Summary of PGRO R&D project activities
Crop year 2018

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.

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

The objectives are 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 are being monitored using standard plate tests, with the aim of using molecular tests once developed, to indicate the influence of improved soil structure on soil-borne pathogens over several years. Grant funding is in place until January 2020. An additional evaluation of the influence of vetch in the cover for disease impact is being carried out. Reports are available at https://www.pgro.org/downloads/CovercropsY1ReportJanuary20192.pdf.

Although being carried out in vining peas, results will be relevant to combining peas. Cover crops were established in August/September 2016, 2017 and 2018. Initial results showed improvements in soil structure following inclusion of cover and catch crops.

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

Downy mildew varietal tolerance screening – funded by PGRO levy

This project followed the end of project AHDB FV346 (PGRO and JIC) (Pea downy mildew diversity in the UK) and evaluated downy mildew varietal tolerance at 6 field sites across the UK. Trials included pea varieties selected by the vining pea groups and from the Descriptive and Recommended List varieties. Seeds were untreated or treated only with thiram. The aim was to create a map of the Eastern regions of the UK to show which varieties show better tolerance to downy mildew.

Addresses strategic priorities 1, 4 and 6.

Downy mildew control using foliar sprays in vining peas – funded by PGRO levy

Trials have been established in Yorkshire and Lincolnshire for several years to evaluate the efficacy of different products to control downy mildew infection in vining peas, including the screening of new and existing foliar active ingredients. Products tested in 2018 were Amistar (azoxystrobin) +/- Wetcit as the standard fungicide and 6 confidential active substances. Most treatments significantly reduced foliar infection when compared to the untreated plots, but none of the treatments provided statistically significant reduction in number of pods infected. Amistar provided statistically significant reduction of foliar

infection compared to untreated plots, although this was not the case when combined with Wetcit. There were no differences in yield between treatments.

Addresses strategic priorities 1, 5 and 6.

Development of diagnostic tests for key footrot pathogens – Co-funded by Innovate UK (132852) and PGRO levy with Warwick University and Nottingham University

The project aims to develop qPCR diagnostic tests for the soil pathogens *Fusarium solani* and *oxysporum, Aphanomyces euteiches* and *Didymella pinodella* (previously *Phoma medicaginis* var. *pinodella*). The project started in January 2018 and ends in March 2019.

Following the Innovate UK-sponsored diagnostics project, we would like to focus on the interaction of soil properties, foot rot pathogens and yield loss. The aim is to determine which other factors in addition to presence of pathogens prior to planting peas will determine whether foot rot disease will develop. Soil characteristics like compaction, soil type, pH, organic matter content will be monitored in areas of the field that show disease versus healthy areas. Yield mapping will be performed to help determine the impact of foot rot disease development on yield loss. If successful in the first year in collaboration with HMC we would like to widen the project out to include further geographical area.

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

Bio-remediation of *Aphanomyces* infected soils using plant baiting technique – funded by PGRO levy

This project investigates the potential to interrupt the *Aphanomyces* disease life cycle using alternative host plants. The selected alternative hosts may cause *Aphanomyces* oospores to germinate and the life cycle to be disrupted before they can release new zoospores. This was undertaken in the glasshouse only in 2018.

Addresses strategic priorities 1, 2, 4 and 6.

Foliar applied active substances for control of downy mildew in field beans – funded by PGRO levy

Evaluation of new active substances has been undertaken for several years. Six foliar products were evaluated for efficacy in a trial at Stubton in 2018. Some products are confidential, and we use this trial to pursue approvals for products for field beans. None of the treatments gave a statistically significant reduction of downy mildew, although there was an observed reduction in infection when SL567 was applied. Rust infection was reduced by all treatments compared to untreated plots, although this was not statistically significant. Treatments with Amistar increased the amount of healthy green tissue. There were no differences in yield between treatments.

Addresses strategic priorities 1, 3, 5 and 6.

Combining pea optimum populations – funded by PGRO levy

A re-examination of optimum populations for combining peas was started in 2015, initially for the large blue variety Crackerjack. Original recommendations or 70 plants/ m^2 for blues and 65-70 plants/ m^2 for marrowfats were based on work done in the late 1960's and varieties have changed agronomically since then. 2018 was the fourth year in which Crackerjack was included in trials and Sakura, a marrowfat, was included from 2016 until 2018. Results showed that the recommended target population for marrowfats of 65-70 plants/ m^2 remains the most profitable plant stand in most years. However, the results for Crackerjack are not as straightforward and indicate that a higher plant stand may be required for optimum

profitability, although results are not consistent enough to change the current recommendation, and work will continue in 2019.

Addresses strategic priorities 1, 4 and 6.

