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RESEARCH ARTICLE

Visual Representation of Science: How Cartoonists Define Crop Biotechnology

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ABSTRACT

The mass media is the primary source of information on science and technology for the layman. How cartoonists "define" a science concept or issue for instance can contribute significantly to how the public forms an opinion about a topic that is not known or clear. Hence, this study was conducted to determine how cartoonists in Philippine national newspapers "define" crop biotechnology. A sample of cartoons published during 2000-2009 was analyzed as to message, tone, and use of frame and symbols. Complementing this study was a parallel analysis of 75 cartoons that were submitted to BiotechToons, a contest for cartoonists on biotechnology, in 2011. Majority of cartoons in the initial years of biotech reporting were generally negative in tone, preferred the fear appeal, used exaggeration in the absence of concrete products, and unfamiliarity with the concept. They often reflected the articles they accompanied. With the commercialization of a biotech crop in 2003, cartoons were more positive in perspective, highlighting the technology's benefits. The availability of science-based sources enabled cartoonists to have a broader view of the technology framed to highlight benefits and its impact on farmers and consumers.

INTRODUCTION

Adoption of biotech crops worldwide by over 16 million farmers in 29 countries has been unprecedented and translates into the highest rate of acceptance among improved crops due to a range of economic, social, and environmental benefits (James, 2011). Hence, it is not surprising that media coverage of science has been largely dominated in the last 20 years by biotechnology. Ironically, the technology continues to be at the center of debate and a magnet for media attention when controversy and contentious issues arise – all contributing to what the public is likely to think about it and how policy development will be affected. Extensive studies have been Done on biotechnology, media, and public opinion particularly in Europe and North America but less so in developing countries such as Asia (Schafer, 2010). Studies exist that specifically analyze cartoon images of cloning and stem cell research (Giarelli, 2006) and nanotechnology (Landau *et al.,* 2009) but hardly any on genetic engineering technology in general. This research on the role of cartoons in science coverage especially crop biotechnology in a developing country like the Philippines is a seminal area of interest.

Interest in the study of visual representations in science has grown and has become a legitimate area of research.. Pang (1997) acknowledges that the field has turned attention to aspects of the scientific process and actors involved. Hence, it has enriched the understanding of the links between science and culture. In particular, perception theory views the primacy of emotions in processing all communication activities. The ability to reason among children and young adults is easily influenced by the emotions that visual images convey. This explains why they are highly susceptible to emotional appeals through the visual media (Barry, 2007). This is corroborated by Schummer and Spector (2007) who stress that public discourses are visually mediated as the public image is substantially a visual image and that even the "written or spoken word is translated into visual images in the human imagination." The intrinsic satirical nature of cartoons and other similar art forms has made it a popular medium for conveying and interpreting issues and concerns that would otherwise be offensive or crude in written or oral communication. It is this quality that has made cartoons a popular means of sharing views on culture and politics (Conners, 2007; Eko, 2010; and Karagoz and Kose, 2011) and as a vehicle of setting social agenda (Sani *et al*., 2012). In the Philippines, the use of allusions, sarcasm, allegories, and lampoon through cartoons to allow a free discourse on society and politics has been documented (Lent, 2009).

Cartoons have also been shown to be effective communication channels for science education. The literature exemplified by Tatalovic (2009) on science comics as tools for science education and communication and Dalacosta *et al*. (2011) on the use of animated cartoons as an assessment tool in teaching science highlight their significant role beyond merely sharing information. Scientoons, a combination of caricature and satire to convey scientific information in a simple, understandable, and interesting manner, was pioneered by Indian senior scientist Pradeep Kumar Srivastava (Jolly and Kesarwani, 2010) to contribute to the popularization of science. A scientoon consists of two parts, a box containing scientific information, data or new research results, and a cartoon on the topic but with a humorous twist. Beyond the classroom, studies have shown that the mass media is the most frequently used source of information on science and technology (Nisbet and Lewenstein, 2002; Marks *et al*., 2007). In addition, Priest (2001) states that public opinion and reaction to agricultural biotechnology are primarily media-driven. Barry (2007) opines that much of visual experience today comes vicariously through media while Carr *et al*. (2009) emphasizes the importance of recognizing that children and young people are active rather than passive interpreters of media representations. Reporters and cartoonists interpret events and societal concerns which may be considered the "pulse of society" and

