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Consequences of GMO Labeling

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Genetically Modified Organisms (GMOs) have been a hot topic of debate for decades. Granted, the biotechnology industry has seen opposition to many advances in terms of their ethical applications. Arguments have been centered around their safe incorporation into the food supply. It is difficult to honestly assess their safety considering their relatively recent introduction. That is why community advocates call for GMO foods to be labeled when incorporated into foods, for transparency and to give consumers autonomy in making decisions on the foods they consume. Opponents to GMO labeling, however, worry about public confusion, price increases and overall costs to producers, manufacturers, and consumers alike. This paper explores the regulation of GMOs, their economic impact, and takes into account several ethical considerations regarding labeling.

Introduction

I walk into the grocery store with my mom, going through our memorized shopping list, a scenario I concocted, in my head. I recall the eggs I would drop at my front door, the aroma of cookies from an open cookie jar in the kitchen, the disappointing discovery of the full gallon of expired milk in the fridge. There is sliced papaya in a bowl next to an open container of cottage cheese and baked frozen pizza with a tub of ice cream in the middle of a table set with plates and utensils. When I head into the living room, a baby blue toothbrush lies on the floor near a wall with red, white, and blue toothpaste smeared all over it in the shape of a pig. In an attempt to build my elaborative rehearsal skills and test my memory, the stories I develop get wilder and wilder with each trip to the store. We walk through the aisles of the store, aiming to spend the least amount of time possible. I pick up the brands that my mom bought when I was younger, trusting in their quality being reminiscent of my childhood and occasionally pick up an off-brand to take advantage of lower prices. I take the time to look at the label on the frozen pizza and find something interesting.

Labeling is a form of communication between producers and consumers, and the labeling of food products ensures the safety of the community when distributing these products for public consumption.[1] For example, the safe regulation and

1 Jagadeesan Premanandh, "Global Consensus—Need of the Hour for Genetically Modified Organisms (GMO) Labeling," *Journal of Commercial Biotechnology* 17, no. 1 (February 2011): 37–44, https://doi.org/10.1057/jcb.2010.24.

I am a University of Hawai'i at Mānoa junior from the island of Maui. I am currently studying Biology and Philippine Language and Literature: Ilokano, with aspirations of becoming a physician. I have always heard of GMOs but never knew exactly what that entailed. With some background in business, I decided to dive deeper into the regulation and economic implications behind GMOs. As someone with an interest in medicine, I realize the importance of understanding the foods you consume. I hope that this paper encourages others to do their own research on the path that their foods take from production to plate. This paper is a culmination of my work in Dr. Zoia Stoytcheva's Honors 491 course.

enactment of recalls is possible due to labeling that allows for the traceability of products processed in a specific period at a specific location.[2] The United States of America has specific labeling laws on just about every processed food. Criteria includes a product name, net quantity, manufacturer, packer or distributor, allergy warnings, serving size, nutrition labeling, and an ingredient list.[3]

My mom never cared to review the labels on the items she buys. She explicitly seeks to identify if something is the product she wants to purchase, in addition to comparing the net quantity and price between products to get the best deal. Curious after taking a human nutrition course, I examine the brand of frozen pizza we typically purchase. I make my own mental calculations of the unit price and nutrition facts. I take into account the amount of servings in each box and how many servings I usually eat of it, and take special consideration into the amount of sugar, sodium content, and types of fats present. All while organic chemistry and biochemistry concepts run through my mind.

When looking at labeling requirements a bit more closely, there are several exceptions as to what is mandatory to disclose on labels. I know there exists a dense amount of information on food labels, and a disparity in the scientific understanding by the general community of the information on those labels. Therefore, how beneficial, or harmful, would it be for companies to disclose the use of ingredients that have been genetically modified? This paper analyzes the impact of labeling GM foods on their consumption and their political, economic, and ethical discussions.

