
Teagasc Potato Breeding Programme Peer Review 2016

Final Report

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Author: Peer Review Panel

Submitted to: Dr Frank O' Mara (Head of Research, Teagasc)

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The Peer Review Panel thanks all of the staff and stakeholders involved for their thorough preparations and presentations and for entering into open discussions with the panel, and Dr Kevin Heanue for providing the secretariat.

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1. Introduction

Teagasc is committed to conducting thorough peer reviews of its research and knowledge transfer activities on an approximate 5-year cycle. The purpose of each Programme review is to:

- Assess if an effective and balanced portfolio of scientific research is being undertaken that effectively fulfils the stated mission of the Programme and meets the needs of its stakeholders;
- Appraise the quality, relevance and impact of the research and knowledge transfer programmes;
- Identify how the research and knowledge transfer programmes could be improved to make best use of resources;
- Provide accountability for public funds expended.

This evaluation report presents the findings of a peer review of the Potato Breeding Programme conducted over the period 12th -13th December 2016 under the auspices of the Director of Research and the Teagasc Business Planning and Performance Evaluation Unit. A Peer Review Panel (PRP) comprised of the following members carried out the review:

John Bradshaw (Chairman), Walter De Jong, Michael Diskin and Mike Storey. Kevin Heanue, Teagasc Evaluation Officer, provided secretarial assistance to the PRP. Details on the panel are contained in Appendix 3.

The review considered management, research and knowledge transfer activities. The management assessment focused on strategy and organisation, while the research and knowledge transfer assessment focused on quality, relevance and impact as well as the programme's sustainability, vitality and feasibility. The review was both retrospective and prospective with an emphasis on arriving at recommendations that would help to achieve improvement in the future. The peer review assessment criteria are outlined in Appendix 2.

The review which included a 2-day series of meetings and presentations took place at Teagasc Oak Park, Co. Carlow. Prior to that, the PRP had received a Programme Description and Self-Assessment document compiled by the Head of Crop Science and the staff of the Potato Breeding Programme. This document provided an internal retrospective summary and appraisal of the Programme's structure, funding, staffing, performance and delivery over the period 2012-2016. Additionally, the PRP were provided with the Review Protocol that guided the Review Process, Teagasc's Technology Foresight Report (2016), Teagasc's 2015 Annual Report, Teagasc's Draft Statement of Strategy (2016-19) and Food Wise 2025, the government's agri-food strategy statement and the Tillage Sector Implementation Plan.

During the 2 days of the on-site visit, the PRP had scheduled meetings with the Potato Breeding Programme management and staff and also had a tour of their research and laboratory facilities in Oak Park. The PRP also had two other meetings, the first with Irish Potato Marketing (IPM), the Programme's commercial partner, and the second with stakeholders (Irish Farmers Association, DAFM, Potato Growers and Bord Bia).

At the outset, the PRP received scene-setting overviews of Teagasc and the Potato Breeding Programme from the Teagasc Director of Research, Dr Frank O'Mara and Head of Crop Science Department, Dr John Spink. This provided the PRP with insights into recent organisational change, the Irish policy landscape, staffing issues, funding levels and drivers of change. The role and remit of Teagasc in general, and the Potato Breeding Programme in particular, were outlined. The PRP were also alerted in broad terms to the importance of Food Wise 2025, Food Harvest 2020, Teagasc Technology Foresight 2016 and the Teagasc Stakeholders Tillage Sector Implementation Plan (2012).

2. Overview of Teagasc Potato Breeding Programme

2.1. Introduction

Teagasc has been breeding new potato varieties since 1962. Originally the programme focused exclusively on breeding for the Irish market but during the 1970s a partnership was formed with Irish Potato Marketing (IPM) which continues to this day (but up for renewal in 2017) and expanded the scope of the programme to breed for export markets. Forty-seven varieties have been released in the intervening period with twenty-seven of these still being marketed commercially by IPM while four new varieties released in 2016 are being commercialized. Rooster is by far the best known of these varieties in Ireland and now accounts for 56% of the total potato area grown in Ireland (approx. 9,000 ha in 2016). Cara was the first commercially successful variety released and is still popular in the UK and some Spanish regions. Royalty income (now ended) from the sales of Cara secured the income and future of the breeding programme.

