
Teagasc Crops, Environment and Land Use Programme Peer Review 2015

Final Report

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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 **Crops, Environment and Land Use Programme** (CELUP) conducted in the period 6-8 October 2015 under the auspices of the Director of Research and the Teagasc Business Planning and Performance Evaluation Unit. A Peer Review Committee (PRC) comprised of the following members carried out the review:

Ian Crute (Chairman), Peter Berry, Oene Oenema, Jens Erik Jensen, Dara Lynott, Paul Withers, Michael Hoey and Lance O'Brien.

Pauline Thibaux and James Maher provided secretarial assistance to the PRC.

The review considered management, research and knowledge transfer activities. The management assessment focussed on strategy and organisation, while the research and knowledge transfer assessment focussed 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 review took place at Oak Park Crops Research Centre, Carlow and, some time prior to their arrival, the PRC had received a Peer Review Self-Assessment compiled by the Head of the CELU Programme and Heads of its component Departments. This document provided an internal retrospective summary and appraisal of the Programme's structure, funding, staffing, performance and delivery over the period 2011-2015. This was a well-prepared document and was an invaluable aid to the work of the PRC. Additionally, the PRC were provided with the Review Protocol, the CELUP 2015 Business Plan, the Teagasc Statement of Strategy (2012-15) and a summary of the Teagasc Change Plan 3 (2014-16).

At the outset, the PRC received thorough scene-setting overviews of Teagasc and the CELU Programme from the Teagasc Director (Professor Gerry Boyle) and the Programme Head (Mr Paddy Browne) respectively. This provided the PRC with insights into recent organisational change, the Irish policy landscape, staffing issues, funding levels and drivers for change. The role and remit of Teagasc in general, and the CELU Programme in particular, were elucidated alongside recent highlights. The PRC were alerted in broad terms to the importance of Food Wise 2025, Food Harvest 2020, Teagasc Technology Foresight 2030, the Sustainable, Healthy Agri-Food Research Plan (SHARP), and industry-led Development Plans for the Tillage and Horticultural Sectors.

In the context of the Teagasc Change Plan 3 (2014-16), the Director emphasised his wish that the PRC would pay particular attention to several key challenges facing the organisation:

- Increasing sectorial challenges and growing demand for service;
- Limits to increases in levels of staff productivity;
- Recruitment in mission-critical areas;
- Prioritisation of resource allocation;
- Increasing collaboration and devising innovative ways of working.

2. Review of Teagasc CELU Programme

The CELU Programme is one of four Programmes managed within the Teagasc Research Directorate. In addition to its primary research role, CELUP is closely connected to the functions of the Teagasc Advisory Programme (within the Knowledge Transfer Directorate) through embedded specialist teams in two Knowledge Transfer Departments (Crops and Energy; Environment). CELUP addresses objectives in four strategic areas of Teagasc's remit:

- Crops agronomy and sustainable crop production
- Soils and the environment
- Horticulture
- Forestry

The stated Mission of CELUP is to be:

“Recognised both nationally and internationally as the knowledge provider and policy influencer of choice in relation to Ireland’s Crops, Agri-Environment, Horticultural and Forestry sectors”

The CELUP review excluded consideration of the Forestry Development Department because a separate peer review of this activity was completed in 2013. There were many common themes and challenges arising in both reviews. The Forestry peer review panel's report and recommendations is available via:

<http://www.teagasc.ie/publications/2013/3279/2013-Forestry-Peer-Review-Final-Report.pdf>

The CELU Programme is the outcome of a relatively recent merger of the Crops, Land Use and Environment research activities within Teagasc and includes the purposeful creation of Knowledge Transfer teams to provide a “bridge” between the research groups and the Advisory Programme within the Knowledge Transfer Directorate. In its specialist areas of expertise, the CELU Programme seeks to be recognised both nationally and internationally as a provider of new scientific knowledge with impact on policy formulation together with the economic and environmental performance of the tillage and horticulture sectors in Ireland.

The work of the CELU Programme is primarily carried out at three Research Centres: Oak Park (Tillage Crops) Johnstown Castle (Soils/Environment) and Ashtown (Horticulture and Forestry) by a staff of approximately 195 (including 50 Walsh Fellows) at a full economic cost of ca. € 14.5 million. The Programme is highly dependent on winning external research grants and commercial contracts. This funding supports almost half of the research staff (who predominantly have temporary contracts of employment). The significant number of PhD students engaged in CELUP projects makes a positive contribution to the vitality of research groups.

The activities of the CELU Programme are organised into eight management “units” (Departments/Sub-Programmes) of which seven formed the basis for the structure of the review. These are:

- Crop Research Department
- Crops and Energy Knowledge Transfer Department
- Environment, Soils and Land-Use Department
- Agricultural Catchments Programme
- Translational Research on Sustainable Food Production Programme
- Environment Knowledge Transfer Department
- Horticulture Development Department

Additionally, CELUP operates five multidisciplinary working-groups to enable effective delivery in cross-cutting areas relating to:

- Greenhouse gas emissions
- Water quality
- Biodiversity
- Soil fertility
- Pesticide use (Sustainable Use Directive).

End-user input to CELUP's on-going activities and future plans is received through a regular process of engagement with eight Stakeholder Consultative Groups addressing all areas of the Programme's remit.

The PRC noted that neither land-use nor food security were specifically identified as cross-cutting themes that warranted the establishment of multidisciplinary working groups (see above) despite the fact that these topics featured prominently as strategic themes in the policy-focussed translational research programme led by Dr Schulte (see Section 7). The PRC suggests that consideration is given to the establishment of working-groups in these two additional cross-cutting areas.

2.1. Reflection on Quality

The PRC recognised that the CELU Programme has a clearly defined end-use-focussed Mission. This Mission provides coherence to what might otherwise be construed as an unstructured and potentially diverse range of activities conducted across the expansive canvass of crop, soil and environmental sciences. The clear Mission provides a sense of "common purpose" to the individual research groups and it is evident that their integration into a single coordinated Programme of work on crop production (tillage and horticultural), soil quality and environmental impacts of agriculture has been beneficial. However, there may yet be more benefits to be achieved from this direction of travel and some recommendations for further steps are made below. These recommendations are made against the background of the current position in which a clear high level CELUP Mission is made obscure to the "world-beyond-Teagasc" by a rather confused nomenclature and a plethora of named departments, programmes, sub-programmes and cross-cutting areas that do not convey confidence in there being a well-managed and integrated structure.

The PRC observed that the success of the Programme is dependent on a relatively small number of highly committed experienced staff who have been instrumental in delivering, with their teams, an impressive set of tangible outputs in terms of peer-reviewed papers, reports, presentations, improved varieties and tools to assist on-farm decision-making. Substantial increases in productivity over the period of the review are to be seen throughout the Programme and to be applauded. However, the PRC concurred with the Director's view that there is a limit to individuals' capacity to increase productivity without a risk that quality might suffer.

A measure of the quality of the teams within the Programme, and their track-record of delivery, is their consistent success in winning competitive external funding as well as being sought as collaborators in international projects and attracting a substantial number of Walsh Fellows (who are contributing significantly to outputs while also being trained). It was also clear to the PRC that the knowledge transfer activities and the quality of independent advice provided to the industry were highly valued. A particular specific example is rapid response to industry emergencies, such as in the horticulture sector.

The regular proactive engagement with a range of stakeholder groups at all stages (from planning to delivery) ensures that outputs meet a diversity of needs. This is an essential element of a successful programme when both policy and commercial users are the intended beneficiaries. As the PRC recognised during the review process, the role of

Teagasc is to be responsive to policy requirements as well as contributing to policy formulation while simultaneously delivering industry requirements. These diverse demands are not always easy to reconcile (see also section 2.3 below), and it is important for senior staff to ensure stakeholder expectations are appropriately managed.

The PRC was provided with a set of metrics by which the scientific impact of Teagasc publications could be compared against similar institutions internationally. Because no information was presented on either number of researchers per institution or the relative scale of financial resources deployed, it was difficult to make fully informed comparisons. Nevertheless, it is reasonable to conclude that the CELU Programme as a whole is definitely internationally competitive in terms of the quality and quantity of its scientific output. Across the whole Programme and review period the publication output is approximately four papers per year per Principal Investigator and for some groups this is up to 50% higher. This level of productivity is very good given that much of the work requires large amounts of data to be captured over several seasons and is predominantly field-based. CELUP scientists are publishing in well-cited journals appropriate to their specialist fields of research. While the average citation rate per paper (about 6) cannot be considered outstanding, it is evident that CELUP scientists have, during the review period, contributed to several highly impacting papers.

In summary, the PRC considers the overall quality of both the research and knowledge transfer elements of the CELU Programme to be **Very Good** with some areas of classed as *Excellent*.

2.2. Reflection on Leadership and Vision

The PRC considered that the mix of experienced managers and relatively new appointees in positions of leadership within CELUP was likely to result in well-considered and progressive future developments throughout the Programme. With the appropriate support and mentoring for new appointees by senior colleagues, the PRC believed that Teagasc is in the favoured position of having a very strong team to lead CELUP over the coming period. The PRC was favourably impressed by the approach taken to the development of annual operational business plans and it encourages this practice to continue throughout all “business units”.

The CELUP leadership had already enunciated a clear vision (see above) and it was evident to the PRC that there was almost universal buy-in among CELUP staff to the alignment with strategic grand challenges as they relate to national priorities for the agri-food sector as a whole. Nevertheless, the PRC takes the view that seeking to deliver wider impact from CELUP research in the context of sustainable agricultural practices beyond Ireland would beneficially broaden horizons for early career researchers and could open up new sources of financial support.

A good balance of strategic and applied research closely linked to knowledge transfer and provision of technical advice with societal impact is a hallmark of the Programme. However, the PRC noted the need for adoption of effective approaches to priority setting throughout the Programme so that limited resources are applied to those areas where return on investment was likely to be greatest. In the context of priority setting, and given the title of the Programme, the PRC felt that there might have been a greater emphasis on Land Use (as distinct from Land Management) i.e. the quantification of environmental and economic trade-offs directed towards strategic approaches to changes in regional land utilisation (e.g. to optimise delivery of ecosystem services and preserve natural capital). The PRC distinguished this type of research from the body of work on optimised management practices where decisions on land usage had already been made. The PRC recognises that

it was not exposed to all components of the CELU Programme and that such work may be proceeding in association with policies to expand land use for forestry.