Intercropping peas to improve standing ability – funded by PGRO levy

Combining peas have a reputation for lodging before harvest and many growers avoid the crop because of this. Lodging can lead to both yield and quality losses and farmers often quote the damage caused to combines from harvesting lodged crops. Wide combine headers do not help in this respect. There are varieties on the Recommended List with good standing ability, but this cannot be guaranteed, unlike spring beans. An intercrop with peas could provide a scaffold for peas and improve standing ability. In 2017, PGRO grew plots of peas with varying rates of spring oats, barley and oilseed rape with virtually no inputs. The crops were hand weeded, but there was an indication that the intercrops suppressed weed levels. The spring oilseed rape suffered establishment issues and was all but wiped out by pollen beetle. Barley provided little support for the peas. Spring oats were better, and while lodging still occurred, this was later than peas grown on their own. However, the oats were still green when the peas were ready for harvest despite desiccation. The work continued in 2018, using varying rates of oats and spring beans with peas. A summary of 2018 results can be found at:

https://www.pgro.org/downloads/pulse-mag-spring-2019-v0.pdf

Addresses strategic priorities 1, 4 and 6.

Evaluation of spring bean row width – funded by PGRO levy

Currently there is no recommendation in the PGRO Pulse Agronomy Guide for row widths (RWs) for either spring or winter beans. From the 1994 PGRO Field Bean Handbook it was concluded that 'narrow RWs of 20cm or less are optimum for spring beans and their use has become general practice'. The target plant population at that time was 40 plants/m². Through the Optibean project, higher plant populations have been recommended, up to 50 to 55 plants/m² as an economic optimum, considering sowing date, likely yield and produce value and cost of the seed. Where beans are grown in higher rainfall areas, or fertile conditions, or where vigorous growth is expected, plant populations should remain around the 40 to 45 plants/m².

Increasing the plant population means drilling more seed, which means the plants will be more closely associated within the rows (intra-row space). Work conducted by SRUC in Scotland as part of the Optibean project, and PGRO-funded work on RW and inter-row herbicide applications, had indicated that lower yields were obtained from wider RWs (up to 48cm), with the tentative conclusion that there was competition between plants within the row. When direct drilling, RWs are often wider than the 20cm mentioned in the Handbook and, indeed, all the spring bean Optibean work was done on 25cm row width.

In 2016 a small replicated plot trial was established in spring beans to look at the effect of row width on yield. Two densities (40 and 60 plants/m²) were used and 3 RWs (15, 24 and 36cm). In 2017 and 2018 RW's were 15, 18.75, 15/30, 25 and 37.5cm. Density and RW appear to have a bearing on the number of plants established. At 60 plants/m² density there was a clear trend of decreasing establishment with increasing RW. At 40 plants/m² density there was a similar, but less pronounced trend. There was no influence of either density or RW on plant height, with the average range only 3cm across the treatments. Branch counts, % Brackling, Standing ability and Maturity appeared to be little influenced by either density or RW. At 40 plants/m² density there was a small influence of RW on yield, with the highest yields at 25-30cm RW. At 60 plants/m² density yields increased with increasing RW up to 25cm after which yields were lower. Treatment of 15/30 was a double row at 15cm RW with a 30cm gap between the double rows. This

attempted to simulate some types of direct drill which drill a double row and a wider gap, but the drill used was not a direct drill. The 15/30 treatment did not perform as either 15 or 30cm RW. Nor did it perform the same as the 25cm RW (in both cases there were 6 rows across the drilled plot).

Addresses strategic priorities 1, 4, 5 and 6.

Pea and bean weevil control – screening products in field beans (applicable to peas also) – funded by PGRO levy

Several active substances are included in trials each year, to evaluate efficacy and support future EAMU approvals.

Addresses strategic priorities 1, 5 and 6.

Lure-and-kill technology to manage beetle pests (*Sitona lineatus* and *Bruchus rufimanus*) of field beans and peas – co-funded by Innovate UK 101910 and industrial partners Oecos, Exosect, BASF and PGRO, with Keele University, Rothamsted Research and Velcourt Ltd.

The project aimed to develop a 'lure and kill' system using a bio-control agent*, Beauveria bassiana*, to control the beetle pests, pea and bean weevil and bruchid beetle (*Sitona lineatus* and *Bruchus rufimanus*). Pea and bean weevil was the main target. The system tested inoculation stations to attract pests which would then be coated in either the fungal pathogen *B. bassiana* or an insecticide, formulated with an electrostatic sticking agent. The project was co-funded by Innovate UK and BBSRC, with additional funding provided by the industry partners PGRO, BASF Plc., Exosect Ltd. and Oecos. The project started on 1 October 2014 and ended on 31 December 2018. The project showed that *B. bassiana* gave good control of both pests in laboratory conditions, and there were good indications that the formulations worked under protected conditions (field cages). Further work using traps in field margins following harvest is being carried out to determine the density at which inoculation stations should be placed. Results indicated that large numbers of weevils were caught as they moved into overwintering sites, presenting the potential for the system to be used to reduce the population following harvest.

