A Coexistence Plan
For
Alfalfa Hay in Eastern Canada

February 13, 2012

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1. Background

Canadian farmers benefit from a diversity of markets and an array of production methods are used to capture these markets. Coexistence plans establish guidelines and best management practices that, when followed, allow seed and crop producers to successfully establish and/or maintain the production systems that best serve their operations and their current and future markets.

This coexistence plan has been designed through a value chain process with a focus on alfalfa hay in Eastern Canada. Alfalfa is a cross-pollinated perennial crop that is grown throughout Canada. Although GM crops such as corn and soybeans have been grown in Canada for several years, there are no GM perennial crops or forages currently licenced for sale in Canada. However, alfalfa which has been genetically modified to be resistant to the glyphosate herbicide; Roundup® (Roundup Ready® Alfalfa) was given full approval for food, feed and environmental release in 2005 and the herbicide was approved for over-the-top use on Roundup Ready® Alfalfa in 2012. This product is therefore the closest to commercialization in Canada.

Ontario and Quebec comprise over 70% of Canada's dairy industry[1], which is the primary market for alfalfa hay and is the focus of interest for the commercializer of genetically modified alfalfa. This coexistence plan serves the potential introduction of GM alfalfa hay into Eastern Canada. **It does <u>not</u> serve GM alfalfa seed production or the introduction of any GM alfalfa to Western Canada.**

It is acknowledged that there are very strongly held views on both sides of the debate on GM alfalfa. This plan does not advocate for or against the commercialization of GM alfalfa. Nor does it favour one production system over another. This plan strives to anticipate the future. Its purpose is to identify clear practises that will allow all alfalfa hay production systems to be successful in Eastern Canada.

2. Principles of Coexistence

1. The goal of coexistence planning is to provide producers with freedom of choice and opportunity to pursue diverse markets.
2. Coexistence plans will be based on good communication and mutual respect between neighbours, individuals and companies who have opted for different approaches to production, to capture different market opportunities (e.g. organic, conventional and biotechnology)
3. Coexistence standards/practises/tolerances must be practical, achievable and economically feasible, and must be focussed on market opportunity. They are not meant to address health and safety of food, feed and the environment. This is the focus of regulation in Canada.
4. Coexistence plans are built on science based stewardship programs and tools for monitoring the efficacy of such programs.
5. Those who benefit from each system must accept the responsibility for implementing the practises required to achieve a coexistence standard.

3. Alfalfa Hay Production Systems in Eastern Canada

A. Organic alfalfa hay production in Eastern Canada

Agricultural products in Canada must be certified in order to be labelled with the word "organic" or to carry the Canada Organic logo. The regulatory requirements for organic certification are outlined in the Canada Agricultural Products Act, Organic Products Regulations, 2009 (SOR/2009-176). For all organic crop production systems, the requirements are stated in CAN/CGSB-32.310-2006 (Organic Production Systems - General Principles and Management Standards) which includes:

- Designating land use to include buffer zones or other physical barriers to prevent contact with prohibited substances
- Minimizing the physical movement of prohibited substances from neighbouring areas onto organic farmland and crops
- Maintaining the fertility and biological activity of soil through crop rotations practices such as plough-down, legumes, catch crops or deep-rooting plants
- Managing crop pests, weeds and disease centred using cultural practices and mechanical techniques, while also adhering to CAN/CGSB-32.311, Organic Production Systems – Permitted Substances Lists
- Using organic seed and planting stock, except In cases where organic seed is not commercially available. In these cases, non-organic seed may be used as long as it is untreated or treated with allowable substances

Organic regulations contain a zero tolerance to any genetically modified (GM) materials and products in Canadian certified organic crop production. The Organic Production Systems -General Principles and Management Standards[2] states:

1.4.1 When producing or handling organic products, it is forbidden to use any of the following substances or techniques:

a. all materials and products produced from genetic engineering as these are not compatible with the general principles of organic production and therefore are not accepted under this standard, except for vaccines only that have been grown on genetically engineered substrates but are not themselves a product of genetic engineering, as specified in CAN/CGSB-32.311, Organic Production Systems – Permitted Substances Lists

In order for a product to be certified as organic in Canada, a federally accredited certification body must verify that the production and processing of the product complies with all of the Canadian Organic Standards.

