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Abstract

Huanglongbing (HLB), commonly known as citrus greening, is a bacterial disease severely affecting the profitability and continuation of the citrus industry in Florida and is threatening the citrus industry in other states as well. Currently, the disease only can be managed, not cured. Gene-based therapies, such as GM science, have been identified as a viable long-term solution. However, consumer acceptance of genetically modified food is low and their understanding and acceptance of new technologies is largely dependent on what they receive through mass media. Therefore, the purpose of this research is to understand news coverage of both citrus greening and gene modification science. This content analysis studied news articles of either citrus greening or gene modification science in national and state-specific newspapers and identified that while citrus greening is not highly covered by newspapers, it is accurately described via appropriate terminology. Genetic modification science is more commonly a topic of news coverage and is somewhat neutral and balanced in coverage. This research shows that source use in media coverage of gene modification science is balanced, but sources are most commonly chosen from organizations with a directed opinion or position on the topic.

Keywords

Citrus greening, GMO, Content analysis, Agenda Setting Theory, Framing Theory

Cover Page Footnote/Acknowledgements

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Media Portrayal of GM Science and Citrus Greening in State and National Newspapers

Florida, California, and Texas are the nation's top three producers of citrus, accounting for 49%, 47%, and 4% respectively of total United States citrus production (United States Department of Agriculture [USDA] - National Agricultural Statistics Survey [NASS], 2016). Citrus production in California, Florida, and Texas is valued at \$2.1 billion, \$1.1 billion, and \$81 million respectively (USDA - NASS, 2016), making the citrus industry in each state a vital component of their respective economies. However, the citrus industry in Florida is being severely diminished by a disease called Huanglongbing (HLB), which also is a major looming threat towards the citrus industry in other citrus-producing states. One viable solution identified to combat citrus greening is the use of genetic modification (GM) and gene technologies (Korves, 2015; Mahgoub, 2016). Using the Agenda-Setting and Framing theories as guidance, this study examined news coverage of citrus greening, GM science, and any overlap of the two topics in the top three national newspapers, as well as top newspapers in the citrus-producing states of California, Florida, and Texas. This study was the first step in a larger effort to understand audience attitudes surrounding GM science and the citrus industry.

HLB, also commonly known as citrus greening, is a bacterial disease that can only currently be managed, not cured (USDA, 2014). The bacterium is primarily spread from tree to tree via the Asian Citrus Psyllid but also can be spread by grafting (University of Florida Citrus Research and Education Center, 2015). The disease causes yellowing of the tree's leaves, decreased fruit size, and decreased fruit quality (Danyluk, Spann, Rouseff, Goodrich-Schneider, & Sims, 2011). Mature infected trees become less productive and young infected trees usually die within one to two years (Brlansky, Dewdney, & Rogers, 2013). Management practices include quarantining infected groves, removing infected trees, heavy pesticide application to control the insect vector, heavy and frequent bactericide application, and a variety of other costly practices (Dewdney, Rogers, & Brlansky, 2016; University of California IPM, 2016). Citrus greening has been identified by the USDA (2014) as one of the most serious citrus diseases in the world. Florida's citrus industry has especially been affected, where orange acreage and yield in Florida has decreased by 26% and 42% respectively since the disease was first found in south Florida in 2005 (Singerman & Useche, 2015). California and Texas have been more proactive in their response efforts and, due to strict quarantines and management practices, have been able to contain the disease and insect vector in isolated areas, preventing the disease from establishing itself yet in the respective states (University of California IPM, 2016; Texas Department of Agriculture, 2016).

Since 2009, the USDA has awarded more than \$400 million in research grants to find viable long-term solutions for the problem (USDA - National Institute of Food and Agriculture, 2016). One viable solution identified is the use of genetic modification (GM) and gene technologies (Korves, 2015; Mahgoub, 2016). Genetic modification is defined by one source as "the process of changing the structure of the genes of a living thing in order to make it healthier, stronger, or more useful to humans" (Genetic Modification, 2017). Gene technologies is a broader term that encompasses techniques to understand genetics and gene expression, genetic modification being one of the many techniques.

