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Economic Implications of Low-level Presence in a Zero-Tolerance European Import Market: The Case of Canadian Triffid Flax

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Triffid is the name given to a genetically modified (GM) variety of flaxseed that was developed in the late 1980s at the University of Saskatchewan's Crop Development Centre. The variety was designed to thrive in soil containing residues from sulfonylurea-type herbicides and offered greater weed control options to flax growers. In 1998, Triffid received Canadian and American feed and food regulatory approvals and entered a seed multiplication program. The following year, Europe threatened to stop importing Canadian flax should GM flax enter into commercial production. By April 2001, Triffid was deregistered and all remaining seed was supposedly destroyed. However, in late 2009, Triffid flax was unexpectedly detected in EU food products and in subsequent flax imports into Europe from Canada. In response to this, the EU immediately halted Canadian flax imports.

This article documents Canadian costs of the Triffid flax issue as an example of low level presence (LLP) of an unapproved transformation event in a zero-tolerance European market. It explores/evaluates the impacts (economic and social costs) on the Canadian industry—including the development of a stewardship program and testing protocols, the engagement and relationship strategies utilized in negotiations with the EU to resolve market access, and the overall industry response to the issue (from producers to exporters).

The article presents survey responses from more than 270 Western Canadian flax farmers. This survey data provides new insights as to how farmers manage LLP on-farm. The production attributes that are examined range from field agronomics to ability to export. Specifically, it examines how farmers have dealt with flax, in terms of production and sale, since the Fall of 2009. Detailed analysis is provided for the following supply chain components: on-farm testing, carryover costs, and opportunity costs. Finally, the article provides some insights as to who farmers trust in terms of communicating information to them on how to best manage this situation.

Key words: flax, genetic modification, international trade, low level presence.

Introduction

Common flax (*Linum usitatissimum* L.) was one of the first crops cultivated by man. There are two types of flax produced—seed flax for oil and fiber flax for the stem fiber. Fiber flax has an average annual global production of 500,000 hectares and is predominantly grown in China, the Russian Federation, and in Western Europe. Approximately 3.5 million hectares of oilseed cultivars (also referred to as 'linseed') are grown in Canada, India, China, the United States, and Argentina. Flax is used in the production of various industrial products including linen, fiber composites, paints, inks, and linoleum. Over the past several years, flax has grown in popularity as a nutritional supplement for its value as an essential fatty acid for both human and animal consumption. It is often consumed raw or is used in whole-grain products such as cereals and breads.

Other than a few brief intervals in the 1960s and 1970s, Canada has been the global leader in flax production, followed by the United States, China, and India. Flax production in Canada ranged from a low of 500,000 tonnes to nearly 1.1 million tonnes in the past decade, with an average of 900,000 tonnes between 2005 and 2010.[1] Only a small portion of that is con-

1. *Production data and average are based on data from the Flax Council of Canada's website: http://www.flaxcouncil.ca/english/index.jsp?p=statistics2&mp=statistics.*

Table 1. Review of regulatory decision for GM flax.

Risk analysis factors	Crop Development Centre's 'CDC Triffid'
Start of field trials	1989
Novel trait	Tolerant to soil residues of sulfonylurea herbicides; kanamycin (antibiotic) resistance; production of nopaline
Invasive potential	Substantially equivalent to non-genetically modified flax
Gene flow to weedy relatives	No wild relatives in Canada that can be freely hybridized with
Impact on non-target organisms	No observed effects
Biodiversity	The presence of nopaline in plant tissue may contribute to the enrichment of *A. tumefaciens* (a soil bacterium), but this enrichment should not have a negative impact on the rhizosphere
Decision	Unconfined release

Source: CFIA (1998)

sumed domestically, averaging about 15% per year, with the export value averaging over $200 million CAD. Canada's export markets include the United States, China, Japan, Australia, Mexico, the United Kingdom, and Brazil. By far, though, Canada's largest export market for flax is Europe. More than 70% of Canada's production is exported to Europe each year. However, the European Union (EU) maintains a zero-tolerance policy for genetically modified (GM) crops.

Given Canada's dominance as a global flax producer, private and public investments have been made into developing cultivars that enhance both productivity and oilseed quality. Transformation processes used in development include conventional breeding techniques as well as mutagenesis. Triffid flax is a GM flax variety designed to be resistant to soil residues of sulfonylurea-based herbicides. The flax variety was developed for environmental purposes, to provide growers with an alternative to continuous cropping of wheat and other cereals. This article tracks the history of Triffid, from its development at the Crop Development Centre at the University of Saskatchewan in the late 1980s to its deregistration in 2001 and, most recently to Triffid's discovery in the EU food supply chain.