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represents public opinion (Bauer *et al*., 2001). Readers often just read the headline and lead paragraph in media articles that are not of direct interest. However, an artwork or cartoon on a topic immediately catches attention and delivers the message instantly. By reflecting on popular contemporary ideas, cartoons elicit emotions that encourage interest, inquiry, and empathy. They can connect with readers' reality and level of understanding. However, Hansen (2009) notes that in news coverage alone, almost half of all portrayals of science or scientists appear in items which are not specifically about science. It is important therefore to understand how cartoonists "define" crop biotechnology as they contribute to informal learning and decision making. How media practitioners portray science in general or crop biotechnology in particular through visual formats, can have an adverse impact on public understanding and policy formulation. This study therefore sought to answer these questions:

- How did cartoons in three national newspapers cover the topic of crop biotechnology during the ten-year period?
- What is the general tone used by cartoonists in defining crop biotechnology?
- What prominent media frames did cartoonists use to portray biotechnology?
- What characters and symbols were used to depict the technology?
- What non-visual cues or words were used in cartoons?

METHODOLOGY

To determine media representation of crop biotechnology through cartoons, a study was conducted using two sample sets: first, a sample of 22 cartoons on modern biotechnology published in three national newspapers in the Philippines from 2000 to 2009; and second, a set of 76 cartoons submitted in 2011 to BiotechToons, a contest for cartoonists on biotechnology. In the first set, cartoons were randomly selected from articles or editorials from three national newspapers with the highest daily circulation: *Manila Bulletin* (MB), *Philippine Daily Inquirer* (PDI), and *Philippine Star* (PS) through online and manual search techniques. The cartoons were published from 2000 to 2009 when GM crops were first introduced and eventually commercialized in the country.

For the second set, a national contest, BiotechToons organized by the International Service for the Acquisition of Agri-biotech Applications (ISAAA) and Southeast Asian Regional Center for Graduate Study and Research in Agriculture Biotechnology Information Center (SEARCA BIC) was held in collaboration with the Philippine International Cartoons, Comics, and Animation, Inc. (PICCA). Most of the professional artists who participated in BiotechToons are members of PICCA and Samahang Kartunista ng Pilipinas (SKP), an organization of cartoonists, while the amateurs were represented by students and hobbyists.

All entries were included in this study. One-on-one interviews with six professional cartoonists from the first set representing the three newspapers were done to validate results obtained. BiotechToons provided a rich source of cartoons from both professional and amateur artists who were tasked to visualize the topic "Benefits and Potentials of Crop Biotechnology". Both sets of cartoons were analyzed by a coding team with each cartoon identified as a study unit and subjected to quantitative content analysis. A coding template was used to summarize the following variables: message, tone (positive, negative, neutral), prominent framing category used, and symbols or characters portrayed. Discussion of the variables was complemented by visual analysis to determine both denotative (literal meaning) and connotative (symbolic meaning) interpretations of the technology. The denotative meanings were determined by analyzing the sex and role of characters in cartoons while symbols were identified to extract connotative meanings. Preference for non visual cues, e.g. words, was measured through a tag cloud or a graphical representation of word frequency.

RESULTS AND DISCUSSION

Sample cartoons published in the newspapers from 2000 to 2009 on crop biotech were a very small percentage and appeared only as a consequence of a media report of either a controversial issue or a favorable scientific breakthrough. Of eight cartoonists identified by their signature on cartoons published in newspapers, three were senior artists who have been in newspaper cartooning for the last 20-30 years, did the editorial cartoons of their respective newspapers, and also had regular individual strip cartoons.