Currently Burren, Rooster, Banba, Nectar, Slaney, Electra, Galactica, Barna, and Infinity are the most widely marketed varieties (in that order) and seed produced in North Western Europe is exported to over 40 markets mainly in southern Europe, North Africa and the Middle East. This accounts for over 50,000 tonnes of seed sold internationally from production bases in Ireland, Scotland, France and the Netherlands. In addition, Teagasc varieties are being grown as far afield as Australia, North America, Brazil, South Africa and Kenya under local production agreements or by IPM themselves. This has been a recent development and has significant potential to increase royalty income.

The breeding programme at Oak Park releases 1-2 new varieties per year with twenty-two released since 2002 when the current breeding team began. These new varieties are becoming established in both traditional and new markets. For instance Infinity has become an important early season crisping variety in the UK while Nectar, Electra and Fandango are established in many European Markets, with particular success in the UK. Tornado, Galactica, Electra and Fandango are showing excellent promise in traditional seed export markets. Gravity which was released in 2016 is particularly suited to Ireland and the UK where it may compete in the fresh and French fry markets. The potato breeding programme in Oak Park is currently self-sufficient for funding due to direct and royalty income from seed production on commercial varieties including Rooster. The relationship with IPM has been an excellent example of public private partnership.

2.2. Vision and objectives of the programme

The Potato Breeding Programme's vision is to breed sustainable, high yielding, disease resistant varieties for domestic and export markets. Adaptation to diverse environments is a key objective. The programme traditionally focused on table and export varieties (suitable for Southern Europe and North Africa) but more recently has focused strongly on varieties for crisping and French fry production, due to these markets accounting for an increasing proportion of potato consumption. An aspiration of the programme is to support the redevelopment of the Irish seed potato industry in Ireland to underpin targets outlined in Food-Wise 2025 and the Teagasc Stakeholder's Tillage Sector Implementation Plan (2012).

2.3. Structure

The potato breeding programme, part of the Crop Science Department, is based in Teagasc Oak Park, Carlow and led by Dr Denis Griffin. Integrated into the programme is a genomics/genetics research capability that is led by Dr Dan Milbourne (who currently has wider responsibility for genome-based breeding across all Teagasc plant breeding programmes). The two scientists have developed a strong collaborative programme of research that seeks to underpin varietal development. The programme is also involved in associated research and knowledge transfer projects.

Within the programme, research and development activities can broadly be divided into “core” and “associated” research. Core-research activities are those whose goal is to directly impact the efficiency, capacity and effectiveness of the breeding programme. These include development of technology, such as genetic markers; pre-breeding activities focused on exploiting wild and adapted germplasm for parental development; and research and development activities associated with the practical deployment of technology and germplasm within the programme.

The main core research activities in the programme continue to revolve around the development of marker-assisted selection approaches and their subsequent deployment in the programme. A typical “research cycle” might involve trait characterisation and mapping in a *strategic research phase*, followed by development of KASP markers for deployment in a *reduction to practice phase*, followed by eventual *routine deployment* in the breeding programme. Other projects have focused on utilising MAS to “diversify” target resistance loci into a broader range of parental material, and more recently, beginning to develop approaches similar to genomic selection using genome-wide markers to improve selection for more complex traits like cooking quality.

Associated research generally has some future potential impact on the programme, or in some cases supports the potato industry in Ireland, or has broader societal impacts that are in line with Teagasc’s increasing contribution to global sustainability of agricultural systems. These are exemplified in the current research portfolio by work on Cd accumulation, which is a potential problem in potato production in Ireland, and contribution to the development of stable seed production systems in sub-Saharan Africa.

2.4. Resources

An overview of staff and funding resources is presented in this section.

Staff

In 2016 there was 18.1 core (FTE) staff directly involved in the Potato Breeding and associated research Programme compared to 20.1 in 2012, 9 of these are grant-in-aid funded and the rest externally funded. Out of the total, 8 of these were research staff, where there was 1.5 (FTE) of a permanent researcher, 4 Walsh Fellows, 2 contract researchers and 0.5 (FTE) of a post doc researcher. The remainder of the overall staff number is support staff.

Funding

The potato breeding programme in Oak Park is self-sufficient for funding due to direct and royalty income from seed production of commercial varieties. Core research activities are funded by a mixture of external domestic funding and Teagasc core funding. The team has developed a philosophy of following up strategic research activities by strongly focusing on the practical deployment of advances from such activities within the programme. A good

early example of this was the exploitation of the programme's participation in the Global Potato Genome Sequencing Consortium, a global initiative, to drive the routine deployment of marker-assisted selection (MAS) for PCN and blight resistance in the programme.

