

A 24-Year Longitudinal Analysis (2000–2023) of Philippine Media Coverage of Agri-Biotechnology

Kristine Grace N. Tome*, Janine Cyren A. Escasura, Clement S. Dionglay, and Rhodora Romero-Aldemita

International Service for the Acquisition of Agri-biotech Applications, Inc., 3rd Floor Khush Hall, International Rice Research Institute, Los Baños, Laguna 4031, Philippines. *Corresponding author, ktome@isaaa.org

The media impacts public understanding of technology and motivates opinions on a number of controversial topics. To understand the media representation of modern biotechnology in the Philippines, a 24-year (2000-2023) longitudinal analysis was conducted covering 2,525 articles from the Philippine Daily Inquirer, Philippine Star, Manila Bulletin, and BusinessMirror. Results of previous analyses (2000-2009 and 2010-2016) were compared with the latest analysis that covered 286 articles from 2017 to 2023, particularly on the following variables: article type, section, topic and focus, source of information, framing category, keyword, and metaphors used, and tone of articles. Chi-Square Tests of Independence, Fisher's Exact Test, and Correspondence Analysis were used to examine the associations between various categorical variables in the 2017-2023 analysis, and trends of news coverage on agricultural biotechnology in four major Philippine newspapers were identified. The government has remained the top source of information cited in the articles since 2000. Public accountability/governance and social progress/economic development have continued as the top two frames used by the writers over the years. Genetic modification and biotechnology remained as major keywords used to refer to the technology since 2000. The use of fear-based metaphors has declined over the years. Articles from the Philippine Daily Inquirer shifted from generally negative to mostly neutral, while the articles from other newspapers were predominantly positive in the latter years. Of the four newspapers, BusinessMirror exemplified consistent and evidence-based coverage of the technology through the years. Statistical test results showed that the word GMO is the most used keyword across all tones, mostly for positive articles. Recommendations include continuous and quality engagements with media practitioners and key stakeholders, the formation of a fact-checking body to prevent the spread of misinformation, and the inclusion of other media channels in future research for a more holistic analysis.

Keywords: agricultural biotechnology, GMO, media monitoring, news framing, print media, sentiment analysis

INTRODUCTION

The world population is projected to reach 9.7 billion in 2050 and 10.4 billion by 2100 (United Nations 2025). An increase in the world's population will cause additional strains on resources due to increased demand for food, water, housing, energy, healthcare, and transportation (Bish 2024). Agricultural biotechnology is one of several tools for addressing the challenges of food, feed, fiber, and energy. The Philippines has consistently demonstrated robust support for biotechnology, recognizing its potential to drive agricultural productivity, enhance food security, and promote sustainable development (Manalo 2024).

The Philippines uses biotechnology to reach its food security goals and modernize its food systems to meet the UN Sustainable Development Goal 2 (Zero Hunger) by 2030. The country remains a biotechnology leader in Asia, being the first to allow the planting of Bt corn and the first to set up a regulatory framework for genetically engineered (GE) crops (USDA FAS GAIN Report, 2024). In 2019, the Philippines was ranked 12th among the 29 countries in the world that planted biotech crops (ISAAA 2019).

The media shapes public understanding of technology and influences public opinion on a number of controversial issues. It works as a vital reservoir of images, stories, and definitions that the public use to understand issues. Thus, how media portrays topics such as science and technology affects public understanding as well as policy development (ISAAA 2017). In the study of Torres et al. (2023), news media are one of the top sources of information on biotechnology in the country. With a trust level of 3 out of 4, these sources are vital elements in the biotech discourses. Thus, media discourses can serve as indicators of public perception as they are key representations of community's sentiments. They are also vital in driving public opinion as the media stories serve as basis of discussions among communities. The same study also showed that journalists and media persons in the Philippines were the most optimistic about biotech information as they rated both its usefulness and quality as very good.

Navarro et al. (2011) investigated ten years (2000-2009) of media coverage on agricultural biotechnology in the Philippines by the top three circulated national English newspapers: Manila

Bulletin, Philippine Daily Inquirer, and the Philippine Star. This period was prime for media analysis as it was during this time that GM crops were first introduced and commercialized in the country. The study revealed that the majority of the articles published by the three newspapers were positive (41.3%) and neutral (38.2%) in tone with only about 19.8% negative in stance.

A follow-through research was conducted in 2017 by Tome et al. that took up from where the 2011 study ended to complete a 17-year analysis (2000-2016). An additional seven years of content analysis (2010-2016) was conducted for the three newspapers and additional coverage from BusinessMirror. Online releases from these sources were also included in the study. A significant increase in the percentage of positive articles was observed. The positive articles dealt mostly with the benefits of the technology and government and scientific support.

Based on the findings of Navarro et al. (2011) and Tome et al. (2017), media coverage of agricultural biotechnology in the Philippines has demonstrated a significant shift toward a more favorable perspective over time. With the progress in approvals for more GM products such as Golden Rice, Bt eggplant, and Bt cotton, and with another court battle in the country from 2017 to 2023, it is crucial to discover how these significant events contributed to Philippine media coverage. Thus, the study aimed to accomplish the following objectives:

- compare and contrast the content and trends of news coverage on agricultural biotechnology in the Philippines from 2017 to 2023 with the findings of two previous studies conducted between 2000-2010 and 2011-2016;
- analyze the statistical significance and correlations between key variables used in the 2017-2023 content analysis; and
- describe the trends of news coverage on agricultural biotechnology in four major Philippine newspapers.

The findings of the study can be used to gauge public perception of biotechnology as represented by media practitioners. The results can also be used as a guide in developing knowledge sharing initiatives in the Philippines to support informed decision making on biotechnology adoption.

METHODOLOGY

This study adds a seven-year data (2017-2023) to the previous two analyses (2000-2009 and 2010-2016) to accomplish a 24-year longitudinal study of media representation of modern biotechnology for agriculture in the Philippines. Content analysis of articles published between 2017 and 2023 from four leading Philippine newspapers (BusinessMirror, Manila Bulletin, Philippine Star, and Philippine Daily Inquirer) were conducted, specifically those that tackled modern agricultural biotechnology—genetic engineering, gene editing, protoplast fusion, and microinjection. Articles about conventional breeding techniques (e.g., cloning, tissue culture, hybridization,

Table 1. A framing typology for biotechnology (Liakopoulos 2002)

Frame	Context
Social Progress/Economic Development	Improving quality of life and harmony with nature; Local/global competitiveness
Morality/Ethics	Identification with values that determine what is right or wrong, acceptable or unacceptable
Scientific Validity	A matter of expert understanding of what is known versus unknown; calls on the authority of sound science or peer-review
Public Accountability/Governance	Research in the public good or responsible use or abuse of science in decision-making
New Research	Discovery announcement, new scientific application
Conflict/Strategy	Who's ahead or behind in debate; battle of personalities
Public Engagement	Focus on poll results, reporting of public opinion statistics, public sentiments, personal testimony of farmer or consumer
Others	Context not included in frames above