Genetic modification to create GM papaya trees was used to save the papaya industry from a similar situation in Hawaii when traditional technologies were unable to stop the papaya ringspot virus. More than 80% of papaya grown in Hawaii was produced from genetically modified trees by 2009 (Gonsalves, 2014). In the U.S., the farmer adoption of GM maize, cotton, and soybeans has exceeded 90% (Lucht, 2015). Biotechnology, in general, has become the fastest adopted crop

technology, with more than 18 million farmers using the technology internationally (Lucht, 2015). This is because farmers profit financially by planting GM crops despite higher seed cost for biotech varieties (Klumper & Qaim, 2014). When utilizing GM crops, farmers also cite non-monetary benefits, such as saving of time, ease of use, and more planning flexibility (Brookes & Barfoot, 2014; Carpenter, 2013; Fernandez-Cornejo, Wechsler, Livingston, & Mitchell, 2014; Qaim, 2009). While the adoption of genetic modification technologies by farmers is high, food from GM crops is a widely unpopular idea across the world and has been met with much criticism and resistance by consumers due to concerns of safety risks and environmental effects (Funk & Rainie, 2015; Frewer, Scholderer, & Bredahl, 2003; US FDA, 2015).

The majority of American adults believe foods produced from genetically engineered ingredients are not safe for consumption even though the safety of consuming GM foods has been thoroughly tested (CSIRO, 2002; Funk & Rainie, 2015; USDA, 2015). In addition, GM science is a much more precise and quicker plant breeding practice than traditional breeding methods, and current research has not yet found significant health hazards related to GM science (Nicolia, Manzo, Veronesi, & Rosellini, 2014; USDA, 2015). This creates a problem because without a viable solution, the Florida, California, and Texas citrus industries face collapse. Citrus production using GM science to address HLB could prevent that from happening, but the adoption of GM science in citrus can create new problems if consumers react negatively towards consuming citrus produced with GM science.

Review of Literature

This study investigated the agenda-setting effect of news media through the absence or presence of coverage of two topics: GM science and citrus greening. This study also researched the framing effect of news coverage by examining the content of the news stories and how the two topics were portrayed in the news. Agenda setting and framing in news media can influence public opinion (Price & Tewksbury, 1997). Agenda setting is described by the guidance of news values in story selection that decide which issue, event, or person is newsworthy. The selection of newsworthy stories out of possible issues, events, and developments can lead audiences and the public to develop a media-induced, and sometimes distorted, view of the greater environment. This effect is referred to as the agenda setting effect of mass communication and political science research (Iyengar & Kinder, 1987; McCombs & Shaw, 1972; Weaver, Graber, McCombs, & Eyal, 1981). The Agenda Setting Theory posits that the media do not influence what people think, but rather influence public perception of issues and how important the public feels the issue is through the frequency of coverage (McCombs & Shaw, 1972). The more often an issue or subject is covered, the more importance audience members give towards the issue or topic being covered (Folkerts, Lacy, & Larabee, 2008; McCombs & Shaw, 1972). Additionally, the media can influence which issues the public views as salient through the effects of agenda setting (Scheufele & Tewksbury, 2007). Agenda setting is primarily focused on the amount of time and attention given to the issue, which carries a more potent effect on the audience (Scheufele & Tewksbury, 2007). Prior research utilizing agenda setting has noted a negative impact on consumer confidence in the preparedness and ability of the food system to deal with food safety problems, suggesting that the mass media play a role as an influential and important component of changing consumer attitudes (Bharad, Harrison, Kinsey, Degeneffe, & Ferreira, 2010).

The second way news values may influence public opinion is through framing or the way in which the content of the article itself is presented. Journalists tend to present public issues with

certain story frames (Gamson, 1992). The frames often reflect broader narratives and cultural themes and the ways in which journalists present ideas, information, issues, and events affects how audiences understand the ideas, information, issues, and events. This phenomenon is known as the framing effect (Iyengar, 1991; Pan & Kosicki, 1993). Frames are cultural structures that organize an individual's understanding of social phenomena and are used to define stakeholder roles and outline relevant beliefs, actions, and values (Hertog & McLeod, 2001). In addition, they are used to determine what content is relevant to the discussion, to outline the values and goals of the content area, and determine the language used to discuss the topic (Hertog & McLeod, 2001). Frames also are what individuals use to organize or structure message meaning (Goffman, 1974). Framing enables a messenger to categorize information and package it in a way that can be easily understood by audience members (Dunwoody, 1992; Gitlin, 1980). Therefore, the media have the power to influence public opinion about the citrus greening crisis or, conversely, the perceived hazards of GM foods through the frequency of news coverage and framing of news information.

Increased exposure to negative media messages can heighten attitudes and influence audience support for public policies and restrictions (McGinty, Webster, & Barry, 2013). Additionally, some research has shown that extensive press media coverage on an issue highlighting important risks to the public can result in greater perceived risk (Vilella-Vial & Costa-Font, 2008). When consumers perceive risk, they develop strategies to reduce risk and ease cognitive dissonance (Bauer, 1967; Cox, 1967). In the case of the citrus industry, this could mean consumers vote for policies that restrict the use of GM science in citrus production, refuse to purchase GM citrus, or choose to buy an alternative product, such as apple juice. With GM science as a possible solution to the citrus greening crisis, it is important to assess what information consumers are being exposed to so communication with the public can be more beneficial.

