

Teagasc

Agriculture and
Food Development
Authority

Food Harvest 2025

Submission

‘Driving Sustainable Profit from Productivity’

April 2015



AGRICULTURE AND FOOD DEVELOPMENT AUTHORITY

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Summary

Teagasc's mission is to support science based innovation in the agri-food sector and the wider bio-economy so as to underpin profitability, competitiveness and sustainability. In the context of Food Harvest 2025 Teagasc's focus will continue to be on the underlying productivity factors on our farms and in our food companies that underpin the aggregate targets on growth, value add, jobs and exports that the FH2025 Committee will determine. We focus in this submission on those factors that are within the control of farms and food companies. Hence our emphasis is on "driving sustainable profit from productivity".

We identify feasible technical targets (Section 2) for our main agricultural sectors: dairy, beef, sheep, pigs, tillage, horticulture and forestry, that underpin productivity. We also set out a number of cross-sectoral issues that will need to be addressed to alleviate constraints on maximising the inherent sustainable productivity growth potential that lies within the various sectors: grass utilisation; genetic improvement; animal health; soil fertility and land improvement; sustainable intensification; price volatility; land mobility; labour efficiency; quality; off-farm income generation; and Health and Safety.

We also consider those issues that need to be remedied to obtain the maximum sustainable value from our main processing sectors (Section 3): dairy, meat and prepared consumer foods and bakery. We focus in particular on a number of cross-cutting factors: improved productivity and efficiency at processor level; improving environmental sustainability at the processor scale; technologies to facilitate exports; and on issues that affect the entire value chain: Infant Milk Formula; meat; and on increasing value through better supply chain management.

Teagasc's well-proven core activities in education, research and advisory/extension will continue to be mobilised in an integrated fashion to support the objectives of FH2025. We also set out a number of initiatives (Section 4) that we plan to embark on over the next few years that will further enhance our ability to support the drive for "sustainable profit from productivity" in our agri-food sector.

Proposed Teagasc Initiatives in Support of FH2025

1. Capacity building for Irish agriculture: deploying Teagasc's integrated research, education and extension model to optimum advantage
2. Grass – the 2 tonne challenge (increase grass utilisation by 2 t/ha)
3. A sustained campaign to improve soil fertility
4. Sustainable improvement of marginal lands
5. Launching the next generation of animal genomics
6. Profit through healthy animals driven by genetics
7. "Big Data" - exploiting the potential of precision livestock farming
8. Teagasc NFS to measure and monitor Ireland's sustainability credentials
9. Updating the Marginal Abatement Cost Curve (MACC) for Irish Agriculture
10. Improving water quality–Teagasc Agricultural Catchments Programme Phase 3
11. A new nutrient management planning software tool
12. Demonstrating environmental efficiency: The Kildalton 'Open Source' Sustainable Farm
13. Make collaborative farming the norm in succession and inheritance transitions
14. A new dairy expansion service
15. Expand the intake into Teagasc's Diploma in Professional Dairy Farm Management
16. Flexible education and training pathways
17. A new vision for farmer education in Ireland
18. Technology outreach service: supporting rural based agri-professionals
19. Helping farmers to get financially fit
20. Teagasc 'Options Plus' programme for improving off-farm income generation of farmers
21. Food Innovation Hub
22. Translating 'food for health' science into practice
23. Industry Walsh Fellows: enhancing the scientific absorption capacity of the agri -food SME sector

SECTION 1

INTRODUCTION AND PLAN OF SUBMISSION

Introduction and Plan of Submission

1. Significant potential exists for the growth of the Irish agri-food sector arising from increasing demand for high-value food resulting from rapid global population growth, income growth in developing countries and the impact of climate change on limiting the expansion of food production in many parts of the world. Food security is one of this century's key global challenges and has positioned the development of sustainable food production and processing at the very top of the international agenda.
2. Ireland has the capacity to contribute to the alleviation of world food insecurity, and Irish agri-food businesses are being presented with major opportunities for those capable of growing and innovating to meet the increasingly sophisticated demands of consumers who place high value on quality, taste and provenance of the food they eat. To fully realise these opportunities, our goal must be for the development of a knowledge-based sustainable and secure food system, embracing social, environmental, health and economic factors. Achieving this goal will require new policies, systems and procedures, and the evidence base to support marketing strategies.
3. Irish agriculture needs to continue to develop so as to ensure competitive, sustainable and safe agricultural production. Future agricultural systems must be able to reconcile the often conflicting goals of competitiveness and sustainability and meet consumer expectations. Technological innovation and transfer of best practice will be key in this regard. This will require continued investment in public agriculture and food research along with support to deliver technology transfer.
4. Future food production systems must be sustainable in terms of delivering a supply of safe, healthy food with low environmental impacts in terms of emissions and biodiversity. This will require a hugely enhanced level of innovation and involve major improvements in efficiency and waste reduction and access to new types of technology. New programmes of R&D will be needed to support the development of lower-input, more sustainable systems.
5. The move to lower-carbon/lower-input systems will present challenges for the resilience and competitiveness of our agriculture. In particular, the livestock sectors face difficulties in securing reductions in greenhouse gas emissions. Support will be required to underpin technological developments and the introduction of innovative agricultural practices.
6. Innovation is the cornerstone of economic growth, improved competitiveness and profitability. Innovation involves change and the ability to respond effectively to change processes. Innovation is necessary so as to remain vigorous and competitive in a world in which European agriculture will increasingly need to compete globally. This involves increasing productivity and responding to market demands, as well as consumer demands for sustainable production methods.
7. To take advantage of the opportunities and minimise the threats, our future strategy must aim to ensure the continuation of a strong agricultural production base that is competitive and sustainable; contributes to a secure and sustainable global food supply; is compatible with the urgent requirement

to reduce greenhouse gas emissions; contributes to future energy needs; addresses wider environmental concerns; is able to respond to market demands; and helps sustain strong rural communities.

8. Teagasc – the Agriculture and Food Development Authority – is the national body providing integrated research, advisory and training services to the agriculture and food industry and rural communities. The Teagasc mission is to support science-based innovation in the agri-food sector and wider bio-economy so as to underpin profitability, competitiveness and sustainability.
9. The combination of research and innovation support in one organisation uniquely positions Teagasc to ensure knowledge transfer and to deliver value for money invested. The organization structure facilitates Teagasc to not only generate/procure the appropriate knowledge, but also to transfer the knowledge through its extensive advisory service and create the capacity within the community to use this knowledge through focused educational programmes. A renewed emphasis on innovation within the organisation aims to ensure that the knowledge is used in rural areas to create sustainable wealth.
10. Teagasc is committed to playing its part in realising the vision to be set by the 2025 Committee. It is in the process of restructuring to focus on a number of key programmes which will achieve better integration and bring the full capacity of its research, advisory and education roles to bear on ensuring the development of a sustainable and secure food system in Ireland and providing the knowledge base needed to support Ireland’s sustainability claims.
11. In this submission, we highlight the key issues in farming and food processing which we believe need to be addressed if our agri-food sector is to meet further ambitious targets in the period up to 2025, and we identify the principal actions which Teagasc, either alone or in collaboration with DAFM, the other national support agencies and other partners, proposes to implement in support of the new national strategy.
12. Teagasc has identified the following as desirable high-level objectives for the sector to 2025:
 - Increase farm incomes through improvements in “sustainable profit from productivity”
 - Ensure environmental sustainability
 - Increase value generated across value chains.
13. In terms of our ambition for the sector, we need to focus on growth, job creation and competitiveness, while maintaining and enhancing our sustainability credentials:
 - Growth ambitions should be linked to real economic measures at both the farm and processing level in terms of profit (excluding subsidies) per hectare or per labour unit, rather than output value.
 - Job creation is important, but a focus on productivity per labour unit is also necessary.
 - The average level of and growth in Irish agricultural productivity is amongst the lowest in the

EU15, with the notable exception of the dairy sector.

- While global demand for food presents a relatively benign and potentially fortuitous price situation in the medium term, much of this is outside our control. As a small food exporting country, we need to focus on those issues over which we have control.
- For a given level of output, improved efficiency is derived from better technologies, management practices and decision making. This relates to the concept of “sustainable intensification”, where we see that our most intensive farms (up to a limit) are also our most environmentally efficient farms. There is still, however, room for greater efficiency, particularly in terms of nutrient efficiency and water quality.

14. Product and input prices are outside the control of Irish farmers which implies that the achievement of value targets is largely outside Ireland’s control. Farmers do, however, have control over their decisions concerning product and input volumes and there is scope, through better financial and risk management, to increase incomes through value added generation, volume increases and cost minimisation.

15. The Plan of this submission is as follows:

- Section 2: focuses on the potential productivity gains and achievable target in the primary sector.
- Section 3: looks at the efficiency advances that can be achieved in the processing sector and across the value chain.
- Section 4: identifies a number of Teagasc-led initiatives designed to drive “sustainable profit from productivity” in our agri-food sector.

SECTION 2

SECTOR and CROSS-SECTORAL ISSUES and TARGETS for OUR MAIN LAND-BASED SECTORS

Introduction

1. Teagasc considers that targets need to be established for Agri-Food 2025 that have a resonance and relevance at a farm and food processing company level. These targets clearly need to be consistent with the higher level targets to be adopted for aggregate output, incomes and exports. In this section, we set out what we consider to be the most important requirements to drive productivity from our main enterprises: Dairy, Beef, Sheep, Pigs, Tillage, Horticulture and Forestry.
2. Food production systems face a threefold challenge to:
 - Meet the changing demand for food within a resource-constrained environment.
 - Produce food in an environmentally, economically and socially sustainable manner.
 - Ensure the achievement of the highest standards of consumer quality and nutritional value.
3. From a farm income perspective, the key challenge is to improve productivity growth. Ireland has had relatively low productivity growth over the past decade. The level of productivity is also relatively low because of structural deficiencies in some sectors. Thus, it will be necessary to drive productivity growth, while meeting or improving in some sectors sustainability and quality. Productivity growth in the sector requires both ongoing technological and management practice development building upon cutting edge research.
4. While a segment of the farming population has experienced rapid productivity growth, through the adoption of new technologies and practices, building upon knowledge transfer innovations such as Technology Adoption Programmes and Discussion Groups, a larger segment has exhibited negative productivity growth.
5. We identify both sectoral-specific and cross-sectoral issues that need to be addressed to enhance the level of and growth in productivity in primary agriculture.

