Summary of PGRO R&D project activities

Crop year 2022

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Outputs from projects are reported in the PGRO journals and on the PGRO web site as and when appropriate. They are further disseminated through various means including presentations, reports industry conferences, trade meetings and seminars throughout their duration and after their conclusion.

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Variety evaluation of vining peas (G2020-1, AHDB FV462), combining peas and field beans (L2020-10)

Full Pulse Descriptive List (DL) tables for 2023 were launched on 23rd November 2022 and are available at https://www.pgro.org/pulse-descriptive-list/. The descriptive system gives the flexibility to present all the data gathered in an open and non-judgemental manner, giving growers the opportunity to balance their needs for variety performance with the demands of the market. PGRO is free to assess varieties for all characteristics identified as potentially relevant and publish verified data accordingly. Lists are presented in a sortable list format for the online edition on the PGRO web site. Growers can search for and list varieties by their preferred characteristics.

The DL trial series uses a 5 year rolling data set, the same as the previous Recommended List with Years 1 and 2 coming from National List. Year 3 varieties are new to the list and established varieties are in year 5. The method of calculating the mean of the control varieties has changed from being just 2 varieties per crop to a more robust selection of varieties that have been in the trial series for 4 or 5 years and applies across all types.

As part of the series of trials to assess performance of pulses, disease observation trials were carried out by PGRO in conjunction with those carried out by NIAB to evaluate downy mildew susceptibility. Rust was recorded in spring beans and the data in the DL is influenced mostly by 4 trials in 2020. All ratings are reported in the DL.

The production of the PGRO Descriptive List of Vining Peas is derived from a series of trials beginning in year 1 with a Preliminary Trial and then continuing in years 2 and 3 in Main Trial. Varieties included petits pois (grown on a light silt soil) and standard peas (currently grown at Nocton, Lincs). These trials were funded by seed companies and PGRO levy. Between 2012 and 2018, to provide data from contrasting soil types, all varieties in the standard pea main trial at Nocton were also grown in South Lincolnshire on a silt soil (funded by AHDB-Horticulture) and data were used to provide a descriptive list of standard peas for silt soils. For 2019 to 2021, AHDB-Horticulture funded a variety trial, where the site and varieties were chosen by representatives of the vining pea grower groups and members of the Legume Panel. The trial was conducted in 2022 using PGRO levy. Varieties included standard and petits pois types.

Addresses strategic priorities 1, 4, 5 and 6.

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Yield Enhancement Networks – peas and beans – co-funded by PGRO and industry (L2020-7 and L2020-8)

The Yield Enhancement Network (YEN) connects agricultural organisations and farmers who are striving to improve crop yields. The pea YEN and bean YEN are not competitions, they are grower to grower learning programmes through coordinated widescale benchmarking and sharing. The YENs are open to any interested individual or organisation, commercial or academic. The YENs are run entirely with industry sponsorship and membership fees. There are currently six crop-specific networks: Cereal YEN; Oilseed YEN; Grass YEN; Pea YEN; Bean YEN; and Potato YEN. There are additional YEN's for crop Nutrition and GHG Emissions.

Twenty-five pea crop entries and 39 bean crop entries were monitored throughout the 2022 season, including crop growth stages, images, root samples, grab samples for yield, quality samples and crop nutrition tests. All work was carried out to a simple but detailed protocol to maintain consistency between crops. A discussion meeting was held for pea and bean YENs on 16 January 2023 and a conference for all YENs on 24 January 2023 to review outputs.

Further information about pea YEN and bean YEN can be found at https://www.yen.adas.co.uk/about or at www.pgro.org.

Addresses strategic priorities 1, 2, 3, 4, 5 and 6.

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Improvement of soil health using cover crops in peas – co-funded by EIP-Agri (via the Rural Payments Agency), the Green Pea Company, Birds Eye, HMC Peas and PGRO (L2020-18)

The objectives were to evaluate cover and catch crops for improving soil structure, organic matter content, nutrient retention and management of soil moisture. In addition, soil-borne pathogen levels were monitored using standard plate tests to indicate the influence of improved soil structure on soil-borne pathogens over several years. Grant funding was in place until January 2020. An additional evaluation of the influence of vetch and Berseem clover in the cover for disease impact was carried out. Reports are available at https://www.pgro.org/research-publications/.

