Produce for any market: coexistence of genetically-engineered and conventional alfalfa hay

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KEYWORDS:

GE Traits in Alfalfa and the Need for Coexistence

Genetically-engineered (GE) alfalfa became a commercial reality in the US beginning in 2005 with ‘Roundup-Ready’ (RR) alfalfa. A second trait was commercialized in 2014, the ‘HarvXtra’ reduced lignin GE trait. Both are products of Forage Genetics International. The RR herbicide tolerance trait confers the ability to control weeds with a broad spectrum over-the-top herbicide (glyphosate), while HarvXtra is a trait to lower lignin and improve alfalfa fiber digestibility. The HarvXtra trait stacked with RR is currently commercialized for planting in US, Canada and Argentina and approval is pending in other regions. To date, millions of hectares of GE alfalfa have been planted.

The major points of this paper are to put forward the propositions that 1) GE alfalfa traits are likely here to stay, and may include additional traits in the future, 2) Growers and buyers should have the ability to choose and successfully produce alfalfa for any market they wish, conventional or GE, and 3) That coexistence on the farm between those who adapt and those who reject GE crops is necessary and certainly feasible. Full discussion of these issues can be found at Putnam et al. (2016) and NAFA (2018).

Defining Coexistence. A recent USDA committee defined coexistence as ‘the concurrent cultivation of conventional, organic, Identity Preserved (IP), and Genetically Engineered (GE) crops consistent with underlying consumer preferences and farmer choices’ (USDA Task Force, 2012). Further, I would define successful coexistence as ‘The ability of diverse systems (GE, organic, non-GE) to thrive without undue influence of neighbors or resorting to extraordinary protection measures.” (Putnam et al., 2016). Coexistence is complicated by the possibility of gene flow which can occur between alfalfa fields and the possibility of unwanted low level gene presence. Attention to the biology of the crop and requirements of different markets are important to accomplish coexistence.

Markets Differ in Sensitivity to GE Traits

For many farmers, these GE traits represent a significant advance and opportunity to try new technology and to improve production efficiency. However, not all growers wish to adopt GE crops due to their personal preference or the sensitivity of their markets. Organic growers are required to use non-GE crops. Additionally, export markets may require non-GE crop products either due to regulatory barriers or market preference. Currently, in the US, less than 3% of alfalfa production is certified organic. However, it has been estimated that >12% of alfalfa production in the 7 western US States goes for export (less than 4-5% nationally). In the past 6 years, export hay has proved to be the major market sensitive to GE alfalfa, either in trace amounts or en total.

In 2006, I estimated market sensitivity to GE traits to be on the order of 3-5% of US alfalfa hay production markets (Putnam, 2006). However, due to the dramatic increase of export of alfalfa to China since 2006, GE Sensitive’ markets have likely increased, with higher sensitivities for areas dominated by export markets. For

export growers in western regions, planting decisions must be made for multiple markets (domestic and export), so the hectares impacted by this issue is greater than just the export quantity.

**Most Markets are non-sensitive.** It should be pointed out that the vast majority of the markets for alfalfa hay and forage in the US are not sensitive to GE presence, either as a trait *en total*, or in trace amounts as a low level presence in hay. US hay consumption is dominated by dairy and beef consumers, both of which have widely adopted GE crops as feedstuffs (e.g.>95% of corn and soy). Additionally, research has shown the RR trait in feeds to be safe for animal production (Van Eenennaam and Young, 2014). Currently over 9 billion animals are fed GE crops annually, accounting for up to 90% of the consumption of GE-crop phytomass in the US (Flachowsky et al, 2005; Van Eenennaam and Young, 2014). This represents a massive demonstration of feed safety and of the adaptation of GE crops in the animal sector.

**Defining Non-GE Alfalfa**

For the purposes of market assurance, a Non-GE alfalfa forage can be defined as: “Alfalfa or Alfalfa-Grass Mixtures that have been produced implementing Protocols for Non-GE Management Practices and the hay has been determined to be ‘Non-Detect’ using an appropriate sensitivity threshold.”

A definition of ‘Non-GE Alfalfa Hay’ is likely to be useful to those producing for sensitive markets. Because the current GE traits (RR and HarvXtra) have been determined to be safe for animal production (USDA-BRS), tolerance levels for low-level presence are determined by market or regulatory factors, not epidemiological factors. Several market categories regarding GE alfalfa can be described (Table 1). These include ‘GE Alfalfa’, non-sensitive ‘Conventional Alfalfa’ and alfalfa produced for GE sensitive markets with some level of sensitivity to low level presence (Non-GE alfalfa – Table 1).

**Low Level Presence.** Unwanted low-level gene presence (LLP) in otherwise non-GE hay can be a problem for sensitive markets. There are three potential sources of an unwanted low level presence of a GE trait in alfalfa hay. Each of these sources represents different levels of risks. These include 1. Gene flow, especially in

| Table 1. Definitions for GE- and non-GE alfalfa forage grown for markets of varying sensitivity. |

<table>
<thead>
<tr>
<th>Name of Crop Product</th>
<th>Type of Market</th>
<th>Non-GE Protocol Followed?</th>
<th>Tolerance Level for GE trait</th>
<th>Testing Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 GE-Alfalfa (currently RR or HarvXtra)</td>
<td>Non GE-Sensitive</td>
<td>No</td>
<td>Highly Tolerant (100% permitted)</td>
<td>Not necessary</td>
</tr>
<tr>
<td>2 Conventional Alfalfa</td>
<td>Non GE-Sensitive</td>
<td>No</td>
<td>Indifferent (no tolerance level)</td>
<td>Not necessary</td>
</tr>
<tr>
<td>3 Non-GE Alfalfa (Market Standard)</td>
<td>GE Sensitive Market-based or Organic Sensitivity</td>
<td>Yes</td>
<td>Varying LLP Tolerance at ≤0.5% to 5% or statement</td>
<td>QIS Test Strips or quantitative PCR*</td>
</tr>
<tr>
<td>4 Non-GE Alfalfa Hay (Regulatory Standard, ND &lt;0.1)</td>
<td>Regulatory Sensitivity (not legally permitted)</td>
<td>Yes</td>
<td>Strict LLP tolerance (generally ND ≤0.1%)</td>
<td>Currently PCR*</td>
</tr>
</tbody>
</table>