Sector-specific issues

6. The sector specific issues have been identified in the most recent Teagasc roadmaps' publication. The "Teagasc 2020 Roadmaps to Better Farming", to be updated next year to 2025, outline the direction for the different sectors, the anticipated size and shape of each sector in the future, the challenges to be overcome and the opportunities to be grasped. The main policy and market issues that need to be addressed are also highlighted. In summary form below we identify, for each of the main sectors, both the key factors that can be influenced and our assessment of the extent to which they can be influenced, to drive productivity growth from the sector in question.

7. Dairy
 - Herbage utilisation: target to increase utilisation/ha from the current level of 7.3 tonnes/ha to 10.9 tonnes/ha.
 - Average EBI: target to increase the level of dairy females born from its current level of €119 to €210.
 - 6-week calving rate: target to increase the rate from its current level of 55% to 80%.
 - Somatic Cell Count: target to reduce the average level in dairy herds from 248,000 to 200,000.
 - Health status: target to enhance the health status of dairy herds through improved biosecurity standards and disease control programmes.
 - Labour efficiency: target to increase labour efficiency on dairy farms from the current level of 50 cows/labour unit to 80 cows.
 - Greenhouse gas emissions: target to reduce the current level from 15.0 kg of CO₂ e/kg Milk Solids to 12.2.
 - N efficiency: target to increase the current level from 25.9% to 29.1%.
 - Milk production costs (constant 2015 prices): target to achieve €2.94/kg MS (including full labour costs).

8. Beef
 - Herbage utilisation: target to increase the current level from 4.7 to 6.2 tonnes of DM/ha.
 - Genetic improvement: target to increase the annual number of calves reared per cow from 0.87 to 0.90.
 - Early calving: target to increase the proportion of suckler cows calving in Feb/March from 33% to 55%.
 - Live weight/ha (dairy beef): target to increase production from 600 to 800 kg/ha.
 - Live weight/ha (suckler beef): target to increase production from 457 to 580 kg/ha.
 - Health status: target to enhance the health status of beef herds by applying best biosecurity standards and through the execution of national disease control programmes.
 - Beef production costs (constant 2015 prices): target to reduce the cost per kg live weight in suckler herd systems from the current level of €2.41 to €2.00.
 - Greenhouse gas emissions: target to reduce the current level from 23.1 kg of CO₂ e/kg carcass to 21.8.

Section 2

Sector and Cross-Sectoral Issues and Targets for our Main Land-Based Sectors

9. Sheep

- Ewe fertility: target to increase the number of lambs weaned per ewe in lowland sheep production from 1.25 to 1.40.
- Carcass output: target to increase carcass output/ha in lowland sheep production from 170 kg to 250 kg.
- Genetic improvement: target to increase the proportion of Sheep Ireland genetically evaluated rams in the national flock to 40%.
- Hill sheep farming: enhance hill farming systems by promoting greater integration with low lands sheep producers.
- Stocking rate: target to increase the average stocking rate on lowland farms from 7.5 to 9 ewes/ha.
- Landscape maintenance: enhance the level of support to hill-sheep farmers to maintain hill and mountain landscapes.
- Grassland management: continue to develop profitable grass/clover-based sheep production systems.

10. Pigs

- Fertility: target to increase the number of pigs produced per sow per year from 23 currently to 25.
- Feed conversion efficiency: target to increase the level from weaning to sale from 2.46 to 2.35 kg feed/kg live weight gain.
- Feed conversion efficiency (production level): target to produce 2 tonnes of pig meat from seven tonnes of feed.

11. Tillage

- Wheat yield: target to increase yield from 8.6 to 9.5 t/ha.
- Barley yield: target to increase yield from 6.6 to 7.3 t/ha.
- Wheat costs: target to reduce costs from €1,150 to €1,100/ha.
- Barley costs: target to reduce costs from from €1,000 to €950/ha.
- Potatoes: target to maintain the area at 8,700 ha; target to increased salad potato production by 9,000 t; target to increase seed pruction by 10,000 t; target to increase peeling production by 30,000 t.
- Rotations: target to have 75% of growers using rotation systems by providing a wider range of rotation options, e.g. oats for the feed/food market, barley for the distilling and malting markets, oilseed rape for food oil products etc.
- Integrated Pest Management (IPM): target that 100% of growers will adopt the system as prescribed by the Sustainable Use Directive.
- Response to restricted use of plant protection products: develop improved prediction systems which determine the impact of key pests/pathogens of crops and improved Integrated Pest Management (IPM) strategies; improve the targeting of plant protection products according to the risk of yield or product quality.
- Precision tillage (and horticulture): develop approaches based on understanding variation in

crop input requirements to improve targeting of inputs.

- Plant breeding: biotechnology will be used for the development of marker- and genomics-assisted breeding to develop varieties of potato, and other crops better suited to Irish tillage systems.
- New 'Knowledge Transfer' models: develop use of ICT-aided decision support; web-based resources; more effective use of industry advisors; consider extension of RDP 'Knowledge Groups' to tillage farms; innovative approaches to inculcating principles of financial management and planning.
- Collaboration with dairy farmers: exploit opportunities arising in provision of forage; utilisation of slurry; re-seeding of grassland, etc.

12. Horticulture

- Mushroom yield: target to increase yield from 318 to 390 kg/t compost; target to increase the proportion of growers using renewable energy from 5% to 40.
- Strawberry tray production: target to increase the adoption of the system from 40% to 80%.
- Protected blueberry production: potential to increase value by 500% (€1 to €6 million).
- Protected strawberry production: potential to increase value by 35% (€37 to €50 million).
- Cut foliage: potential to increase jobs to 500 and export sales to €500 million by 2025 through the establishment of a centre of excellence.
- Integrated Crop Management (ICM): 'Knowledge Transfer' systems will need to prioritise ICM for all horticultural crops.
- Integrated Pest management (IPM): target that 100% of growers will adopt the system as prescribed by the Sustainable Use Directive.

13. Forestry

- Planting rates: increase to 15,000 ha/annum.
- Roundwood production: double to 6.4 million m³ per annum.
- Timber production (private forests): target to increase production from 200,000 to 1,000,000 t/annum.
- Forest margins: target to increase average margins from €454 to €496 per ha on an annualised gross margin basis.
- Seed orchards: establish to provide indigenous supply of adapted and improved broadleaf planting stock.
- Broadleaf crops: target to increase value by 50% through management interventions to enhance end-use value.
- Improve crop productivity: match species to site characteristics, especially on marginal lands; improve genetics of broadleaf and conifers; develop new disease resistant tree varieties; investigate new systems of forest creation (e.g. low impact silviculture); research potential of agroforestry; improve the carbon capture potential of Irish forests; increase the amount of sawnwood from conifers and hardwoods; leverage the multi-functional nature of our forests.

Cross-sectoral issues

14. Grass utilisation

Effective grass production and utilisation underpin the competitive advantage of the Irish animal-based agricultural sector. Increasing grass utilisation on commercial dairy, beef and sheep farms is critical to increase competitiveness. Studies have shown that each additional tonne of grass utilised on dairy farms, for example, increases farm profit by €161/ha per year. Average grass utilisation on commercial dairy farms is 7.1 tonnes DM/ha, while on suckler beef farms it is 4.7 tonnes. Greater adoption of pasture measurement and budgeting will be essential in lifting grass utilisation from its current level. Recent research has shown that at higher stocking rates both grass production and utilisation can be increased. This is based on the need to ensure that availability of green leaf in the grazed horizon is increased. The development of web-based grassland management decision support tools such as PastureBase Ireland will be critical in increasing the adoption of best grazing management practices at farm level. The development of such reliable, easy-to-use decision support tools will encourage greater reliance on grazed grass.

15. Genetic improvement

In well-developed breeding programs, genetics is responsible for approximately half of the change in phenotypic performance (favourable or unfavourable). The national dairy breeding program in Ireland was responsible for most of the deterioration in reproductive performance prior to the introduction of EBI. The national breeding program is now almost exclusively responsible for the recently observed improvement in reproductive performance. If the genetic trends for the past four years persist, then reproductive performance of the dairy heifers born in 2020 will be equivalent to levels in 1989 and milk solids per cow is expected to be 60% greater in 2020 compared to 1989. Increased herd EBI will improve profit further. Increasing the EBI of heifers born from €119 to €210 will increase profit at farm gate by >€20 million annually (assuming a 20% replacement rate), which is cumulative and permanent (i.e., >€100 m annually after 5 years). Fundamental to a profitable beef (and sheep) sector is a pertinent, accepted, and penetrant breeding program. A successful breeding program requires a scientifically sound and accepted breeding goal, relevant and accurate genetic evaluations based on large databases, thus achieving high accuracy of selection, and a national breeding scheme to ensure that continuously new, genetically elite germplasm excelling in the breeding goals is made available to producers.

16. The introduction of genomic selection in dairying in 2009 caused a paradigm shift in the national dairy cow breeding scheme design and accelerated the rate of genetic gain for profit. Across-breed genomic predictions for different dairy cow breeds will be available in the coming years to facilitate more accurate identification of elite germplasm from other breeds. Genomic selection breeding schemes will be well established in Irish beef and sheep by 2025. The Irish custom genotype panel will continue to be updated to include informative genomic mutations to further increase the precision of genomic evaluations.