When it comes to news coverage, news editors and reporters develop distinctive work ways, values, and procedures to help them produce news quickly and frequently (McLeod, Kosicki, & McLeod, 1994). Beliefs about what makes a good story enter into editorial decisions of story selection and into how reporters present their stories. It is because of this that particular perspectives, story angles, and journalistic themes dominate the news flow (Bennett, 1988; Gans, 1979; Gitlin, 1980).

Framing studies have been used in the past to explore agricultural topics, including GM science. Newspapers in the U.S. and in the United Kingdom historically have focused on the hazards or risks associated with using biotechnology in agriculture (Marks, Kalaitzandonakes, Allison, & Zakharova, 2002; Marks, Kalaitzandonakes, Allison, & Zakharova, 2003). Additionally, the frames used by the newspapers tended to become more negative over time, which corresponded with the public's increasingly negative perceptions toward the technologies (Marks, Kalaitzandonakes, Wilkins, & Zakharova, 2007). Crawley (2007) explored how newspapers in different regions of the U.S. frame agricultural biotechnology. Frames in Missouri focused on the economic importance of the technology to the region, but newspapers in California framed agricultural biotechnology by the controversies surrounding the topic. Crawley (2007) concluded the frames used in the two locations were reflective of the public's viewpoints as well. This finding indicated that there were differences in opinions regarding agricultural biotechnology across the nation despite how national newspapers presented the topic (Crawley, 2007). Sources also were identified in the study, and government agencies, biotechnology research companies, and universities were most frequently used in the news articles (Crawley, 2007).

Ruth and Rumble (2016) used framing theory to explore how Golden Rice, which was developed through GM science, was portrayed in the U.S. and in the Philippines. Golden Rice

could serve as a solution to Vitamin-A deficiency (VAD) in countries like the Philippines. In the U.S., humanitarian and science-driven frames were used to describe the product. However, conflict and risk frames were identified in the Philippines. Sources were not often used in the newspapers in the U.S., and the people who were quoted were typically industry or university researchers (Ruth & Rumble, 2016). Recommendations from the study included providing more information through Extension to journalists in the U.S. and consumers in the Philippines to influence framing in the media. A recent content analysis by Krause, Meyers, Irlbeck, and Chambers (2015) analyzed YouTube videos about a proposed labeling bill in California that failed to pass. The sources who were pro-GM science and against the bill were mostly scientists. The researchers concluded that the public likely viewed the scientists as a credible source related to the topic.

Purpose & Objectives

This study was guided by McCombs and Shaw's (1972) Agenda Setting Theory and Goffman's (1974) Framing Theory. The purpose of this study was to better understand the frequency of media reporting of GM science and citrus greening and how the media are presenting information about GM science and citrus greening to the public. The results from this study can be used to guide future research on consumer attitudes – both nationally and in top-citrus states – related to GM science and citrus products. National news and Florida, California, and Texas's news coverage of GM science and citrus greening also were examined due to the lack of research on local news coverage of GM science (Crawley, 2007). The national newspapers evaluated in this study were: The New York Times, The Wall Street Journal, and USA Today. Newspapers from the top three citrus-producing states included: Tampa Bay Times, Orlando Sentinel, and South Florida Sunset/Sun Sentinel (Florida); Los Angeles Times, San Francisco Chronicle, and Orange County Register (California); and Houston Chronicle, Dallas Morning News, and San Antonio Express (Texas). Using Agenda Setting Theory as a framework, researchers documented the frequency of coverage of both GM science and citrus greening. Using Framing Theory as a guiding framework, the tone of coverage in the articles was evaluated to get a sense of how GM science and citrus greening are being framed in the news.

Objective 1: Describe and characterize how the media portrayed information about GM science nationally and within each of the top three U.S. citrus-producing states (Florida, California, and Texas).

Objective 2: Identify the sources and the frequency with which each of these sources was cited in the newspapers' coverage of GM science.

Objective 3: Describe how the media presented information about citrus greening nationally and within each of the top three U.S. citrus-producing states (Florida, California, and Texas).

Objective 4: Identify potential solutions to citrus greening that have been presented by the media and their associated frames.

