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Green Food Project Wheat Sub Group Report

Themes, Tensions and Recommendations

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Introduction

This document is written and owned by members of the wheat sub group. The content does not necessarily reflect the views of Green Food Project Steering Group members. This is a discussion paper by representatives from the following organisations: National Farmers Union(Chair), Agriculture and Horticulture Development Board- Home Grown Cereals Division (AHDB-HGCA), Agrii, BASF plc., Biosciences Knowledge Transfer Network (BKTN), Department for Environment, Food and Rural Affairs (Defra), Game & Wildlife Conservation Trust (GWCT), Morrison's, National Institute of Agricultural Botany (NIAB TAG), Natural England, RAGT, Royal Society for the Protection of Birds (RSPB), Syngenta.

Aim

In the Natural Environment White Paper there was a commitment to 'bring together government, industry and environmental partners to reconcile how we will achieve our goals of improving the environment and increasing food production.'[1] This is the key driver behind the Green Food Project.

Vision

Sustainable intensification is one of several important concepts arising from the 2011 Foresight Report on the Future of Food and Farming. It means *"...simultaneously raising yields, increasing the efficiency with which inputs are used, and reducing the negative environmental impacts of food production. It requires economic and social changes to recognise the multiple outputs required of land managers, farmers and other food producers and a redirection of research to address a more complex set of goals than just increasing yield."*[2] This concept provides the vision behind the aim outlined above.

The aim and vision of the Green Food Project therefore is not just to produce more food, or in this case wheat, but rather to reconcile the needs of food production and the environment up to 2050. This ambition cannot be met by making changes piecemeal to parts of the food system, and in many cases action must be taken over the next 5 and 10 years if the desired outcome is to be achieved by 2050.

Instead, improvements in yield, environmental outcomes and resource use efficiency will best be achieved through taking a "Systems Approach" to agriculture. Modern farming systems rely on the integration of technologies (mechanisation, plant nutrition, crop protection and improved seeds) with farmers' agronomy knowledge, and implementation of good management practices. At the heart of this, there is a need to take account of biodiversity, water and soils, which will underpin not just the improved environmental outcomes, but also a sustainable base for food production into the future.

[1] The Natural Choice: Securing the Value of Nature, HMG, 2011

[2] The Future of Food and Farming, Government Office for Science, 2011

Headline Tensions

If no action is taken, the following tensions will result in stagnation or reduction in wheat productivity, biodiversity and resource use efficiency and protection. Raising production dramatically will increase tensions with the environment. Likewise, improving the environment in isolation of production could also have a negative effect on total yields.

Yield Plateau

Since the mid 1990s increases in national average farm yields in the UK have not kept pace with increases in yields seen in best practice trials. This has been caused, in part, by low prices as well as by UK and EU policies. There is a wide variation in the productivity of wheat growers, and there are opportunities for knowledge exchange to help raise low yields and to work with more technologically advanced growers to speed wide deployment of new tools and techniques.

Defra and HGCA's yield plateau project, due to be published in early summer 2012 will go a long way to address this challenge.

A recent report by Mackay et al. (2010)[3] found that, for the period from 1982 to 2008 as a whole, 88% of the yield improvement in wheat was attributable to plant breeding. Breeding advances must continue to make a significant contribution to yield improvement, and the introduction of genetic resistance to biotic and abiotic stresses has clear environmental benefits. For example the introduction of orange blossom midge resistant varieties reduces the need to treat the crop with insecticide. However, genetic advances alone are insufficient and a systems approach and profitable farming are needed to both ensure the full expression of varietal genetic gain on farm and to ensure that production systems, that release land for environmental benefits, are developed and deployed.

Environmental protection

Current production levels require more effective environmental mitigation than is currently taking place. It has recently been suggested that around 18% of the total land area in the UK needs to be devoted to environmental protection, significantly higher than the 7% of land currently committed[4]. In terms of cropped land, the recent Farm4Bio report indicated that having 4% land uncropped and well managed provided clear benefits for farmland birds[5]. Lawton noted that future production increases are likely to require greater levels of mitigation, but it should still be possible to balance production and environmental protection needs if farming practice is integrated toward these dual objectives at the right scale. Such tradeoffs need to be fully understood and considered and a more

[3] Reanalyses of the historical series of UK variety trials to quantify the contributions of genetic and environmental factors to trends and variability in yield over time, Mackay et al., 2010

[4] Making Space for Nature, Lawton et al., 2010

[5] Enhancing arable biodiversity through the management of uncropped land, HGCA, 2011

interventionist approach to the management of wildlife and the environment is needed to off-set the pressure of intensified production. A cultural shift is needed if the farming community as a whole is to recognise the need for environmental mitigation.

