Lot 1 innovations.
- Provide centres for hosting Knowledge Exchange events with growers and other stakeholders in the sector.

5.1.2. Satellite sites

Satellite trials are smaller replicated trials, which will be conducted at a large number of sites covering a range of climatic and edaphic gradients. These sites will provide data on the potential range of energy crop species and varieties, both in terms of climate, and soil conditions. In addition, Satellite trial sites will provide ad-hoc demonstration sites, for Lot 1 suppliers needing specific site conditions (e.g. waterlogging, slopes, etc.) for testing or demonstration.

5.1.3. Existing energy crop sites

In addition to planting up to 100 replicated trials at the Core and Satellite sites, NIAB will engage with growers in the NIAB network with existing energy crop plantations. There are a

number of additional sites controlled by our Lot 2 competitors. We have been told that when NIAB is successful in its Lot 2 proposal these will also be made available where possible for evaluation and demonstration purposes.

In addition to testing of Lot 1 innovations, mature sites will allow for assessment of the long-term impacts of energy crops on:

- Long term crop growth and yield
- Carbon Life Cycle Analysis (LCA) and Greenhouse Gas (GHG) emissions
- Impact on soil health
- Water quality and flood mitigation
- Landscape scale impacts to biodiversity.

Without access to replication and controls, these fields must be proximal to similar sites, which have been committed to other crop or plant growth to draw comparison. These include:

- Arable crop growth
- Woodland/ natural restoration
- Managed restoration/ pasture

5.1.4. Exhibition sites

NIAB will host at least two Exhibition style sites, established purely to showcase the BEIS programme, Lot 1 Innovations, and the range of energy crop species and varieties available to farmers. NIAB plants exhibition style plots at multiple sites every year, at both the main NIAB sites and at industry events such as Cereals and Groundswell. These sites will not contribute to the energy crop species and varietal evaluations but will provide two or more additional centres for KE activities.

5.2. Site assessment and evaluation

The experimental trials require homogeneity of soil conditions for fair evaluation of crops or varieties. This is less likely to occur at some of the more marginal sites being considered.

To ensure that trials are conducted on homogeneous, marginal land, NIAB has implemented a Fuzzy C-Means clustering algorithm with auto completion to quantitatively select these areas. The C-Means clustering algorithm clusters 10m2 areas of the potential field sites, based on the following factors:

- Topography
- Mean temperature
- Mean Rainfall
- Soil nutrients
- Soil structure
- Soil organic matter content
- Historic yield maps

The model identifies areas of fields which behave in similar ways. NIAB will select areas for assessment which are:

- The lowest performing areas of fields
- Consistent across their area and from year-to-year

C-means clustering analysis is being conducted on all Core sites, as well as the 60 to 100 Satellite sites to determine the optimal regions of fields for trialling. This analysis may also illuminate variation in crop productivity within single fields, posing potential avenues for additional research. More information on the clustering algorithm is available in deliverable WP3.2 – Statistical Approach.

5.3. Site selection

5.3.1. Core sites

NIAB has identified five geographically widespread sites for hosting of Core trials. These will form the basis of the energy crop species and variety trials, as well as providing key locations for KE activities. These sites are adjacent to substantial existing willow and miscanthus crops.

5.3.2. Satellite sites

NIAB has secured 70 Satellite sites, which have been selected for the range of different climatic and soil conditions that they cover.

5.3.3. Existing sites

To date, 27 existing sites have been identified to evaluate innovations which require a mature crop, such as low ground pressure harvesting machinery, or pelletisation equipment. The number of available sites for testing will further increase when NIAB wins the Phase Two funding, following commitments from companies currently engaged with other Lot 2 bids.

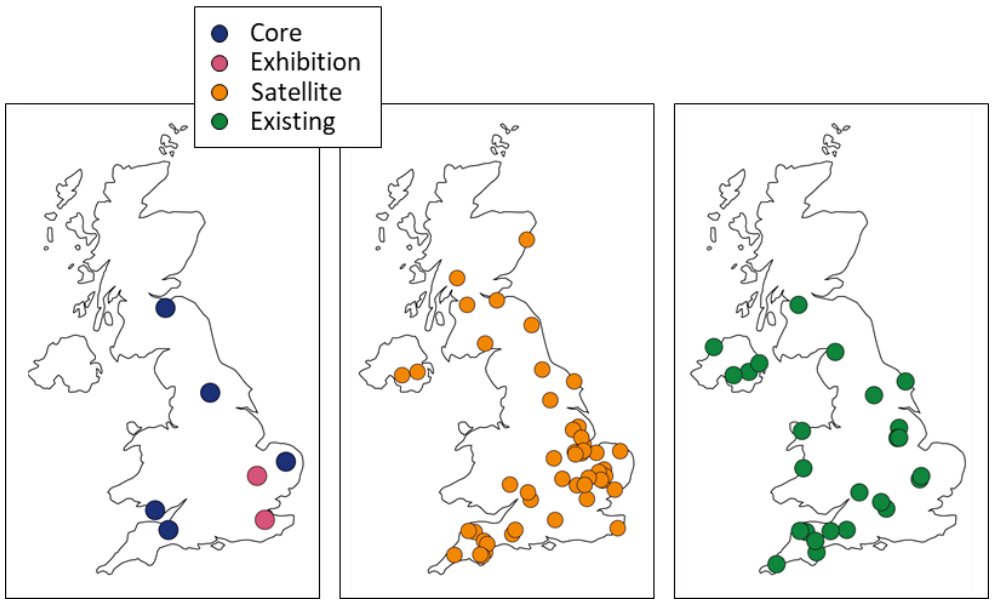


Figure 1 – Demonstration trial sites

6. Demonstrator activities

The over-arching aim of the NIAB multi-site energy crop demonstrator is to demonstrate the technical and commercial feasibility of Lot 1 biomass feedstock innovations with a particular focus on those that have been selected for Lot 1, Phase 2 funding. There is an additional aim specified by BEIS to act as a showcase for their overall programme and to engage with the biomass sector and the stakeholders. This is to promote increased production of biomass feedstocks in the UK.

For the purposes of the multi-site demonstrator, the Lot 1 innovations are in seven main groups. NIAB's proposed approach is heavily focused on technologies that relate to short-rotation coppicing and 2nd generation energy crops. These are the best established of the technologies and have the greatest potential in the short to medium term of supporting the UK's transition to net-zero.

6.1. Short rotation coppicing and 2nd generation energy crops

As has been described above, NIAB intends to run sites across the UK in which varieties of willow, miscanthus and other related crops are planted to evaluate the quality of crop establishment in different climatic and edaphic conditions.

These sites will provide platforms for demonstration of the technologies being developed by all of the Lot 1 suppliers looking at these crops or technologies that directly relate to them. Depending on the nature of the technology it can be demonstrated at some or all of the sites.