Methods

This study used a quantitative content analysis to determine how leading national newspapers and leading newspapers within the top-three citrus-producing states, Florida, California, and Texas (USDA - NASS, 2016) are presenting information about citrus greening and genetic modification science. A content analysis is a systematic and objective research method that provides news

insights and increased understanding of a phenomenon or actions (Krippendorff, 2013; Wimmer & Dominick, 2003) and is considered quantitative if the researcher draws conclusions from variables established *a priori* (Ary, Jacobs, Razavieh, & Sorenson, 2006). Krippendorff's (2013) guidelines to content analysis of social research are to make data measurable by separating the data into units; choosing a sample of the data when units of data are numerous; and coding the units in a way that they can be described and analyzed.

Sample

Circulation data from audits conducted by Alliance for Audited Media (2015) were used to choose the top three highest circulating national newspapers and the top three highest circulating newspapers within Florida, California, and Texas. The sample was restricted to the top three circulating newspapers nationally and statewide to make the data analysis more manageable. Florida, California, and Texas were chosen in addition to the national sample because of the importance of the citrus industry in those states and the higher likelihood that citrus, citrus greening, and possible solutions would be covered. Articles from the three national newspapers were included in the sample to collect an idea of the national discussion concerning gene technologies and citrus greening. Researchers ensured that the list of newspapers for each of the four groups was mutually exclusive, meaning the three highest circulated newspapers in each of the states also were not one of the three highest circulated national newspapers.

All chosen newspapers had an online archive of news articles published in print. Online archives were chosen because they contained more recent publications, ease of accessibility, and because initial searches within online archives showed articles that were not found on Lexus Nexus. However, to ensure the sample included all possible journalistic articles disseminated by the newspapers during the selected time period, researchers also conducted searches using Lexus Nexus and duplicate articles were excluded from the sample. Search terms used to collect articles about citrus greening included Huanglongbing, HLB, citrus greening, greening, and yellow dragon disease. Search terms used to collect articles about GM science included genetic modification, genetically modified, genetically engineered, genetic engineering, GMO, genetically modified organism, and gene technologies. These terms were identified as common terms and term variations of citrus greening and GM science. To avoid complications of bias on part of the newspaper article's author, the final sample included only news stories and excluded opinion pieces.

The original sample resulted in 125 newspaper articles, and 112 were coded. The 13 excluded from coding were excluded because the focus of the articles was not specifically about citrus greening or GM science and only mentioned the terms in passing. For consistency, the coders analyzing the articles read hardcopy articles only, instead of digital copies. The articles collected and analyzed were published from June 16, 2015 to September 24, 2015. This study was conducted in tandem with a related research project, which led to the timeframe of 101 days.

Instrumentation

A codebook was created using guidelines set forth by Krippendorff (2013). The unit of analysis for the study was an individual article. Each article was assigned a number from 1 to 112. Two coders were trained to use the codebook: coder 1) a second-year master's student in agricultural communication and coder 2) a junior-year undergraduate student in agricultural communication. The researcher-developed codebook included 51 items. Six of the items were factual descriptors including coder ID, article number, article title, which newspaper the article was published in, and

whether the article talked about citrus greening or GM science. For articles that discussed GM science, coders documented:

1. GM terminologies used in the articles, such as GMO, genetically engineered food, and any sensationalized terms such as "frankenfood"
2. The tone of coverage in regards to GM science, using questions and a 5-point Likert scale in the codebook to determine: (a) the article's portrayal of GM science (Negative/Positive); (b) if the article portrayed GM science as ethical or unethical (Unethical/Ethical); (c) how accepting of GM science the article was (Non-accepting/Accepting); (d) how progressive the article implied GM science to be (Non-progressive/Progressive); (e) how necessary the article portrayed GM science to be (Unnecessary/Necessary); and (f) how dangerous or safe the article implied GM science to be (Dangerous/Safe).
3. Any mention of benefits or drawbacks of GM science were noted, such as more food grown, fewer resources used, better quality of life, etc. (benefits); versus cancer-causing effects, causes sickness, results in using more pesticides, not thoroughly tested, etc. (negatives or drawbacks).
4. Sources used in the articles. Whenever an individual was quoted as a source, the coders took note of what type of group, organization, or category that source represented, including university scientist, non-university scientist/private industry, government agency (to include government scientists), elected government officials, activist, farmer, consumer, and journalist/reporter. Documenting what types of sources are used in coverage of GM science may provide insight into the framing of news coverage and, in future studies, audience response/behavior.

For articles that discussed citrus greening, coders documented:

1. The terminology used to describe citrus greening (e.g., citrus greening, Huanglongbing, Yellow Dragon Disease)
2. What type of information about citrus greening was discussed in the news article (e.g., does the article mention symptoms of the disease; does the article talk about the history of the disease; what varieties of affected citrus does the article mention, if any; and what states are referenced as being affected by the disease, etc).
3. What solutions, if any, were mentioned or discussed in the article, such as bactericides, pesticides, thermotherapy, and genetic modification.