Climatic changes

Changing weather patterns underpinned by a changing climate will have a negative effect on yields, biodiversity and resources. This can lead to new opportunities for UK growers as well as bringing in new challenges, recognising that the UK is likely to be less affected by climate change than other parts of the world. In the UK wheat adaptation to moderate increases in temperature may be addressed through the normal course of selection by breeders accessing the wheat gene pool of central and southern Europe, however the combinations of day length and temperature not previously seen means this will require adequate investment. If wildlife is to adapt to climate change, it will be necessary to build resilient ecological networks across England[6]; farmland will be central to this.

Nutrient management

Nitrogen, phosphate and some micronutrients are costly or limited global resources that need to be in balance for optimum results and to avoid damage to the environment and human health. Access and availability of nutrients is a long term tension, which could be mitigated by; : better soil management to promote the biological activity of soils, an increased understanding of soil microbiology and interactions with roots, improved nutrient use efficiency of the crop, and technological developments that alter root architecture to increase crop nutrient uptake. Shifts in wheat production towards more mixed farming, or looking forward, better links between farms supporting integration of arable and livestock production could improve issues of nutrient access and management in some areas. There is also need to address the impacts arising from excess nitrogen in the environment.

Water availability

Higher yields will require more water, however in wheat growing areas water availability is likely to decline over time. Technological developments or changes in farming practices to increase water use efficiency, improve the water holding capacity of soils and maximise the extent of rooting, could help mitigate this tension, or farmers may respond to the market by altering crops so wheat shifts to wetter areas.

Water quality

Diffuse pollution by nutrients and chemicals is a significant concern. Agriculture and rural land management are responsible for more water bodies failing to meet good status than all other sectors other than water companies[7].

[6] Making Space for Nature, Lawton et al., 2010

[7] Water White Paper, HMG, 2011

Land use change

Loss of land from agricultural production due to coastal erosion and land use change will put further pressure on farm productivity and increase environmental challenges. Also important is erosion and degradation of peat and soil resulting from current agricultural practices and the loss of semi-natural habitats or long term uncultivated habitats due to agricultural improvement.

Energy production

Diversion of arable crops from food to energy production post farm gate partly conflicts with the objectives of the Green Food Project, which relate directly to food production. This incorporates bio fuels, crop based anaerobic digestion and carbohydrate based substitutes for hydrocarbons. In the future, extra demands on land for energy production could have further impacts on the environment, with the effects being difficult to model. Such diversion of crops does support agricultural production in general however, and could be used to provide opportunities for the industry such as investment in wheat research and development (R&D). Wheat could also play a part as 2nd generation bio fuels are developed through the creation of ethanol from wheat straw, although this would reduce the amount of organic matter being returned to the soil.

Our Approach

The approach we have taken is to consider whether we are delivering as much as we can in an environmentally-sustainable way from the area we currently have in production.

The themes below have been identified as the important tools for increasing the productivity and environmental performance of wheat production in the future.

This report forms the definitive conclusion of the partnership of the wheat subgroup. In compiling this we have drawn on several areas of source material and work carried out during the period December 2011 to April 2012. These included meetings convened as the Green Food Project wheat sub group, and separate related reports commissioned specifically by AHDB- HGCA to support discussion[8].