Although being carried out in vining peas, results will be relevant to combining peas. Cover crops were established in August/September 2016, 2017, 2018, 2019, 2020, 2021 and 2022. Results showed improvements in soil structure following inclusion of cover and catch crops, and generally no detrimental effects following the inclusion of vetches or Berseem clover in the cover crops. In 2022 there was an indication that vetch cover crops may have caused a higher level of soil-borne *Aphanomyces euteiches,* although infection in the pea crop was very low.

Addresses strategic priorities 1, 2, 3, 4 and 6.

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Varietal susceptibility of combining peas to downy mildew – funded by PGRO levy (L2020-10)

As part of the series of trials to assess the relative susceptibility of combining peas to downy mildew, two disease observation trials are carried out by PGRO in conjunction with those carried out by NIAB. Ratings are reported in the DL.

Addresses strategic priorities 1, 4, 5 and 6.

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Downy mildew control using foliar sprays in peas – funded by PGRO levy (L2020-4)

Foliar downy mildew infection in peas at Stubton in 2022 was low to moderate. Pod infection was high. Revus, Phorce and Amistar were included as fungicide standards, although Revus is approved only in vining peas for DM control, not combining peas. There were 8 confidential treatments. After the first application all treatments gave significant control of DM compared to the untreated plots. Some of the confidential treatments continued to provide effective control later into the season, although the standards did not. At the final assessment, there were no significant differences in foliar or pod infection between any of the treatments, and the crop started to senesce early and rapidly. The 2022 report will be available at Research Publications | PGRO. Work will continue in 2023.

Addresses strategic priorities 1, 5 and 6.

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Foliar applied active substances for control of downy mildew in field beans – funded by PGRO levy (L2020-3)

Downy mildew infection in beans at Stubton in 2022 was moderate to high early in the season, becoming less problematic later. SL 567A, metalaxyl-M, provided significant downy mildew control early in the season compared to untreated plots. Phorce, a fertiliser containing phosphites, also reduced levels of spring bean downy mildew, a result which PGRO has observed in previous trials, although not statistically significantly in 2022. One of the confidential treatments in 2022 gave significant control of downy mildew. The 2022 report will be available at Research Publications | PGRO. Work will continue in 2023 and additional work will be undertaken to evaluate the effects of phosphite products on MRL's in beans.

Addresses strategic priorities 1, 3, 5 and 6.

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Intercropping peas and beans – funded by PGRO levy (L2020-12 and L2020-13)

From 2018 to 2022 PGRO evaluated peas with varying rates of spring oats and spring beans with virtually no inputs. In 2022 as in 2020 and 2021, peas, beans and oats were sown as sole crops and as various intercrop mixtures. In 2022 the LER's dropped for the bean-oat mixtures compared to previous seasons, but the Pea-Oat and Pea-Bean mixtures performed well. A summary of 2021 results can be found at: Pulse Magazine - Spring 2022 | PGRO. 2022 results will be reported in the spring 2023 edition of Pulse Magazine.

Addresses strategic priorities 1, 4 and 6.

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Bean seed fly (*Delia platura*) management – funded by PGRO levy (L2020-6)

Crop losses due to bean seed fly (BSF) are reported to be up to 60% due to failure of establishment and seedling damage. BSF has been identified as high priority for UK vining peas, picking peas, green and runner beans, as well as alliums, asparagus and leafy salads, due to increasing incidents of damage and the loss of key insecticidal substances. There are no approved seed treatments available in UK legumes that control BSF, and ground sprays are not very effective. Crops at most risk are

those planted in late spring and early summer (from mid-late April onwards), and it is reported that the presence of germinating seeds, with recently disturbed soil and high levels of organic material are the key factors that attract the flies. In 2019, 2020 and 2021, PGRO evaluated cultivation techniques that may help to manage BSF attacks in legumes, including timing of spring cultivations compared to drilling date, and degree of tillage (including min-till and no-till). We also evaluated the effects of cultivation techniques and BSF damage on plant infection with soil-borne diseases. Trials were carried out using farm-scale machinery with the assistance of grower groups. Results indicated that that the period between cultivation and drilling may be more important than either drill type or whether rolling had been undertaken. The data also suggested that the traps gave a good indication of periods when attack would be the greatest, and when drilling took place before highest numbers of bean seed fly adults were recorded in traps, damage to seedlings was much lower. This would be expected, as better-established plants are less at risk of damage than imbibing seed and emerging seedlings. In 2022, work was conducted in conjunction with AHDB to evaluate in-furrow and spray applications to control BSF. The final report will be published on the AHDB and PGRO websites.