Production of Organic Hay - In Canada, the production of organic alfalfa is estimated to be 2.4% of total alfalfa production[3]. Exact acreage of organic alfalfa production in all of Eastern Canada could not be obtained, but several pieces of data can be used to estimate production. The breakdown of organic forage production in Ontario is shown in Table 1. The total acreage of organic alfalfa and other forages in 2010 was 17 703 hectares, which is 1.4% of the total alfalfa acreage in Ontario[4]. Although not a large portion of the total alfalfa production area, organic alfalfa production is an important sector in some areas of the province.

Table 1: Area of certified organic forage production in Ontario in 2010

Land use	Acres	Hectares
Hay/pasture	33 499	13 556
Pasture	2 408	974
Hay	3 935	1 592
Green manure/plowdown	3 516	1 423
Total organic forages Ontario	43 745	17 703

Source: "Certified Organic Production Ontario 2010" by Anne Macey for the Organic Council of Ontario. Data was compiled from certification bodies throughout the province. Numbers have been rounded to the nearest whole number.

In Quebec, the total acreage certified for organic crop production in 2010 was 42 492 hectares, with an average organic farm size of 68.95 hectares[5]. These numbers are quite similar to the organic sector in Ontario in 2010, which had a total acreage of 49 911 hectares and an average organic farm size of 72.86 hectares[4]. Based on the similarities in the average farm size and the total organic acreage, it is estimated that the production of organic alfalfa in Quebec is in the same order of magnitude as Ontario organic alfalfa production. In 2009, Atlantic Canada had a total 153 certified organic farms with 8 076 hectares of total farmed land[6].

Uses of organic alfalfa hay - The predominant use of organic alfalfa hay is feed for organic livestock production, either as dry hay, silage or pellets. Alfalfa is also an important green manure or plow down crop in organic crop rotations. Organic hay is processed into soil fertility amendment pellets and alfalfa leaves are also marketed as a health food product or dietary supplement.

Current and potential markets for organic alfalfa hay - The number of acres in certified organic production in Quebec rose dramatically between 2006 and 2008, but remained constant for the period 2008-2010[5]. Similarly, the number of certified organic farms in Ontario rose dramatically between 2002 and 2007, but remained relatively unchanged for the period between 2007 to 2010[4].

The largest market for organic forages in Ontario and Quebec is organic dairy feed, and so the future market for organic alfalfa hay depends largely on the demand for organic milk products. The amount of organic milk produced in Ontario rose from 45000 hectolitres (hl) in 2000 to 255768 hl in 2010, but with surplus production in some areas of the province, organic dairy production in Ontario is not expected to grow in the near future[4]. In 2011/2012, Atlantic Canada produced 1% of the organic milk in Canada, but this number is expected to grow as more producers become certified[6]. The global organic dairy product industry, valued at $7 billion in 2009, is expected to expand with increasing demand in emerging markets such as Brazil, China and India[7].

B. Conventional alfalfa hay production in Eastern Canada

Production - Alfalfa and alfalfa mixes account for 15% of the total crop land in Eastern Canada, excluding pasture[1]. Although Eastern Canada produces less than 20% of the alfalfa in Canada[1], the value of the hay industry is Eastern Canada is estimated to be $1.2 billion[8]. Table 2 shows the acres of land in Eastern Canada devoted to alfalfa and other forages.

Table 2: Area of alfalfa and other forages in Canada

Land use	Canada		Eastern Canada		% of total acreage located in Eastern Canada
	acres	hectares	acres	hectares	
Alfalfa and alfalfa mixtures	11 230 105	4 544 662	2 130 579	862 215	18.97%
Irrigated alfalfa, hay & pasture	550 260	222 682	2 495	1 009	0.45%
Tame or seeded pasture	13 671 483	5 532 652	1 080 175	437 141	7.90%
Total	25 451 848	10 299 996	3 213 249	1 300 365	

Source: Statistics Canada. Census of Agriculture 2011.

Uses of conventional alfalfa hay - Alfalfa hay is premium forage for dairy cattle and horses. Typically, 85-90% of alfalfa hay is fed to on-farm livestock, 5-10% is destined for farm-to-farm sales, while 5% is sold for export[9]. Alfalfa is generally fed in the form of hay or silage, but can also be used as a pasture crop, or processed as alfalfa pellets or cubes. Alfalfa is also used in crop rotation to improve soil structure and add fixed nitrogen to the soil.