The PRC recognises the difficulties that have resulted from recent reductions in core funding and embargoes on recruitment. The PRC realises that there are no quick and easy ways to resolve these difficulties. However, it is the view of the PRC that the most urgent issue to address, for those vested with leadership role, will be the constraints imposed by pressures on staffing levels, career progression and, in places, inadequacy of facilities. In the same context, a more strategic approach will be required to staff professional development and succession planning than has been the case hitherto. The PRC felt that a strategic plan for the employment of well-regarded and successful Walsh Fellows could provide one route forward. In particular, it was recognised that Teagasc and Fellows themselves would benefit from a plan that enabled them to maintain their affiliation with the organisation while gaining career-enhancing experience elsewhere.

The PRC believes that the demonstrable benefit that has accrued from past actions to achieve closer integration of previously disconnected components of the Programme should provide the confidence that further steps in this direction will be appropriate. Some recommendations for possible actions to be considered are provided below.

The PRC was pleased to learn that, pending necessary funds being forthcoming, plans for much-needed upgrading of facilities were already well advanced in areas of priority. However, PRC were of the view that it would be advisable for senior CELUP staff to work together on agreeing, and regularly reviewing, a forward looking, prioritised programme for capital investment in equipment and facilities. This exercise could usefully be informed by reference to a site-specific CELUP capital asset register indicating the period over which specific items had been or were being depreciated.

2.3. Reflection on Relevance and Impact

The PRC was pleased to have the opportunity to meet and have discussions with representative members of CELUP Stakeholder Consultative Groups. These discussions provided the PRC with insights into the way in which work conducted within the CELU Programme was viewed by commercial end-users in the agri-food industry and also how they were able to exert influence over future shaping of the Programme.

From these discussions it became clear to the PRC that the CELU Programme was highly valued and directly relevant to the needs of stakeholders. Stakeholder representatives particularly emphasised the importance they attached to the independence of Teagasc when it came to the communication of results from research and their translation into practical advice. The PRC concurs with the need for Teagasc to value and guard its independence as a major asset.

Discussions with stakeholder representatives reinforced for the PRC the strong impression they had obtained from the Self-Assessment regarding the CELU Programme's high degree of relevance to both policy and commercial stakeholders as indicated by an impressive catalogue of deliverables with both practical commercial and societal value.

The PRC learnt that Stakeholder Consultative Groups, in concert with Teagasc staff and others, had been instrumental in the development of Sector Development Plans (for tillage crops and horticulture) that had, in turn, influenced Government policy, the future direction of CELUP research, and priorities for knowledge transfer activities. The PRC was convinced of the necessity of keeping these Consultative Groups active and regularly reinvigorating them with new blood.

One area where the PRC felt that clarification was required relates to the expectations that the industry may have of Teagasc in the area of market development and exploration of opportunities for Irish farmers to adopt new agricultural products (examples included sugar beet, protein crops and high value specialist crops). The PRC was left with questions. Should it be the role of Teagasc to de-risk industry investment by conducting feasibility studies, mapping out supply chains and performing the necessary gap analyses? Are there lessons to be learnt from the early development of the highly successful Irish mushroom production industry and the comparative failure of energy crops? Should the precise roles in this area of DAFM, Bord Bia and Teagasc be more clearly specified?

The PRC observed areas where work conducted under the CELU Programme had impacted significantly by informing soundly based Government policy-making (“science-led policy”). At the same time there were areas of work being conducted in response to Government policy that emanated from other influences such as the EU (“policy-led science”). The PRC recognised that Teagasc was experienced in managing these apparently conflicting approaches to the design and delivery of research projects.

The PRC noted that there are necessarily intimate linkages between the planning of research activities in the CELU Programme and the drive to achieve Government’s “political” targets (e.g. for increased agricultural production and/or environmental improvements). The ability to achieve more than one objective in the same time and place is not often likely to be achievable. However, the PRC noted the successful communication of advice on nutrient management that simultaneously addresses issues of productivity and environmental protection. The PRC concludes that the impact of researchers in the CELU Programme will be greatest if they continue to adopt the scientific method of conducting experiments designed to disprove plausible and testable hypotheses.

The PRC was favourably impressed by the close and productive interactions that existed within the CELU Programme between those Departments undertaking research and those charged with knowledge transfer and the delivery of advice to farming businesses. The practical impact of CELUP that is manifest in the positive and supportive views expressed by stakeholders is founded on a close working relationship between researchers and knowledge transfer professionals. However, it was difficult for the PRC to discern precisely what model CELUP was working to in this regard. Was the research agenda being set and led by knowledge gathered and conveyed from professional advisers or, alternatively, was it new insights provided by researchers that set the agenda for new initiatives in knowledge transfer to end-users? The PRC recognises that this is a “two-way-street” but suggests that clarity on primacy in priority setting should be discussed and is relevant to decisions about recruitment and other aspects of resource allocation.

PRC was concerned that CELUP tended to under-sell the impact it makes (e.g. implementation of the nitrate directive derogations) and the current scale of its dissemination activities (e.g. through the agricultural press). Based on the Self-Assessment documentation, and backed by evidence provided by stakeholder representatives, the PRC gained the firm impression that there was a strong case for the CELU Programme collectively to promote its successes more proactively to the range of different interested parties on whom their work has had positive tangible impact. This would include: farmers, government agencies, food chain companies and consumers.

2.4. Key Recommendations for CELU Programme

Throughout the process of the review, the PRC encountered several recurring themes that substantially reflected issues the Director had already drawn attention to in his opening

overview. The PRC considered it appropriate to make recommendations to the senior management team of CELUP under four broad headings. All the areas identified for attention will likely have to be addressed more broadly within the organisation than exclusively in the context of CELUP. However, there is a case to be made for CELUP becoming a vehicle for innovation in some cases. The four areas relate to:

- Resource Management Structures
- Future Skills for Effective Knowledge Transfer
- Expertise and Human Resource Management
- Data Curation, Access and Analysis

2.4.1 Resource Management Structures

The PRC recommends that managed units (Departments?) within CELUP are minimised and that consideration is given to amalgamation of all activities into just two: a Crops Group (embracing tillage and horticultural crops) and a Soils and Water Group (embracing environmental impacts of land management practices). It is envisaged that knowledge transfer specialists would be embedded within the appropriate group but would also participate actively in a newly created cross-Programme grouping of knowledge transfer specialists directed specifically towards two important objectives:

- Consistency of messaging and reconciliation of potentially conflicting advice emanating from different Programmes or Sub-programmes;
- Development of innovative “next-generation” digital approaches to the customised delivery of technical information and advice to end-user businesses (see also recommendation on *Future Skills for Effective Knowledge Transfer* below).

The PRC considers that this further step in the evolution of CELUP would facilitate integration of soils research with outputs from catchment studies and enable resource planning to meet future requirements for research on environmental impacts of agriculture. It would also be possible within the structure, subject to demand and resource availability, to establish a set of “technical platforms” for necessary and pervasive technologies and expertise including such areas as genomics, microbiology, informatics, analytical chemistry, crop nutrition etc. (see also recommendation on *Expertise and Human Resource Management* below)

2.4.2 Future Skills for Effective Knowledge Transfer

With the legacy of more than a century of accumulated knowledge, the translation of research into practice on farm *via* effective knowledge transfer can be considered as both a Teagasc “USP” and its *raison d’être*. The level of expertise and specialist knowledge required for this activity it likely, in future, to both broaden and deepen. It is also evident that this key objective will have to be met with fewer employees. The PRC recommends the establishment of a time-limited taskforce to advise the Director on the competences and resources required to build an appropriately equipped and resourced specialist team (perhaps located within an expanded ICT Department) to ensure the organisation will, in future, be able to exploit fully the benefits that digital communication technologies can deliver for stakeholders. This taskforce should include knowledge transfer experts from across the organisation among its membership as well as technical specialists. In parallel, the PRC recommends the establishment of a working group (reporting to the Director), with external membership as necessary, tasked to define the generic attributes and additional technical skills that will be expected of tomorrow’s knowledge transfer specialists together with an outline of the professional development programme likely to be required for current and future staff who will occupy these critical positions. For example, ecosystem services provision, agro-ecological practices and utilisation of a diversity of IT-dependent precision farming applications are just a few of the anticipated innovations that farmers might be expected to adopt widely in future. This will require advisers to be fully informed and conversant with latest developments as well as having an appreciation of social contexts and drivers for change.

2.4.3 Expertise and Human Resource Management

The PRC recognised that the moratorium on recruitment since 2008 coupled with natural wastage and increasing dependency on short-term contracts has, in places, created significant problems with workload and staff morale. If there is now a prospect for some rebuilding, the PRC recommend that this is done with care and in the context of a thorough work force planning exercise that encompasses coherent strategic plans for succession and staff professional development including criteria for promotion and other career progression. The PRC accepts that such forward planning has, until recently, been impossible to implement. However, the demand likely to be placed on Teagasc to deliver against the SHARP and Food Wise 2025 agendas necessitate that clear, strategically driven plans for recruitment and staff career development are made. The PRC recommends that the first step for CELUP might be an assessment of expertise and capability requirements at all levels over the next 10 - 15 years alongside an audit of the current staff expertise, experience and age profiles. Subject to required procedures, and when judged appropriate, the PRC also recommends that every opportunity is taken to transfer to permanent positions those strong performers among staff currently on period appointments where their skills are recognised as a good fit with future requirements. Similarly, the PRC recommend that regular assessment of the performance of Walsh fellows and their training needs might usefully take into consideration their potential suitability for future vacancies.

Taking CELUP forward in new directions and extending the scope of the Programme (e.g in horticulture, informatics or environmental sciences) will require access to experience and specialist expertise that is not currently available. The PRC recommends that the senior CELUP team think creatively about a range of different initiatives that may provide this access without always requiring new recruitment. Among things to consider are:

- strategic partnerships with university departments or individual faculty members that could be mutually beneficial on a *quid pro quo* basis;
- creation of virtual research networks;
- involvement of retirees in an emeritus capacity as mentors;
- establishing new research networks to provide added value in terms of project planning or access to facilities as well as strengthening relationships with academic and company researchers (nationally and further afield);
- creating attractive opportunities for visiting scientists to spend periods of study leave in association with CELUP research groups.

2.4.4 Data Curation, Access and Analysis

The PRC realises that CELUP is one of several components in Teagasc that generates, and is the custodian of, a range of diverse and valuable data sets that, in some cases, are not being fully exploited through lack of capacity or expertise. The PRC recommends that CELUP takes a lead within Teagasc in establishing and delivering a new and strategically planned approach to data. This will include routes to efficiency gains and adding value in the context of data collection, storage, curation, annotation, access, analysis, synthesis and presentation. Examples of the expertise likely to be required to derive added value from “big” data sets include; spatial analysis, modelling, genomics, GIS and customised software development (such as independently validated algorithms for the agricultural industry to exploit). In addition, the PRC recommends that CELUP takes the lead on the development of a Teagasc policy on open data as set out by DPER <https://data.gov.ie/data>. Increasing amounts of potentially valuable data are being collected routinely on farm and throughout supply chains. The PRC recommends that CELUP should give some priority to the development of a strategy for accessing, storing, organising and adding value to data of relevance to its strategic remit and specifically examine ways in which use of mobile technology platforms may facilitate information exchange with stakeholders for mutual benefit.