Addresses strategic priorities 1, 2, 4, 5 and 6.

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Investigation of the effect of cultivation timing on damage caused to vining peas (*Pisum sativum*) by bean seed fly larvae (*Delia platura*) (Becky Howard) AHDB FV462/ PGRO L2020-33

A small plot trial was established in 2020, 2021 and 2022 at Stubton in Lincolnshire to evaluate the effect of cultivations made at weekly intervals up to one month before drilling. Significant reductions in damage were achieved if a period of at least 7 days was left between cultivation and drilling, and the longer the period, the lower the level of damage. This trial was co-funded by the AHDB FV462 Horticulture Strategic Centre for Vegetables in 2020 and 2022, and by PGRO in 2022. Damage from BSF larvae in 2022 was very high at Stubton, and the trial failed due to lack of establishment.

In addition, PGRO maintains a page in the PGRO App to allow incidence of bean seed fly damage to be recorded by growers and advisors across the country. Instructions for use are available and the PGRO App can be downloaded at Google or Apple stores.

Addresses strategic priorities 1, 4, 5 and 6.

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The use of entomopathogenic nematodes (*Steinernema feltiae*) to control bean seed fly larvae in vining peas (Becky Howard PGRO/ Stemgold Peas/ Richard Binks Koppert UK) PGRO L2021-3

A large-scale strip-design trial was carried out at a site in Lincolnshire to assess the efficacy of different timings of entomopathogenic nematodes applied using a dribble bar against bean seed fly larvae in vining peas. Timing of treatment was 2, 4 and 6 days after drilling. In a non-replicated large plot trial, although there were no statistically significant differences between treatments, bean seed fly larval damage was lower in all the treated strips compared to the untreated area, with the lowest level recorded in the strip that was treated six days after drilling. Further work is being conducted to evaluate the effectiveness of entomopathogenic nematodes for control of BSF damage.

Addresses strategic priorities 1, 4, 5 and 6.

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Improved management of virus diseases: Production of a recommended approach to study virus diseases in horticultural crops and its application to example crops (peas) (Becky Howard/ Shona Duffy) – AHDB FV459/ PGRO G2020-11/ FERA Science Ltd./ Defra. (AHDB FV459, G2020-11)

The aim of the project was to develop a cost-effective approach to surveillance of any horticultural crop for the presence of known and unknown viral pathogens, and to allow quantification of the incidence of such pathogens. Each year for 3 years, twenty pea crops were sampled to provide virus incidence data and to identify fields for focused further study of virus yield reduction/impact assessment. High-throughput sequencing (HTS or Next-generation sequencing) was used early in the sampling process to allow identification of the pathogens present in each field, followed by quantification using ELISA and PCR.

In year 1 the project uncovered turnip yellows virus (TuYV) as a novel virus not previously recorded in UK pea crops. TuYV was found to be present in 13 of the 20 crops in 2019, 14 in 2021 and all 20 fields analysed in 2022 had TuYV to some degree. PEMV was present at 6 sites in 2019 and 2021, and 12 in 2022. Other new findings include Soya bean dwarf and Pea Necrotic Yellow Dwarf Virus.

Results are available for 2022 and all results were presented at the PGRO/ Syngenta Road Shows in January. The videos of the road shows have been made available in an email to the PGRO mailing list. A final report will be available in the next month and will be distributed when available.

Addresses strategic priorities 1, 4, 5 and 6.