In addition to the provision of the platform for the innovation activities there is also a need to provide a robust baseline for these crops in order to support BEIS's aim of promoting the sector with the various stakeholder groups. The baseline assessments will include:

- Crop assessments
    - Establishment
    - Green Area Index (GAI)
    - Normalised Difference Vegetation Index (NDVI)
    - Biomass production
- Economic modelling
- Soil health
    - Nutrient availability
    - Soil Organic Matter (SOM)
    - Soil structure
    - Earthworm count
    - Microbial abundance
- Biodiversity assessments – birds, bats and insects
- Greenhouse gas Life Cycle Analysis (LCA)
- Other environmental measures – flood mitigation and water quality

These assessments will be carried out using a combination of planted crops, and existing crops and datasets. Innovations from Lot 1 will be evaluated against this baseline. Further detail with regards the assessment approaches is given in Annex 4.

6.2. Hemp

Hemp differs from the crops described in section 6.1 above in that it is an annual crop with the potential to be either a break crop, or should legislation change to allow for harvesting the components containing CBD, a high-value element of an arable rotation. In either case it is unlikely that commercial production of hemp will be limited to marginal land.

NIAB currently provides the Hemp DUS (Distinctness, Uniformity and Stability) trials for DEFRA and as such have strong experience working with hemp. Depending on the timing of variety releases from York University's Hemp-30 programme these can be demonstrated alongside the DUS trials. Should it be appropriate to carry out a wider national demonstration of new varieties, NIAB has an established network of growers with hemp licences who would be willing to host trials alongside their crops.

The assessments made for hemp would be the same for SRC and 2nd generation energy crops above.

6.3. Semi-wild crops

NIAB's Farming Systems team will carry out assessments of the economic and environmental impact of those semi-wild crop innovations that are successful in gaining Phase 2 funding. The assessments will look at the impact of the innovation versus the current status quo in terms of:

- Economic modelling
- LCA for Greenhouse gases
- Biodiversity
- Other environmental measures

NIAB will get support on specialist elements of these assessments.

6.4. Algae

As with the semi-wild crops, NIAB will support any algae related projects that are successful in gaining Phase 2 funding. In this instance, the baseline used will be the growing environment without the innovation. As before, the assessments will include:

- Technical feasibility
- Economic modelling
- LCA for Greenhouse gases
- Biodiversity
- Other environmental measures

6.5. Forestry

The two forestry innovation projects (NMC2 and Mostex) are very different in terms of scope. They too can be assessed against the measures of:

- Technical feasibility
- Economic modelling
- LCA for Greenhouse gases
- Biodiversity
- Other environmental measures

NMC2's biodegradable tree shelter can also be demonstrated at a number of the directly NIAB controlled sites but in particular it lends itself well to the two Exhibition sites where there are ongoing tree-planting programmes which it can be used in.

The Mostex equipment could also be shown at Core sites as appropriate but given the development is largely taking place near Thurso in the north of Scotland this may not be logistically feasible.

6.6. Others

There are two projects (led by AFBI and Forest Creation Partners) which are primarily related to the development of crop advisory software applications. Our understanding is that the AFBI application has a degree of overlap with parts of the Knowledge Exchange programme that forms part of NIAB's Lot 2, Phase 2 proposal.

NIAB will look to work with either or both of these projects if they receive Phase 2 funding. Discussions to date would suggest that this would include:

- Sharing of data that NIAB generates
- Providing links to the applications from NIAB's Energy Crop pages
- Providing opportunities to showcase the software to appropriate stakeholders.

In the event that the AFBI project is funded for Phase 2 then NIAB will ensure that there is no duplication between that project and its own programme.

7. Knowledge exchange and public platform

While the demonstration and evaluation of the Lot 1 innovations is a key focus for NIAB's multi-site demonstrator its role as a showcase for Energy Crops more generally is important for BEIS to achieve its programme aims. A significant Knowledge Exchange effort is proposed. An overview is given below with more detail available in the deliverables WP5.1 – Blended KE Programme and WP4.1 – Data Management Plan.

NIAB is a well-respected independent source of science-driven advice that the agricultural sector in the UK has become accustomed to relying on. The KE programme will act as a showcase for the BEIS programme, disseminating key findings, demonstrating innovations, and highlighting the value of innovations, and energy crops more generally, to sustainable, and economically viable energy production, GHG mitigation, and other environmental goals.

The scale of the proposed demonstrator programme when combined with NIAB's unique position as a respected and trusted independent advisory body within the agricultural sector will have a significant impact on the profile of these crops as an option for growers looking to diversify their farms.

7.1. Showcase events

Physical showcasing of energy crops and their associated Lot 1 innovations in the NIAB Multi-Site Demonstrator programme will be conducted at:

- Up to 13 existing NIAB regional centres, many of which already host events and open days
- 5 BEIS 'Core' Multi-Site Demonstration Sites
- 60-100 national ad-hoc locations for demonstration of 'mobile' innovations
- NIAB's Innovation Farm, Cambridge
- NIAB's East Malling campus in Kent
- Other collaborative events, including:
    - AgriTechE AgriTech Week
    - The Morley Agricultural Foundation Young Innovators Forum
- Public facing events and trade shows

7.2. Dissemination of project findings

Dissemination of project findings will be through material available in several formats to suit the range of stakeholders in the energy crop sector. NIAB has extensive experience in production of such material, with dedicated Comms staff with experience in:

- Events delivery
- Digital media
- Website production
- Videography

Classical means of dissemination will be pursued, such as digital and physical media, conferences, and websites. Utilising previous experience in the evaluation of KE activities, NIAB will also produce:

- Short instructional videos
- A 'growers guide'

Project findings will be synthesised in an interactive web-based tool. Stakeholders will further be engaged through delivery of regional 'Energy Crops Clubs', which aim to foster farmer-to-farmer learning, as well as engagement with Lot 1 Suppliers and the wider industry.

7.3. Audience

The NIAB Multi-Site Energy Crops Demonstrator KE Programme will be tailored to the full range of stakeholders involved in the widespread scale-up and adoption of energy crops in

the UK. NIAB is a recognised source of independent knowledge and advice. NIAB's independence of any given technical solution means that growers across the industry have an unrivalled level of trust in NIAB's advice that cannot be replicated by organisations with commercial interests in specific crops or technologies.

NIAB has a dedicated Communications team that focuses on the dissemination of NIAB's research and activities to a wide range of different audiences. For this programme, the range of audiences, and their requirements for KE are:

- Growers – Confidence within the grower community is critical for the widespread adoption of energy crops
- Industry – Engagement with producers of plant material, machinery and end users in power stations and other biomass industries will drive the rate of uptake.
- Policy makers – For the level of acceleration required to meet the CCC's targets, alignment of policy will be essential. It is important that this project ensures that they are being led by independent science rather than narrow commercial interests.
- Academia – In order to maintain the pipeline of innovation it is important that academia is engaged with the BEIS programme.
- Public – NIAB feels that for change at this scale it is important that the public understands the basis of the approach and is engaged in the development of the solutions across the climate change spectrum.