17. The cost of procuring the genotype, per unit information, is also expected to reduce, thereby further augmenting the adoption rate. Genomic predictions will also be available for a larger range of traits (e.g., animal health). The resulting larger population of genotyped animals, coupled with improved developed prediction algorithms, will materialise into greater reliability in genomic predictions and thus greater genetic gain for profit in dairy, beef and sheep.
18. **Animal health**
Animal health is soon likely to become the limiting critical factor to achieving maximum performance within the farm gate. Animal health is the hub of animal performance, affecting the efficiency of production, reproductive performance, animal welfare as well as production costs. Given Ireland's reliance on export markets, protecting our "safe-food" image through the reduction and control of animal disease is crucial. Multi-disciplinary, multi-species/sectors actions are required to improve the health status of the national herd and flock and this must be built on collaboration with stakeholder bodies such as AHI, ICBF and Veterinary Ireland. National sero-prevalence analysis for many diseases on Irish herds and flocks is complete or well underway, thus providing an indication of the reality of the challenges that are being faced. The economic consequences both within and outside the farm gate, need to be quantified to generate awareness. The tools (i.e., management and genetic) to combat compromised animal health must be developed and disseminated to stakeholders.
19. **Bovine viral diarrhoea (BVD)**. BVD is a highly contagious viral disease of cattle. In 2009, the prevalence of exposure to BVD in Irish herds was greater than 95% with approximately one third of dairy herds recording evidence of BVD active infection. BVD can be economically devastating at farm level and estimates from 2012 highlighted losses of €32/cow/year and €63/cow/year on beef and dairy farms. On the basis of prevalence data and economic losses, a national eradication scheme was initiated in 2012 on a voluntary basis and expanded to a mandatory scheme in 2013. All calves born in Ireland are now tissue tagged and tested for BVD virus. Significant reductions in the number of BVD persistently infected (PI) animals detected have been recorded since 2012; the current prevalence of BVD PIs in Ireland is 0.3%. The national eradication scheme is due to move into a surveillance phase in 2016 which will be based on serological testing. Teagasc will examine the predicative ability of youngstock serological testing in dairy and beef herds and also investigate the impact of BVD vaccination of serological testing at the individual animal level.
20. **Parasitic diseases** (*Fasciola hepatica*, *Dictyocaulus viviparus*, *Ostertagia ostertagi*). The major economic losses from parasitic infections in Irish livestock stem from liver fluke (*F. Hepatica*), lung worm (*D. viviparous*) and gutworm (*Ostertagi ostertagi*). Interest in parasitic diseases and their control has greatly increased recently with the detection of anthelmintic resistance and the need for alternative and sustainable strategies for effective parasite control. Recent data (2009) from Teagasc has recorded a prevalence of 75%, 98%, and 60% for liver fluke, gutworm and lungworm, respectively, in Irish dairy herds. Teagasc is evaluating on-farm rapid diagnosis of fluke, alternative strategies for liver fluke control such as vaccination, and genetics and genomic aspects of liver fluke infections. Alternative strategies for sustainable gut and lungworm control are also being investigated.

21. **Bovine herpesvirus-1 (BHV-1).** BHV-1 is a viral agent of cattle that causes the highly infectious bovine rhinotracheitis (IBR). In 2009, over 80% of dairy herds studies had evidence of exposure to BHV-1 and the national prevalence across all herds is estimated at greater than 70%. Many herds antibody positive for BHV-1 experience minimal clinical signs of disease but preliminary studies from Teagasc indicate that milk yield losses can occur sub-clinically. Further investigations are continuing in this regard. The awareness of this disease has increased greatly over the past number of years at farm level and it is interesting to note that in 2009, a mere 12% of dairy herds included in a Teagasc prevalence study vaccinated against BHV-1. A recent update of these data has highlighted that over 60% of the same population of dairy farmers now vaccinate for the disease. A national policy is required for BHV-1 and Teagasc is working closely with AHI's technical working group to provide the data necessary to inform such a policy. Teagasc is also working with Tyndall to develop a point of care diagnostic device for BHV-1.
22. **Johnes' Disease.** Johnes disease, a mycobacterial infection of ruminants, has been the subject of much public debate over the years. It is a global phenomenon amongst dairy herds and a postulated link to Crohn's disease has pushed it to the top of the public health agenda. The most recent prevalence study in Ireland (2005) recorded a prevalence of approximately 20% in the cattle population. Clinical cases of disease, however, are relatively rare compared to international data. Teagasc are examining Johnes diagnostics in an Irish setting and also looking at the relationship between bovine tuberculosis and Johnes from an immunological perspective. Teagasc has also just completed an economic analysis of over 20 commercial dairy farms based ELISA testing of individual animals. No economic losses at farm level between ELISA positive and negative individual was highlighted but Johnes control remains of vital importance from the point of view of international markets.
23. **Mastitis.** Antibiotics are used extensively in the dairy industry for the treatment and prevention of mastitis. Antibiotics are often administered routinely to entire herds to prevent mastitis during the dry period. An increase in the incidence of disease in a herd generally results in increased use of antimicrobials, which in turn increases the potential for antibiotic residues in milk and the potential for increased bacterial resistance to antimicrobials. Continued use of antibiotics in the treatment and prevention of diseases of dairy cows will continue to be scrutinized. Strategies to reduce the level of antibiotics used for the treatment and prevention of mastitis will be evaluated. This includes only treating cows with high cell count with antibiotics over the dry cow period; teat seals will be used in the remainder. Determining the susceptibility/resistance of the pathogen during lactation to assess the most appropriate antibiotic to use for treatment. Additionally, evaluate non-antibiotic treatment of mastitis (vaccination, probiotics etc.).
24. **Lameness.** Dairy cow lameness can be one of the most significant welfare and productivity issues in dairy farming. The general causes of lameness are multi-factorial, but are generally recognised as poor cow tracks, long walking distances, cows being forced to stand for too long on hard surfaces, poorly-designed cubicles, ineffective foot trimming etc. Farmers need to be able to identify the specific reason(s) for a particular herd's mobility problems, make an accurate measurement of the levels of lameness within a herd and effectively manage mobility problems by preventative measures.

25. **Soil fertility and land improvement**

There are growing concerns in relation to soil fertility, identified by Teagasc research. Of the 36,000 soil samples processed through Teagasc in 2014, 90% were sub-optimal in terms of soil pH, P and K. It is calculated that the loss of productivity as a consequence on an average Irish dairy farm can be as high as €30,000.

26. Sub-optimal fertility of soil presents a severe challenge to the efficient production of grass and other crops, requiring additional feed, increasing costs. The environmental footprint is also increased. Accordingly, to achieve the objectives of the Agri-Strategy 2025, it is vital that the management of soil fertility is prioritised.

27. Irish farmers have demonstrated their capacity to respond to new drivers in relation to fertiliser/slurry application, particularly in responding to the Regulations within the Nitrate's Directive. A major drive is now needed to improve soil pH, optimise the use of slurry and to apply the most appropriate fertilisers in the right place at the right time.

28. Land improvement needs to go hand-in-hand with improving soil fertility. Enhancing the productivity of land through prudent and environmentally sensitive drainage along with careful management of livestock and machinery to protect the soil's potential are key to achieving our growth targets.

29. Key to the delivering maximum grass utilisation is the management and improvement of marginal land. Marginal land occupies a large proportion (about 50%) of Ireland's total land area. This land is limited principally by its poor drainage status, and farm profitability on such land is highly weather-dependent. Land drainage and improvement strategies are vital in reducing income volatility and sustaining viable farm enterprises on such land.

30. The Teagasc heavy soils research programme is focussed on developing and demonstrating site-specific land drainage design methods to ensure that efficient drainage can be achieved regardless of variations in soil/site conditions. In order to deliver learnings from this research programme, and to ensure widespread use of optimal land improvement strategies, there is a need for knowledge transfer and training initiatives to up-skill contractors, farmers and their advisors.

31. **Sustainable intensification**

Food Harvest 2020 placed sustainability at the core of its strategy for agricultural growth. To meet enhanced growth targets, there is a need to further accelerate environmental efficiency gains in order to avoid increased pressures on the environment in future that will arise from climate change and from sectoral expansion.

32. Teagasc research has shown that sustainable intensification is technically possible. There are practical and cost-beneficial measures that reduce greenhouse gas emissions from agriculture. It is also possible to reduce nutrient losses to water without compromising productivity.

Section 2

Sector and Cross-Sectoral Issues and Targets for our Main Land-Based Sectors

33. Challenges to sustainable intensification include:
- Continued reduction in the environmental footprint.
 - Further sustainable growth will require further gains in efficiency.
 - Environmental targets are becoming more stringent and wider in their scope.
34. Environmental policies continue to evolve at global, EU and national levels. Thus, even in the absence of growth within the sector, further gains in agricultural efficiency will be required to remain in compliance with environmental legislation.
35. **Price volatility**
Prior to 2005, while the farm sector exhibited a cost-price squeeze, where output prices grew at a slower rate than input prices on average, putting pressure over the long term on margins, volatility was relatively limited. The liberalisation of agricultural markets has seen European and Irish farmers experience increased price volatility. More generally, globally food prices have experienced greater price volatility due to various weather, economic and geo-political shocks and related issues such as reduced stocks which magnify the impact of such shocks. On the input side, we have also seen increased price volatility. While farm subsidies have provided a stable and relatively non-volatile income support for farms, these supports will become relatively less important, especially on the more productive farms, in the years ahead. Thus farm incomes have become more volatile and are likely to become even more so in the future.
36. Public policy has adapted to incentivise the use of these technologies within the Dairy Efficiency Programme, and the various Technology Adoption Programmes for different sectors. Changes to agricultural taxation also recognise the demands of enhanced volatility.
37. **Land mobility**
Land markets in Ireland, are characterised by:
- Extremely low numbers of land sales.
 - Relatively high prices.
 - Moderate levels of leasing compounded by the predominance of short leases.
 - Excessive land fragmentation.
- These features of the land market are a barrier to more efficient land use.
38. While many policy initiatives have been devised to encourage land mobility in Irish agriculture, access to land continues to be a problem. These initiatives include tax incentives to encourage land leasing; the removal of barriers associated with the adoption of farm partnerships and measures to facilitate greater farm consolidation. However, challenges remain.
39. **Labour efficiency**
In terms of labour markets, a number of challenges exist including:
- The rapid ageing of the farm population where the average age is increasing.
 - Low succession transition at present associated with this rising age profile.

