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| **Project leader:** | Pat Croft, STCRF |
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**AUTHENTICATION**

We declare that this work was done under our supervision according to the procedures described herein and that the report represents a true and accurate record of the results obtained.

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# GROWER SUMMARY

## Headline

A new website (http://www.stockbridgetechnology.co.uk/Automated_Margins/) has been produced to help growers identify the right seed mix for their field margins, specifically tailored to their own crop and management preferences. Login using the password '**entomos'**.

## Background

The horticultural industry faces a range of crop protection issues. Pressures to reduce pesticide use have led to the investigation of many alternative methods for maintaining pest populations below economic damage thresholds. Non-crop plants in farming landscapes can provide a range of important ecological services, including conservation of native flora and fauna and the enhancement of pollination and biological pest control (Gurr *et al.,* 2003). Field margins containing non-crop plants can play an important role in meeting current UK conservation targets (Vickery *et al*., 2004). Margin seed mixes have already been developed that target conservation of bees (Carvell et al., 2006), butterflies (Pywell et al., 2004) and farmland birds (Vickery *et al*., 2009). The effectiveness of field margins in boosting pest control strongly depends on their botanical composition. Not all flowers are suitable for supporting pest natural enemies, despite many biological control agents requiring flowering plants as a source of nectar and pollen (Wäckers *et al*., 2005). Often non-crop elements that are designed for bird or pollinator conservation do not simultaneously make resources available to biological control agents (Olsen & Wäckers, 2007). Furthermore, the inclusion of certain flowering species in field margins can promote pests and impact upon nearby crops (Winkler *et al*., 2010).

Research is now being conducted to design multifunctional field margin seed mixes that can be sown to provide benefits to many target groups simultaneously. Such margins still provide desirable conservation benefits to farmland birds and pollinators, but by also providing resources to encourage pest natural enemies (without encouraging pests) these margins can play a greater role in pest control than they have previously. To achieve this aim, the plants included in a seed mix must be carefully and individually selected based on many criteria and tailored to the crop next to which they are sown.

Ongoing research is also looking to develop field margins that can be employed on a longer-term basis, using perennial species in seed mixes (HortLink – HL0192). Such field

margins should offer an improved return in the long-term, where repeat sowing after several years would not be necessary to retain the multifunctional margin.

It has been shown that growers are more likely to sow flowering margins if these can be tailored to their own fields and circumstances, and are designed to provide beneficial pest control, as well as pollination and conservation. Ensuring that margin mixes provide minimal resources to pest species is important to increase grower confidence in, and uptake of flowering field margins, particularly as evidence is emerging to suggest that this is not always the case (Winkler et al., 2010).

## Summary

Whilst growers commonly construct their own seed mixes, selecting mixes that are beneficial to growers through providing food and nectar for predators/parasitoids and pollinators, is a knowledge-intensive and lengthy process, and unlikely to be embarked upon by the majority of growers. However, the automated system developed within this project is capable of providing details of field margin seed mixes best suited to a grower's crop, management and budget, making tailored, multi-functional margins available to all.

To create an easy-to-use tool for growers, and after feedback, five criteria from the database were selected as most relevant:

1) **The main crop** grown next to the proposed margin - Brassicas, carrots, peas and potatoes were chosen to be included after recommendation from the HDC FV Panel. The answer to this question lead to the omission of plant species known to be associated with pests.
2) **Soil type –** clay, loam or sand. These three broad soil types were chosen because they represent the types of soil relevant to the selection of species from the raw database. Growers will choose the type that best describes their land.
3) **Margin lifespan** – annuals only or perennials included. This allows growers to choose if they wish their margin to persist for multiple years. An annual mix may be more relevant to a grower's rotation. Whereas, a mix with perennials included would have a longer lifespan and allow the margin to become a more permanent landscape feature.
4) **Provenance –** native only or naturalised species included. Growers can use this selection criterion to choose whether they would prefer to sow only native species. No truly exotic species are included in any of the mixes. The naturalised species are

those that are already present to an extent in UK habitats (e.g. *Phacelia tanacetifolia*)

5) **Budget** – economy or premium. This will allow growers to reduce costs should they want to. An "economy" mix will exclude or reduce in number those species known to be more expensive. An explanation on the role of the excluded species will be provided with the seed mix to inform the grower of the plant's value in a multifunctional mix. This will allow growers to decide on the balance between cost and function.

The website can be seen on Stockbridge Technology Centre web site and accessed using the password **entomos**. Growers will be able to access the site through a link from the HDC website (http://www.hdc.org.uk/interactive-tools) or directly through the STC website http://www.stc-nyorks.co.uk/.