Current and potential markets for conventional alfalfa hay and hay products: Processing - There are two types of alfalfa hay processing: alfalfa dehydration and hay compaction. Processed products include dehydrated alfalfa meal and pellets, sun-cured alfalfa pellets, alfalfa cubes, and compressed bales of alfalfa or mixed hay. Most processing facilities concentrated in western Canada, but some processing done in eastern Canada (specifically Ontario, Quebec and New Brunswick). A 2010 report estimated the number of processing facilities in Eastern Canada as follows: Ontario – 1 low density press, 1 cuber and 1 pelleter; Quebec – 1 double compressor, 2 low density press and 1 pelleter; Maritimes – 1 pelleter.[10]

Current and potential markets for conventional alfalfa hay and hay products: Domestic - In Eastern Canada, the primary markets for alfalfa hay are the dairy industry, the horse industry, and other livestock, such as beef cattle, dairy goat and sheep. Each market has different requirements for hay quality. The dairy industry prefers nutrient quality over quantity, while the horse market prioritizes mould-free and dust-free hay. Alfalfa hay may potentially be used as a source of biomass to supply the domestic and EU markets for biomass pellets for combustion. Future markets may also include the use of alfalfa biomass for incorporation into plastics and other bioproducts.

Current and potential markets for conventional alfalfa hay and hay products: Export - Alfalfa hay is generally exported as dehydrated meal, pellets and cubes or compressed bales. The hay export market accounts for approximately 5% of Canada's forage export market. Japan and the United States comprise Canada's main export market, followed by several smaller markets (Figure 1). A recent study indicated that in 2011, less than 50,000 tonnes of the 5.4 million tonnes of hay produced in Ontario were exported. (Less than 1%)[11]. The export market in Ontario and Quebec is predominantly for Eastern US dairy and equine markets, Florida equine market and EU markets. The export market for conventional hay in Atlantic Canada is predominantly for the French Islands, Saint Pierre and Miquelon.[10]

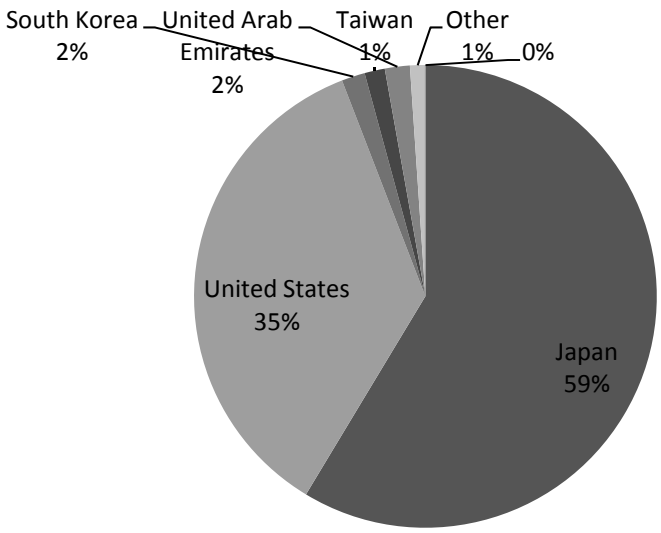

Figure 1: Major forage export market for Canadian hay (2009). Data source: Statistics Canada 2010.

The first export of Canadian forage to China occurred in 2012, and demand for imported forages in China is expected to grow as China's dairy production grows. Most exports of hay to Asia are from Western Canada because of the large transportation advantage that Western producers have to Asian markets.

The Middle East is also expected to increase forage imports as domestic production decreases because of water restrictions. The Middle East may be a potential market for hay from Eastern Canada. Export to markets in Europe is not as lucrative, as the price per tonne is lower.

Of Canada's forage export markets, there is varying tolerance for GM technology. The EU has a zero tolerance policy for non-approved GM seed, while the Roundup Ready® trait is approved in both the United States and Japan. Despite its regulatory approval, some export customers may have different requirements for the presence of GM material in hay. Some producers at the coexistence workshop indicated that their export customers specifically request GM-free hay.

C. Genetically Modified Alfalfa Hay production in Eastern Canada

Production of GM alfalfa hay - No GM alfalfa varieties have been registered for sale in Canada. In 2011, a few small demonstration trials of Roundup Ready® alfalfa (RRA) were grown in Ontario and Quebec to evaluate the suitability of GM alfalfa for the dairy forage market.