- Access to skilled contract labour for expanding farms.
 - Skill levels on existing farms.
40. These issues can be addressed through:
- Enhanced policy drivers to facilitate succession.
 - Extension programmes in relation to succession planning.
 - Delivering agricultural education programmes to farmers.
 - Delivering targeted skills programmes to potential agricultural contractors.
 - Health and Safety.
41. Methodologies to leverage the multi-functional nature of forests should be developed. This will help to optimise the balance between commercial timber production and ecosystem services including carbon capture, biodiversity and recreational needs.
42. **Quality**
43. Underpinning Ireland's food industry and in particular the high value added components are rigorously high food safety standards.
44. Milk quality can impact human health, milk processing and on-farm profitability and thus is an important driver of the success of the industry. The **Somatic Cell Count (SCC)** is the most important indicator of milk quality, reflecting the health status of the mammary gland and the risk of non-physiological changes to milk composition. An elevated SCC is indicative of mastitis (inflammation of the mammary gland), generally caused by presence of infectious microorganisms. Recent Teagasc research has highlighted that the average dairy farmer can improve net profitability by at least 1 cent per litre by improving mastitis control to reduce SCC to an achievable and sustainable level. Ireland as the largest producer of powdered infant milk formula requires high quality milk.
45. **Bovine Tuberculosis** is a chronic highly infectious disease of cattle caused by *Mycobacterium bovis*. The bacterium can cause disease in other domestic or wild animals and also in humans. *Mycobacterium bovis*, the causal organism of bovine tuberculosis (TB), remains an important infection of cattle in many countries. A TB eradication programme has been operating in the Irish cattle herd since the 1950s, with control costs being borne by both government and industry. There is a large gap in knowledge on genetic predisposition to TB and how current breeding programs may be affecting this. Results from Teagasc research provide an understanding of the genetics behind susceptibility to TB, and has the potential to identify Irish and foreign animals with relatives in Ireland that are genetically predisposed to infection with TB.
46. The single biggest risk factor for the red meat sector is **Verocytotoxigenic E. coli (VTEC)**. It is well recognised that ruminant animals, in particular, may carry VTEC in their gastro-intestinal tract and there is potential for contamination of meat with this highly pathogenic micro-organism. It will be a significant challenge over the next ten years to assess and manage the risk posed by this group of

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emerging pathogens in vivo, on farm and in meat production, and to meet the expected changing EU regulations related to monitoring and control of these pathogens, as well as meeting export market requirements (US, Asia etc).

47. One of the key requirements for Ireland to gain access for Irish Beef to US markets was to provide evidence to the US regulators (USDA/FSIS) that Irish beef was safe and that we were addressing the risk from the key microbial safety concern – Verocytotoxigenic E.coli (VTEC). DAFM, Backweston conducted some studies on VTEC in Irish beef production, and a number of published Teagasc research studies on VTEC in the Irish Beef chain, were used to provide evidence that Ireland had both the capability in the area and that some of the VTEC serogroups that the US authorities were concerned about had not been detected in Ireland.
48. Following the opening of the US market, all beef plants now intending to export to the US will be audited by the US regulatory authorities. This audit will require each plant to have conducted extensive baseline microbiological studies relating to both carcass hygiene and Verocytotoxigenic E.coli and the DAFM are in current negotiations with the US re the sample numbers and requirements of this audit.
49. **Off-farm income generation**
About a third of Irish farms are “viable” according to Teagasc research in so far as they generating an income of more than the minimum agricultural wage, plus a modest return on investment. In years of strong commodity prices, the share of “viable” farms increases and in poor years, such as 2009 (and possibly in the current year), the share of “viable” farms declines. Another third are considered to be “sustainable”, in that they have access to off farm employment, while the remaining third are classed as “vulnerable”. One of the biggest impacts of the economic crisis has been the collapse in the availability of off-farm employment. The increased numbers involved in off-farm employment from the mid-1990’s was eliminated in the first two years of the crisis. Much of this resulted from the loss of construction-related employment.
50. Teagasc has developed an ‘Options Programme’ since 2011, targeting about 500 farm families on an annual basis. The programme advises on the options for farm families on off-farm employment and income-generating opportunities. The programme is delivered in 12 locations on a regional basis over five nights. Workshops co-ordinated locally by Teagasc Options co-ordinators, with local agencies invited, while local entrepreneurs provide information and advice on their (on and off-farm) enterprises. This is supported by Teagasc’s Rural Development newsletters and website (which had nearly 100000 hits in 2014) and its network of local offices.
51. **Health and Safety**
There were 29 deaths recorded on Irish farms in 2014, which amounted to 53% of all occupational deaths. Apart from this unacceptably high level of mortality, there are, on average, 3,000 non-fatal serious injuries to farmers and farm workers each year. Research has established that high levels of mortality among farmers are related to the generally poor health status of farmers. Fatalities,

accidents and ill health are a major issue for farm families and the industry as a whole resulting in tragedy, pain and suffering, and disability. These have both short and long-term economic and health implications for the individuals and the families affected.

52. To achieve a reduction in the number of fatalities and accidents, a much greater emphasis must be placed on developing our understanding of the behaviours that result in accidents and fatalities. Based on this understanding we need to then develop practical evidence-based interventions that facilitate positive behavioural change amongst farmers and farm workers.
53. As a family-operated enterprise, farming is distinguished from most other industries and occupations. As a consequence, a dedicated research, education and extension service is required. On-going research is required to provide up-date evidence to inform health and safety awareness initiatives, input to education and training courses and the design and implementation of extension programmes targeting members of farm households. Key areas requiring a dedicated research focus include:
 - Surveillance of accident and ill health occurrence.
 - Farm work and workplace adoption of 'best practices' to prevent accidents.
 - Development of approaches to assist farmers to effect behaviour change related to health and safety issues.
54. Extension support is needed to adapt farms to meet essential occupational health and safety requirements and adapt workplace behaviour, thereby improving safety by minimising risk of accidents and ill health occurrence. All advisors require formal training in risk assessment and mitigation so that they can provide appropriate and practical advice to farm families and the wider industry that interact with farmers.
55. The potential of developing Continuous Professional Development courses, with possible incentives to encourage participation, should be explored. Whilst these courses might cover a variety of issues, ranging from business planning, adoption of knowledge and technology and environmental issues, farm health and safety would, necessarily, form a core component of such program.

SECTION 3

GENERATING VALUE IN THE PROCESSING SECTOR AND THE VALUE CHAIN

Processing: sector-specific issues

1. Dairy

With the extra milk volumes as a result of the expansion in milk supply, adding value to large volume commodities will be key, supported by the latest developments in separation science for the fractionation and valorisation of milk components. Research is required to support the integration of process data analytics and sensor technology to support restructuring of milk processing post quota, i.e., provided by new processing facilities in the dairy sector.

2. Demographic and lifestyle associated characteristics of food in export markets will determine new techno-functional and nutritional requirements of dairy. In order to succeed in foreign markets, Irish scientists must re-calibrate their analytical approach including sensory, to develop dairy produce for these markets. An example here is 'Cheese for China', i.e., cheese with acceptable sensory characteristics designed to achieve acceptance amongst Chinese consumers.

3. With the rapid increase in global population there is increasing concern as to the strain it will put on food resources and in particular protein. Better understanding of high protein dairy ingredients and behaviour in final product applications will be required in order to extend their usage and maintain competitiveness in global markets.

4. Life-Stage nutrition and healthy ageing are nutritional trends that dairy products are ideally suited to support. Research is required to align dairy with physiological responses in people of different age categories from infant to elderly. With continued developments in processing technologies, dairy can provide a complex range of nutrients for targeting all stages of life.

5. Significant value generation is possible in the area of dairy ingredients and nutritional beverages covering many markets including nutritional, sports, therapeutic, clinical and supplement sectors. The aim is to develop innovative new dairy ingredients for these sectors, which will command a premium price and provide opportunities for new market development.

6. A three-pronged approach can be taken:

- Market-driven development of ingredients with the nutritional and techno-functionality profile required in the complex end products.
- Developing manufacturing efficiency seeking to develop new technologies that will enhance process efficiency while simultaneously enhancing the end functionality and nutritional attributes.
- Utilising the technology to generate greater added value such as fractionation technologies to develop of new ingredients.

7. Research is needed in the following specific areas:

- Understanding the drivers behind digestibility, bioavailability and wellbeing.
- Generating new sensory attributes in food through flavour and texture modification.

- Introducing 'Bio-Switches' within our foods, i.e., real time modification of food structure during events such as cooking, thawing etc. to produce a targeted modification of structure and altered sensory properties depending on how it is cooked or stored.
- There is a real need to re-examine the analytical techniques used to measure food composition, through the development of new state-of-the-art methodologies for nutrient analysis to better understand the effect of processing and shelf- life on food.
- Sensometric approaches to food development, i.e., the application of developing techniques for connecting sensory perception, mathematics and statistical methods. The association between sensory and chemical data to develop new foods.
- Sequencing will be commonplace in the future, driving a need for data storage coupled with analysis of the resulting data.
- Establishing a new PCF-specific focus on R&D and innovation by up-grading food processing unit similar to DIL in Germany.
- Sustained efforts in supporting new product development to meet new consumer opportunities especially in meat, cereal and seafood sectors.

8. **Meat**

The Irish beef and sheepmeat processing sectors operate in a highly competitive global marketplace. To remain a competitive force on the global meat market and take advantage of the population growth and meat consumption trend forecasts, the industry must further embrace export competition through enhancing its reputation for product quality and safety and thereby increasing the production of higher value products. Some of the challenges include innovating for consistent meat quality excellence by:

- Using genomics to predict the expected outcomes from a processed animal, in terms of weight of cuts, value of cuts and meat eating quality attributes.
- Developing a meat tenderness management system.
- Developing strategies to manage meat safety and reduce spoilage event.
- Innovating for value in Irish meat processing.
- Biomarkers that provide an evidence base that quantifies the benefits of Irish grass fed beef.
- Meat carcass grading technologies.
- Technologies to significantly extend the shelf-life of beef/ sheep meat for export markets.

9. **Prepared consumer foods and bakery**

The impact of compositional changes on health, e.g., low salt, low fat consumer foods will continue to be a key priority for the prepared consumer foods sector. The objective is to provide products that are safe, healthy, sustainable and high quality through:

- Harvesting allergen free cereals; agronomic studies combining optimised harvesting conditions with breeding programmes for production of high quality cereal grains.
- Advanced manufacturing of cereals incorporating protein extraction technologies.
- Cereal snacks for the future; structure manipulation and storage self-life; relating molecular structure to functionality.
- Wholesome nutritious cereals for elderly – for controlled energy release and targeted nutrition.

Processing: cross-sectoral issues

10. Improved productivity and efficiency at processor level

A key strategy to improve efficiency in the processing sector will be to improve food process design by engineering food processes that are highly flexible and which will be facilitated by integrated sensor technology and data capture. Significant efficiency improvements can be generated by integrating food chemistry into control and data acquisition systems.