Reliability and Analysis

To meet intercoder reliability and ensure accuracy, coders were trained and a pilot test was conducted. Lombard, Snyder-Duch, and Bracken (2002) defined intercoder agreement as "a measure of the extent to which independent judges make the same coding decisions in evaluating the characteristics of messages" (p. 587). For the validity of the study and to obtain intercoder reliability, two coders were independently trained to use the codebook on five sample articles, separate from the research sample (Lombard et al., 2002; Potter & Levine-Donnerstein, 1999). After addressing disagreements and concerns, the codebook was altered to clarify any unclear descriptions. Once coders had completed this aspect of training, a pilot test was conducted to assess intercoder reliability. The reliability measure Cohen's Kappa was calculated for each variable to ensure coder consistency. All variables had a Kappa score of .76 or higher. Lombard et al. (2002) indicated that a reliability score of .70 is acceptable in exploratory studies with .80 or higher seen as favorable. Additionally, since it is a more conservative measure, reliability measures for Cohen's Kappa are more liberally accepted (Lombard et al., 2002). Because the pilot study

confirmed that the coders were consistent and reliability was met, data collection proceeded. The sample was divided evenly among coders and coding was completed within two weeks. Upon completion of coding, the data were analyzed using SPSS.

Results

News stories from national and state-specific newspapers were collected and analyzed for this study. A total of 112 stories were gathered from the 101-day timeframe. These 112 units were subdivided for analysis into two groups, those that discussed citrus greening ($n = 17$) and those that discussed GM science ($n = 95$). Specific coverage within citrus-producing states was of interest to the study rather than coverage by individual newspapers, so articles were grouped by coverage into national, Florida, California, and Texas for this study. All three states had articles discussing GM science during the study timeframe. Only two of the states, California and Florida, had articles about citrus greening.

Objective 1: Describe and characterize how the media portrayed information about GM science nationally and within each of the top three U.S. citrus producing states (Florida, California, and Texas).

Gene Modification science, or GM science, is referred to by the papers of interest using different terms at varying frequencies (Table 1). The most common reference was GMO, which is an acronym for a genetically modified organism. The additional terms in Table 1 were identified and listed on the code sheet prior to article analysis and were variations of GM or GMO. Of the 27 “other” forms identified, only one term, engineered, was used more than once ($n = 3$). The remaining 24 instances often were variations as well, such as bioengineered food or gene modification.

Table 1

Type and Frequency of Reference Toward GM Science.

GM science reference	Frequency ($N = 302$)	Percentage
GMO	87	28.8
Genetically modified	36	11.9
Genetically modified organism	29	9.6
Other	27	8.9
Genetically engineered	25	8.3
Genetically modified food	15	5.0
Genetic engineering	9	3.0
Genetically engineered organism	7	2.3
Genetically engineered food	3	1.0
Frankenfood	1	0.3

Six questions with dichotomous stems on a 5-point scale were developed to characterize the type and tone of coverage for GM science in the identified articles. These six questions are summarized in Table 2. In general, the extent of coverage was in the neutral category of the scales. Rating of coverage toward the “anti” GM end of the scales (extremely low or somewhat low) was more balanced than the rating of coverage toward the “pro” end of the scales (somewhat high or extremely high).

Table 2

Extent of Descriptive Tones Characterizing GM Science in News Stories.

Characteristic stem*	Extremely (low)	Some what	Neutral	Some what	Extremely (high)	Mean	SD
Negative/Positive	15	18	30	6	26	3.11	1.41
Unethical/Ethical	14	16	34	7	24	3.12	1.34
Non-accepting/ Accepting	16	14	29	10	26	3.17	1.42
Non-progressive/ Progressive	10	13	38	8	26	3.28	1.29
Unnecessary/Necessary	10	15	37	9	24	3.23	1.28
Dangerous/Safe	10	15	37	5	28	3.27	1.32

* Data is presented in a Likert-type scale from 1-5. “Extremely low” or 1 refers to extremely negative, unethical, etc, while “extremely high” or 5 refers to extremely positive, ethical, etc.

News articles were reviewed for reporting of what benefits might originate from using GM science (Figure 1). The ability to grow more food was the primary benefit reported. Benefits categorized as “other” included benefiting science and the environment; improved product quality, safety and nutrition; and increased profit. The national newspapers had less of an emphasis on the food production benefit compared to the state-specific papers and were more balanced across the benefits reviewed.