In order to address the problems of limited resources and low critical mass, the programme has, in recent years, developed a model of commissioned/collaborative/pre-competitive research with other continental European commercial potato breeding programmes and Wageningen University. Currently, this is largely realised by participation in two consortia that are carrying out pre-breeding to introduce a large pool of blight R-genes into elite backgrounds, and developing genetic markers targeting potato wart disease resistance loci in existing cultivars. The goal of this approach is to drive future technological developments in the programme by allowing most core resources to be focused on the "reduction to practice" phase that will allow this research to positively impact the programme.

3. Review of Teagasc Potato Breeding Programme

The potato breeding programme was presented as two components, Teagasc Potato Breeding Programme and Associated Potato Research. Hence the overall programme is reviewed followed by the two components.

3.1. Reflection on Quality

The PRP recognize that the strength and quality of the overall programme derives from the intimate way in which the two components are integrated, making the breeding of finished cultivars more than a routine conventional breeding programme.

The PRP note that research activities in the programme can be broadly divided into core activities whose goal is to directly impact the efficiency and capability of the programme, and those more indirectly associated with the programme, but reliant on programme resources (e.g. development aid work in sub-Saharan Africa). The programme seeks to validate the scientific quality of its research by publishing this work in peer reviewed journals and other scholarly formats where appropriate. Since 2010 there have been 12 peer reviewed articles and 32 non-peer reviewed ones comprising book chapters, edited conference proceedings, articles in technical journals and international conference papers and posters.

The PRP acknowledge that although still relatively new and comprised of a small team, the associated potato related KT is positioned to impact the sector as it has a clear vision and industry-partnered initiatives around salad, chipping and seed potatoes to achieve import substitution and market growth, and also strategies to target practice change and agronomic issues.

In summary, the PRP considers the overall quality of the Potato Breeding Programme to be **very good**.

3.2. Reflection on Productivity

The PRP acknowledge that the primary output of the Potato Breeding Programme is commercial varieties and there are an impressive twenty-two varieties released (or pending Grants of Plant Breeders Rights) since 2002 when the current leadership team took over the programme. But this does mean that the number of peer reviewed publications (on average under 2 per year) is less than expected in a pure research programme.

The PRP considered the overall productivity to be **very good**. **Excellent** in terms of the output of cultivars and **good** in terms of publications.

3.3. Reflection on Relevance and Impact

The PRP note the good stakeholder collaboration and interaction that helps keep this programme focused on industry needs and concerns. The PRP meetings with stakeholders revealed a general satisfaction with the programme and heard that there is a very open and trusting relationship between IPM and the Programme.

The PRP were unclear about the alignment of the objectives of the Potato Breeding Programme with Teagasc strategic goals and CELUP Programme and Crop Science Department objectives.

The PRP note that reflecting the relative newness of associated KT activities, clearer evidence of behaviour change should emerge in the medium term. There is a need now to decide on what are measures/KPI's to benchmark/evidence change.

In summary, the PRP considers the overall relevance and impact of the Potato Breeding Programme to be **good**.

3.4. Reflection on Leadership and Vision

The PRP acknowledge the clear vision, mission and objectives set out by the programme while acknowledging the funding, market, staff renewal and small size challenges that need particular attention.

The PRP recognise the well-integrated, enthusiastic and dedicated team that comprises the Potato Breeding Programme, and particularly note the good understanding and working relationship between the two Principal Investigators driving the breeding and research programmes.

In summary, the PRP considers the overall leadership and vision of the Potato Breeding Programme to be **very good**.

4. Review of Potato Breeding Programme - Breeding

4.1. Reflection on Quality

The PRP acknowledged that while the aim of the Potato Breeding Programme is to deliver cultivars, it develops and deploys novel strategies and technologies from associated research to keep it internationally competitive. The PRP recognise that there is a trade-off inherent between increased publications and servicing the developmental objectives of the programme.

The PRP were of the view that the Potato Breeding team was running a highly effective potato breeding programme which successfully competes with larger programmes.

The PRP noted that the breeding programme is a conventional one, based on 100,000 seedlings per year from 300-350 pair crosses and intensive, early generation selection; an approach still adopted by most commercial potato breeding programmes. But it does incorporate marker-assisted selection and is exploring genomic selection.

The PRP observed the enthusiasm and dedication of all staff and particularly how the skills and knowledge of the technical staff and their integration in the Potato Breeding team was clearly evident. However, the PRP expressed concern that the potential mobility of these staff could seriously jeopardise the science, delivery and impact of the programme because of its unique public private partnership structure.