The following two sections provide the background to the development and detection of GM flax in Europe. The subsequent section provides the details on the development, containment, and removal of GM flax in Canada. The third section discusses the 2009-2011 period, which was when GM flax was detected in Canadian flax exports to Europe. The economic impacts of Europe's zero-tolerance policy are presented, drawing upon the results of a flax producer survey undertaken in Canada in the spring of 2011. Finally, some concluding thoughts are offered.

Background of Genetically Modified Flax to 2001

The Crop Development Centre (CDC) at the University of Saskatchewan conducted research on several varieties of transgenic flax and after several years of field trials, selected variety FP967 to submit for registration to the Plant Biotechnology Office[2] (PBO) of Agriculture and Agri-Food Canada in February 1994. This variety is more commonly known by its marketing band name of CDC Triffid. In May 1996, the PBO approved CDC Triffid since it was found to be substantially equivalent to conventional flax varieties for environment and health concerns (Table 1). However, at the time, CDC Triffid only received approval for animal feed use. A split-run decision was made with GM flax, which made it approved only for animal feed or industrial purposes (McHughen, Rowland, Holm, Bhatty, & Kenaschuk, 1997). Health Canada had not given approval for CDC Triffid flax to be marketed for human consumption. Full variety release was approved by the Canadian Food Inspection Agency (CFIA) in 1998.

The implementation of the 1998 EU moratorium on GM crops and foods presented a formidable obstacle to the Canadian flax industry. Approximately half of the flax production in Canada at the time was being exported to Europe and the commercialization of a GM flax variety alarmed the European importing firms. While the canola industry was able to effectively identity preserve their GM varieties and continue to supply the European and Japanese markets from 1995-97 (Smyth & Phillips, 2001), the flax industry did not have

2. *The PBO was the forerunner to the Canadian Food Inspection Agency, which was the agency that was created when the PBO moved out of the Department of Agriculture and Agri-Food Canada in 1997.*

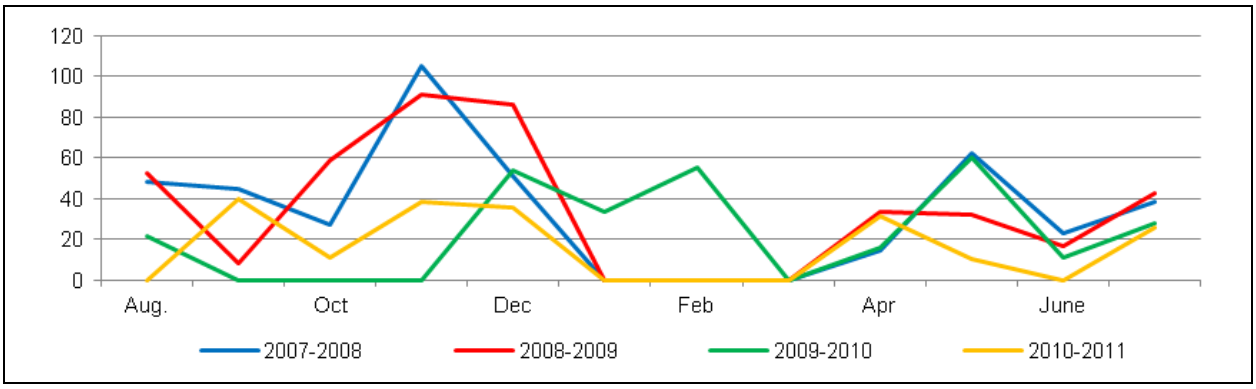

Figure 1. Month-over-month flax exports to the EU (000s tonnes).

Data source: Canadian Grain Commission database, available at: http://www.grainscanada.gc.ca/statistics-statistiques/ecgwf-egcfb/ecgm-megc-eng.htm.

Note: Some of the December 2009 exports were able to be shipped through the St. Lawrence Seaway, but much of this month's exports, as well as those of January and February 2010, were either railed to the port of Montreal and exported or exported through the West Coast of Canada, substantially adding to the export costs in Canada.

this option because of the dominant role of the European market. European importers were adamant that they would halt flax imports from Canada if GM flax was grown commercially.