7.4. Data management

A full data management plan has been developed and presented in deliverable WP4.1 - Data Management Plan.

7.4.1. Trials software

It is intended to use Quicktrials as the management tool for the trials programme. It provides the right combination of sophistication of operation with simplicity of use. The API is a necessary feature for easy dissemination of trials results through the knowledge base.

7.4.2. Knowledge base

In addition to gathering data directly there is an ambition to aggregate data from published and unpublished sources in a format to help growers and researchers quickly and easily find relevant material. It is proposed to use the neural search framework Haystack to allow users to locate those documents with the most relevant information for their query. The algorithm "learns" with the number of queries and can be configured in a way that is ideal for non-technical users.

7.4.3. Recommendation engine

In order to guide growers and industry professionals to choose the most appropriate biomass crop, a recommendation engine will be developed in conjunction with researchers. Design of the recommender will be iterated over the course of the project as more data becomes available for analysis. The recommendation engine will be embedded in the user interface described below.

It should be noted that a number of the Lot 1 projects are proposing to develop this functionality and it is NIAB's intention to integrate with their approaches where possible and where we believe this will provide best value to the growers and other stakeholders in the industry.

7.4.4. Delivery

Delivery of the information described above will be through a portal on the NIAB website. This will include intuitive interactive elements and initial wireframes of the user interface have been developed (Figure 2).

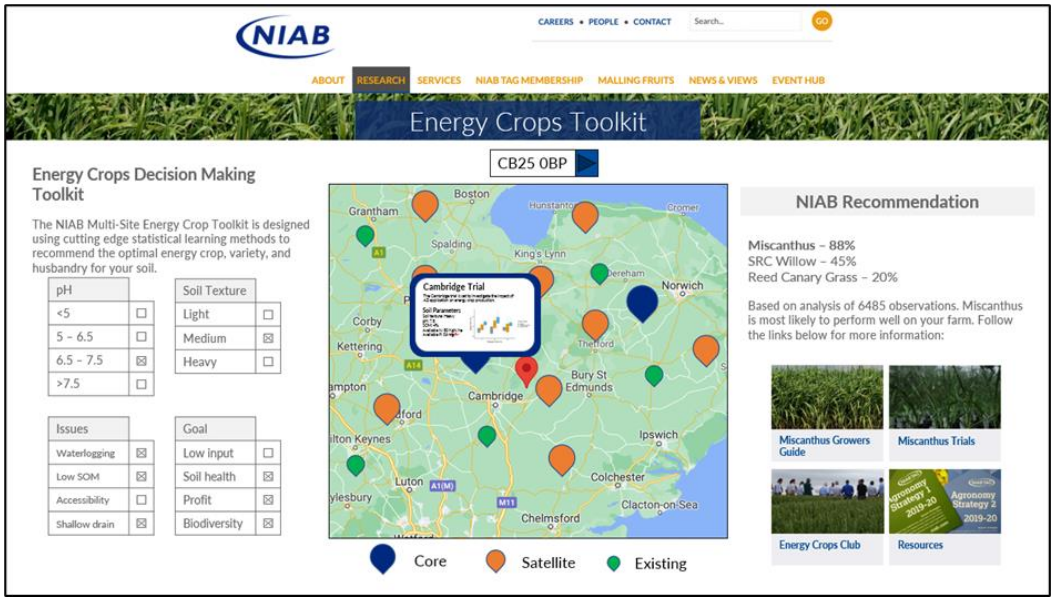


Figure 2 - Example page for Recommendation Engine

8. Conclusion

NIAB has prepared a detailed plan for the delivery or a Multi-Site Demonstrator that will support:

- The trialling of Phase 2, Lot 1 innovations in a range of locations across the UK.
- The trialling of different Phase 2, Lot 1 innovations in conjunction with each other to identify instances of greater cumulative impact.
- The showcasing of the BEIS programme, engaging with stakeholders across the UK biomass sector, sharing data and information and promoting the increased production of biomass feedstocks in the UK.

NIAB's experience and expertise in delivering demonstrator projects of this nature is extremely strong. When coupled with its independence from commercial interests in this area it places NIAB in a unique position of being able to support the growth of these crops. It seems apparent that the lack of NIAB's direct involvement in this role may well be one of the reasons why the sector has stagnated despite the large amounts of government funding that has been invested in it to date.

Without a trusted advisor such as NIAB providing independent science-based advice and support, most growers have avoided energy crops as an option. We strongly believe that with NIAB running this Multi-Site Demonstrator and the activities that we are proposing alongside, it will make a significant difference to uptake and move the UK towards the CCC's aim of >700,000 ha planted by 2050.

Alongside the energy crops focused activities, NIAB is able to also support, evaluate and demonstrate the full range of other Lot 1 innovations. Collaborating with sector specific experts allows NIAB to work with whichever Lot 1 suppliers are selected for Lot 2 funding.

Annex 1 Criteria and scoring for innovations

A 1.1 Evaluation Criteria

The categories of innovation have an impact on the evaluation process. With many of the Lot 1, Phase 1 innovations not being easily demonstrated in a conventional demonstration trials programme, there has been a need to outline what options exist for demonstration.