The PRP are satisfied that the Potato Breeding Programme is well resourced in terms of biotech and pathology laboratories, glasshouses, fieldwork and storage facilities and infrastructure. However, there is a need for replacement of the grader system (including data capture to make breeding more efficient) and refurbishment of the screen house.

Overall, the PRP rated the quality of the work to be **very good**.

4.2. Reflection on Productivity

The PRP acknowledge that the primary output of the Potato Breeding Programme is commercial varieties and there are an impressive twenty-two varieties released (or pending Grants of Plant Breeders Rights) since 2002 when the current leadership team took over the programme.

The PRP acknowledge that within Teagasc programmes, Potato Breeding is unique in being 100 per cent externally funded.

The PRP considered the overall productivity to be **very good**. **Excellent** in terms of the output of cultivars and **good** in terms of publications.

4.3. Reflection on Relevance and Impact

The PRP consider the relationship between the Teagasc Potato Breeding Programme and IPM to be a good example of public private partnership and note the very integrated, open, trusting relationship developed between the partners over their 40-year relationship.

The PRP were not aware of any other comparably structured arrangement in the potato breeding sector (i.e. public/private partnership) as opposed to a vertically integrated breeding and marketing operation.

The PRP is satisfied by the evidence of transmission of market-related signals in this partnership as exemplified by how some years ago, IPM correctly identified the emerging importance of the processing sector and that has driven the direction of the breeding programme to focus more on processing quality, as well as PCN resistance.

The PRP are keen to emphasise that for both IPM and Teagasc Breeding programme, a continued focus on export markets is essential, while not ignoring the Irish market.

The PRP were unclear about the alignment of the objectives of the Potato Breeding Programme with Teagasc strategic goals and CELUP Programme and Crop Science Department objectives.

Overall, the PRP assessed the relevance and impact of the programme to be **good** on the evidence presented.

4.4. Reflection on Vitality, Feasibility and Vision for the future

The PRP were impressed by the comprehensive nature of the SWOT analysis presented in the Programme Description and Self-Assessment Document, a fact all the more important as it was confirmed through discussion that the analysis was a combined effort from across the programme.

The PRP learnt that while there are competitor breeding companies they are unable to penetrate the Irish market with new varieties acceptable to Irish consumers. Teagasc's Potato Breeding Programme, although facing the same challenge, should have a better opportunity to consolidate their position through collaboration with Irish-based stakeholders (e.g. Bord Bia, producers, DAFM etc.).

The PRP noted the peculiarity of the Irish potato market in terms of environment, cultural preferences and market structure and hence the opportunities for new Teagasc cultivars in this market. The PRP is of the view that there is a need for the Potato Breeding Programme to better understand this peculiarity. The peculiarity of the Irish market also underpins the need for an Irish-based and focused potato breeding programme.

The PRP were pleased to learn about the imminent appointment of a Bioinformatician who will enhance data analysis, particularly in relation to molecular and genomic data.

The PRP rated the Vitality, Feasibility and Vision of the Potato Breeding Programme as **very good**.

4.5. Recommendations

There is a need to quantify the impact of the Potato Breeding Programme to demonstrate its alignment with Teagasc's strategic goals and goals of Food Wise 2025.

The balance between technologists and Walsh Fellows on the programme should be examined against the programmes needs for publications, scientific integrity and necessary skills.

For Walsh Fellows, their research programme needs to be clearly defined in terms of thesis requirements and publications.

The Potato Breeding Programme should consider ways to:

- improve the efficiency of early generation selection
- continue to develop and incorporate MAS and genomic selection and
- adjust the breeding and selection strategies to give more importance to processing cultivars.

The breeding programme should continue to help Irish growers with salad potatoes, chips and crisps without compromising the export programme.

There is a need to replace the grader system (including data capture to make breeding more efficient) and refurbishment of the screen house.

There is a need for closer collaboration with the consumer-facing expertise in Teagasc's Food Centre in Ashtown and social sciences in Teagasc's Rural Economy and Development Programme (REDP) in terms of attitudes, farmer behaviour and market structures.

A dedicated Potato Breeding Programme stakeholder group should be established comprising Irish seed producers, growers, processors and consumers.

The Teagasc Potato Breeding Programme needs to ensure that it maintains on-going market feedback.

The continued success of the programme requires partnership with the seed producing companies and possibly a commercial partner for crisping and French fry varieties.

5. Review of Potato Breeding Programme - Associated Research

The PRP reflected and commented separately on the 'associated research' programme as this was presented separately in the Programme Description and Self-Assessment Document.