Themes ↓	Impact on...		
	Productivity	**Biodiversity**	**Resource Use Efficiency and Protection**
Knowledge Exchange	Education, skills, agronomist advice, training the trainers, demonstration farms, social media, farmer to farmer and networks that take account of all these areas.		
Research and Development	Plant breeding including biotechnology, crop protection, soil and nutrient management tools. Integrated environmental packages to minimise and mitigate for environmental impacts of current and future agricultural practices. Agronomy, Governance/coordination of R & D (government and private sector led).		
Incentives and market measures	Getting the most from agri- environment schemes. Role of CSR and market signals/consumer demand. Creating markets for ecosystem services. Economically viable rotation crops		
Regulatory Framework	Regulation setting a firm baseline, ensuring that all farmers meet a common standard in environmental performance and providing a stable, level playing field in which all farm businesses operate Regulation should be effective, proportionate and based on scientific assessment. Proper enforcement and implementation is critical.		
Business Structures	Structural change eg competitiveness and environmental performance of lowest performers in the sector, value of collaborative co-operatives or contract farming. Barriers to business development and incentives for effective environmental protection.		

[8] Increasing the production of wheat in the UK – Essential actions to meet wheat's potential by 2050, ADAS, 2012; How to increase the production of wheat in the UK, The Andersons Centre, 2012

Specific Tensions and Recommendations

1. Knowledge Exchange (KE)

Recommendations

a. **Refocus and coordinate knowledge exchange delivery more towards face to face interaction and demonstration** through the development of a yield and environmental enhancement network of demonstration farms and extension services. These should integrate both needs whilst recognising the need to segment delivery and utilise modern methods of communication such as e-learning and social media. Current examples of face to face or demonstration based knowledge exchange initiatives include the National Agronomy Centres initiative, distributor-led on farm demonstration sites and the network of monitor farms in Scotland.

b. **Encourage a more holistic approach to advice** by further integrating and embedding environmental advice within conventional agronomy for example by increasing uptake of environmental training by agronomists or incentivising environmental outcomes to increase the desirability of environmental knowledge. Environmental knowledge should focus on both biodiversity and resource protection and efficiency - resource use efficiency, as expressed in economic terms, is not a proxy for all environmental impacts. All demonstration sites / case studies / decision support tools / training / advisory programmes / benchmarking should deliver optimal production and effective environmental mitigation to reinforce the needs to combine these two needs, using integrated campaigns and advice packages such as the; Farming Advisory Service, Campaign for the Farmed Environment, Entry Level Stewardship Training and Information Programme, and the Voluntary Initiative, see Box 1 below.

c. **Increase environmental knowledge of the next generation of farmers and advisers** by adapting training syllabuses to include a greater emphasis on relevant environmental aspects. Support skills and training to maintain and improve both R&D and knowledge exchange goals. Educational programmes (including school, college and university, as well as professional development and industry education) must be used to increase knowledge uptake, demand and consistency.

d. **Encourage technology exchange**: Join up the whole R&D/ knowledge exchange chain to get innovation moving from lab to field. Could be through supporting public private partnerships or encouraging a portion of research funding on projects to be devoted to ensuring the knowledge is applied, for example many projects funded by the AHDB already incorporate knowledge exchange in the project plan. This should encompass a “training the trainers” approach so that the few scientists carrying out the research can cascade the information to others who for example could apply and communicate this at demonstration farms and will be boosted by the recently started Biotechnology and Biological Sciences Research Council (BBSRC) Advanced Training Partnerships (ATPs). Further examples include the; Australian Commonwealth Scientific and Industrial

Research Organisation (CSIRO), Scottish Agricultural College, US Department of Agriculture (USDA), French National Institute for Agricultural Research (INRA) and Brazilian Agricultural Research Corporation (Embrapa), all of which are national research institutes with a joined up knowledge exchange element. This may not be appropriate for 'blue sky' research that is far removed from the market, however it could be useful for focusing research funded by Research Councils, for example.

e. **Tailor knowledge exchange to the audience** by segmenting the way knowledge is exchanged with those that will use it. This will require understanding of how different communities within the sector take on knowledge, and targeting of knowledge exchange methods accordingly. Research and apply new levers available in terms of knowledge exchange and behavioural change by commissioning and applying social research through the Economic and Social Research Council (ESRC). HGCA is in the process of piloting work in this area.

Tensions

Uncoordinated approach

The current effort on knowledge exchange is somewhat uncoordinated, and is not effective in changing behaviours and practices of many growers. Commercial advice is largely productivity focussed, whilst public advice is largely environmentally focussed. The two need to be integrated across the piece to move towards a system based approach.