3. Review of Crop Research Department

3.1. Reflection on Quality

The PRC considered that the focus and primary objectives of the Crop Research Department (also referred to in documents as the Crop Science Department) were appropriate and well aligned with stakeholder expectation as outlined in Food Wise 2025, SHARP and the 2012 Tillage Sector Development Plan. The Department had adopted a sound approach to priority setting that the PRC applauded; it considered the process should be repeated on a 3-5 year cycle to ensure attention was given to newly emerging issues (such as ever more refined MRL data and managing without pesticides). The PRC were convinced that team leaders in the Department had a clear grasp of the major constraints facing tillage farming businesses in Ireland in seeking to increase crop diversity, productivity and competitiveness. Stakeholders provided additional evidence for very good quality of output from the Department.

The PRC recognised the impressive breadth and depth of expertise and experience that resided within the Department as well as the critical mass of younger researchers who were making a significant contribution. This enabled the Department to undertake applied research directed towards increased crop productivity and production system sustainability by adopting a strategic approach that aimed to provide a sound scientific basis for adoption of improved products or practices.

In addition to taking note of the published work delivered from the Department over the review period, the PRC considered the level of success in securing competitively won external funding in their assessment of quality.

The body of work directed towards genetic improvement of potatoes was well integrated and particularly impressive in terms of innovation, outputs and practical outcomes; it provides a model in the way highly effective teams with long-range vision can be constituted when there is stability and continuity of resource provision.

Despite labouring under a deficit of skills in some scientific disciplines (including entomology and modelling), the cereals research is well focussed, internationally competitive and has delivered work of international significance in the area of fungicide resistance.

The PRC did not consider that the scale and scope of the work being undertaken on energy crops (now “deprioritised”) could be considered competitive in comparison with other European groups working in this area.

Overall, the PRC rated the quality of the work in the Crop Research Department to be **Very Good** with some areas of Excellence.

3.2. Reflection on Productivity

The work of the Department is organised into three sub-programmes (agronomy, genetic improvement and energy crops) that attract different levels of resource; the PRC took this into account when assessing productivity. Published output was the primary criterion used to assess productivity but the other professional contributions made by researchers (which were recorded in the Self-Assessment) were also taken account of.

Given the type of research that the Department was undertaking (predominantly field-based and often requiring several seasons to assemble meaningful data), the PRC considered the

overall productivity to be **Very Good**. The Department has sustained an output of three to four papers per Principal Investigator per annum over the past three years in addition to a range of other external professional contributions. It was clear that the group is highly productive at transferring information to stakeholders through open days, conferences and technical guides.

3.3. Reflection on Relevance

The prioritisation process undertaken within the Department provided confidence to the PRC that all the work being undertaken had a high level of relevance to either policy or commercial stakeholders, or both. The PRC saw good evidence of external collaborations throughout the Department and viewed this as another independent indicator of relevance as was the success in securing a high proportion of its research income from external sources.

The PRC noted that agro-ecological approaches to crop management and provision of ecosystem services did not feature in the current or future priorities for the Department and, dependent on resource availability and policy drivers, this may require consideration in future.

The re-prioritisation of resource allocation away from bioenergy crops based on market considerations was considered appropriate and should alert the Department to a need for work to develop markets for new crops ahead of significant investment in technical issues related to production (see also comments in Section 2.3)

Overall, a close focus on work directed to maintaining the competitiveness and profitability of the relatively small number of tillage farmers in Ireland was judged by the PRC to be appropriate and the relevance of the Crop Research Department was therefore judged to be **Excellent**.

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

The PRC gained the impression that the Department was being well led and that it comprised a set of motivated well-managed research teams that were committed to their mission. The PRC considered that research leaders were making the most of the resources at their disposal while always attempting to find the means to achieve more.

The PRC sensed senior staff frustration that it was not possible for them to pay attention to some high priority areas due to the lack of expertise or resource limitation (two different but closely related issues). The PRC observed that this situation is likely to be the reason why they were unable to discern a clear forward-looking plan for the Department's future (as distinct from more of the same). For example, the PRC expected that aspects of precision farming including algorithm development to aid agronomic decision-making and greater use of real-time data capture systems would have been more prominent. Similarly, the PRC would have expected to hear more about the potential for internal collaborations directed towards increased productivity and quality of forage crops. The PRC was also of the view that, in the context of soil fertility, there was scope for more collaborative interactions with researchers in the Environment, Soils and Land Use Department than was evident.

The number of PhD students deployed throughout the Department was enabling a variety of new work to be undertaken and made a significant contribution to its vitality. However, the PRC noted that to maintain its vitality into the future there is an urgent need to pay attention to age-structure, balance of available expertise, provision of adequate technical assistance to research teams, professional development and staff career progression.

The PRC was interested to learn about the VICCI initiative that represented an innovative and important response to the paucity of coordinated work on crop germplasm evaluation and genetic improvement directed specifically to traits of high strategic relevance to performance and productivity in an Irish setting. This role that the Department is fulfilling in establishing and fostering this activity is applauded. However, there is a risk that the ambition may exceed the feasibility of achieving impact and the PRC made a specific recommendation relating to this (see 3.5 below). The connectivity with universities implicit in VICCI is an important component and the PRC suggest that similar opportunities for the Department to gain access to expertise unavailable internally would be worthy of exploration.

Taken together, the PRC rated the Vitality, Feasibility and Vision of the Crop Research Department as **Good** but felt that the future needed to involve new avenues that encompassed work going beyond “more of the same”.

3.5. Conclusion

The Crop Research Department comprises a strong collection of committed researchers who are well organised in appropriate teams that are, for the most part, equipped with good facilities adequate for their work. The Department is delivering high quality applied research to the point where it can be translated into practical impact on farm and/or to influence policymaking or implementation. There is a close, functioning relationship with the Crops and Energy Knowledge Transfer Department but there are as yet unrealised opportunities for closer collaboration with the Environment, Soils and Land Use Department.

The Department has some important gaps in expertise including entomology, mathematical modelling and pathology as well as needing more technical assistance for teams to operate at full levels of efficiency. Under-resourcing for several years could be the reason why the Department’s forward plans are not as ambitious as might have been expected with regard to embracing new scientific and technological opportunities. The demands likely to be placed on the Department through the drive towards sustainable intensification through the implementation of Food Wise 2025, SHARP and the 2012 Tillage Sector Development Plan bring some of the points raised by the PRC into sharp focus.

3.6. Recommendations

The PRC in its appraisal of the Crop Research Department makes five recommendations for actions to be taken forward as follows.

1. Filling gaps in critical expertise

The Crop Research Department should undertake a critical quantitative analysis of the risks and rewards pertaining to the loss or acquisition of specific scientific/technical expertise and experience. Such an exercise could be unbounded or be bounded by currently available evidence on opportunities lost or reductions in efficiency experienced as a consequence of staffing deficiencies already recognised (entomology, mathematical modelling, pathology, agro-ecology, precision agriculture, bioinformatics, technical support). The analysis should include options to fill gaps by means other than internal recruitment (see also Section 2.4.3 above)

2. Adding value to soils research

The Crop Research Department should take the initiative to explore the added value to be derived from closer awareness of data and expertise residing with the Environment, Soils and Land Use Department including outputs from catchments research. Soil mapping and fertility; soil health and metagenomics; and precision soil management are examples of areas worthy of consideration.

3. Engaging with technologies for precision farming

The Crop Research Department requires a coherent strategy and “road map” for its engagement with the application of technologies pertaining to precision farming (robotics, sensors, GPS etc.). This plan should include algorithm development and “real-time” agronomic decision-making as well as the value to be derived from “big data” (weather, geo-referenced soil and crop data etc.). This activity should include colleagues involved in knowledge transfer (See Section 4 below) and it is also likely that actions could beneficially be taken forward in collaboration with colleagues already addressing similar issues in the livestock sector. The latter prospect should be explored. (see also Section 2.4.4 above)

4. Realising the ambition of VICCI

The Crop Research Department should take responsibility for ensuring that progress towards realising the vision of VICCI is realised by action designed to maintain momentum among all partners in this strategically important venture. This could involve the establishment of an external review group of relevant international experts (from both the public and commercial sectors) who would meet regularly to receive progress reports, appraise progress towards objectives and advise on future priorities and directions of travel.

5. New market developments – defining the role

The Crop Research Department should consider if they have a role in assisting farming businesses to develop new markets for arable crop products and if so, what that might be and how such opportunities might best be realised to minimise the risk of market failure (see also Section 2.3 and questions posed therein).

4. Review of Tillage and Energy Crops Knowledge Transfer Department

4.1. Reflection on Quality

The PRC were impressed with the impact and future plans of the small but dynamically led Tillage and Energy Crops Knowledge Transfer Department. With rather limited resources at its disposal, the Department is required to be knowledgeable and provide services over a wide canvass including agronomy, crop protection, business planning, and adherence to legislation. The PRC considered that the quality of its contribution was best judged by evidence for “repeat business” and also testimony from farming businesses. On this basis the meeting with representatives of CELUP Stakeholder Consultative Groups gave the PRC confidence that statements about the success of recent activities contained in the Self-Assessment documentation were accurate. The role of the Department in providing training to front-line Teagasc advisers is of fundamental importance to the way the whole organisation is perceived among the end-user community.

On the basis of the evidence received, the PRC judged the quality of the Tillage and Energy Crops Knowledge Transfer Department to be **Very Good** with some areas of excellence.

4.2. Reflection on Productivity

The PRC considered the scale and scope of the deliverables from the Tillage and Energy Crops Knowledge Transfer Department to be impressive. A diversity of knowledge transfer activities is delivered regionally and throughout the year such that all tillage farmers should be provided for. However, the PRC recognised that the dissemination and implementation of technical advances could be given higher priority if less time was devoted to the requirement for 1:1 advice on such things as help with subsidy/grant aid/environment regulation forms. A strategy is required to relieve the time pressure created by demand for what are primarily administrative services since this potentially places the delivery and future quality of technical knowledge transfer activities at risk. Consideration should be given to extending the current deployment of commercial agencies, particularly at peak times when pressure is greatest.

Recommendations are made above (Sections 2.4.1 and 2.4.2) that recognise the need for an intimate working relationship between staff operating in the Tillage and Energy Crops Knowledge Transfer Department and those operating in the Environment Knowledge Transfer Department in order to ensure consistency of messages and to advance the utilisation of appropriate digital channels as a means of increasing outreach to stakeholders.