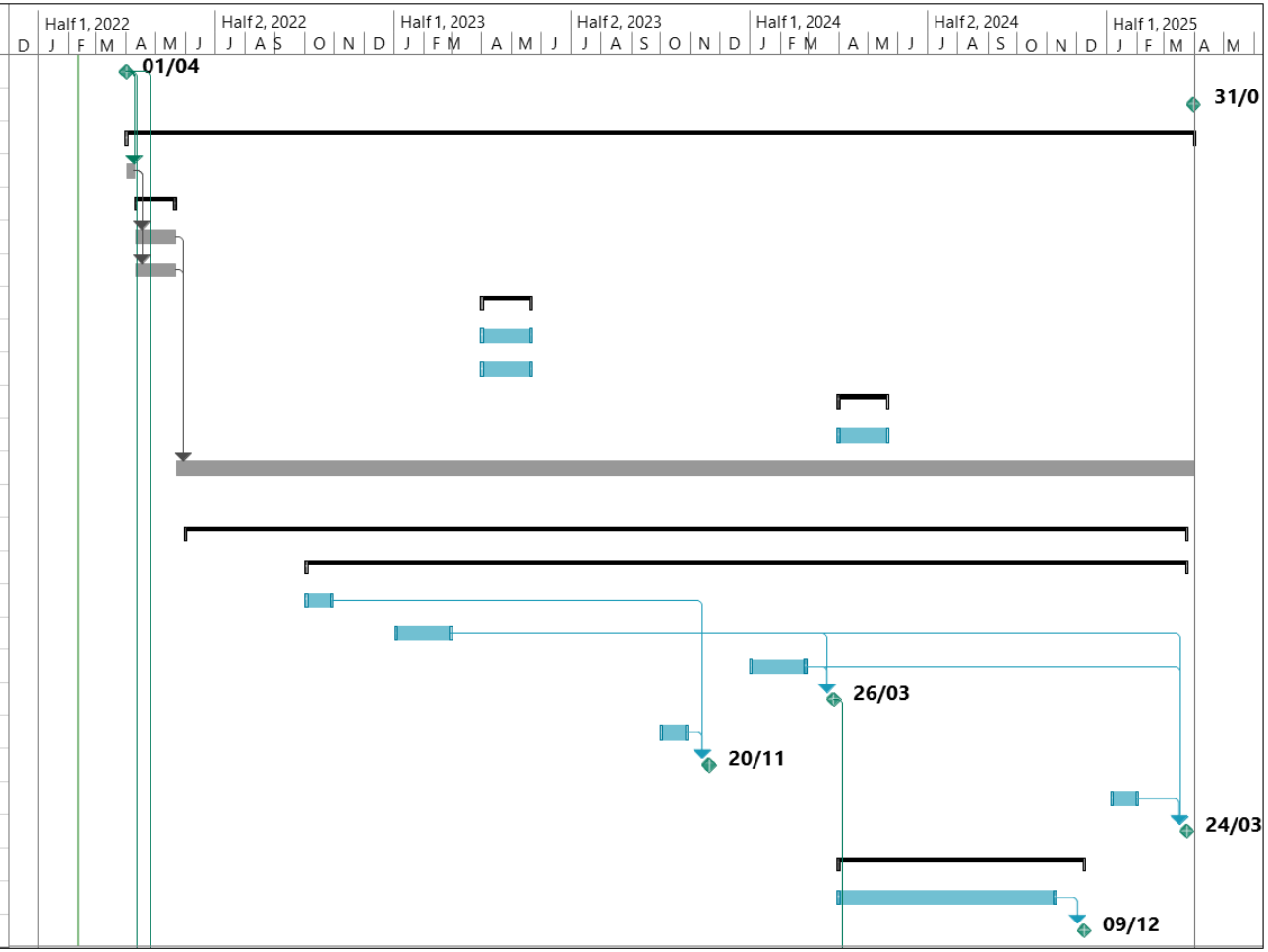
To aid in determining the potential options for demonstration, a set of criteria have been established to quantitatively assess Lot 1 innovations. The key criteria are:

- Technology Readiness Level (TRL)
- Likelihood of success
- Availability of innovation
- Impact of innovation on sector
- Impact of demonstration on innovation
- Cost of demonstration
- Risk

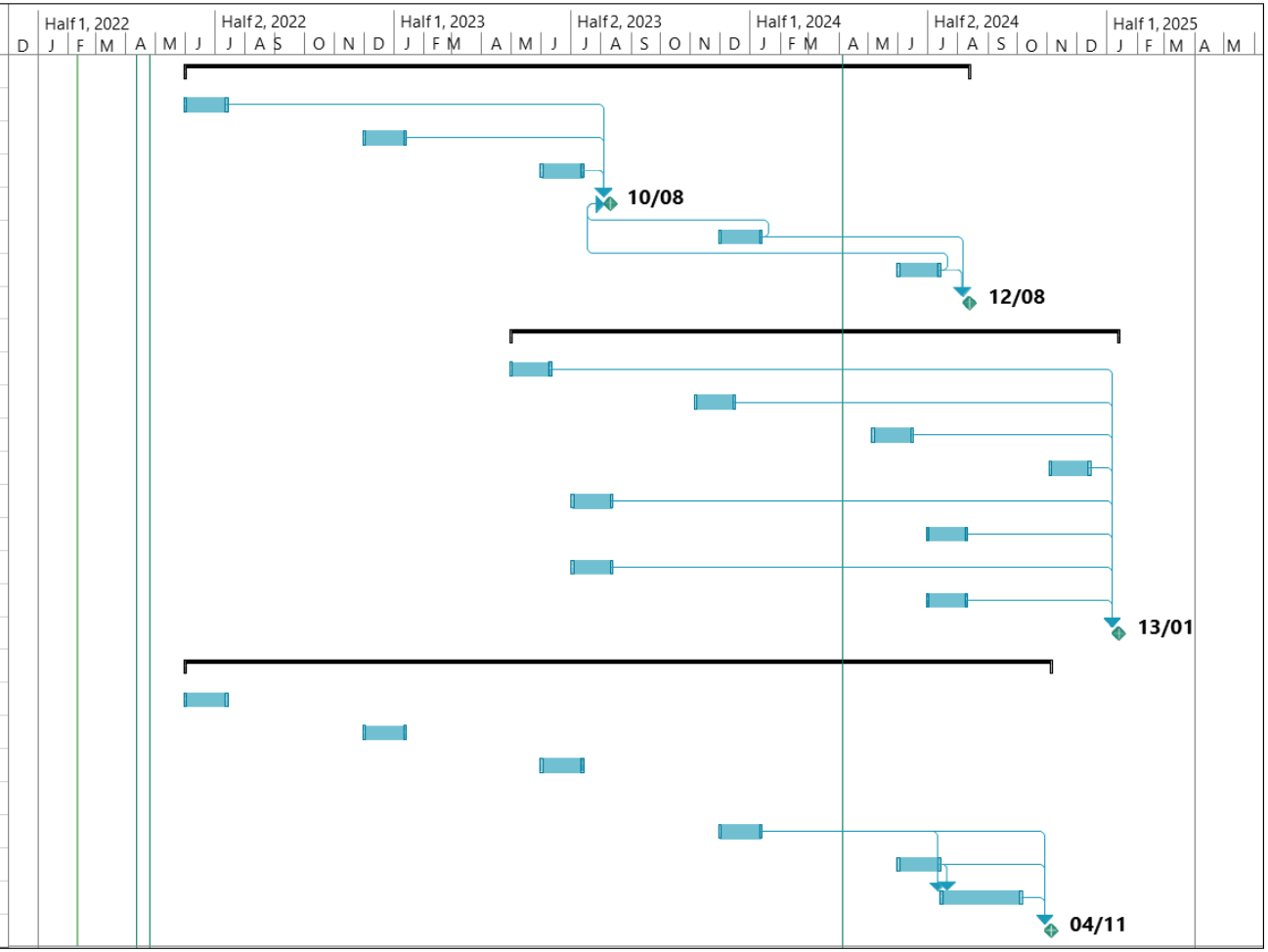
A combined 'pass/ fail' and 'weighted scoring' approach has been taken with regards to the criteria, with weightings associated with each criterion to reflect their relative importance. NIAB has hosted a workshop to independently score each Lot 1 innovation, to identify innovations which may benefit most from demonstration by a multi-site approach. Outcomes from the innovation selection workshop guided the design of the Multi-Site Demonstration Programme, as well as highlighting potential innovations which will need to be independently demonstrated and evaluated by NIAB as part of Phase Two of the BEIS programme.