Productivity focussed

Current knowledge exchange structures are focussed on managing risk, short to medium term profitability, and to a limited extent on crop productivity. Until environmental productivity is valued effectively there is no incentive for growers to purchase environmental advice. Guidance to enable farmers to make the right choices for the environment, through a combination of well-designed regulations and agri-environment scheme opportunities, are essential for farmers and commercial advisers to properly embrace outcome focused environmental advice.

Box 1: Coordinated and integrated advice to farmers

The agricultural supply industry plays a key role in advising farmers on production as well as environmental issues. Many of the businesses carry out near market R&D and some are involved in publicly funded R&D projects. For example Agrii conduct R&D to the value of approximately £1m. Most of the advice is provided to farmers on a one to one basis at field level by qualified agronomists and almost all arable farmers seek advice from an agronomist.

As well as direct advice, many companies also have demonstration farms. For example Agrii have approximately 25 demonstration farms and NIAB TAG a further 20 sites in England where regular meetings are held through the year. As well as other sites not mentioned here, there is also the Linking Environment And Farming (LEAF) Demonstration Farm network. They demonstrate the latest research and development and include environmental and business content, using both in-house as well as external speakers. It is important to have regional/ local meetings so that the information shared is relevant to the local farms, soil types and climate. These need to be developed and supported to ensure coordinated key messages on productivity and the environment, as well as delivering the latest R&D findings.

2. Research and Development (R&D)

Recommendations

a. **In depth agronomic investigation to reverse on farm yield stagnation.** This should build on the output from the Defra Yield Plateau project and take into account effects of soil compaction and organic matter, rotation, farm consolidation and climate change. This will require mechanisms that support the funding of longer term research programmes including field experiments in excess of 5 years duration.

b. **Strong and continued investment in R & D both for fundamental and applied science** using public private partnerships to establish a more rapid route to wide adoption and to ensure that research is targeted at delivering public goods and improving economics of farming. A rational approach to intellectual property exchange from public to private sectors must be developed. It should be remembered that plant breeder privilege, enshrined in plant variety rights legislation, ensures unencumbered access to commercial varieties for breeding purposes at the national and international level. Develop an overarching strategy for R&D that contains an appropriate balance of short, medium and longer term targets and benefits. All available technology, including genetic modification, will need to be carefully considered as part of this.

c. **All R&D towards increasing yields of wheat and other arable crops should be undertaken with full environmental risk assessment,** looking for dual functions of increasing yields and improving the environment. Genetic improvement of the wheat crop through plant breeding, to increase yield potential and durable resistance to abiotic and biotic stresses will be key to ensure sufficient productivity without increased environmental degradation.

d. **Raise the understanding of resistance by organisms to pesticides and weeds to herbicides** and promote practices such as Integrated Pest Management and cultural control that reduce the risk of transfer of inherited resistance or slow the rate of resistance selection through reduced dependence on a limited number of pesticide modes of action.

e. **The benefits and risks of an appropriate rotation should be addressed.** Crop rotation can play a key role in soil management, crop nutrition, disease and pest control; however the practicalities of incorporating pulse crops do currently carry an economic risk. R&D is needed to address these risks and identify ways to support the role of rotation, developing programmes using particular rotation crops and appropriate agronomy to maximise benefits. This should specifically include the nitrogen management of oil seed rape and wheat.

f. **Improve knowledge, understanding and the health of soils** including:

i. Develop a better knowledge of the interrelationship between the soils physical, chemical and biological characteristics to improve its resilience to support increased production in a changing climate.

ii. Develop a better understanding of soil pests and diseases and beneficial organisms and their interaction with agricultural practices such as tillage methods, plant genetics and agrochemicals.

iii. Develop a better understanding of the interrelationship between soil, roots and the rhizosphere, particularly in relation to water and nutrient use efficiency.

iv. Develop current knowledge of soil cultivation and its implications and interactions with agronomy, production and environmental outcomes.

v. Explore potential of zero and minimum tillage systems and develop understanding of the implications and benefits on soils. Build soil resilience through management practices appropriate to soil type, including optimising organic matter or biomass content and avoiding compaction and erosion.

g. **Encourage end users to invest in technology and products** that use flour with lower protein concentrations, and therefore lower nitrogen requirements (see Box 2).