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Integrated pest management (IPM) in faba beans (Vicia faba): the combined effects of trap cropping and semiochemical attractants on the management of pea and bean weevil *(Sitona lineatus)* and bruchid beetle *(Bruchus rufimanus)* – funded by the Ekhaga Foundation and PGRO levy (G2021-01)

An approach to pest management is to use perimeter trap crops to attract insect pests and prevent infestation of the main crop. Bruchid beetles may be more attracted into earlier developing host crops as they emerge from overwintering sites, where they are able to feed and oviposit, sparing later sown crops from the highest levels of infestation and damage. Pea and bean weevils are also known to have other plant hosts, which in trap crop mixtures, may lead to reduction of migration into bean crops. In conjunction with semio-chemical attractants, we are evaluating the effectiveness of legume trap crops (field beans, lucerne, vetch) to help manage both beetle pests. The results from the first year showed that weevil and bruchid damage were higher in the bean trap crop area but declined significantly further away from the trap crop. There were differences in biodiversity between sites, largely due to farming practice. There were no major differences in biodiversity between the bean trap crops and the rest of the commercial field. Results from the vetch and lucerne trap crops are less clear but show some effects. In 2022 PGRO focused on variations in trial design at the same farm. Three fields had a bean trap crop, one with lures and the others without, and another field contained no lures or a trap crop for comparison. Pest damage from weevils, bruchids and aphids was evaluated in all of the fields. The second-year report will be available following approval of the funder in March 2023. Some of the 2022 results were presented at the Syngenta/ PGRO roadshows on 25th and 26th January 2023 and are available on YouTube. Work continues in 2023.

Addresses strategic priorities 1, 4, 5 and 6.

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Aphid control in field beans (L2020-23)

A trial was undertaken in 2022 containing the standard treatments Decis Protech followed by Aphox, Stealth followed by Aphox and Teppeki followed by Aphox (Teppeki is not approved in SB's). Only very few aphids were present and there were no differences between treatments. The 2022 report will be available at Research Publications | PGRO. Aphid screening will continue in 2023.

Addresses strategic prioirites 1 and 4.

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Aphid control in peas (L2022-01)

A trial was undertaken in 2022 containing the standard treatments Decis Protech followed by Aphox, Stealth followed by Aphox and Teppeki followed by Aphox (Teppeki is not approved in CP's). T1 was applied 23 May and T2 on 13 June. There were 3 confidential treatments. Pea aphid was recorded earlier in the season, and very low numbers of black bean aphid and peach potato aphid at the final assessment in July. All treatments, including the pyrethroid standards, gave significant control of pea aphid after T1. Following T2, all treatments gave significant control of pea aphids. There were no significant differences in the number of black bean and peach potato aphids, mainly due to low numbers of these. One of the confidential treatments gave persistent control throughout, although it was applied only at T1 timing. The 2022 report will be available at Research Publications | PGRO. Aphid screening will continue in 2023.

Addresses strategic prioirites 1 and 4.

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Impact of bruchid seed damage on field performance of field beans (L2020-14)

A replicated, small-plot experiment was conducted in 2020, 2021 and 2022 at Stubton, Lincolnshire, to determine the effect of high levels of bruchid damage to seed on field bean establishment, vigour, disease and pest incidence, and yield. Varying levels of damage were tested. Prior to stem extension, there were significant differences in the early growth of the plants in the first two years of trials. The more infested seeds led to plants with slightly delayed maturity and smaller leaves, although these differences disappeared as the canopy developed. There were no variations in standing ability or haulm length between the plots. In both years there were no significant differences in yield between any of the various levels of seed infestation, although there was a slight trend towards lower yields at the higher infestation levels. Seed costs were calculated using the John Nix pocketbook. The seed cost was only slightly higher for the more infested seed, as the requirement for a greater number of seeds to compensate for the poor germination was offset slightly by the smaller seed size. Income per hectare was generated by multiplying the yield at 15% moisture by £198 £/t (Average of 2020 and 2021 from John Nix). The seed cost was then subtracted from the income calculation to give a margin for each ratio of bruchid in the seed. Spraying and labour costs weren't factored into this but would have no reason to vary between treatments. The margins created by this calculation don't differ significantly from each other but do trend towards a decreased margin for the lower quality seed. This trendline corresponds to a drop of £22.93 per tonne between clean seed and fully infested. A report will be available for the 2022 season in the 2023 spring edition of PGRO Pulse Magazine.

Addresses strategic priorities 1, 4, 5 and 6.