Table 2. ISAAA's trilogy of media study on biotechnology

Coverage	2000-2009 (10 years)	2010-2016 (7 years)	2017-2023 (7 years)
No. of articles	1,355 (print)	884 (print and online)	286 (print and online)
Newspapers analyzed	Philippine Daily Inquirer Philippine Star Manila Bulletin	Philippine Daily Inquirer Philippine Star Manila Bulletin BusinessMirror	Philippine Daily Inquirer Philippine Star Manila Bulletin BusinessMirror
Author/s and year of publication	Navarro et al. 2011	Tome et al. 2017	Tome et al. 2025

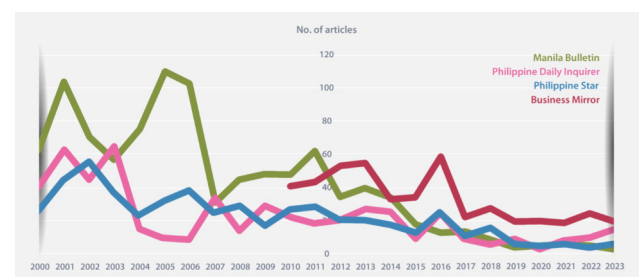


Figure 1. Number of articles per year and per newspaper (2000-2023)

crossbreeding, and artificial insemination) were excluded in the analysis.

Articles were collected through online searches of the newspapers' databases and manual review of scanned print editions. Missing issues were retrieved from the E-Resources and Multimedia Services Section of the University of the Philippines Los Baños Library and BusinessMirror's archive section.

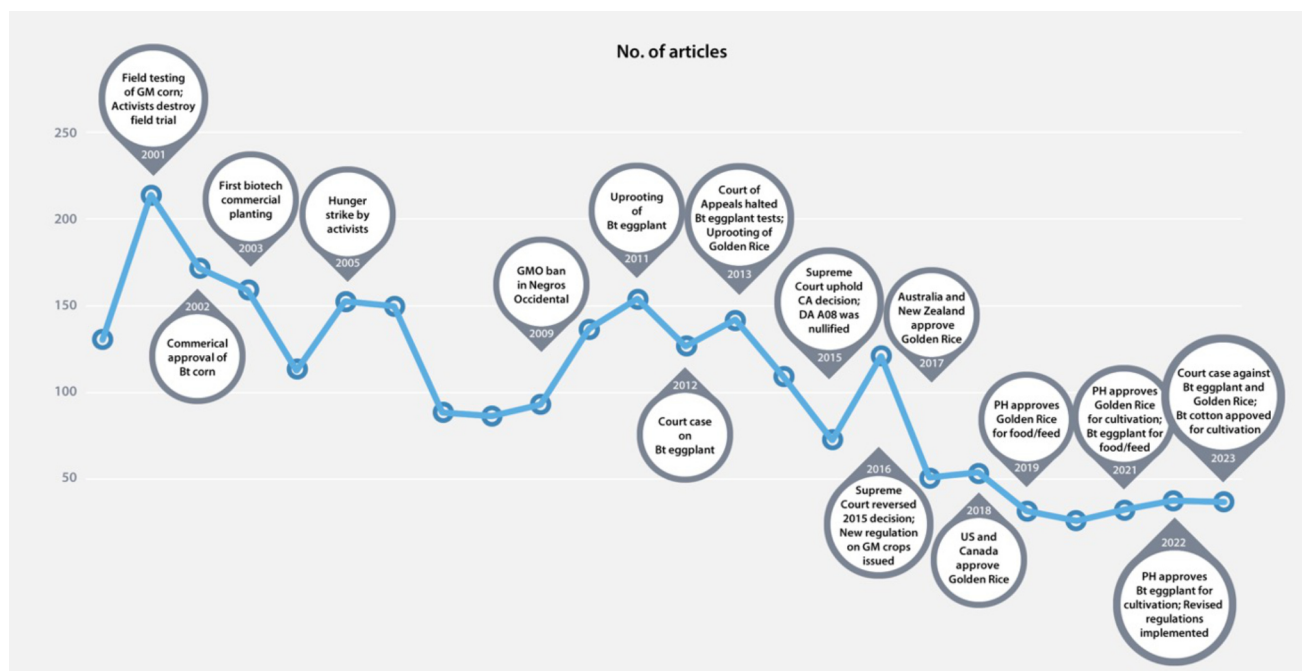


Figure 2. Key biotech events per year (2000-2023)

For each article, the following information was recorded: title, newspaper, publication date, publication channel (print, online, or both), page number, section, and name of writer. For the data analysis, both qualitative and quantitative methods were used to analyze the collected articles. The analysis focused on publication, article type, and section, topic and focus (local, foreign or global), source of information, definition of biotechnology, framing of messages (Table 1), metaphors, keywords referring to biotechnology, and tone.

IBM SPSS Statistics 27 software was used to run Chi-Square Tests of Independence (Chi-square test of association) to examine the associations between various categorical variables. For variables with low expected counts, Fisher's Exact Test was used as an alternative to the Chi-Square test to ensure the validity of the results. Correspondence Analysis (CA) was used to visually represent relationships between categorical variables by reducing the data complexity and visualizes association through the distance between points, represented in a biplot.

RESULTS AND DISCUSSION

Content and trends of media coverage (2000-2023)

From 2000 to 2023, a total of 2,525 articles on the applications of modern biotechnology in agriculture were analyzed in three phases, completing a trilogy of media study on biotechnology (Table 2).

The latest analysis covered 286 biotechnology articles from the Philippine Daily Inquirer (Inquirer), Philippine Star (PhilStar), Manila Bulletin (MB), and BusinessMirror. This count shows a significant decline in the number of articles, compared with the past two analyses. This decline is consistent with another study conducted in the US which reported that

science coverage in traditional US news media, such as newspapers, is decreasing (Cacciatore et al. 2012). This general decline could be attributed to event-driven news reporting wherein the number of articles only increases whenever there are newsworthy events that draw interest from the media. Pew Research Center (2008) also confirmed the trend of devoting a small percentage of coverage to science issues among news media platforms.

Newspaper

From 2017-2023, the widest coverage was delivered by BusinessMirror, with 147 articles in the seven-year span (51.4%) (Figure 1). The remaining three newspapers all garnered an article share ranging from 13 to 18%. These newspapers were also listed as most trusted news outlets in the Philippines in 2024 (Statista 2024).

Consistent with the findings of Tome et al. (2017) that BusinessMirror had the highest number of articles on biotechnology from 2010 to 2016, BusinessMirror remains as the top media outlet among the four selected sources of articles for this study (2017-2023) (Figure 2). BusinessMirror's exemplary coverage of biotechnology-related topics over the years has been recognized by Jose G. Burgos Jr. Awards for Biotechnology Journalism. In 2024, the award-giving body hailed BusinessMirror as Hall of Fame awardee in the Institutional category. This category honors newspapers that published the most number of articles on biotechnology for five consecutive years (Biotech for Life 2024).