Varietal registration (which allowed for seed multiplication but not commercial production) was granted in May 1996, and pedigreed seed production was initiated. Seed multiplication continued in 1997, and by the end of the 1997 harvest, there was an estimated 5,000 tonnes of pedigreed CDC Triffid seed in existence in Canada. That year turned out to be the final year for multiplication of GM flax. At that point, existing seed stocks of CDC Triffid were identified and contained in separate grain bins in compliance with pedigreed-seed production regulations.

In late 1997 and early 1998 it became apparent to the Canadian flax industry that the proposed (at that time) EU moratorium on GM crops would proceed. The Flax Council of Canada (FCC) initiated discussions about how to handle the situation. The Council determined that all of the existing contained seed stocks would remain that way until a suitable location could be found to crush the flax seed. Coordinated by the FCC, a CanAmera Foods crushing plant in Manitoba was ultimately contracted to crush the flax. The resulting flax meal was mixed into livestock feed and fed to Canadian livestock, while the oil from the crush was diverted into industrial application. Any and all breeder seed stock held by the CDC was incinerated. This effectively removed all breeders' seed from pedigreed seed growers that were contracted to multiply the seed.

To ensure that CDC Triffid flax would not jeopardize future export markets, the developers of the variety applied to deregister the transgenic flax variety. This process was initiated in 2000, and by 2001 the CFIA had officially deregistered CDC Triffid flax. This meant that it was illegal to produce or distribute this variety anywhere in Canada but was not illegal to grow it. As agricultural history would write it, Triffid became the first transgenic crop technology to be withdrawn in Canada.

Varietal deregistration in 2001 represented an end to Triffid and any trade issues associated with GM flax. The Canadian flax industry believed that GM flax would no longer be an issue for them. Unfortunately, this was not to be the case.

The Re-emergence of GM Flax: 2009-2011

In July 2009, the EU reported that a Canadian shipment of flax had tested positive for the NPTII marker, indicating a GM event. At this point, it was assumed that GM canola or another GM crop variety had comingled in the shipment. However, by September 2009 the EU's Rapid Alert System for Food and Feed (RASFF) was notified by a German company that its bakery/cereal products had tested positive for Triffid.[3] Notification on the RASFF system is equivalent to an air siren going on in the EU—it is an incredibly effective communication tool. This notification in September was the first of more than one hundred over the next several months

3. *Please refer to the initial (full) notification recorded as RASFF 2009.1171 at: https://webgate.ec.europa.eu/rasff-window/portal/index.cfm?event=notificationDetail&NOTIF_REFERENCE=2009.1171*

that would report Triffid in bakeries, cereals, and other products made by companies throughout the EU.[4]

The Canadian seed-trade industry was quick to respond to the initial notification. Industry stakeholders—Flax Council of Canada, the CFIA, and the Canadian Grain Commission (CGC)—moved in quickly to try to mitigate the impacts of what threatened to close market access for Canadian flax producers. With winter approaching and the looming closing of the St. Lawrence Seaway, there was an impetus to ensure that markets opened before the winter freeze-up, usually sometime in December. This export option is not available for the three winter months of January, February, and March. Figure 1 shows the crop-year export figures for Canadian flax to Europe, highlighting the impact of Europe's zero-tolerance policy. When compared to the crop year just prior to the detection of GM flax, Canadian flax exports to Europe are down by 51%. As is evident, the final quarter of the calendar year is the peak export period for flax to Europe.

On October 19, 2009, the FCC and the CFIA met together in Brussels, Belgium, to work with the Directorate General for Health and Consumer Affairs (DG Sanco) and other EU stakeholders to develop a testing protocol to manage the situation in Canada (European Commission, 2009). The protocol, launched immediately in the Canadian market, quickly established a system of sampling (one test for every 5,000 bushels) and testing of flax stores. Samples that tested positive at levels greater than or equal to 0.01% for Triffid[5] would not be accepted for import into the EU market (FCC, 2009). According to James (2010), Canadian flax averaged a failure rate of 20% at EU ports during the last six months of 2009.

By early 2010—following much speculation—the source of the Triffid contamination was identified by the Flax Council of Canada as originating from two of the CDC pedigreed flax varieties—CDC Normandy and CDC Mons.