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Fertiliser Manual (RB209), PLANET and MANNER-NPK updates – funded by AHDB, PGRO and BBRO Peas and beans (L2020-21)

In March 2022, sections 1 to 4 of The AHDB Nutrient Management Guide (RB209) were updated. A list of updates can be found at RB209 updates – what's new? | AHDB. The digital version of RB209 can be found at Nutrient Management Guide (RB209) | AHDB.

There are currently no changes for legumes.

Priorities for review and further research are in place, as per steering group meetings. PGRO has a place on the steering group and in the technical working groups.

Addresses strategic priorities 1, 2, 3, 4, 5 and 6.

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Combining pea optimum nutrition (L2020-15) – funded by PGRO

PGRO carried out nutrition trials between 2018 and 2022 to determine optimum practical nutrition options for combining peas. A dry year meant that results from 2022 were not statistically significant. An article can be found that summarises work to 2020 in the spring edition of Pulse Magazine Pulse Magazine - Spring 2021 | PGRO.

Addresses strategic priorities 1, 2 and 3.

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Knowledge transfer partnership No. KTP011104 – vining pea crop development modelling – funded by PGRO and Innovate UK (G2020-10) with Nottingham University and Birds Eye

Vining peas must be harvested within a 1 to 2-day window and time between harvest and processing must not exceed 150 minutes. These constraints lead to wastage and processing inefficiencies which are addressed in this project by predicting yield and quality to enable efficient scheduling of harvest and processing.

The associate, Leah Howells, started this three-year Innovate UK KTP project between PGRO and the University of Nottingham in October 2019, and completed the project in August 2022. Data sources are a combination of direct field and remotely sensed measurements from grower group field sites, and preliminary data analysis and modelling was carried out using historic trial data for the Nocton vining pea site. Work continues to commercialise the model in 2023 and 2024 through Innovate UK Smart grant funding.

Addresses strategic priorities 1, 4, 5 and 6.

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Pulse Crop Genetic Improvement Network – combining peas, field beans and lupins – funded by DEFRA and led by the John Innes Centre (G2020-2)

The network, formed in 2005, is based on collaboration between a strong research base and the UK plant breeding industry to promote development of peas, beans and lupins and assist with more sustainable development of the arable sector. 2021 was the final year of trials

There was a meeting for stakeholders on 18th November 2022, to discuss the latest developments within genetic research on UK pulse crops. The project aims to improve genetic knowledge and resources for plant and seed traits in pea and faba bean, including components of yield, major disease and seed quality traits, including protein content, develop toolkits for UK legume crop breeding programmes, and maximise opportunities for UK legume crop improvement through UK and European collaborations. The project has been extended for a further year. For more information about PCGIN go to Pulse Crop Genetic Improvement Network (PCGIN) (jic.ac.uk).

Addresses strategic priorities 1, 2, 4, 5 and 6.

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PeaGen - Genetic improvement of pea to replace soyabean in the diets of poultry and monogastric livestock – peas – BBSRC Link with Aberystwyth University (IBERS), Stonegate Holdings Ltd., Gressingham Foods, Moy Park Food Company, Senova Ltd., The John Innes Centre, Dalehead Foods, iDNA Genetics, PGRO and Phytatec UK Ltd. (G2020-6)

In this BBSRC-LINK project new genetic approaches to enhance the nutritional value (protein and water-soluble carbohydrate) of the pea seed have been developed. The aim is to increase the use of peas as a high-quality feed in animal diets, reducing the UK protein deficit from the import of soya products and delivering environmental benefits to livestock production systems. The project started in October 2017 and duration was planned for 5 years. PGRO carried out multiplication and evaluation in the first three years. The project has been extended for a year.

Addresses strategic priorities 1, 3, 5 and 6.

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Variety evaluation of lentils (L2020-20) – funded by PGRO levy

21 lentil varieties were evaluated in a replicated (x3) small plot trial in 2022. The lentils performed well with some yellowing due to foot rot and early senescence. A three-year summary report will be published in the spring edition of Pulse Magazine at www.pgro.org. The highest yielding type (red lentils) averaged 3.09 t/ha over the 3 years and were the highest yielding type in both 2020 and 2022. The average yield per year for all varieties was 3.02 t/ha in 2020, 1.68 t/ha in 2021 and 2.42 t/ha in 2022. The likely profitability threshold is 0.8 t/ha.