5.1. Reflection on Quality

The PRP commented that they were not aware internationally of any publicly funded programme which has used molecular markers as thoroughly and efficiently as this programme.

The PRP noted that the programme was able to contribute to the sequencing of the potato genome and the subsequent development of pseudochromosome assemblies that are still the main driver of genome-based research in potato.

Overall, the PRP rated the quality of the work to be **very good**.

5.2. Reflection on Productivity

The PRP were of the view that the marker assisted selection (MAS) and genomic selection (GS) research being carried out were excellent contributions to the productivity of the potato breeding programme; the former has already resulted in good publications.

The PRP considered highly appropriate the leveraging of access to late blight resistance and wart resistance at minimal cost through collaborations with Wageningen (SIP).

Overall, the PRP rated the productivity of the work to be **very good**.

5.3. Reflection on Relevance and Impact

The PRP note that this research activity has consistently focused on high priority traits (e.g. late blight resistance and PCN resistance). Hence it is making a valuable contribution to cultivar development and production related issues.

Overall, the PRP rated the relevance and impact of the work to be **very good**.

5.4. Reflection on Vitality, Feasibility and Vision for the future

The PRP are of the view that the associated research programme is an integral part of the Potato Breeding Programme (delivery of cultivars), and should be viewed in this way.

The PRP concur with the research staff that some of the work undertaken by Walsh Fellows would more appropriately be undertaken by technicians (e.g. marker development that can't be published).

The PRP rated the Vitality, Feasibility and Vision of the Potato Breeding Programme Associated Research Activity as **very good**.

5.5. Recommendations

The Potato Breeding Programme should continue the development of MAS and also continue the evaluation of genomic selection.

The PRP would encourage the programme to get involved with gene editing but agree with the programme that involvement with GM or diploid F1 hybrids would be premature.

Sustainable sources of external funding should be explored.

6. Review of Potato Breeding Programme - KT Activity

The PRP observed that the KT programme was relatively new with little opportunity yet to record strong evidence of practice change, but it had clear focus and objectives and was deploying a range of best practice KT methods and approaches to achieve its objectives.

6.1. Reflection on Quality

The PRP recognise the commitment and cohesion of the KT team who showed good linkages with the sector in terms of client numbers and stakeholder interaction. This was acknowledged by the stakeholders.

The PRP observed that there was clear communication between PBP staff and KT staff.

The PRP recognised the positive contribution of technicians/technologist from the breeding team and associated research to KT delivery.

Although there was no strong evidence of change being delivered as the KT programme is too new, the PRP are of the view that such evidence will be generated in the near future given the approach and positioning of the KT programme.

Overall, the PRP rated the quality of the work to be **good**.

6.2. Reflection on Productivity

The PRP are conscious that the potato sector in Ireland is small and that the KT targeted at that sector is resource limited.

The PRP note that the appointment of a potato agronomist reflecting industry need for specific agronomic focused advice should help with the uptake/exploitation of new cultivars.

Overall, the PRP rated the productivity of the work to be **good**.

6.3. Reflection on Relevance and Impact

The PRP welcomes the clear vision of KT and their industry-partnered initiatives around salad and seed potatoes to achieve import substitution and market growth.

The PRP recognise the collaboration between the KT and Potato Breeding Programme around actions such as the National Potato Conference, the National Seed Potato Workshop, and the inclusion of seed production as a priority under Food Wise 2020.

The PRP also acknowledge the advisor training, diagnosis and other support provided by Potato Breeding Programme personnel to the KT programme.

The PRP note from discussion with the stakeholders their suggestion for demonstration farm infrastructure to provide localised on-farm agronomic advice and trial sites. Perhaps this suggestion reflects the feeling that there are new practice adoption issues facing the sector and the need for variety specific advice on new cultivars.

Overall, the PRP rated the relevance and impact of the work to be **very good** in terms of development and industry support and **good** in terms of KT.

6.4. Reflection on Vitality, Feasibility and Vision for the future

The PRP note the existing evidence aligning KT objectives with economic, market, consumer and grower realities and are of the view that such realities need to continue to be proactively understood.

The PRP welcome the targeting of KT effort towards PCN, blight control, viruses and crop nutrition and cadmium mitigation as part of some initiatives.

The PRP rated the Vitality, Feasibility and Vision of the Potato Breeding Programme associated KT activity as **good**.

6.5. Recommendations

KT should explore how to integrate with social science (economics and sociological) expertise within Teagasc REDP to gain a better understanding of decision making and barriers to adoption of new knowledge and cultivars.