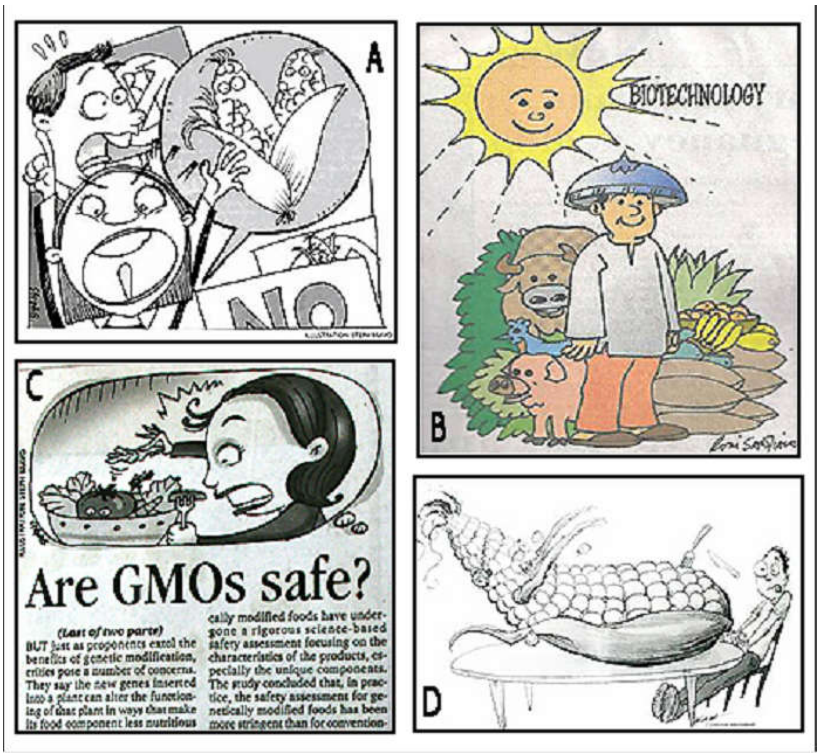

Fig 1. Sample cartoons on biotechnology published in national papers from 2000-2009.

About 13 or 59% of the cartoons were contributed by at least 5 artists of the *Philippine Daily Inquirer* (PDI). In contrast, Navarro *et al*. (2011) reported that 76% of articles on biotechnology were published in the *Manila Bulletin* (MB) and *Philippine Star* (PS) with the PDI accounting for only 24%. Cartoons provided the visual counterpart to the text as an editorial cartoon or as a graphic complement in an article. The PDI had the only female artist among the 11 cartoonists, nevertheless she was responsible for contributing 23% of cartoons for the period. BiotechToons attracted 75 entries of which 31 were by professionals while 44 were submitted by amateurs. Of the 75 BiotechToons cartoonists, 53 or 71% were male. Asked why women cartoonists were few, the respondents said that women generally preferred to go into animation and advertising although they did concede that newspaper cartooning was no longer attracting the younger set of artists. The succeeding discussion compares the first set of cartoons with BiotechToons.

Message

The artists who did the first set of cartoons relied on the articles that were published on biotechnology as they were assigned to produce a visual complement to the text. Editorial cartoons coincided with certain biotech-related events such as the celebration of National Biotech Week. Stories about anti-biotech campaigns, protests/bans (Fig 1A), doubts about food safety (Fig 1C); and consumer fears (Fig 1D) generated cartoons that played up these concerns. The wide-eyed, scared looks of the characters generalized the prevailing mood of the times – that of unrest and uncertainty as the debate on biotechnology was at its peak. Artists highlighted biotech crops, particularly Bt corn, on 50% of the cartoons (Fig 1A&D). This can be attributed to the fact that most of the articles during the initial years of media coverage coincided with the approval of the crop in 2002 and its eventual commercialization in 2003. At a time when the crop was not yet available on farmers' fields, and its safety as a food and feed crop was being debated, the Bt corn symbolized either the uncertainty felt by the public or the promise that the crop had to offer. The science of biotechnology was also a favorite message, showing how the research community was doing its share to bring benefits to farmers and consumers, thus assuring food security and alleviating poverty. Cartoonists portrayed scientists with the products they developed in the laboratory or farmers posing with their bountiful harvest. The sun symbolized light of hope and promise (Fig 1B).