Key biotech events and coverage

While biotechnology received modest attention on the overall media agenda compared to major issues concerning politics or entertainment, spikes and declines were evident in the coverage depending on the key biotech events at that time (Figure 2).

Table 3. Titles of articles that landed on frontpages (print, 2017-2023)

Newspaper	Article title
Philippine Daily Inquirer	--
Philippine Star	Philippines OKs GMO 'Golden Rice'
Manila Bulletin	--
BusinessMirror	PH may soon export genetically modified corn - Monsanto exec Feeding 10 billion people will require genetically modified food Can we grow more food on less land? We'll have to, a new study finds Mutant pigs 'Golden Rice safe for humans' Will Golden Rice help us climb the PISA ladder? Revoke biosafety permit of Golden Rice-group Searca backs Golden Rice amid calls to void permit Next, after Golden Rice Pass biotech law - solon

With the absence of a key biotech event in 2020, the number of articles declined in all newspapers. The quantity of biotech articles spiked the following year (2021), when key approvals were granted to Golden Rice (cultivation), and Bt eggplant (food/feed use).

A similar trend was also observed in the past two studies (Navarro et al. 2011 and Tome et al. 2017). Dramatic events such as uprooting of field trials, hunger strikes, and court cases received public attention but not enough to sustain interest in the succeeding years. Such emotion-fueled stories were not recorded in 2017-2023, except for the court case filed by biotech critics against Golden Rice and Bt eggplant.

Publication, article type, and section

The advent of the Internet caused a major disruption in the delivery of news articles through print publications such as newspapers. In the Philippines, newspapers continue to be a source of information, with website and social media platforms as additional channels. From 2017 to 2023, the majority of the articles on biotechnology appeared in print and online (62.6%). There were articles that were published solely in print (21.7%) or in the newspaper's websites (15.7%).

A total of 10 articles landed in the front page of printed issues as headlines (Table 3). One article was published in the PhilStar, and the rest (9) in BusinessMirror. Over half of these headlines were about Golden Rice. This result is a diversion from the findings in the previous study (Tome et al. 2017) wherein BusinessMirror did not publish any headline about biotechnology. In that time period (2010-2016), Inquirer featured two front-page articles related to Bt eggplant: one in 2013 about the Court of Appeals halting field tests, and another in 2016 covering the Supreme Court's reversal of that ruling. The PhilStar also ran front-page stories on Bt eggplant in 2016, with headlines like "UP students slam SC on Bt talong" and "SC reverses ruling on Bt talong tests."

Table 4. Top writers per newspaper (2017-2023)*

Newspaper	Writer	No. of articles	Percentage of the total news coverage per newspaper (%)
Philippine Daily Inquirer	--	--	--
Philippine Star	Louise Maureen Simeon	16	34.00
Manila Bulletin	Dr. Emil Javier (National Scientist)	10	25.60
	Madelaine Miraflores (currently affiliated with National Economic and Development Authority)	7	17.90
BusinessMirror	Jasper Emmanuel Arcalas	32	22.70
	Lyn Resurreccion (Science Editor)	10	7.10

*with at least 7 articles from 2017 to 2023 or one article per year

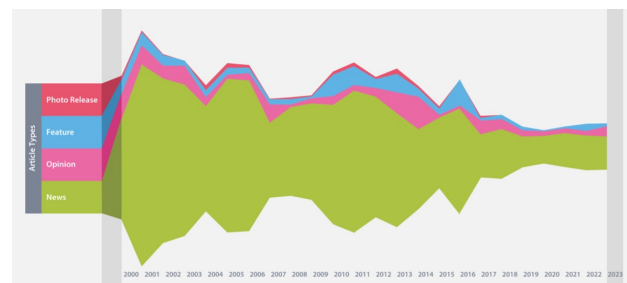


Figure 3. Article type per year and per newspaper (2000-2023)

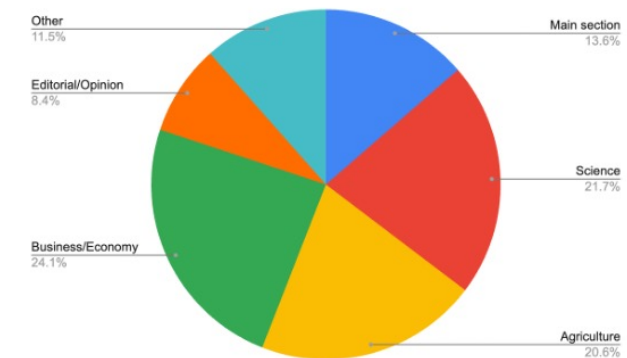


Figure 4. Distribution of articles in newspaper sections in the US (2017-2023)

Most of the articles analyzed (2017-2023) were classified as news (76.9%) in all newspapers; while it is notable that MB and Inquirer had the highest number of opinion pieces, and 11 out of 12 editorials were published by BusinessMirror (Figure 3). The predominance of news articles was also reported in the two previous studies, 85% in 2000-2009 and 79% in 2010-2016.

Figure 4 shows that most articles commonly appeared in the Science (21.7%), Agriculture (20.6%), and Business/Economy (24.1%) sections, and rarely in the main section of the newspaper (13.6%). A 20-year analysis of U.S. newspaper coverage of

Table 5. Association between focus and topic (2017-2023)

Topic	Focus				p-value
	Local (%)	Foreign (%)	Global (%)	Regional (%)	
Biotech crops	5	1	4	0	<0.001
R&D developments	1	1	0	0	
Government pronouncements	2	0	0	0	
Biosafety	2	0	0	0	
Biotech	8	1	3	0	
Bt eggplant	5	0	0	0	
Golden Rice	19	0	2	1	
GM corn	7	1	1	0	
Bt cotton	2	0	0	0	
Others	18	8	6	1	

biotechnology revealed a different distribution. Only 4% of articles appeared in science sections, while 26% were news stories, 24% were in the business section, 28% were opinion pieces, and 5% appeared in food or lifestyle sections (Stenier and Bird, 2008).

Writer

Media practitioners are instrumental in forming opinions and mobilizing the people to engage in a certain issue. Thus, it is crucial that writers of biotech articles are well-informed about the various facets of the technology to be able to deliver prolific interpretations of the technology's impact to various stakeholders, particularly the farmers and consumers.