There is a welcome page, explaining the background behind the project and the rationale for the website. The top of the page has several tabs relating to:

**Home** – returns the user to the welcome page

**Establishment** – contains notes on land preparation and margin establishment. These guidelines, as used in the hortLINK HL0192 project, give advice on the four steps for optimum margin establishment: site selection; site clearance and weed control; seed bed cultivation; seed sowing.

**Management** – contains notes on how best to manage the margin once established, with particular reference to controlling grasses and weeds in perennial margins using mowing regimes. This section has been developed in consultation with our project partner, Emorsgate Seeds, and a link is provided on the website for further information.

**FAQ** – contains 'frequently asked questions' relating to margins generally and this project more specifically such as justifications for including a greater diversity of plants in a seed mix for increased likelihood of good establishment and for multiple ecosystem service benefits.

**Links** – contains links to appropriate seed producers as well as relevant information on field margins and agro ecosystem research such as the ecostac (FV334 – Hortlink project HL0192), Natural England and SAFFIE websites.

## Financial Benefits

1. Reduced labour costs and seed inputs where perennial rather than annual margin seed mixes are selected (annual options available if preferred), and through the use of seed mixes tailored to establish well under the conditions present on site.
2. Expected reduction in insecticide inputs as a result of improved pest control where field margins are used.
3. Provision of a quick and easy-to-use tool to generate field margin seed mixes, tailored to a growers crops, site, requirements and budget, for use with vegetable crops in the UK. This will potentially save time and money compared to conducting their own research.
4. Provision of 'best practice' guidelines to assist margin establishment and management, potentially reducing the risk of a flowering margin failing to establish.

## Action points for growers

- Use the website tool to identify the correct seed margin mix for your specific vegetable crop and conditions.
- Use the guidelines on the website to establish and manage the field margins.

# SCIENCE SECTION

## Introduction

The project has developed a website capable of generating site-specific multifunctional field margin seed mixes for use in UK vegetable crops (Brassicas, peas, carrots and potatoes). The mixes are considered multifunctional because they provide resource for biological control species, pollinators and birds simultaneously. At the same time, the mixes are also designed not to provide resource or host plants for crop pests. This project collated information from multiple sources into a database to generate a detailed prescription of annual and perennial flowering field margin plants. The output is a site-specific suggestion of a seed mix which takes into account the crop, soil and budget of the grower as well as the grower's preference for a perennial/annual mix or for a mix containing native/non-native species.

## Materials and methods

### *The database*

In order to develop this website information was obtained from several databases: http://www.ecoflora.com/ , http://www.brc.ac.uk/ , and a confidential database obtained from an existing project (FV334, HortLink HL0192). In addition a broad literature review was conducted in order to make additions and amendments to the raw database. The most important criteria from the database were selected, through consultation with the industry representative and agronomists from Agrii (United Agri Products Ltd).

### *The website*

The website was developed by IT consultants under instruction from Catherine Jones and Pat Croft (STCRF) to provide an interface for growers to use.

There was a delay developing the website because the original IT consultant had to step-down because of a change in circumstances (David Chesmore), the first replacement (Charles Standing) had to withdraw from the project due to illness. Second replacements were found (Peter Sawycki and Jill George), the IT company (Branding Iron) also entered into liquidation.

## Results

### *The database*

The database has been finished. After a review of the literature, it contains 109 species that are described using the following criteria:

- Provenance
- Typical height
- Pollen, nectar, bank plant and extra-floral nectar status
- Beneficial insect associations
- Bird associations
- Weed status
- Typical cost
- Pest associations (crop specific)
- Availability from seed companies
- Soil type preference
- Flowering period
- Typical competitive status and dominance
- pH
- Lifespan (annual, perennial, herbaceous)

‘Typical height’ and ‘competitive status and dominance’ were not considered because they have been shown to vary greatly according to environment and management. These will be included as additional information under the headings ‘Establishment’ and ‘Management’.

‘Availability from seed companies’ was universally good and tended to be reflected in the cost of seed anyway.

pH was considered to be a variable that is corrected by growers as part of their land management. All the species in the database could survive over a range of pH values, none of which were at the extremes. Therefore, pH was not included as a website criterion.

Five criteria from the database were selected that relate directly to questions on the website: lifespan, provenance, soil type, typical cost and pest association (relating to ‘main crop’; see next section ‘The website’).

The remaining database criteria were all included in the development of the seed mixes but do not directly relate to questions asked. Instead, they will be included in the information

provided to the grower once the questions have been answered (e.g. red clover has been included in your mix because it provides nectar and pollen for pollinators, has a lot of extra-floral nectar for parasitoids and hoverflies and typically flowers from May to September).