The PRC judged the productivity of the Tillage and Energy Crops Knowledge Transfer Department to be **Very Good**

4.3. Reflection on Relevance

So far as the PRC was able to judge, all activities being undertaken by the Tillage and Energy Crops Knowledge Transfer Department have a high degree of relevance to stakeholders. However, the PRC considered that prioritisation and means of delivery required some early consideration. Given the limited resource available, a focus on conveying information relating to the most pressing or topical issues utilising the most effective methods was necessary. The PRC recognised the success being achieved with large discussion groups (as distinct from 1:1 meetings) but believes that it will be necessary to accelerate the use of video, social media and customised applications for hand held devices alongside other creative uses of digital technology. In addition, the PRC considers

that there is a need for the Department to continue building relationships with external consultants to ensure agri-food consistent messages are conveyed to farmers and others in the food supply chain.

The PRC judged the productivity of the Tillage and Energy Crops Knowledge Transfer Department to be **Very Good**

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

The PRC was impressed with the expertise, commitment and enthusiasm of the Tillage and Energy Crops Knowledge Transfer Department. The PRC noted the Department's flexible approach to the setting of priorities and considered that this may need to be moderated in future. The PRC suggests that establishing a focus on topical time-limited "campaigns" dealing with a few specific issues should be considered. This approach may enable a sufficiently wide agenda to be maintained indefinitely but without the expectation that everything was "live" all the time.

The PRC pointed to the need for some investment of time in the Department to develop new skills and expertise, particularly around the continuing advances in Information and Communications Technology. The PRC was also doubtful about the gains to be achieved from investing a lot of additional resources into the refinement of the website (as distinct from other IT based approaches to direct communication with stakeholders).

The PRC considered that the Tillage and Energy Crops Knowledge Transfer Department was still at an early stage in its development under a new Head of Department but it had the potential to be the flagship of the CELU Programme once more work had been undertaken on establishing priorities and honing delivery mechanisms.

The PRC judged the Vitality, Feasibility and Vision for the future of the Tillage and Energy Crops Knowledge Transfer Department to be **Good**

4.5. Conclusion

The PRC concluded that the Tillage and Energy Crops Knowledge Transfer Department is very important to the overall success and impact of CELUP and it definitely has the potential to meet expectations. However, there is: a requirement to prioritise activities; a need to embrace a diversity of new communication technologies; and a benefit to be derived from building relationships with commercial consultancies.

4.6. Recommendations

The PRC's recommendations directed to Tillage and Energy Crops Knowledge Transfer Department are already substantially captured in Sections 2.4.1 and 2.4.2 but can be summarised concisely as:

- consider more outsourcing of "administrative" advice;
- ensure consistent messaging by close working with the Environment Knowledge Transfer Department, other Teagasc KT specialists, and, where appropriate, external agricultural consultancies.
- deliver a strategy for, and develop greater capability in, the deployment of digital technologies as a major component of engagement with "next generation" farmers.

5. Review of Environment, Soils and Land-Use Research Department

5.1. Reflection on Quality

The PRC are of the view that the Environment, Soils and Land-Use Department comprised a group of dedicated, well-qualified and highly motivated individuals. Many members of the team are early-career scientists and the PRC considered that it was important for CELUP to nurture and retain this scientific talent for the future by active management practices. The PRC saw the Department as one of the “cornerstones” of Teagasc with a key role in charting the route to sustainable Irish agriculture.

The PRC recognised that the Department has good national and international visibility in the area of “sustainability science” and the interactions between agricultural practice, land use/management and environmental impact. This visibility had attracted several international visiting workers to spend time in the Department during the period under review.

The Department’s project portfolio is extensive (soils, water, atmosphere and biodiversity) which reflects a positive response to several current productivity and environmental policy drivers. However, this demands a requirement for capability in a diverse array of environmental sciences. The PRC recognised that it was necessary for the Department to have access to a diversity of contemporary technologies (at scales ranging from sub-cellular to landscape) in order to ensure scientific competitiveness. Maintaining competitiveness across such a diverse portfolio represents a large challenge for a relatively small group, particularly if there is an expectation that the whole agriculture-related environmental policy arena will be addressed. In this context, it will be important for CELUP management to ensure external stakeholder expectation does not exceed the capacity to deliver and to guard against over-commitment and the potential adverse impact on quality that may ensue.

The Department is publishing its work in a range of good quality and internationally recognised journals and the work is being well cited. The high proportion of its funding that is being won competitively provides additional evidence for the quality of its scientific contribution. The Department enjoys access to a range of specialist field facilities but the PRC was informed that the laboratories were inadequate for the work being undertaken. The Department has been responsible for the organisation of several well-attended international scientific conferences during the reporting period.

On the basis of the evidence received, the PRC judged the quality of the Environment, Soils and Land Use Department to be **Very Good** with some areas of Excellence.

5.2. Reflection on Productivity

The PRC noted a consistently high rate of publications from members of the Department over the period of the review. Additionally, it was making significant contributions to training through PhD students and engagement with a number of important external national and international scientific groupings concerned with policy development and implementation. The PRC recognised that the Department’s research was being delivered to end-users through innovative vehicles such as Nutrient Management Planning On-line and the availability of a national soils classification database.

The PRC sensed that the demand for large amounts of routine sample analysis may be inhibiting productivity and, thereby, the time available for more innovative activities.

The PRC judged the productivity of the Environment, Soils and Land Use Department to be **Very Good**

5.3. Reflection on Relevance

The PRC noted that the Department was organised as five research units. Of these, the work of two: Nutrient Efficiency; Soil Quality/Classification are particularly relevant to farming and other businesses concerned with agricultural productivity. The work of the other three units: Gaseous Emissions; Agro-ecology; Water Quality have particular societal relevance through the development and implementation of environmental policy. The PRC recognised that there are synergies between commercial and policy relevant research since increases in resource use efficiency usually (but not invariably) result in environmental benefits. In relation to environmental policy development and implementation, the PRC considered it important that the Department played an influential role in ensuring robust scientific objectivity. Desired policy outcomes were sometimes in conflict and a scientific approach to the analysis and quantification of trade-offs between a range of environmental outcomes and impacts was essential. This aspect of Departmental strategic thinking was not evident to the PRC and suggested the need for greater strategic integration between groups. Such integration would both reveal scientific synergies and ensure a coherent overview of interacting factors in terrestrial and aquatic ecosystem management.

The PRC was concerned that the Department had deficiencies in certain key areas of expertise that were likely to impact on the extent to which expectations of stakeholders could be met. These included: spatial analysis, modelling and soil metagenomics. The PRC acknowledged that resource limitations were restrictive but felt that consideration could be given to the provision of access to expertise by forging strategic alliances with one or more universities.

The Environment, Soils and Land Use Department is the source and custodian of large and strategically important data sets of national and international relevance. The existence of a clear policy on data collection, storage, annotation, availability and access was not evident to the PRC.

The PRC considered the relevance of work in Environment, Soils and Land Use Department to be **Very Good**

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

The leadership of the Environment, Soils and Land Use Department has recently changed and the PRC were of the view that the team of well-qualified and relatively young researchers has the potential to increase further the impact of its work and elevate its international visibility. The PRC considered that there was scope for closer integration and cooperative working between what appeared to be a number of sub-groups that, to a large degree, appeared to be operating independently (see Section 5.3 above) including those within and outside the Department; i.e. the Agricultural Catchments Programme; Translational Research on Sustainable Food Production; Environment Knowledge Transfer Department. There also appeared to be some frustration that the Department had built physical capacity but was not in a position to exploit it to the full.

The PRC felt that if the ambitious national targets associated with water quality, gaseous emissions, biodiversity and land use were to be met there was need for the Department to articulate more clearly the actions required internally and externally to bring this about. These include optimised deployment of available resources within and outside the Department and will likely require active dialogue between experts in the Department and

those tasked with developing and implementing policy. In this context, engagement of the team involved in cross-cutting translational research will be particularly important.

The PRC felt that the future vision for the Department was still “work in progress”. There was work to do to channel the evident Vitality of the Environment, Soils and Land Use Department towards the coordinated achievement of a set of feasible objectives captured in a clear Vision. Nevertheless, on the basis of recent achievements, the PRC rated this aspect of performance as **Good**.

5.5. Conclusion

The PRC recognised that the Environment, Soils and Land Use Department was a strong and productive group of researchers working to achieve highly topical and relevant research objectives. There was scope for further development and strengthening of the team and the PRC hoped that this would not be hindered by resource limitation. Further integration of those researchers involved in environmental research and its translation into practice was deemed by the PRC to be necessary alongside a 5-10 year strategic plan that involved the career development and mentoring of early-career researchers. In addition, there was a need to develop a strategy for outsourcing routine sample analysis in order to free up time for more innovative activities.

5.6. Recommendations

The PRC make the following recommendations for the Environment, Soils and Land Use Department to consider alongside the reflections recorded above:

1. *Routine sample analysis*

Consider contracting out all routine sample analysis to one or more commercial or public laboratories to direct resource allocation to more innovative activities. Care over service level delivery and quality control will, of course, be necessary.

2. *Deficiency in expertise*

Develop and put in place a plan to enable ready access some specific areas of existing expertise in the organisation such as spatial analysis and modelling as well as other areas of priority that may need to be sourced externally. Consider a mix of creative solutions including re-training, external collaborations and support for visiting workers as well as staff recruitment.

3. *Vision*

The Department needs to develop a well-articulated vision and 5-10 year plan for the creation of a world-class centre of environmental sciences related to agriculture. This is likely to include:

- prioritisation of research projects relative to resource and expertise availability;
- establishing a network of collaborations with other leading research groups;
- establishing work with global relevance (i.e. beyond Ireland);
- becoming a venue of choice for talented PhD students and post docs;
- facilitating staff exchanges (sabbatical leave) with other leading research centres;
- plans for succession;
- plans for laboratory up-grading and necessary technical support.

4. *Data* (see also Section 2.4.4)

The Department is rich in data (particularly spatially referenced) that is still accumulating and has not yet been exploited to the full. Internal (eg within CELUP) and external collaborations should be established to enable more data organisation, annotation, analysis and utilisation, particularly with a view to extracting greater end-user value *via* knowledge transfer teams.

6. Review of Agricultural Catchments Programme

6.1. Reflection on Quality

The PRC was pleased to hear that Phase 3 (2016-19) of the Agricultural Catchments Programme had received funding. This well planned and managed programme of long-term work was considered by the PRC to be potentially of very considerable significance both nationally and internationally. The conception, implementation and operation of the research programme were judged to be of the highest quality. Some unique facilities had been established which were generating long time-series of data as well as building a reservoir of experience and skills within the well-led and efficiently organised team of innovative young researchers.