Brief History of Genetically Modified Organisms (GMOs)

Plants have been genetically modified since the 1980s. These plants are referred to as GMOs. [4] The integration of these plants into the food supply has been rapid in the United States. However, opposition is seen all over the world, including the United States and specifically strong opposition in the European Union, where strict laws govern the incorporation of GMOs into the general food supply. [5] Proponents of GMO use have advocated for its ability to increase the efficiency of agriculture in decreasing the amount of land needed to grow crops, making efficient use of water, increasing crop yield, increasing the nutritional value of crops, and its overall proposal as a solution for world hunger.[6]

Figure 1 SmartLabel Disclosing Use of BE Ingredients. (*Source*: "SmartLabel QR Testing," *Bar Code Graphics* (blog), accessed October 29, 2019, https://www.barcode.graphics/smartlabel-qr/).

Curious about the SmartLabel, as shown in Figure 1, on the box of frozen pizza, I scan it to view the information it provides. I discover that it contains ingredients that have been bioengineered (BE), or in other terms, GM. My mom shrugs it off, saying it is the brand we always purchase. With the little background I have on GM foods, I press on questioning the ingredients with a more cautious eye. What type of genetic modifications were performed on this ingredient? What was the purpose of that genetic modification? How will that affect my health? Is the frozen pizza safe to eat? How much of the ingredients were BE?

Regulation—United States and State of Hawai'i Laws

Food labeling is regulated by the government, and in the United States, it is done so by the Food and Drug Administration (FDA). In the labeling of BE foods, however, the U.S. Department of Agriculture (USDA) was commissioned to write a

2 JOHN R. LUPIEN, "Food Quality and Safety: Traceability and Labeling," *Critical Reviews in Food Science and Nutrition* 45, no. 2 (March 30, 2005): 119–23, https://doi.org/10.1080/10408690490911774.

3 Center for Food Safety and Applied Nutrition, "Guidance for Industry: Food Labeling Guide," U.S. Food and Drug Administration, April 22, 2019, http://www.fda.gov/regulatory-information/search-fda-guidance-documents/guidance-industry-food-labeling-guide.

4 "Traceability and Labelling," Text, Food Safety—European Commission, October 17, 2016, https://ec.europa.eu/food/plant/gmo/traceability_labelling_en.

5 "How Are GMOs Labeled around the World?," *GMO FAQs* (blog), February 9, 2016, https://gmo.geneticliteracyproject.org/FAQ/how-are-gmos-labeled-around-the-world/

6 Premanandh, "Global Consensus—Need of the Hour for Genetically Modified Organisms (GMO) Labeling."

National Bioengineered Food Disclosure Standard (NBFDS) through Public Law 114-216, signed by President Barack Obama in 2016. It nullified any previously defined state laws on the labeling of genetically modified ingredients to ensure uniform requirements nationwide.[7] This was in an attempt to create uniform mandates on labeling across the U.S. where previously states, such as Virginia, had been able to mandate labeling in their state alone. The NBFDS was drafted in 2018 to be implemented in 2020 and requires mandatory labeling of food products containing bioengineered ingredients by 2022.[8]

The law's enactment has been slow, therefore, its effects in the United States are yet to be analyzed. The NBFDS requires foods containing BE or GM ingredients to display a Quick Response (QR) code (Figure 1), "bioengineered" symbol (Figure 2A), or text message (Figure 2B) to provide consumers with information on BE ingredients.[9] Implementation of the NBFDS poses a new set of challenges for the average consumer who is already overwhelmed by those labels that exist for food products. There is a significant disparity in the scientific background of the general population, especially that concerning GMOs. There is also a disconnect when the recognizable term of "GMO" is replaced by "BE".

Figure 2 Sample BE Symbol (A) and Text Message (B) for NBFDS. (*Sources*: (A) "The National Bioengineered Food Disclosure Standard Part I | Food Safety & Quality Blog," accessed October 29, 2019, http://foodsafety.merieuxnutrisciences.com/2019/04/03/national-bioengineered-food-disclosure-standard-part1/; (B) "The ABCs of GMO Disclosure in the United States | Center for Science in the Public Interest," accessed October 29, 2019, https://cspinet.org/news/abcs-gmo-disclosure-united-states-20170925).

