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Amy Elizabeth Jenkins
Vineland Research and Innovation Centre

Alexandra Grygorczyk
Vineland Research and Innovation Centre

Andreas Boecker
University of Guelph

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Abstract

Use of effective public communication strategies is critical for Extension professionals to successfully navigate challenges faced by the agriculture sector and local community, effect policy changes, and ensure public value for the Extension program. Simply addressing the public knowledge deficit is ineffective for gaining public trust in science. Thus, implementation of public engagement and increased dialogue are central to contemporary Extension practice. Such an approach requires balancing factual knowledge with an engaging and open communication style. We draw on both research findings and advice from experienced science communicators to provide a synthesis of practical tips for achieving this balance. Guidance is given regarding framing, word choices, and common pitfalls.

Keywords: science communication, public communication, education, message framing

Amy Elizabeth Jenkins
Research Technician, Consumer Insights
Vineland Research and Innovation Centre
Vineland Station, Ontario, Canada
amy.jenkins@vinelandresearch.com

Alexandra Grygorczyk
Research Scientist, Consumer Insights
Vineland Research and Innovation Centre
Vineland Station, Ontario, Canada
alexandra.grygorczyk@vinelandresearch.com

Andreas Boecker
Associate Professor
Department of Food, Agriculture, and Resource Economics
University of Guelph
Guelph, Ontario, Canada
aboecker@uoguelph.ca

Introduction

The work of Extension professionals centers on public communication of science. Although there is a great deal of valuable science communication guidance available (Clifford & Monroe, 2018; Clyde, Eberhardt, Prysby, & Stofer, 2018; Niebaum, Cunningham-Sabo, & Bellows, 2015; Osmond et al., 2010; Robinson, 2013), there is a need to synthesize the guidance from published sources and the advice of experienced science communicators (Weitze & Pühler, 2013) into a concise format for easy reference.

Clear guidance on effective science communication strategies is particularly important for Extension professionals addressing controversial topics such as climate change and biotechnology. It has been demonstrated that simply addressing the public knowledge deficit is ineffective for gaining public trust in science (Bauer, Allum, & Miller, 2007; Covello & Sandman, 2001). Thus, public engagement and increased dialogue are central to contemporary Extension practice (Clyde et al., 2018; Robinson, 2013). Such approaches require balancing factual knowledge with an engaging and open communication style, which may

be challenging to navigate. We present here a guide that addresses this need. Although originally developed for the biotechnology sector, the principles discussed are relevant to all areas and will help Extension professionals working in areas such as food and health, agriculture, and climate variability, among others.

Communication Elements

The guidance presented here provides background for effective science communication. To aid in implementing this information, we have developed a checklist, found in the appendix, which provides practical wording examples and can act as a quick reference guide for Extension professionals when preparing fact sheets, public presentations, and workshops. The elements of the checklist are explained in Tables 1 and 2.

Table 1.

Effective Science Communication: Content and Wording

Guideline	Explanation
Present both risks and benefits.	Although there is conflicting research regarding whether presenting both risks and benefits helps in changing individual opinion, presenting all information is important so that individuals do not feel as if an organization is withholding information (Covello & Allen, 1988).
Avoid exaggeration and emotive language.	Do not try to minimize or overstate risks or benefits (Covello & Allen, 1988).
Manage risks.	Focus on known risks (Center for Food Integrity, 2014), but address fears of unintended consequences (Grygorczyk, Jenkins, Deyman, Bowen, & Turecek, 2017). Emphasize where scientists have control over a process. Point out what is currently being done to minimize risk. You may also consider reminding the audience that there is no risk-free solution or technology, be it modern or traditional (C. Mackay, Farm & Food Care, personal communication, April 13, 2016).
Use consumer-friendly language, and keep in mind words' cultural associations.	As an example, "chemical" which in the scientific community has a neutral connotation is often associated with "toxin" in the mind of the public (Grygorczyk et al., 2017). Be aware of jargon and check for comprehension with someone outside your industry. A 2017 study showed that the term "traditional plant breeding" was misunderstood by around two thirds of surveyed Canadians and that many believed it referred to pesticide-free farming (Grygorczyk et al., 2017). Note that language at a 10th grade level is most comfortable for general audiences.
Avoid anthropomorphisms.	Although anthropomorphisms, such as "baby bugs," are commonly used in classrooms to explain scientific phenomena, they can elicit negative connotations as the audience imagines treatments applied in an experiment being applied to humans (Grygorczyk et al., 2017).
Do not try to cover up previous mistakes.	Using the example of pesticides, when a pesticide that was previously in use is removed from the market as it no longer meets modern health or environmental safety standards, be clear about how the science has evolved and the corrective action taken (Covello & Allen, 1988).

