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Towards the development of an Irish coexistence strategy for GM and non-GM oilseed rape

Key external stakeholders:

Policy makers, tillage farmers

Practical implications for stakeholders:

Although a national strategy for the coexistence of GM and conventional/organic crops in Ireland was published in 2005 measures pertaining to the coexistence of GM and non-GM oilseed rape crops were omitted due to a scarcity of Irish-specific research. Output from this study has begun to address this knowledge gap by:

- Developing a computer model to quantify the potential impact of pollen and/or seed spread from GM oilseed rape fields on EU coexistence thresholds across an Irish landscape.
- Identifying crop-specific measures (e.g. isolation distance, field clustering) to minimise the potential spread of material from GM herbicide tolerant (HT) oilseed rape fields.
- In addition, a complimentary study was completed to identify the demographic factors most likely to affect farmer's decision to adopt GM crops suited to the Irish agri-environment.

Main results:

- The GeneSys gene flow model predicted that the incorporation of GMHT oilseed rape into an existing winter wheat-based rotation without a complimentary modification to the cropping regime would rapidly compromise the EU coexistence labelling threshold of 0.9% in neighbouring non-GM oilseed rape crops.
- Enhanced herbicide efficacy, the application of robust volunteer control, the inclusion of a single spring crop (potato, barley, maize) post-oilseed rape would reduce regional harvest impurities in non-GM oilseed rape crops below the 0.9% threshold.
- The establishment of GM zones by clustering GMHT oilseed rape fields presents a potentially viable mechanism to achieve effective coexistence with neighbouring non-GM oilseed rape sites.
- Economic analysis determined that the likely early adopters of GM technology will be specialist farmers with large acreage and who have formal agricultural education and access to high-quality soils.

Opportunity / Benefit:

Output from this project will inform stakeholders of the most pertinent issues relating to the coexistence of GM and non-GM oilseed rape in Ireland. This is of most relevance to regulatory agencies and policymakers.

Collaborating Institutions:

INRA, France

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1. Project background:

A crop's propensity to spread its genes through pollen and/or seed transfer is significant in light of European Union (EU) guidelines on the coexistence of genetically modified (GM) and non-GM crops and the labeling and traceability of GM material through food and feed pipelines. Coexistence relates to the adoption of crop-specific management regimes to maintain potential GM content in conventional/organic commodities below the 0.9% labelling threshold for food or feed. In short, coexistence is focused on restricting the potential for and consequence of a crop's gene flow, whether via seed and/or pollen.

Oilseed rape has significant gene flow potential via pollen dispersal and seed loss post-harvest. Furthermore, the high fecundity and long-term persistence of volunteers as a result of seed dormancy along with the emergence of ferals outside the confines of the agri-environment ensures the persistence of oilseed rape populations through a rotation. Hence, it can be expected that in the absence of appropriate controls, the cultivation of GM oilseed rape will see EU labelling thresholds surpassed with the movement of GM traits across production systems.

Obtaining reproducible field-based spatial and temporal gene flow experimentation at a landscape level is logistically and economically unfeasible. An alternative is to employ a spatial model (e.g. GeneSys) which can simulate the movement of a GM trait via seed and pollen over diverse landscapes through multi-year rotations against varied farm management practises. The objective of the project was to employ GeneSys to develop an Irish-specific management strategy for both policymakers and potential early adopters of GMHT oilseed rape in Ireland. In addition, a parallel economic analysis would determine the cost-effectiveness of individual measures and also complete an adoption factor analysis.

2. Questions addressed by the project:

- Can existing crop management regimes be employed to maintain the effective coexistence of GM and non-GM oilseed rape crops?
- What additional crop stewardship measures could be adopted to facilitate the efficient segregation of GM material from neighboring non-GM oilseed rape cropping systems?
- What is the impact on coexistence thresholds of forming regional clusters of GM oilseed rape fields?
- What factors influence the decision of Irish farmers to adopt GM technology should they be given a choice in the near future of selecting between GM and non-GM varieties of crops?

