

GMO Case Study

Debate over the GMO Rainbow Papaya in Hawaii, by Amy Harmon

Amy Harmon is a correspondent for the *New York Times*, covering the impact of science and technology on American life. She has won two Pulitzer Prizes, one in 2008 for her series, “[The DNA Age](http://www.bit.ly/thednaage)” (www.bit.ly/thednaage) the other as part of a team in 2001. In 2013, she received a Guggenheim Fellowship in Science Writing. In 2014, her articles on the clash between scientific consensus and public perception on the value of genetically engineered crops were awarded a prize for in-depth reporting from the Society of Environmental Journalists and the Science in Society Award from the National Association of Science Writers. Harmon especially strives to engage readers in science’s social implications through the tools of narrative journalism: suspense, conflict, scenes and dialogue. Her current project involves neuroscience and longevity research. Harmon’s career began at *The Michigan Daily*, the student newspaper at the University of Michigan, where she earned a B.A. in American culture. She lives in New York City with her husband and 11-year-old daughter.

The goal of this case study is to discuss the issues surrounding the use of genetically modified organisms (GMOs) in agriculture. We will focus on the Rainbow papaya, a variety of this fruit that was engineered to resist a virus that has heavily impacted papaya crops across the globe.

In 2013, the Hawaii County Council, the nine-member body that governs the “Big Island,” passed a bill that banned the introduction of new GMO crops to the island; however, it exempted the Rainbow papaya, which is already extensively grown on Hawaii. In this case study we will discuss a hypothetical new bill introduced in the Hawaii County Council to ban the Rainbow papaya.

Case study participants will play the role of an assigned stakeholder with interests in the Rainbow papaya and other agricultural biotechnologies. Stakeholders are modeled on real people to focus the discussion through composite archetypes of actors. Roles include:

- 1) A **local activist** who believes that GMOs represent an attack on Hawaiian culture and independence by outside corporate forces and should therefore be banned.
- 2) A **papaya farmer** whose crops were devastated by the virus and whose livelihood depends on the Rainbow papaya.
- 3) The **Cornell scientist** who developed the Rainbow papaya and who believes deeply in the potential for biotechnology to help farmers, consumers and the environment.
- 4) An **organic farmer** who believes that pesticides, herbicides and GMOs are destroying the planet and making people sick.
- 5) A **mainland environmental activist** who sees banning GMOs as part of a larger strategy to weaken multinational corporations.
- 6) A **conventional farmer** who likes the convenience and economic benefits of GM crops but not the restrictions that come with their use.
- 7) A **GMO-organic farmer** who believes that the best future is one in which we use biotechnology to reduce chemicals in farming and to make more sustainable and ecologically friendly crops.
- 8) A **regulator** from the US Department of Agriculture involved in the approval of GMO crops for sale to consumers.
- 9) A **council member** who acts as a moderator for the discussion and debate.

A brief bio of each of these characters is provided below, along with a description of their stance on the Rainbow papaya, a series of talking points, questions they are likely to be asked, and questions they could ask other participants. There is also some character-specific background reading provided.

Small classes (Fewer than 10 students):

In small classes, one student will play the city council chair/debate moderator. Remaining students will adopt roles of the assigned stakeholders testifying before the council.

Stakeholders will each prepare a statement of no more than three minutes outlining their primary reasons for supporting or opposing the ban. At the end of the three minutes, they will be asked questions by the council chair. After everyone has spoken, speakers will have an opportunity to ask each other questions—with the council chair acting as moderator. At the end of the moderated debate, the council chair will announce his or her decision.

Medium sized classes (10-20 students):

In medium-sized classes, students will adopt the roles of each assigned stakeholder, the council chair, and the remainder will play council members.

Stakeholders will each prepare a statement of no more than three minutes outlining their primary reasons for supporting or opposing the ban. At the end of the three minutes, the council will ask them questions. All participants should review the “possible questions” sections detailed below for each speaker, in order to not only see what questions may be asked of them, but also to get ideas for questions to ask of other stakeholders.