Reference credible and influential information sources.	When relevant (e.g., during a speaker introduction or in a brief author biography in a fact sheet), state credentials such as relevant education, experience, and values-based achievements, including awards for environmental stewardship (Center for Food Integrity, 2017; Covello & Sandman, 2001; Sapp et al., 2009).

Table 2.

Effective Science Communication: Message Framing

Guideline	Explanation
Make the message relevant.	Provide information that is directly relevant to an individual's own life (Center for Food Integrity, 2014). When speaking with the public, avoid discussing benefits to corporations or producers. Consumers are often concerned that risks and benefits are not distributed evenly (Covello & Sandman, 2001), with consumers more often forced to bear the risks while companies reap the benefits.
Make the message relatable.	It is not always possible for a situation to be directly relevant to your audience (e.g., a technology addressing food security in a foreign country). However feelings of connection to affected individuals can make the content feel more relevant (Green, Grorud-Colvert, & Mannix, 2018). Relatability can be created by emphasizing commonalities in the human condition, such as the need to feed our families or the need for safety. Storytelling is particularly effective (Green et al., 2018) and can motivate nonscientist audiences (Kelly, Cooley, & Klinger, 2014), humanize the science, and make the communicator more relatable. Although using emotive language in formal public communications is generally discouraged, its use is expected and beneficial when describing personal experiences. In this context, emotive language helps immerse the listener in the story (Stephens, Silbert, & Hasson, 2010), resulting in greater engagement (Green & Brock, 2000).
Use loss framing.	Individuals are more prone to consider information that conflicts with their own views when they are in a loss-decision frame (Fischer, Jonas, Frey, & Kastenmüller, 2008) (e.g., discussing the potential economic loss to the local community if rapid regional ocean acidification is not stopped; Kelly et al., 2014).
Discuss shared values.	Having values in common with your audience—for instance, environmental protection—is one of the most important factors for building public trust and communicating persuasively (Allum, 2007; Earle & Cvetkovich, 1995; Sapp et al., 2009). Simply stating shared values is not enough, however. Communication should focus on relationship building, with shared values continuously demonstrated through trustworthy behavior in line with those values. Leading with a relationship-building approach means communication is conversational rather than conversional (C. Ryan, personal communication, May 20, 2018). As the famous quote from Theodore Roosevelt goes, "No one cares how much you know, until they know how much you care."
Emphasize familiarity.	
Use familiar risk equivalents.	Unfamiliar risks can be perceived as more of a threat (i.e., Ebola vs. Influenza) (Covello & Sandman, 2001). Where possible, relate risks to known risk equivalents. For example, explain that the chances of falling ill from a certain level of contamination is 1,000 times

	lower than the risk of being struck by lightning.
Humanize the process.	Showing the people behind a process can make the practices more approachable and create more positive feelings toward those practices (Grygorczyk et al., 2017). This strategy could involve naming individuals responsible for certain tasks and including quotes and relevant personal details.
Humanize photographs.	Including pictures of people involved in a scientific task helps give a face to scientific concepts, making them more familiar and approachable (Rumble, Chiarelli, Culbertson, & Irani, 2014). When appropriate, include individuals' faces without personal protective equipment. Depict the reality of the process, and do not exaggerate the technical aspects (Grygorczyk et al., 2017). For example, do not show images of workers standing in an agricultural field in protective suits and goggles if that is not the routine outfit of the workers when in the field.
Evoke known techniques.	Refer to familiar processes that are elements within larger and unfamiliar processes (e.g., the use of plant breeding as a step in genetic engineering). If applicable, refer to parts of a process that are also present in nature.
Observe history of use.	Safety information is more impactful when it demonstrates safety through history of use rather than when safety is confirmed by using other technologies such as advanced genetic screening tools (Grygorczyk et al, 2019).