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

AHDB Surveillance approaches, impact and epidemiology of virus diseases to improve management strategies – co-funded with PGRO and FERA Science Ltd.

Plant viruses are transmitted by vectors including invertebrate, fungal or human. Once a plant is infected with a virus it can't be treated and will form a source of inoculum for other plants. Gaining an in-depth knowledge of the epidemiology of plant virus diseases is the key to effective disease management. With the decrease in availability of pesticides for the horticultural industry, alternative approaches such as novel chemistries and cultural management can be expensive to apply prophylactically or may only be allowed with a limited number of applications. Therefore, the primary elements to understanding effective virus management become identification of key vectors and the timing of transmission to formulate management strategies. The aim is to develop a cost-effective generic approach to allow surveillance of any horticultural crop for the presence of both known and unknown viral pathogens, and to also allow quantification of the incidence of such pathogens. Working in pea crops as an exemplar system virus incidence data will be used to identify fields for focused further study of virus yield reduction/impact assessment. The proposal is funded under the AHDB call 'Improved management of virus diseases'.

Addresses strategic priorities 1, 4, 5 and 6.

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

RB209 was updated in May 2017 and 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. The update is available as a downloadable pdf document containing basic principles and crop sections https://ahdb.org.uk/projects/RB209.aspx.
There are currently no changes for legumes.

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

Biostimulants, bio-control agents and nutritional products in vining peas, combining peas and field beans for legume disease management – funded by PGRO levy

Following preliminary trials of several biostimulants, fertilisers and trace element seed treatments in vining peas in 2017, additional trials have been undertaken to evaluate products in vining peas, combining peas and field beans. Impacts on yield and legume diseases (*Aphanomyces euteiches* (root rot) and *Peronospora viciae* (downy mildew)) were monitored. New biological products may offer an opportunity to improve management of soil-borne diseases, and the project aims to test a variety of biostimulants, biocontrol agents and nutritional products in field conditions. Soil applied products were TFP Pro Soil and Serenade ASO. Seed treatments were Radiate ST, Start-Up ST, Take-Off ST, MultiMax GPA ST and Kick-Off ST. TFP Pro-Tect, Zynergy Na13, Agrihit Foliar Tonic, Phorce and Prestop were foliar applications made on two occasions.

2018 results can be found at:

https://www.pgro.org/downloads/pulse-mag-winter-2018.pdf

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

Improving productivity in pea and bean growing through advanced data analytics, machine learning and artificial intelligence techniques – co-funded by Innovate UK and Hummingbird Technologies, with PGRO as a partner

The project aims to develop a remote sensing software analytics platform for peas and faba beans. The platform will allow growers to better understand the health of crops and aid decision making. Experiments and ground truthing will focus on soil health, nutrition and crop growth to stabilise and improve yield and quality in peas and field beans. The project started in October 2018 and ends in September 2020.

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

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

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. PCGIN continued for a further year in 2017 and will be extended for 5 years. Please go to the website for further details www.pcgin.org

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

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.

In this LINK project new genetic approaches to enhance the nutritional value (protein and water-soluble carbohydrate) of the pea (*Pisum sativum* L.) seed will be developed and applied. 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 is 5 years. PGRO will carry out trials to evaluate the agronomic character of the peas and will help to disseminate findings.

Addresses strategic priorities 1, 3, 5 and 6.

Fostering sustainable legume-based farming systems and agri-feed and food chains in the EU (LEGVALUE) – funded by EU Horizon 2020, project no. 727672

The goal of LEGVALUE is to develop routes to sustainable and competitive legume-based farming systems and agri-feed and food chains in the EU. The project will assess both the economic and environmental benefits for the EU agro industry to widely produce and use legumes in a sustainable manner. PGRO is a work package manager for dissemination of findings, as well as a partner to develop farm networks and supply chain case studies. Within this project three UK farm networks have been created to provide further information about the following:

Field beans – benefit of N to following crop

Vining peas – effects of cover crops on soil health

Combining peas – PEA YEN may be used in the first instance to start the pea farm network and show examples of best practice – this farm network is still being formed.