h. **Modify and enhance existing integrated environmental packages** to address resource protection and the declines of farmland biodiversity, building on MESME, and ETIP/ CFE. Once developed, these should be tested and implemented to mitigate for the environmental impacts of current practice, and reviewed for their effectiveness in mitigating for future changes

i. **Environmental policy development**. Develop schemes for releasing land for new nature reserves and for on farm environmental schemes (to improve and promote ELS and HLS) that encourage the reversal of the decline seen in key indicator species. For example, research should be undertaken to find a sustainable solution to the bridging of the January to March hungry gap suffered by farmland birds. Until a solution has been found, more interventionist approaches such as supplementary feeding may be appropriate. These will not replace the importance of ensuring adequate provision of habitat and winter feed resources across the farmed landscape[9].

j. **Build a much better knowledge of precision farming techniques** how and decision support systems can enhance production and environmental protection across the farm. This should include financial and time commitment, so improved farming techniques are developed that small as well as larger farms can adopt.

k. **Support research into what land sparing versus land sharing means** for the UK context, with a focus on landscape planning and farming systems, and how this may be effectively undertaken.

l. **In addition to measures that need to be taken on enclosed farmland** in order to achieve the aims of this project, investigate the need to manage non-agricultural land to maximise environmental output from the landscape, by intensifying management for environmental protection. For example through corridors linking habitats between and

[9] Testing agri-environment delivery for farmland birds at the farm scale, Hinsley et al., 2010

adjacent to agricultural land, through roadside verges, abandoned railway, water bodies etc, further to recommendations made in 'Making Space for Nature'[10] Protection of certain species from predation may be appropriate but only in conjunction with efforts to provide sufficient habitat. The priority should always be to ensure sufficient provision of quality habitat.

Tensions

Technological development

There is a significant lag time in new technological development reaching the market due to the time taken for products to be developed or approved (for example plant breeding innovations or crop protection discoveries). Appropriate testing for environmental and human safety is essential, however should be proportionate to the risks.

The breeding of new commercial wheat varieties is dependent on royalty income that is currently insufficient to fund the long term research investment needed to deliver. There is also an increasing danger that agrochemical producers' willingness to invest in new products for European farmers will decline due to the high cost and uncertainty involved in meeting regulatory requirements within the EU.

There has been an increase in the use of hazard based cut offs in EU regulation affecting farming which risks loss of key tools for productivity with minimal environmental benefits, a science based approach is crucial.

There is much less incentive for R&D that is not near market to be funded by industry or farmers as the benefits are not seen as directly beneficial.

Limited investment and funding

In the current economic climate it is difficult for any sector to invest more money. The way forward is through broad public private partnerships that can harness the skills and resources of government, industry, foundations, academia and non-governmental organisations. In the long term this may change as food security rises up the political agenda. In terms of GDP, England's spend on agricultural development is very low.

There is much less incentive for R&D that is not near market to be funded by smaller groups of industry or farmers as the benefits and risks for large, individual projects are not seen as proportionate to the costs involved.

More habitat or more management

Wildlife conservation can be achieved by taking more land out of production for wildlife, or to manage existing habitat more intensively to increase wildlife. The former approach negates some of the advances made in increased yields as less land is available for cropping, while the latter looks more generally at the life cycle needs of a species and

[10] Making Space for Nature, Lawton et al., 2010

seeks to employ more intensive management strategies to increase population levels while minimising the amount of land removed from food production. This is a more complex approach, is more knowledge intensive and requires greater commitment.

An example is flower-rich margins vs grass margins: a farm with all-grass margins will support a much lower diversity of insects than one where a proportion of margins have plenty of wild flowers in them: the seed mix is more expensive and the level of management is more intensive, but the environmental benefits are much greater in comparison, and less land is needed out of production to meet thresholds for environmental delivery.

Some management options also require intensive advice to be effective. For example, lapwing plots involve taking patches of between 1 and 2 ha out of production in the middle of the field with a loss of wheat yield of potentially between 8 and 20 t/ha/plot. A survey of 212 plots paid for under agri-environment schemes confirmed breeding on just 23, or 11% of plots. This is largely because they were situated in locations that would never attract nesting lapwings, indicating the importance of good advice provision to the success of environmental management.