Labels communicate the contents of foods to consumers, allowing consumers to make decisions on the foods they buy. They may be geared towards specific groups of consumers who prefer foods from a particular producer over others due to the ingredients used. Consumers may even make decisions on the foods they purchase based on a producer's mission statement and morals. Consumers looking specifically at the ingredient content of foods are today able to do simple searches online or even download apps to help with monitoring their dietary health. These technologies are able to assist those in underserved populations, improving their "access to care" in which they are able to take control of their health with public information.[10]

My mom asks what I am doing on my phone while grocery shopping and asks me to put it away. I assure her that I am using it to do a quick search on the contents of the frozen pizza I picked up. She does not quite understand how to use her phone to do such research and scan the QR code, but she asks for the information I found. Those who are not fortunate enough to own an electronic device would be at a disadvantage for BE ingredient disclosures presented in the form of a QR code. Of those who do own electronic devices, individuals who do not know how to scan QR codes, such as my mom, would be at a similar disadvantage. How then, does the NBFDS provide a standard if labels are not standardized so as to give equal access to information with these types of disparities?

The advent of the commercialization of GM crops in the seed industry, and the relocation of large sugar and pineapple plantations in Hawai'i left a perfect vacancy for the biotech industry. It could claim land in paradise, which had the infrastructure, supply of employees, and ideal weather for testing GM crops.[11] However, at what cost does this come to residents? With an average 10-16 applications of pesticides daily between 2007 and 2012 in Kauai by DuPont alone, was claimed as the most probable cause of acute poisonings experienced by the community.[12]

In 2016, laws in Hawai'i, Maui, and Kauai county were preempted by the U.S. Court of Appeals for the Ninth Circuit by the Plant Protection Act. The laws attempted to regulate the

10 Jiska J. Aardoom, Alexandra E. Dingemans, and Eric F. Van Furth, "E-Health Interventions for Eating Disorders: Emerging Findings, Issues, and Opportunities," *Current Psychiatry Reports* 18, no. 4 (March 5, 2016): 42, https://doi.org/10.1007/s11920-016-0673-6.

11 Andrea Brower, "Hawai'i: 'GMO Ground Zero,'" *Capitalism Nature Socialism* 27, no. 1 (January 2, 2016): 68–86, https://doi.org/10.1080/10455752.2015.1112420.

12 Brower; "GMOs Are Tearing a Tropical Paradise Apart," Salon, September 4, 2013, https://www.salon.com/2013/09/04/a_battle_in_paradise_how_gmos_are_tearing_a_tropical_utopia_apart/; Bruce P. Lanphear, "The Impact of Toxins on the Developing Brain," *Annual Review of Public Health* 36, no. 1 (2015): 211–30, https://doi.org/10.1146/annurev-publhealth-031912-114413.

"movement of interstate commerce" and plant pests already regulated by the aforementioned act.[13] Hawai'i's agricultural industry is essential to the livelihood of many residents, but it does not come without its costs. When sugar plantations were still around, cane burning was cause for concern for respiratory health. There will always be a struggle in fighting for the preservation of land, culture, and history, which is exemplified in many Hawaiian movements. It takes understanding and honest discourse to reach a consensus between the coexistence of preservation movements and research and development.

Whatever the case, genetic engineering is soon to require greater transparency in the disclosure of genetically engineered ingredients in processed foods. The U.S. has already implemented widespread nutrition mindfulness through MyPlate, helping Americans make better food choices.[14] What more if they educate the public on genetically engineered foods. America is based on the freedom of choice, are we actually given a choice when most foods are already genetically modified, and we are not given the option to choose otherwise?