PGRO conducted a pre-emergence herbicide trial in lentils in 2022. All of the products tested appeared to be crop safe, although none are currently approved in lentils.

Addresses strategic priorities 1, 2, 4, 5 and 6.

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Pre and post-emergence herbicides in field beans and combining peas (L2022-03) – funded by PGRO with agrochemical companies

PGRO conducted pre- and post emergence herbicide trials in 2022. The 2022 report will be available at Research Publications | PGRO. Work will continue in 2023.

Addresses strategic priorities 1, 4 and 5.

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Pea powdery mildew screening (L2020-34) – funded by PGRO levy with chemical companies

Thiopron, Signum and Sunorg Pro were included as standard treatments, with 5 confidential treatments. After the first application in 2022, all treatments provided significant reduction of powdery mildew compared to untreated plots. Powdery mildew is a later developing disease and as crops senesced very early and rapidly in 2022, a second assessment was not possible after T2. One of the confidential products gave the best control, and the standards gave significant control after T1 compared to the untreated plots. The 2022 report will be available at Research Publications | PGRO. Work will continue in 2023.

Addresses strategic priorities 1, 3, 4 and 6.

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Field bean disease screening (L2022-02) – funded by PGRO and agrochemical companies

A trial was conducted at Stubton in 2022 containing four standard treatments and one confidential treatment. Standards were: Amistar fb Sunorg Pro, Elatus Era at T1 and T2, Signum fb Sunorg Pro, Custodia fb Signum. Rust and chocolate spot levels were low in 2022, although downy mildew levels in spring beans were high at the beginning of the season. The 2022 report is now available (see enclosed).

Addresses strategic priorities 1, 3, 4 and 6.

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BBSRC-LINK Pea and bean Downy Mildew Pathosystem: deploying disease resistance, pathogenomics and microbial biocontrol (G2020-13). Lead partner University of Worcester – funded by BBSRC and industrial partners.

The disease is managed using resistant varieties and a limited number of chemical controls; lack of information on prevalent isolates can lead to serious yield losses in crops grown on contaminated sites with incorrect variety selection. Although a differential set of plant cultivars is available to identify the virulence genes in pathotypes of downy mildew, the test is too time consuming to be of immediate use to commercial growers. Use of molecular tools will enable breeders, epidemiologists, modellers and growers to: a) identify the prevailing virulent isolates; b) investigate the epidemics of disease; c) monitor pathogen movement; d) select appropriate cultivar(s) resistant to prevailing isolates; and e) provide a medium/ long-term strategy to minimise increases of disease on land for pulse production.

This project focuses on the identification of new R-genes for breeding and the development of tools for accurate detection and diagnosis of downy mildew isolates. It will also explore biological control agents to control downy mildew. The project consortium consists of 16 academic and industrial partners

Addresses strategic priorities 1, 2, 4, 5 and 6.

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Scaled-up Production and Validation of Pea Midge and Pea and Bean Weevil Pheromones for Pest Management (peas and beans) (G2021-2/ UKRI 10004414). Funded by UKRI and co-funded by PheroSyn Ltd. with PGRO as partner.

Midges and weevils are significant pests of legumes in the UK. There is a growing global trend to move away from reliance on chemical pesticides in favour of integrated pest management (IPM) strategies. Pheromones form an important component of IPM strategies. In this project, PheroSyn developed routes for commercial-scale production of the pea midge sex pheromone and pea and bean weevil aggregation pheromone. PGRO validated the efficacy of the midge pheromone in 2021 and 2022 and found that it is highly effective. Data from both years showed that midge emergence was prolonged, high numbers of midge being recorded in traps from 18th June to 14th July leading to vulnerability of more pea crops to damage as flower buds were forming. Koppert Biological Systems market the pheromones for use in legume production systems. Although less of a problem in the less determinate combining pea crops, the pest can occasionally affect combining peas. The pea and bean weevil pheromone was evaluated in 2022. The project ended in September 2022.

Addresses strategic priorities 1, 4, 5 and 6.