conditions, are better yielding and thus, result in higher income for farmers were also a prevailing visual concept. Fig 3D shows a happy farmer with his bountiful harvest of healthy crops and more food choices for consumers. The crops are portrayed as characters with "super" powers or improved traits. Biotech crops exemplified by Bt eggplant (Fig 3B) whose fruits are expected to contribute to economic growth and progress if nurtured through biotechnology; and Golden Rice whose potential availability to farmers is expected to be the proverbial light at the end of the tunnel (Fig 3C) were featured to show their impact on farmers' lives. The slant on benefits is consistent with that of Reinhart (2007) who noted that discussions on biotechnology were more likely to focus on costs and benefits than other issues.

Fig 3. Sample cartoons from BiotechToons entries, 2011.

The second set of cartoons had a more diverse and detailed portrayal of crop biotechnology since ISAAA gave a 10-minute briefing to PICCA members during one of their meetings on what biotechnology is, the science behind the technology, and benefits of existing and

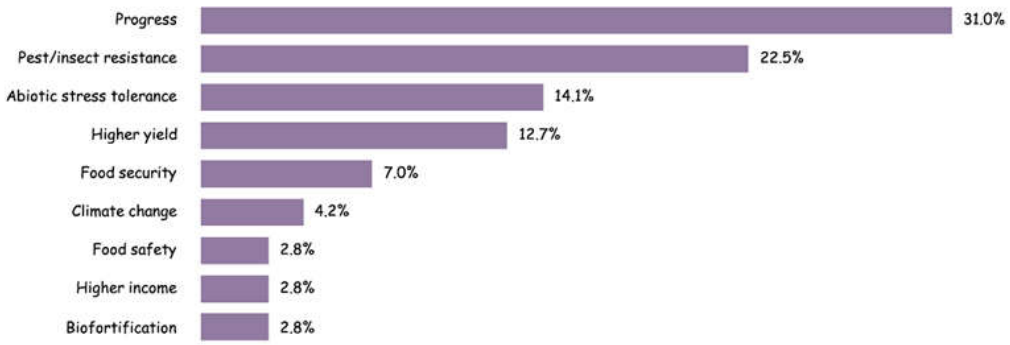

Fig 2. Benefits of biotechnology as perceived by BiotechToon cartoonists.

Since the theme of BiotechToons was on the benefits of crop biotechnology, the prevailing message of 31% of the cartoons was the progress or improvement in the quality of lives among farmers and consumers that is being realized (Fig 2). An example of this cartoon entry with this message is typified by Fig 3A showing a farmer moving from a state of poverty and stressed environment to a better quality of life characterized by higher yields and improved crops and enhanced by the presence of a rainbow and a sunny environment. The transition from a poor state to a better life is linked by a DNA helix that symbolizes biotechnology. The excitement and eagerness of the farmer to get to the "greener pasture" connotes the potential impact that awaits end-users. Specific benefits of biotech crops (Fig 2), e.g. pest or insect resistant, can thrive under adverse

potential biotech crops. This interaction enabled the cartoonists to understand the technology better and ask questions from experts. Relevant biotech resource materials were also provided to them. In addition, BiotechToons' Facebook page provided sources of information to help contestants conceptualize the theme. One winning artist narrated his effort to interview an expert at the Bureau of Plant Industry, an agency under the Department of Agriculture in charge of regulating, assessing, and monitoring the safety of biotech crops, to understand better what biotechnology is. An artist who was among those who drew negative messages in newspapers said that during the initial years of biotech reporting, articles had negative messages and little information was available on the topic. His

perspective of the technology changed with new information he received.