Speculation did not end there. There were also allegations that some seed growers had held back seed after deregistration in the hopes that EU policy and consumer opinion would change and the market could take advantage of this valuable flax variety. Additionally, the widespread low-level presence of Triffid flax across the Canadian growing belt was speculatively due to pollen or gene transfer. The notion of 'flow' and spread of flax seed, however, is much more complex than that. Flax primarily self-pollinates, so seed-mediated gene flow is probably a more important factor in terms of gene flow. There are two scenarios at work in seed-mediated gene flow. First, there is *persistence* of the cultivar (where it was previously grown). For growers that did not rotate for three years, volunteer flax may have *persisted* in fields, and this could potentially have included small amounts of volunteer Triffid flax. Second, there is seed mixing and movement by equipment (seeders, combines, trucks, etc.) that may account for *dispersal* of the GM flax seed in trace amounts. Flax seed sticks like glue when it is wet and exhibits static cling properties when it is dry. Both wet and dry, flax seed will inevitably stick to any manner of farm equipment. While great care is taken by the seed growers to prevent this, a few seeds can remain stuck in a combine or in seeding equipment. It only takes a handful of Triffid plants, combined with another flax variety, to produce as many as 1,000 seeds at harvest. This could quite easily account for the widespread low-level presence of Triffid across the flax-growing region in Canada.[6] Seed movement has many pathways and it is quite likely that all pathways outlined above accounted for the widespread low-level presence of Triffid (Hall 2012).

Testing was conducted on CDC Normandy and CDC Mons in January 2010, and both tested positive for Triffid at 0.01%. These two varieties—now both essentially obsolete—were withdrawn from the program, and seed stores were destroyed. By early March 2010, after extensive testing, extremely low indications of Triffid contamination were discovered on a limited number of other breeder seed samples of four other varieties: CDC Bethune, CDC Sorrel, CDC Sanctuary, and CDC Glas (FP 2300). These varieties tested positive at trace levels well below the 0.01% detection level. Rather than being withdrawn and destroyed, these latter varieties were reconstituted. Individual plants were tested for the presence of Triffid and those that are deemed Triffid-free were used as a seed source for the reconstitution process. The seed increase from this first step was sent to a partnering organization in New Zealand, where it was grown under confined conditions where flax has not been grown on the land for at least five to ten years.

4. *One hundred and eleven (111) notifications were filed with the RASFF between September 8, 2009, and January 18, 2011. A notification dated July 28, 2010 was qualified as a 'border rejection' by Finland.*
5. *No detection at a 0.01% level, 19 times out of 20.*
6. *There are unsubstantiated allegations that there was a sample that tested positive at 100%.*

Once cultivated, the seed was tested again to ensure that there was no detection of any transgene. Once the reconstitution process is completed (2012), the seed will be transported back to Canada for introduction into the foundation seed program and will be distributed to seed growers or to seed companies and multiplied. At this point, it will take another four years before the seed will be ready for distribution to producers.

As part of the requirements for the EU, and in keeping with the contractual obligations of the protocol, testing of Canadian flax is ongoing. In fact, testing is conducted repeatedly all along the value chain—from farm-held stores of flax to the elevator and at ports where flax shipments await export. Early results suggest a widespread but extremely low-level presence of Triffid in Canadian flax. As of September 2011, almost 26,000 tests have been conducted on more than 10,000 seed lots. Updated results are detailed further in the following section.

Evaluating the Economic Impacts of Triffid Flax

This article provides an overview of the results from a grower survey that was part of a three-phase study conducted in 2010-2011 in collaboration with the Saskatchewan Development Commission and funded by the Canadian Agricultural Adaptation Program (CAAP). Through the combined study,[7] we document the impact of the Triffid issue for Canadian producers and broader industrial actors. The grower survey, a key tool in our study, was administered in early Spring 2011 and was included, in hard-copy, in the scheduled circulation of the SaskFlax newsletter to approximately 8,000 members. We collected a total of 278 responses, six of which were deemed outliers and incomplete and were not included in the analysis. Thus, a total of 272 records/surveys were available for analysis. We qualify our quantitative results with qualitative information gathered through grower comments. These comments better illustrate/highlight complexities and provide insights into perceptions around management of the Triffid issue.

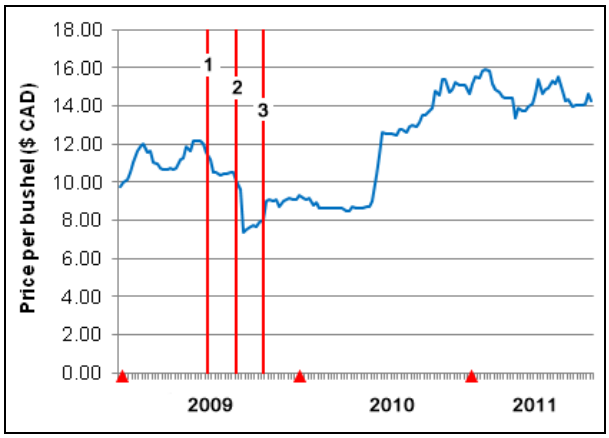

Figure 2. Flax prices (per bushel) by week (January 2009 to September 2011).
Source: Saskatchewan Ministry of Agriculture (2011)

Results from the Flax Grower Survey

The baseline grower survey information revealed that 92% of survey respondents identified themselves as 'conventional' growers, 5% as 'organic' growers, and 3% as 'other' growers. Of those that identified as 'organic,' 86% stated that they were exclusively organic producers. Data on farming location (by municipality) by respondents was sporadic, as only 43% provided this information. Thus, this data has not been included in the analysis.