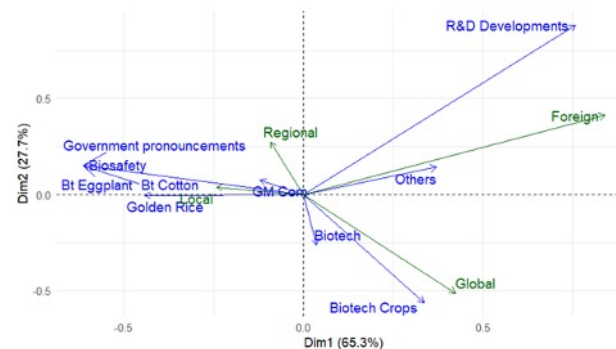
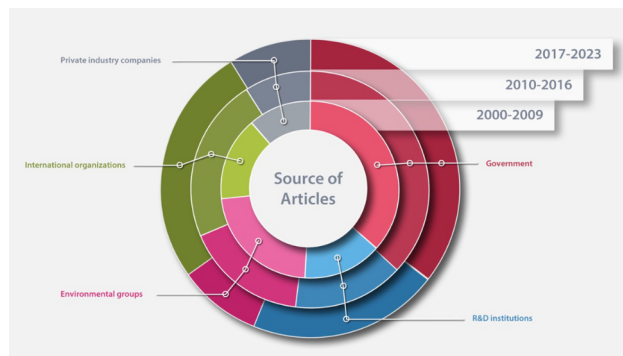
Of the 286 articles analyzed, 70% were authored by the respective newspaper's correspondents. The writers who delivered the most number of articles (Table 4) were identified to be multi-awarded journalists and one National Scientist. All of them are known to exhibit evidence-based reporting of biotechnology, usually in neutral or positive tone. The same set of writers (except for one) were also found in the list of journalists who published articles in the two previous studies covering 2000-2009 and 2010-2016.

Jasper Emmanuel Arcalas (used to be a correspondent for BusinessMirror during the study period) wrote the most number of articles (32), which was 22.7% of the total number of articles released by BusinessMirror about biotechnology. His accolades include Oriental Leaf Awardee (Hall of Fame), Agribeat Reporter of the Year (First Prize), Agricultural Journalist of the Year (First Prize), and Best News Category in the 2024 Jose Burgos Jr. Awards.

Prominent biotech writers, defined as those with at least seven articles or wrote at least one article per year, were identified for each newspaper except Philippine Daily Inquirer. This absence suggests a lack of deliberate attention to biotechnology developments in that publication except in 2023, wherein one author wrote several articles on novel biotech applications in other countries.

Topic and Focus

In 2000-2009, the significant occurrences reported were about the research and development of Bt corn leading to its commercialization in 2002 and the

**Figure 5.** Tag cloud of coverage topics (2017-2023)**Figure 6.** Correspondence analysis biplot for the relationship between focus and topic (2017-2023)**Figure 7.** Sources mentioned in the articles (2000-2023)

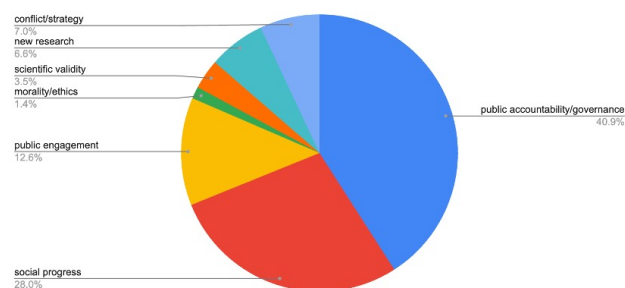
planting years which started in 2003 (Navarro et al. 2011). From 2010 to 2016, the majority of the coverage shifted to the research and development of Bt eggplant and Golden Rice, which gained significant public interest. A court case filed by environmental groups in 2012 until 2016 against Bt eggplant further added more stories in the media reportage of biotech crops in the Philippines during this time period.

For 2017-2023, each article was analyzed and categorized based on the primary topic/s covered. A total of 335 topics were identified and Golden Rice was tagged as the main topic of 77 articles (23%), dominating the discussions in the 7-year coverage. The other primary topics identified were biotechnology (11.9%) and biotech crops (12.8%), followed by GM corn (9%), Bt eggplant (6.6%), and gene editing (3.6%) (Figure 5).

The list of common topics showed new ones that were not mentioned or received very low interest in the previous studies. These include gene editing, modern biotech act, and counterfeit seeds.

Table 6. Sources of information quoted in the articles (2017-2023)

Source Category	Percentage (%)	Top sources quoted
Government	29.50	Department of Agriculture Philippine Rice Research Institute Department of Science and Technology Dr. Vivencio Mamaril (Former Director of Bureau of Plant Industry)
International organization	21.30	International Service for the Acquisition of Agri-biotech Applications International Rice Research Institute Southeast Asian Regional Center for Graduate Study and Research in Agriculture
Scientist	11.00	Dr. Reynante Ordonio (Former Project Leader of Golden Rice Project) Dr. Gabriel Romero (Former Monsanto Regulatory Policy and Scientific Affairs Head) Dr. Roel Suralta (Head of DA Crop Biotech Center)
Civil society group	7.40	Magsasaka at Siyentipiko para sa Pag-unlad ng Agrikultura (MASIPAG) Greenpeace Cris Panerio (National Coordinator of MASIPAG)
Private company	7.40	Monsanto
Academe	6.20	University of the Philippines Los Baños

**Figure 8.** Message frames of the articles (2017-2023)

The majority of the articles (65.0%) focused on local happenings or issues, 18.9% on foreign topics, 14.7% with global perspective, and only 1.4% with regional scope. In 2010-2016, local stories also dominated biotech coverage (Tome et al. 2017).

The Chi-Square test results (p -value < 0.001) revealed a significant association between topic and focus (Table 5). The results showed that Golden Rice (19%) dominated the discussion at the local level, followed by topics on biotech (8%), biotech crops (5%), and Bt eggplant (5%). Other topics have a more varied distribution, with notable focus on both local (18%) and foreign (8%) contexts. Topics on GM corn and Bt cotton were mostly discussed in the local context.

The association between specific topics and focus was confirmed by Correspondence Analysis, generating a biplot showing that articles focusing on local news and events are aligned with topics on Bt cotton, Golden Rice, Bt eggplant, and biosafety (Figure 6). The articles focusing on foreign news were more aligned with R&D developments and other topics.

Source of information

The article writers relied on various sources of information, but a common source was evident in all phases of analyses (Figure 7). From 2000 to 2023, government agencies and representatives were the main sources cited by the writers. In the first study (2000–2009), civil society/environmental groups and international organizations were the secondary

sources of information. The second study (2010–2016), government sources were followed by international organizations and then by civil society/environmental groups. For 2017 to 2023 (Table 6), government agencies (29.5%) such as the Department of Agriculture, Philippine Rice Research Institute, and the Department of Science and Technology were frequently mentioned in the articles. The International Service for the Acquisition of Agri-biotech Applications and International Rice Research Institute were among the international organizations (21.3%) that were commonly quoted in the articles. Lesser reference to the statements of civil society groups (7.4%) was observed in 2017-2023 compared to the previous time periods. These findings may suggest that article authors have a greater degree of trust in information from government officials, international organizations, and scientists compared to civil society or environmental groups. Alternatively, the observed pattern could be attributed to the greater accessibility of information from government and international sources.