Annex 2 Phase 2 Gannt chart

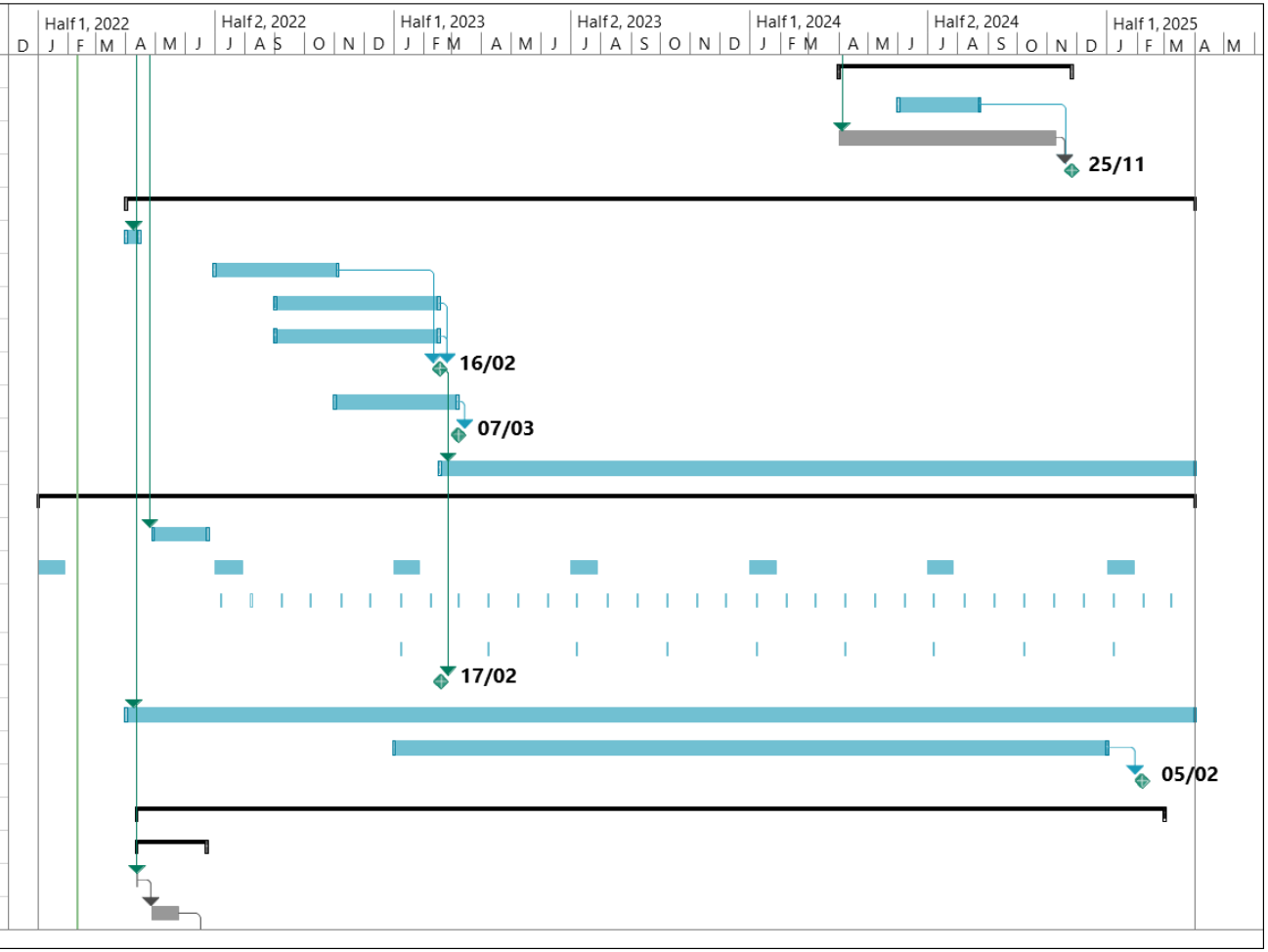
ID	Task Name
1	Project kick-off
2	Project completion
3	**WP1 - Trial site cultivation**
4	Mobilisation
5	**Year 1 planting**
6	Core site planting
7	Satellite site planting - tranche 1
8	**Year 2 planting**
9	Satellite site planting tranche 2
10	Lot 1 germplasm demonstration
11	**Year 3 planting - if required for Lot 1**
12	Lot 1 germplasm demonstration
13	Ongoing site management
14	<New Task>
15	**WP2 - Assessments**
16	**Crop assessments**
17	Establishment assessment - Yr 1
18	Yield assessment - Yr 1
19	Yield assessment - Yr 2
20	Interim yield report
21	Establishment assessment - Yr 2
22	Establishment report
23	Partial yield assessment - Yr 3
24	Yield report
25	**Greenhouse gases - inc Lot 1 innovations**
26	Greenhouse gas assessment
27	Greenhouse gas report