Tone

Cartoons published in national newspapers were negative (45%) in perspective with the rest as either positive (41%) or neutral (14%). Cartoons that appeared from 2000-2003, before Bt corn commercialization, tended to be negative. This was to be expected as there was a lot of uncertainty and doubts about the technology during this period when protests against the technology or call for a moratorium on research were at its peak. It was also during this period that frequent allusion to Frankenstein's creation was used to "portray" biotechnology, hence the word 'Frankenfood' was a favorite word used by writers. It personified the perceived fear of the unintended and uncontrollable consequences (Devos, 2007) although over time, constant usage of the metaphor lost its heuristic value and diminished its contextual meaning. Fig 1D shows the visual interpretation of the word through a Frankenstein-like corn that is bigger than the person expected to eat it. Instead of the consumer Having a normal meal, he, however, is alarmed by the sight of a corn that is ready to pounce on him. The use of Frankenfood as both a textual and visual metaphor eventually died a natural death (Navarro *et al*., 2011). This can be attributed to the eventual commercialization of a product, positive experiences of farmers in planting the crop and availability of science-based information sources as information feeds or story pegs for writers and cartoonists. Due to its prescribed theme, cartoon entries in BiotechToons were all positive. Nevertheless, it is interesting to note that while the tone was set, the context or message was substantiated by accurate information such as the potential and available biotech crops, and scientists' efforts to address agricultural challenges such as drought, salinity, low yields, and pest infestation. From merely generic and abstract representations of the technology as either being fearful on one hand, or being an option for a better life, cartoons evolved into a more science-based perspective. A possible shift in opinion as shown by the modification of messages shows the social impact of visual images and how they can be tapped to aid better understanding.

Visual Frame

Story frames determine the importance of a topic or issue. They can highlight certain points of view, define perceived aspects of significance, and explain how issues should be understood. Framing establishes indicators for what concerns or affects society as different aspects of an issue are selected for emphasis. Studies (Maeseele *et al*., 2007; Marks *et al*., 2007) show the use of frames to analyze media coverage. Frames identified in textual formats were adapted to categorize visual frames. About 27% of sample cartoonists in newspapers framed biotech from a social progress perspective or defined it in terms of a new development or breakthrough (Fig 4).

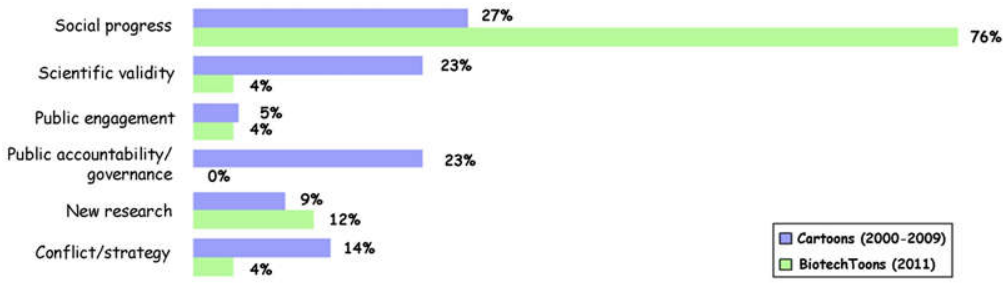

Fig 4. Comparison of visual frames used by newspaper cartoonists and BiotechToons artists.

Cartoons showed how the technology can improve the quality of life through a variety of improved crops with enhanced traits and savings for the farmers through reduced agricultural inputs (i.e. chemical pesticides and water) translating to a better environment and agricultural industry. Since the technology was perceived as unfamiliar territory, the scientific validity frame was chosen by 23% of the artists. This frame elaborates expert understanding of what is known versus the unknown and calls on the science community to address this concern. Public accountability frame to show demand for transparency with respect to procedures, regulations, and more public involvement and participation was used by 23%. Cartoons captured perceived uncertainty in the technology and government's support and role in assuring its safety. The objective of these cartoons was to encourage public participation in the biotech debate as it sought to raise issues and address increasing concerns among the public.