Seed Source(s), Production, and Sales

When asked, more than 70% of the 272 growers surveyed indicated that they did not change their flax seed source after the Triffid issue began in 2009. Of those that did switch seed sources (n=66), we asked growers to qualify their response (check all that apply). Almost 75% indicated that they bought certified seed from a regular supplier; 25% no longer use farm-saved seed, and/or 17% used different farm-saved seed. As a result of the Triffid issue, 78% of our respondents indicated that the practice of saving farm seed has become more important to the grower and to farming operations:

> *"I am worried that the right to use your own farm-saved seed is being forced away from the producer. It is not a large corporation 'right' to be able to force these seed issues."*

As for sales of flax, 52 of the 272 total respondents (19%) indicated that the amount of flax that the grower sold in the 2009 crop year was reduced after the Triffid issue. Of those, 83% indicated sales were reduced by

7. *The study was comprised of a three-part methodology that included the administration of the grower survey, one-on-one interviews with industry stakeholders and the moderation of a focus group on the development of low level presence policy in Canada.*

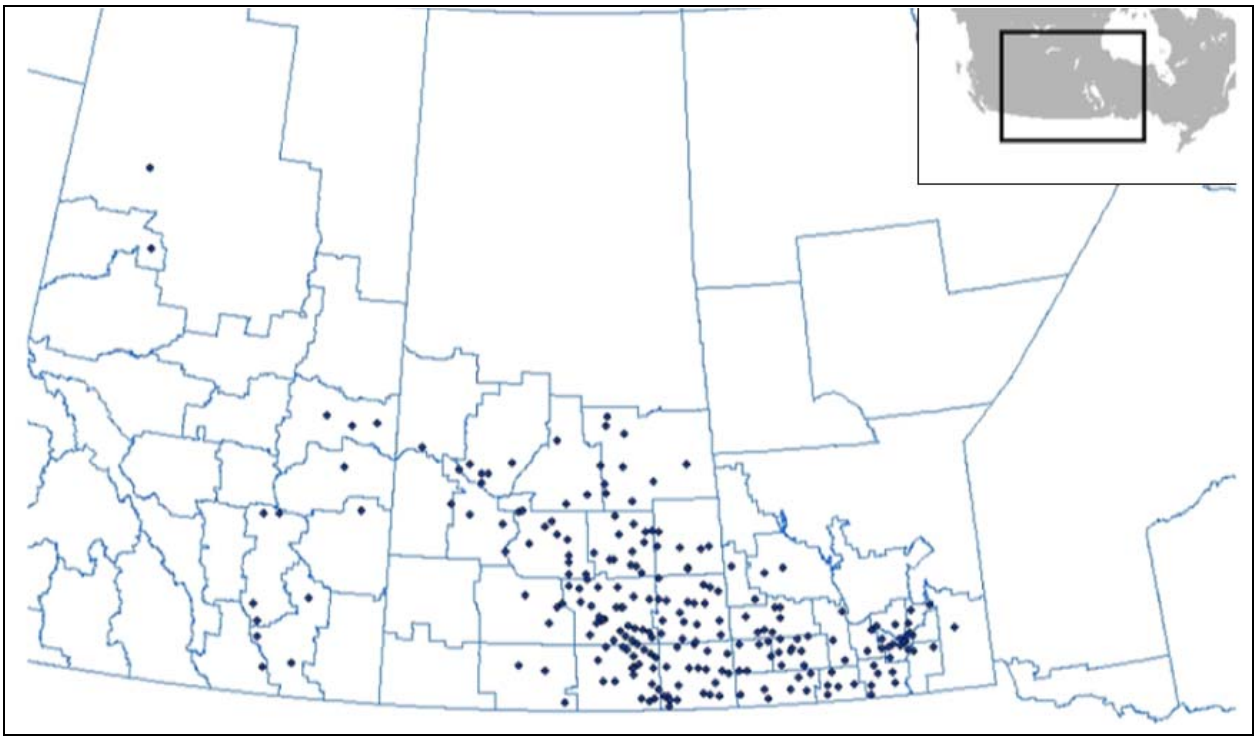

Figure 3. Positive tests plotted by Census Divisions.