Definition of biotech

One hundred (100) articles or 35.0% of the total article collection from 2017 to 2023 provided definition of key terms on biotechnology. Of the 100 articles, 25 contained definitions of the technology itself, but a greater portion (61 articles) defined specific products of the technology, mostly Golden Rice. It was commonly defined using three key phrases: (1) a new type or variety of rice; (2) contains beta carotene in its grain; and (3) can help combat vitamin A deficiency.

In the previous studies by Navarro et al. (2000-2009) and Tome et al. (2010-2016), only 5.6% and 1% of the articles cited definitions of biotechnology, respectively. The current surge in the number of articles with definitions could be attributed to the rising popularity of Golden Rice. To ensure reader understanding, the writers likely provided background on Golden Rice due to its relatively recent introduction as a GM crop.

Framing of articles

Framing is a sociology concept that explains how humans derive meaning from their interpretation of daily processes or happenings using a cultural lens.

Table 7. Association between message framing category and topic (2017-2023)

Topic	Category (frame)								p-value
	Public Accountability (%)	Social Progress (%)	Public Engagement (%)	Morality/Ethics (%)	Scientific Validity (%)	New Research (%)	Conflict/Strategy (%)	Others (%)	
Others	8	12	4	1	1	4	2	1	<0.001
Bt cotton	1	1	0	0	0	0	0	0	
GM corn	4	4	0	0	0	0	0	0	
Golden Rice	5	10	2	0	2	0	2	0	
Bt eggplant	1	2	1	0	0	1	0	0	
Biotech	2	6	2	0	0	1	0	1	
Biosafety	0	1	0	0	0	0	0	0	
Government pronouncement	2	0	0	0	0	0	0	0	
R&D	0	1	0	0	0	1	0	0	
Biotech crops	4	4	1	0	0	0	2	0	

Table 8. Association between source of information and message frame (2017-2023)

Source of information	Category (message frame)								p-value
	Public Accountability/Governance (%)	Social Progress (%)	Public Engagement (%)	Morality/Ethics (%)	Scientific Validity (%)	New Research (%)	Conflict/Strategy (%)	Others (%)	
Government	13	11	1	0	1	0	2	1	<0.001
Scientist	2	3	0	0	0	3	1	0	
Academe	1	2	0	0	0	2	1	0	
Civil society/environmental groups	1	1	3	0	1	0	3	0	
Private company	3	5	0	0	0	1	1	0	
News agency	0	0	0	0	0	0	0	0	
International organization	4	8	2	0	0	1	1	0	
Farmers	1	1	1	0	0	0	0	0	
Intergovernmental organization	2	2	0	0	0	0	1	0	
Others	2	5	1	0	1	1	2	0	

In mass media communication, framing refers to how information is packaged to encourage or discourage an interpretation of a concept. Analysis of early narratives about biotechnology showed how the manner of framing biotechnology in the media is crucial in consumer attitudes, and eventually in GM crop adoption (Esquivel et al. 2023).

Each of the articles collected from 2017 to 2023 were categorized using the framing typology of Liakopoulos (2002) for biotechnology. The majority of the articles released in this time period were framed toward public accountability or governance (40.9%) (Figure 8). For instance, an article from PhilStar highlighted the impact of Golden Rice adoption in achieving the Sustainable Development Goals set by the United Nations, "...the commercial propagation of Golden Rice bodes well for the country's efforts to achieve SDGs on ending hunger and ensuring food security." Another article from the same newspaper pointed out that the Philippine Fiber Industry Development Authority (PhilFIDA) was pushing for the revival of the country's cotton industry through its propagation application for Bt cotton.

The common use of public accountability/governance frame aligns with the finding that government agencies and officials as the top sources of information (29.5%) by the article writers.

Table 9. Categories of metaphors used in the articles (2000-2023)

Category	Description	Examples (2017-2023)
Potential/promise	Positive images or developments that will affect people in the future	agriculture miracle explosion to combat human disease gleaming light of hope ushering in a new agriculture
Fear	Negative images about biotechnology and its applications in the future	unproven quick fixes false miracle solution Frankenfood Superweeds a weapon to touch off a new round of COVID-style lockdowns
Ethics	Moral issues and ideas that influence values of people	corporate gift to solve hunger and malnutrition
Human intervention	Creation or transformation into something unnatural or different from its former state	Trojan Horse biggest environmental disaster of all times

The predominant use of public accountability/governance frame is also consistent with the results of the first study (2000-2009) by Navarro et al. (2010) wherein the same frame was used most frequently in the articles.

Social progress was the secondary frame used in

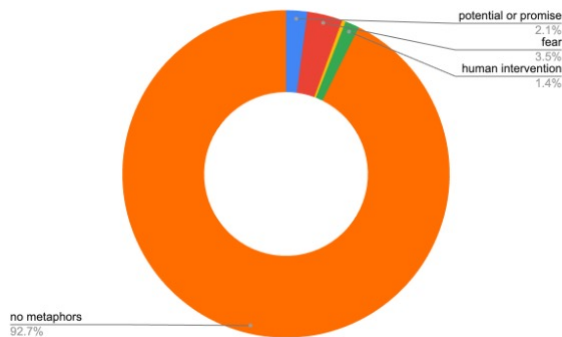


Figure 9. Presence of metaphors (2017-2023)

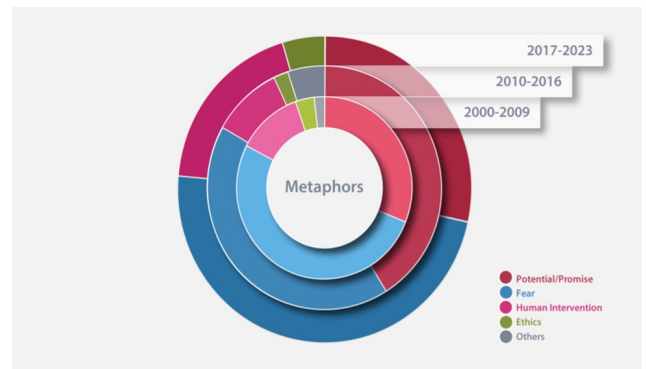


Figure10. Category of metaphors (2000-2023)

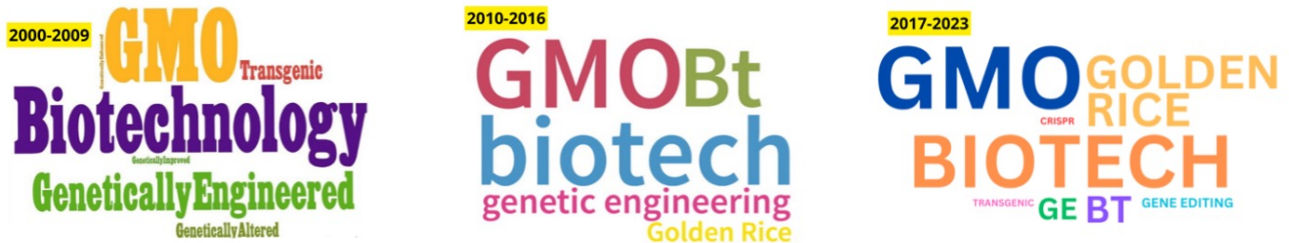


Figure 11. Keywords used in articles (2000-2023)

articles (28%) released in 2017-2023. In an article about counterfeit corn seeds, the author highlighted the role of biotechnology in attaining food security stating, "Biotechnology crops are seen as a more lasting solution to food hunger problems, as they are capable of doubling food production amid a protected surge in global population to nine billion by 2050." This frame was also reported as the predominant frame used by authors in the second study (Tome et al. 2017) covering articles in 2011-2016.