The PRC noted the output of high-quality research papers while recognising that firm conclusions on such things as relationships between farming activities and impacts on water quality were still some way distant. The PRC judged the Agricultural Catchments Programme to be at the leading edge of work in this area, being one the best co-ordinated and executed catchment research programmes in the world. The PRC assessed the quality of the Agricultural Catchments Programme as **Excellent**

6.2. Reflection on Productivity

The Agricultural Catchments Programme was delivering a regular output of peer-reviewed research papers in widely read, relevant journals. The PRC noted that these papers were being well cited but felt that it would be appropriate for team members to try in future to specifically target their most significant work towards higher impact publications. In addition to the published output, the PRC were impressed to learn of the range of other important deliverables from the research team. These included numerous presentations from team members to national and international scientific and policy audiences as well as engagement with highly successful PhD student training and contributions to numerous external working-groups. The PRC noted that recording on-farm data was always a challenge and to do so successfully over so many catchments for such an extended period, in a uniform manner, was a great achievement to be applauded.

The PRC judged the productivity of the Agricultural Catchments Programme to be **Very Good**

6.3. Reflection on Relevance

The Agricultural Catchments Programme originates in a requirement to address societal issues captured in EU and national policy associated with water quality (Nitrates Directive and Water Framework Directive) with close connectivity to more recent national policies for the agri-food sector. The PRC noted clear linkages between the programme and practical on-farm advice on nutrient management planning (NMP), with evidence that farmers engaged with the programme were more likely to adopt the CELUP NMP. Nevertheless, because linkages between on-farm practice and outcomes for water quality impacts at a catchment level were not always clear-cut, there was a delicate balance to be struck.

The PRC felt that the content of the programme involving investigative science, routine monitoring and knowledge transfer was well balanced and should be maintained into Phase 3. The PRC considered it necessary to emphasise the potential relevance beyond Ireland to high rainfall catchments in other geographical regions. The relevance of maintaining the sites recruited into the programme over a sustained period was that they could also be of value for testing catchment models developed outside the programme.

The PRC judged the Relevance of the Agricultural Catchments Programme to be **Very Good**

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

The PRC considered that receipt of funding from Phase 3 of the programme indicated the continuing vitality of the research group. However, the PRC also noted how important it would be to retain intact the integrity and expertise of the group and also continue the post-graduate training opportunity it provided. The vision and long-range objectives of the programme were clearly elaborated but the PRC emphasised the need to manage the expectations of policy stakeholders since well-proven mechanistic understanding of cause and effect may be difficult to establish. In the next phase of the programme, the PRC felt that there was need for greater emphasis on synthesis of data and refinement of hypothesis testing. Communication of findings to the international scientific community and to policy makers will be increasingly important; the feasibility of achieving environmental targets through changes in on-farm practice was still an open question. The future emphasis on catchment modelling in Phase 3 represents a significant challenge and one that could potentially make high demands on limited resources.

The PRC judged the Vitality, Feasibility and Vision for the future of the Agricultural Catchments Programme to be **Very Good** although is not too early for plans to be laid for maintaining expertise and continuity of activity in the event of cessation of time-limited funding.

6.5. Conclusion

Overall the PRC considered that the programme was going very well under good management. The PRC suggest that the work should be more closely integrated with the Environment, Soils and Land Use Department than is evident at present; there will be mutual benefits to be derived from this in terms of sharing data, insights and expertise. The team was functioning well but much depended on retaining the critical mass of expertise to maintain momentum. The objective of fully understanding the underlying processing determining N and P movement in the catchments was challenging but vital to any credible, policy relating to generic farming practices.

6.6. Recommendations

The PRC noted that the current evidence was that weather and hydrology “trumped” farmer operations in terms of influence on catchment water quality. Consequently, the priority recommendation from the PRC was for the research group to commence work, with colleagues in the Environment Knowledge Transfer Department, on investigating the feasibility of developing of a site-specific decision support tool, with the potential for use on mobile technology platforms, to enable farmers to take informed land use and management decisions based on weather and local hydrological knowledge.

Given the ambitious objectives of Phase 3, the PRC recommends that the group looks critically at ensuring appropriate balance is maintained between advancing the understanding of catchment processes, monitoring, modelling and formulating farm-based advice.

7. Review of Cross-Cutting Area: Translational Research on Sustainable Food Production

7.1. Reflection on Quality

The PRC applauded the philosophy of the research group under the leadership of Professor Schulte, i.e. the importance of formulating and presenting readily assimilated messages for policy makers and society at large that are founded on a sound, scientific consensus derived from a coherent body of peer reviewed literature. In this context, the assessment of quality has two elements:

- analysis and synthesis of a body of scientific data of high policy or societal relevance;
- presentation of this synthesis to achieve influence and impact.

It was apparent to the PRC that from the examples discussed (GHG emissions and sustainable land management) the work had been recognised internationally by virtue of the critical analyses it had carried out and the relevant way that these had been presented to influential audiences.

The PRC felt that there was a risk that this area of work was too dependent on one individual (i.e., Professor Schulte) whose time was spread over a wide range of different topics. The PRC considered that the depth of analysis on a few key areas should not be sacrificed for a more superficial approach to a wider agenda.

The PRC judged the quality of output from the Sustainable Food Production group to be **Very Good** noting that the group was well motivated and led in an area of strategic importance (i.e. policy-targeted knowledge transfer).

7.2. Reflection on Productivity

The high level of productivity from this group was clear to the PRC from their success in generating external funding from a diversity of sources and their output of refereed papers published in well cited journals in addition to publications directed to a policy audience. The PRC also noted that Professor Schulte was sought as a presenter to a range of audiences.

The PRC considered the level of productivity from the Sustainable Food Production group to be **Very Good**.

7.3. Reflection on Relevance

The long-term societal relevance of the primary interest of Professor Schulte's group (i.e. the Sustainable Intensification of agriculture) is hard to overestimate. The achievement of increased per hectare agricultural productivity alongside simultaneous reductions in adverse environmental impacts is an outcome of high international societal importance. This objective has now become embedded in national and international policy. However, while policy makers would like to think that "win-win" outcomes are readily available this is rarely the case and the need to carefully quantify trade-offs at a range of scales (e.g. national, regional, catchment, field) is necessary. In this context, identification and utilisation of informative metrics for quantification is essential. The PRC recognised that Professor Schulte and his group were making useful and innovative contributions to this area of endeavour by drawing on the expertise and data resident in Teagasc and using the depth of available knowledge about Irish production systems as the proving ground. Nevertheless, the PRC considered it important that there should be a clearer recognition in the group's work of the importance of spatial scale as well as the need to work towards agreed sets of metrics. Additionally, it was necessary to ensure policy makers understood that it was not

possible to meet all desirable objectives simultaneously in all locations at all scales (for well-established scientific reasons).

The PRC judged the Relevance of the work being undertaken by the Sustainable Food Production group to be **Excellent**

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

While not doubting the vitality of the sub-programme, the PRC considers that the future direction and scope of the Sustainable Food Production Group required careful consideration. The PRC took the view that the work should be strategically planned and closely aligned with the objectives both of the Crops Research Department and the Environment, Soils and Land Use Department (as well as other Departments outside CELUP involved with livestock production). A high level of dependency on the lead researcher needs to be recognised as a risk factor. Arguably, the highest future priority could be the delivery of a science-based analysis of regional land use optimisation (see also Section 2.2 above). This will require integration of metrics quantifying the range of different beneficial and adverse outcomes resulting from land use decisions and land management options. Such research should be undertaken without being too closely aligned from the outset with desired policy objectives when aspects of its feasibility (given limits on data availability) have yet to be determined. At present, the group appeared to be more policy-responsive than taking their direction from strong internal mission-driven scientific objectives.

There is significant potential for this sub-programme to expand and to be increasingly influential, nationally and internationally, but priority setting will be important if this is to be realised.

The PRC judged the Vitality, Feasibility and Vision for the future of the Sustainable Food Production group to be **Good** but there is vulnerability in the dependency of the sub-programme on Professor Schulte. A consideration would be to put in place stronger linkages to the overall organisations research strategic direction.

7.5. Conclusion

There is much to commend in the Cross-Cutting Area: Translational Research on Sustainable Food Production and its programme of work. However, it should not just be carried along under its own momentum. There is a need for greater strategic integration with the rest of CELUP and other components of Teagasc. Some high-level discussion seems to be necessary about long-term priorities and what the primary drivers should be (i.e. science-driven investigation or policy-reactive requirements). The PRC was of the view that the boundaries of the work require clearer definition.

7.6. Recommendations

The PRC recommend that the Cross-Cutting Area: Translational Research on Sustainable Food Production should have a departmental “home” and, over the next 12 months, develop a strategic 5-year plan. This plan should lay out the data acquisition and analysis requirements for a programme of work that addresses the issue of how trade-offs between different land uses and management options will be quantified at a range of spatial scales in order for policies on sustainable intensification to be appropriately and realistically implemented; this is at the core of translational research on the design of sustainable food production systems. Further, the position of this sub-programme should be clarified; is this part of the Soils and Environment Programme or is it the foundation for a larger integrated

programme on sustainable food production systems encompassing other existing work within Teagasc?

8. Environment Knowledge Transfer Department

8.1. Reflection on Quality

The PRC were impressed by what they judged to be a dedicated and well-qualified team of knowledge transfer specialists. The PRC also noted the fact that the existence of a Department dedicated to the objective of knowledge transfer relating to environmental issues is unusual (maybe even unique); consequently, benchmarking was not straightforward. This situation could be judged beneficial in demonstrating the importance being attributed to environmental issues; but it could also be seen as drawing an unnecessary distinction between production-related decision-making and that concerned with meeting environmental regulation.

In judging the quality of the Department's work, PRC noted the range of specialisms among the staff, the range and extent of stakeholder interaction, and the tools being employed to enable end-user uptake of advice. The current focus on soil fertility was considered to be a particularly well-selected priority since dual benefits to productivity/profitability and the environmental could be readily elaborated. The development of the Carbon Navigator (a decision support tool to assist in reducing greenhouse gas emissions from livestock production systems) is also seen as a key output of the Department's work.

The PRC judged the quality of output from the Environment Knowledge Transfer Department to be **Good**.

8.2. Reflection on Productivity

The PRC recognised that the Environment Knowledge Transfer Department was delivering a large number of different outputs including: site visits, stakeholder events, leaflets, training courses and tools such as the Carbon Navigator, GLAS and NMP-online. However, the PRC felt that there was scope for more involvement in discussion groups. There was also a suggestion that too much priority was being accorded to supporting farmers in obtaining support from government schemes as distinct from developing specific strategies for delivery of the complexity of messages pertaining to environmental issues in agricultural systems.