Source: Map generated by M. St. Louis (University of Saskatchewan), and drawn-on data sourced from Flax Council of Canada and analyzed by E. Lamb (University of Saskatchewan).

50% or more. More than half of the growers (of the 52) lost 100% of their sales in the 2009 crop year.

Seventy-four percent of the survey respondents sold their flax to grain companies in the 2010-2011 year, while the remaining sold through brokers, processors, producers, or 'other.' For the most part, growers sold flax through the same channels as the previous year (other than 6% that stated otherwise).

Flax prices from January 2009 to September 2011 are charted in Figure 2, with key points in the Triffid timeline outlined. These points in time represent events that signaled changes in prices in the market. Fluctuations in flax prices follow an almost predictable pattern given key events as highlighted in the graph. Point 1 indicates the point in time where the NPTII marker was discovered in a shipment of flax at an EU port (July 2009). Point 2 represents the price point at the time that the notification of FP967 (Triffid) was registered to RASFF by a German company (September 8, 2009). Point 3 shows the point at which the DG Sanco/EU and the Canadian flax industry agreed upon, developed, and launched the Stewardship Protocol for sampling and testing flax. Market confidence appears to rise (with small fluctuations) in the following months into 2010, with a peak price at $15.91 by February 9, 2011. Optimism appears to have returned to the market.

Testing and the Stewardship Protocol

Since October 2009, there have been close to 26,000 tests conducted on more than 10,000 seed lots.[8] Results indicate that 0.0498% (n=548) of seed lots sampled (n=10,982) tested positive for Triffid. Figure 3 shows the results from April 2010, suggesting a widespread, very low-level presence of Triffid along the flax belt.

As of September 27, 2011, the FCC identified eleven labs in Canada and the United States approved for provision of these testing services. According to the FCC, these labs had "…successfully completed proficiency testing conducted by the Canadian Grain Commission (CGC)" (FCC, 2011, p. 1). At the height of the Triffid issue there was only one or two labs accredited by the CGC and available to conduct testing. This resulted in significant bottlenecks within the system, with samples wedged in the pipeline for up to a month at a time.

8. *Data was compiled by the Flax Council of Canada and sourced through the Crop Development Centre, University of Saskatchewan.*

Testing, as prescribed by the Stewardship Protocol, was complex to say the least. Sampling and testing was conducted throughout the value chain, which suggests duplication within the system. The rules changed periodically as well. For example, at one point, final samples were taken at the Canadian port directly before transport. The problem with this was that once test results were finalized (which could be as many as four days later), that ship—both figuratively and literally—had already sailed. This caused considerable problems for the shipments that tested positive as, in the case of their predecessors, they would be quarantined in port once they reached Europe. As a result, the FCC adjusted the protocol and implemented a 'pre-loading test' in lieu of the 'at-point-of-shipment test.' Despite continuous sampling and testing along the Canadian supply chain, there remains an unfortunate reality of the protocol and its endorsed processes: negative at origin does not necessarily mean negative at destination. In short, extensive sampling and testing offer no guarantees for the Canadian flax industry. This is reflected in derisive comments by growers as to the logic behind the protocol:

"I don't see the need to have flax tested in the Fall for sale and then the same seed tested in the Spring for seeding. That's a total rip off in my opinion."

The efficacy of the scientific test protocol was also challenged:

"I think the testing for Triffid is way over-priced and inaccurate. I have sent flax samples from the same lot twice and have received two results: one negative and one positive."

And:

"The tests are a joke. The same sample will first test positive and then test negative—at the SAME lab. The whole issue is an expensive joke."

Allegations that the tests were prone to false positives circulated early on during the Triffid issue. Recently, using a simple statistical approach on simulation modeling, Lamb and Booker (2011) explored the quantification of low levels of GM contamination. Results of their research indicate that GM contamination is likely present at extremely low levels in breeder seed lots and that levels are virtually indistinguishable from 0 given the potential rates of false positive tests.

Table 2. Grower response on testing: Samples submitted for testing (n=272).

	September 2009 to March 2010	April 2010 to April 2011
0	4%	12%
1	36%	34%
2 - 5	57%	53%
More than 5	3%	2%
Total	247	197

Our surveyed growers were queried about testing and costs incurred. Based upon the results outlined in Table 2, the overall number of samples that were submitted for testing in the most recent crop year (2010-2011) has, for this sample, diminished from the previous year (2009-2010).

When asked to estimate the costs for testing flax since Fall 2009, 55% of growers indicated an amount of less than $500 CAD. Twenty-nine percent said that testing costs were estimated in the $500 to $999 CAD range, while 11% of respondents sustained $1,000 CAD or more in testing costs.

Growers were asked why they submitted their samples to the testing facilities that they did, and many ranked grain handlers' recommendation as a highly important and influential factor, while awareness of the lab, distance and convenience, and price appeared to be less-important drivers for facility choice. Some grain companies and flax buyers will only accept certification from particular accredited labs. For example, Richardson International/Pioneer only accepted test results from Eurofins/GeneScan, Inc., or Quantum Biosciences, Inc. Navigating markets while managing decision-making in terms of samples and testing options added new levels of frustration for growers. One grower stated:

"[The grain company] didn't even ask to see test results—I think we have tested enough."

Despite having the testing protocol in place, growers questioned its ability to assist in meeting market requirements:

"The acceptable levels of Triffid are much too low. Even with rigorous testing there is no way of guaranteeing shipments will meet such very low tolerance levels."

In assuming the testing costs, it is not unforeseeable that growers would anticipate a reward for having Triffid-free certification. When asked, 74% of respondents stated that they did not receive a price premium or delivery advantage for having Triffid-free flax. Fifteen percent (15%) stated that they did receive some form of a premium, while the remaining respondents indicated that it was 'not applicable.' Comments from growers suggest that costs incurred were not reflected in market price obtained:

> *"If this Triffid thing is such a big deal,* why *is there not a difference in price of positive and negative tested flax?"*

And:

> *"Why are farmers on the hook for paying testing costs anyway? We didn't make Triffid flax."*

Also:

> *"I hate the added costs and inconvenience of Triffid tests, especially when a lot of our flax is marketed to the United States, where GMOs are not restricted."*

Perceptions Around the Issues of Management and Information

As previously outlined, the Canadian grain industry was quick to respond to the initial notification of Triffid flax in European food supply chains. Efforts were led and coordinated primarily by the Flax Council of Canada, with support from grain companies and the federal government.

When growers were asked who they thought were the primary actors that managed the Triffid issue, results were differentiated and scattered. This would indicate an overall lack of awareness of key actors involved in the issue. It was evident, however, that growers relied on key sources for information on Triffid as the issue developed. Most identified grain elevator managers, The Western Producer, and SaskFlax (website, communiqué, meetings, conference calls, personal contact) as key sources of information. Additionally, 73% of respondents stated that there was an adequate or more than adequate amount of information about Triffid and strategies to deal with the issue. Only 5% stated that the information provided was not acceptable at all. The remaining respondents suggested that information was less than adequate or responded with 'n/a.' When asked how growers preferred to be updated about the Triffid issue and others like it, most (63%) stated that newsletters (i.e., SaskFlax) were the information source of choice:

> *"I enjoy the SaskFlax grower newsletter. Very informative."*

Flax and Future Production

When asked if they would continue to grow flax, 63% of respondents stated that they *would* and would likely grow the same or more in terms of quantity:

> *"I have not grown flax for three years but plan to use certified seed next time and into the future as my seed source."*

Twenty-three percent said that they would continue to grow flax, only less of it; 9% of growers stated that they would abandon flax altogether. When asked what the primary reason was for choosing to grow less flax or not to grow flax at all, most cited market volatility as a detractor:

> *"We will only grow flax when the Triffid issue is gone and no testing is required before delivery. Testing is time consuming, costly, and a big hassle."*

Time and Other Costs

The complexities of the Triffid issue would suggest that, at the very least, growers' time would be diverted to other activities, including seeking out prices and alternate markets relative to other years. We queried the growers on this and responses varied to this question. Fifty-seven percent stated that they spent three hours or less on these activities, 17% stated that they spent three to eight hours on these other activities, while 25% spent a day or more. As a result of the Triffid issue, 78% of respondents indicated that the practice of saving farm seed has become more important to the grower and to farming operations.

As for carryover costs, growers were explicitly queried on this.[9] Many did not respond at all or indicated that they would "prefer not to answer" this question. As such, this data or information is underreported in our

Table 3. Total estimated costs associated with the Triffid event in Canada.