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PGRO PhD program (http://www.pgro.org/phd-studies/):

Realising the environmental benefits of faba beans (*Vicia faba* L.) via optimised nutrition and nitrogen fixation (P2022-02) – PhD Harper Adams University

A consortium of large producers, supply chain businesses, charitable organizations and Universities has been formed to focus on key challenges in a range of crops. PhD projects will address the challenge areas of sustainable farming and the transition to net-zero production, supply chains and the need to enhance food security, use of data science and automation in the agriculture industry to improve productivity and sustainability.

In the first round of applications a proposal submitted by Harper Adams University to examine the effects of nutrients on rhizobial activity and productivity in field beans was approved, and the PhD started at the beginning of October 2022. Trials will be established at PGRO, Harper Adams University and at the James Hutton Institute in 2023 to assist the student.

Addresses strategic priorities 1, 2, 3, 4, 5 and 6.

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Understanding the diversity of organisms contributing to foot and root rot disease in faba bean in the United Kingdom (P2022-01) – Newcastle University with practical support from PGRO

The aim of the study is to describe the essential disease causal agent for faba bean foot rot in the UK and develop a risk prediction system for farmers. Foot and root rot is a disease complex with several contributing organisms. The project will first investigate the causal agents of disease using a combination of classical pathology (isolation/ culturing/ pathogenicity studies) and molecular identification (DNA barcoding). Following characterisation, species specific molecular tools will be developed to enable a broader survey of plant and soil from bean growing locations from around the UK. DNA extraction methods from soil will be evaluated with the aim of developing a risk prediction service for growers, focused on profiling the presence of the key disease-causing agents at sites. Finally, faba bean germplasm available in the UK will be evaluated for the presence of resistance/ tolerance phenotypes which could become the focus of future breeding programs and integrated disease management strategies.

Addresses strategic priorities 1, 2, 4, 5 and 6.

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Understanding and mitigating the causes of yield decline in peas – co-funded by PGRO and BBSRC with Warwick University (P2020-3)

The objectives were to: Understand the components and dynamics of the foot-rot complex as well as associated microbiota in the pea rhizosphere using both conventional and metagenomics approaches; DNA sequence key pathogens and investigate soil microbial communities; Identify green manure / biofumigant crops that can suppress foot-rot. Several pathogens contribute to the foot rot complex, and it was identified that least is known about *Didymella pinodella*. The PhD therefore focused on *Didymella* and its role within the complex. Interactions with the other foot rot pathogens were investigated. The PhD started in March 2018 and the thesis was submitted in early 2022. A summary can be found at www.pgro.org.

Addresses strategic priorities 1, 2, 4, 5 and 6.

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Stem nematode (*Ditylenchus gigas* and *D. dipsaci*) in field beans – co-funded by industry with harper Adams University (P2020-04)

The study aims to better understand the crop pest relationship, to establish a more reliable quantification method and to investigate likely control methods, whether biological treatments (such as catch/ cover/ biofumigation) or cropping techniques, to speed the remediation of infested land and bring it back into economic bean crop production. The PhD started in April 2017 and trials were carried out at sites known to have a high level of stem nematodes. Initial results indicated that some biofumigant mustard crops, such as Indian Mustard, led to potential reductions of nematodes of up to 30% in soils. Laboratory tests indicated that low levels of isothiocyanates lead to immobilisation of the nematodes, preventing plant invasion. The study also showed that some mustard species hosted *Ditylenchus dipsaci* and may be undesirable in rotations that contain this species. The student, Nasamu Musa, was awarded his doctorate in 2022. A summary is available at www.pgro.org.

Addresses strategic priorities 1, 2, 4, 5 and 6.

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Strategies to optimise pollination of the UK field bean crop – funded by PGRO and BBSRC with Cambridge University (P2020-05)

Beginning in October 2018 the project explored strategies to maximise pollination of the UK field bean crop. Recent reports suggest that pollination service is limiting yields in field beans. The study explored strategies for optimising field bean flowers to provide maximum reward to pollinators for minimum foraging energy expenditure. This will have the dual benefit of increasing pollinator attraction to current crops, thus increasing yield, while also supporting wild pollinator populations, thus increasing future pollinator population sizes. A combination of analytical, molecular genetic and behavioural ecology techniques was used. Commercial lines were screened for variation in pollinator-relevant traits and to identify genetic variation of potential use in breeding programmes. The student, Jake Moscrop, completed his studies in late 2022.