Given benefits as the key message, the dominant frame was social progress among 57 of 75 or 76% of BiotechToons entries (Fig 4). This finding is similar to that obtained among the first set of cartoonists. Visual images showed positive changes in farmers' (and his family) lives which translated into increased yield, better crops, and higher income. This is consistent with Poortinga and Pidgeon's (2007) assertion that personal issues (those that touch people's personal life) are considered more important than social issues (world poverty, population growth, and climate change). To a lesser extent, new research was also a preferred frame where the scientist's role in producing new improved crop varieties was highlighted. Generally, the concept of benefit was viewed from either the perspective of a farmer or a scientist.

Characters and Symbols

Cartoons in national newspapers were male-dominated in the depiction of characters or symbols used. Over 67% of the characters had male attributes. Preferred characters were the scientist, genetically modified corn, farmer, and the consumer. This is consistent with findings that a scientist is generally perceived as male (Schummer and Spector, 2007; Christidou *et al*., 2011). Unlike the Western media that tended to portray the scientist as evil and dangerous and thus embodying the fear of science (Haynes, 2003), the Filipino researcher was perceived more in a positive light. The overall image of the scientist was that of a happy person holding a flask, in a position of responsibility and high status, and being consciously aware of his contribution to the upliftment of mankind (Fig 5). The researcher, however, was stereotyped as being in a laboratory and wearing a lab gown and never as one in the field or outside the confines of a work area. In addition, science as an activity is perceived as a solitary rather than a team effort. Science symbols or emblems were a magnifying glass, microscope, flask, and test tube. These traditional instruments used for scientific research are the same ones also reported by Christidou *et al*. (2011) and reinforce an unchanging depiction of science as a laboratory-centered endeavor. Corn, whether a conventional or biotech variety, was the most drawn crop. It was either depicted as a super crop with improved traits or a "Frankenfood" that attempted to instill fear among consumers. The use of a Frankenstein monster to symbolize the creation of unnatural beings was also reported by Hellsten (2003) and Giarelli (2006).

The public was represented by both male and female characters, either as being undecided in accepting a biotech crop or as a recipient of the bounties of biotechnology. There was a trend to use the fear appeal in conveying messages about biotech. The visual metaphor was depicted through the use of an abnormal looking and larger than life corn and scared consumers rallying against the biotech corn. Also

appealing was the use of the potential or promise metaphor shown through a smiling sun and happy farmer and his produce, and a ray of hope over agricultural plants and animals. This observation is consistent with that of Christidou *et al*. (2004) who noted metaphor images of science and technology as a dipole of promise and/or scare. BiotechToons characters were male scientists or farmers who were portrayed as happy, smiling people. Scientists were featured as developing biotech products that enabled farmers to reap the benefits of high yielding and pest resistant crops. There was a trend to depict a "super" farmer, defined by one artist as "one who uses biotech that gives power to increase crop yield and protects him from the agony of pest attacks and weather discrepancies." Women in the two sets of cartoons were relegated to a wife or mother figure who either feared for the safety of food or shared the happiness of the male characters in using biotech crops. Although there was a tendency to portray women in a more positive light, their exposure was not significant. This observation is also documented by Durham and Brownlow (1996) whose work on sex difference in the use of science and technology in children's cartoons revealed that women were not the main focus of action but as assistants who focus on the social aspects of interaction with others.

Among the biotech crops, biotech corn, eggplant, and papaya were often included in the cartoon frame (Fig 3d). Similarly, they were portrayed as having above average powers with one artist identifying them as Captain Corn, Wonder Tomato, and Super Papaya. As one artist said to explain his cartoon: *My editorial cartoon is about how biotechnology has been able to transform certain crops into more resilient varieties making them virus and insect resistant, or able to survive in abnormal conditions like drought or flooding. This technology will be able to lessen the impact of global food shortages by making crops more hardy especially now at the time of climate change. Stronger crops would mean high crop yield and more food for the growing world population.* Connotatively, the cartoon highlighted the positive attributes of the crops that translate into higher yield in the same way that Super Heroes are able to literarily save people from various elements.