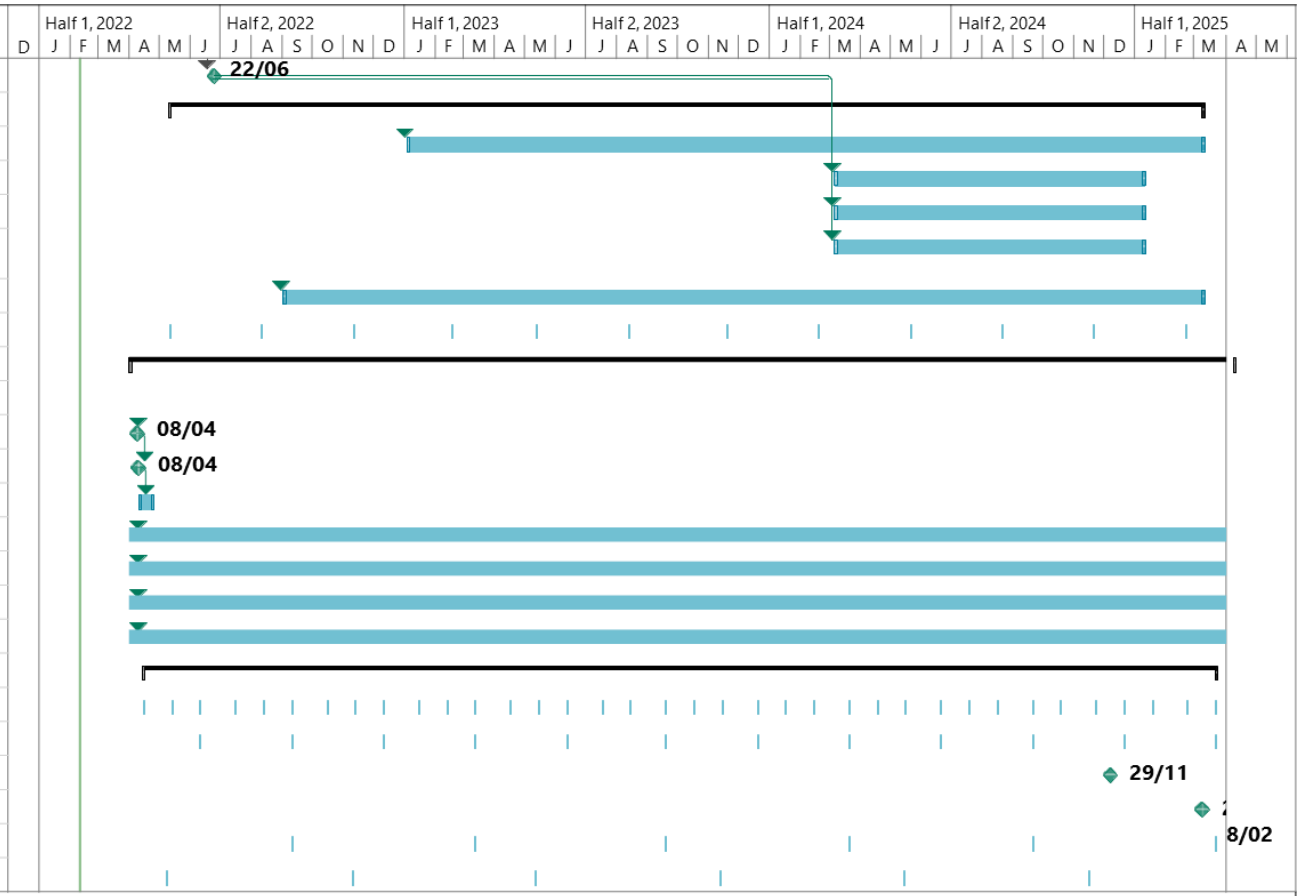
ID	Task Name
28	**Soil - inc Lot 1 innovations**
29	Soil assessment 1
30	Soil assessment 2
31	Soil assessment 3
32	Soil organic impact and organic carbon interim rep
33	Soil assessment 4
34	Soil assessment 5
35	Soil organic impact and organic carbon final report
36	**Biodiversity - inc Lot 1 innovations**
37	Bird count (summer)
38	Bird count (winter)
39	Bird count (summer)
40	Bird count (winter)
41	Invertebrate count
42	Invertebrate count
43	Bat count
44	Bat count
45	Biodiversity report
46	**Water - inc Lot 1 innovations**
47	Water quality assessment 1
48	Water quality assessment 2
49	Water quality assessment 3
50	Water impact interim report
51	Water quality assessment 4
52	Water quality assessment 5
53	Flood mitigation assessment
54	Water impact final report



ID	Task Name
55	**Economic & social impact - inc Lot 1 innovations**
56	Social impact assessment
57	Economic assessment
58	Economic & social impact report
59	**WP3 - Data management**
60	Configure Quicktrials
61	Literature search
62	Configure knowledge hub
63	Configure Haystack
64	Knowledge hub launch
65	Develop grower support tool
66	Launch grower support tool
67	Ongoing data maintenance
68	**WP4 - Knowledge exchange**
69	Digital asset development
70	**Demonstration events - inc Lot 1 innovations**
78	**Conferences, seminars & workshops - inc Lot 1 innovations**
112	**Publications**
122	Energy crop club launch
123	Stakeholder mapping and engagement
124	Policy guidance
125	Policy guidance report
126	**WP5 + - Lot 1 demonstration**
127	**Initial engagement**
128	Lot 1 suppliers announced
129	Lot 1 supplier workshops



ID	Task Name
130	Lot 1 demonstration, assessment and KE plan
131	**Lot 1 activities**
132	Demonstration events - within WP 1
133	Technology assessment - within WP2
134	Environmental assessment - within WP2
135	Economic, social and business case assessment - within WP2
136	KE activities - within WP4
137	**Lot 1 supplier calls**
150	**WP6 - Project management**
151	Mobilisation
152	Kick-off meeting
153	KPI agreement
154	Bubble.io tool
155	Team management
156	Financial control
157	Risk management
158	Planning and change control
159	**Reporting**
160	**PMO reports**
197	**Quarterly reports**
210	Draft final report
211	Final report
212	**Reviews**
219	**Project Advisory Board**