Articles also were reviewed for negatives, or detriments, of using GM science (Figure 1). The most commonly reported detriment was GM science not being thoroughly tested. This was reported about two and a half times as frequently as the next specified detriment, using more pesticides. The “other” detriments, cumulatively ranking second, included bad for the environment and health, causing disease and environmental issues such as contamination, confusing customers, and not knowing contents of food items.

Objective 2: Identify the sources and the frequency with which each of these sources was cited in the newspapers’ coverage of GM science.

The number of specific sources cited in each news story was analyzed and is reported in Table 3. In general, the frequency of citing a source decreased as the number of sources in an article increased. More than 70% of the articles contained between 0 and 2 sources. A clear drop-off in articles using more than 3 sources existed in the state-specific newspapers and was not as evident in the national newspapers.

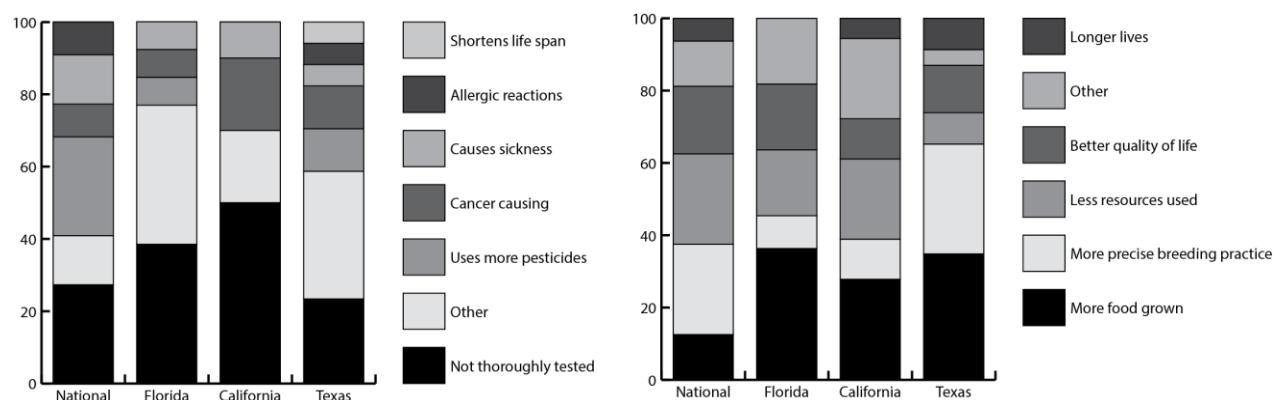


Figure 1: Relative Frequency of GM Science Detriments (left) and Benefits (right) Mentioned in News Stories by Area of Coverage.

Table 3

Frequency of Sources Used in News Stories About GM Science by Newspaper Location

Number of sources in each news story	National	Florida	California	Texas
0	9 (45%)	7 (28%)	6 (28.6%)	11 (37.9%)
1	0 (0%)	5 (20%)	5 (23.8%)	5 (17.2%)
2	4 (20%)	3 (12%)	6 (28.6%)	8 (27.6%)
3	2 (10%)	3 (12%)	2 (9.5%)	5 (17.2%)
4	0 (0%)	3 (12%)	2 (9.5%)	0 (0%)
5	0 (0%)	2 (8%)	0 (0%)	0 (0%)
6	2 (10%)	1 (4%)	0 (0%)	0 (0%)
7	1 (5%)	0 (0%)	0 (0%)	0 (0%)
8	2 (10%)	1 (4%)	0 (0%)	0 (0%)

This study also was interested in the type of sources being cited in news stories (Table 4). Primarily, the articles used sources from entities that had an opinion toward GM science, such as industry scientists and activists. For the purpose of this study, coders did not differentiate between supportive and non-supportive activists. Private industry scientists and activists contributed nearly half (48.7%, $n = 58$) of the sources cited in the analyzed news stories. Scientists employed in

public-service sectors (university and government), as well as governmental agencies and officials, contributed an additional 40.3% ($n = 48$) of the sources.

