School of Sustainable Food and Farming

School of Sustainable Food and Farming – Project Funding Report

1. Names of applicant(s). Nicola Randall
2. Project title. Sainfoin as an alternative legume forage for Net Zero on commercial beef farms
3. Budget of the project. £14,650
4. Final or interim report Interim (final to be submitted in September 2022)
5. Original objectives of the project.

The project aims to investigate the potential of the expansion of sainfoin as a forage legume around the UK. There are two objectives:
a) Collate the existing evidence for the environmental factors influencing the establishment, yield and nutritional composition of Sainfoin in temperate systems
b) Assess the impact of soil and environmental conditions on the establishment of Sainfoin

6. Changes to objectives.

No key changes. Based on the findings of the evidence review, the focus of the glasshouse experiments will be on soil type and water availability. In addition to the original objectives, the student is carrying out a case study (desk study) investigating evidence relating to the nutritional benefits of sainfoin, which will add value to the project

7. Brief description of the approach taken.

The project is being carried out as an MRes project. The student, Katie Parkinson, is supervised by Nicola Randall and John Reade. This approach offers good value for money & also offers the opportunity for an early career person to gain relevant experience and a postgraduate qualification.
Part 1 addresses Objective 1. A structured evidence review (rapid evidence assessment) of the research evidence for the impact of different environmental factors on the growth, impact, yields and nutritional quality of Sainfoin.
Part 2 addresses Objective 2. Practical experiments to investigate specific environmental factors that influence the establishment of Sainfoin.

8. A summary of progress on the project against the objectives.

Objective 1 complete. Objective 2 (glasshouse experiments) just commencing.
Additional evidence gathering on the nutritional value of sainfoin is also taking place using similar methods to those outlined for Objective 1 (in progress)

9. Achievements and outputs

The evidence review has been written up for submission to a peer reviewed (open access) journal. Once the practical work has been completed, we hope to prepare that for a journal too. We hope to also prepare a technical summary for the agricultural industry. The MRes student undertaking the work, has already completed an outstanding advisory note for an assignment and will use a similar format for this work.

A summary report on Objective, prepared by the student follows:

Evidence for the impact of different environmental factors on the establishment of Sainfoin (*Onobrychis viciifolia)* in pastures: A rapid evidence assessment

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Background

Reducing greenhouse gas emissions (GHG) within agriculture is a challenging concept, requiring major changes to livestock and land management practices. Sainfoin (*Onobrychis viciifolia)* is a perennial forage legume that offers multiple benefits in reducing the environmental impact of farming within sustainable food systems. These benefits include enhanced soil fertility, pollinator resources, natural anthelmintic qualities, reduction of bloating and methane emissions in livestock. Traditionally grown in alkaline soils in the South of England, it is unclear from current available research if sainfoin can be cultivated under different conditions elsewhere in the UK.

Developing knowledge and understanding of alternative forage legumes such as sainfoin can contribute to reducing the environmental impact of agriculture and promote the resilience of farming systems to achieve Net Zero. The objective of this study was to examine the impact of different environmental factors on the germination and establishment of sainfoin for use within sustainable farming systems. This includes factors such as soil type, soil pH, temperature and waterlogged conditions which may influence the establishment of sainfoin. A rapid evidence assessment was conducted, and a searchable database of relevant research was created through systematic mapping methodology.

Methods

To collect an un-biased selection of published and grey literature, a comprehensive search was undertaken using four online databases containing peer reviewed journals, conference proceedings, PhD theses and organisational reports. Web-based search engines were also used to gather relevant research. The title and abstract of articles were examined for relevance against inclusion criteria. A full text analysis was then undertaken to identify studies relevant to the establishment of sainfoin. Studies published in English and focusing on environmental factors influencing establishment of sainfoin were included. Grey literature studies were identified through manual searching and screened against inclusion criteria.

Meta-data was extracted from relevant studies identified in the screening process and key words were used to describe studies. These studies were categorised using a data coding strategy with a range of variables within a spreadsheet. All meta-data and coding are represented in a searchable systematic map database of coded studies. This database was created to illustrate the extent of the research identified during the searches and to highlight any knowledge gaps.