3. The experimental studies:

The gene flow model Genesys was adapted to the Bridgetown landscape of Co. Wexford. A digitised map of Bridgetown, was created from a suite of aerial photographs and consisted of 607 cropped fields and 58 no-vegetation areas (roads, farms. . .). Borders (mainly hedgerows) along roads and fields were added manually. Briefly, the GeneSys input variables include (1) the field pattern consisting of fields and semi-natural areas (hence "borders") where feral oilseed rape can grow; (2) the crop cultivated each year in each field; (3) the cultivation techniques used to manage each crop (tillage tools and dates, sowing date and density, herbicide efficiencies and application stages, mowing dates, efficiency of mechanical weeding, harvest date) and (4) the genotype of the OSR varieties. These input variables influence the annual life-cycles of cultivated, volunteer and feral OSR populations.

The impact of six crop rotations was assessed for three possible GM adoption levels (5%, 15% and 30%) across the landscape. Additional scenarios examined included; enhanced weed management strategies, impact of isolation zones and the grouping of GM fields into 'GM clusters' to facilitate coexistence management.

For the adoption factor analysis, datasets from the 2006 National Farm Survey were employed, representing 841 farmers, which represents a population of 82,091 farmers using a weighting system representing size and system of production.

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4. Main results:

For a 5% regional uptake of GMHT oilseed rape, the introduction of such a GM crop into a standard winter wheat rotation (e.g. Year 1 GMHT oilseed rape, Year 2 winter wheat, Year 3 winter wheat, Year 4 winter wheat) with no additional modifications resulted in a mean of 17% of non-GM fields exceeding the 0.9% food labelling threshold and thus being discarded from the non-GM food chain. If the GM adoption rate increased through 15% and 30% the percentage of non-GM oilseed rape fields that would exceed the EU coexistence threshold rose to 50.04% and 89.18%, respectively.

The degree of contaminated non-GM oilseed rape fields dropped significantly with the substitution of spring barley (or maize, potato) into year 3 and year 4 of the rotation. Also, increasing herbicide efficiency (to 99%) or the number of herbicide applications (×2/growing season) significantly reduced the levels of regional harvest contamination at either of the three GM adoption levels, but as expected this led to a substantial increase in farmer costs.

The effect of clustering the cultivation of GMHT oilseed rape into 'de facto' GM zones substantially reduced the average level of harvest pollution across the landscape (5% regional adoption), as the size of individual clusters increased. By increasing the size of each cluster but decreasing the number of clusters, the level of harvest impurities for the 10% GM adoption level was significantly reduced below the food labelling 0.9% threshold, compared to the non-clustering control treatment.

The inclusion of a 50m buffer zone in which no oilseed rape was cultivated around each cluster had the greatest impact of all treatments considered in the study. Irrespective of the cluster arrangement, the level of harvest impurities did not exceed 0.2% (for 5% GM uptake), implying that the combination of this spatial arrangement with reasonable isolation distances presents a powerful method to limit the potential for gene flow from GMHT oilseed rape. This was reflected in the % of fields with harvest impurities in excess of 0.9%, which in the absence of clustering was simulated at 17.24% at GM adoption level of 5% across the landscape. A combination of clustering and buffer zones reduced this 50-fold.

The adoption factor analysis concluded that farmers likely to be early adopters of GM crops will be those with large farm acreage who are specialist crop farmers and who have formal agricultural education and access to high-quality soils. This result is in accordance with similar ex-post adoption studies on Bt and HT corn adoption in the United States.

5. Opportunity/Benefit:

Using a landscape modelling system, this research is the first study to identify Irish-specific agronomic measures that could facilitate the development of a coexistence regime for GM and non-GM oilseed rape crops. This will be of benefit to policy makers, regulators, tillage farmers and the general public at large.

6. Dissemination:

Main publications:

Keelan, C., Thorne, F., Flanagan, P., Newman, C. and Mullins, E. (2009). 'Willingness to Adopt GM Technology at Farm Level'. AgBioForum, The Journal of Agrobiotechnology Management and Economics,12: 394-403.

Tricault, Y., Flanagan, P., Fealy, R., Colbach, N. and Mullins E. (2009). 'Towards an optimal management regime to facilitate the coexistence of GM and non-GM oilseed rape'. European Journal of Agronomy, 34: 26-34.

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