The new potato agronomist should be embedded into the Potato Breeding Programme for a period so that s/he has a thorough understanding of the breeding programme and associated research.

The programme should consider the possibility of providing opportunities for a wider cohort of staff (in addition to the breeder) to interact with industry for two-way awareness and staff development.

Consideration should be given to the establishment of demonstration farms and associated KT groups.

Peer Review of the Teagasc Potato Breeding Programme 2016

Action Plan for Implementation of Recommendations

Date:

Submit to: Dr. Frank O'Mara, Director of Research

This action plan outlines the recommendations from the peer review report on the *Potato Breeding Programme 2016*. To complete this action plan please specify the actions to be taken, if any, to implement the recommendations outlined, allocate responsibility for these actions and set a target date by which the recommendation is to be implemented.

1. Recommendations for Potato Breeding Programme – Breeding

No.	Recommendations	Actions to be taken	Person responsible	Date for completion
1	There is a need to quantify the impact of the Potato Breeding Programme to demonstrate its alignment with Teagasc's strategic goals and goals of Food Wise 2025.	Selection for crisping, chipping, salad and ware varieties adapted for Irish conditions are major priorities of the Teagasc breeding programme which directly supports the goals of Food Wise 2025 to increase exports, increase the use of Irish grown Potatoes for processing and salad markets and expand the seed export market. Over 70% of the total area of potatoes grown in Ireland are Teagasc varieties. As new varieties develop in the above market sectors impact will be recorded but this will be a medium term goal due to the length of time needed to establish new varieties which are currently in development for these sectors.	Denis Griffin	Review annually
2	The balance between technologists and Walsh Fellows on the programme should be examined against the programmes needs for publications, scientific integrity and necessary skills.	Funding for additional staff from core funds for this activity is unlikely, payments to support the research that underlies the breeding programme is a key element of the retendering of the commercial rights to Teagasc bred varieties which may fund additional technical support.	John Spink	Q4 2017

3	For Walsh Fellows, their research programme needs to be clearly defined in terms of thesis requirements and publications.	To a large extent this has already been implemented. As a policy, Walsh Fellows will conduct no research that cannot be published. A thesis plan outlining the research path and targeted publications is now a standard starting point for all Walsh Fellows associated with the programme.		Complete
4	<p>The Potato Breeding Programme should consider ways to:</p> <ol style="list-style-type: none"> 1. improve the efficiency of early generation selection 2. continue to develop and incorporate MAS and genomic selection and 3. adjust the breeding and selection strategies to give more importance to processing cultivars. 	<ol style="list-style-type: none"> 1. Due to the diverse environments which the breeding programme serves very strict predictions of performance cannot be made in early generations in comparison to programmes with narrower geographic focus. However progeny scores have been assigned to first year field families for the last number of years to assist with parental selection in future crossing years. More formalised scoring of basic traits will be undertaken for whole progenies and the data analysed appropriately. This process will be reviewed throughout 2017 and formalised for 2018 harvest and 2019 crossing programme. 2. The breeding programme is currently expanding the use of MAS (from 5 to ten markers by 2018) for economically important traits such as blight and PCN resistance and developing GS strategies for processing selection. 3. The programme has already adjusted its focus to give more importance to processing cultivars as evidenced by the number of processing seedlings currently under evaluation at the advanced generations of the programme and 	Denis Griffin Dan Milbourne	<ol style="list-style-type: none"> 1. Q3 2018 2. Q2 2018 3. Complete

		also the construction of pilot scale stores for processing.		
5	The breeding programme should continue to help Irish growers with salad potatoes, chips and crisps without compromising the export programme.	As stated above at point 1 and in support of Food Wise 2025. Varieties' in these categories are a key objective of the breeding programme.	Denis Griffin	Objective implementation is complete Variety development Ongoing
6	There is a need to replace the grader system (including data capture to make breeding more efficient) and refurbishment of the screen house.	The potato breeder has undertaken negotiations with Miedema who manufacture new electronic graders and will continue this process, to avail of budget when available. We agree the screen house should be refurbished as a matter of urgency when budget becomes available	Denis Griffin	Budget dependant
7	There is a need for closer collaboration with the consumer-facing expertise in Teagasc's Food Centre in Ashtown and social sciences in Teagasc's Rural Economy and Development Programme (REDP) in terms of attitudes, farmer behaviour and market structures.	The breeding programme (in association with IPM) is currently in direct contact with packers for most retail multiples in Ireland and the UK so already receives significant commercially relevant feedback on consumer preferences. Contact has already been made with Carol Griffin in the food industry development department in Ashtown to evaluate consumer preferences of new varieties. Discussions will be initiated to determine if meaningful collaboration to benefit the breeding programme can be established. The breeding programme already has a proposal for a Walsh fellow on the area of consumer preferences in Kenya supervised by Monica Gorman in UCD. The breeding programme and Potato KT will pursue a similar project through the Teagasc/UCD M.AIS programme in association with REDP. Please refer to response 1 in KT section	Denis Griffin	Q2 2018