Results

Initial searches identified 485 articles. After the application of inclusion criteria and removal of duplicates, 12 studies were coded for the systematic map database. The studies were located mainly in Europe and North America. Companion crops and weed control were the most common intervention present in the studies. No studies on the influence of soil type, pH or waterlogging conditions on sainfoin establishment were identified.

Conclusions

This systematic map brings together the current available research on the factors influencing the successful establishment of sainfoin and can be used to inform future primary research on the topic. Several knowledge gaps have been highlighted which may benefit from further research. These include the success of establishment on varying soil types and on soil where the pH tends more towards acidity. The influence of waterlogged conditions with high soil moisture was another factor that had not been investigated. These knowledge gaps will be used to inform upcoming practical experiments undertaken by the authors.

General Trends

- There were limited studies available that focused specifically on the establishment of sainfoin, indicating a gap in research. Most studies that were found during the searches were focused on growth and yield after the establishment year, as well as nutritional value for livestock.
- Only one study included in the database after full-text analysis was undertaken in the last decade, suggesting that recent research has focused on factors other than establishment.
- The location of studies was largely contained within Europe and North America; however, this could reflect the exclusion of studies with full texts in languages other than English.
- Influence of companion or nurse crops and weed control were the two main intervention factors included in the articles.
- The spatial scale of plots was generally small, with no studies taking place at a whole field level.
- Most field-based studies took place over 3 – 4 years, while lab-based studies were much shorter.
- A number of sainfoin cultivars were investigated in the studies. Over half the studies also used companion or nurse crops when growing sainfoin.
- Several different soil types were present ranging from heavy clay to silty clay loam. The soil pH ranged from 7.3 – 8.1, indicating a gap in knowledge regarding establishment on more acidic soil types.
- The seeding rate of sainfoin was very variable across the articles with some studies opting for a higher seed rate of 90 – 100 kg/ha and some a much lower rate of 40 – 50 kg/ha.
- Sowing date varied from mid-April to mid-November, however, this may reflect the different geographic location of the studies. The most common sowing date was May.
- Sowing method varied between studies, with some choosing to broadcast seeds by hand, use a plot seeder or undertake cultivation. The small sizes of field study plots may reflect the presence of methods such as hand broadcasting, which would be impractical in larger fields.
- Herbicide treatment was not used in all of the studies, however, the requirement for weed control was noted as an important factor in establishment. A large number of the studies chose to use fertiliser.

Gaps in the Research

- The available literature on the establishment of sainfoin was limited, with only 11 studies being identified after application of inclusion criteria.
- Excepting companion crops and weed control, other intervention factors such as seed rate, cutting date, temperature or seed pod presence did not overlap between studies. The influence of factors such as drought or waterlogging tolerance were not found.
- An identified gap in the research was the pH range of soils that sainfoin can tolerate. Neutral to alkaline soils were present in the studies examined (7.3 – 8.1 pH). It is understood that sainfoin favours alkaline soils, however, it is uncertain to what extent sainfoin will tolerate acidic soils.
- The geographic location of studies was limited mainly to Europe and North America. Only texts in the English language were included in the database, indicating a possible bias to English-speaking countries.
- Sainfoin has traditionally been grown on alkaline soils in the South of England. Three studies were found in the South of England, however, the potential of sainfoin to be grown elsewhere in the UK has yet to be investigated.

Potential Focus for Practical Experiments

This systematic map was created in part to inform practical experiments on the successful establishment of sainfoin under different environmental conditions. The gaps in research that have been identified include the influence of different soil types and soil pH. Sainfoin is traditionally grown in thin, calcareous soils with an alkaline pH, however, it is unclear from the current research if it can successfully germinate and establish in different soil types and at a more acidic pH.

Additionally, the influence of waterlogged conditions on the establishment of sainfoin was not identified in the studies included in the systematic map. It is known that sainfoin is tolerant of dry soils, however, it is uncertain whether it can establish in soils with higher moisture content. Gaining further understanding in these areas would help to better inform sainfoin establishment and its potential to be successfully grown in different locations within the UK.

The practical experiments leading on from this research will focus on evaluating the success of establishment in different soil types and at different soil pH. Additionally, a second study will investigate the establishment of sainfoin at different soil moisture levels ranging from dry, drought conditions to waterlogged soil. These experiments will take place in the glasshouse under controlled conditions.