Overall, the PRC rated the productivity of the Environment Knowledge Transfer Department to be **Very Good**.

8.3. Reflection on Relevance

The Environment Knowledge Transfer Department has the challenge of formulating and delivering consistent and scientifically well-founded messages to end-users across a complex range of environmental issues (nutrient use, waste, GHG emissions, water quality biodiversity etc.). Actions to address environmental issues are themselves difficult to reconcile, never mind the difficulty of reconciliation with actions directed towards agricultural productivity and competitiveness. The PRC recognised that it was likely to be through the CELUP as a whole that specifically customised environmental messages for particular sites and circumstances would need to be worked out and agreed.

The PRR understood that meeting Irish agri-environmental policy objectives was going to be difficult to achieve, not only because of the complexity of the interactions referred to above,

but also because of the need to influence behaviours. In this context, the need to draw on social science was deemed necessary.

The PRC rated the relevance of the Environment Knowledge Transfer Department to be **Very Good** while acknowledging the difficulty of achieving rapid progress.

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

As implied above, the PRC recognised that there is tension in the work of the Environment Knowledge Transfer Department between delivering messages on science-based nutrient management and soil fertility on the one hand, and contributing to achieving governmental policy targets related to water and air quality or biodiversity on the other. The small team was required to deliver in a complex and challenging area. This caused the PRC to question feasibility of success despite the fact that there was no doubting the vitality of the group.

The current priority appeared to be primarily on soil nutrients and while the PRC applauded this focussed approach, it was unable to discern a strategic plan for how other areas of knowledge transfer would be tackled. The PRC suggested that collaborations with those outside Ireland who are trying to resolve similar problems might feature in a future vision.

The PRC recognised that the Environment Knowledge Transfer Department was substantially engaged in “work in progress” and considered the Vitality, Feasibility and Vision for the future was **Good**

8.5. Conclusion

The PRC concluded that the Environment Knowledge Transfer Department was a highly motivated, dedicated and knowledgeable group that was addressing complex and important issues. The PRC emphasised the need for close cooperation with other Teagasc knowledge transfer groups in order to ensure consistency of messages and optimised methods of delivery. The PRC noted that the Department occupies a ‘sensitive’ position in the sense that it could be seen as a promoter of policy as distinct from science-based, innovation for business profitability; the PRC suggest that this will need careful management.

8.6. Recommendations

The PRC’s recommendations directed to the Environment Knowledge Transfer Department are not very different from those indicated for other areas of Teagasc and CELUP knowledge transfer. The recommendations are generalised in Sections 2.4.1 and 2.4.2 above but can be summarised specifically as:

- work towards more outsourcing of support on “administrative” advice (schemes, grants etc.);
- ensure consistent messaging by close working with the Crops Knowledge Transfer Department (and other Teagasc KT specialists);
- develop greater capability in, the deployment of, digital technologies as a major component of engagement with “next generation” farmers including a social media strategy;
- seek collaborations with groups outside Ireland (e.g., Denmark, Netherlands) who are involved in knowledge transfer activities directed towards resolution of the same environmental issues; such collaborations should feature in the development of a clearly articulated plan for future actions.

9. Review of Horticultural Development Department

9.1. Reflection on Quality

Horticultural businesses cover a diverse range of high value crops and growing systems as well as having to be highly entrepreneurial in an unsubsidised economic environment. The environmental footprint of horticulture is small but many of its products represent important components of a healthy diet and there is a drive to increase local production and consumption. The industry is also a significant employer. Against this background, the small Horticulture Development Department has an important and increasing role to play. The recent appointment of an energetic new Head with wide industry experience is an important starting position for development of a growth strategy based on the Horticulture Sector Development Plan.

The PRC recognised the experience and high level of expertise that exists among the technical specialists in the Department that was particularly well equipped to advise on pest and disease management issues that represent major constraints in a range of crops. It was evident to the PRC that, in the areas of crop specialism the Department was equipped to address, it was delivering high quality outputs of importance to producer businesses especially with regard to dealing with emergency issues.

The PRC judged the quality of output from the Horticulture Development Department to be **Good** given that breadth as distinct from depth was necessitated by the demand placed on limited resources.

9.2. Reflection on Productivity

Within the limits of the Department's modest resources and when set against the extensive diversity encountered among horticultural crop production, the scale and scope of the delivery was considered impressive by the PRC. In addition to a modest contribution to the scientific literature, this includes: numerous technical publications, conferences (and conference papers), training courses, discussion groups and a very large number of client visits (ca. 400 per annum!).

The PRC considers the level of productivity from the small Horticulture Development Department to be **Very Good**.

9.3. Reflection on Relevance

The PRC recognised that the Horticulture Development Department has an essential role in ensuring that successful components of the Irish horticulture industry (e.g. mushrooms) remain competitive and new enterprises are able to thrive. Horticulture features significantly in objectives set within recent national strategy documents (SHARP and Food Wise 2025). In this context, the Department will be required to provide a "rapid response" to meet industry emergencies (such as previously unencountered pests and diseases) and at the same time undertake strategic investigations to guide the industry in new directions. The Department's planning for the future is underway, and has yet to mature, but its relevance now and in the future to the successful delivery of national strategic objectives is unquestioned.

To achieve impact, the PRC felt that it will be necessary for the Department to focus on key industry requirements and it seemed likely that integrated approaches to pest and disease management (including avoidance of highly susceptible varieties) would be the highest priority cutting across all horticultural crops. The PRC found it less easy to judge the

relevance to producers or consumers of work on product composition (e.g phytochemicals), since the economic returns and EU regulatory framework, as well as magnitude of environmental interactions, were all substantially unknown.

Taking all aspects into consideration the PRC rated the relevance of the Horticulture Development Department to be **Very Good**.

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

The Horticulture Development Department has a good track record with its clients and is receiving positive messages about its future importance. Coupled with the appointment of a new Head and the upgrading of facilities, this has stimulated an expansive and optimistic forward look that the PRC applauded. However, the PRC felt that this ambition was unlikely to be realised without additional staff and the strategic development of networks involving Teagasc colleagues and other researchers in Ireland and overseas (to enable access to the breadth of knowledge and expertise required). Working closely with the Crop Research Department, the establishment of specialist discipline-related “platforms” was considered by the PRC to be well worth exploring. However, the PRC felt that the Department also needed to explore a range of innovative options for providing access to the breadth of expertise and capability required to be responsive to likely industry demands. In this context, comments already recorded in Section 2.4.3 are particularly pertinent including mapping out and linking up with existing networks of national expertise.

The PRC was encouraged that the Department has a close awareness of the issues being raised and recognised that it needed to manage the risk of being unable to keep pace with industry requirements. Emergency responsiveness, capacity building and future-proofing research activities all needed to be in the mix but crop-related priorities would have to be established with industry buy-in.

While there was still much work to do, the PRC was firmly of the view that the Horticulture Development Department’s Vitality, Feasibility and Vision for the future could be rated as **Very Good**. However, it was only likely to remain so if resources were found to retain and extend the existing capability of the Department and enable plans to be realised.

9.5. Conclusion

The Horticulture Development Department is very dependent on a few experienced staff but is entering a period of great opportunity that it is clearly keen and ready to grasp. The capacity must be built back carefully and strategically if national objectives are to be realised. It may be that there is scope for some redeployment/retraining from other parts of Teagasc. Before decisions are made on new recruitments, an analysis of where the greatest return on investment is likely to come from would be appropriate. Economists in Teagasc could perhaps be encouraged to work with crop experts in the Department to conduct a crop x constraint gap analysis informed by projections of sector growth potential.

9.6. Recommendations

The PRC recommends that the Horticulture Development Plan (to 2020) should provide the basis for on-going dialogue between Teagasc and industry representatives about priorities for future investment in expertise and specialist facilities. The PRC did not feel sufficiently well informed to make specific recommendations on recruitments but was clear that any decisions should be taken in concert with the Crop Research Department. PRC observed that integrated pest and disease management was likely to be the one area requiring input in all crops given the anticipated reductions in availability of crop protection products.

The PRC recommendation for an evolution of the CELUP Resource Management Structure made in Section 2.4.1 would pertain to the Horticulture Development Department as do the recommendations relating to knowledge transfer (Future Skills for Effective Knowledge Transfer at 2.4.3) and expertise (Expertise and Human Resource Management 2.4.3).

Appendix 1 Response of Management and Staff to the Report

Follow up actions in response to the report:

	<u>Recommendation</u>	<u>Response Action</u>	<u>Time Frame</u>	<u>Person Responsible</u>
	Overall Programme Recommendations			
1.	<p>2.4.1 Resource Management Structures The PRC recommends that managed units (Departments?) within CELUP are minimised and that consideration is given to amalgamation of all activities into just two: a Crops Group (embracing tillage and horticultural crops) and a Soils and Water Group (embracing environmental impacts of land management practices). It is envisaged that knowledge transfer specialists would be embedded within the appropriate group but would also participate actively in a newly created cross-Programme grouping of knowledge transfer specialists directed specifically towards two important objectives:</p> <ul style="list-style-type: none"> • Consistency of messaging and reconciliation of potentially conflicting advice emanating from different Programmes or Sub-programmes; • Development of innovative “next-generation” digital approaches to the customised delivery of technical information and advice to end-user businesses (see also recommendation on <i>Future Skills for Effective Knowledge Transfer</i> below). <p>The PRC considers that this further step in the evolution of CELUP would facilitate integration of soils research with outputs from catchment studies and enable resource planning to meet future requirements for research on environmental</p>	<p>We accept the need for greater integration between the Environment related departments and the Crops related departments. While we would agree that some of the departments, particularly the KT departments are relatively small, we would also argue that there is a need for each of the existing departments to have a figurehead to provide public leadership to the sector. Accordingly we propose to establish an environment grouping and a crops grouping to meet at least 3 times a year to discuss issues of mutual concern and to seek to achieve greater synergies in how they operate. Specifically this structure would facilitate the establishment of Technology Platforms in areas such as Plant Pathology, Entomology, Informatics, Genomics etc. These Technology Platforms would harness existing expertise both within CELUP and the wider organisation and would also seek to leverage expertise from outside Teagasc through integrated</p>	Ongoing	HOP

	impacts of agriculture. It would also be possible within the structure, subject to demand and resource availability, to establish a set of “technical platforms” for necessary and pervasive technologies and expertise including such areas as genomics, microbiology, informatics, analytical chemistry, crop nutrition etc. (see also recommendation on <i>Expertise and Human Resource Management</i> below)	projects.		
2.	<p>2.4.2 Future Skills for Effective Knowledge Transfer</p> <p>The PRC recommends the establishment of a time-limited taskforce to advise the Director on the competences and resources required to build an appropriately equipped and resourced specialist team (perhaps located within an expanded ICT Department) to ensure the organisation will, in future, be able to exploit fully the benefits that digital communication technologies can deliver for stakeholders. This taskforce should include knowledge transfer experts from across the organisation among its membership as well as technical specialists. In parallel, the PRC recommends the establishment of a working group (reporting to the Director), with external membership as necessary, tasked to define the generic attributes and additional technical skills that will be expected of tomorrow’s knowledge transfer specialists together with an outline of the professional development programme likely to be required for current and future staff who will occupy these critical positions. For example, ecosystem services provision, agro-ecological practices and utilisation of a diversity of IT-dependent precision farming applications are just a few of the anticipated innovations that farmers might be expected to adopt widely in future. This will require advisers to be fully informed and conversant with latest developments as well as having an appreciation of social contexts and drivers for change.</p>	This recommendation is consistent with the recommendations contained in the Teagasc Technology Foresight 2035 Report which states that farming must become considerably more efficient on existing farmland by deploying more targeted and precise management systems. As part of the implementation of the Foresight report, a taskforce such as that proposed in 2.4.2 will be established to develop strategies relating to the use of digital technologies in relation to Teagasc’s overall Knowledge Transfer efforts.	Taskforce T.O.R. to Director by Sept. 2016	HOP