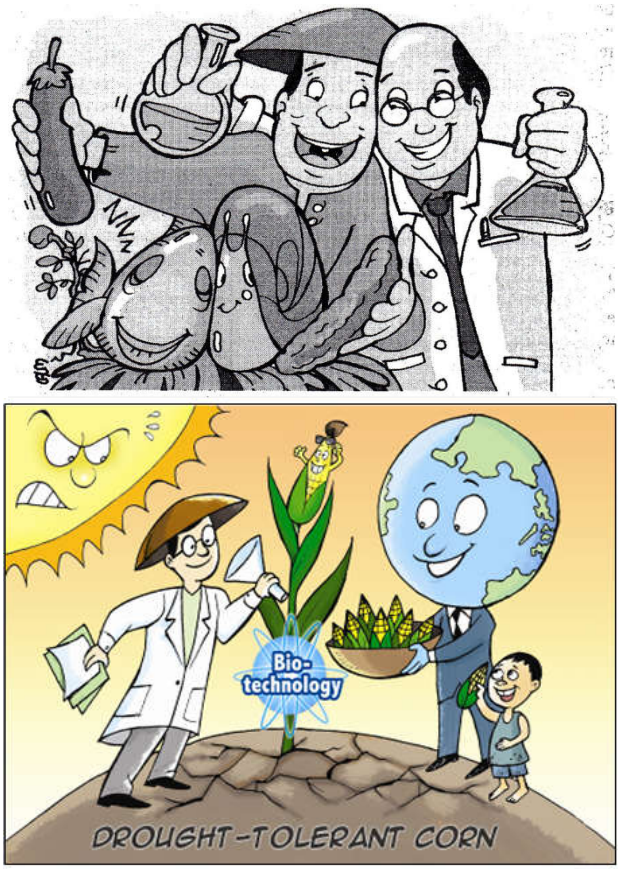

Fig. 5. Representation of a scientist by newspaper cartoonists (left) and BiotechToons artists (right).

Despite biotechnology being an advanced and modern field of science, no artist attempted to draw new tools such as a gene gun although reference to DNA (building block of life) was observed in a few cases. Interestingly, the use of the DNA structure attested to efforts on the part of artists to go beyond "given" concepts and introduce a scientific viewpoint into the frame. One artist elaborated his inclusion of the symbol: *The double helix code/DNA symbolizes crop biotechnology which helps bridge the gap between poverty and increased productivity/food security. The benefits and potentials of crop biotechnology show the brighter side of genetic engineering* (Fig 3A). The denotative meaning of the DNA was the science of life but connotatively, it hoped to be the bridge of life by extending its potential benefits to a greater mass of people. The use of science symbols such as flasks did not change in cartoons whether drawn in early 2000 or the present, signifying a constant view of the role of science as an experimental activity. However, entries in BiotechToons regard science in context of a bigger environment, e.g. in relation to the farmer or consumer's worldview, rather than as an isolated, abstract endeavor. This pragmatic view of science enables readers to identify with the efforts of the research community and consider themselves as part of the process of discovery and development.

Use of Word Text

Cartoons use allusions instead of words as they do not attempt to explain elaborate and abstract concepts or ideas. However, words are used to highlight or convey messages to a level that the reader can identify or relate with. A visual representation of the frequency of key words referred to as a tag cloud was developed with the highest word count depicted by having the largest font size. Words were not commonly used in newspaper cartoons. If ever, choice of words or phrases were limited to biotechnology or its shortened form, genetically modified, and "no" (referring to opposition to the technology) with an insignificant number using Bt, ban, gene, Golden Rice, genetic pattern, and genetically engineered corn (Fig 6). During the period when information about the technology was not widely available, generic symbols with few details and few words or phrases were used.