*ELISA QIS- Quantitative Immunoassay Strips and Polymerase Chain Reaction (PCR) can be used for desired level of detection. There may be ELISA tests with sensitivity at 0.1% and below available in the market, but generally PCR is preferred.
These risks can be mitigated by a series of management factors (see below and van Deynze et al., 2006, Putnam, 2016, and NAFA, 2018).

**Non-GE Alfalfa – Market Standard (organic or export)—Category 3, (Table 1).** For organic producers, or for buyers who simply don’t want the trait, the standard is a bit fuzzy. There is a demand for non-GE, but are no thresholds for LLP – it all depends upon the market. Some markets simply require a statement of non-GE status, others require testing. Organic rules do not define thresholds or testing. The same is also largely true for export buyers who don’t want GE traits but they are permitted by importing countries (e.g Japan). Some buyers rely on statements by growers, but most require routine testing, since significant alfalfa hay goes to China. The non-GMO Project (see [https://www.nongmoproject.org/](https://www.nongmoproject.org/)) defines a tolerance level for alfalfa seed (for the Non-GMO label) at 0.5%, and 5% for livestock feed and supplements (alfalfa hay).

**Non-GE Alfalfa-Regulatory Standard—Category 4.** This is the strictest threshold for LLP tolerance. Large volumes of exports to China has ushered in a new era of testing for low level presence (LLP). This standard is essentially zero tolerance, but is determined by the level of detection possible by the most sensitive method – PCR (typically <0.1%).

**The Impossibility of a GE-Free Designation.** To analytically and practically declare an agricultural product as ‘GE-Free’, containing none of a GE trait, is a technical and practical impossibility. In order to be 100% assured that a hay mass is ‘GE-Free’, every last gram of that mass must be tested, leaving none for its intended use. Thus, declaration of ‘Non-GE’ status is made within a definition of the threshold of tolerance, sampling protocol, implementation of a protocol to prevent unwanted gene presence, and recognition of the analytical limits of detection and the sampling method. For Category 4, this is typically non-detect at ≤0.1%, and thresholds varies for Category 3.

**A Combination of a Process-based and Testing Approach.** For those interested in satisfying a ‘non-GE’ market, I recommend a combination of a production protocol and non-GE hay testing. The management practices suggested below are a ‘process-based’ approach similar to that taken for certified organic production or certified seed.

**Protocols for Producing Non-GE Alfalfa**

The stewardship of both non-biotech and biotech traits within a region will depend not only on testing, but upon a range of practices, beginning with seed production and purity. Here are the most important aspects of a process for assuring non-GE alfalfa (more fully covered in Putnam et al., 2016 and by NAFA coexistence documents):

**I. Select Certified Cultivars for Seed Purity and Quality.** This is likely the most crucial step to assure trait purity in a hay product. Before planting, seed should be tested to the appropriate non-detection at a given level of market sensitivity (Table 1).

**II. Reduce Possibility of Gene Flow in Hay Fields.** There is some risk of gene flow in hay fields, but this risk is very small (Putnam, 2016, van Deynze et al., 2008). The greatest issues are distances to GE-fields, prevention of excessive flowering or seed, and removal of feral alfalfa from areas in close proximity to GE-sensitive alfalfa fields.

**III. Prevent Inadvertent Transfer of Hay During Harvest.** Clean balers and equipment when moving between fields to prevent mixing of bales which contain unwanted genes.

**IV. Identification of Non-GE Alfalfa Hay/Prevent Mixing of Lots.** Prevent the mixing of hay lots after harvest, maintain identity, and assure customers of that identity for either GE-containing or Non-GE alfalfa hay.

**V. Understand the Sensitivities and Tolerances of the Market.** The threshold of market or regulatory sensitivity must be determined (Table 1).
VI. Testing to Confirm non-GE status in hay. Testing for the presence or absence of a GE trait should be used in combination with process-based protocols (1-5) above. The limits of detection of each specific method, and the limitations of sampling should be considered when interpreting laboratory GE tests (Putnam, 2014).

VII. Cooperation with neighbors and between buyers and sellers. Working with GE-sensitive or GE-adapting neighbors to understand the risks of gene flow and neighbor influence is important, similar to cooperation on invasive weeds or pesticide drift.

SUMMARY

Coexistence strategies are a necessary and important component of successful production of both GE- and non-GE alfalfa hay, consistent with consumer preferences and a farmer’s right to farm. A number of farmers have produced both GE-sensitive (organic or export) and GE alfalfa hay successfully on nearby farms or adjacent fields. Communication and cooperation between farmers are important components of any coexistence strategy within a region. Common-sense steps for the production of non-GE alfalfa hay include primarily securing of non-detect (tested) seed, preventing accidental mixing of hay lots, and taking steps to prevent gene-flow between alfalfa fields. Market assurance can be further assured by hay testing to meet tolerance of a given market, but the limits of testing and sampling must be considered. A combination of production protocols and testing is recommended to satisfy sensitive non-GE markets.

BIBLIOGRAPHY:


