Agriculture, Science and Public Perceptions on

BIOTECHNOLOGY

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Executive Summary

The food production system is complex, comprised of a number of actors and institutions along an extensive value chain.

Agriculture relies upon science and technology to meet demand in an efficient and sustainable manner. Unfortunately, these technological advances create uncertainties for the public. Consumers are often misinformed within an environment where distorted information about food and the food production system rapidly circulates. It is within this environment that staunch and vocal opposition to genetic engineering and genetically modified foods has appeared. It was reported in 2011 that more than 500 activist organizations in North America spent in excess of $2.5 billion U.S. dollars annually in food-related campaigns.

The goal of communication – from a marketing or public relations standpoint – is to be understood, to create awareness, and/or to establish a common frame of reference in order to build value. In the context of food and agriculture, however, more traditional business approaches to communication and associated strategies have not always worked within the limitations of such a simple formula - particularly in the past two decades in the case of 'big agriculture' and the area of biotechnology. Building a communication strategy involves choosing the right message while, at the same time, having an awareness or appreciation that the message may be interpreted by receivers in one of any number of ways any number of ways. Thus, understanding the market and the customer-base

plus other stakeholders is important when developing and executing a successful marketing and communications plan.

There are a number of key factors that drive public opinion of biotechnology:

- **the public's awkward relationship with science (and, to some degree, the level of scientific literacy);**
- **human cognitive habits and perceptions of risk;**
- **the role of personal networks in influencing opinions, attitudes and behaviours;**
- **the prolific use of social media platforms which has fundamentally changed how humans interact and exchange information, and;**
- **the rise and influence of 'false experts' or celebrities.**

The methodological approach used in this study was, first and foremost, the administration of a qualitative survey to query communication experts as to their understanding and opinions on issues such as: public perceptions of agriculture and science, communication strategies, and insights into communicating and accessing ag-based information and resources. Secondly, these results were supplemented by a landscape analysis of existing (reliable and credible) online sources, evaluating those sources on a number of factors including, but not limited to, the type and format of information provided, navigability/searchability of the site, level of Canadian content, and the role of experts (if any).

The goal of this exercise is not only to gather results and data but to encourage discourse. The agriculture and agri-food community must re-think and revolutionize communication strategies by taking into account how the environment has evolved, to learn from mistakes and better understand factors that contribute to this growing and very complex (and sometimes damaging) environment.

Key Observations

Of the 103 individuals invited to participate in the survey, 51 responded and contributed (almost 50% response rate).

Respondents expressed concerns regarding agriculture biotechnology's public image, as 61% of respondents indicated that, overall, public perceptions are either negative or getting worse, while 35% said perceptions were neutral. Only 4% of respondents suggested that public perceptions were improving. It was found that public opinion is greatly influenced by the media with

contributing factors identified as a lack of transparency in government, industry and science. These factors affect the public's trust in science and the food production system.

Respondents rank highest, as problematic, the absence of a coordinated effort (among industry actors) combined with a lack of human and other resources to develop and support organizational-based communication strategies. Respondents also point to a scarcity of proactive communication strategies.

Other problems identified by survey respondents include:

- **Reliability and truthfulness of sources;**
- **The lack of a credible voice to speak to issues more broadly; and**
- **Budget and time constraints**.

Based upon the results of our landscape analysis of online sources, problems may be less about quality and credibility of information (there appears to be a plethora of good, reliable resources), and more about accessibility and individual capacity to determine the quality and credibility of that information. More Canadian-based content would also be useful.

Recommendations

- The greatest challenge to sharing good, reliable information was in finding and navigating sources that present information clearly. The Internet is not just overloaded, it is also extremely disorganized. Easy-to-access tools to effectively evaluate online information for efficacy and validity needs to be developed and communicated. Both public and private sectors need to think more strategically about utilizing search engine optimization strategies. Online resources need to be easily accessible, easy to navigate and include simple messages. A searchable online tool (webpage and/or app) which collects, organizes and simplifies all credible Internet sources would be an invaluable resource for the agriculture community as a whole.
- Access to expertise on a broad range of technical topics is required. Public sector institutions such as universities need to support science communication activities, to develop and define mechanisms/incentives that are structured in order to strengthen participation of experts in the broader strategic effort to manage controversy and issues.
- Bridges need to be built within the agricultural industry and with stakeholders outside of the industry in order to reduce polarization in the debate and move towards addressing some of the most pressing food related problems.

- Resources (namely money and people) must be mobilized within organizations and more broadly in the industry. There is a need to foster leadership and create opportunities for those with the interest, the credibility and the means to be a voice or advocate for industry.

- Development or distribution of educational materials was ranked low in terms of existing efforts made in outreach and communications. How to develop, support, or contribute to education-based programs or efforts needs to be further discussed. Identifying points of influence and how to reach them in a meaningful way also needs to be explored.

- Organizational and industry-based strategies should not only include understanding public attitudes and opinions but also an appreciation for what drives people's opinions and subsequent behaviours. This understanding can help agriculture communicators better connect with their audiences and encourage positive changes in attitudes.

Overall, traditional communication models and strategies need to be re-examined, reframed and fundamentally changed and 'silos' (between agricultural sub-sectors and scientific disciplines) need to be broken down. Actors all along the value chain need to come together to proactively tackle these very complex issues, with one voice yet using a range of strategies.

There is unlikely to be a one-size-fits-all, prescriptive approach to managing issues in biotechnology (and agriculture, more broadly). Thus a coordinated, reflexive and proactive approach needs to be adapted and employed in any strategy. And although strategic efforts must be made at the organizational level, industry stakeholders need to work collaboratively to address issues with a unified voice.

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Introduction

1.0

The food production system is complex, comprised of a number of actors and institutions along an extensive value chain.

The system increasingly relies on scientifically and technically complex production methods and inputs to achieve production efficiencies to meet demand (Lang 2013). These rapid technological changes create uncertainties for the public (Arnot et al 2009; Arnot 2013a; Arnot 2013b; Ryan and Doerksen 2013). Rapid growth in Internet usage (estimated at over 500% over the past decade), rapid adoption of mobile devices and increased use of social media (Rainie and Fox 2012) offers the consumer immediate access to an information-rich environment. The role of mass media and the rise of citizen journalist (Gant 2007) as well as the influence of celebrity have created an environment where distorted information about food and the food production system rapidly circulates (Ryan 2014). This environment has led to staunch and vocal opposition to products of genetic engineering (Chassy 2007).

While critics argue that benefits of genetic engineering technology accrue only to agribusiness, the rapid worldwide adoption of biotechnology crops suggests that farmers are also generating significant gains (James 2013). Products of genetic engineering are widely tested, well-regulated and the scientific consensus around their safety has been well-demonstrated (Nicolia et al 2013). Despite these well-documented facts, anti-genetically modified organism (GMO) campaigns have become a commonplace tool for non-government organizations (NGOs) and interest groups to influence negative public opinion about the technology (Cohen et al 2000; McHughen 2013; Ryan 2014b). More than 500 activist organizations in North America are spending in excess of 2.5 billion U.S.dollars annually in food-related campaigns (Byrne 2011). These campaigns promote that genetically engineered crops and foods are harmful to human and animal health and the

environment, and cast doubt and fear in the mind of the consumer. The conjecture, it has been suggested, can lead to bad public policy (McHughen and Wager 2010; Paarlberg and Pray 2008), regulatory bottlenecks and delays (Chassy and Miller 2013; Phillips McDougall 2011) as well as lost innovations[1] (Ryan and McHughen 2014).

Science has fundamentally changed how farming is done and has significantly increased productivity levels worldwide. Biotechnology offers up a set of tools to modify organisms for a particular purpose. In the context of agricultural biotechnology, that purpose can include anything from generating higher yields in crops to genetically conferring resistance to certain diseases in plant varieties (Ryan and McHughen 2014). The use of genetic engineering techniques (e.g. cloning, gene-splicing) applied to crop development (in conjunction with traditional plant breeding techniques) has led to the development of a variety of high yielding, disease resistant and more environmentally friendly crop varieties. As of 2013, there was more than a 100-fold increase to 175.2 million hectares planted to biotechnology crops, up from 1.7 million hectares in 1996. This growth makes biotech crops the fastest adopted crop technology in the history of modern agriculture (James 2013; Ryan and McHughen 2014).

There are a series of factors that play into the perpetuation of misinformation exacerbated by mass media and the prolific adoption of social media platforms as tools for human-to-human interactions, society's diminishing conceptions of what expertise really is and who the experts are, and – most of all – the role of cognitive habits as fundamental (and pervasive) factors in society's (mis)understanding and buy-in into misinformation. There is a dire need for credible resources and/or tools to identify credible resources for both the public and for communications experts.

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[1] For example: Calgene's Flvr Svr tomato, NewLeaf potato and Triffid Flax – of which received feed and food safety approval - were pulled from the market, due in large part to the actions and influence of anti-GMO activists.

The Evolving State of Misinformation and Public Perceptions of Science and Agriculture

2.0

Despite the touted benefits of biotechnology, this family of techniques, its products and the industry has received quite a bit of negative publicity in the media and in the court of public opinion (Marks and Kalaitzandonakes 2001).

The reasons for this negativity are varied and complex. Some argue that what is deemed as 'anti-science' or 'anti-GM' rhetoric has been spawned through the concerted, tactical efforts of special interest groups and/or NGOs (Ryan 2014b; Ryan and McHughen 2014). Some would suggest that simplistic (more traditional) strategies of science communication and scientific literacy have not been particularly effective in improving the public opinion of science particularly in the context of new technologies. Others argue that opposition to genetic engineering and biotechnology also gained a foothold in the public psyche due, in large part, to the failings on the part of the industry to consider the 'end user' (i.e. consumer) beyond that of its primary target market (producers/farmers) (Pinstrup-Anderson and Cohen 2000; Gaskell et al. 2000; Moschini 2001). Current (negative) public opinion is likely a function of a complexity of these and other factors including, but not limited to, the public's awkward relationship with (and perceptions of) science (Maeseele 2009), the level of scientific literacy (Miller 2007; 2010) and the proliferation of misinformation and the rise of the "fear industry" (Byrne 2006 and 2011; Chassy 2007). The factors will be explored in more detail throughout this report.

Models of Communication in a Complex Environment

2.1

If you pull any post-secondary marketing and/or communications text from the shelf, it is likely to contain some version of the following: The art and science of communication involves a 'source' (for example, a company or organization) that is trying to reach a 'receiver' (customer or stakeholder). The goal of communication – from a marketing or public relations standpoint – is to be understood, to create awareness, and/or to establish a common frame of reference in order to build value (Ryan 2014b). Building a communication strategy involves choosing the right message (inclusive of images) while at the same time having an awareness or appreciation that the message may be interpreted by receivers in one of any number of ways. Thus, understanding the market and the customer base plus other stakeholders is important when developing and executing a successful marketing and communications plan. In the context of food and agriculture, traditional text-book-style business approaches to communication and associated strategies have not always worked within the limitations of such a simple formula, particularly in the past two decades in the case of 'big agriculture' and the area of biotechnology (Ryan 2014b).

> ***...communication challenges in this complex ag-biotech environment are compounded by poor scientific literacy among the general public.***

It is suggested by some that communication challenges in this complex ag-biotech environment are compounded by poor scientific literacy among the general public. In his 2010 study, Jon Miller of Michigan State University found that only 37% of adults accepted the concept of biological evolution and that the level of acceptance has declined over the past couple of decades. He also found that while 44% of adults defined deoxyribonucleic acid (DNA) correctly, half of those surveyed thought that genetically modified tomatoes had genes while ordinary tomatoes do not (Miller 2010). Earlier this year, the National Science Foundation in the U.S. conducted a survey that included more than 2,200 participants. Twenty-five percent (25%) of respondents thought that the sun revolved around the Earth (NSF, NCSES 2014). In a context where science and technology is rapidly evolving, and where public policy controversies around things like nuclear energy, climate change, GMOs and stem cell research have arisen, it is necessary, according to Miller (2007), that the public have some level of technical knowledge for effective participation in dialogue and in driving public policy.

In the case of industrial agriculture (or 'big ag'), the commercialization of science to develop biotechnology crops has led to the rise of what is viewed by critics as a 'science-industrial complex'. Science, for many, has evolved into a 'private good' that is driven by exploitative interests to promote and develop technology for profit (Maeseele 2009). As far as the public is concerned the profit-motivated, private sector is neither credible nor unbiased. Thus, any attempts in

science communication are largely perceived as paternalistic, technology-driven, top-down practices (Scholderer and Frewer (2003)). The traditional communication model (adopted and employed by industry or business) sees public acceptance of science and technology as being enabled simply by raising awareness through the diffusion of more scientific information (Bucchi 1996; Salleh 2004). This is often referred to as the 'deficit model' in communication. It too is often criticized as being overly simplistic or lacking more nuanced interpretations of the complex relationship between science and public attitudes towards science (Sturgis and Allum 2004).

It is really difficult to parse out what and how people think about food-related technologies. According to the Pew Initiative on Food and Biotechnology (2006), public understanding of biotechnology and food in general is very low (also reflected in Gaskell et al 1999). Studies on consumer preferences of genetically engineered food have been conducted in over 20 countries based on a number of factors including willingness to pay (Colson and Rousu 2013). Recently Ipsos Reid conducted a survey in Canada on behalf of BioAccess Commercialization. While three-quarters of Canadians say the GMO-free product claim influences their food purchase decisions and 52% of respondents indicated they would pay more for GMO-free food (BioAccess 2014), the survey also showcased confusion, high levels of misunderstanding about biotechnology and genetic engineering technologies.[2]

Colson and Rousu (2013) observe that consumer preferences of genetically engineered food play out in different ways under different survey conditions, which speaks to "wildly differing results" of studies. Results are significantly influenced by the methods used to elicit those preferences (e.g. mail, phone surveys, experimental auctions, in-person surveys) (Lusk 2011). Given the differing results, it is difficult to draw any definitive conclusions on consumer perceptions about genetically engineered foods (Lusk 2011). It has been reported, however, that U.S. consumers are more accepting of GM foods than their European counterparts (Hoban, 1997; Gaskell et al 1999, as cited by Lusk 2011). Economic experiments involving real food and real money by Lusk et al (2006) confirmed this finding.

Lusk (2011) further reported on a survey by the Pew Initiative on Food and Biotechnology (2006) that only 26% of consumers surveyed believe that they had consumed a GM food and 74% indicated that they had little to no knowledge about the government regulation of food. Lusk et al (2005) conducted a meta-analysis where 82% of the 57 studies demonstrated a willingness to pay a premium to avoid GM foods. Despite stated 'low' to 'no' preference for GMO foods, the market for GM-free food remains quite small in the United States (Lusk 2011).[3]

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[2] Daniel Ramage. April 28, 2014. Address to Standing Committee on Agriculture and Agri-Food. 41st Parliament of Canada, 2nd Session.
[3] Other results of the meta-analysis suggest that consumers are most averse to the use of biotechnology in meat products and least averse to its use in oil (Lusk 2011).

The reality is, we are living in a time where society and industry are highly dependent upon technology. Technology (in multiple contexts: information and communication technology, nanotechnology, agricultural and crop development, etc.) is advancing faster than society's capacity to adopt or even understand it. Rapid technological changes create uncertainties for the public (Arnot et al 2009; Arnot 2013a; Ryan and Doerksen 2013). Social, environmental, health and economic issues related to agriculture and the sciences used in agriculture and food production get conflated in conversations and in the media. Gaps in information and in understanding are bound to accumulate. If gaps in understanding exist, and there is no reliable, credible information provided in a timely manner, there is room for myths and false beliefs to fill in those gaps. A failure to proactively address these gaps has led to what we are experiencing today; a proliferation of misinformation as it relates to biotechnology and sciences around agriculture, even agriculture (all manners of production) more broadly (Ryan 2014b; Ryan and Doerksen 2013).

> ***If gaps in understanding exist, and there is no reliable, credible information provided in a timely manner, there is room for myths and false beliefs to fill in those gaps.***

Our goal then should be to re-think and revolutionize our communication strategies by taking into account how this environment has evolved, to learn from those mistakes and better understand what factors contribute to this growing and very complex (and damaging) environment. This exercise includes examining not only public attitudes and opinions (as outlined above), but also understanding what drives people's opinions and behaviours. There is unlikely to be a one-size-fits-all, prescriptive approach to managing these issues. Thus a reflexive and proactive approach needs to be adapted and employed in any strategy. And although strategic efforts must be made at the organizational level, industry stakeholders need to work collaboratively to address issues with a unified voice. In particular, strategies must explicitly take into account the role of the 'human condition;' how the human mind works, how people think and how and why people believe the things that they do.

How People Think, See and Believe 2.2

People's thoughts and values are interrelated in complex ways and together feed into human behavioural responses. First, humans are conspiratorial thinkers. Public Policy Polling conducted a survey in 2013 where (among other things) it found that 20% of voters believe there is a link between childhood vaccines and autism while another 14% of U.S. voters believe in Bigfoot. As Maggie Koerth-Baker reported in a New York Times article in May of 2013:

> *"Conspiracy theories appear to be a way of reacting to uncertainty and powerlessness" where the human brain jumps into "analytical overdrive … in an attempt to create a coherent and understandable narrative."*

Humans also tend to think in pictures. We do this in order to visually organize and process information (Burmark 2013). We use parts of our grey matter that pull together both the emotional and the creative facets of our brains (Bostrom and Clawson 2000). Those 'scary' myths, metaphors and images effectively employed by interest groups to push anti-technology agendas are visually compelling and, because of how humans think, can be powerfully influential (e.g. "Frankenfood").

Another interesting human cognitive habit is our tendency to conform. Ideological loyalties rise within our close personal networks where ideas are communicated and reinforced by the people around us: "People acquire their scientific knowledge by consulting others who share their values and whom they therefore trust and understand" (Kahan 2012: 255). Entman (1989) further expands on this:

> *"[People] form and maintain the orientations they use to process information. Their partisan and ideological loyalties arise from socialization in a political culture transmitted, reinforced, and constantly altered by [close personal networks]…" (366).*

Additionally humans not only source information from personal networks but also seek information that validates their beliefs. Psychologists refer to this phenomenon as 'confirmation bias' (Plous 1993; Risen and Thomas 2007; Arceneaux 2012). We are constantly drawn to information that resonates with our worldviews. If by chance we are faced with scientific facts that quite literally shake the ground beneath our fictional 'sacred cows', we are more likely to ignore those facts while seeking information that validates our beliefs, fiction or not.

Humans are also 'pattern seekers'. Author and Harvard School educator Ropeik (2014) states that human nature constantly nudges us to seek out risk; to continuously 'connect the dots' and make connections where no connections may actually exist. Michael Shermer (1997) refers to this psychological phenomenon as 'patternicity' - a tendency to 'find meaningful patterns in meaningless noise'. It is a very natural human inclination and it is how all organisms adapt to their environments and survive. This is why we see things like the 'man in the moon' or hear voices in random patterns of noise.[4]

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[4] This psychological phenomenon is referred to as pareidolia.

Anecdotal association is a form of patternicity that explains the power of storytelling. Myths provide context and explanation during times of change. As Claude Levi-Strauss (1966) observed, myths offer gateways to a nostalgic past or to what may be perceived as a more promising future.

> ***...myths offer gateways to a nostalgic past or to what may be perceived as a more promising future.***

What is most compelling about what Levi-Strauss said – particularly in the context of the GMO debate – is his claim that mythmaking is, in and of itself, an act of power (Levi-Strauss 1964). We see this demonstrated over and over again by the anti-GMO movement with the success they have in perpetuating myths about biotechnology.

According to Lewandowsky et al (2012), false beliefs based on misinformation are held strongly and with forceful and infectious conviction. These false beliefs are probably greater impetuses for a cause than 'ignorance' or lack of scientific literacy. Ropeik (2014) states that human perception of risk is much more about feelings and instincts than in response to the facts alone:

> *"The brain is first and foremost in charge of keeping us alive and it uses everything it can to figure out whether something might pose a risk, including not only conscious reasoning but all the subconscious animal instincts we have evolved to make quick, protective judgments about whether something feels scary…the emotional factor is a core theme in fear of GMOs".*

All of these human cognitive factors feed into a new kind of consumerism, a new set of buying behaviours. Today's consumer is more privileged than in the past. Society's once functional relationship with food, for example, has grown into something that appears to be principally aesthetic in nature. First world societies (in particular) have moved into a realm of 'conscious' or 'ethical' consumerism with new aspirations to be a "good, responsible" shopper (Trendwatching 2014). It is estimated that we have 2.5 billion of these 'aspirational' consumers in the world today. This one-third of the planet is characterized by: 1) a love of shopping, 2) the desire for responsible consumption, and 3) an attraction to brands that appear to act in the best interest of society. There is a growing hunger for a new kind of consumption that is free from worry about its negative impact, yet still allows the consumer to pursue continued indulgence; thus, an attraction to brands, strategies and market actors that appear to adhere to, typify or advocate for these partialities (Trendwatching 2014).

Channels for Misinformation

2.3

The human condition outlined in the previous section suggests that we will always be dealing with oppositional viewpoints, much of it fueled by misinformation. According to Lewandowsky et al (2012), misinformation originates through any number of sources: rumours and fiction, vested interests (NGOs) and/or the (mass and social) media.

While science, its methods and protocols are only a few hundred years old, superstition and magical beliefs are an age-old part of the human condition (Shermer 2008). Anecdotal thinking and understanding (referred to in the previous section) comes more naturally for people. Humans are more apt to respond to or be moved by stories, not facts. Anecdotes have personal and human dimensions; they are more likely to be fascinating or of interest (and often completely fictional). In light of this, humans are more apt to embrace and/or pass on information or anecdotes that "will evoke an emotional response in the recipient" (Lewandowsky et al 2012: 108). The emotive nature of information ensures that it will be passed on to others. In his book The Righteous Mind (2013), John Haidt states that the human mind has evolved to be a story processor, not a logic processor. Even known and recognizable fictional information is "shown to be stable and difficult to eliminate," according to Lewandowsky et al (2012: 109).

Our personal networks are the principal conduits for misinformation. Yale Law and Psychology Professor Dan Kahan (2012) warns, however, that a combination of tight, influential networks and a 'richly-stocked' science-communication environment can create imbalances:

> *The trouble starts when this communication environment fills up with toxic partisan meanings — ones that effectively announce that 'if you are one of us, believe this; otherwise, we'll know you are one of them'. In that situation, ordinary individuals' lives will go better if their perceptions of societal risk conform with those of their group [networks]" (255).*

Our patterns for absorbing and sharing information are incentivized by our need to belong within close personal networks (Entman 1989).

Digging further into the social aspects of our human-to-human relationships and networks, 'Dunbar's number' represents the total number of relationships or people that an individual can manage within their personal network (n=150) (Dunbar 1992). The quantitative restriction

has, again, to do with human cognitive limitations. According to Dunbar, an individual has a limited capacity to be connected, in a meaningful way, where he or she can know who each person is and how each person relates to every other person. Dunbar, however, made observations on social networks of "primates and villagers in less-developed societies and structured military organizations" (Wellman 2012). Dunbar's 'cognitive limit' does not (necessarily) apply in our contemporary western world (Bernard et al, 2001). With the onset of the Internet, in particular, the nature of our personal networks has changed both quantitatively and qualitatively. Estimates now suggest that an individual can have a mean number of 610 connections (Wellman 2012).

Social media platforms such as Facebook have increased capacity for humans to participate in and develop relationships; the 'rumour mill' (or the channels for misinformation) has been radically and irreversibly restructured. Internet usage is steadily growing at a rate of over 500% worldwide from 2000 to 2011 (Internet World Stats/Usage and Population Statistics 2012). Fifty-nine percent (59%) of Americans surveyed in a study by the National Science Board indicated that the Internet is the main source for information on specific scientific issues such as global climate change or biotechnology (National Science Board 2012). Almost 75% of North American adults are 'tapped in' to social media (via mobile devices) and look to online sources and social networks for information (Pew Research Internet Project 2014). According to Richards et al 1998, the Internet has become the "world's largest vanity press allowing anyone with Internet access to act as an author and publisher of material on any subject" (281). By default, we have evolved into 'citizen journalists' where even the casual user can now quickly post and transmit messages, photographs and/or videos on any subject at all on Facebook, Twitter and other social media platforms (Gant 2007).

And while adult use of Facebook rose steadily from 2005 onwards, rapid adoption of the Twitter platform came later starting in 2010 (Pew Institute 2013). The younger demographic – GEN Y (born 1970 or later)[5] – has always been the fastest adopter of social media. That being said, this is also the demographic that is defined as socially conscious, individualistic, idealistic and anti-corporate (Kann et al 2007; Sullivan and Heitmeyer 2008), has no idea how our food is produced and is dissociated from anything upstream from the grocery store (Farmers Feed Cities 2012).

While the benefits of the Internet and social media would appear to outweigh its costs, drawbacks of the technology that characterize it as a fundamental 'misinformation channel' have been long recognized (Ryan 2014b; Ryan and Doerksen 2013). While there is inaccurate and often dangerously

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[5] Author Marc Prensky parses out the 'digital brain,' differentiating between 'digital natives' (younger demographic) and 'digital immigrants' (age 40+) in "Digital Natives, Digital Immigrants" (2001) On the Horizon. MCB University Press. Volume 9; Issue 5. Pps: 1-6. The older demographic shows variability in adaptation and adoption of the Internet and social media; some may be technically illiterate and, as a result, the demographic thinks differently than their 'digital native' counterparts.

misleading information on the Internet (Cline and Haynes 2001), Lunik (1998) points to the real misfortune: the lack of 'policing' or 'moderation' of online information. "… There is no arbiter of truth on the Internet" (Lunik 1998: 40). The Internet, Lacroix et al (1994) affirms, lacks 'quality filters.' Silberg et al (1997) state that "science and snake oil may not always look all that different on the [Internet] …" (1244-5) and "… within the context of a large world made smaller by our modern communication methods, [r]umor holds more power than ever before …" (Shelton and Roush (1999: 832)).

The inability for the 'receiver' of information to differentiate fact from fiction, let alone disentangle from the influence of close, personal networks leaves him/her open to information from individuals and organizations that may have ulterior motives or hidden agendas. Lewandowsky et al (2012) points to NGOs, governments and politicians, corporate interests as well as the media as particular sources or origins of misinformation.

Special interest groups and NGOs now sport a new kind of professional activism which "combines money and marketing with the growing influence of the Internet to sway public opinion and public acceptance" (Byrne 2006: 144). Chassey (2007:170) asserts that "thousands of consumer, environmental, and charitable NGOs have participated in a well-organized, well-financed and professionally managed global campaign against GMOs. They have been supported by governments, the organic food industry, the chemical industry, food manufacturing industry, and food retailers among others." These organizations are often motivated by an anti-corporate agenda but have shown to be quite proficient at interweaving well-crafted words with disarming visual images to create highly influential anti-technology campaigns. This practice has particularly proven to be a fruitful strategy for many organizations countering biotechnology (Ryan 2014b). As Maeseele (2009) outlines, NGOs have "eagerly employed the discursive weapon and have communicated many alternative frames for people to interpret this technology" (170).

> ***The celebrity can act both as source and conduit for misinformation and when the weight of celebrity is propelling misinformation forward, it gains even more momentum.***

Enter the celebrity who holds significant power in pushing ahead political agendas and misinformation. It has been a common part of corporate strategies to use celebrities as a way to create a salient connection between the celebrity endorser and the brand or product (Costanzo and Goodnight 2005; Khatri 2006). Mass media has brought celebrities into our homes over the past few decades, humanizing them like never before and "creating a new intimacy between performers and audiences" (Larkin 2009). Society's closer, more intimate connection to celebrity (Larkin 2009) represents 'buy-in' into celebrity lifestyles or belief patterns and a need to tap into that perceived 'good life' (Hirschman

and Thompson 1997). Interpreted meanings or framing around an issue, or image or myth can readily emerge from this. Celebrities have power. And they often exude that power by endorsing 'junk science' and 'pseudoscience' (Ryan 2014b). The celebrity can act both as source and conduit for misinformation and when the weight of celebrity is propelling misinformation forward, it gains even more momentum.[6]

Tom Nichols, professor of National Security Affairs at Harvard University calls the era we face now as the "death of expertise" which he views as a rejection of knowledge, science and rationality (2014). It seems like everyone (particularly celebrities and pop culture icons) is considered an expert in food, agriculture and nutrition except the experts themselves (Ryan 2014a). 'Credibility' – the believability of sources - is reflected in two dimensions according to O'Keefe (1990): authoritativeness and trustworthiness. Celebrities can appear to be credible experts (despite a lack of credentials) as their credibility (through authority and trust) can be falsely reinforced through repeated viewings and exposure to audiences.[7] Hirschman and Thompson (1997) state that "motion pictures, television shows and fashion and entertainment magazines present images, icons and stories that give the [public] a [powerful] frame of reference" (43). Further exacerbating all of this is our human cognitive habit to over-value or over-state (and sometimes, inappropriately, under-value) our own expertise. The Dunning-Kruger Effect is cognitive bias wherein "unskilled individuals suffering from illusory superiority, mistakenly rating their ability much higher than is accurate" (Wikipedia entry). In a study performed by Cornell University psychologists, those with less competence or knowledge performed considerably lower on test scores than they had anticipated while those with more knowledge sometimes underestimated their true level of expertise (Dunning and Kruger 1999).

Today's marketing strategies employed by food companies are tapping into the fears, cognitions and buying habits of the 'aspirational' shopper who has an attraction to brands that appear to act in the best interest of society (see section 2.2). These campaigns are designed to build brand equity while, at the same time, tap into the public's (unsubstantiated) fears. Take, for example, Chipotle's Scarecrow campaign, A&W's 'raised with no hormones and steroids'

"Today's marketing strategies employed by food companies are tapping into the fears, cognitions and buying habits of the 'aspirational' shopper who has an attraction to brands that appear to act in the best interest of society.

[6] Dr. Oz has aired three episodes expounding upon the 'danger' of genetically modified foods. In December of 2010, a single clip from one episode was shared on Twitter (alone) more than 1500 times within the space of a single day (author's observations/calculations)

[7] The Dr. Oz Show has an estimated daily audience of four million viewers.

promotion. These strategies manufacture doubt in the mind of the consumer and create uncertainty where none needs to exist. In the endeavor to win customers, these campaigns create pressure for those in the supply chain that it relies on. “The Scarecrow [in the Chipotle ad] isn’t advertising. It’s a narrative” (Vinjamuri 2013). The company’s goal here was to get the audience to believe in a preferred reality in order to markets its products: “Chipotle is relying on social messengers to connect the [narrative] to the brand” (Vinjamuri 2013). Companies use narratives to influence the aspirational shopper and his/her networks.

Finally, with the advent of the Internet and growing use of mobile technology, it is important to note that traditional media (newspaper, TV) – a once primary source for news and information - no longer operates in a vacuum. The rise of the new [social] media and the ‘citizen journalist’ (Gant 2007) undermines the (established practice and the) professional ethics of journalists. “[B]loggers flout the rules, in turn putting more pressure on journalists to rush stories out and take less care in sourcing stories and policing conflicts of interest” (Tambini 2010). Objective journalism was a well-established (if not, idealistic) tenet of journalism “… premised on the belief that journalism refers to things that have objective existence, not just people’s opinions about the world …” (Parker, 2012). In the 1990s, a new journalistic theory developed – ‘balanced journalism’ – where there is deemed to be “… two sides to every story and that to favour one side is to not be objective” (Parker 2012). This outcome reflects what is termed as a ‘false balance’ (Kloor 2014), where a journalist can readily dismiss certain informants as untrustworthy while implicitly trusting others. In doing so, they would have failed to conduct an objective investigation. And this matters a great deal for objective reporting on science. Journalists and reporters operate in a completely different environment today. Storylines are often designed to be inflammatory. This controversy attracts readers and ‘shares’ in an information-rich environment where people’s attention spans are rapidly diminishing[8]; where people often pursue immediate gratification without considering long term costs (O’Donoghue and Rabin 2000; Kahneman 2011). These storylines may be great for journalism but they are not so great for science (or evidence-based narratives) (Shermer 2008). While the media cannot really tell people how to think, it can certainly influence what people think about (Parker 2012; Entman 1989).

The Social and Economic Costs of Misinformation 2.4

The growing disconnect between science and the public (or scientific discourse and public debate) further highlights important issues about the social dynamics surrounding science communication.

[8] In 2000, the attention span of a human being was 13 seconds. By 2013, it was only 8 seconds. (The Statistic Brain: http://www.statisticbrain.com/attention-span-statistics/).

Communication gaps and misinformation (no matter what the source, where the bottlenecks exist or how they are managed or mismanaged) can have tremendous (direct and indirect) downstream impacts on people's opinions, on markets and policy debates (Paarlberg and Pray 2008; McHughen and Wager 2010; Fischhoff and Scheufele 2014; Ryan and McHughen 2014). We can examine the outcomes of the anti-vaccine movement to see the devastating implications of misinformation. (Gangarosa et al 1998; Salzberg 2012).

> *"[S]ometimes the misinformation and fear can become infectious and pathogenic, instigating bad public policy, with substantial negative consequences to everyone" (McHughen and Wager 2010: 727).*

Ryan and McHughen (2014) examine the cases of the Flavr Savr tomato, the NewLeaf Potato and Triffid Flax and the research costs, regulatory costs, lost value, opportunity costs and quarantine costs that were incurred when all of these products (deemed safe for human and animal consumption) were withdrawn from the market due to anti-GM activism and political pressures. Conservative cost estimates are in several millions of dollars. And these costs do not take into account the lost value of second-order or follow-on innovations that can potentially advance from product or technology development. 'Innovation progeny' are usually knocked out of the innovation race when the original product is eliminated from the market (Ryan and McHughen 2014). A number of scientists also argue that the media debate (and the misinformation) about Bt-corn has done irreversible damage to the emerging scientific field of genetic engineering more broadly (Shelton and Roush 1999; Scheufele 2013).

> *"[I]mmediately after publication of the Nature correspondence [Losey monarch butterfly brief][9], there was a nearly 10% drop in the value of Monsanto stock, possible trade restrictions by Japan, freezes on the approval process for Bt-transgenic corn by the European Commission (Brussels), and calls for a moratorium on further planting of Bt-corn in the United States" (Shelton and Roush 1999: 832).*

There are not only economic costs (lost innovations and unrealized potential from sunk research costs) but also social costs like prolonged famine. An example of this social loss is illustrated in the case in Zambia where then-President Levi Mwanawasa was convinced by European activists that the GM corn in food aid contributed by the U.S. was 'poison'. It was the height of the famine crisis in 2002 in Zambia. Despite this famine, Mwanawasa locked up the food, defending his actions by stating that "[s]imply because my people are hungry, that is no justification to give them poison" (BBC News,

[9] Losey, J., Raynor and M.E. Carter. 1999. Transgenic pollen harms monarch larvae. Nature. 399, 214.

2002; McHughen 2013; McHughen and Wager 2010). Environmentalist and author, Mark Lynas, gave a keynote address and participated in a panel in Saskatoon, Saskatchewan in October of 2013. He referred to the case of cassava in East Africa,stating that although scientists have developed a virus-resistant solution for the crop, farmers do not necessarily have access to it. "It's really very tragic because it's holding back technology that has the potential to do a lot of good" (Lynas 2014). Lynas asserts that misinformation is a key resource for the anti-science movement:

> *"… People have been told that GM cassava and other crops will turn them sterile, will make their children homosexuals … these lies are undermining the food security of innocent people" (Lynas quoted in Layug-Rosero 2013).*

Despite numerous tests for safety of products passing through the rigorous regulatory approval processes (Nicolia et al 2013; Rowe et al 2013), there appears to be no guarantee for success of products of biotechnology in today's complex market. The current environment into which these innovations are introduced is highly politically charged and communication channels are muddied with misinformation. The pace and manner of Internet growth and information accumulation is complicit in all this, as seeking out valuable and credible information is more and more difficult (Jadad and Gagliari 1998). According to McKinley et al (1999), the Internet is not only overloaded, it is extremely disorganized. The Internet is inherently unstable, with sites disappearing, changing or moving without warning; it is in a constant state of flux (Pereira and Bruera, 1998). Its lack of permanency means that information can be not only be inaccurate, good, credible information can be out of date or obsolete (Gallagher, 1999). Separating the proverbial 'wheat' from the 'chaff' can be challenging, for laypeople and experts alike.

Mitigating Misinformation: Models, Methods and Insights

2.5

Anyone can develop an Internet site with any kind of information attached to it at all (Cline and Haynes 2001; Gant 2007). Authorship alone can be misleading as anyone can claim expertise in any one of a number of topics. Websites can be constructed and designed to appear authentic and authoritative (Pereira and Bruera, 1998) when they are not and it is relatively easy to create 'fake' website or imitation identities on social media (Seife 2014). Expertise and its twin qualifying dimensions of authoritativeness and trustworthiness (O'Keefe 1990) are a fuzzy notion in this information-rich, hyper-connected online world.

There is a pressing need for easy-to-access tools to effectively evaluate online information for efficacy and validity and that information needs to be communicated. Cline and Haynes (2001) review and evaluate online health information using a series of criteria outlined in Table 1 below. The model captures some fundamental components for evaluating online information and can readily be applied in the context of information as it relates to biotechnology, agricultural sciences and agriculture more broadly. The authors identify three main components that provide the overarching parameters for the evaluation model: 1) quality of information; 2) design features, and 3) mechanisms for evaluating web sources. The typology is outlined below.

Table 1: Landscape analysis of resources (source: Cline and Haynes (2001))

Quality of Information

Authority

- Clearly identified authorship
- Attribution
- Clearly identified editorial practices
- Opportunities for feedback and interactivity
- Evidence of monitoring and moderation

Trustworthiness

- Disclosure of mission, purpose, and process
- Disclosure of conflicts
- Disclosure of info collection process
- Warning signs (too good to be true claims)
- Disclaimers

Message Characteristics

- Currency of info (site updates, policies and methods regarding updates)
- Accuracy of info
- Organization/logical
- Readability/intelligibility
- Disclaimers

Audience Characteristics

- Clearly identified audience and context

Design Features

- Accessibility
- Ease of Use
- Links between sites
- Aesthetics and form

Mechanisms for evaluating websites

- Peer review
- Rating system
- Codes of conduct

In theory, this model works well. It is nuanced and helps users to assess the efficacy of online sources. However, there are other, more practicable, factors that need to be highlighted as well; those that are indicators of low-credibility sites such as: continuous (circular) self-referencing within text, lack of independent, reputable sources or input of expertise, websites that are bookended with advertisements, claims that “sounds too good to be true” (Federal Trade Commission 1997), etc.

Further complicating matters is what can only be presumed to less-than-proficient use of search engine optimization strategies on the part of our most reputable, evidence-based organizations on

the Internet. Alexa Rankings is a web analysis system of assessing online websites according to traffic. A review of several sites (see Appendix A) in December of 2012 (C. Ryan, previously unpublished data) including the American Medical Association (AMA) and the American Society for Plant Biology (ASPB) shows that these 'expert' organizations rank low on Alexa web analysis rankings relative to other (less credible) sites.[10] The self-correcting nature that characterizes science as process rather than a body of knowledge means that anecdotes and absolutes are not part of the scientific culture or the language of science or experts in science. Simply stated, good, sound science is not sexy and even if backed by solid search engine optimization strategies, evidence-based sites are not likely to attract the readership/viewers that the less credible sites do.

So where are the scientists? Scientists have been reluctant to descend the Ivory Tower and to participate in non-traditional outreach activities (such as online dialogues) for a number of reasons. First, science in its self-correcting nature seeks to be objective; to remain removed from the society that it seeks to observe. This objectivity is inherently ingrained in the culture of science. As part of the culture of science, most scientists stay busy with the business of science itself; teaching, researching, grant-getting. Additionally, the institutions that house them (Universities, public research institutes, etc.) still operate traditional models that have been in place for decades. They do not have reward mechanisms in place to incentivize scientists to participate in more non-traditional forms of communication or engagement (Ryan and Doerksen 2013).

As important as rewards are to incentivize behaviours, institutions need to have mechanisms in place to support the right people to do the communication job well. Not all scientists are necessarily built for the job of communicating to the lay public. The manner by which new technologies or scientific breakthroughs are communicated in social settings is as important or even more important as the scientific material or content that is being conveyed. How public sector institutions support science communication activities, and how mechanisms are structured, needs to be part of a broader, strategic effort to manage controversy and issues (Ryan and Doerksen 2013).

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[10] Higher numbers are indicative of lower traffic numbers.

Methodology

3.0

The methodological approach in this study is two-part and driven much by what was elucidated in section 2.0 through the literature review.

First, a desktop analysis is conducted with a systematic and comprehensive review of online information sources (agriculture/science) that are freely available. Each resource (website, blog or other) is evaluated individually based across several factors including but not limited to: type and format of information provided, navigability/searchability of the site, level of Canadian content, role of experts (if any), etc.

The second part of the methodology involves a survey. Of the 103 individuals across Canada invited to participate, 51 responded (almost 50% response rate). The survey was initiated and administered in May 2014 and queried respondents as to their understanding and opinions on issues such as: public perceptions of agriculture and science, communication strategies, and insights into communicating and accessing ag-based information and resources. Baseline information regarding organizational (or company) affiliation and the respondents' role with that organization was also gathered.

Desktop analysis of online resources

3.1

Understanding that facts aren't everything in tackling the technology communication conundrum, but access to information does play a contributing role in at least informing opinion. The public, scientists and science communicators (experts), if consulted, queried or involved in a conversation about agricultural biotechnology, may not know how to answer all questions and will seek out information to 'fill in the gaps'. Thus, an understanding of the informational resources that are out there and the credibility of the resources matters a great deal. Alternatively, understanding where the gaps are in information or sources that have accessibility issues (in terms of understanding and in searchability/navigation) are key to our understanding of what types of resources need to be created, adapted or changed and how they can better be structured for usability.

Based upon the literature review, we find a number of key things that drive public opinion of biotechnology: human cognitive habits and perceptions of risk, the public's awkward relationship with science (and, to some degree, the level of scientific literacy), and – more significantly - the role of not only personal networks in influencing opinions, attitudes and behaviours but also the role of the Internet and the rise of social media platforms as key, human-to-human channels for information. As the Internet and social media platforms are the primary sources for information (anything from health to other science-related topics), it is important to evaluate existing (credible) sources based upon a number of parameters.

In this desk study, 12 websites, 10 science/policy-based blogs, four farm blogs with science content and a few online dialogue forums are assessed. The sources are evaluated on a number of factors inspired largely on the fundamental parameters outlined by Cline and Haynes (2001) (see section 2.4). The data is outlined in Appendix C, Tables a, b, c and summarized and analyzed in section 4.2.

Agriculture Biotechnology Communications Survey

3.2

The purpose of the 26 question survey is to identify available communication resources, understand the communications challenges, recognize the sector's strengths and identify opportunities to improve overall efforts. A total of 103 agriculture biotechnology communication leaders from across Canada were selected to receive the electronic survey based on feedback from our project partners coupled with an internet search. The survey recipients represented a broad range of stakeholders including producer organizations, industry associations, private industry, research funders, academia

and government. The survey was designed to take 10-15 minutes to complete and featured a variety of response options including multiple choice, check all that apply and ranking. Space was also provided for respondents to ensure that comments and any critical insights could be captured.

In addition to collecting some baseline information, themes covered by the survey are as follows:

- **public perceptions of agricultural biotechnology,**
- **communication strategies,**
- **expertise, information and resources.**

A copy of the survey is included in Appendix B and the results of the survey are discussed in section 4.1 of this report.

Data and Analysis

4.0

Survey Results

4.1

Baseline information

In May of 2014, our survey was sent out to 103 individuals and we received N=51 responses (response rate = 50%). Thirty-five percent (35%) indicated that they were communications professionals, another 51% identified as executives or management while 12% identified as other. Only 2% identified as researchers. Various "roles" were identified: Communications Manager, Regulatory, Business Development Officer, Policy and Communications, Policy Analysis and Production Extension Specialist. Table 1 outlines the breakdown of responses by organizational type represented.

Table 2. Respondents (by Organizational Type) (n=51)

Respondent Type	Percentages
Not for profit	25.5%
Grower organization	21.6%
Small and medium enterprise	13.7%
Industry organization	11.8%
Government	9.8%
Multinational enterprise	7.8%
Academia	5.9%
Other	3.9%

Public perceptions of agriculture and science

When asked how they viewed agriculture's public image, 41% of respondents indicated that it was positive or improving and another 41% indicated that it was neutral. Eighteen percent (18%) stated that agriculture's public image was negative or negative and getting worse.

> *"Too many facts are getting construed within the media and people seem to be quick to jump on the anti-big ag bandwagon without looking at the facts."*

Nuances to this were further delineated in comments such as:

> *"The public likes and trusts farmers … agriculture has a good public image, but many of the aspects of modern agriculture do not. This is a problem for the industry that is growing over time."*

While the general public views farmers positively, seed developers and food processors are viewed negatively and with mistrust. The public also views small-farm-style agriculture more positively than what are perceived to be larger 'corporate' farms.

> *"People love to think that a little old farmer goes out to the fields and talks to his crop, cares for his chickens, pets his cows … I think people are scared of production agriculture because they don't understand or see the stewardship decisions that are made on a daily basis."*

> *"… factory farming, big business and its impact on independent farmers … GMOs, use of pesticides … these are all stories that often affect agriculture's public image."*

> *"It depends on the audience. The informed audience is most likely neutral to positive. However, there is a huge, uninformed and not interested in being informed audience out there. These are the people making comments in social media or news media and because they sound credible or instill fear that others follow."*

Sixty-one percent (61%) of respondents indicated that overall, public perceptions of agriculture biotechnology are either negative or getting worse, while 35% said perceptions were neutral. Only 4% of respondents suggested that public perceptions were improving.

In qualifying comments, respondents indicated that there was a great deal of misinformation circulating (particularly via social media) which perpetuates much of the confusion and negative public perceptions of agriculture biotechnology.

> *"[Misunderstanding] is influenced by media campaigns from anti-biotech groups that confuse rather than inform…"*

> *"The public gets bits and pieces of information from various angles, so issues are becoming more complex. Both government and biotech companies don't do a very good job of communicating and being transparent about what new research is showing, what new strategies are being implemented and for whose benefit."*

> *"Industry has done a disappointing perhaps even pathetic job at bringing forward the real story of biotechnology."*

One respondent pointed out that care must be taken in generalizing responses to this question:

> *"For the majority of the people who go into the super-market the response would be 'neutral'. However, there is a loud vocal minority who are very opposed to modern agriculture practices … the difficulty is that this vocal minority tends to be an opinion leader and make extensive use of social media …."*

Public understanding:

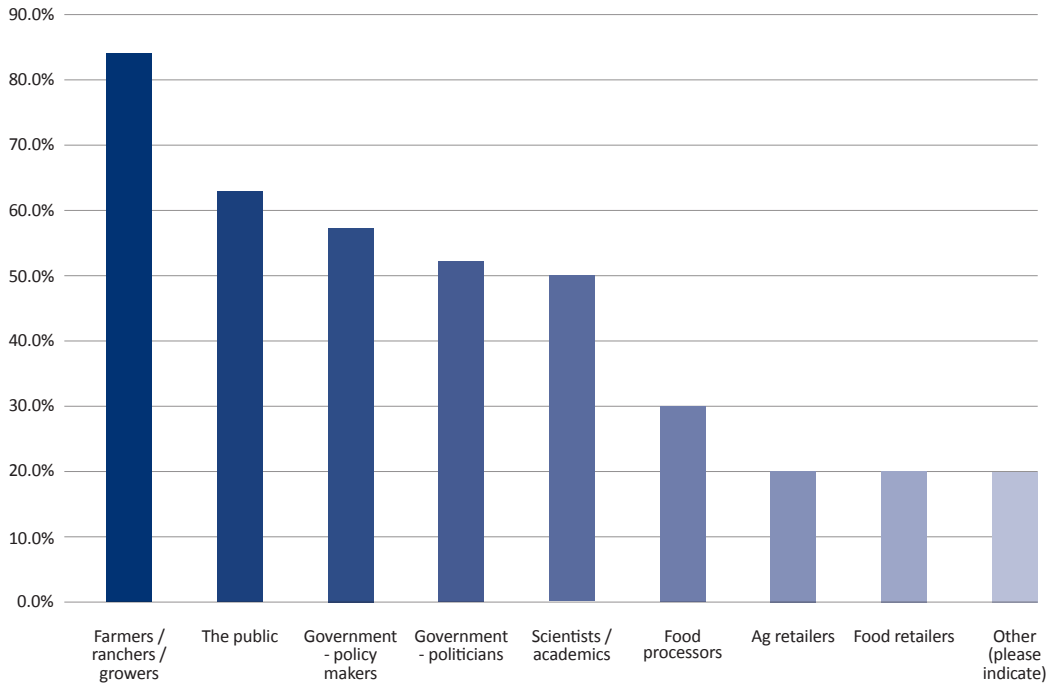
> *"Most people don't know what agricultural biotechnology is or involves. While there is some negative perception around 'tinkering with nature' when it comes to food, most people don't think about how food is produced, let alone understand the science involved in food production."*

> *"Low level of understanding leads to low levels of trust in products and the companies that develop them."*

Communication strategies

When queried, the primary audiences for surveyed respondents were identified as follows:

Figure 1. Primary Audiences for Communication Efforts



Others pointed to agricultural associations, health promoters, journalists, teachers and students as other key audiences as well. The high number of multiple responses by survey respondents alludes to the complexity of the communication conundrum. As one respondent stated:

> *"We, as an industry, need to effectively communicate with all of these groups."*

We queried respondents as to key messages (if any) that they communicated to target audiences. Seventy-six percent (76%) indicated that they use key messages to reach out to audiences.

Marketing of ideas or products:

> *"Canola Oil #1. Growing producer prosperity!"*

Some key messages were pro-science or pro-biotech. Rather than promoting products per se, messages were about promoting manners of production:

> *"We do not produce products containing GMOs."*
>
> *"We are committed to promoting research and commercialization and marketing all aspects of agricultural biotechnology."*

Other messages were qualified as follows:

- **Providing strong science and safety messaging referencing health and environmental safety, regulatory environment and agencies in Canada.**
- **Providing evidence based information to stakeholders (e.g. journalists).**
- **Solutions based messaging.**

In some cases, respondents indicated that they rely on other organizations (through memberships) for key messaging (e.g. CropLife).

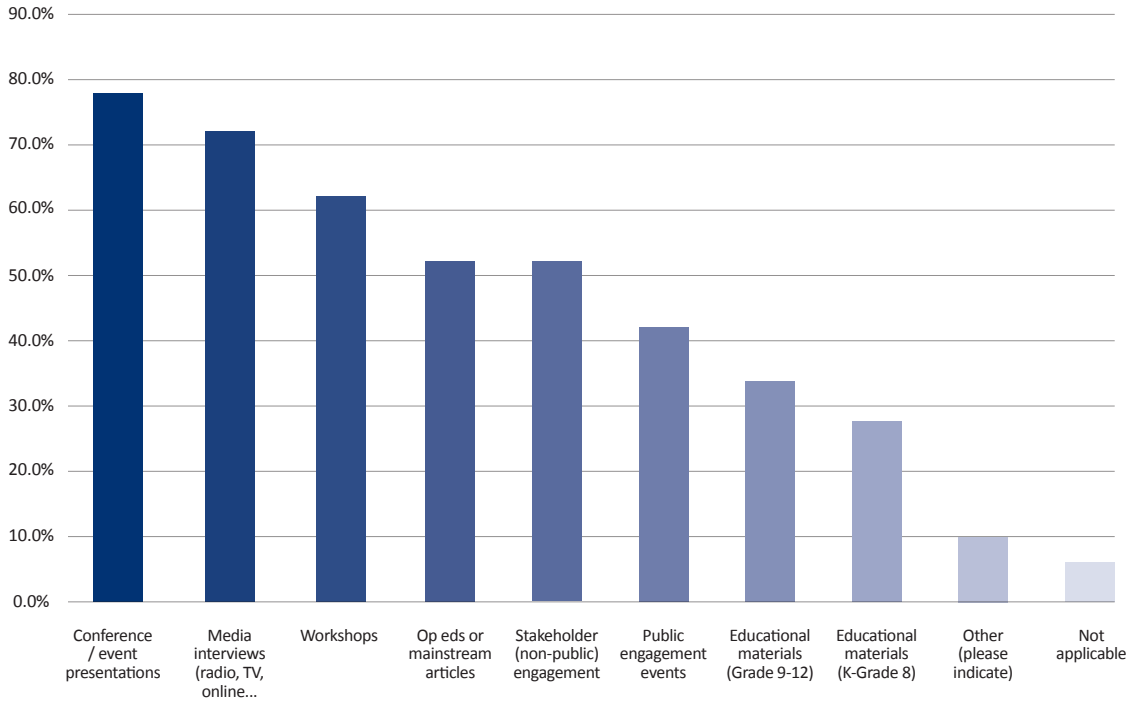
Fifty-two percent (52%) of respondents indicated that they access and develop resource content through a combination of internal and external sources. Another 40% stated that they only use internal sources. Four percent (4%) indicated that they access content from external sources.

When asked if their organizations have the financial resources to carry out an effective communications strategy, 50% said "no" while 42% said "yes." Another 8% stated that they didn't know.

Twitter, YouTube and Facebook ranked highest in terms of social media tools used as part of communication strategies. More than 75% indicated that they do not use Pinterest, Instagram or Tumblr as part of their communication strategies. Only half of respondents indicated that they use LinkedIn.

In terms of outreach and communication activities, most respondents participated in or led initiatives such as conferences/presentations, media interviews, workshops; in that order. Stakeholder engagement, public engagement events and educational outreach activities ranked relatively lower.

Figure 2. Outreach and Communication Activities

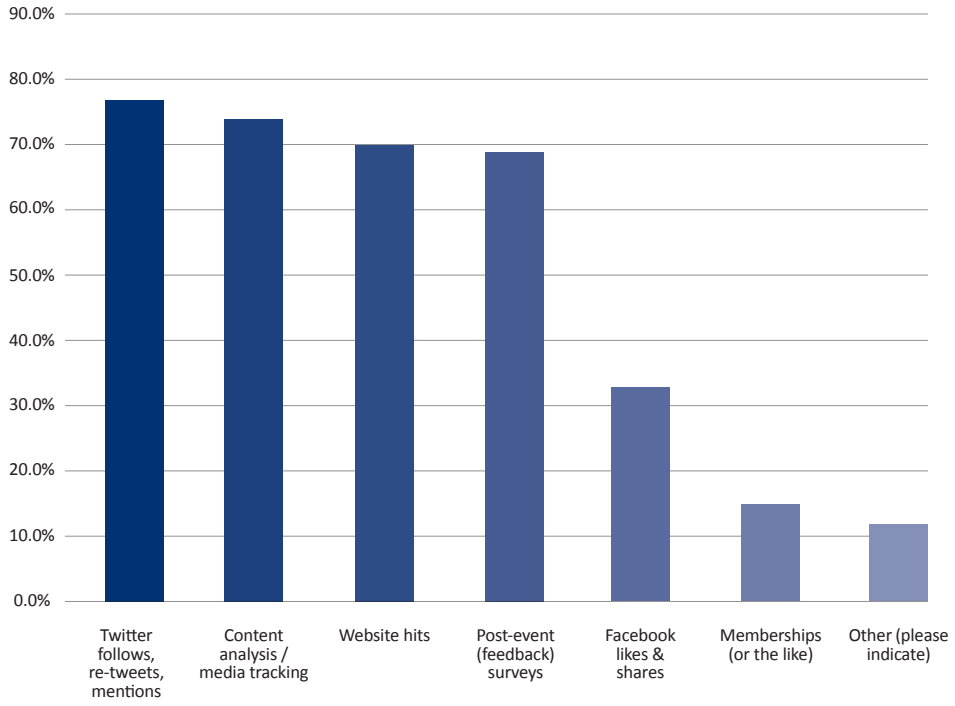


Twenty-two (22) of the 51 respondents (43%) indicated that they have authored mainstream articles or op eds that have been posted online. When asked to qualify the 'tone' of posted comments in response to these articles, 46% of respondents stated that they didn't know or that they didn't follow up or check. Forty percent (40%) stated that comments were either neutral, with some positive or were balanced and/or leaning positive. Only 9% of respondents stated that comments on online articles or op-eds were leaning negative. No one reported extremely negative or abusive comments. Five percent (5%) of respondents stated that overall comments were extremely positive.

Further to that, respondents were asked whether or not online bullying was a deterrent for the organization and its employees in participating in dialogues about agricultural biotechnology. Fifty-five percent (55%) said "no" while another 21% answered in the affirmative. Twenty-four percent (24%) stated that they didn't know.

When asked which measures are used to evaluate outreach outcomes, many respondents pointed to Twitter follows/re-tweets, content analysis/media, and website hits.

Figure 3. How do you evaluate outreach outcomes?



When asked, most (66%) respondents stated that, yes, they felt that they achieved some success with communication strategies while another 11% responded negatively. Twenty-four percent (24%) stated that they had not evaluated the impact of the communication strategies or that they didn't know. Responses were qualified:

> *"Open communication and transparency comes with some push back from anti-GMOers, but overall has helped foster a more positive company image than if we had chosen to sit on the sidelines."*

> *"Our efforts have had a positive impact, however the voices of the 'opposition' are louder and more consistent and ultimately drowning out a lot of our efforts."*

> *"Our engagement with stakeholders is helping to increase knowledge and skills to engage in conversations with consumers and policy makers. I'd say we've had success with policy makers but our influence over consumer perception is likely minimal."*

Others stated that evaluation of communication outcomes were out of the scope of their responsibility:

> *"I don't address these issues directly and we are asked to leave the communications to our communications department."*

The value of strategy around dialogue was also illuminated:

> *"With each "conversation" that is had, we make a better conversation and a more compelling conversation. The only conversations that I can confirm actually have an impact are those that are one on one and the ones that are proactively started … when the conversation is created in response to a negative beginning, they do not seem to have the desired effect."*

> *"Often speaking to the converted though. I do engage in one on one Twitter battles with people who are truly ignorant of basic facts, sometimes to let off steam. Sometimes we agree to disagree, other times they give up."*

Expertise, Information and Resources

In an effort to understand the scale, scope, accessibility and management of ag-based information and resources, we queried respondents on a number of key issues in order to parse out strategies used to respond to controversial issues or difficult questions by stakeholders, the types of sources leveraged, perceptions of who the subject matter experts are, etc.

When faced with a question that the respondent did not know the answer to, most (55%) stated that they looked first to internal sources and external sources next. Thirty-two percent (32%) stated that they had, at one time or another, avoided responding to a question or query. When prompted, a primary reason for this was that the respondent felt that they didn't have the information, expertise or knowledge to respond accurately or in a timely manner:

> *"I work for government and so need to make sure that I respond with the right information. Usually topics outside my area of specialty are passed to other experts to respond to."*

> *"I did not want to engage with the person because I felt that my knowledge was not strong on the topic."*

"If I am not the expert or do not have up to date information, I am not comfortable responding to a question not in my area of expertise."

Respondents also alluded to exchanges or points in conversations where the return on the time invested would start to diminish:

"The source of the question was really not interested in dialogue."

"They were blatant trolls and really not open to debate."

"We respond to 90%+ [of queries], but once in a while will ignore/block particularly malicious queries."

"You need to know when to pick your fights."

When seeking external sources of information or expertise in response to queries, respondents ranked people within professional networks first. They ranked expert individuals, expert organizations and notable independent web sources (public or not-for-profit, blogs, etc.) second, third and fourth as sources of information. Government organizations were ranked lowest (fifth).

Two respondents did not know of any expert organizations while another stated that he/she would consult with a scientific research expert to get recommendations.

Table 3. Who do you identify as expert individuals in agricultural biotechnology?
(by absolute counts)[11]

Category of Expert	Absolute Counts
› Expert Individuals (n=18 identified)	32
› Academic / Public Sector Scientists (referred to 'generally' (as a category) or specifically (individuals))	31
› Industry Organizations	9
› Government Agencies and Organizations	5
› Private Sector Scientists	2
› Other Non for Profit Organizations	1
› Private Sector Company	1

[11] Beyond the request for individuals, respondents included organizations and broadly defined groups as well. They are included in this table but have been re-categorized for consistency and readability.

Table 4. Who do you identify as expert organizations on the topic of agricultural biotechnology?

(respondents were asked to list up to five) (absolute count of mentions)

Organization	Absolute Counts
Private Companies (n=5 identified)	14
CropLife	9
Universities	8
Agriculture and AgriFood Canada	8
Canola Council of Canada	5
Council for Biotechnology Information	4
Provincial Ag Ministries	4
AgWest Bio	3
Canadian Food Inspection Agency	2
Biotechnology Industry Organization	2
ISAAA	2
Genome Prairie	2
Genome Canada	2
SaskCanola	1
Canola Growers Association	1
Western Grains Research Fund	1
BioteCanada	1
AgBioWorld	1
International Food Information Center	1
National Research Council (Canada)	1
VALGEN	1
International Seed Foundation	1
Food Policy Research Institute	1
World Wildlife Fund	1

We asked respondents to rank, in order of importance to their organization, tools for disseminating information about agricultural biotechnology. Informative websites/online articles ranked as a number one tool. Op-eds, commentaries and blogs (second); print materials (brochures, summaries, etc) (third); visual media (photos, memes, infographics) (fourth); videos (short, shareable, plain language) (fifth).

Related to this, and according to respondents, the value of an online resource (ranked first above) is characterized by the simplicity of its message (first). This was followed by how easily it can be

found on the Internet (second) and how user friendly it is (third). Ranked last was how thorough the information was/is on that online resource.

Further to the notion of the value of 'simplicity of message,' the greatest challenge (identified by respondents) to sharing good, reliable information was in actually finding sources that present information clearly and in actually locating that information or source without having to sift through several sources to find it. Determining who and what information sources are trustworthy and how user-friendly the online source or site is was deemed (relatively) less important.

Respondents were asked to identify online, independent sources for information.

Table 5. Notable Independent Internet-based Information Sources

(by absolute counts of mentions)

Source	Absolute Counts
› Online journals/blogs	6
› Best Food Facts	4
› Council for Biotechnology Information	4
› GMO Answers	3
› Biofortified	3
› AgWestBio	2
› Agriculture and Agri-Food Canada	2
› Canadian Food Inspection Agency	2
› CropLife	2
› Health Canada	1
› Saskatchewan Ministry of Agriculture	1
› Individual Experts	1
› The American Association for the Advancement of Science	1
› The Information Technology and Innovation Foundation	1
› Biotechnology Industry Organization	1
› Biotech Research Centre / U of Minnesota	1
› National Center for Biotechnology Information	1
› Sense About Science	1
› AgBioWorld	1

In addition to the 19 web-based sources outlined above, four respondents stated either that there are no balanced or independent sources out there or that they didn't know of any.

Respondents were asked to identify and rank the gaps that exist for them and their organizations in terms of agricultural biotechnology communication resources. A lack of coordinated effort in addition to a lack of human resources applied to these kinds of organizational based activities were ranked highest. Respondents ranked the lack of proactive communications strategy third and leadership issues fourth. Lack of/or difficulty in accessing information sources, the scarcity of experts and access to Canadian content were ranked fifth, sixth and seventh respectively.

"A lack of coordinated effort in addition to a lack of human resources applied to these kinds of organizational based activities were ranked highest.

We also asked respondents to identify other gaps (or issues) in terms of agricultural biotechnology communication resources that may have not otherwise been outlined as options or thought points in the survey.

Some noted responses are as follows:

"Reliability and truthfulness of sources is a problem."

"We require a credible voice to speak to the issues … because often we feel that our organization isn't the most appropriate spokesperson."

"Budget and time constraints."

"Government is not taking a clear stand on what they support."

"Trying to get many players to agree to a common approach or a message is a challenge … we need more coordinated efforts."

"We need the ability to build bridges outside of agriculture [with other stakeholders] … the current debate is too polarized."

"We need to better understand the psychology of distrust; the lack of critical thinking …."

Landscape Analysis: Review of Online Sources

4.2

The 12 websites, 10 science/policy-based blogs and four farm blogs with evidence-based content were analyzed and evaluated and results presented in Appendix C, Tables a, b, c. The sources are evaluated on a number of factors inspired, largely, on the fundamental parameters outlined by Cline and Haynes (2001) (see section 2.4); factors that include: information types (e.g. food, technology, crop, weeds, etc), information format (whether there are videos, memes, policy briefs, etc. included), as well as other qualifying factors.

Overall, these two dozen plus resources – collectively - provide credible information covering a full range of issues relevant to agricultural biotechnology. While some sources specialize in specific areas (e.g. Andrew Kniss, Weed Control Freaks), others cover a broader set of topics (Kevin Folta, Illumination; GMO SkeptiForum; Steve Savage, Applied Mythology). Content, of course, is largely dependent upon scale, scope and resources behind the source (for example, GMO Answers has considerable funding behind the project as well as a cadre of scientific experts to draw from; Biofortified also has access to topic-expert bloggers as recurring contributors to build its informational capital). Most effort has been at a 'grassroots-level' having grown out of individuals' initiatives. These particular sources continue to be manned, managed and moderated solely by the author (expert) (see Appendix C, Table b). In the case of those that are public sector experts, it is presumed that these efforts are not necessarily supported by the institution (other than for provisional online space for websites) (for more on this see: Ryan and Doerksen 2013). Also, with a cursory glance at some of the most 'maverick' efforts (e.g. Kevin Folta or Steve Savage), we see an evolution in the communication and outreach process. Clearly, learning has occurred with communication and engagement efforts growing nuanced and definitely more proactive over time.

One category that online sources were evaluated on was the presence of or links to subject-matter relevant policy briefs. A policy brief is a "… concise summary of a particular issue" that provides "… the policy options to deal with [that issue] and some recommendations on the best option" (FAO UN 2011: 141). Policy briefs are aimed at government policymakers or policy influencers and are useful tools in bridging gaps between research, scientists or experts and those policy-making audiences: "… a method by which knowledge can be mobilized in a format that is easy to comprehend because they do not presume expert knowledge" (VALGEN 2013).[12] Policy briefs are a

[12] Over the course of the four-year project (funded through Genome Canada), VALGEN produced 50 policy briefs that – in that specialized format - reflected the research conducted by project constituents. The goal is to reach out and communicate research results to those in policy-making circles (see: http://www.valgen.ca/policy/).

form of 'knowledge synthesis'; they are part of a larger package of knowledge translation 'methods or tools' that can cut across disciplinary and expert-level boundaries (Ryan et al 2013). They are written in the present tense and they focus on critical issues rather than reviewing background information (VALGEN 2013).

> ***Accountability, responsibility and transparency are key components in any knowledge mobilization model.***

In our landscape analysis of websites, blogs and bloggers, policy briefs are not a communication tool of choice. Accountability, responsibility and transparency are key components in any knowledge mobilization model (Ryan et al 2013). It follows then that as a society we need to access and appropriately use sound scientific and technological information. Policy briefs can offer up a way to mobilize knowledge and expertise in a more user friendly manner (Ryan et al 2013). Time is always an issue. But expert bloggers are in a position to either develop or help develop policy briefs based upon their knowledge and expertise. At the very least opportunities for leveraging that expertise and developing briefs based upon that knowledge needs to be cultivated. Perhaps even via a separate collaborative-based hub or (knowledge mobilization) platform.

Another factor upon which the evaluation of websites and bloggers was based was on the presence or use of memes as communication tools. The word meme is a shortening (modeled on gene) of mimeme[13] and was coined by the British evolutionary biologist, Richard Dawkins in The Selfish Gene (1976). Memes are often used as tools for mimicry but they can also be used to communicate valuable information in meaningful ways by combining images and brief, shareable messages. They can tell stories, evoke emotions and provide valuable information if executed effectively (Ryan 2014c).

Given the diminishing attention spans of online lurkers or information-gathers, memes are an effective way to capture attention and relay information in meaningful ways in a very short time period. In our collection of websites and bloggers (Appendix C, Tables a through c), those who utilize this type of tool are the exception as opposed to the rule. Dr. Jude Capper (BoviDiva.com) is an example of an expert blogger that utilizes memes both as a tool in her social media communications (Facebook and Twitter) and to illustrate key points on her blog. Canadian blogger, Sarah Schultz (nurse, self-identified "farm wife"), also makes proficient use of memes. She generally includes at least one in each of her blogs. As standalone information pieces, they too are shareable and combine easy-to-process information with a visually stimulating format. Probably the most important feature

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[13] (from Ancient Greek μίμημα Greek pronunciation: [míːmɛːma] mīmēma, "imitated thing", from μιμεῖσθαι mimeisthai, "to imitate", from μῖμος mimos "mime")[4]

of memes is their 'share-ability.' Again, it takes skills and thought to develop an effective meme. Not only that, it requires an influential community to share if, in the end, it is to have the capacity to effectively build 'brand equity' for the communicating individual expert or organization. Memes can also be a tool to draw online users back to a (credible) source.

Most online resources reviewed here (websites, blogs) are either publicly funded, author-funded, may have funds from multiple (often non-profit) sources or are non-profit themselves, relying on donor contributions or sponsorship to maintain an online presence. These public or non-profit entities have an advantage in that they are more likely to be viewed as being "independent" and perceived to be free from industry funding or influence. Some of the sources are very transparent in (and clearly communicate) how they are funded or structured. GMO Answers, for example, is funded by Council for Biotechnology Information members (BASF, Bayer CropScienceDow AgroSciences, DuPont, Monsanto Company and Syngenta). Biology Fortified Inc. (Biofortified) clearly states that it is independently run on a volunteer basis and is not supported by any funding from any companies or government entities. Other online resources, such as Food Safety News, are less clear. Transparency with respect to this kind of information goes a great distance in establishing trust with the public; particularly if the funding structures are viewed as or perceived to be "independent."

> ***The willingness to engage in and contribute to reasoned dialogue would likely send a positive signal of accountability and transparency.***

Expert commentary and/or contributions are evident across websites and blogs - in some cases formally (through invited or guest posts as in the case of GMO Answers or BestFoodFacts) and in other cases, expert input is less formal in the form of comments to blog posts or dialogue/exchanges. Expert input and interaction of this kind is extremely valuable. Again, it lends to credibility to any given site or blog but also feeds into the credibility of the science and for agriculture from a 'big picture' perspective. Visible interaction or contributions by experts (beyond self-authored blog posts) also holds value for site lurkers – those that may be less engaged but just as (if not more) curious about information. The willingness to engage in and contribute to reasoned dialogue would likely send a positive signal of accountability and transparency. In expert blogs in particular, the "expert input" is probably taken for granted (the authors/hosts are themselves experts).

While there is some evidence cross-fertilization of expertise across blogs via comments (and references and hyperlinks), it is less formal and difficult to quantify. This could, however, be evaluated further utilizing a webcrawler tool as a way to formally quantify or visualize those connections. Supporting that evidence with a survey that seeks to examine the history and nature of connections among experts and organizations would also be useful. Presumably, many of the individuals connected to websites/organizations or those that are expert bloggers examined here

did not know of one another only a few short years ago. Understanding how those relationships were established and how they have evolved over time would provide some insight into "learning" by experts and organizations in terms of managing issues. It would appear that responses to issues have improved over time and 'collective responses' have become more effective and timely. For example, the initial response to the original publication of the now infamous Seralini et al study (2012) was much slower (two to three weeks) than that of the follow-on issues surrounding the retraction and subsequent republication earlier this year. In the latter case, responses were reported almost immediately with hyperlinks across various sources.

> ***A single conversation can quickly cross lines between agriculture, the environment, animal and human health and science.***

As mentioned previously, issues readily become conflated in our day-to-day conversations. A single conversation can quickly cross lines between agriculture, the environment, animal and human health and science. Thus, there is pressure upon experts to have at least some cursory knowledge about facts and information that may be outside of his/her immediate brand of expertise. At the very least, this requires experts to have knowledge about who the experts are and ensure that they are referenced or brought into the online dialogue (if available). Online sources (websites, expert blogs and others) need to acknowledge that this conflation exists and ensure (at least in terms of content, links and references) that implicit and explicit connections are being made between science and agriculture; between science and the public; and between agriculture and the public. In this evaluation, it is noted that the level of these kinds of overlaps varies from site to site or blog to blog. Some form of 'division of expert labour' appears to be cogent here. Over the past few years, the network(s) that tie these individuals and organizations together with respect to communicating science and/or agriculture are growing and certainly are more well-connected. The fact that good sources are geographically and institutionally dispersed matters less now as knowledge and expertise appears to cut across disciplinary, institutional and geographic boundaries. The online platform (social media, Twitter and Facebook) provides an environment wherein expert individuals with their knowledge, that would have otherwise be disconnected, can come together to address issues.

Another notable and very important source is the rise of Facebook-mediated discussion fora. A good example of this is GMO SkeptiForum. The Forum, established by Knigel Holmes in early 2013, sets itself apart from others in terms of its 'governance' model. The dialogue threads are driven by well-conceptualized guidelines for posting and moderating. While GMO Skepti-Forum warmly welcomes new members, it also compels accountability in both its members and in the growing group of proficient and engaged moderators. The structural guidelines that are fundamental to the Forum are important, especially in an online world where accountability is practically nil and where drive-by meme-drops and anonymous (often disingenuous) posts are the norm.

GMO Skepti-Forum has been incredibly popular and well-managed and has since evolved 'progeny.' In a personal email to Camille Ryan , Knigel Holmes states:

> *"My main goal [for Skepti-Fora] is to have somewhere that spans several social media networks that users can easily access to get questions answered. When people are confused with scientific information, I want to have a recognizable community they can go to easily. These days we have people insulating themselves in social media bubbles, and I don't think it's enough to build a website. Instead, I want to be their neighbour so that it's easy to just walk next door. People often don't want to move onto another platform, for example, Facebookers don't want to go to Google Plus. Perhaps the funny way to look at it is that I'm stealing the idea of how Starbucks creates a known atmosphere which people know and feel comfortable in when they travel to new countries. I want our atmosphere to be known so that people know it's a place for reasoned, evidence-based discussion."*

GMO Skepti-Forum has been a virtual breath of fresh air in the muddy world of misinformation. Those that strive for reasoned discourse and evidence-based approaches to evaluating information on the Internet appreciate this Forum (and its progeny: Health Skepti-Forum, Veterinary Skepti-Forum, Canadian GMO Skepti-Forum, etc). The broader Skepti-Forum family consists of more than 6,500 members and almost 40 moderators and has inspired the spin-off of other independent discussion groups such as Food and Farm Lab Discussion.

As was previously outlined, a majority of North American adults carry around some form of mobile technology twenty-four hours a day and seven days a week. As a wholly 'tapped in' society, the Internet has grown to be a fundamental part of social interaction and a 'go to' source for information on practically anything (Pew Research Internet Project 2014). Sources for credible, independent, online information sources about agricultural biotechnology need to be readily available, navigable, searchable, and user friendly (refer to list in Appendix D). And no one resource can readily cover all issues in entirety. Based upon this preliminary evaluation of credible online resources, problems may be less about quality and credibility of information, and more about accessibility and individual capacity to determine the quality and credibility of that information. It may be safe to say that there is a gap in the communication continuum between sites and sources outlined here and those that seek credible information about agricultural biotechnology. A filtering mechanism or strategy may be beneficial.

Summary and Concluding Thoughts 5.0

In short, traditional communication strategies no longer work in this information-rich environment where issues around agricultural biotechnology are complex and often conflated (Ryan and Doerksen 2013; Ryan 2014b).

Some key observations from this study:

Sources/Gaps:

- The Survey revealed a gap in communications with respect to stakeholders who wield a tremendous amount of power with consumers; the food processors and food retailers. These actors are closer to the consumer and can more readily be influenced by consumer opinion (Ryan and McHughen 2014).
- Respondents also identified gaps in the overall coordinative efforts, and dedicated resources to do so. Many within the community are coordinating efforts 'off the side of the desk.' Professional communicators need buy-in from those who control resources within organizations to engage in proactive communications strategies.
- What about credible resources? Public sector institutions (universities, research institutes, etc.) need to re-formulate existing traditional academic models in order to encourage scientists (with the appropriate knowledge) to step out and engage more

fully in dialogues. This means not only developing new incentive systems and reward mechanisms, but also offering technical support and training and incorporating search engine optimization strategies.

› Canadian-specific content appears to be lacking in online resources. This was noted by survey respondents and in our landscape analysis, however clear efforts are being made. Of note, the SaskCanola Board has allocated funding in its 2015 budget to develop a 30-minute documentary-style video to inform farmers and the public about the safety of GMOs.

› According to the results of the survey, very few organizations engage in education activities. We need to define who should be educated. Kindergarten to Grade 12 of course, but we cannot forget points of influence like teachers. We need to re-evaluate how this can best be accomplished, by whom and how efforts can be funded. A notable program has just been launched in the U.S. by the University of Nebraska-Lincoln and Iowa State University. Genetic Engineering: The Journey of a Gene is a detailed learning resource for educators, students, parents or anyone who wants to learn the science of genetic engineering, using the example of a soybean and an important soybean disease. Tools like these are invaluable for teaching and learning.

Strategies:

› Communications strategies do not take into account human behavioural factors. We see this in the lack of memes, pictures, videos used by our survey participants. In our community, traditional communications (newspapers, etc.) are still 'king' but the media environment has quickly evolved as have the demands for information (immediacy, simple messages, shareable formats).

› The response, "… we are asked to leave the communications to our communications department" from a survey respondent suggests that there may be a lack of appreciation for the complexity of the current issues-based environment that organizations operate in. Everyone in a given organization is in communications. Cross-departmental training and awareness-building should be mandatory.

› As many as 50% of survey respondents indicated that there is a lack of resources (human and dollars) attributed to communication efforts/strategies. As many as 25% of respondents indicated that they do not follow up or evaluate the outcomes of communication efforts. This suggests that more money and better monitoring is required.

› While not necessary to reinvent the wheel in terms of developing internal resources, it is important that communicators (and others who work in science and agriculture)

have a clear understanding of who and what is deemed as good expertise. According to survey results, many respondents struggle to respond in a timely manner to queries or engage in dialogue because they do not know where to seek out reputable, trustworthy, expert information. Communicators also need to be able to better leverage those key 'intermediate' sources such as GENetic Engineering Risk Atlas, or GENERA, a searchable database of peer-reviewed research on the relative risks of genetically engineered crops that includes important details at-a-glance[14] or participate (at the very least, "lurk" or search topic content) in discussion groups such as GMO Skepti-Forum.

› The use of mobile devices is becoming universal. Lay people and communicators alike need information at their fingertips. As we develop Canadian-based content or sources, we need to ensure that content is developed with user needs in mind (e.g. mobile-friendly websites, open or closed access, etc.), while keeping pace with technologies and trends (social media, apps, gamification, etc.).

Professional communicators in agricultural biotechnology as well as the lay public are dealing with information overload and problems with a socially-dominant public sphere (Internet) that is largely disorganized and often burdened by overly technical language or terminology (Cline and Haynes 2001). This environment makes good information difficult to seek out and sites (when found) difficult to navigate, especially since sources (good ones) can be incongruent (in terms of information, formatting, writing/presentation style) and very widely distributed (geographically and in terms of discipline). What was traditionally thought to be the private sector's 'job' is now becoming a challenge for the broader agriculture community. For example, the seed industry has to recognize it is in the food industry with a whole new set of stakeholders at the figurative boardroom table. Additionally, science has to step up and engage in non-traditional outreach activities, even if it's only in 140 characters or less. This new reality requires fundamental changes in approaches across the board - the public, private and quasi sectors – and all along the value chain. Traditional models and strategies need to be re-examined, reframed and fundamentally changed and 'silos' (between agricultural sub-sectors and scientific disciplines) need to be broken down. Actors all along the value chain need to come together to proactively tackle these very complex issues, with one voice yet using a range of strategies.

"Traditional models and strategies need to be re-examined, reframed and fundamentally changed and 'silos' (between agricultural sub-sectors and scientific disciplines) need to be broken down.

[14] GENERA was made public on August 25, 2014 by Biology Fortified Inc. GENERA has now entered its betatesting phase with the first 400 out of over 1,200 studies that have been curated http://genera.biofortified.org/wp/about/about-genera

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Appendix A

Landscape Analysis: Review of Online Sources

Legitimate Sources of Scientific Information	December 16 2012 Alexa Ranking	Less than Legitimate Sources of Scientific Information	December 16 2012 Alexa Ranking
The American Medical Association, (AMA)	2,686	Dr. Mercola	1,923
World Health Organization (WHO)	4,657	Natural News	2,183
U.S. Food and Drug Administration (FDA)	5,852	Dr. Oz	4,335
U.S. Environmental Protection Agency (EPA)	6,428	Greenpeace	10,705
Food and Agriculture Organization (FAO)	9,030	Consumers Union	118,470
Chinese National Academy of Science	28,961	Institute for Responsible Technology (J Smith)	155,399
Royal Society (London)	197,948	Cryptomundo	173,332
The U.S. National Research Council (NRC)	235,704	Friends of the Earth UK	246,847
National Academy of Science in India	236,121	Age of Autism	276,213
Third World Academy of Sciences	316,718	Friends of the Earth US	576,635
U.S. National Academy of Sciences (NAS)	673,756	Australian Vaccination Network (license revoked for charitable status)	764,759
American Society for Plant Biology (ASPB)	677,178	Health Ranger	1,213,700
Brazil National Academy of Science	1,989,732	ETC Group	1,321,345

Source: C. Ryan, previously unpublished data

The lower the number, the higher the traffic (relatively speaking).

Appendix B

The Survey Instrument

1. Do you wish to continue your participation in this survey?

- Yes
- No

2. As you may know, Canada's Anti-Spam Legislation (CASL) is coming into force on July 1, 2014. If you would like to continue to receive information regarding the results of this survey from Genome Prairie after that day, we require your express consent. You will always have the option to unsubscribe from our communications at any point in the future. Please click on the "Yes, I Consent" button to continue to assist us in complying with this legislation.

- Yes, I consent
- No, I do not consent

3. How would you describe your organization? [select one]

- Not for profit
- Small and medium enterprise
- Multinational enterprise
- Government
- Academia
- Grower organization
- Industry organization
- Other (please indicate)

4. How would you describe your role within your organization? [select one]

- Communications professional
- Communications support
- Management
- Executive
- Researcher
- Other (please indicate)

5. Agriculture's public image is... [select one]

- Negative and getting worse
- Negative

- Neutral
- Improving
- Positive

Please qualify your response (optional)

6. Overall, public perceptions of agriculture biotechnology are... [select one]

- Negative and getting worse
- Negative
- Neutral
- Improving
- Positive

Please qualify your response (optional)

7. Who do you view as your primary audience(s)? [check all that apply]

- [ ] Farmers / ranchers / growers
- [ ] Scientists/academics
- [ ] The public
- [ ] Government - policy makers
- [ ] Government - politicians
- [ ] Food processors
- [ ] Ag retailers
- [ ] Food retailers
- [ ] Other (please indicate)

8. Do you or your organization use key messages with respect to agriculture biotechnology with your target audience? [select one]

- Yes
- No
- I don't know

If so, please provide examples of those key messages (optional)

9. Who develops your communication resources? [select one]

- I / We develop resource content internally
- I / We access content from external sources
- I / We access and develop resource content internally and from external sources
- Not applicable

10. In your opinion, does your organization have the financial resources to carry out an effective agriculture biotechnology communications plan? [select one]

- Yes
- No
- I don't know

11. Please rank, in order of importance, the following social media tools that you use as part of your communication strategies:

Don't use in our organization [ ] Facebook

Don't use in our organization [ ] Twitter

Don't use in our organization [ ] Pinterest

Don't use in our organization [ ] LinkedIn

Don't use in our organization [ ] Instagram

Don't use in our organization [ ] YouTube

Don't use in our organization [ ] Tumblr

12. What outreach or communication activities has your organization (or individuals within your organization) participated in / led around the topic of agriculture biotechnology / sciences? [check all that apply]

- [ ] Op eds or mainstream articles
- [ ] Conference / event presentations
- [ ] Workshops
- [ ] Media interviews (radio, TV, online, mainstream publications / journals)
- [ ] Public engagement events
- [ ] Stakeholder (non-public) engagement events
- [ ] Educational materials (K-Grade 8)
- [ ] Educational materials (Grade 9-12)
- [ ] Not applicable
- [ ] Other (please indicate)

13. Is online bullying a deterrent for your organization, and its employees, to participate in online discussions about agriculture biotechnology? [select one]

- ( ) Yes
- ( ) No
- ( ) I don't know

14. Based upon your efforts, do you feel that you achieved some success with your communication strategies? [select one]

- ( ) Yes, awareness was raised
- ( ) No, not really
- ( ) Don't know, have not evaluated outcomes

Please qualify your response (optional)

15. Which measures do you use to evaluate your outreach outcomes? [check all that apply, or if none move to the next question]

- [ ] Content analysis / media tracking
- [ ] Website hits
- [ ]

☐ Facebook likes & shares

☐ Twitter follows, re-tweets, mentions

☐ Memberships (or the like)

☐ Post-event (feedback) surveys

☐ Other (please indicate)

16. When faced with answering a question that you don't know the answer to, what is your next step? [rank in order of importance]

[ ] Look to internal sources of information (brochures, reports, people, etc.)

[ ] Look to external sources of information (brochures, reports, people, Google, search engines, websites, etc.)

17. Have you ever avoided or not responded to a query? [select one]

○ Yes

○ No

○ Unsure

If so, why? (optional)

18. When seeking external sources of information or expertise, what is your preferred source? [rank in order of importance]

[ ] Contact someone within my existing network

[ ] Seek expert individuals

[ ] Seek expert organizations

[ ] Notable independent web sources (public or not-for-profit, blogs, etc.)

[ ] Government websites

19. Who do you consider to be expert individuals on the topic of agriculture biotechnology (examples of expertise include but are not limited to plant science, animal feeding studies, environmental studies, economics)? [list up to 5 experts]

20. What do you consider to be a notable independent web source on the topic of agriculture biotechnology (including blogs and informational websites)? [list up to 5 web sources]

21. Who do you consider to be an expert organization on the topic of agricultural biotechnology? [list up to 5 organizations]

22. Please rank, in order of importance to your organization, these tools for disseminating information about agricultural biotechnology:

Not applicable ☐ [ ] Visual media (photos, memes, posters)

Not applicable ☐ [ ] Videos (short, shareable, plain language)

Not applicable ☐ [ ] Print materials (brochures, summaries, etc.)

Not applicable ☐ [ ] Informative websites / online articles

Not applicable ☐ [ ] Op-eds, commentaries, blogs

23. The value of an information resource (online) is characterized by: [rank in order of importance]

A simple message

Thorough information

A user-friendly resource

How easily it can be found on the internet

24. In your opinion, what is the greatest challenge for your organization in finding good, reliable information? [rank in order of importance]

This isn't a challenge — Actually locating information sources

This isn't a challenge — User-friendliness of site / resource

This isn't a challenge — Determining who and what information can be trusted

This isn't a challenge — Sifting through a lot of sources to locate the right ones

This isn't a challenge — Finding sources that present information clearly

25. In your opinion, what is the greatest challenge for your organization in sharing good, reliable information? [rank in order of importance]

This isn't a challenge — Determining a medium for sharing information (listserv, blog, social media, etc.)

This isn't a challenge — Actually finding reliable information to share

This isn't a challenge — Finding resources that will be clear and easy to understand

This isn't a challenge — User-friendliness of site / resource

This isn't a challenge — Developing content

This isn't a challenge — Negative public perceptions

26. In your opinion, what are the gaps in agricultural biotechnology communication resources and / or services for you / your organization? [rank in order of importance]

Lack of human resources (new positions within organizations, consultants, etc.)

Lack of / or difficulty in accessing information sources

No coordinated efforts, piecemeal approach

Scarcity of experts

No proactive communications strategy

Leadership

Access to Canadian content

27. Can you identify gaps in agriculture biotechnology communication resources and / or services that are not listed in the question above?

Appendix C

Table a. Landscape Analysis (Websites)

Title of Source	Type (how funded)				Canadian Content?	Searchability	Information Type (check all that apply)							Information Format (check all that apply)						Content Qualified			
	private	public	non-profit	other	yes/no	x	food	technology	animal/livestock	crops	third world	weeds	other	videos	expert input/comment	memes	policy briefs	media statements	mainstream articles/blogs	Expert Input?	Science/Agriculture Connection Made?	Science/Public Connection made?	Agriculture/Public Connection Made?
GMO Answers	yes	x	x	yes	not explicitly	weak	yes	yes	yes	yes	yes	yes	x	x	yes	x	no	x	yes	yes	yes	yes	yes
Best Food Facts	x	x	yes	x	not explicitly	moderate	yes	yes	yes	yes	some	yes	x	yes	yes	x	no	x	yes	yes	yes	yes	yes
Biology Fortified	x	x	yes	x	not explicitly	moderate	yes	yes	some	yes	yes	yes	yes	yes	yes	x	no	x	yes	yes	yes	yes	some what
Genetic Literacy Project	x	x	yes	x	not explicitly	weak/moderate	yes	yes	some	yes	yes	yes	yes	no	yes	x	no	x	yes	yes	yes	yes	yes
Find Our Common Ground	x	x	x	unclear	not explicitly	moderate/high	yes	yes	yes	yes	less	less	x	yes	yes	x	no	x	yes	yes	some what	some what	x
Food Safety News	x	x	x	unclear	yes	moderate	yes	yes	less	yes	less	less	x	yes	yes	x	no	x	yes	yes	yes	yes	x
Center for Food Integrity	x	x	x	unclear	no	moderate	yes	yes	less	yes	some	not explicitly	x	no	yes	x	no	x	yes	yes	some what	some what	x
GMO Skepti-Forum	x	x	yes	user-funded	some	moderate	yes	yes	less	yes	yes	some	x	no	yes	x	no	x	yes	yes	yes	yes	x
Science-based Medicine	x	x	x	unclear	not explicitly	moderate	some	yes	not explicitly	yes	some	not explicitly	x	no	yes	x	no	x	yes	yes	some what	yes	x
Academics Review	x	x	yes	x	not explicitly	weak/moderate	not explicitly	yes	not explicitly	more policy based	yes	no	x	no	yes	x	no	x	less so	yes	yes	yes	x
Alliance for Food and Farming	x	x	yes	x	not explicitly	moderate	yes	yes	yes	x	less	some	x	yes	yes	x	no	x	yes	yes	yes	yes	x
Food and Farm Care	x	x	yes	x	yes	moderate/high	yes	yes	yes	yes	less	less	x	yes	yes	x	no	x	yes	yes	yes	yes	yes

Table b. Landscape Analysis (Expert Blogs)

Title of Source		Institutional Affiliation	Specific Canadian Content?	Information Type (check all that apply)							Information Format (check all that apply)					Expert Input						
			yes/no	food	technology	animal/livestock	crops	third world	weeds	other	videos	memes	policy briefs	media statements	mainstream articles/blogs	# experts (if recorded)	private	public	other	Science/Agriculture Connection Made?	Science/Public Connection made?	Agriculture/Public Connection Made?
Folta, Kevin	Illumination	U of Florida	no	x	yes	x	yes	yes	x	yes	yes	yes	n/a	n/a	x	n/a	n/a	n/a	n/a	yes	yes	yes
Ronald, Pam	Tomorrow's Table	UCDavis	no	yes	yes	x	x	yes	x	yes	yes	x	n/a	n/a	x	n/a	n/a	n/a	n/a	yes	yes	yes
Kniss, Andrew	Weed Control Freaks	University of Wyoming	no	yes	yes	x	yes	x	yes	x	x	x	n/a	n/a	x	n/a	n/a	n/a	n/a	yes	yes	yes
Savage, Steve	Applied Mythology	independent	no	yes	yes	x	yes	some	some	yes	x	x	n/a	n/a	x	n/a	n/a	n/a	n/a	yes	yes	yes
Yancy, Janeal	Mom at the Meat Counter	independent	no	yes	some	yes	x	x	x	x	x	x	n/a	n/a	x	n/a	n/a	n/a	n/a	yes	yes	yes
Capper, Jude	Bovidiva	Washington State U	no	yes	some	yes	some	x	x	yes	x	yes	n/a	n/a	x	n/a	n/a	n/a	n/a	yes	yes	yes
Brazeau, Mark	RealFood.org	independent	some	yes	yes	x	yes	yes	some	x	x	x	n/a	n/a	x	n/a	n/a	n/a	n/a	yes	yes	yes
Novella, Steve	Neurologica Blog	Yale U School of Medicine	no	some	yes	x	x	x	yes	yes	x	x	n/a	n/a	x	n/a	n/a	n/a	n/a	x	yes	yes
Gianessi, Leonard	PesticideGuy.org	Director of Crop Protection Research Institute	no	yes	yes	not explicitly	yes	some	yes	x	x	x	n/a	n/a	x	n/a	n/a	n/a	n/a	x	x	x
Daynard, Terry	Comments on Food, Ag and the Bioeconomy	independent	yes	yes	yes	x	yes	some	yes	x	x	x	n/a	n/a	x	n/a	n/a	n/a	n/a	yes	yes	yes

Table c. Landscape Analysis
(Ag Blogs with Evidence-based Content)

Title of Source		Canadian Content?	Expertise (beyond that of farmer)
		yes/no	
Sarah Schultz	Nurse Loves Farmer	yes	nurse
Jennifer Schmidt	The Foodie Farmer		RD
Rob Wallbridge	The Fanning Mill		unclear
Scott, Brian	A Farmer's Life		B.Sc.

Appendix D

List of Credible (Online) Resources

Title/Source		URL	category
GMO Answers		http://gmoanswers.com/	Website
Best Food Facts		http://www.bestfoodfacts.org/	Website
Biology Fortified		http://www.biofortified.org/	Website
Genetic Literacy Project		http://www.geneticliteracyproject.org/	Website
Find Our Common Ground		http://findourcommonground.com/	Website
Food Safety News		http://www.foodsafetynews.com/	Website
Center for Food Integrity		http://www.foodintegrity.org/	Website
GMO Skepti-Forum		http://www.gmosf.org/	Website
Science-based Medicine		http://www.sciencebasedmedicine.org/	Website
Academics Review		http://academicsreview.org/	Website
Alliance for Food and Farming		http://www.safefruitsandveggies.com/	Website
Food and Farm Care		http://www.farmfoodcare.org/	Website
Folta, Kevin	Illumination	http://kfolta.blogspot.ca/	Blog
Ronald, Pam	Tomorrow's Table	http://scienceblogs.com/tomorrowstable/	Blog
Kniss, Andrew	Weed Control Freaks	http://weedcontrolfreaks.com/	Blog
Savage, Steve	Applied Mythology	http://appliedmythology.blogspot.ca/	Blog
Yancy, Janeal	Mom at the Meat Counter	http://momatthemeatcounter.blogspot.ca/	Blog
Capper, Jude	Bovidiva	http://bovidiva.com/	Blog
Brazeau, Mark	RealFood.org	www.realfood.org	Blog
Novella, Steve	Neurologica Blog	http://theness.com/neurologicablog/	Blog
Gianessi, Leonard	PesticideGuy.org	http://pesticideguy.org/	Blog
Daynard, Terry	Comments on Food, Ag and the Bioeconomy	http://tdaynard.com/	Blog
Schultz, Sarah	Nurse Loves Farmer	http://www.nurselovesfarmer.com/	Blog
Schmidt, Jennie	The Foodie Farmer	http://thefoodiefarmer.blogspot.ca/	Blog
Wallbridge, Rob	The Fanning Mill	http://thefanningmill.com/	Blog
Scott, Brian	A Farmer's Life	http://thefarmerslife.com/	Blog
GMO Skepti-Forum		Facebook Discussion Forum	
Farm and Food Lab Discussion		Facebook Discussion Forum	
GMO Canadian		Facebook Discussion Forum	