Subdividing GMO classifications for food labeling

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Executive Summary: In May 2014, the Vermont state legislature passed a law requiring food containing Genetically Modified Organisms (GMOs) to be labeled, which goes into effect in 2016. Vermont is the first state in the nation to pass such a law, but this issue is gaining traction in several other states. Supporters of GMO labeling cite transparency and access to information as their primary reasons for requesting the change. The authors agree that in order for consumers to make informed choices about the foods they eat, a labeling system must be implemented. However, we are concerned that labeling a product as "GMO" or "produced with genetic engineering" is far too simplistic and may be perceived as a warning label. In order to better serve the customer, a universal label for GMO foods needs to be designed that does not reduce the items in your grocery store to two categories: "GMO" or "free of GMOs". GMOs such as soybean, for example, exist in several different varieties based on the traits they acquired through genetic modification (also known as a transgenic trait), which includes increased yield and pest resistance. These details need to be easily accessed by the public. In order to make strides towards increased transparency, the public must be aware of the GMO manufacturer, the transgenic trait of the plant, the technology used to modify the plant as well as the GMO's impact on human health and the environment. We propose a labeling system that highlights GMO diversity by sub-classifying the product based on the transgenic trait. This labeling system will conveniently direct the customer to an online resource containing relevant information about the GMO of interest. We also provide details about how this labeling scheme could be implemented in a pilot program and assessed for its effectiveness.

I. Introduction

Genetically Modified Organisms (GMOs) are defined as any plant, animal or microbe whose genetic information has been altered using genetic engineering (FDA 2015). In 1996, 4.2 million acres of cropland were planted with GMO crops. Fast forward to 2013, where 169 million acres of cropland (which is approximately half of the arable land used for crop production in the U.S.) are planted with GMO crops (Fernandez-Cornejo et al. 2014). There are a number of reasons why a crop would be modified, including: introducing resistance to pests, enhancing nutritional content of the food, increasing crop yield and improving plant growth in environmentally stressful conditions.

One example of genetic modification for pest resistance is Hawaiian Rainbow papaya, which is widely considered a success story for agricultural biotechnology. The Ringspot virus devastated papaya crops in the 1990s. The Rainbow variety of papaya was modified to carry a gene from the Ringspot virus itself, rendering it resistant to infection in a manner reminiscent of immunity provided by vaccines. Testing shows that the modified Rainbow papaya is equivalent to its conventional counterpart in both nutritional value and allergenic properties (Fermin et al. 2011, Tripathi et al. 2011).

Enhancing the nutritional content of food is another goal of genetic modification of crop plants. Vitamin A deficiency is a worldwide health concern and the leading cause of preventable blindness in children, a prominent issue in the developing world where diets consist primarily of staple foods such as rice, wheat and corn that are poor sources of vitamin A (WHO/CDC 2014). Golden Rice is engineered to carry two additional genes allowing it to produce beta-carotene, a vitamin A precursor, in the edible portion of the plant (Beyer et al. 2002). Research into Golden Rice is ongoing, yet in countries such as the Philippines, there is resistance to Golden Rice due to questions about safety and efficacy (IRRI 2015, Al-Babili and Beyer 2005, Harmon 2013).

Environmental stresses such as drought, high levels of salt, and extreme temperatures can have a significant impact on plant health and crop yield. Genetic modification of plants to be more stress tolerant is another goal of agricultural biotechnology. In Australia, drought resistant wheat is planted in order to combat frequent dry spells that are diminishing yield and profit margins for farmers (Fleury et al. 2010). Genes have been introduced into the wheat from corn and other well-studied species in an effort to improve tolerance to drought.

This proposed labeling scheme will provide relevant information to those who demand to know what they are eating and make information available to those who have yet to form a strong opinion about GMO foods. Additionally, labeling of GMOs can facilitate large-scale studies on the impacts of GMO foods on human health and the economy. Such research could help inform the debate regarding the safety and benefits of GMO foods to humans.

In this labeling scheme we divide GMOs into four categories: Pest Resistance (PR), Enhanced Nutrition (EN), Environmental Stress Resistance (SR), and Improved Yield (IY) (Figure 1). Each category will also contain a QR ("Quick Response") code, which can be scanned by a mobile device and link the consumer to a section of the USDA website with a list of GMOs found in that product and additional information about each GMO. The online database will be especially useful in cases where a food item contains multiple GMOs. The database will include the identity of the GMO, the method of modification, the transgenic trait and safety information. Ideally, there would be a comment section for the public to request additional information. This may assist in re-branding GMOs through openness between the consumer and manufacturer. We hope that the labeling system will help people to determine what variety of GMO food, if any, they will purchase.

Vermont's law requires GMO foods to be labeled with the words "produced with genetic engineering". In the simplest method of satisfying this requirement, food manufacturers could add these words to the Nutrition Facts panel on the product (VGA 2015). The labeling scheme that we describe here can satisfy these requirements, but also provides more extensive information about the GMO. A commentary from 1998 suggests that GMO foods be labeled with either "Process-based GMO" or "Product-based GMO" (Phillips and Issac 1998). A process-based GMO would be any crop that is modified in a way to aid the process of crop growth or harvest (like pest-resistance or improving yield) while a product-based GMO would be any crop where the end traits of the plant are altered (an example is enhanced nutrition). Our proposed labeling scheme expands upon the Process- or Product-based label by adding details about the transgenic trait introduced into the plant in an effort to increase transparency. Another GMO labeling guideline proposed by the non-profit organization Non-GMO Project seeks to verify and distinguish non-GMO options for the consumer (NGP 2015).

In order to test this labeling scheme, Vermont can be used as a pilot program. The GMO labels must be incorporated in Vermont by 2016. In the instance that there is only one GMO associated with a food item, there will be just one sub-category label on the package indicating the sub-category of the GMO. However, if a food contains several GMO ingredients, more than one sub-category could appear on the packaging. A QR code will be associated with each sub-category. In addition, the designation "produced with genetic engineering" will be included on each label to satisfy the requirement of Act 120 (VGA 2015). State and federal level agencies can assess this label and the educational resources for efficacy and determine its affect on consumer-shopping choices.

GMO technologies have the potential to impact human health and food crop yields in various different ways. However, their safety and purpose are being questioned in a way that suggests they are all the same. Lumping GMO foods into a single category could lead to public perception that all

GMO foods are bad and that the "produced with genetic engineering" label is a warning. This proposed labeling scheme will allow consumers, if they choose, to re-evaluate how they think about GMOs and expand their knowledge about GMO foods.

Figure 1: Proposed GMO Labeling Scheme that subdivides GMOs into categories based on their transgenic trait. The QR code was generated using http://www.qrstuff.com.

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Amanda is a Ph.D. candidate in the Molecular and Cellular Biology program at Dartmouth College. She received her B.A. from Mount Holyoke College where she majored in Biology and minored in Chemistry. Her research focuses on how plants acquire and utilize metal micronutrients from the soil using the model organism *Arabidopsis thaliana*. The ultimate goal of her research is to improve crop yield and nutrient content to contribute to world food security. Amanda is passionate about using science to solve world issues. She hopes to use her scientific training to impact science policy by improving science communication.