Annex 3 Risk Register

Risk ID	Date identified	Risk Title	Risk Description / Summary	Risk Category	Inherent Impact (1-5)	Inherent Likelihood	Inherent Risk Rating	Mitigating Risk Controls & Actions
1	08/02/2022	Plot variability	Excessive intra-plot variability	Technical	3	2	Medium	• Use yield data and satellite derived history to identify homogenous plots • Engage with statistical protocol design techniques to minimise impact
2	08/02/2022	Analysis delays	Delay in soil, water or harvest analysis	Technical	2	2	Medium	• Retain a portion of the sample for alternative analysis • Use trusted and reliable analysis supplier
3	08/02/2022	Commercial impasse	Grower changes price and conditions of site lease	Commercial	3	2	Medium	• Engage early with growers • Use standard terms and pricing approach • Have sufficient sites that no individual site is essential
4	08/02/2022	Baseline germplasm	Year 1 germplasm supply disrupted	Technical	3	2	Medium	• Confirm immediately with industry suppliers post-contract award
5	08/02/2022	Planting equipment	Allocated planting equipment not available	Technical	2	2	Medium	• Revert to hand-planting
6	08/02/2022	Key NIAB or sub-contractor staff	Key staff are unavailable to project due to illness, injury or leaving the organisation	Management	2	2	Medium	• Develop contingency plan • Ensure work and plans are centrally stored and accessible • Identify substitutes for key staff
7	08/02/2022	Clash of timescales	Key staff are unavailable to the project in a timely manner due to a clash of timing between this project and their other duties. Of particular concern during the main harvest period.	Management	2	2	Medium	• Plan activities well in advance • Ensure engagement with delivery team during planning • Plan activities with harvest schedule in mind • Minimise reliance on field staff during harvest period for other crops
8	08/02/2022	Covid-19 transmission	Covid-19 is transmitted to, by or between project team	Management	3	2	Medium	• Continue to observe government and NIAB internal guidelines on safe working • Continue to monitor AIRTO communications and associated best practice • Consider remote workshops and meetings where appropriate
9	08/02/2022	Lockdown prevents fieldwork	Lockdown prevents staff travelling to sites - note, NIAB staff were considered essential workers in previous lockdowns.	Management	2	1	Low	• Request farmer collects samples if not possible for NIAB staff
10	08/02/2022	Lockdown prevents events	Lockdown prevents in-person KE events	Management	1	1	Low	• Re-arrange any in-person events to take place on-line • Re-schedule events that must take place in-person
11	08/02/2022	Inflationary pressures	Costs rise and are not affordable within budget	Technical	2	2	Medium	• Schedule cost reviews • Maintain dialogue with BEIS around costs and expectations
12	08/02/2022	Project Advisory Board unavailability	Preferred candidates for the Project Advisory Board are no longer available	Management	1	2	Low	• Identify alternative candidates • Engage early with PAB members
13	08/02/2022	Inaccurate cost assumptions	Costs calculated for proposal are incorrect and actual delivery costs are substantially higher leading to a financial strain on NIAB	Commercial	2	2	Medium	• Ensure regular monitoring of costs during delivery • Review costs with finance team • Ensure that activities are planned with cost as a consideration
14	08/02/2022	Lack of BEIS engagement	BEIS staff unable or unavailable to engage with the project leading to differences in expectation and delivery	Management	3	4	High	• Engage early with BEIS staff • Identify alternative engagement options if direct involvment is not possible
15	08/02/2022	Lack of DEFRA engagement	DEFRA do not engage with the project and so impact on policy is limited	Commercial	2	4	High	• Engage early with DEFRA contacts • Leverage support from BEIS links
16	08/02/2022	Accident or injury on site	NIAB staff are injured whilst operating on trial or demonstration sites.	Safety	4	2	High	• Ensure that NIAB staff follow standard SOPs whilst on site • Ensure that site risk assessments are carried out before accessing sites
17	08/02/2022	Delay to innovators due to supply chain issues (inc. Brexit)	Innovation suppliers are unable to develop their projects in a timely manner due to issues associated with transfer of germplasm, materials or equipment across national borders.	Commercial	3	2	Medium	• Maintain ongoing dialogue with innovation suppliers around timings • Where NIAB has particular expertise (i.e. germplasm transfer), offer advice to innovation organisations

Risk ID	Date identified	Risk Title	Risk Description / Summary	Risk Category	Inherent Impact (1-5)	Inherent Likelihood (1-5)	Inherent Risk Rating	Mitigating Risk Controls & Actions
18	08/02/2022	Site access	Inability to access sites for sampling due to restrictions relating to foot-and-mouth or similar.	Technical	3	1	Low	• Follow all bio-security requirements on site and in NIAB SOPs • Request farmer carried out tasks if not possible for NIAB staff
19	08/02/2022	Licensing	Innovations require hemp, GM or novel crop licences to be applied leading to additional cost and potential delays.	Commercial	2	3	Medium	• Identify licence requirements once Lot 1 plans are understood • Incorporate activties into NIAB's existing licenced trials • Maintain dialogue with BEIS regarding impacts and options relating to timing of licence applications • Commence trials for annual plants in 2023
20	08/02/2022	Climatic event	Extreme climatic event (drought, flood, hail, etc) prevents crops establishing where they might normally expect to	Technical	4	2	High	• Check short and medium range forecasts before planting • Replant up to 50% of sites in year 2 if required
21	08/02/2022	Failure to engage with innovation programmes	The NIAB Lot 2 Phase 2 programme fails to engage in an effective way with the Lot 1 suppliers leading to compromised demonstration activities	Commercial	2	2	Medium	• Continue to communicate with Lot 1 suppliers • Ensure programme provides value to Lot 1 suppliers.
22	08/02/2022	Poor crop management	Poor crop management leads to crop failures and outcome data being compromised	Technical	2	2	Medium	• Review and follow trials protocol • Ensure sufficient dedicated staff to oversee any crop activities - e.g. site preparation, planting, harvesting • Regular visits by NIAB specialists to demonstration sites
23	08/02/2022	Staff on extended illness during programme	Key staff unavailable during the programme. Knowhow difficult to replicate	Commercial	3	2	Medium	• Ensure that record keeping is good • Audit trial documentation • Keep clear protocols for all site related activities • Ensure handovers are complete and sufficient
24	08/02/2022	Difficulty in recruiting	Recruitment to new project posts proves difficult and slow	Commercial	3	2	Medium	• Allow sufficient time in programme for recruitment • Check staff packages against market • Identify existing capability that can be used to cover delay
25	08/02/2022	Farmers backing out	Significant number of farmers remove their land from the demonstration programme	Technical	4	2	High	• Large number of sites reduces reliance on individual farms • Ensure incentivisation is appropriate • Communication with farmers to be clear and appropriate
26	08/02/2022	Pest and disease arises	Pest and disease emerges that affects biomass crops	Environmental	3	2	Medium	• Monitor sites • Liaise with international pest monitoring schemes • Apply appropriate controls to prevent spread
27	08/02/2022	Pest and disease introduction	Biomass germplasm introduces pest or disease to trial farm	Environmental	4	2	High	• Check germplasm for signs of disease ahead of planting • Monitor sites • Work with NIAB pest & pathogen teams if outbreak occurs
28	08/02/2022	Data breach	Leak of sensitive personal and/or commercial data relating to project	Commercial	3	2	Medium	• Ensure staff are appropriately briefed and trained • Work with NIAB DPO when setting up digital systems • Ensure that data-sharing agreements are clear and complete
29	08/02/2022	Environmental damage to site	Area used damages important ecosystem services through traffic, chemical or fuel spillages, destruction of habitat during crop establishment.	Environmental	3	2	Medium	• Carry out full risk assessment ahead of site activities • Ensure staff are appropriately experienced and qualified for tasks • Owners assessment of sites before planting • Check timing of activities against nesting (and similar) periods
30	08/02/2022	Phase 2 late	Phase 2 kicks off late and it is not possible to plant crops during 2022	Commercial	4	4	Very High	• Ensure BEIS are aware of impact • Make sure all BEIS questions are answered promptly • Have planting capability as "ready to go" as possible
31	08/02/2022	Lot 1 innovation risk profile	Lot 1 innovations may have associated environmental, safety or reputational risks that mean they can't be included within the Demonstrator programme.	Safety	3	3	High	• Carry out risk assessment once Lot 1 selection is known • Work with Lot 1 suppliers to identify risk mitigation measures

Table 1 – Highlights of Phase 2 Risk Register.

Annex 4 Innovation assessments and baselining

Agronomic assessments of energy crops, including soil health measurements are routinely conducted by NIAB trials staff. The following assessments are designed predominantly for the Core and Satellite sites but will also be utilised at Existing sites where appropriate.