The council chair will moderate the questions to ensure appropriateness and to keep time. After all stakeholders have spoken, the members of the council will debate the bill under the council chair’s moderation. At the chair’s discretion (and if time allows), members can re-call speakers to answer additional clarifying questions. At the end of the debate, the council will vote on the measure; a majority is required for the measure to pass.

For large classes (more than 20 students):

For classes of more than 20 students, follow the same basic scheme as that described for medium sized classes, with multiple students assigned to work collaboratively for each stakeholder role.

Special note on council chair

The role of the council chair in this case study is to act as a moderator for the discussion and debate, to ensure that questions are directed to the appropriate person and that the discussion and debate do not get sidetracked or bogged down in acrimony.

The person assigned to the council chair role should take extra care to familiarize themselves with the background and arguments from all sides prior to the discussion. The council chair should enter the discussion and debate as a neutral observer interested in getting to the bottom of the issue. When someone raises an issue, the chair should select the best stakeholder to answer it. When someone makes a point, the chair will identify the best person to counter it. The chair should view his or herself as on the side of truth.

To prepare for this role, the council chair should carefully read “[On Hawaii, a lonely quest for facts about GMOs](https://www.bit.ly/questforfacts)” (www.bit.ly/questforfacts), and imagine themselves as the city council member at the center of the story (Gregor Ilagan)—although one should not feel obligated to reach the same conclusion he did.

Background on papaya

The papaya is a tropical fruit, native to Central and South America that is now widely cultivated in the tropics. Around 11 million tons of papayas are sold every year, with the major producers being India, Brazil and Mexico. The United States is, by far, the largest importer of papayas. Most papayas consumed in the US are imported, but there is concentrated production in Hawaii, accounting for 15,000 tons per year. The Solo papaya, also known as the “Hawaiian papaya”, was introduced to Hawaii in the early 20th century, and quickly became a signature export of the islands.

Like all plants, papaya is affected by a series of pathogens, the most significant being the papaya ringspot virus (PRSV). The virus began having a severe impact on the Hawaii papaya industry in the 1950s, leading to a shift of production from Oahu to its current center on the Big Island’s Puna region.

The Puna papaya crop remained unaffected by PRSV for several decades, but in 1992 the virus was detected in the region. Efforts to isolate infected trees failed, and within five years all areas of Puna were affected, and the local papaya industry was nearing collapse.

Natural immunity to PRSV in papaya does not exist, and efforts to induce immunity by a form of vaccination (known as “cross protection” in plants) did not prove practical or economically viable.

In the 1980’s researchers at Cornell University and the USDA launched a research program to develop transgenic papaya that would be resistant to PRSV. They used a strategy that had shown success in other plants whereby the insertion of a single gene from the virus into the plant genome, and production of the encoded protein in plant tissue, protected the plant against the pathogen.

The first PRSV-resistant papaya cultivars were generated in 1991 and were approved for commercial use by the USDA in 1998. Introduction of the original transgenic variety, known as SunUp, and a derivative known as the Rainbow papaya (which was a cross between SunUp and a locally popular non-transgenic papaya variety) began soon after.

There was some initial reluctance from farmers about patents and costs, but after the scientists who developed SunUp and Rainbow arranged to have them distributed in Puna for free, they were rapidly adopted and led to the quick recovery of the Puna papaya industry. These two varieties now account for over 80% of papaya production in Puna. These papayas were the first GMO tree fruits to be approved for sale in the US, and were recently approved for import by Japan, a major market for papaya.

Although GM crops were met with public scrutiny and skepticism when they were first under development in the 1980s, there was little controversy over GM papayas until recent years, when a loosely knit coalition of anti-GMO organizations, natural products suppliers and the organic farming industry began to push local GMO bans and GMO labeling as an alternative to increased federal regulation of the industry. This effort began to gain momentum throughout Hawaii in 2010, with the 2013 GMO ban on the Big Island being a prominent manifestation.