Uses of GM alfalfa hay - The first product being considered for release in Canada, Roundup Ready® Alfalfa (RRA), allows for weed control in alfalfa stands by the application of Roundup® herbicide over the top of alfalfa. The uses of GM hay are the same uses as conventional hay, namely: dairy, horse and other livestock feed. The potential uses of Roundup Ready® hay are anticipated to be the same as conventional potential markets, livestock feed, processing and biomass.

Other biotechnology traits are currently in the pipeline; for example, a GM reduced lignin alfalfa variety has been developed by Forage Genetics International. Reducing the lignin content in alfalfa increases fiber digestibility, and this and other new GM varieties may permit new uses for alfalfa hay in Eastern Canada.

Domestic and export approval status - Regulatory approvals for the importation of RRA feed and/or food purposes has been granted by Japan, Canada, Mexico, Korea, Philippines, Australia, the United States and New Zealand. None is required at the present time for feed import to Taiwan.

China currently does not allow importation of RRA, but approvals are in process. Several other importing countries (e.g., UAE, Saudi Arabia, Costa Rica) have no government approval process so regulatory approvals per se cannot be obtained for RRA at this time.

With the exception of the specialty livestock market sector (e.g., organic, grass fed, GM free), most Asian producers are currently importing and feeding other Roundup Ready and GM trait feedstuffs to their dairy and livestock. This includes corn, cottonseed, soybean, and several other GM products, primarily for livestock feeds. RRA does not differ substantially from these other products, since it contains the same gene.

Although there are no regulatory restrictions on the importation of RRA into Japan and several other major importing countries, export buyers have made decisions not to purchase RRA since its inception in 2005. Some have stipulated in their contracts that the hay be non-GM. Some importers have rejected RRA (or at least expressed preferences for non-GM alfalfa) due to concerns about the sensitivity of their markets.

4. The Biology of Alfalfa – Potential for Gene/Pollen Transfer

In order to ensure that producers have access to both GM-tolerant and GM-sensitive markets, genetic purity must be maintained. In order to understand the potential for undesirable gene flow of transgenic material into non-GM crops, the specific biology of alfalfa must be examined. This section describes the key aspects of alfalfa biology and examines their relevance to the establishment of a coexistence plan for the production of organic, conventional and GM alfalfa hay in Eastern Canada using a science-based approach.

Alfalfa Reproduction: Flowering and Pollination - Alfalfa seed is formed predominantly by cross-pollination and relies on insects to "trip" the flowers to release pollen.[15] Two of the five alfalfa flower petals form a "keel" that encloses the reproductive organs, and the disruption of these petals by pollinating insects causes the stamens to be released from underneath the petals and pollen is released[12]. Tripping the flower also causes a membrane on the stigma to break, permitting fertilization[13]. Alfalfa has varying degrees of self-incompatibility, and self-fertilization may occur, although this typically results in fewer and less competitive seeds than cross-pollinated cases.

Because of the alfalfa floral structure, alfalfa requires an insect pollinator to visit each flower. Wind alone cannot act as a pollinator[12]. Gene flow from a GM crop would require the insect-mediated tripping of a GM flower and the subsequent carrying of that pollen by an insect, by wind, or by other means (such as adherence to machinery) to a susceptible non-GM alfalfa plant. This pollen flow still does not equal gene flow, as the GM pollen would have to successfully land on a female floral pistil, fertilize the ovule, and produce seed.[15]

Alfalfa Seed: Hard Seed and Autotoxicity – In the Eastern Canadian environment**,** post-fertilization, alfalfa requires 6 to 8 additional weeks to develop viable seed, depending on growing conditions and varietal differences.[15] Alfalfa seed is contained in a coiled, non-shattering pod. Seed dispersal is local and not likely to be dispersed by the wind. Seed dispersal by animals feeding on ripe pods is possible. As managed hay fields are generally harvested long before seed maturation, dispersal of seed by animal feeding is unlikely to occur in the context of GM-alfalfa hay fields.

For harvested alfalfa seed, a portion of every lot is considered "hard seed" which displays post-harvest dormancy. This hard seed may remain dormant after planting, but can often subsequently germinate in field conditions, and may represent a source of volunteer alfalfa plants in following crops. The appearance of GM alfalfa from hard seed in a field's following crops is a topic for best management practices.