A 4.1 Crop assessments

A 4.1.1 Establishment

As new planted energy crops are unlikely to provide robust yield data within the project duration, it is important to evaluate establishment as another important factor of energy crop production.

A 4.1.2 GAI

Green Area Index (GAI) is a qualitative proxy for growth, comparing the amount of green material to bare soil against a pre-determined scale. GAI can be normalised using photo-based analysis, to prevent bias between those making observations.

A 4.1.3 NDVI

Normalized Difference Vegetation Index (NDVI) is a quantitative measure of greenness, and is measured by a specialised camera mounted to a drone, or sometimes, satellite imagery can be appropriate for analysis. NDVI can be used to estimate plant biomass, and can be included in the aforementioned clustering model to identify more and less productive areas of fields, and farms.

A 4.1.4 Height

Crop height is a standard proxy for growth, and combined with stem thickness can act as a proxy for total biomass.

A 4.1.5 Stem number

Counting number of stems per plant will enable determination of varieties or treatments which increase biomass through increasing stem number. Combined with stem height and thickness, stem number can be used to estimate total biomass.

A 4.1.6 Early biomass

Many energy crops are cut back after the first year to encourage increased growth. Although there is only limited evidence that year 1 biomass production can be used to predict future biomass potential, it is indicative of establishment success. Where possible, biomass will be measured after cutting and drying, then weighing biomass on a per plot basis. Where this is not feasible, such is the case for willow, NIAB will implement established methodologies for estimating crop biomass, from measurements of stem height, number, and thickness.

A 4.2 Soil Health

A 4.2.1 Nutrient availability

Marginal land may be deficient in certain macro or micronutrients required for optimal crop growth. Therefore, monitoring of soil nutrients over time will be essential to ensure that

nutrients do not become limiting to growth, and that the soil is not depleted of nutrients for if/ when the field is returned to arable cropping.

A 4.2.2 SOM accumulation

Sites may be classified as marginal due to degradation of soil organic matter (SOM), which is essential for several ecosystem services, and many farmers strive to maintain or increase SOM levels on farm. Large, perennial energy crops are associated with the ability to increase SOM, which may return marginal land into land suitable for arable cropping after the 20-year lifespan of the crop.

A 4.2.3 Soil structure

Improved soil structure is another reported benefit of perennial energy crops but can be heavily impacted by harvesting the crop while the soil is wet. The Visual Evaluation of Soil Structure (VESS) is a semi-quantitative method of the assessment of topsoil structure, shown to correlate well with more complex methodologies.

A 4.2.4 Earthworm count

Earthworms are often used as one component in assessments of soil health. As part of the assessment of topsoil structure by the VESS method, the number, and type of earthworms can be assessed. Some ability to identify species/ ecotypes is required to realise the full benefit of the analysis, however identifying adults and juveniles can also provide useful data.

A 4.2.5 Microbial community/ abundance

There is increasing evidence that the soil microbiome can influence growth/health of arable crops. There are several tests for assessing the abundance and diversity of all or specific groups of microorganisms. One simple analysis is the CO2 burst test, which measures the partition of actively respiring microbes in the soil. More complex analyses, such as microbiome metabarcoding may be feasible with interaction with academic partners/ PhD students, looking for experimental sites to test hypotheses.

A 4.3 Biodiversity Assessments

NIAB will deliver a high-quality quantitative synthesis of studies comparing biodiversity in willow and miscanthus with standard agricultural crops or grassland. NIAB will compare biodiversity in perennial bioenergy crops with equivalent areas of marginal land managed for conservation of nature and ecosystem services, which is an important comparator. It is hoped that these observations will guide farm management decisions, as well as inform policy on the cultivation of energy crops as part of Environmental Land Management Schemes (ELMS).

A 4.3.1 Approaches and Methods

NIAB will supplement the existing literature on biodiversity impacts of willow and miscanthus, with a combination of new quantitative synthesis and empirical biodiversity surveys across the UK. Empirical studies will focus on taxa that are functionally important in productive agricultural landscapes, easy to sample at scale, but relatively understudied for

bioenergy crops in the UK – ground-dwelling invertebrates and bats. NIAB will also measure wider biodiversity of birds, bats and insects using acoustic indicators, collected with passive acoustic monitoring. Passive acoustic monitoring represents a cost-effective and scalable method for gathering biodiversity data from a large number of sites simultaneously. Species level identification of bats is possible from the recordings, and acoustic indices calculated from the recorded soundscapes have recently been demonstrated through simulation to be driven by bird abundance and species richness[3].

A 4.4 Expert assessment of bioenergy innovations beyond perennial cropping systems

For other innovations where NIAB does not have an array of test sites to monitor biodiversity impacts directly, NIAB will run a structured expert elicitation exercise, based on the IDEA[4] protocol to develop an informed view of the potential or likely impacts on biodiversity. These innovations include harvesting and extraction of heather or bracken from marginal land or moorland and harvesting agricultural hedges for biomass production. For this purpose, NIAB will convene a panel of experts on biodiversity (all major taxa represented), conservation, habitat management and agriculture.

A 4.5 Greenhouse gas estimation and measurement

NIAB has developed a robust approach to assessing the full carbon budget for perennial energy crops, and related, and unrelated Lot 1 innovations. Where possible, NIAB will conduct a Life Cycle Analysis (LCA) to include all inputs and outputs associated with the biomass stream that the innovations impact on. As none of the biomass cycles are completely contained standard figures will be used for external inputs. The LCA approach includes activities associated with construction of plant, assumed throughput or length of plantation and those activities involved in decommissioning plant or removal of crops at the point that their productivity declines below an economic level.

NIAB believes direct measurement of gas fluxes to be outside the scope of this project but estimates of these fluxes and their CO2 equivalence will be used. In the case of soil organic carbon and biomass carbon being sequestered direct measurement will be made. How the overall levels translate to the CO2 emissions resulting from energy generation will be calculated based on assumptions for distances travelled and information obtained from power station operators.

It is important to note that the approach taken is general and can be applied to all the Lot 1 projects.

[3] Morrison, C. A., A. Auniņš, et al. (2021) Bird population declines and species turnover are changing the acoustic properties of spring soundscapes. Nature Communications 12(1): 6217.
[4] Hemming, V., M. A. Burgman, et al. (2018) A practical guide to structured expert elicitation using the IDEA protocol. Methods in Ecology and Evolution 9(1): 169-180.

A 4.6 Other Environmental Measures

Throughout the course of the programme, observational results may highlight the requirement to undertake additional assessments, outside the original scope of the NIAB Multi-Site Demonstrator.

Where NIAB does not have expertise (for example in the case of water quality and flood mitigation), NIAB will engage with third party contractors to complete the work. Using the example of flood mitigation.