11. Across the meat sector for instance, there is a need to enhance the competitiveness of the Irish beef and sheep meat industry through deployment of best global practices:

- Drive a step change in the quality of the animals supplied to the processing plants.
- Drive a step change in consistency of meat quality at point of consumption.
- Increase the shelf-life of Irish beef and lamb.
- Increase the yields of high value cuts.
- Deepen scientific understanding and commercial insights that allow processors to predict and manage for assured outcomes (tenderness, eating quality, shelf-life, yield).
- Enhance supply chain management capability.
- Enhance the marketability of Irish beef and lamb through research into the validation of bio markers for Irish grass-fed and nutritional information.
- Identify and develop potential new revenue streams to compete in new markets, partner with new customers and access new consumer opportunities.
- Improve meat safety control strategies that ensure Brand Ireland is protected.
- Build science and technology platforms that will underpin the appeal and value of the meat processing industry to the farming community.

12. Improving environmental sustainability at the processor scale

Improved environmental sustainability is required across the entire value chain to maintain and develop Ireland's Green image. Specific measures are required in the following areas:

- The application of material sciences to food production can create process optimisation at macro-scale, enhancing the sustainability of the processing end of the value chain.
- There is a need to explore new approaches in quantifying and reducing energy consumption in the processing sector.
- More widely, we need to improve our knowledge of environmental efficiency across the entire value chain, through a full chain lifecycle analytical approach.
- Better valorisation technologies of by-products and waste streams, particularly in meat and sea-food sectors.

13. Technologies to facilitate exports

As Irish food production expands, there will be a requirement to ship product to more distant markets. This will require research and innovation in the following areas:

- Dehydration (spray and freeze drying: e.g., dairy ingredients, sea food, meat waste products).
- Liquid concentration (e.g., evaporation of dairy streams).

- Shelf-life extension – fractionation, freezing and ultra-high temperature (UHT) technologies applied to fresh Irish beef, lamb, pork and seafood to reach new markets in US and China.
- Design of novel packaging and refrigeration technologies to extend shelf-life.
- Integrating dairy and non-dairy ingredients to create foods with structural and sensory characteristics for the Chinese and other Asian consumers.

Generating value across the supply chain

14. **Infant Milk Formula**

Higher value production comes with risks. Quality failures can pose significant reputational risks that could result in value destruction. Constant vigilance is required at processor and research support level to protect the high-end value sector by ensuring the maintenance of quality products for the infant formula, medical, and functional food sectors etc.

15. At farm scale, research and extension programmes exist to maintain and improve product quality. At factory scale we need to understand the sources of risk through process Microflora (Factory Flora) microbial mapping of our processes and processing plants. Understanding the ‘process Microflora’ can identify signatures for process unit operations. It can be used for traceability and ‘quality’ marketing applications and identification of cross- contamination in plants. It is a key to protecting the infant formula sector.

16. **Meat**

To protect Ireland’s reputation and growing meat export markets, assuring meat is safe from microbial and chemical contaminants is a prerequisite. Research will be needed to:

- Assess the risk posed by emergent VTEC in food production animals and in meat, via a statistically designed national monitoring programme.
- Assess impact of beef production factors (animal age, season, diet, etc.) on VTEC carriage and shedding in faeces, which may be used to risk rank animals presented for slaughter.
- Develop and implement control strategies targeting VTEC in the animal, the farm environment and in meat slaughter and processing.

17. The composition and concentration of micro-organisms in food (meat and infant formula) have a direct impact on shelf-life and spoilage. To allow Irish fresh and vacuum packaged beef and lamb reach new distant export markets, increased shelf- life and reduced specific spoilage events based on innovation technology solutions are needed. In the infant formula sector, spoilage due to thermoduric Spore formers is a significant issue to be addressed.

18. **Increasing value through better supply chain management**

Effective supply chain management has economic, social and environmental benefits. Research is needed to promote more effective supply chain management and help to prevent adverse supply chain-related incidents, and improve the performance of supply chains.

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Generating Value in the Processing Sector and the Value Chain

19. Supply chain research can be used to:
- Understand the behaviour of supply chain actors so as to improve efficiency and develop the concept of a sustainable chain.
 - Promote efficient and effective information flows and information sharing along the supply chains thereby supporting greater market responsiveness.
 - Examine price transmission mechanisms and price transparency issues along the chain.
 - Identify supply chains solutions to underpin quality assurance, supply chain integrity, authenticity, provenance, etc.
 - Examine the implementation of Life Cycle Assessments (LCA) assessments of the carbon footprint for the entire value chain.
 - Assess the economic implications of supply chain developments (e.g. the establishment of discount retail chains): new supply chain organisations (e.g. collective group to support the development of quality brands such as PGI, PDO); alliances between companies; and Producer Organisations (POs) in the meat sector.

SECTION 4

PROPOSED TEAGASC INITIATIVES IN SUPPORT OF FH2025

Section 4

Proposed Teagasc Initiatives in Support of FH2025

Introduction

1. Teagasc's well-proven core activities in education, research and advisory/extension will continue to be mobilised in an integrated fashion to support the objectives of FH2025. In this section we also set out a number of initiatives that we plan to embark on over the next few years that will further enhance our ability to support the drive for "sustainable profit from productivity" in our agri-food sector.
2. **Capacity building for Irish agriculture: deploying Teagasc's integrated research, education and extension model to optimum advantage**
3. Teagasc combines research, advisory and education services into an integrated agency that serves farmers and firms, government and society. There is no equivalent service internationally. The combination of research and innovation support in one organisation uniquely positions Teagasc to generate new knowledge, ensure knowledge transfer and to deliver value for money invested.
4. Teagasc is also a respected brand for the quality and independence of its research, analysis and advice that can reach into every aspect of the rural economy and the countryside. It has built strong strategic partnerships with Irish and international educational, research, industrial and policy organisations as a means of leveraging the best available technologies for the benefit of the Irish agri-food sector. This puts Ireland in an excellent position to continue to invest in a knowledge-driven agriculture and food sector.
5. Teagasc intends to prioritise over the period of FH2025 through its advisory, research and education programmes to support Ireland's 'family farm model' by working to improve the productive capacity of Irish farms and by focusing on those farms with demonstrable development potential. The following areas will be emphasised in its 'Knowledge Transfer' activity:
 - Business planning/management of price volatility.
 - Deliver a 'one-to-one' farm business planning service, particularly for dairy farmers.
 - Encourage the adoption of support tools to help producers hedge against price volatility.
 - Encourage diversification of farming enterprises where appropriate.
 - Encourage diversification through off-farm income via the Teagasc Options Plus Programme.
 - Improving productivity of land to improve output and reduce GHG emissions / kg output.
 - Work with industry partners across value chains to identify sustainable supply chain models, including QA schemes.
 - Work with vets and AHI to ensure that animal disease and health issues are improved (e.g. diseases IBR, BVD, Johnes, lameness etc).
 - Identify and monitor simple KPIs for all farm enterprises as the major driver of efficient production.
 - Improve the use of discussion groups.
 - Improved use of data-smart farming.
 - Increase Teagasc's capacity to work 'one-to-one' with clients around strategic decision making.

- Promote expansion of Discussion Group programmes.
 - Work with partners to encourage producers to engage with professional advisory services.
 - Focus on farm succession through a Farm Family Partnership Model.
 - Mobilise DAFM-EU-funded initiatives, (e.g. Knowledge Groups and European Innovation Partnerships).
6. Key to delivery of these objectives is the existence of an effective, independent, national advisory service providing a locally based contact point for all farmers through farmer education, consultation and a wide range of communication and influencing activities.
7. Teagasc's advisory service has been dramatically reduced in recent years, and its overall age profile has become unbalanced due to the constraints on recruitment. Teagasc's future ability to influence a new generation of farmers is directly linked to the number of front-line advisors. A young innovative population of farmers needs to be matched with a similar capacity in terms of an extension service. A minimum of 240 Teagasc advisors is an urgent requirement to ensure that a public advisory service will be in place in order to deliver on the ambitious targets of Agri-Food 2025.
8. A public advisory service is only as good as the underlying level and quality of public research support. Research is vital to underpin the profitability, competitiveness and sustainable growth of agricultural production. A public research service is also essential in assisting our food companies to innovate and compete on international markets. Teagasc will continue to build its research programme on a solid, scientific base, aiming to achieve impact through excellent science. Priorities for Teagasc research will include the following:
- Grass breeding, production and utilisation.
 - Animal breeding and genetics.
 - Animal health.
 - Farm systems optimization.
 - Crop Production, particularly disease and pest control.
 - Soils and nutrient use efficiency.
 - Environment, particularly water and greenhouse gas related issues.
 - Land use (including Forestry) and spatial analysis.
 - Economic analysis of Irish agriculture using the FAPRI-Ireland model.
 - Farm Level economic analysis, utilising the unique Teagasc National Farm Survey database.
 - Food ingredient, product and process innovation.
 - Food quality and foods for health.
 - Food safety.
9. Additional research capabilities that need to be developed include Precision Livestock Agriculture, including the use of 'Big Data' in agriculture, genomic selection in grass, soil microbiology, sustainable land improvement and drainage, alternative tillage crops and sensory science.
10. The moratorium on recruitment in the public service has left significant gaps in Teagasc's research

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capability (e.g., grassland science, dairy cow nutrition, nutrient management in soils, soil mapping, soil microbiology, meat science, sensory analysis, bioinformatics, alternative tillage crops, forestry) and has seriously eroded the skilled technical base required to sustain a research programme in the longer term. These deficits will need to be addressed if the flow of knowledge is to be sustained.