Economic Considerations

The general population may not have an opinion on topics such as the labeling of GMO ingredients, although those who purchase products with ingredients that are genetically modified may see price increases due to new labeling. With about an estimated 11% increase in the cost of products that will require labeling of genetically engineered ingredients, product prices will see an increase, impacting consumers.[15] In states such as Hawai'i with an already high cost of living, this may make the desire to live here less than it already is. Given that over 90% of corn and soybeans grown in the U.S. are genetically modified, everyday foods that contain these, including many that use High Fructose Corn Syrup (HFCS) as a sweetener due to its low price, will be more costly for the average family. About 17 million pounds of HFCS was produced in 2016.[16]

In response to the labeling of foods with BE ingredients, Table 1 shows a variety of possible consumer, marketer, and producer responses. This exemplifies how mandatory labeling will affect all aspects of the market. Consumers and marketers may be entirely unaffected by choosing indifference to the new standard. There is already a niche of consumers who gravitate towards foods that are not GM, or genetically engineered, as listed in the table, and this may grow as more and more foods begin to disclose BE contents.

The variability of disclosure methods for foods with BE ingredients may confuse consumers attempting to differentiate and identify these products. This variability is seen in the possible responses of consumers to avoid products with a specific disclosure label. Part of this variability in responses is exemplified for products that will be labeled with a QR code. Individuals without access to a device to read the disclosure through this method will be at a disadvantage. This disparity also gives rise to the questionability of the standardized mandatory labeling given such variable methods of labeling. Overall, consumers who wish to learn more about the methods in which BE foods were manufactured will still have to conduct their own research, which is still a step up from non-disclosure.

The NBFDS will still be voluntary until January of 2021. As such, marketers who advertise food products may feel indifferent about disclosing the use of BE ingredients. They may opt to not market foods with a BE ingredient disclosure, decreasing their public presence in the marketing realm. This would give a greater presence to organic foods, or those that simply do not contain BE ingredients.

When producers are eventually required to disclose the use of BE ingredients in their products, they may do so through text disclosure statements, QR codes, or disclosure labels, which would increase their expenses. To avoid incurring these expenses, they may opt to produce foods which do not contain BE ingredients, or even organic foods shall costs outweigh possible negative responses by consumers. The impact on the agricultural industry in response to consumer demands may cause a shift in the manufacturers who purchase GM crops or require a shift in the proportion of GM crops grown in the U.S. overall.

Since moving to attend college, I have had to take more consideration into the foods I eat. Science courses have made me more knowledgeable about the weird ingredients I had just learned to pronounce, and I have a deeper appreciation for their presence in the foods I purchase. Price, however, is still a substantial factor in the foods I choose to buy.

With the possible response that BE foods would be portrayed in a negative light due to labeling, a shift in the market may demand more foods to be produced without incorporating BE ingredients. Researchers have speculated that this will lead

13 Greg Herbers, "Ninth Circuit Holds Anti-GMO Regulations In Hawaii Preempted By Federal And State Law," Forbes, accessed October 1, 2019, https://www.forbes.com/sites/wlf/2016/12/08/ninth-circuit-holds-anti-gmo-regulations-in-hawaii-preempted-by-federal-and-state-law/.

14 "About Us | ChooseMyPlate," accessed October 16, 2019, https://www.choosemyplate.gov/about-us.

15 Annie Gasparro and Jacob Bunge, "GMO Labeling Law Roils Food Companies," *Wall Street Journal*, March 20, 2016, sec. Business, https://www.wsj.com/articles/gmo-labeling-law-roils-food-companies-1458510332

16 John Bovay and Julian M. Alston, "GMO Food Labels in the United States: Economic Implications of the New Law," *Food Policy*, Special issue on The Economics and Politics GM Food Labeling, 78 (July 1, 2018): 14–25, https://doi.org/10.1016/j.foodpol.2018.02.013; "High Fructose Corn Syrup (HFCS) Production U.S. 2016," Statista, accessed October 2, 2019, https://www.statista.com/statistics/496475/high-fructose-corn-syrup-production-in-the-us/.