The Chi-Square test results (p -value < 0.001) revealed significant associations between topics and message framing (Table 7). The results showed that Golden Rice is mostly associated with social progress (10%) and public accountability/governance (5%), implying its prominence in development and governance discussions. GM corn (4%) and biotech (6%) were linked to social progress, while Bt cotton (4%) and biotech crops (4%) were associated to public engagement.

A significant association between message framing and source of information was also found in the Chi-Square test results (p -value < 0.001) (Table 8). The analysis showed that government sources (13%) were the most frequently mentioned source of information for the public accountability/governance frame. International organizations (8%) are prominently featured in the social progress frame, while scientists (3%) and academics (2%) are aligned with the new research frame. Civil society/environmental groups (3%) are more associated with the conflict/strategy frame, while private companies (5%) are associated with public engagement.

Metaphors

Metaphors are commonly used by writers in framing their articles. Various types of metaphors can impact issues through different underlying messages. Similar

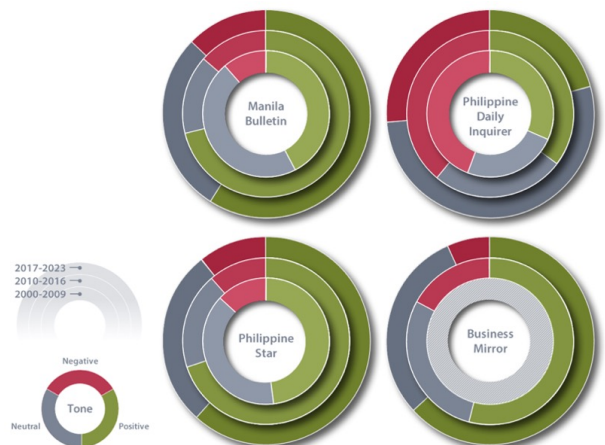


Figure 12. Tone of articles per newspaper (2000-2023)

with the previous studies, metaphors in the articles were categorized into the following: potential/promise, fear, ethics, and human intervention (Table 9). A declining trend in the use of metaphors was observed in the articles from 2000 to 2023.

During the first decade (2000-2009), 137 articles used fear-based metaphors often citing inaccurate negative effects like cancer, homosexuality, physical deformities, and mental retardation. Language evoking fear, such as "Frankenfood," "monster," "poison," and "bomb," was also prevalent. However, fear metaphors were still used in 2010-2016 but in lesser percentage than the first ten years of analysis. Biotechnology and biotech crops were then described as "new hope," "answer to farmers' dreams," "salvation of the cotton industry," and "light of hope." In 2017-2023, metaphors were rarely found in the articles (Figure 9), regardless of tone, though a milder creative treatment was still used by the writers to

Table 10. Association between keyword and tone (2017-2023)

Keywords	Tone			p-value
	Positive (%)	Negative (%)	Neutral (%)	
Biotech	14	0	6	0.002
GMO	15	4	9	
GE crop	4	2	3	
Bt	7	1	3	
Golden Rice	7	3	4	
Transgenic	1	0	0	
Malusog Rice	0	0	0	
Gene Editing	3	0	1	
CRISPR	3	0	0	
Others	4	0	2	

Table 11. Association between article type and tone (2017-2023)

Article Type	Tone			p-value
	Positive (%)	Negative (%)	Neutral (%)	
News	41	7	29	0.003
Feature	4	1	2	
Opinion	7	3	1	
Photo Release	0	0	0	
Editorial	3	1	1	

explain biotech. Only 10 articles exhibited fear metaphors (3.5% of total articles), referring to biotechnology as a “false miracle solution,” “Frankenfood”, “communist zombies”, or “band aid solution to hunger.”

Figure 10 shows the proportion of metaphor categories from 2000 to 2023. The top two metaphor categories in all phases of the analyses were fear and potential/promise.

Keywords

The content analysis included listing the keywords referring to biotechnology. The most used word from 2017 to 2023 was “genetic modification” (including derivatives of the word such as GMO, GM crop, etc.) (26.8%). “Biotechnology” or “biotech” was the second most common keyword (22.50%). The predominance of these two keywords (GM and biotech) was also evident in the two previous studies by Navarro et al. and Tome et al. “Bt” or *Bacillus thuringiensis* was also among the top keywords in 2010-2016, but with lesser use in 2017-2023 (11.4%). “Golden Rice” became a more popular term in the articles (14.33%) in 2017-2023. “Gene editing” also started to gain traction in the 2017-2023 coverage. Figure 11 shows the evolution of main keywords used from 2000 to 2023.

Tone of articles

All newspapers except Philippine Daily Inquirer exhibited a predominantly positive (54.5%) to neutral (33.6%) stance on biotechnology (Figure 12). Negative sentiments were exhibited by 11.9% of the articles, which commonly included quoted statements from biotech critics. About 18.2% of the articles contained misinformed statements about biotechnology, mostly in negative tone.

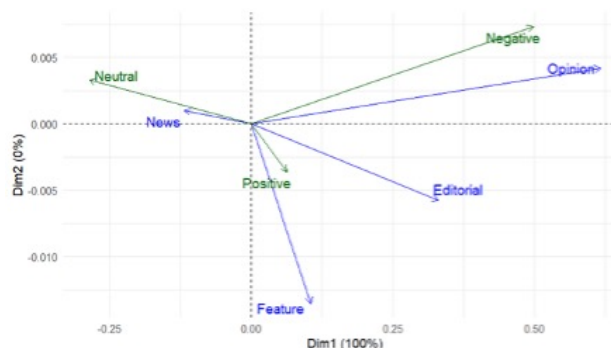


Figure 13. Correspondence analysis biplot for the relationship between article type and tone (2017-2023)

Misinformation was also reported by Lynas et al. (2022) in their two-year study on global coverage of GMOs. They also found that none of the misinformation was positive in tone and mostly negative. About a fifth of Africa’s media coverage on GMOs was found to exhibit misinformation, which is a disturbing information given the potential of the technology to contribute to the food security in the region.

About half of the articles (49%) had images and only one article used negative imagery to represent biotechnology (corn with GMO label on kernels). Visual representations of biotechnology or GMO such as Frankenfood or syringe on a crop were not observed in 2017-2023, indicating a more evidence-based visual representation of biotechnology through images.