Table 4

Frequency of Source Type Used in News Stories About GM Science by Newspaper Location

Source type	National	Florida	California	Texas	Total
Non-university scientist/ private industry	7 (25.0%) ^a	10 (22.8%)	7 (30.4%)	7 (29.2%)	31 (26.1%)
Activist	6 (21.5%)	11 (25.0%)	3 (13.0%)	7 (29.2%)	27 (22.6%)
University scientist	6 (21.4%)	6 (13.6%)	6 (26.1%)	4 (16.6%)	22 (18.5%)
Government agency	2 (7.1%)	5 (11.4%)	5 (21.7%)	3 (12.5%)	15 (12.6%)
Government official	4 (14.3%)	6 (13.6%)	1 (4.4%)	0 (0.0%)	11 (9.2%)
Consumer	2 (7.1%)	2 (4.5%)	0 (0.0%)	1 (4.2%)	5 (4.2%)
Journalist/reporter	0 (0.0%)	1 (2.3%)	1 (4.4%)	2 (8.3%)	4 (3.4%)
Farmer	1 (3.6%)	1 (2.3%)	0 (0.0%)	0 (0.0%)	2 (1.7%)
Other	0 (0.0%)	2 (4.5%)	0 (0.0%)	0 (0.0%)	2 (1.7%)

NOTE: ^a Percentages are for location, vertically in the column.

Objective 3: Describe how the media presented information about citrus greening nationally and within each of the top three U.S. citrus-producing states (Florida, California, and Texas).

Citrus greening disease, the common name, is a bacterial disease transmitted among citrus trees by the Asian Citrus Psyllid. However, the disease is referred to by multiple names in the stories focused on the disease (Table 5). The disease was most frequently referred to as citrus greening within the newspapers, followed by its original Chinese name, Huanglongbing, as the second most frequent. Other, less commonly used names in the media (Table 5) were derivatives of the two most commonly used names. The common name, citrus greening, was more frequently used than other forms in Florida, which has experienced a longer presence of the disease than California. The national newspapers and Texas newspapers did not mention citrus greening during the selected time period and were not included in this analysis.

Table 5

Variations of Names for “Citrus Greening” Used in News Stories.

Name	Florida	California	Total
Citrus Greening	11 (37.9%) ^a	5 (35.7%)	16 (37.2%)
Huanglongbing	8 (27.6%)	5 (35.7%)	13 (30.1%)
Yellow Dragon disease	2 (6.9%)	2 (14.4%)	4 (9.3%)
Candidatus Liberabacter Asiaticus	2 (6.9%)	1 (7.1%)	3 (7.0%)
HLB	2 (6.9%)	1 (7.1%)	3 (7.0%)
Greening	2 (6.9%)	0 (0.0%)	2 (4.7%)
Other	2 (6.9%)	0 (0.0%)	2 (4.7%)

^a Percentages are for location, vertically in the column.

Citrus greening disease can infect trees of various types of citrus fruits, and media coverage was representative of such broad potential impact. Oranges, a leading citrus crop in the United States, were represented equally as often as limes in Florida and were mentioned more often than any other citrus product in California newspapers. Nationally, oranges were mentioned most often.

Media reporting of disease presence was focused on two states, Florida and California. Nationally, the presence of the disease in Florida was mentioned in 20.4% ($n = 13$) of the articles focused on citrus greening and 17.2% ($n = 11$) of the national articles mentioned disease presence in California. Texas, the other top-ranking citrus state, was referenced less than half as frequently as the other two top states in the California, Florida, and national newspapers. While citrus greening and the Asian Citrus Psyllid have been identified in select groves and trees in Texas, no coverage during the timeframe of interest was present in any of the three Texas newspapers studied.

Objective 4: Identify potential solutions to citrus greening that have been presented by the media and their framing of the identified solutions.

While discussing the problem of citrus greening is important to increasing awareness and understanding of the disease and its potential impacts, discussion of solutions also is important to allow for these solutions to be considered by the marketplace and end users. The 17 articles that discussed citrus greening were analyzed to see what solutions to citrus greening, if any, were identified. Three of the 17 articles (17.6%) identified pesticides, and two articles (11.8%) identified bactericides as possible solutions. An additional seven articles (41.2%) listed predatory insects or predatory wasps as a possible solution. The solutions of pesticides and predatory wasps/insects are not targeted at the disease specifically, but at the insect (Asian Citrus Psyllid) that transmits the disease among the trees in the citrus groves. Only the bactericide is intended to target the disease-causing organism.

Discussion

The purpose of this study was to understand how newspapers, nationally and in citrus-producing states, reported GM science and citrus greening. More than half (50.3%, $n = 152$) of the references to GM science were derivatives of one term, GMO, which was the most common reference. The second and third most common references were genetically modified and genetically modified organisms. Additionally, the term Frankenfood was the least used in the study with only one mention. This shows that terminology with negative connotations and meaning, such as Frankenfood, are not commonly used in the media. However, the term GMO is a common term being presented to consumers. The most frequently reported detriment by the newspapers is the concern of presence or absence of GM science in food products. The newspapers in this study most commonly presented GM science in neutral tones. However, there were more references to benefits of GM science ($N = 68$) than there were to detriments ($N = 62$) (Figure 1). This result could be linked to the fact that a high number of non-university and non-government scientists were sourced in the analyzed articles. Overall, the news coverage in this study suggests that GM science, while not a new technology to agriculture, is being covered in the news in a fairly balanced manner among the assessed papers during this study's timeframe.