8	A dedicated Potato Breeding Programme stakeholder group should be established comprising Irish seed producers, growers, processors and consumers.	This group is already established and comprises representatives from DAFM, IFA Bord BIA, Teagasc IPM and the IFA. This group was set up specifically to develop the Seed industry and combat import substitution in Ireland. This group can also feed back into objectives for the breeding programme.	Denis Griffin	Complete
9	The Teagasc Potato Breeding Programme needs to ensure that it maintains on-going market feedback.	As stated previously the breeding programme (in association with IPM) is currently in direct contact with packers for most retail multiples in Ireland and the UK so already receives significant commercially relevant feedback on consumer preferences. The breeding team work very closely with commercial representatives in each country where clonal trials are held such as Spain, the UK Morocco Israel etc. In addition the team meet regularly with IPM agents in countries such as north America, Kenya Australia etc. The team maintain very close links and feedback with commercial customers who also regularly visit the programme.	Denis Griffin	On-going
10	The continued success of the programme requires partnership with the seed producing companies and possibly a commercial partner for crisping and French fry varieties.	The breeding programme is currently engaged in a process to select a commercial partner for the next fifteen year cycle of breeding. Under the current model it is not possible to make separate commercialisation agreements with specific processing companies. Under the current agreement IPM have made several strategic alliances with different processing companies and it is expected this model will continue in any new arrangement.	John Spink	Q4 2017

2. Recommendations for Potato Breeding Programme - Associated Research

No.	Recommendations	Actions to be taken	Person responsible	Date for completion
1	The Potato Breeding Programme should continue the development of MAS and also continue the evaluation of genomic selection.	The breeding programme will continue the development and implementation of MAS. Current plans are to increase the number of genetic markers routinely deployed on the 2nd field generation to >10 by the end of 2018. Experiments to assess how genomic selection might be implemented in the programme are underway as part of VICCI – the feasibility of different modes of implementation will be examined towards the end of that project (Q4 2018). A permanent bioinformatician has recently been recruited to assist with with.	Dan Milbourne	Q4 2018
2	The PRP would encourage the programme to get involved with gene editing but agree with the programme that involvement with GM or diploid F1 hybrids would be premature.	In preparation for the possible deregulation of gene editing, the PIs of the potato breeding and genetics programme will identify one or more Teagasc varieties or breeding lines that would be suitable (possibly bruising susceptibility or cold temperature sweetening) for a pilot gene editing experiment to create targeted gene knock-outs, as these are the most likely gene editing events to be de-regulated. The goal will be to address perceived deficits in these elite genotypes in order to increase their market attractiveness. Once appropriate candidates have been identified, a mechanism to staff and fund this experiment will be identified.	Dan Milbourne and Denis Griffin	Q2 2018
3	Sustainable sources of external funding should be explored.	This is being included in the current retendering for a commercial partner	John Spink	Q4 2017

3. Recommendations for Potato Breeding Programme - KT Activity

No.	Recommendations	Actions to be taken	Person responsible	Date for completion
	<p><i>Note: The Crops Knowledge Transfer Department was delighted to be involved in the peer review of the Potato Breeding Programme and to demonstrate where the Potato Breeding Programme interacts with the Crops KT Programme. The PRC was therefore only presented with information by the Crops KT Department in the "Teagasc Potato Breeding Programme Description and Self-Assessment" document and during the Peer Review visit with KT activity with a direct involvement of the potato breeding team and not the full breadth of Potato knowledge transfer activities as carried out by the Crops KT Department and advisors across the country</i></p>			
1	<p>KT should explore how to integrate with social science (economics and sociological) expertise within Teagasc REDP to gain a better understanding of decision making and barriers to adoption of new knowledge and cultivars.</p>	<p>The KT department will investigate and pursue work in this area through the Teagasc/UCD M.AIS programme .</p>	M Hennessy	Q1 2018
2	<p>The new potato agronomist should be embedded into the Potato Breeding Programme for a period so that s/he has a thorough understanding of the breeding programme and associated research.</p>	<p>The newly appointed potato agronomist completed his PhD studies in Oak Park over a 4 year period during which he had exposure to the potato breeding programme. However, we agree with this suggestion and he will be given every opportunity to visit and spend time with Potato Breeding staff to gain a full understanding of the potato breeding programme. He will also have constant interaction with these staff through initiatives such as; Cadmium research, salad and chipping potato industry initiatives, open days, conferences, etc.</p>	M Hennessy	Q4 2017
3	<p>The programme should consider the possibility of providing opportunities for a</p>	<p>We agree and have been involving breeding staff in KT and industry events</p>	Denis Griffin	On-going