The phenomenon of autotoxicity refers to the release of compounds by an alfalfa plant and alfalfa debris that prevent the germination of alfalfa seeds in close proximity to an existing alfalfa stand. This autotoxic effect has implications for alfalfa best management practices with regards to feral populations, as seeds produced by feral plants would experience low germination rates due to the autotoxic compounds produced by the feral stand.

Alfalfa Populations: Cultivated and Feral Populations in Eastern Canada

There are no known wild relatives of alfalfa that may cross-pollinate with cultivated alfalfa, however one potential source of gene transfer is through the cross-pollination from GM plant pollen with feral alfalfa in roadsides or ditches. In Eastern Canada, few alfalfa plants are found outside of the field, and feral alfalfa is not expected to be a major risk for GM gene flow[8]. In addition to the relative scarcity of feral populations, alfalfa is not a good seed producer in Eastern Canada and auto-toxicity would prevent feral/GM alfalfa seedling establishment. Another potential source of GM pollen is volunteer alfalfa in the crop following a GM-alfalfa crop. Because hay fields are harvested pre-bloom or in early bloom, it is unlikely that that a mature viable seed would be produced from a GM hay crop. Volunteer plants may result from delayed hard seed germination as described in the 'Hard Seed and Autotoxicity' section above, or from the re-growth of the previous alfalfa stand. The management of volunteer alfalfa using best practices should be considered in coexistence planning.

5. Routes To Unintended Low Level Presence Of GM Alfalfa

There are several ways the Roundup Ready trait could occur as low level presence (LLP) in conventional alfalfa hay. These could be from seed co-mingling during planting of a hay crop, pollen flow during hay production, rotation of a non GM crop after production of a GM alfalfa crop, and inadvertent mixing of GM alfalfa and conventional hay during harvest, transportation, and storage. Of these, a low level presence in seed and the possibility of mixing hay after harvest are clearly the most likely routes to LLP (and the most easily addressed). Adventitious presence due to pollen flow and crop rotation problems are less likely sources of LLP due to a range of biological factors.

6. Mitigating the Risk of Low Level Presence

GM traits may enter non-GM alfalfa hay production in Eastern Canada through the following:

- Seed mixing before, or during, planting
- Pollen flow and subsequent gene flow during production
- Volunteer GM-alfalfa in a non-GM alfalfa field
- Mixing of GM and non-GM hay during harvest, storage and/or transportation

Because alfalfa hay is comprised of the vegetative portion of the plant, and not the seed, the movement of transgenes through pollen-flow is unlikely to occur in the context of alfalfa hay grown in Eastern Canada. However, best management practises (BMPs) can further reduce the probability of gene flow from GM to non-GM alfalfa and further reduce the unintended release of GM traits resulting from handling, storage and transportation processes. Detailed best management practises (BMPs) should be developed in each of the following categories.

A. Preventing LLP at Planting

- Choose a seed variety which does not contain the GM trait
  - obtain certified seed of a conventional variety from a reputable supplier
- Planting equipment should be cleaned and free of any unknown alfalfa seed.
- If production is for a non-GM market, It is recommended that seed for planting be tested for the GM trait prior to planting, either by the seed company or the producer
- It is recommended that seed suppliers require the return of unused GM seed

B. Reducing the Risk of LLP from Gene Flow

- Communication between producers to assess the distance to neighboring GM alfalfa fields
  - Consider GPS tracking
- Control flowering alfalfa on the edges of fields and in ditch banks
- Harvest before significant flowering or seed pod formation
- In cases where feral populations have been identified, mowing of roadside populations is an effective method to control seed production.[14]

C. Preventing Volunteers from a Prior GM Crop

- Treat volunteers as weeds in subsequent crops
- Crop rotation with non-alfalfa crops (years of separation)

D. Preventing Mixing during Harvest

- Assure that swathers, rakes, balers, wagons etc. are free of partial bales or stems of hay
- Consider eliminating the first one or two bales when collecting non-GM hay if the equipment has previously been used in a GM fieldMonitoring of compliance

E. Preventing Mixing during Handling and Storage

- Label GM Hay Lots
- Consider testing hay lots
- Physically separate hay lots for transportation and Storage

F. Monitoring and Compliance

- Formalized compliance monitoring – in contracts and stewardship agreements for GM alfalfa and for organic production.
- Clear corrective action for noncompliance.

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