Cost category		Notes	Source
Demurrage/quarantine costs	$12,000,000[a]	As of September 2010	Authors' calculations
Testing costs	$3,900,000[b]	2009 to 2011	Authors' calculations
Cost of segregation and other costs for: breeders, certified seed suppliers, producers, grain companies, AAFC, and SaskFlax	$13,185,217	2009 to 2011	Dayananda (2011)
Total estimated costs	$29,085,217		

[a] *This cost estimate is calculated as follows: $30,000 CAD per day, which is equivalent to $1 million CAD per month. We conservatively estimate a total of 12 months with this level of costs.*
[b] *Based on the number of tests conducted (26,000) as reported by FCC and assuming a conservative (average) cost per test at $150, we estimate total testing costs (2009 to 2011) at almost $4 million CAD.*

survey results. Thus, we are unable to draw any conclusions on carryover costs.

Costs, in a context such as this, inevitably raise questions regarding liability. Although they were not asked directly, growers communicated their opinions about the issues of accountability and liability:[10]

> *"I feel like whoever introduced Triffid flax into the flax production system should be responsible for compensating farmers for the cost and problems incurred in production and marketing."*

> *"Growers did not cause this mess but have been told to clean it up. [Expletive] ridiculous!"*

> *"Why are plant breeders wasting time and money developing varieties that nobody wants? This should never have happened!"*

> *"We did not make the mess, but once again we are left holding the bag!!!"*

These comments (and others such as *"Tests are very costly and need to be spread across the rest of industry; not just farmers…"*) suggest that growers may not recognize the substantive costs borne by the grain companies and other stakeholders during the past several months. Once flax leaves the hands of the grower, the grain companies are wholly responsible for any costs incurred thereafter. Thus, all post-elevator quarantine and testing costs have been—and are—the responsibility of the grain companies. See Table 3 for an estimate of costs.

Other respondents point to the EU as the primary problem:

> *"Europe is playing unfairly. This is basically a way for them to practice protectionism within their flax industry. Can we make them realize that they may be hurting their own flax industry in the long run?"*

And:

> *"I think the Triffid issue is a joke and the markets that are causing this problem should be aggressively informed that their concerns are overblown."*

Also:

> *"The Triffid issue is nothing more that protectionism and artificial market manipulation. Zero tolerance is unrealistic and we need to get usable rules in place ASAP."*

The EU, too, sustained significant costs all along its value chain—calculated at more than $50 million CAD (COCERAL/FEDIOL 2011).

Conclusions

The Triffid issue represents an unfortunate turn of events for Canada's flax industry. A 'winter of discontent' turned into the 'perfect storm' of all that can go wrong with a transgenic crop variety in a zero-tolerance export market. Triffid has left many growers discour-

9. *QUESTION: Approximately how much flax carried over from previous crop years did you have in storage as of September 2009?*
10. *Quality Assured Seeds, originally formed in the 1990s through the merger of Value Added Seeds and Performance Seeds, was contracted by the University of Saskatchewan Crop Development Centre to propagate and distribute Triffid seed through its retail network. Quality Assured Seeds was renamed FarmPure Seeds in 2005 and went into receivership in 2008.*

aged. Prices have recovered, at least to some degree, which has settled some of the dissatisfaction. It was fortuitous for Canada's flax industry that China swooped in and bought up a majority of the flax in early 2010. This alone helped to offset some of the economic losses that the Canadian flax industry incurred. Some stocks were shipped to the United States during that time as well. In the meantime, Russia and the Ukraine have leapt in and increased production to service short supplies in the EU flax market. It is not surprising that Canada has lost some share to these two countries as a result. Linseed production in former Soviet Union countries is estimated to jump 45% to 480,000 metric tons in 2011 (Ruitenberg, 2011).

As time has passed, a certain amount of complacency around the Triffid issue has set in on the part of the EU. Despite this, there has been little to no resumption of exports into the food market, as Canadian growers just do not want to take the risk. The EU's industrial market is being looked after, however, so the EU is relatively happy at this point.

Despite this, the Triffid issue has not been completely resolved. The Canadian industry is not where it needs to be. According to our agreement with the EU, the industry still has to test, which represents ongoing costs for the Canadian flax industry. According to the Flax Council of Canada, however, "…the situation *is* workable…" (W. Hill, personal communication, September 5, 2011).

Economic impacts are very difficult to quantify. Some costs are explicit; others are less so and are time- or opportunity-cost related. This makes it difficult to attach a specific number to costs associated with the Triffid issue. One thing is certain, though: significant costs were incurred on both sides of the pond.

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