The frequency of source use in the analyzed articles was not surprising for newspaper stories. However, the type of sources used is interesting to note. The prevalence of non-university/private industry scientists and activists suggests writers were looking for those who had some form of interest in the acceptance or rejection of GM science. When developing a balanced news story, both perspectives are necessary to provide those viewpoints. Private industry and activists could easily fill those roles as sources. This study did not differentiate between supportive and non-supportive activists, and researchers assumed that activists and industry scientists were biased sources. Another assumption made in this study, due to the goals of land-grant institutions – openness, accessibility, and service to people (APLU, 2012) – and ideal transparent government, that government agencies and university scientists were unbiased sources. The lack of knowledge in the sources' personal bias is a limitation of the study.

Coverage of citrus greening was limited to state-specific newspapers in California and Florida. This coverage makes sense as these are by far the two most prominent citrus-producing states in the United States (USDA-NASS, 2016). However, given the potential economic impact from reduced citrus production and reduced citrus quality, this was considered a topic of potential inclusion in both Texas and national newspapers. Using a broader window, such as 6 months or a year, would potentially provide a more comprehensive view of citrus greening coverage in the four coverage areas. This study's length of sampling was chosen because it directly preceded another research study related to the same overall project. While not ideal for a general view of newspaper coverage, it will provide data to contribute to a bigger investigation into citrus greening and perceptions of GM science as a solution to the disease. Citrus greening is not a new problem to the United States citrus industry (University of Florida Citrus Research and Education Center, 2015), but it is beginning to have a significant enough impact on the production quantity and quality that it is starting to appear in the popular press, not just trade press.

The coverage of citrus greening in sampled newspapers is following science communication conventions by discussing the potentially complex disease using common terms. "Citrus greening" was more frequently used than other forms in Florida, which has experienced a longer presence of the disease than California. Also, a breadth of citrus products was mentioned in the

articles. However, while the list is fairly exhaustive of citrus products, these items are not referenced very frequently in the articles. This may be due to multiple factors not a part of this study, such as overall focus of the article or the limited diversity of citrus production in the respective states. Additionally, it may hint that consumers are not currently exposed to the breadth of citrus products being affected by the disease or to the fact that the majority of citrus produced in Florida supplies the majority of orange juice in the United States (Florida Agricultural Statistics Service, 2013).

Just as citrus types were limited in reference frequency in articles, so too were potential solutions to citrus greening. This is not surprising though, as there is still a considerable amount of research being conducted into solutions. Current practices being used by the industry are focused on trying to control the extent of the damage and losses from citrus greening rather than preventing the disease. The reference to bactericides is promising as this technology has only recently received emergency approval for trial use to combat citrus greening in Florida. One interesting note is also the lack of articles mentioning GM science as a solution to citrus greening given its identification as a viable solution (Korves, 2015; Mahgoub, 2016). Consumers are not being exposed to the option of GM science as a solution to citrus greening, and in turn, may not know it exists. If balanced coverage supporting the use of GM science as a solution were to increase, it could possibly increase the importance of the issue to consumers as well as support for the technology.

One recommendation for future research is to conduct a national survey to better understand how agenda setting influences consumer attitudes related to both GM science and citrus greening. Additional future research that would build upon this study would be to gather longitudinal data on news coverage of the same topics, which could provide insight into seasonal, weather-related, and long-term trends in news coverage. Future research could also examine a wide variety of news sources, rather than just newspaper coverage, to assess agenda-setting and framing of GM and citrus greening through various channels.

Conclusions

Citrus greening, while becoming a more prevalent threat to and impact on the United States citrus industry, is not a commonly discussed topic in prominent mass media publications. Even in states at greatest risk of economic impacts such as California and Texas, citrus greening coverage was minimal at best when present. The coverage that did exist was primarily informative of disease presence.

One potential solution for citrus greening, the use of GM science, was not discussed in the citrus greening articles included in this study. However, GM science was presented in a somewhat neutral approach in articles with GM science as a focus, sharing both potential benefits and detriments to the technology. Source use was focused to provide the most diverse of perspectives on the technology, allowing readers to gather both sides of the discussion and make their own decisions regarding the technology. This is critical as new GM labeling laws go into effect.

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