The Chi-Square test results (p -value = 0.002) revealed significant associations between several keywords and tone (Table 10). The analysis showed that the word GMO is the most used keyword across all tones, but mostly for positive articles (15%). Similarly, biotech, Bt, and Golden Rice were commonly used in positive articles (14%, 7%, and 7%, respectively).

A significant association was found between article type and tone (Table 13) based on the Chi-Square test results (p -value = 0.003). Most of the articles were categorized as news, mostly in positive tone (41%). The biplot showed a similar association of news, feature, and editorial articles with positive tone, while opinion articles were closely linked with negative tone.

Trends of news coverage in major Philippine newspapers

Philippine Daily Inquirer

The Philippine Daily Inquirer is the top three most trusted news outlet in the Philippines in 2024 (Chua, 2024) and the leading broadsheet in the country in terms of readership with over 2.7 million readers daily (Inquirer, n.d.). Inquirer carries the tagline “Balanced news, fearless views,” which is evident in the newspaper’s strong journalistic voice and active participation in various socio-civic programs.

A total of 53 articles on biotechnology were published in Inquirer from 2017 to 2023, which is 18.5% of the total articles on the topic. Most of the articles were neutral in tone, which is a unique finding compared to the other three newspapers that published most articles in positive tone. In the two previous analyses, the portion of negative articles in Inquirer was higher than the others. While 35.8% of the articles contained misinformed statements, the significant change in predominant tone may imply a more evidence-based stance of the technology.

Though there was no prominent Inquirer writer who followed the story of biotech happenings in the country, one writer named Dale Arasa contributed several articles in a single year featuring new developments in other countries such as air-cleaning pothos, engineered fruit flies, worms with tougher fibers, and a new plant cell type. These topics were not featured in other newspapers. His articles significantly contributed to the number of articles published in 2023, the same year with the highest coverage from Inquirer.

Most of the articles released by Inquirer were news, but a significant number of opinion pieces came from Inquirer. Their top source of information was government agencies or representatives, followed by civil society groups. The common keyword used to refer to the technology and its products were “genetically modified/genetically modified organisms” (39%).

Philippine Star

The Philippine Star is a well-established digital news platform in the Philippines, known for delivering reliable and diverse content across politics, business, sports, entertainment, and lifestyle. With its award-winning multimedia journalism, the newsroom provides timely breaking news, in-depth analyses, and compelling stories that inform and engage readers. Philippine Star is the flagship title of PhilStar Media Group, the country's largest print media enterprise (PhilStar, n.d.).

From 2017 to 2023, the PhilStar published a total of 47 articles related to biotechnology, which constitutes 16.4% of the number of articles. Consistent with the findings of the previous studies, most of the articles in PhilStar were news articles (87.2%) and were written in a positive tone (61.7%). The articles in PhilStar were mostly published in the business/economy section (44.7%), followed by the agriculture section (27.7%). The dominant topic published in PhilStar shifted from Bt eggplant in 2010-2016 to Golden Rice in 2017-2023.

Similar to the other newspapers, government sources (36.7%), and international organizations (21.7%), such as ISAAA and IRRI, were the top sources of information in PhilStar. Among the identified authors, the PhilStar Business Reporter Louise Maureen Simeon contributed the highest number of articles (34.0%) on biotechnology. The vast majority of biotech-related articles in PhilStar were written by media practitioners, correspondents, or journalists (97.4%). Five articles used metaphors, with four

showing positive metaphors and one using a negative metaphor. The most used keywords in the PhilStar were “biotechnology” (24.5%), “Golden Rice” (21.43%), and “genetically modified/GMO/GM crop” (19.4%).

Manila Bulletin

Manila Bulletin, one of the oldest news companies in the Philippines, is known for its vision of “a just and prosperous society” (Manila Bulletin, n.d.; Ibrahim, 2025). It has combined the features of traditional online news sites and social media to bring readers a fresh and dynamic experience. Its website alone has 36 million unique viewers.

From 2017 to 2023, Manila Bulletin contributed 13.6% of total articles, a significant decline in percentage of coverage compared to the results of the previous study (2010-2016) wherein it was reported to be second to BusinessMirror. A possible reason for this decline is that several prominent writers who regularly covered biotechnology were no longer active during the latest analysis. However, National Scientist Dr. Emil Q. Javier, who has a regular column in the newspaper, frequently tackled biotechnology in his pieces. Thus, his articles contributed significantly to the portion of opinion articles in all newspapers (11.5%).

Most of the articles in Manila Bulletin focused on local biotech events and had low coverage of foreign or international happenings or issues. Government agencies or representatives were the main source of information cited in the articles, followed by scientists.

A huge portion (79.3%) of the articles were positive in tone, consistent with the newspaper's coverage style and goals: “...positive rather than negative in its coverage and interpretation, build-up rather than destroy, encourage rather than take a stand of negative criticism and be courageous in reporting abuses and dishonesty...” (Manila Bulletin, 2025).

BusinessMirror

BusinessMirror is a leading daily business newspaper in the Philippines, known for its in-depth coverage of economic, financial, and industry trends. Launched to provide a broader perspective on business and policy developments, it goes beyond numbers and statistics to analyze their real-world impact on individuals, businesses, and society (BusinessMirror, n.d.).

BusinessMirror published the highest number of biotech-related articles among the analyzed newspapers with 147 (51.4%) articles from 2017 to 2023, with an average of 21 published articles per year. Out of the 147 articles published by BusinessMirror, 93 (63.3%) were written in a positive tone, while 44 (29.9%) articles were neutral and only 10 (6.8%) articles were negative.

Similar with other newspaper dailies, the articles published in BusinessMirror were mostly news articles (79.6%) and focused on local events (64.63%). The top three topics covered were biotech (26.0%), biotech crops (16.4%), and Golden Rice (15.8%). In terms of framing, most of the articles were

categorized under the public accountability/governance (48.30%), followed by social progress (19.7%) and public engagement (16.3%). These articles appeared mostly in Science (36.1%) and Agriculture (27.9%) sections.

Consistent with other daily newspapers, most of the biotech-related articles in BusinessMirror were written by a media practitioner, correspondent, or journalist (68.0%). Among the 147 articles, six were published with a metaphor, with two using positive metaphors and four using negative metaphors. The most used keywords in BusinessMirror were “biotech/biotechnology” (64.63%), “genetically modified/GMO/GM crop” (63.3%), and “Bt/Bt eggplant/Bt talong/Bt corn/Bt cotton” (31.3%).

With BusinessMirror's excellent coverage of agricultural biotechnology over the years, it serves as a model for communicating scientific topics that are evidence-based and consistent.

CONCLUSION AND RECOMMENDATIONS

For the past 24 years, media coverage on newspapers and their respective websites have evolved. The news articles covering 2017 to 2023 showed a more positive tone of reporting towards the technology. Philippine Daily Inquirer, which has previously reported the technology with mostly negative articles, has now shifted to a more neutral tone of reporting. Thus, a gradual maturation of editorial stance is evident in the past 24 years.