### *The website*

The website is being hosted by the STC server. Growers will be able to access the site through a link from the HDC website or directly through the STC website http://www.stc-nyorks.co.uk/ with the password **entomos**.

From the database and after consultation, five criteria were identified as crucial to the selection of species included in the suggested seed mixes. Agronomic consultation led to limiting the criteria as much as possible to ensure that each criterion is strongly related to the agronomy of the species in the seed mix or to its role within the mix (e.g. not feeding pests known to be associated with a crop, or flowering period). This limitation allowed the website to be easy to use as well as encompassing the crucial selection criteria. The five criteria chosen will result in 96 different seed mixes, each designed to offer maximum value to the grower for a particular suite of field and crop specifications. The criteria are:

6) **The main crop** grown next to the proposed margin - brassicas, carrots, peas and potatoes were chosen to be included after recommendation from the HDC FV Panel. This answer to this question lead to the omission of plant species known to be associated with pests.
7) **Soil type –** clay, loam or sand. These three broad soil types were chosen because they represent the types of soil relevant to the selection of species from the raw database. Growers will choose the type that best describes their land.
8) **Margin lifespan** – annuals only or perennials included. This allows growers to choose if they wish their margin to persist for multiple years. An annual mix may be more relevant to a grower's rotation. Whereas, a mix with perennials included would have a longer lifespan and allow the margin to become a more permanent landscape feature.
9) **Provenance –** native only or naturalised species included. Growers can use this selection criterion to choose whether they would prefer to sow only native species. No truly exotic species are included in any of the mixes. The naturalised species are those that are already present to an extent in UK habitats (e.g. *Phacelia tanacetifolia*)
10) **Budget** – economy or premium. This will allow growers to reduce costs should they want to. An "economy" mix will exclude or reduce in number those species known to

be more expensive. An explanation on the role of the excluded species will be provided with the seed mix to inform the grower of the plant's value in a multifunctional mix. This will allow growers to decide on the balance between cost and function.

There are two more questions on the site, relating to the grower's details and location these will not affect the resulting seed mix; however, it will provide information on the regions where the website is being used.

The website can be visited at http://www.stc-nyorks.co.uk/. There is a welcome page, explaining the background behind the project and the rationale for the website. The top of the page has tabs relating to:

**Home** – returns the user to the welcome page.

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**Links** – contains links to appropriate seed producers as well as relevant information on field margins and agro ecosystem research such as the ecostac (FV334 – Hortlink project HL0192), Natural England and SAFFIE websites.

**Figure 1.** Welcome page for automated margins website

Click “BEGIN” to be prompted for a password. The password to access the site is **entomos**.

You will be taken to the questionnaire page where you can supply the selection criteria listed above.

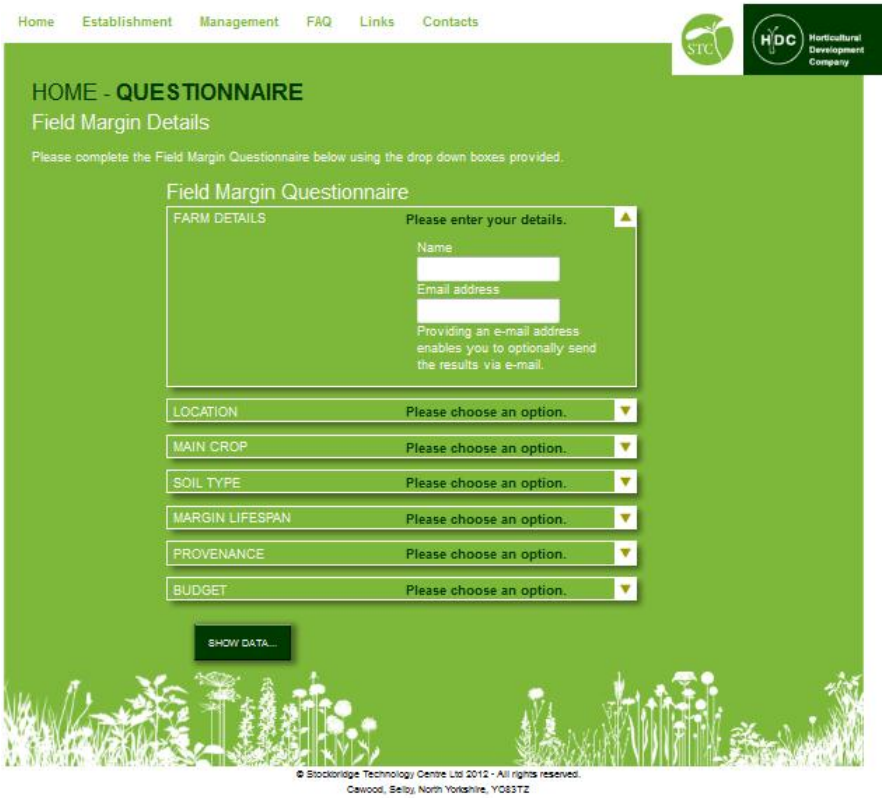


**Figure 2.** Questionnaire page

At all times, users can be returned to the welcome page or any of the other pages relating to the tabs at the top.