Table 1 Possible consumer, marketer, and producer responses to the NBFDS

POSSIBLE CONSUMER RESPONSES	POSSIBLE MARKETER RESPONSES	POSSIBLE PRODUCER RESPONSES
Indifference toward buying foods with or without GE disclosure label	Indifference toward marketing foods with or without GE disclosure label	Add GE disclosure label to existing products
Avoiding foods with text disclosure statements	Opting not to market foods with text disclosure statements	Opting not to produce foods with text disclosure statements
Avoiding foods with QR codes	Opting not to market foods with QR codes	Opting not to produce foods with QR codes
Avoiding foods with GE disclosure labels	Opting not to market foods with GE disclosure labels Advertising and PR campaigns about marketing foods that do not require GE disclosure labels	Increased production of foods that do not require GE disclosure labels; reduced production of foods that require labels Increased production of foods that do not require GE disclosure labels; reduced production of foods that require labels
Increased demand for foods with non-GE or organic labels	Increased shelf space for foods with non-GE or organic labels	Increased production of foods with non-GE or organic labels

Notes: This table represents a consumer-driven structure in which the (perceived or anticipated) responses of consumers and marketers to the NBFDS drive responses of marketers and producers, respectively. Each horizontal or numbered response in the table reflects one possible response of consumers or a subsect of consumers, and the corresponding response of marketers and producers. If producers respond to NBFDS with a label only (items 1–3), costs will be substantially lower than if they respond by replacing GE ingredients with non-GE ingredients and undertaking segregation, certification, and monitoring activities (items 4–5).

Source: John Bovay and Julian M. Alston, "GMO Food Labels in the United States: Economic Implications of the New Law." *Food Policy* 78 (2018): 14–25.

to a reduction in investments in research and development within the biotechnology industry surrounding GM crops, as well as disrupt trade.[17] It may affect the livelihood of researchers with an altruistic goal of solving hunger and malnutrition or reducing the use of harmful pesticides and herbicides. Labeling may imply that GM foods are unsafe.[18] Communities demand that more long-term health impacts be analyzed. It took decades to directly correlate smoking to respiratory diseases.[19] Similarly, it may take more conclusive and well controlled studies to determine the effects of GM foods on health.

In markets with a diverse group of consumers, labeling would be attractive in giving those with varied food preferences to make informed decisions. There is a largely diverse population in Hawai'i; there may exist consumers from particular religious groups that are not allowed to eat certain foods. Groups that are mindful of what they eat may be more inclined to read labels and explore the contents of their food, and for them a lack of labels may be misleading in disclosing the entirety of a food product's contents shall they contain foods that groups are religiously obligated to avoid.[20]

Ethical Considerations

There already exists an overwhelming amount of information on food products, not all of which are understood by consumers. The question remains whether or not consumers indeed should have the right to know what is in their foods. Opponents to labeling may argue that the labeling of genetically modified foods serves no real purpose as the community should focus on the larger picture of how safe their food is as opposed to how their food was manufactured and processed.[21] There is also concern about how a food was made, considering that recombinant DNA may include genes from other organisms that are not listed in the ingredients of a food product. That is where proponents argue for the transparency in the ingredients listed on the foods they are spending hard-earned money on.

17 Bunge, "GMO Labeling Law Roils Food Companies.

18 Bovay and Alston, "GMO Food Labels in the United States."

19 "The Study That Helped Spur the U.S. Stop-Smoking Movement," accessed October 23, 2019, https://www.cancer.org/latest-news/the-study-that-helped-spur-the-us-stop-smoking-movement.html.

20 Jacob Bunge, "U.S. Judge Overturns GMO Crop Curbs in Hawaii," *Wall Street Journal*, August 26, 2014, sec. Business, https://www.wsj.com/articles/u-s-judge-overturns-gmo-crop-curbs-in-hawaii-1409009260.