11. Teagasc has recently commenced a Technology Foresight project which will focus on identifying key technologies with the potential over the next 20 years to underpin competitiveness, sustainability and growth in the Irish agri-food sector. The new project will provide a comprehensive source of evidence for resource decisions relating to Teagasc's future science and technology programmes. It will assist in identifying new areas of technology which Teagasc should prioritise. It will also bring together people from different science backgrounds, both national and international, to explore new ideas on the long-term challenges confronting the Irish agri-food sector and its future technology needs.
12. Since 2008 enrolments at agricultural colleges have increased by over 150%. Over this period the numbers employed as teachers and technicians have been maintained at roughly the same level, despite Teagasc's inability to recruit replacements for the retirements of college teachers and technical support staff. The level of staff was held constant as Teagasc prioritised education through the redeployment of staff resources from other areas of the organisation, such as, the advisory service. Even with this level of redeployment the student-staff ration has increased from about 12:1 to an unsustainable 20:1. In the last year the education service has come under further pressure due to the exceptional demand for agricultural courses arising from the 'young farmer' measures in the Rural Development Plan. Teagasc estimates that an extra 2,200 course places will be required to meet the additional demand. It will be essential that adequate staff resources are in place to cope with this welcome additional inflow of students.
13. **Grass – the 2 tonne challenge (increase grass utilisation by 2 t/ha)**
Increasing grass production and utilisation on commercial dairy and beef farms is critical to increased competitiveness. Previous studies have indicated that each additional tonne of grass utilised increases farm profit by €161/ha per year. Based on PastureBase Ireland statistics, average grass utilisation on commercial farms is 7.3 tonnes DM/ha.
14. It is essential that grass utilisation increases by a further 2 tonnes DM/ha to meet the additional feed requirements of an expanded dairy industry over the next five years. Future improvements in grass utilisation will require improved grazing management practices assisted by the widespread use of grass measurement and budgeting. Additionally, it will require a significant increase in soil fertility and sward renewal initiatives to obtain perennial ryegrass/white clover dominated pastures.
15. Improving grassland management and grass-based productivity requires localised information to facilitate decision making. The use of Smart Agriculture-based tools such as the Teagasc-developed PastureBase Ireland (PBI) and the Satellite Remote Sensed Grass Growth Maps can help to significantly increase the level of grass production and utilisation at farm level. PastureBase Ireland is a grassland management decision support tool capable of quantifying seasonal grass dry matter

production across different enterprises, grassland management systems, regions, and soil types using a common measurement protocol. We propose to publish daily grass growth maps using PBI and satellite data to provide localised grass production advice to farmers. Increased participation in PastureBase Ireland in terms of grass measurement and budgeting is required.

16. **A sustained campaign to improve soil fertility**

Teagasc plans to mount a series of campaigns designed to improve Ireland's soil fertility status through a number of initiatives:

- Soil fertility conference launching the new Green Book on fertiliser application practices and 'NMP Online.'
- Discussion group initiative linking soil fertility status to grass and silage D.M. yield.
- Autumn soil sampling campaign with a target of 10 NMPs per advisor.
- Upgrade soils and soil fertility website.
- Soil nutrient census launched to track soil fertility trends.

17. **Sustainable improvement of marginal lands**

Key actions include:

- The development of novel design, installation and characterization of drainage systems in poorly drained soils on a total of 10 sites throughout the country.
- Optimizing soils fertility (P, K and pH) status on poorly drained lowland mineral soils in high rainfall regions.
- Designing farm grazing infrastructure that facilitates grazing in difficult weather conditions while at the same time minimizing pasture and soil damage.
- Developing grassland management systems that optimize milk/beef production efficiency
- Evaluating methods of renovation to damaged pasture and soils to reduce surface roughness, increase plant density and reduce soil compaction
- Communicating the innovations coming from the research to the main stakeholders.

18. **Launching the next generation of animal genomics**

Genomic predictions are currently based on an unsupervised statistical approach without cognisance of the underlying biology governing differences in phenotypic performance. The ability to decipher the contribution of the underlying variome to phenotypic performance has, to-date, been hampered by a combination of both low density in genomic information per individual and the population size of genotyped and phenotyped individuals. Initiatives are underway to generate full sequence data on hundreds of thousands of Irish cattle, thus increasing the density of information per individual from tens of thousands of genomic loci to tens of millions of genomic loci per individual.

19. Computational approaches to handle and edit these data will need to be re-evaluated. Current genomic prediction models must better exploit available biological information. Breeding schemes also require re-evaluation to maximise the benefit of such information, including precision genomic matings. Breeding objectives and the basics of genetic improvement, nonetheless, become even more important in the genomic era as genetic change is expected to accelerate.

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20. Genetic gain achieved to date in the Irish sheep sector remain low (3c/lamb/year); this is in direct contrast to the breeding scheme in New Zealand, which is achieving a level of genetic gain that is over 10 times greater. The breeding goal traits in both the New Zealand and Irish genetic evaluations are similar; despite this, animals of high genetic merit from New Zealand and Ireland have not been compared under a similar environment.
21. A nucleus sheep flock comprising of elite Suffolk and Texel females representing the top genetic merit Irish and New Zealand ewes has been established in Teagasc Athenry. Results from this study will facilitate benchmarking of Irish elite genetics against their contemporaries in New Zealand and guide future Irish breeding schemes on how to accelerate genetic gain for profit.
22. As well as generating genetic linkages with other populations to aid in the exploitation of genomic selection in sheep, this project will provide clear guidance on future developments of the Irish profit-based national sheep index: including 1) what additional traits should be included in the index; and 2) consideration of the relative weighting on traits within the index.
23. **Profit through healthy animals driven by genetics**
Over 80% of Irish milk and 90% of beef is exported as food products. Much of the current marketing strategy involves promoting Ireland as a country with a clean green environment, high compliance with relevant food safety legislation, milk and meat of high quality standard and produced on farms with high animal health and welfare standards. Additionally, cost related to biosecurity, testing and vaccination can be significant on farms. There is a significant economic benefit to the eradication of some of the well-known infectious diseases such as BVD, IBR and Johnes. It has been estimated, for example, that there is a benefit: cost ratio of 10:1 to the eradication of BVD. Other disease such as mastitis and lameness relate to issues in terms of reduced milk production, increased use of antimicrobials and reduced animal welfare. Improving the health status of Irish animal production systems will result in greater profitability at farm level, as well as increasing the competitiveness of Irish food in international markets.
24. Initiatives will include a multi-disciplinary approach, including veterinarians, animal production scientists and animal geneticists, which will 1) quantify the cost associated with a plethora of diseases on Irish farms, 2) the management factors contributing to these diseases, and 3) management and genetic-based solutions to reducing the incidence of disease on Irish farms. The importance of such diseases and the available control mechanisms will be disseminated through the Teagasc extension service and collaborating bodies (e.g., AHI, and ICBF).
25. **“Big Data” - exploiting the potential of precision livestock farming**
In the future, farm systems will use precision technologies to reduce manual tasks on farms and thereby allow farmers to shift their focus from operational tasks to management and strategy. These systems will enhance decision support systems to increase efficiency, reduce costs, improve product quality, minimise adverse environmental impact and improve animal health in real time.

26. Precision technologies to capture grass measurement data automatically from a ‘rising plate meter’ with GPS and mapping capabilities plus ‘virtual fencing’ are examples of technologies that have developed recently with Teagasc support. Increasing the health and welfare status of livestock will reduce costs at farm level and further strengthen Ireland’s credentials as a producer of food of the highest standards in terms product quality and animal welfare. There will be a continued requirement to reduce the level of infectious disease such as BVD, IBR and Johnes using national eradication programmes. Additionally, there will be a requirement to reduce the level of production disease such as mastitis and lameness with improved management to improve both product quality and animal welfare.
27. Agriculture now has the potential to benefit from the huge volumes of data collected through CMMS and ICBF databases, digital soil maps, remote sensing images of crops and grassland, weather forecasts and environmental databases. Exploitation of so-called “Big Data” will enable enhanced decision making, insight discovery and process optimization, and is both a challenge and an opportunity for agriculture and food scientists to improve productivity.
28. Innovations based upon the availability of this data, combined with the presence in Ireland of a significant ICT industry, provide real opportunities for both farm-level productivity gains and increased income from service exports. Ireland, through agencies such as Teagasc, ICBE, the Tyndall and Insight institutes at UCC and UCD and others, has the potential to become a world leader in the exploitation of state-of-the-art sensor technology, ICT and computation biology for pasture-based production systems. In order to deliver on the opportunities from the use of “Big Data”, consideration should be given to the establishment of an industry-wide “Big Data” initiative.
29. Strategies will include:
- Development of precision technologies applicable to the internationally unique Irish pasture-based system of animal production.
 - Develop integrated real-time autonomous systems to manage sensor infrastructures.
 - Use computational biology to develop accurate relationships among biological systems.
 - Use real time data develop decision support tools that can be used at farm level to aid in the decision making process, thereby increasing profitability and sustainability.
30. **Teagasc NFS to measure and monitor Ireland’s sustainability credentials**
Evidence-based sustainable farming is the unique selling point of the Irish agri-food sector. It is important to back-up this claim through demonstration based upon reliable representative data.
31. The concept of sustainability needs to be broadened beyond the carbon focus of recent years to encompass other environmental dimensions such as biodiversity, water use and quality and animal welfare as well as embracing non-environmental aspects that concern wider economic, social and innovation issues. A truly sustainable farm is one that can generate a sufficient income in an environmentally friendly and innovative manner to support a good quality of life for the farm family. Teagasc is one of the few organisations internationally that has the capacity to measure and monitor a holistic concept of sustainability.