Once all 6 options have been chosen, click the “Show data” button. You will be taken to seed mix (landing page) which matches the criteria from the database that you have selected.

Whilst under development, the landing pages are not connected to the database. However, the layout can be seen.

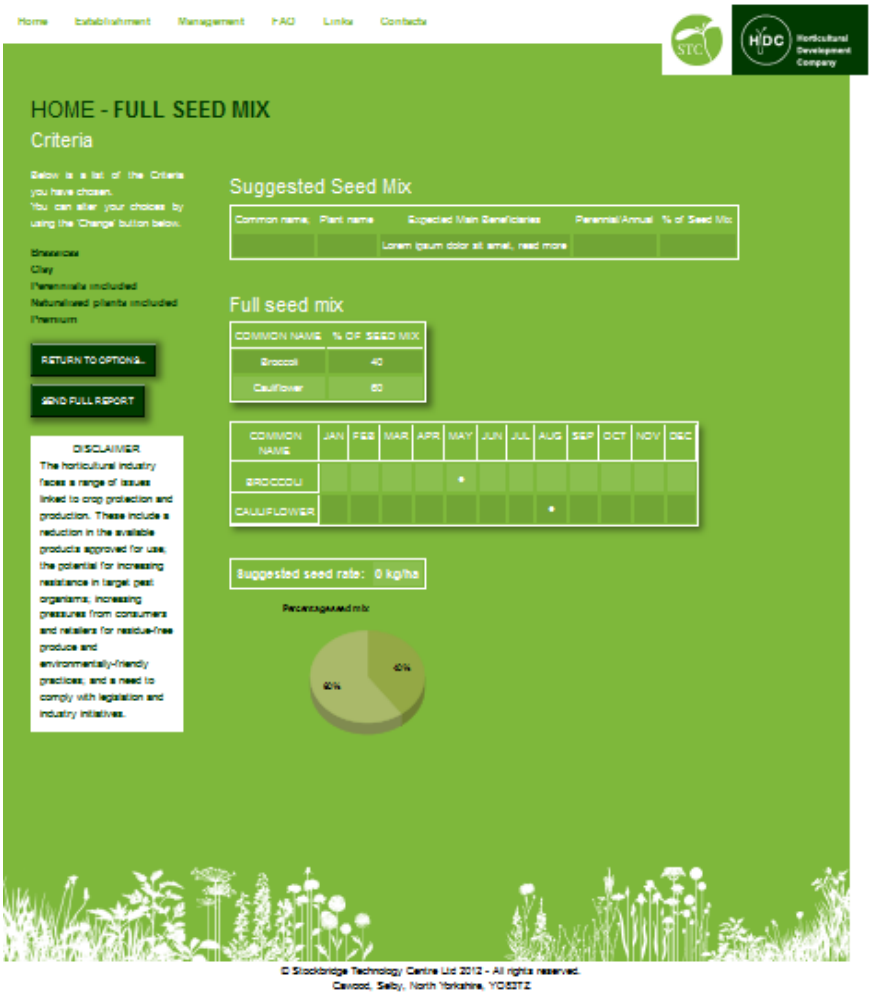


**Figure 3.** Seed mix page (landing page)

On the landing page there is also an option to have the report sent to an email address for printing. Users can return to the home page to begin the process again.

### *Feedback*

Feedback on the development of the database has been collated from growers and HDC and improvements made as requested. However the database is designed for a small number of crops and there is the need to expand

## Conclusions

The database and website are completed. Future feedback on the website can be used to make changes, such as expanding the number of crops covered, soil types and addressing knowledge gaps within the available databases relating to the relationship between species of flowers and crop pests and their natural enemies. Further development of the website in these areas will increase usability and uptake of the website. The website can lead to an increase in the understanding and uptake of multifunctional flowering margins, and the role they can play in Integrated Pest Management (IPM), pollination and biodiversity in field crops.

## Knowledge and Technology Transfer

*HL0192 (FV334) project meeting* – introducing the project consortium to this "spin-off" project

*Invited lecture (Luke Tilley)* – Environment Department, University of York

## Glossary

*Database* – The raw and original data, from which the program (website) formulates the seed mixes

*Program* – refers to the website, the interface to be used by growers to access the information from the database that relates to seed mixes

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