	<p>and specialist expertise that is not currently available. The PRC recommends that the senior CELUP team think creatively about a range of different initiatives that may provide this access without always requiring new recruitment. Among things to consider are:</p> <ul style="list-style-type: none"> • strategic partnerships with university departments or individual faculty members that could be mutually beneficial on a <i>quid pro quo</i> basis; • creation of virtual research networks; • involvement of retirees in an emeritus capacity as mentors; • establishing new research networks to provide added value in terms of project planning or access to facilities as well as strengthening relationships with academic and company researchers (nationally and further afield); • creating attractive opportunities for visiting scientists to spend periods of study leave in association with CELUP research groups. 			
4.	<p>2.4.4 Data Curation, Access and Analysis The PRC realises that CELUP is one of several components in Teagasc that generates, and is the custodian of, a range of diverse and valuable data sets that, in some cases, are not being fully exploited through lack of capacity or expertise. The PRC recommends that CELUP takes a lead within Teagasc in establishing and delivering a new and strategically planned approach to data. This will include routes to efficiency gains and adding value in the context of data collection, storage, curation, annotation, access, analysis, synthesis and presentation. Examples of the expertise likely to be required to derive added value from “big” data sets include; spatial analysis, modelling, genomics, GIS and customised software development (such as independently validated algorithms for the agricultural industry to exploit). In addition, the PRC</p>	<p>This is a trans Teagasc issue which requires an organisational response. It is planned to address this challenge in Teagasc’s new ICT strategy. It is recognised that, increasingly, governments and public bodies are seeking to make all sorts of big datasets freely available to facilitate the development of applications that can exploit these datasets particularly by the private sector. CELUP will play a leading role in the development of an organisational strategy for accessing, storing, organising and adding value to the valuable datasets that reside within</p>	Ongoing	HOP

	<p>recommends that CELUP takes the lead on the development of a Teagasc policy on open data as set out by DPER https://data.gov.ie/data Increasing amounts of potentially valuable data are being collected routinely on farm and throughout supply chains. The PRC recommends that CELUP should give some priority to the development of a strategy for accessing, storing, organising and adding value to data of relevance to its strategic remit and specifically examine ways in which use of mobile technology platforms may facilitate information exchange with stakeholders for mutual benefit.</p>	<p>Teagasc and to liaise with relevant other public bodies and Departments to ensure that databases held by them are leveraged to the full.</p>		
	Crops Research Department			
5.	<p><i>3.6.1. Filling gaps in critical expertise</i> The Crop Research Department should undertake a critical quantitative analysis of the risks and rewards pertaining to the loss or acquisition of specific scientific/technical expertise and experience. Such an exercise could be unbounded or be bounded by currently available evidence on opportunities lost or reductions in efficiency experienced as a consequence of staffing deficiencies already recognised (entomology, mathematical modelling, pathology, agro-ecology, precision agriculture, bioinformatics, technical support). The analysis should include options to fill gaps by means other than internal recruitment.</p>	<p>We are currently revising our research prioritisation for the next 3 years with the new tillage stakeholder group. This will be the first step in identifying gaps in our current scientific and technical capabilities, and provide the basis for a plan for recruitment of core staff as well as targets for external funding and strategic collaborations.</p>	Dec 2016	HOD
6.	<p><i>3.6.2. Adding value to soils research</i> The Crop Research Department should take the initiative to explore the added value to be derived from closer awareness of data and expertise residing with the Environment, Soils and Land Use Department including outputs from catchments research. Soil mapping and fertility; soil health and metagenomics; and precision soil management are examples of areas worthy of consideration.</p>	<p>Agreed there is scope for further co-ordination of activities particularly in relation to precision farming and as we expand our activities within this area we will be seeking greater collaboration particularly in relation to soils. Once our new entomologist is recruited we will be seeking greater linkages with ecologists within ESLU as we</p>	Dec 2016	HOD

		seek to develop IPM approaches.		
7.	<p><i>3.6.3. Engaging with technologies for precision farming</i></p> <p>The Crop Research Department requires a coherent strategy and “road map” for its engagement with the application of technologies pertaining to precision farming (robotics, sensors, GPS etc.). This plan should include algorithm development and “real-time” agronomic decision-making as well as the value to be derived from “big data” (weather, geo-referenced soil and crop data etc.). This activity should include colleagues involved in knowledge transfer (See Section 4 below) and it is also likely that actions could beneficially be taken forward in collaboration with colleagues already addressing similar issues in the livestock sector. The latter prospect should be explored. (see also Section 2.4.4 above)</p>	<p>Agreed, currently we are aware that this is an area in which we should be doing more but don’t currently have a well thought out plan. The re-prioritisation exercise along with the Teagasc technology foresight will provide more clarity as to where crops research can usefully progress the areas of precision farming and big data management alongside the skills and expertise elsewhere in the programme and Teagasc more widely</p>	Dec 2017	HOD
8.	<p><i>3.6.4. Realising the ambition of VICCI</i></p> <p>The Crop Research Department should take responsibility for ensuring that progress towards realising the vision of VICCI is realised by action designed to maintain momentum among all partners in this strategically important venture. This could involve the establishment of an external review group of relevant international experts (from both the public and commercial sectors) who would meet regularly to receive progress reports, appraise progress towards objectives and advise on future priorities and directions of travel.</p> <p><i>5. New market developments – defining the role</i></p> <p>The Crop Research Department should consider if they have a role in assisting farming businesses to develop new markets for arable crop products and if so, what that might be and how such opportunities might best be realised to minimise the risk of market failure (see also Section 2.3 and questions posed therein).</p>	<p>We agree that VICCI (along with wider involvement in genetic improvement of crops) is strategically important but high risk in terms of being seen to fail to deliver to expectations. Ensuring momentum and focus is an objective of the 2016 business plan. We will establish an external group of 5-6 international experts from both academia and industry to advise on our work in this area.</p> <p>We are getting involved in trying to facilitate such initiatives driven by Foodwise 2025, primarily to identify technical constraints to such developments that require a research input, however, I’m not clear how involved we should become in this area</p>	Dec 2016	HOD

Tillage and Energy Crops Knowledge Transfer Department				
9.	4.6.1 Consider more outsourcing of “administrative” advice;	<p>This Department in conjunction with local management have implemented the following in 2016: 1. Outsourcing identified clients administrative work to an organisational partner (Farm Relief Service, FRS), 2. Utilising temporary advisors for the peak administrative period.</p> <p>The success of this will be monitored at the end of 2016 with the view of extending the number of clients serviced by Teagasc organisational partner.</p>	Dec. 2016	HOD
10.	4.6.2 Ensure consistent messaging by close working with the Environment Knowledge Transfer Department, other Teagasc KT specialists, and, where appropriate, external agricultural consultancies.	<p>This department is strongly involved in environmental working groups (Greenhouse gasses, Water Framework Directive, biodiversity, sustainability, etc.) whose input provides a key driver for program direction which is integrated into the Crop programme. In recognition of points 2.4.1 and this specific recommendation, these working groups will be utilised further to strengthen the environmental messages in the crops area.</p> <p>Jointly the KT departments will develop on farm tools to improve production at least environmental cost. Areas will include using existing tools and development of a Crops Sustainability Navigator which will encompass</p>	Ongoing	HOD

		Carbon emissions, Ammonia emissions, Biodiversity and Water Quality. Specialist expertise will be needed to develop this tool (possibly from a research background)		
11.	4.6.3 Deliver a strategy for, and develop greater capability in, the deployment of digital technologies as a major component of engagement with “next generation” farmers.	<p>In recognition of point 2.4.4 and this specific recommendation, the Department recognises the need to increase its presence in the digital space and has embarked on strategy to address this area.</p> <ul style="list-style-type: none"> • Develop a strategic alliance with online base company to deliver a cloud based on-farm recording solution with a proposed start date in 2017. • Developing a series of audio /videos for critical management areas each year for the next 5 years • An on-going program to demonstrate precision farming technologies on BETTER farms to develop recommendations on these technologies and advise in their best use to help improve profitability. <p>The department will endeavour to develop mobile technologies tools to help improve advice efficiency in Integrated Crop Management and other areas appropriate for this technology</p>	2017	HOD
	Environment, Soils and Land-Use Research Department			
12.	5.6.1 <i>Routine sample analysis</i>	The analysis of research samples does	Ongoing	HOD and

	<p>Consider contracting out all routine sample analysis to one or more commercial or public laboratories to direct resource allocation to more innovative activities. Care over service level delivery and quality control will, of course, be necessary</p>	<p>generate considerable income for the department. .The department is already outsourcing the majority of routine analysis. While this saves some resources there is a considerable resource required to manage outsourcing. There are certain areas such as water and greenhouse gases where there is no private service available that can meet the mandatory time limits for analysis or the sensitivity required. There are considerable QA/QC concerns with outsourcing of research analysis which arose last year as part of the advisory soil outsourcing. Every effort is and will be made to outsource routine analysis.</p>		<p>Lab Manager</p>
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13.	<p><i>5.6.2 Deficiency in expertise</i></p> <p>Develop and put in place a plan to enable ready access some specific areas of existing expertise in the organisation such as spatial analysis and modelling as well as other areas of priority that may need to be sourced externally. Consider a mix of creative solutions including re-training, external collaborations and support for visiting workers as well as staff recruitment.</p>	<p>The expertise deficiencies highlighted through the peer review process is already being addressed through the recruitment strategy for the department. There a number of mission critical posts that are on the Teagasc staffing and efficiency plan. The creative solutions suggested have been used for many years to plug expertise gaps. There are a number of staff who have been retrained and are currently providing invaluable support for the department. This has now been exhausted as a potential way to increase expertise due to the limited number of staff and their current work-loads. Collaborative projects have been used to also plug deficiency gaps but there are sometimes conflicting priorities between Teagasc and the other institutions. External funding is being used to plug expertise and personnel shortages in priority areas. There is an increasing risk of staff loss through retirement or resignation. A staffing succession plan is needed to help plan for these losses of staff.</p>	Sept. 2016	HOD
14.	<p><i>5.6.3 Vision</i></p> <p>The Department needs to develop a well-articulated vision and 5-10 year plan for the creation of a world-class centre of environmental sciences related to agriculture. This is likely to</p>	<p>The peer reviewers have identified the need for us to update the department's vision. A short vision document will be</p>	June 2016	HOD