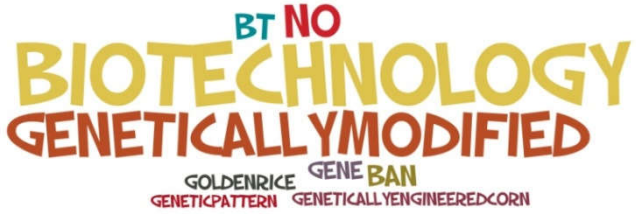

Fig. 6. Tag cloud of words used by cartoonists in newspapers and a sample cartoon with a word descriptor.

In contrast, the tag cloud of frequently used words in BiotechToon cartoons showed preference for the following terms or phrases: higher yield, improved (plants and animals), increased nutrients, health, more food, and safer environment. (Fig 7). Again, artists conceptualized "benefit" in terms of these keywords which are similar to the visual images used. Biotech crops were identified as either a papaya, eggplant, rice or corn with any of the following attributes: drought tolerant, vitamin-enriched, virus resistant, or insect resistant. The availability and access to more information sources motivated cartoonists to amplify their thoughts on the subject matter, hence, the use of key words and phrases.

Conclusions

The barrier to a better understanding of biotechnology has often been attributed to the perceived difficulty of the subject matter, and knowledge gaps, but more significantly, to a lack of trust in institutions and interpersonal source credibility (Brossard and Shanahan, 2007).

Fig 7. Tag cloud of words used by BiotechToons cartoonists.

The study demonstrated that cartoons as a popular art form can contribute to greater awareness and understanding of the technology through the use of images that the public can relate to. An artist articulates this observation: *There is low interest in science among readers but it is vital to the country's progress. Cartoons provide nuggets of wisdom through visual symbols. We need to get the right information out.* The relatively positive image of a scientist and the institution that he/she represents in a local setting demonstrates a favorable level of respect and credibility from the viewpoint of visual communicators. This deviates from traditional stereotypes of scientists which indicate ambivalence or low trust towards science as reported by Christidou *et al*. (2011). Cartoons can be a springboard into a transparent debate and discussion on a technology that has benefits just waiting to be tapped. By providing science-based information to cartoonists as experienced in the BiotechToon project, particularly those in the mass media, visual practitioners can narrow the complexity of the subject matter and allow readers to share their thoughts on an otherwise contentious issue. In the same manner, artists represent the general public in being able to contribute to the discussion on the topic and link it to a broader social context. An artist forwarded this insight: *Biotech is a new topic for me. I read about it on the internet but there is so much information. We have to make sure it is accurate. I see the potential of the technology but farmers must still make the choice of whether to use it or not.* Similar to political cartoons, science-focused cartoons can also provide commentary and debate by mirroring the wider socio-cultural and technological environment. By highlighting the positive aspects of a technology, the cartoonists as well as media can enhance public attention and reorient people's ideas about certain important issues.

It is a positive and significant trend for cartoonists to be able to put more substance in their symbolic representation of biotechnology. In the process, they can articulate key elements of the technology for the public who depends on the visual medium to help them process information. In like manner, constant thematic frames reflect the general concerns that need to be amplified or given attention to. Artists' conceptualization and analysis of a broader range of issues related to biotechnology through visual representation augers well for the better appreciation of the science. Nevertheless, it is important that accurate terminology and information are constantly made available to these communicators as well as opportunities to interact with appropriate stakeholders such as scientists, government experts, and farmers. Similarly, as artists work generally in tandem with writers, even the latter must not be left from this process of information sharing and exchange. As cartoons are communicative and social artifacts (Sani *et al*., 2012), the study proved that they can be a complementary tool in a wider strategy to help the public understand better the social phenomenon behind crop biotechnology and in building and shaping public opinion based on empirical information. That science in general is viewed in a positive light and that researchers are perceived as credible, responsible, and pragmatic pave the way to an enlightened perspective of what is oftentimes a detached and abstract "definition" of science and technology.

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