Conclusions

Effective science communication involves many more stylistic elements than just using simpler terminology. When communicating with the public, it is critical to also consider appropriate framing to bring familiarity to a subject that may seem foreign and intimidating to a general audience. Audience-appropriate communication strengthens relationships and influence, making Extension activities more impactful.

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Appendix
Communication Checklist

The content herein is derived from the "Agricultural Biotechnology Communicator (ABC)'s Checklist" found at https://www.vinelandresearch.com/best-practices-for-agricultural-technology-communication/.

Openness and transparency

1. **Present both risks and benefits**

Both risks and benefits are clearly stated

Either risks or benefits are stated

It is explicitly stated that no risks or benefits are present

2. **Present both risks and benefits**

Language used is neutral. Extent of risk and benefit is clear

"GM cotton has contributed to reduced pesticide use in India"

"Development of increased tolerance in weeds and pests is possible but can be addressed by..."

Some hyperbole and emotive language used however text contains many parts with neutral wording

Language used is mostly hyperbolic and overly emotive

"GM foods are environmental suicide"

"GM foods will revolutionize our world"

3. **Manage risks**

Safety precautions are addressed and a clear link is made as to how they address unintended consequences

"To minimize the risk of unintended consequences, all our new products undergo allergen testing"

Either risks or benefits are stated

"Allergen testing is conducted on all new products"

It is explicitly stated that no risks or benefits are present

4. **Use Consumer friendly language**

Language used is at a Grade 10 comprehension level similar to that used in newspapers and magazines. If scientific terms are used, their meaning should be explained without the use of acronyms

"In plant breeding, pollen is transferred manually between plants with the intent to produce new plants that combine the best features from both original plants."

Scientific terms are explained. Language remains technical

"Plant breeding relies on controlled cross pollination. This is the transmission of pollen from one specific plant to another and yields hybrid offspring (offspring with characteristics of both original plants)."

Scientific terms are not explained and vocabulary used is unnecessarily complicated

"Cross pollination of plants using controlled pollination yields hybrid offspring."

5. **Avoid anthropomorphisms**

Processes explained without using human or animal metaphors

Avoid terms such as "Plant parent" or "Match-making with plants."

6. **Add back familiarity**

Below are three ways to effectively add familiarity to your writing.

Processes or risk explanations are equated with examples from everyday life

"Flying in a plane is safer than driving in a car."

"The method has been used for over 90 years..."

Agricultural practices are humanized by naming individuals responsible for specific tasks, including quotes and relevant personal details

"...using imaging technology similar to that used in modern medicine."

"John, a father of two, was raised in Des Moines, Idaho and has his own hobby farm. He is responsible for..."

Highlight familiar aspects of novel or unfamiliar processes

When explaining the development of new plant varieties using mutagenesis (an unfamiliar process) explain how traditional breeding (a familiar process) is always involved as a step in the process as well.

Pictures are included, depicting the faces of the people behind the work or product. Technical aspects of the workplace are not exaggerated and when realistic, people are shown without personal protective gear.

Additional Consideration

Message Context

1. **Relevance**

Benefits shown to have a direct impact on the target audience or a group the audience identifies with

Benefits indirectly affect the individual or only benefit society as a whole

"Increased yield of GM crops helps feed the world's growing population."

Benefits framed in context not relevant to the consumer or as a benefit to companies or producers

"Increased stability of income from GM crops helps farmers."

Additional Consideration

Outcomes that are not relevant to the target audience are made relatable

"Will there be enough food to feed ~~the world~~ everyone?"

"...safe and nutritious food to feed ~~the population~~ families."

"...empower (people in) developing countries to achieve food security."

"Small hold farmers like Vincent, are having difficulty growing food to feed their families. Vincent is on a mission to access technologies such as these..."

2. **Credible and influential sources**

Credible and/or influential sources are cited

AND

Use storytelling to humanize the challenges and discoveries of credible sources

"Farmers have been growing papaya on the island for many years. Most depend on it to feed their families. When we realised ringspot was deveastating this staple crop we knew something had to be done."

3. **Loss framing**

Below are three ways to effectively add familiarity to your writing.

Risks associated with not adopting new technology are presented in a loss frame. Most effective when referring to a specific case.

"By not using GM products to combat banana wilt we miss an opportunity to help smallholder East African farmers feed their families."
