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Assessing the relevance and impact of GM crop management on the Irish landscape

Key external stakeholders:
Policymakers, tillage farmers and advocacy groups

Practical implications for stakeholders:
Although the potential of GM crops is often discussed, a specific list of GM crops of most relevance to the Irish agri-environment has yet to be compiled. In addition, little is known about the overall impact(s) of GM crop management on the wider landscape. In response, output from our research has:

- Identified a series of GM traits that are most relevant to the Irish tillage sector in light of future challenges facing the industry
- Developed a semi-quantitative biodiversity index to identify areas in the wider landscape where biodiversity is likely to be negatively or positively impacted by Irish-specific GM crops.

This index (termed 'CINMa') provides stakeholders with a clear indication as to the broad impact of specific GM crops as well as identifying agricultural zones which may, or may not benefit from the land use change associated with the management of GM crops.

Main results:
- GM traits with significant agronomic potential include; late blight resistant potato, Septoria resistant wheat and herbicide tolerant winter oilseed rape and maize.
- Enhanced nitrogen-use efficiency would clearly benefit the tillage sector in light of EU-based restrictions on nitrogen usage.
- Herbicide resistance can be transferred from GM herbicide tolerant oilseed rape into related Irish wild species but this will not confer an advantage to the weedy species unless they are sprayed with the specific herbicide.
- It is the management of the GM crop, and not the GM crop itself, that has the greatest potential for biodiversity impact.

Opportunity / Benefit:
The project output will (i) inform stakeholders of the most relevant GM crops to the Irish tillage sector and (ii) provide a biodiversity score to highlight the potential ecological impact of each GM crop and their associated management regimes. Further details are available on the project's website www.gmoInfo.ie.

Collaborating Institutions:
NUI Galway, NUI Maynooth

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1. Project background:

To be in a position to describe the impact of a range of different GM crops/traits on Irish biodiversity, it is first necessary to identify those GM crops that could be suited to Ireland's agri-environment over the next 20 years against a backdrop of future agricultural challenges. These include (but are not exclusive to):

- mitigating biodiversity loss,
- responding to climate change predictions
- addressing environmental legislation requirements
- producing sustainable biofuels
- preparing for changes to the Common Agricultural Policy

Against these challenges, the European Union (EU) must meet the current and future demands for food/fuel security but in doing so, species and habitat diversity in rural landscapes will be subjected to continual and increased stress. An urgent need exists therefore to mainstream sustainable agricultural and land management practices.

In order to monitor the possible ecological impacts of a novel crop there is also a need to augment, and ultimately harmonise, risk assessment strategies especially when technologies such as GM crops are incorporated into established agricultural landscapes. Under the terms of European Directive 2001/18/EC, the post-market environmental monitoring of GM crops within the EU must adopt both case specific monitoring and general surveillance strands of assessment. General surveillance is intended to ascertain the possible unintended effects of a GM crop release, but general surveillance is not adequately defined from a practical point of view.

Indeed, much of the GM crop research completed thus far has focussed on issues such as crop co-existence, genetic introgression and volunteer dynamics, often in the context of the on-farm environment. As a result, far less is known about the possible impacts of crop management (GM or non-GM derived) on the wider landscape. Overall, impact assessment research is fraught with the difficulty of identifying, from the outset, what is to be assessed, what an impact may be and where to look for this impact. While there is the need to focus on GM crops in order to satisfy requirements, little attention has been focussed on non-GM crops and this imbalance is generally believed to have served to reinforce concerns on GM crop impact. We believe that the impact of GM and non-GM crops can be jointly assessed using a broad index that encapsulates the management of both cropping systems and the corresponding stresses each may cause to landscape biodiversity.

2. Questions addressed by the project:

Is it possible to identify a cohort of GM crops that would be of most relevance to Irish farmers in light of future challenges to the Irish tillage sector?
Can a crop-specific index be developed to:

(i) quantify the impact of a specific GM crop and its non-GM counterpart based on a series of potential biodiversity stressors?