Box 2: Lower protein wheat

Wheat breeding for bread and biscuit making has been successful so far, but the future for bread in particular will be more difficult due to genetic and nitrogen/environmental limitations. End users are beginning to respond to the problem; for example Warburtons will now accept a new variety of wheat, Crusoe, at 12.5% protein rather than the industry standard of 13% protein, which should therefore require less nitrogen.

Continued research to maintain flour functionality at lower protein levels is needed as well as improved resistance to pre-harvest sprouting to ensure the quality of the grain in less certain harvest conditions.

3. Incentives and Market Measures

Recommendations

If farmers were better rewarded for achieving environmental outcomes, it would provide an incentive for advisors to deliver practical advice that is more likely to achieve the desired result. There can be a perceived risk in trying new approaches and technologies, however these can be de-risked for example through devising alternative methods and or training and mentoring to reduce the likelihood of negative outcomes and increase the likelihood of success of new approaches being tried.

a. **Develop future agri-environment programmes to deliver greater benefits to the environment.** Schemes should become outcome focussed, targeted to specific measures to address local issues but must continue to attract broad participation whilst increasing the rewards for the measures which deliver at the expense of those that do not.

b. **Support the industry to invest in long term sustainable intensification through tax regime change** for example through allowances for capital investments such as water storage facilities, managing manures and other environmental capital works complementary to agri-environment schemes.

c. **Introduce an element of directed option choice into broad and shallow agri-environment schemes** to ensure uptake of the most effective measures. Clarity of aims and guidance on selecting the right package of measures to meet environmental objectives is essential to get the best value for farmers efforts in AES

d. **Develop metrics on environmental performance** to make it easier for farmers to relate their actions to a tangible and financial benefit.

e. **Explore the development of Payments for Ecosystem Services (PES) schemes** to better integrate biodiversity and resource protection into conventional market structures.

f. **Encourage environmental premium products** – e.g. labelling to enable consumers to make informed choices about buying more sustainable products e.g. Conservation Grade.

Tensions

Complexity

Complex documentation and management associated with agri-environment programmes and many different schemes/policy/practices can ultimately become confusing and so may not achieve the environmental gains hoped for. However, higher quality environmental habitats are complicated and difficult to deliver, and so there is a tension between the

need to simplify environmental schemes and advice to increase uptake, and the quality of the environmental outcomes delivered.

Market Structures

Biodiversity and some other ecosystem services are not significantly rewarded by conventional market structures

Limited funding

Current agri-environment schemes deliver useful benefits, but could be much more effective. This requires smarter use of funding to realise their full environmental potential. This should recognise that environmental management on farmland requires a more active approach than say in a nature reserve. Farmland is by its nature substantially altered habitat and in order to mitigate against negative environmental consequences we need to intensify our environmental knowledge and management.

In the medium to long term lack of funds and incentives will need to be addressed through a shift in CAP funding from Pillar 1 to Pillar 2 if co-ordinated environmental policies are to be implemented, with opportunities existing to influence the 2013-2015 environmental stewardship renewals. Shorter term minimal changes to current ELS and HLS schemes, at no extra cost, could provide some immediate positive outcomes however opportunities are limited as the current environmental stewardship cycle is coming to an end. Although new ways of managing options can be developed under the current scheme, these cannot be implemented into current agreements until they renew, which is a tension that is likely to persist under recurring CAP cycles.

Box 3: Environmental Indicators

The Farmland Bird Index is a robust indicator of the health of terrestrial biodiversity on farmland because it is less prone to annual fluctuations and includes a range of species dependent on lowland farmland for feeding and nesting, therefore reflecting the abundance of seeds and insects on farmland which underpin the food-chain. Similar indicators, for example based on long term mammal and pollinator data, would be valuable additions to the use of measures to evaluate the environmental performance of agriculture and to monitor the success of schemes such as agri-environment. Further developing indicators to allow targeted measures for certain species, eg early foraging bumble bees, would also be beneficial.