Addresses strategic priorities 1, 4, 5 and 6.

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Bean seed fly (*Delia platura*) – Biology and management (supervised by Rosemary Collier and Becky Howard) PGRO/ Warwick University/AHDB (P2020-06)

PGRO is co-sponsoring with AHDB a PhD student at Warwick Crop Centre (University of Warwick) that will further investigate the lifecycle of the bean seed fly, aim to produce an accurate prediction model to aid forecasting of peak activity, and carry out further investigation of cultural techniques (cultivations and land preparation) for improved management. The PhD started on 01 October 2019 and the student is working with PGRO to gather more data from field-scale sites.

Addresses strategic priorities 1, 2, 4, 5 and 6.

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The link between N-cycling and the bacterial cytoskeleton in the Rhizobium-legume symbiosis. University of East Anglia/ PGRO/ BBSRC iCASE (P2020-08)

Species of Rhizobium bacteria form a symbiosis with legume roots where they fix atmospheric nitrogen and provide this to the host plant. Many rhizobia also utilise nitrate/nitrite and must carefully regulate this pathway to control nitric oxide formation, which inactivates nitrogenase. The legume-Rhizobium symbiosis has significant benefits for agricultural sustainability by decreasing the need for synthetic nitrogen fertilisers and associated environmental pollution. Furthermore, legume breakdown returns nitrogen to the surrounding soil and acts as a green fertiliser to enhance soil health. Little is known about the molecular mechanisms of rhizobial growth, its link to nitrogen utilisation and plant colonisation via infection thread structures. Bacterial growth can take place either at lateral or polar locations driven by cytoskeletal proteins. Rhizobiales species exhibit polar growth but very little is understood of the cytoskeletal network that controls this growth in these bacteria. Polar cytoskeletal complexes have been extensively studied in a different group of bacteria, the actinomycetes, where cytoskeletal complexes are not only essential for polar growth but also for cellular organisation of proteins with wide ranging functions. This work will identify the molecular basis for polar growth amongst the Rhizobiales and determine how the rhizobial cytoskeleton controls the cellular localisation of enzymes for N-fixation and N-cycling. The research will study the sequence divergence of both cytoskeletal and N-cycling proteins by analysing field samples from selected UK locations. The work will shed light on how the bacterial cytoskeleton affects the legume-Rhizobium symbiosis and regulates symbiotic nitrogen-fixation in agricultural contexts.

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Remote Sensing and Machine Learning for the Field-scale Prediction of Maturity and Yield in Vining Pea (*Pisum sativum* L.) – Leah Howells Nottingham University – PGRO P2021-1

Leah Howells started this PhD in April 2021, co-funded by The Morley Agriculture Foundation (TMAF). Leah will expand on and publish work from the KTP project described above (Knowledge transfer partnership No. KTP011104/ PGRO 2020-10).

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Knowledge Exchange

a. Advice and literature are produced throughout the year with technical information made available via the web site at www.pgro.org.
b. Marketing reports are collated in conjunction with BEPA and distributed monthly throughout the year.
c. Pulse roadshows/ webinars are held across the country each year during January and February. Details are available at http://www.pgro.org/pgro-diary-of-events/.
d. Technical members of staff contribute to an increasing number of grower/merchant and Ag-chem Meetings.
e. All issues of PGRO Pulse Magazine are distributed through Crop Protection Magazine (CPM).
f. The PGRO Descriptive Lists of vining peas and pulses are published annually.
g. PGRO has developed an Android and Apple application to replace the printed Pulse Agronomy Guide and Vining Pea Guide. All information from the guides are updated in the App.
h. Monitoring services are carried out for bean seed fly, pea and bean weevil, pea moth, silver Y moth and bruchid beetle.
i. Field visits are carried out on request.
j. The PGRO legume crop protection training course is held annually at the beginning of the year.
k. The plant clinic operates all year.
l. Crop updates are distributed to inform about topical issues throughout the year.
m. Telephone consultations remain a very popular contact route for engagement for technical advice.

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Processors & Growers Research Organisation

The Research Station, Great North Road, Thornhaugh, Cambridgeshire PE8 6HJ, UK

Chief Executive: Roger Vickers Tel: +44 (0)1780 782585 email: info@pgro.org www.pgro.org