(ii) assist policy-makers and regulators to address the knowledge deficit that often arises from the legislated requirement for post-market general surveillance of commercialized GM crops?

3. The experimental studies:

The identification of Irish relevant GM crops was achieved by first quantifying the inputs to Irish tillage systems and then assessing how the macro-challenges listed previously will impact on these inputs and on the viability of each respective cropping system. To test the ecological impact of each GM crop trait, it was necessary to examine all aspects of land management – such as crop rotations and treatments, crop type and variety and length of operations. While geography, biology and taxonomy are key areas of ecological impact and will exert stress on biodiversity, it was decided that such stressors would be unmanageable on a

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practical level for the construction of a biodiversity index. Therefore, we used the four main areas where data are available and upon which farmers can exert the most control: the level of chemical input, potential for gene introgression from GM crops into non-GM relatives, requirement for nutrient load on the specific crop, crop management strategy designed to accompany the designated GM crop.

The resulting CINMa index was designed as a semi-quantitative representation of a qualitative analysis of the literature (published and peer-reviewed material and expert-driven reports). Thus some of the underlying variables were collated using different sources, landscape locations and experimental methodologies. The resulting CINMa grades were derived from sources with relevance to heterogeneous landscapes and allocated based on significance to Irish landscapes or species located within those landscapes. As assessments must specifically identify the impact area, the CINMa index is focused on four impact zones across a typical agricultural landscape: the managed field, semi-natural landscape within 10m of the managed field, the soil column and watercourses within the influence of the managed field.

4. Main results:

The crops with the greatest potential for genetic modification in Ireland are those grown on a large scale, namely barley, wheat, oilseed rape and maize and/or currently receive very high applications of pesticides and fertilisers (e.g. potato). Applying a sample of these crops to analysis using CINMa, the ecological impact of the crops is variable and is dependent on the trait, but most specifically, the management of the trait and the crop through rotation.

For GM oilseed rape, engineered for herbicide tolerance, CINMa indicated that there was a modest potential benefit for soil organisms under a newer management regime for herbicide tolerant crops. The potential for trait transfer into wild relatives was noted but these GM-wild hybrids will not possess a fitness advantage unless sprayed with the specific herbicide that the GM crop is modified to resist. For GMHT maize, CINMa yields a higher likelihood of this variety positively impacting upon biodiversity as there is zero risk of gene introgression as maize does not have any wild relatives growing in Ireland.

For GM late blight resistant potatoes, CINMa reported a positive benefit from management regime change, though again there are no data on potential impacts on the typical semi-natural habitats such as hedgerows that may be found in heterogeneous landscapes. The practical reduction or elimination of farm traffic, tanker washing, chemical mixing, and soil compaction have a high likelihood of reducing biodiversity stress. However, the use of GMLBR potatoes will impose an evolutionary pressure on the late blight pathogen to evolve resistance against the GM traits, as has been recorded for previous potato varieties bred through more conventional approaches.

5. Opportunity/Benefit:

This research is the first study to specifically identify what GM traits are relevant to Irish agriculture and significantly detail the possible ecological impact of the GM crops and their respective management regimes. This will be of benefit to policy makers, regulators, tillage farmers and the general public at large.

6. Dissemination:

Main publications:

Collier, M. and Mullins, E. (2010). The CINMa Index: Assessing the potential impact of GM crop management across a heterogeneous landscape. Environmental Biosafety Research, 9, 135-145.

O'Brien, M. and Mullins, E. (2009). Relevance of genetically modified crops in light of future environmental and legislative challenges to the agri-environment. Annals of Applied Biology, 154, 323-340.

O'Brien, M., Spillane, C., Meade, C. and Mullins E. (2008). An insight into the impact of arable farming on Irish biodiversity: A scarcity of studies hinders a rigorous assessment. Biology and Environment, Proceedings of the Royal Irish Academy, Volume 108B, Issue 2, pp 97 - 108.

Popular publications:

www.gmoInfo.ie

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