The government, including its agencies and officials, remain to be the top source of information cited in the articles. This may indicate writers' preference to government sources or it could be these sources are more accessible than the others. Most of the articles were also categorized to exhibit public accountability/governance message frame, conforming the role of political will in moving the technology toward better acceptance and adoption.

The evolution of media reporting is characterized by new issues of discussions including gene editing, modern biotech act, and counterfeit seeds. These topics were not reported in the previous studies. The most prominent biotech article writers are a roster of award-winning media practitioners and a well-respected National Scientist. This finding reflects the quality of reporting and solicits higher trust from the readers. However, once the prominent writers become inactive, it causes a decline in biotech coverage.

Aside from contributing the most number of articles, BusinessMirror also exemplified excellent coverage of agricultural biotechnology over the years characterized by accurate and consistent release of reports, thus serving as a model for communicating scientific topics.

Based on these findings, it is recommended that media practitioners be engaged in frequent and high-quality interactions. These engagements should

include learning opportunities and provide a means for journalists to appreciate the technology through direct interaction with its developers and end-users (farmers and consumers). This is expected to foster trust in the technology and an understanding of its impacts, respectively.

To counter the flow of misinformation in newspapers and other channels, a fact-checking body can be instrumental. The body, composed of experts in biotechnology and communication, will monitor all misinformed publications and release a corrected explanation of the topic in as many channels as possible.

Government agencies which are involved in biotech research are encouraged to form communication teams who will be responsible to release popularized articles about their research or events, which will be forwarded to journalists or submitted to the news agencies for wider dissemination.

For future studies on media discourses in the Philippines, it is recommended to include stories from other communication channels in the analysis to create a more holistic representation of agri-biotech coverage.

FUNDING

This study was part of the project *Know the Science: Paving the Way to Inclusive Knowledge Sharing and Policy Development* (2023-2024), implemented by ISAAA Inc. and funded by the Philippine Agriculture and Fisheries Biotechnology Program of the Department of Agriculture (DA Biotech).

ACKNOWLEDGEMENT

Special thanks to the following individuals who contributed significantly to this research: Eric John Azucena, Panfilo De Guzman, Sofia Jean Tenorio Carpio, Lucille Grace Punzalan, Alfred Betis, and all the ISAAA and DA Biotech staff.

LITERATURE CITED

- Biotech for Life. 2024. Business Mirror's 'broader look at biotech draws recognition. Retrieved from <https://biotechforlife.ph/news/businessmirrors-broader-look-at-biotech-draws-recognition/>.
- Bish Joseph J. 2024. Overpopulation: Cause and Effect. Population media center. Retrieved from <https://www.populationmedia.org/the-latest/overpopulation-cause-and-effect>.
- BusinessMirror. (n.d.). A name, a commitment. Retrieved from <https://businessmirror.com.ph/about-us/>.
- Cacciatore MA, Anderson AA, Choi DH, Brossard D, Scheufele DA, Liang X, Ladwig PJ, Xenos, M, Dudo A. 2012. Coverage of emerging technologies: A comparison between print and online media. New Media & Society,

- 14(6), 1039-1059. <https://doi.org/10.1177/146Cacciatore 1444812439061>.
- Chua YT. 2024. Philippines. Reuters Institute, University of Oxford. Retrieved from <https://reutersinstitute.politics.ox.ac.uk/digital-news-report/2024/philippines>.
- Esquivel MM, Aboobucker SI, Suza WP. 2023. The impact of 'framing' in the adoption of GM crops. *GM Crops & Food*. 14(1): 1-11.
- Ibrahim M. 2025. The Manila Bulletin: 125 years of service to Filipinos. *The Manila Bulletin*. Retrieved from <https://mb.com.ph/2025/2/2/the-manila-bulletin-125-years-of-service-to-filipinos>.
- ISAAA. 2017. From fear to facts 17 Years of Agri-biotech Reporting in the Philippines (2000-2016). Retrieved from https://www.isaaa.org/resources/publications/fromfearstofacts/download/From_Fear_to_Facts.pdf.
- Lynas M, Adams J, Conrow J. 2022. Misinformation in the media: global coverage of GMOs 2019-2021. *GM Crops & Food*. 1-10.
- Manalo A. 2024. Advancing Philippine agriculture: strategic framework for the commercialization of Biotech Innovations. ISAAA. Retrieved from <https://www.isaaa.org/resources/publications/policybriefs/2024/pb2/2024-policy-brief-framework.pdf>.
- Manila Bulletin. (n.d.). Our company. Retrieved from <https://mb.com.ph/our-company>.
- Navarro MJ, Panopio JA, Bae Malayang D, Amano Jr, N. 2011. Print media reportage of agricultural biotechnology in the Philippines: A decade's (2000-2009) analysis of news coverage and framing. *Journal of Science Communication*, 10(3), A01.
- Pew Research Center. 2008. Audience segments in a changing news environment: Key news audiences now blend traditional and online sources. Retrieved from <http://www.people-press.org/2008/08/17/key-news-audiences-now-blend-online-and-traditional-sources/>.
- Philippine Daily Inquirer. (n.d.). Inquirer Philippine News for Filipinos. Retrieved from <https://philippinedailyinquirerplus.pressreader.com>.
- Philippine Star. (n.d.). About Us. Retrieved from <https://www.philstar.com/about-us>.
- Statista. 2024. Most trusted news outlets in the Philippines in 2024. Retrieved from <https://www.statista.com/statistics/1219827/philippines-trust-in-news-outlets-by-brand/>.
- Steiner L, Bird N. 2008. Reporters see indifference on genetically modified food. *Newspaper Research Journal*. 29(1):63-76.
- Tome KGN, Navarro MJ, Mercado SM, Monina M, Villena CA. 2017. Seventeen years of media reportage of modern biotechnology in the Philippines. *Philipp J of Crop Science*. 42(1): 26-35.
- Torres CS, Osalla MTB, Gopela JLN, Torres DMS. 2023. Public perception of agricultural biotechnology: 16 years after the public debates on GM crops. Department of agriculture biotech program office, international service for the acquisition of Agri-biotech Applications, Inc., College of Development Communication, UP Los Baños, and Southeast Asian Regional Center for Graduate Study and Research in Agriculture: Los Baños, Laguna, Philippines. Retrieved from https://www.isaaa.org/resources/publications/perceptionstudies/publicperception16years/pdf/Public_Perception_on_Agribiotechnology.pdf.
- United Nations. 2025. Global issues: population. <https://www.un.org/en/global-issues/population>
- United States Department of Agriculture Foreign Agricultural Service. 2024. Agricultural Biotechnology Annual: Philippines. Retrieved from https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Agricultural%20Biotechnology%20Annual_Manila_Philippines_RP2024-0039.