Other case studies across the EU are being used to demonstrate best practice and novel interventions for pulses. There are several combining pea networks.

http://www.legvalue.eu/

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

Transition paths to sustainable legume-based systems in Europe (TRUE) – funded by EU Horizon 2020, project no. 727973

The main aim of TRUE is to identify and enable pathways to successful legume-supported production systems and agri-feed and -food chains. PGRO is a partner for dissemination and stakeholder engagement.

https://www.true-project.eu/

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

PGRO Recommended and Descriptive Lists for vining peas and pulses – funded by PGRO and seed industry
Varietal evaluation

http://www.pgro.org/downloads/A4-rec-list-2019.pdf and http://www.pgro.org/agronomy-guides-publications/

Addresses strategic priorities 1, 4, 5 and 6.

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

Developing novel seed treatments for legumes: Optimising sustainable outcomes in agricultural systems – Co-funded by the University of Stirling, Legume Technology Ltd., PGRO and The James Hutton Institute

Legumes fix atmospheric nitrogen through their symbiotic root-nodule bacteria (e.g. *Rhizobium* spp.) and reduce the need for synthetic fertiliser input. Successful root nodulation relies upon agricultural soils having a sufficiently high inoculum potential. Intensively farmed soils are often lacking in populations of rhizobia due to the rotation of non-leguminous crops and high application rates of synthetic nitrogenous fertilisers. A strategy to combat this is to directly treat the seed with a concentrated inoculum of rhizobia, which ensures suitably high concentrations of root-nodule bacteria in the rhizosphere of the growing root. Because this technology is suitably advanced, there is the opportunity to optimise this process by combining seed treatments that can simultaneously increase biological nitrogen fixation and induce disease resistance through the addition of plant growth-promoting rhizobacteria (PGPR) and resistance elicitors. The focus of this studentship is to develop novel legume-microbe seed treatments as practical liquid, solid or seed coating formulations, and assess subsequent root nodulation, plant development and disease resistance in peas and faba bean. The PhD started in October 2017.

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

Investigating the relationship between *Aphanomyces euteiches* and yield decline in peas – co-funded by PGRO and Nottingham University

The PhD investigates the relationship between *Aphanomyces* and yield in peas and aims to develop molecular techniques for identification of the disease. The PhD started on 1 October 2015 and study continues for 3 years, with a 4th year for writing. Soil sampling and testing was carried out in several fields in different UK regions in 2016 and 2017, prior to planting and just before harvest. Sampling was undertaken to determine UK distribution of *Aphanomyces* and factors that encourage disease. Molecular LAMP assays were carried out at Nottingham University and correlated against the plate test developed at PGRO to determine whether the LAMP assay can be used for quantification of *Aphanomyces* levels. Good correlations were shown, and qPCR was followed up to further validate the LAMP assays. A glasshouse experiment was undertaken in 2018 to determine effects of cover crops (including legumes) on -*Aphanomyces* infection. Thesis submission is due June 2019.

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

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

The objectives are 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.

The PhD study period started in March 2018. Several pathogens contribute to the foot rot complex and we identified that least is known about *Didymella pinodella*. The PhD will therefore focus on *Didymella* and its role within the complex. Interactions with the other foot rot pathogens will be investigated.

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

Stem nematode in field beans – co-funded by industry with harper Adams University

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 initial trials were carried out at a site known to have a high level of stem nematodes. Results are being analysed. The 2018 site selected for trials is known to have a pre-existing infestation of *Ditylenchus gigas* (previously 'giant' race) and potentially *Ditylenchus dipsaci* (previously 'oat-onion' race) and is based at Harper Adams University.

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

PhD – Strategies to optimise pollination of the UK field bean crop – funded by PGRO and BBSRC with Cambridge University.

The project will explore strategies to maximise pollination of the UK field bean crop. Recent reports suggest that pollination service is limiting yields in field beans. We will explore 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 will be used. Commercial lines will be screened for variation in pollinator-relevant traits and to identify genetic variation of potential use in breeding programmes.

Addresses strategic priorities 1, 4, 5 and 6.

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 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 Recommended and Descriptive Lists of vining peas and pulses are published annually;
g. PGRO has developed an android and Apple application to replace the Pulse Agronomy Guide and Vining Pea Guide. All information from the guides will be updated in the App;
h. Monitoring services are carried out for 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. AHDB Aphid News is distributed to members via the PGRO website amongst others.

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The assistance and co-operation of Bees Wax Farming who own the arable land at Stubton and Nocton where the PGRO home based trial grounds are sited and the owner, Sir. James Dyson is gratefully acknowledged.

The cooperation of Mr Michael Sly of Park Farm, Thorney is also acknowledged in allowing part of his land to be used for PGRO pulse trials.

The help of the numerous growers in the provision of additional field trial sites and the many commercial concerns, levy collectors, Industry Panel members, Associates and individuals too numerous to mention by name, is also gratefully acknowledged with sincere thanks.