21 Premanandh, "Global Consensus—Need of the Hour for Genetically Modified Organisms (GMO) Labeling."

Public safety is always a priority for the FDA[22], and ensuring adequate agriculture for a healthier America is part of the USDA's mission.[23] The commercialization of GM crops is subject to a series of regulations, as depicted in Figure 3, before their introduction to the market. This includes research, field tests, and safety assessments.[24] This does not, however, take into account the assurance that the public knows exactly what they are consuming.

This process of releasing a biotech crop for public consumption includes the marketability and business viability aspects of these crops and may show that safety is not always the number one priority. Businesses still need to make money to offset the initial costs of research and development. Labeling would increase awareness of the processes undergone to create the foods we eat.

Nutrition labels may be hard to interpret, but those who are able to navigate the complicated language and facts on foods they consume do have better dietary behaviors.[25] This goes to show that a niche of consumers do care about or are mindful of the contents of their foods. Transparency through labeling will grant them this ability to continue being mindful about their foods, whether it be the ingredient content or genetic modifications made to those ingredients.

Figure 3 Various stages of regulation in the commercialization of a biotech crop. (*Source*: Bunge, "GMO Labeling Law Roils Food Companies.")

Discussion

GMOs have been a hot topic of debate. Not everyone may understand them completely, but proponents of labeling them argue that consumer autonomy should be preserved. Opponents, however, argue that labeling would increase prices for all, and be the cause of confusion for something that should be a form of communication between producers and consumers. Consumer knowledge of information on nutrition labels may already be lacking, and labeling may not be ideal for all parties affected. In a country that produces an abundance of GM crops, however, consumers may appreciate the transparency provided by producers, and those genuinely interested in the processes undergone by GM ingredients will soon have access to that information.

Being more mindful of the foods I consume grew in importance to me as my family noticed I was not paying attention to the foods I ate. The process of reading nutrition labels or asking my mom for the ingredients in our home-cooked meals was something new to me. Once I had my first experience with tainted food however, being mindful of the contents and the methods of preparation of the foods I consume became more of a habit. After familiarizing myself with ingredients that had intimidatingly long names, I found myself making healthier decisions. I knew a bit more about their use in the food and associated health consequences. Sure, ignorance may be bliss, but the absence of any labels meant forfeiting my control over the foods I consume and subjecting myself to junk foods that I knew I would regret later. Nevertheless, I am always hungry and keep eating.

Future discussions should look into the impacts of BE labeling on producers, manufacturers, and consumers once the NBFDS is implemented as the next few years will see many changes in this implementation, as compliance will not be mandatory until 2022. There will be no shortage of opinion; therefore, GM foods will continue to be debated. Discussions should look at the impact of the NBFDS on commerce across borders and economic impact with prices and consumer preferences. Given that this standard was created as a uniform approach to the labeling of GM foods, the impact on commerce across the U.S. and internationally should be analyzed. An accurate assessment of price impacts should be analyzed, as well as how these prices affect families and their preferences when buying food.

The general public should be informed as well. Schools should teach students more about where their foods come from, how they were made, and how they may impact their health. I may not know everything about the foods that I consume at all at times. It is nice, though, to know that when I want to be more conscientious of the foods I consume when I buy food, I can turn to the labels already present on them. I

22 Office of the Commissioner, "What We Do," FDA, November 3, 2018, http://www.fda.gov/about-fda/what-we-do.

23 "About the U.S. Department of Agriculture," accessed October 23, 2019, https://www.usda.gov/our-agency/about-usda.

24 Bunge, "GMO Labeling Law Roils Food Companies."

25 Alexander Persoskie, Erin Hennessy, and Wendy L. Nelson, "US Consumers' Understanding of Nutrition Labels in 2013: The Importance of Health Literacy," *Preventing Chronic Disease* 14 (28 2017): E86, https://doi.org/10.5888/pcd14.170066.

walk out of the store, with the cheapest frozen pizza I found and smile as my stomach rumbles, ready for dinner.

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