4. Regulatory Framework

Recommendations

a. **CAP reform should aim to facilitate environmental mitigation** for current and future agricultural practices: better regulation, better implementation and better compliance towards effective environmental protection.

b. **Regulation and voluntary approaches need to be properly monitored** to quantify their effectiveness in delivering their stated objectives. Good regulation will often be the most effective solution to deliver benefits to society, with voluntary initiatives used to complement, rather than as an alternative to, good regulation. The end goal is to achieve the desired outcomes by inspiring behavioural change, and therefore regulation needs to work with incentives for best effect.

c. **When considering what approach to take, government should look at the cost and benefits of various options** across society and business sectors, and not just the sector that is under consideration.

d. **Review the current basis for the EU pesticide limit of 0.1ppb in water,** including risks to human health, costs to farmers, and political and social acceptability. Move towards a risk based approach based on sound science so that limits are appropriate to the toxicological profile of the product.

e. **Instigate a review of the approvals process for genetically modified organisms** in Europe. Scientific considerations should form the basis of this process.

f. **Negotiate EU / CAP greening measures** to remove conflict so the British government can implement initiatives that are directly appropriate to help achieve British aims.

g. **Support a better regulatory framework** to allow efficient nutrition with more efficient use and recycling of phosphorus including making better use of resources such as sewage sludge and precision farming to match inputs to crop requirements. There is a need to address the impacts arising from excess nitrogen in the environment, namely on water quality, air quality, greenhouse gasses, ecosystems, biodiversity and soil quality as identified by the European Nitrogen Assessment[11].

h. **There is a need to fully understand the implications for agriculture and the environment that may result from the EU Indirect Land Use Change policy.**

[11] European Nitrogen Assessment, Sutton et al. (Eds.), 2011

Tensions

Common Agricultural Policy

Currently the Common Agricultural Policy does not meet its potential to support agriculture across the EU to achieve economic, social and environmental sustainability.

Voluntary approaches

Voluntary approaches lack incentives for farmers to engage with effective environmental mitigation and an improved regulatory framework is required to direct a sea-change across the whole industry

Genetically Modified Organisms

Reviewing the current basis for approval of Genetically Modified Organisms and encouraging changes to the current European Union system for approvals to a purely science based approach could increase the uptake of the technology. This may deliver production, environmental and consumer health benefits. However many view social concerns as extremely important when considering the approval of genetically modified products as well as their uptake, for example through the ownership of patents and consumer choice.

5. Business Structures

Recommendations

a. **Raise the business and environmental performance of all farms** to ensure their long-term sustainability allowing investment in infrastructure, equipment, technology and advice particularly across generations. This includes both raising the lowest performers up to a basic standard (where regulation plays a vital role) and continually raising the bar for best practice (see Box 4).

b. **Consider how to integrate mixed enterprises on farm** to increase the efficiency of the whole farm system (e.g. crops and livestock). Examples would be the use of biofuel by-products fed to livestock, and manure or AD digestate used as fertiliser within a farming system. Expanding the opportunities for integrating manures on arable rotations should be sought, and investigating the benefits of a variety of crops in the rotation to reduce the need for other resources is required, without diluting the advantages of specialisation as this will have the effect of significantly reducing wheat production in the UK.

Box 4: Promoting current good business practice

Benchmarking, both environmental and agronomic, and grower business survey data shows wide performance gaps across the spectrum of growers. Publicise more widely the performance of the top growers to raise awareness of what can be achieved – including the growers in the communication to raise awareness of what can be achieved in terms of productivity and environmental performance

Conclusion

The wheat sub group of the Green Food Project has achieved strong consensus from a broad range of stakeholders and has agreed specific recommendations calling for; the integration of R&D and innovation to achieve useful environmental and production impacts, coordinated knowledge exchange, more focussed support where there is a market failure, and policy changes to allow an appropriate regulatory and fiscal framework. The areas identified here, and supported by evidence, provide the first steps to support agriculture in moving much further along the road to sustainable intensification in England, to the benefit of agricultural production and the farmed environment.

Areas for further work

The group is aware that there may not have been adequate expertise on the group to adequately articulate the tensions and subsequent recommendations on dealing with resource use efficiency and protection. In addition, the extremely tight timescales and lack of any additional resource beyond the staff time volunteered by participating organisations, in addition to the funding for the two reports commissioned by HGCA, has limited the extent to which we can explore the issues. The group suggest that any detailed work on this area is taken forward with support from Defra, the Environment Agency, AHDB or other partners.