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32. The Teagasc National Farm Survey (NFS) has been used to develop sustainability indicators, built on the OECD Green Growth Indicators, developed for farm level and encompassing four aspects of sustainability: economic, environmental, social and innovation. The indicators, which have been peer reviewed, were published in 2013 and will be updated on an annual basis.¹ The Teagasc NFS, which has been in operation for over 40 years, is the only nationally representative and objectively collected data source on farming in Ireland. The data collected through this survey are both verifiable and representative of the sector, both important attributes when measuring and monitoring sustainability. Furthermore, the NFS is linked to an EU-wide network of harmonised datasets, the Farm Accountancy Data Network, thus allowing the development of similar farm-level Sustainability Indicators for Member States across the EU. Teagasc researchers are members of the FLINT project, which is currently in the process of using FADN data to develop EU-wide farm-level Sustainability Indicators for the purposes of international benchmarking.²
33. The sustainability of Irish farming is a unique selling point: indeed Bord Bia has built its “Origin Green” marketing campaign on the extensive, low-input, grass-based production systems employed in Irish food production. This campaign aims to exploit mature market segments that are willing to pay more for food with credible sustainability attributes. It is important to back-up this claim through demonstration based upon reliable, internationally accepted, representative data. The Teagasc NFS Sustainability Indicators are an important means of improving transparency, accountability and ensuring the success of monitoring, and evaluating the sustainability attributes of Irish farms for international consumers. Furthermore, the NFS Indicators extend beyond the environmental sphere, including measures of social sustainability, which are integral to Ireland’s image of a small, family-run, socially integrated farm sector.
34. In addition to marketing, the NFS Sustainability Indicators are also useful for policy making. The Sustainability Indicators are linked to the Teagasc suite of farm-level policy models, making it possible to test the impact of policy scenarios on the sustainability of Irish farming. For example, the Teagasc farm-level policy models can be used to simulate the impact of an expanded dairy sector and the consequent effects for farm-level sustainability. Furthermore, the models can also be used to assess the impact of the more widespread adoption of various farm management techniques and technologies on the sustainability of farming.
35. DAFM-funded research is currently underway to develop robust indicators at farm level. Future research will be required to be able to undertake risk assessments in relation to these indicators. In addition it is necessary to incorporate more indicators across the life-cycle of production.
36. **Updating the Marginal Abatement Cost Curve (MACC) for Irish Agriculture**
Teagasc published the first Marginal Abatement Cost Curve (MACC) for Irish agriculture in 2012. It’s planned to publish a second version next year. The current MACC presents the total abatement potential and associated cost-benefits of a number of mitigation options based on aggregated farm data. The revised MACC will take account of inter-farm differences in, for example, climatic conditions, production costs, enterprise mix and level of efficiency, etc., as well as variation between

farms in terms of the ability to adopt new technology and implement practice change and in terms of the understanding of and attitude towards achieving GHG mitigation on farms. It is intended to use the Teagasc National Farm Survey (NFS) to provide THE farm-level data necessary to construct farm-level MACCs. The Teagasc NFS also provides the data necessary to understand individual farm and farmer characteristics that impact on a farmer's ability to realise their mitigation potential. It is also planned to incorporate a number of additional mitigation options based on on-going research into new technologies and measurement of GHG mitigation. These include:

- The use of sexed semen which can improve the carbon efficiency of Irish beef by improving average animal performance and increasing the proportion of beef output coming from the dairy herd.
- The use of urea in combination with effective nitrogen stabiliser additives has the capacity to make significant and cost-effective reductions in emissions from grassland and tillage crops.
- Additional improvements in animal health status have the capacity to improve herd fertility and out put efficiency and reduce the carbon efficiency of dairy and beef production.
- Irish pastures have the capacity to sequester carbon and on-going research is underway into the extent and sustainability of this sequestration with a focus on the management practices that may encourage enhanced sequestration.

37. **Improving water quality–Teagasc Agricultural Catchments Programme Phase 3**

Generating improvements in the environmental footprint of the sector will require a greater understanding of the processes by which agriculture impacts on the environment. This is particularly the case in respect to water quality. Dairy expansion will have a more pronounced local impact, as expansion will occur in particular parts of the country. A continuation of research programmes such as the Agricultural Catchments Programme will be critical in understanding drivers and mitigation strategies to facilitate a better environmental footprint.

38. The Agricultural Catchments Programme should build on the research from its first two phases, using archive data as well as new high-resolution biophysical data and extensive socio-economic data, to further develop the understanding of the processes in its six catchments to:

- Explore the potential economic and environmental impacts of changes across a range of possible land-use scenarios.
- Identify critical source areas for nutrient and sediment loss.
- Measure the cost-effectiveness and acceptability of mitigation measures to improve water quality.
- Develop a more complete understanding of the pathways of nutrient loss.
- Link research outputs to policy and deliver double dividends for farmers that will improve profitability and reduce environmental risk.

39. **A new nutrient management planning software tool**

Teagasc will soon launch a new Nutrient Management Planning tool that will greatly enhance and facilitate field specific and cost effective application of fertiliser and slurry. The programme will be based on the most up-to-date research-based recommendations as outlined in the Teagasc Green

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Book, which is to be updated and published in 2015. Technology is also being developed to facilitate soil specific nitrogen advise to account for the background mineralisation across soils using soil test methods to enable farmers to optimise N fertiliser application rate and timing.

40. **Demonstrating environmental efficiency: The Kildalton ‘Open Source’ Sustainable Farm**

Teagasc and Glanbia Ingredients Ireland launched the Kildalton Open Source Sustainable Farm initiative in November 2014. The initiative will measure success across four key pillars: resource use efficiency, including water, energy and nutrients; land management to maintain and develop biodiversity; animal welfare and health and safety. Progress in each of these important areas will be benchmarked globally and measured against target on an annualised basis. The farm will be used to demonstrate best practices which will ensure sustainable farming systems into the future.

41. This project will demonstrate environmentally and economically sustainable farming to current and future farmers and showcase the sustainability of Irish food to international customers. The seven-year project plan will be flexible to accommodate market and policy changes and will be rolled out in four phases:

- Measuring and benchmarking the current sustainability of the farm.
- Implementation of proven sustainability technologies and practices.
- Improvement of the farm infrastructure including buildings and ecological infrastructure such as woodlands and hedgerows.
- Implementation of emerging technologies such as automated sensors for crop and animal management.

40. **A new dairy expansion service**

Dairy expansion has specific needs, requiring investment, technical skills and business planning and risk management skills, which require dedicated advice and business planning support for farmers either wishing to expand or to convert from other sectors to dairy farming. Teagasc is prioritising a new dedicated service to facilitate dairy expansion to be known as the Dairy Expansion Service.

¹ See Hennessy et al (2013) for a copy of the report on indicators www.teagasc.ie/publications/2013/3042/SustainabilityReport.pdf

² For more information on FLINT see <http://www.flint-fp7.eu/>

42. The new service will involve the delivery of an intensive “one-to-one” type service by Dairy Expansion Advisers supporting dairy farm businesses in the planning and monitoring of a major dairy farm expansion exercise, typically over a three-year period for each client. Recent Teagasc NFS data indicates that over 1,200 such farmers may avail of this service over the next 3-4 years. This new programme will allow Teagasc to leverage its current network of Dairy Advisers, Dairy and Financial Management specialists and researchers to benefit both the individual farmers receiving the service as well as the dairy industry and the wider economy. The purpose of the new service is to enable farm businesses to grow in a sustainable manner while reducing the risk of poor business decisions leading to business failure. Delivery of this new service is dependent on the availability of suitable staff resources.
43. **Make collaborative farming the norm in succession and inheritance transitions**
Collaborative farming arrangements are a useful practice to improve land use efficiency through increasing land availability via leasing sharing farming/partnerships. Short-term rental (conacre) tends to be relatively costly and the short-term tenure impacts negatively on the willingness of farmers to invest in critical management practices such as liming and the improvement of soil fertility. Methods of achieving the necessary scale efficiencies, particularly associated with machinery use, need to be developed.
44. In facilitating succession and inheritance, family partnerships should be the norm, or should be mandatory. There is a need for a more coherent, longer-term succession strategy. We want to see a transition to younger farmers, as these will drive the necessary increase in productivity. However, we need to recognise that there are still disincentives in the scheme.
45. More consideration needs to be given in policy formulation to the interaction between land mobility incentives arising from both the tax system and the direct payments system. The definition of an “active farmer” is one such example where the taxation system and direct payments system need to be aligned.
46. **Expand the intake into Teagasc’s Diploma in Professional Dairy Farm Management**
Commercial dairy farming is a highly complex business, combining animal husbandry, grassland management, business planning and financial control, and other operational and farm management skills. Given the increasingly volatile environment and regulatory challenges dairy farmers face, there is a need to up-skill Irish dairy farmers.
47. Teagasc’s Level 6 Advanced Dairy Programme provides a strong education platform for young farming entrants intending to pursue a career in dairy farming. In addition, the organisation has introduced a Teagasc Professional Diploma in Dairy Farm Management, which is validated by UCD. This follow-on professional work experience based diploma is intended to deepen and enhance the farm management and business skills of those intending to manage their own farms, to work as dairy farm managers or seeking to enter dairy farming through a collaborative arrangement.

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48. It is vital that all dairy stakeholders (farm families, future young entrants and wider industry) view dairy farming as a career that requires investment in a quality education. Teagasc, in partnership with other stakeholders, will strongly promote dairy farming as a rewarding career and proactively highlight the recommended dairy education pathways and routes of entry to dairy farming. Additionally, we will seek over the coming years to significantly increase enrolments to both our Level 6 Advanced Dairy Programme and the Teagasc Professional Diploma in Dairy Farm Management. Additionally, we will explore the most appropriate entry mechanisms to dairy education for those non-agricultural award holders seeking a career in dairy farming on home farms or elsewhere.
49. Teagasc will actively pursue this strategy on three fronts; through extensive collaborative promotion of dairy education pathways, making adequate resource provision for increased enrolments and developing a wider range of alternative entry routes to dairy education. Modern dairy farming as a career requires investment in a quality education. There is an urgent industry wide (i.e. farm families, future young entrants, educators, wider industry and policymakers) need to pro-actively and positively promote the importance of dairy education. Teagasc, in partnership with other stakeholders, will strongly promote dairy farming as a rewarding career and proactively highlight the recommended dairy education pathways and routes of entry to dairy farming. Additionally, we will seek over the coming years to significantly increase enrolments to both our Level 6 Advanced Dairy Programme and the Teagasc Professional Diploma in Dairy Farm Management. Over recent years high performance dairy herds have been developed at the three Teagasc colleges. The dairy herds at Ballyhaise and Clonakilty colleges' incorporate high profile Teagasc Moorepark dairy systems research programmes. The herd at Teagasc Kildalton will form the basis of a Teagasc-Glanbia Ingredients Ireland Open Source Sustainable Farming research project. Teagasc will ensure that these college based research programmes will be more efficiently harnessed to enhance teaching and learning for Teagasc dairy education. It will also be essential to ensure that farm and teaching facilities and staffing resources are adequate to provide a quality learning experience. Teagasc will also review barriers to entry that may be inhibiting application to key dairy education programmes. Specifically in the short term Teagasc will seek to develop access routes to the Teagasc Professional Diploma for key cohorts of Teagasc graduates who are not currently eligible such as Teagasc 'green cert students'. It is also likely that cohorts of graduates with non-agricultural qualifications will seek to take up a career in dairy farming be it on a home farm, through a collaborative farming arrangement or by becoming an employed dairy farm manager. Appropriate access routes to Teagasc dairy education will need to be developed for such situations. This will require more flexible entry criteria, and accelerated and distance learning programmes to be developed.
50. **Develop flexible education and training pathways**
As agriculture becomes more knowledge-intensive, education and skills development are even more critical for success. A recent major Teagasc study clearly establishes the very substantial benefits of investment in agricultural education. Investment in agricultural education should be a primary strategy to capture the 2025 Agri-Food Strategy vision for competitiveness and innovation. As a practical multi-skilled industry, practical, applied education, combined with an apprenticeship model, is the desired delivery mechanism.