	<p>include:</p> <ul style="list-style-type: none"> • prioritisation of research projects relative to resource and expertise availability; • establishing a network of collaborations with other leading research groups; • establishing work with global relevance (i.e. beyond Ireland); • becoming a venue of choice for talented PhD students and post docs; • facilitating staff exchanges (sabbatical leave) with other leading research centres; • plans for succession; • plans for laboratory up-grading and necessary technical support. 	<p>written.</p> <p>There are a number of steps for further developing the centre in to a world class centre. The physical resources need to be urgently improved and the current new laboratory and refurbishment plan, when funded, will provide this. There is potential to further attract leading students and postdoctoral researchers to the centre. Further investment in the analytical facilities and research facilities will also contribute to this. Researchers and students are encouraged to travel and the sabbatical scheme has been used previously by staff.</p>		
15.	<p>5.6.4 <i>Data</i> (see also Section 2.4.4)</p> <p>The Department is rich in data (particularly spatially referenced) that is still accumulating and has not yet been exploited to the full. Internal (eg within CELUP) and external collaborations should be established to enable more data organisation, annotation, analysis and utilisation, particularly with a view to extracting greater end-user value <i>via</i> knowledge transfer teams.</p>	<p>The department has a massive data and sample archive which are national and international resources. There is a personnel resource constraint within the department to fully realise the potential of this resource. The recruitment of a spatial modeller, as per the Teagasc Staffing and Efficiency plan, will help to realise this potential. The further development of NMP online and other extension support resources will greatly benefit farmers and policy makers. Further integration between research and KT specialists will help to realise</p>	Ongoing	HOP

		this potential but it is resource constrained in terms of personnel and expertise.		
	Agricultural Catchments			
16.	6.6.1 The PRC noted that the current evidence was that weather and hydrology “trumped” farmer operations in terms of influence on catchment water quality. Consequently, the priority recommendation from the PRC was for the research group to commence work, with colleagues in the Environment Knowledge Transfer Department, on investigating the feasibility of developing of a site-specific decision support tool, with the potential for use on mobile technology platforms, to enable farmers to take informed land use and management decisions based on weather and local hydrological knowledge.	This recommendation is in line with the broad thrust of the work proposed in Phase 3 of the ACP. Collaboration with the Environment KT Department on the development of a site-specific approach to supporting better nutrient management decisions by farmers should be feasible provided the appropriate technical resources (ICT, meteorological etc.) are available to the development team.	Ongoing over Phase 3 – 2016-2019	HOD
17.	6.6.2 Given the ambitious objectives of Phase 3, the PRC recommends that the group looks critically at ensuring appropriate balance is maintained between advancing the understanding of catchment processes, monitoring, modelling and formulating farm-based advice.	The ACP team will endeavour to achieve the recommended balance with the support of the newly constituted Expert Steering Group, Consultation and Implementation Group and Teagasc Project Team.	Ongoing over Phase 3 – 2016-2019	HOD
	Translational Research on Sustainable Food Production			
18.	7.6.1 The PRC recommend that the Cross-Cutting Area: Translational Research on Sustainable Food Production should have a departmental “home” and, over the next 12 months, develop a strategic 5-year plan. This plan should lay out the data acquisition and analysis requirements for a programme of work that addresses the issue of how trade-offs between different land uses and management options will be quantified at a range of spatial scales in order for policies on sustainable intensification to be appropriately and	The research officer working on this area is leaving Teagasc and we will need to decide as to how we are going to address this area going forward. As outlined in section 2.4.4 above, it is planned to develop a more strategic approach to data collection, curation and analysis. This in turn will facilitate Teagasc to place greater emphasis on	Land Use Workshop on 20/05/2016	HOP

	<p>realistically implemented; this is at the core of translational research on the design of sustainable food production systems. Further, the position of this sub-programme should be clarified; is this part of the Soils and Environment Programme or is it the foundation for a larger integrated programme on sustainable food production systems encompassing other existing work within Teagasc?</p>	<p>Land Use as distinct from Land Management i.e. the quantification of environmental and economic trade-offs directed towards strategic approaches to changes in regional land use utilisation.</p> <p>This will require us to identify existing land use and the agronomic context of land use i.e. identify soil, weather, slope, hydrological characteristics etc of land use.</p> <p>It is planned to hold an initial internal workshop to help determine our future involvement in functional land use.</p>		
Environment Knowledge Transfer Department				
19.	<p>8.6.1 The PRC's recommendations directed to the Environment Knowledge Transfer Department can be summarised specifically as:</p> <ul style="list-style-type: none"> work towards more outsourcing of support on "administrative" advice (schemes, grants etc.); 	<ul style="list-style-type: none"> In the last 12 months there has been considerable outsourcing of Scheme work with the Full outsourcing of GLAS planning and support. More recently Derogation Nutrient Management Planning has been approximately 75% outsourced. The completion of TAMS II application has also been substantially outsourced. The process of outsourcing will continue for suitable work packages in order to achieve the delivery of a comprehensive package of services to clients while at the same time prioritising the output of advisory staff. It has become evident that the level of outsourcing which is envisaged will require dedicated resource to manage 	Ongoing	HOD

	<ul style="list-style-type: none"> • ensure consistent messaging by close working with the Crops Knowledge Transfer Department (and other Teagasc KT specialists); • develop greater capability in, the deployment of, digital technologies as a major component of engagement with “next generation” farmers including a social media strategy; • seek collaborations with groups outside Ireland (e.g., Denmark, Netherlands) who are involved in knowledge transfer activities directed towards resolution of the same environmental issues; such collaborations should feature in the development of a clearly articulated plan for future actions. 	<p>and provide quality control – both at regional level and within the Environment KT Department.</p> <ul style="list-style-type: none"> • The growing importance of a range of sustainability metrics, particularly water quality and GHG emissions require increased integration of environmental KT into technical advisory programmes. This will be done through inclusion of environmental deliverables (such as Carbon Navigator, Crop Sustainability Navigator and NMP-Online) in programmes and the delivery of IST to B&T advisers. The development of the Crop Sustainability Navigator will integrate expertise from Crops and environment disciplines. The working groups provide a forum for the integration of programmes across all environmental sub-programmes and will be strengthened to ensure inclusion of all technical areas. • Redevelopment of Environment Web Site. Further development of NMP online and Carbon Navigator to incorporate apps and other automated communication elements (eg automated emails and texts with alerts). Increased use of social media – in particular twitter. • Increase involvement in EU wide KT initiatives where opportunities arise. 		
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		Introduction of short visits to other services into annual program of specialists. Organisation of themed foreign visit by S&E advisers on an annual/bi-annual basis as part of annual training programme training		
Horticulture Development Department				
20.	<p>9.6.1The PRC recommends that the Horticulture Development Plan (to 2020) should provide the basis for on-going dialogue between Teagasc and industry representatives about priorities for future investment in expertise and specialist facilities. The PRC did not feel sufficiently well informed to make specific recommendations on recruitments but was clear that any decisions should be taken in concert with the Crop Research Department. PRC observed that integrated pest and disease management was likely to be the one area requiring input in all crops given the anticipated reductions in availability of crop protection products.</p> <p>The PRC recommendation for an evolution of the CELUP Resource Management Structure made in Section 2.4.1 would pertain to the Horticulture Development Department as do the recommendations relating to knowledge transfer (Future Skills for Effective Knowledge Transfer at 2.4.3) and expertise (Expertise and Human Resource Management 2.4.3).</p>	<ol style="list-style-type: none"> 1. The Horticulture development department has on-going dialogue with industry representatives to inform the research and KT programme. This is facilitated through the stakeholder groups. 2. Regarding IPM, HDD plan to focus on best practice in IPM for horticulture crops and access existing technical platforms in Europe and elsewhere to update best practice. Building capacity (the IPM toolbox) requires the integration of expertise in the core scientific disciplines (plant/crop science, agro-ecology, entomology, plant pathology, weed science etc.) most of which exists across jurisdictions. It is agreed that the only way is to build technical platforms with individuals and organisations that have these core disciplines. 3. Regarding 2.4.3, HDD is in 	<p>Ongoing</p> <p>Ongoing</p> <p>To develop a Mushroom</p>	HOD

		agreement that creation of technical platforms and virtual research networks is paramount to expanding the impact of the HDD and will allow scope to move the HDD in new directions in terms of future skills and knowledge transfer.	Technology Centre in 2016	
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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. 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 CELUP Peer Review Panel

TEAGASC CROPS ENVIRONMENT AND LAND USE PROGRAMME PEER REVIEW PANEL

	Name and Contact details
1.	Professor Ian Crute CBE Non-Executive Director Agriculture and Horticulture Development Board 35 Northumberland Road Leamington Spa Warwickshire, CV32 6HE
2.	Prof. Dr. Ir. Oene Oenema Green Environment, Professor, Nutrient Management & Soil Fertility, Building 104, Room B.301 Wageningen University & Alterra Research Institute Postbus 47 6700AA, Wageningen, Netherlands
3.	Dr. Pete Barry, Head of Crop Physiology ADAS UK Ltd ADAS High Mowthorpe, Duggleby, Malton, North Yorkshire, YO17 8BP
4.	Prof Paul J A Withers Professor of Geography School of Environment, Natural resources and Geography Bangor University Deiniol Road Bangor, LL57 2UW
5.	Jens Erik Jensen SEGES P/S Agro Food Park 15, DK 8200 Aarhus N, Denmark
6.	Michael Hoey, Country Crest, Rathmooney, Lusk, Co. Dublin
7.	Dara Lynott, Director of the Office of Climate, Licensing, Research & Resource Use Environment Protection Agency PO Box 3000 Johnstown Castle Estate, Wexford
8.	Dr. Lance O'Brien Head of Foresight and Strategy, Teagasc Oak Park Lance.oBrien@teagasc.ie

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