	wider cohort of staff (in addition to the breeder) to interact with industry for two-way awareness and staff development.	such as the salad potato events. This is something that both KT and Denis Griffin intend to build on in the future.		
4	Consideration should be given to the establishment of demonstration farms and associated KT groups.	This will be considered as the roles of the recently appointed potato specialist and advisor develop as part of the wider potato KT activity.	M Hennessy	Q4 2018

Appendix 2 Peer Review Assessment Criteria

Table 1 Peer Review Assessment Criteria

Criteria	Sub-Criteria	Aspects that may be considered – Research Departments	Aspects that may be considered - Knowledge Transfer Departments
Quality	A1. Quality and scientific relevance of research and knowledge transfer	Originality of the ideas and the research, significance of the contribution to the field; coherence of the programme; quality of the scientific publications; scientific and technological relevance.	Quality of technical knowledge gathered and disseminated / transferred. Up to date knowledge transfer methods used.
	A2. Leadership	Leadership by primary individuals; mission and goals; strategy and policy.	Leadership demonstrated by individuals and teams. Advisory Programme development and leadership. Problem solving and mentoring for advisors
	A3. Reputation	International position and recognition; prominence of the programme director and other research staff; impact and significance of the research in the field.	External Collaboration. Stakeholder Interaction. Prominence of programme manager and staff. Recent programme knowledge transfer achievements.
	A4. Resources	Human resources; funding policies and earning capacity; relevance of research facilities.	Capacity and knowledge base of existing staff. Quality of In-service training programme developed and delivered to advisory staff.
Productivity	B1. Productivity	Publication output; external income; stakeholder interaction.	Knowledge transfer output; training & education.
Relevance and impact	C1. Development Industry Support	Alignment to national priorities and collaboration with industry stakeholders.	Tillage Advisory Programme Objectives. Influence and collaboration with Stakeholders and Industry.
	C2. Knowledge Transfer	Behaviour change, practice adoption.	Behaviour change, practice adoption. Evidence of impact assessment.
Sustainability, Vitality and Feasibility	D1. Strategy	Strategic planning; investments and collaboration; research and knowledge transfer topics planned for the near future and their perspectives; flexibility and anticipation of expected changes.	

For the assessment of the programme, the report should follow the suggested terminology in table 2. In the text, the most important considerations and recommendations of the panel should be clearly presented.

Table 2 Qualitative Peer Review Assessment

Qualitative Assessment		
	Research	Knowledge transfer
Excellent	Research is world leading. Researchers are working at the forefront of their field internationally and their research has an important and substantial impact in the field.	KT Programme has very high national visibility; employs the most up-to-date methods; draws on significant stakeholder involvement; and delivers significant economic/social impacts. – Comprehensive evidence of regular impact assessment.
Very good	Research is internationally competitive and makes a significant contribution to the field. Research is considered nationally leading.	KT Programme has high national visibility; employs the most up-to-date methods; draws on stakeholder involvement; and delivers significant impacts for the sector. Strong evidence of regular impact assessment.
Good	Work is competitive at the national level and makes a valuable contribution in the international field. Research is considered internationally visible.	KT Programme has a national visibility; employs a range of methods; draws on stakeholder involvement; and delivers good outcomes for stakeholders. Selected evidence of impact assessment.
Satisfactory	Work adds to our understanding and is solid, but not exciting. Research is nationally visible.	KT Programme has low national visibility; employs limited range of methods; has satisfactory stakeholder involvement; and delivers outputs with some stakeholder impact. Some evidence of impact assessment.
Unsatisfactory	Work is neither solid nor exciting, flawed in the scientific and or technical approach, repetitions of other work, etc.	KT Programme has no national visibility; employs limited range of methods; has little stakeholder involvement; and has little impact. No evidence of impact assessment.

Appendix 3 Potato Breeding Programme Peer Review Panel

TEAGASC POTATO BREEDING PROGRAMME PEER REVIEW PANEL

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