51. Teagasc must ensure that young farmers are given a variety of education and training options so as to achieve a continued improvement in the proportion of farmers with recognized agricultural training. The minimum level of training should be set by industry norms at or equivalent to current FETAC level 6.
52. Pathways need to be further developed from entry level to high-level skills programmes. Management practices and technologies need to be incorporated on the home farm, supervised project work and membership of discussion groups must be part of training programmes: linkages with higher level education institutions will be extended, so that students can progress from certificate to honours degree and beyond.
53. Teagasc, as the lead provider of education to agriculture, horticulture, forestry and equine sectors, will need to continue to develop innovative methods for agricultural education delivery, using participatory training methods, e-learning and other best practice as part of the entrant and adult programmes.
54. As the industry changes, there is a need to continuously review existing Level 5 and 6 further education awards in agriculture and associated curricula. The curriculum review needs to ensure that agricultural education knowledge, skill and competency requirement meet learner and stakeholder needs for the more immediate future in the context of Agri-Food Strategy 2025.
55. Agricultural education needs to fit into wider skills and education strategies. A longer term strategic vision for further and higher education goals and strategies is necessary to align and enhance the type and quality of provision to best serve the sector in the longer term.
56. A more comprehensive and structured approach is necessary for advising potential young farming entrants, farm families, career guidance counsellors on the importance/benefit of investing in formal agricultural education on appropriate education pathways.
57. Incorporate career path opportunities to potential young farmers in terms of planned succession and inheritance, farm partnerships and other collaborative farming models within curricula.
58. There is a need to address education deficiencies in niche sectors and industries such as the poultry where access to customised education and training is inadequate.
59. **A new vision for farmer education in Ireland**
Future entrants to dairy farming will require a much wider and deeper portfolio of knowledge, skills and competencies than heretofore. Aside from the constant competitive need to farm at high levels of technical efficiency and business expertise, future dairy farmers will require a much greater proficiency in the areas of intensive sustainable farming and ability to use information technologies and applications. In the shorter term, Teagasc will under the auspices of Quality and Qualifications Ireland (QQI), review in consultation with a wide body of stakeholders existing Level 5/Level 6 agricultural awards and curricula to ensure that they are both fit-for-purpose and to future proof

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them in terms of emerging industry needs. Teagasc will also continue to develop and introduce customised short training programmes along the lines of the recently introduced milking skills training for operatives.

60. It is over thirty years since the introduction of the Certificate in Farming ('Green Cert') raised young farmer education requirements from the then equivalent of Level 5 to a Level 6 standard. Both the overall education landscape and the agri-food sector have evolved considerably in the meantime, and further changes are required. The recent Education Act establishing QQI enables Teagasc to seek delegated authority to make awards. This would, if granted, allow the organisation to be more flexible and responsive in the development of future agricultural education programmes. Given the changing context, Teagasc will activate a high-level review to develop a new strategic long-term vision for 'young farmer' agricultural education requirements.
61. **Technology outreach service: supporting rural based agri-professionals**
Farmers work with a variety of rural-based professionals from agricultural advisors through vets, accountants, solicitors, coops etc. In order to deliver productivity gains in Irish agriculture, it is important that a consistent message is given to farmers in relation to technological and management practice adoption.
62. Teagasc intends to provide support services to rural-based agri-professionals who are employed in agricultural consultancies, the banks, the Co-ops, in veterinary practices and so on, to ensure they are aware of Teagasc views on the suitable technologies to be adopted at farm level to minimise conflict in messages delivered to clients.
63. Though this service Teagasc will also identify and engage with high innovation potential SMEs to design and deliver confidential R&D and skills development on a company by company basis. Learnings from the successful food High Potential Start Up programme delivered by Teagasc, Bord Bia and Enterprise Ireland, Food Works programme, will be applied to established SMEs to facilitate a radical improved growth and export focus for these companies.
64. **Helping farmers to get financially fit**
The business of farming becomes more complicated due to the three challenges of:
- Managing volatility in running the day to day business.
 - Planning for the future in terms of farm investment.
 - Ensuring Farm Viability.
65. Getting Farm Financially Fit, through the adoption of financial and business planning has thus become an ever more important management practice on farms.
66. Developing toolkits to support decision making in relation to financial fitness have been recognised within Teagasc programmes and within public policy. Teagasc has developed a variety of farm-management tools that can facilitate farmers in financial decision making, These include:

- eProfit Monitor.
 - Cash Control Planner.
 - Business Planner.
 - Farm Household Expenditure Planner.
67. With increasing financial risk, it is essential that financial and business planning become part of the technological toolkit for farmers.
68. While several thousand farmers complete the Teagasc eProfit Monitors each year, the majority have not engaged with these tools. Also, for those that have engaged, it is not clear to what extent they have actually used the information provided by these tools as part of their decision making.
69. Thus there is a need to get farmers to move from engaging with financial and business planning tools to actual financial and business planning. This is partially a behavioural change process and partially a skills development process. There is a need to develop simpler tools, particularly for part-time farmers and to develop alternatives.
70. Dealing with these issues will require
- Targeted extension campaigns.
 - Education and training for farmers.
 - Research, building upon 'big data' to provide potential benchmark data for farmers who do not engage currently with benchmarking.
71. **Teagasc 'Options Plus' programme for improving off-farm income generation of farmers**
Market research from participants on Teagasc's Options Programme has indicated the need for additional more targeted employment and income generating skills to meet the off-farm employment needs so that farmers can benefit from the improvement in the labour market. These include:
- On-farm income generating skills in relation to food production, butchery, rural tourism, organic production, forestry, succession planning, energy saving technologies etc.
 - Generic business skills such as financial planning, starting up a business, business planning and direct selling.
 - Specific employment skills targeted at particular off-farm employment opportunities.
72. It is proposed within the 'Options Plus' programme to provide a range of courses to meet these skills needs. Teagasc could provide some of these courses, particularly those with a farm focus and for generic skills in relation to farm financial planning, business planning and direct selling.
73. The challenge however is to link farm families with the variety of learning opportunities provided by other agencies including the ETBs, LEOs, LDCs, third level institutions and Social Welfare etc. Research has shown that non-farm focused organisations have had challenges in connecting with farm families.

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74. A potential innovation under ‘Options Plus’ is to develop a communication tool linking these service providers with farm families, facilitated by Teagasc and potentially DAFM. This could be delivered by a web based tool, OptIn, which contains a calendar of skills training opportunities on a regional basis. OptIn would collate information on all training opportunities in a region provided by the agencies and communicate with farm families via Teagasc’s communication and local network. Communication would be via the web, email, text message, poster and client advisor interaction.
75. **Food Innovation Hub**
Teagasc plans to establish a ‘Food Innovation Hub’, built on the concept of the Wageningen Food Valley in the Netherlands, but applied to the food industry in and around Cork. The Food Hub would encompass pilot plant facilities (in the form of a futuristic Moorepark Technology Ltd.), together with 20 newly-built customer application units which would be private “carded spaces” to be occupied by industry. Each of these units would contain office and laboratory space, so that each industry client could conduct new product development within their own “Embassy”. These units would be physically linked to the pilot plant facilitating manufacturing to pilot scale, which would allow each company to produce product for quality assessment and test marketing. Moreover, access to and support from the internationally-recognised Teagasc Food Research Programme would ensure a pipeline of research and innovation to fuel new product development and technology based HPSUs.
76. The principal objective of the “Hub” is to create a network for innovation and business development involving companies, research institutes, experimental facilities, incubators and public-private partnership based R&D programmes with a focus on food, health and nutrition. The proposal would result in the development of a regional food cluster which would be unique in terms of intensive collaboration between companies and research centres with the objective of developing innovations that would form the basis for new food products and processes, leading to economic growth and new jobs. The Hub concept would leverage findings from virtual research centres located within Ireland, i.e., APC, FHI, DPTC and MTC for the development of new market opportunities for clients.
77. **Translating ‘food for health’ science into practice**
Global trends and regulations have prompted a need for linking the molecular structure of food with health. Staged nutrition can be realised through integration of existing sciences such as Gut Health and food structure / formulation science. In recent years there has been substantial public investment in the science underlying food matrices designed to deliver ‘food for health’ through the creation of several virtual research centres, e.g., the Alimentary Pharmabiotic Centre (UCC and Teagasc and industry), Food for Health Ireland (UCD, Teagasc, UCC, UL and industry), Dairy Processing Technology Centre (UL, Teagasc, UCC, UCD and industry) and the soon to be established Meat Technology Centre (MTC). Teagasc plans to develop transformational food science platforms to assist in converting scientific outputs from these centres into commercial applications.
78. **Industry Walsh Fellows: enhancing the scientific absorption capacity of the agri -food SME sector**
There is a real need and opportunity to drive a step change in the performance of the food SME sector. Many of our large agri-food processors possess R&D capacity and are significant exporters.

However our SME sector faces challenges particularly in utilising technology to innovate and create the pipeline of products to create a sustainable business capable of supplying a continually changing international marketplace. SME development and growth can be supported by identifying high innovation potential companies and connecting such companies with the Teagasc food R&D facilities, technical expertise and technical skills development expertise. SMEs require knowledge and technology to be interpreted and applied to their business needs while at the same up skilling their technology absorption capabilities.

79. Teagasc has devised a variant of its long-established Walsh Fellowship programme that's uniquely tailored to the needs of industry. Through this programme suitably qualified industry employees can obtain a fellowship at M.Sc. or Ph.D. level to enable them to upgrade their scientific capabilities. The candidates will be jointly supervised by Teagasc and university-based researchers. The research topics chosen will be integrated into the work programme of the employee's company. The employees will undertake the bulk of their research activity on their company's premises but will also spend some time at Teagasc and the supervising university sites.