Place of papaya in the Hawaiian economy

The economy of Hawaii is dominated by tourism, with around 20% of the workforce employed directly in the “leisure” sector, with a knock-on effect on construction and other important areas of the state’s economy. This dependence on tourism makes the state particularly susceptible to economic downturns on the US mainland and Asia, where most of its tourism originates.

Efforts to diversify the Hawaiian economy have focused on exports. Exports from Hawaii are hampered by the high cost of transportation, and account for only approximately 1% of the state’s overall economic activity. In 2013, Hawaii exported \$598m in goods, \$40m of which was food. At \$9m the papaya export crop is thus around 25% percent of all food exported from Hawaii and 1.5% of all Hawaiian exports. Approximately 1% of the Hawaiian population works in agriculture.

Because of Hawaii’s year-long growing season, the seed industry (crops grown strictly for the development, testing and export of seeds) was established in Hawaii in 1966, accounting for approximately \$106 million in economic activity in 2018-19. The industry’s footprint in the Islands has been steadily shrinking in recent years. A large fraction of the seed crops in Hawaii are GMOs.

Local activist

Character background

You grew up on Hawaii and have lived here your whole life. You love the island as a natural paradise and enclave from the problems of the rest of the world. You see the fight over GMOs as the latest battle in an effort to prevent corporate takeover of the island. Although you worry about the safety of GMOs, you care more about the loss of a simple life on the island and see GM crops as a failed and unnecessary intrusion.

Stance on banning GMO papaya

You strongly support banning GMO papayas as the final step in freeing Hawaii of GM crops.

Role in debate

To represent locals who see GMOs as part of corporate takeover of Hawaii and to emphasize that the Rainbow papaya has not been as successful as claimed.

Talking points

1. GM crops and the multinational companies behind them are destroying Hawaii.

The multinational companies (Monsanto, Syngenta) that are pushing GMOs do not care about Hawaii, our people, and our way of life. They want to turn our beautiful islands into a giant outdoor laboratory to develop and test products that they will use to take over agriculture on the planet. They patent their seeds, making it impossible for farmers to do what they've done for millennia (and nature has done for millions of years!): collect seeds from last year's crop to replant next year. And they want to make sure that all of the profits in farming go to them, and not farmers. Do we really want these global corporations to control our farms and our food?

Don't let Hawaii become a laboratory! Ban GMOs and send Monsanto back to Missouri.

2. The Rainbow papaya is a Trojan horse.

People will tell you that the Rainbow papaya wasn't made by Monsanto, that it was developed by academic and government scientists, and that the seed companies let them give it away to us for free. And this is technically true. But did you ever stop to wonder why the seed companies did this? These are people who sue farmers whenever they get the chance. Do you think they suddenly became generous with Hawaiian papaya farmers? No chance. They saw the Rainbow papaya as a chance to convince people that GMOs are good. They want us to think that they're the good guys – that they and their technology are here to help farmers fight off diseases and keep their livelihoods. They knew that if they

succeeded in getting the Rainbow papaya growing in Hawaii that it would be easier for them to introduce other GMOs to the island. So don't believe the hype! The Rainbow papaya was a Trojan Horse set up to get GMOs onto the island. And just like the people of Troy should have tossed the horse into the sea, we should toss the Rainbow papaya into the sea and tell it to never come back.

3. The Rainbow papaya is failed biotechnology.

Everyone will tell you that the Rainbow papaya saved the Puna papaya industry. And I'm sure it helped when things were really bad a few years back. But if it's such a great thing, why is Hawaii the only place where it is grown? They have the ringspot virus everywhere papayas are grown – Thailand, Philippines, Brazil, Africa – but none of these other places will use the Rainbow papaya. Governments, farmers and consumers in all these countries have rejected GMO papayas. They have all sorts of reasons. They worry if they are safe. They worry about GMO contamination. They worry about the cost. They worry about what will happen if the protection fails. And most of all, they worry about markets.

In many countries where papayas are sold, consumers don't want to eat GMOs – especially Europe and Japan. Our papaya farmers have been hurt by the loss of markets more than they have been helped. Organic papaya farmers on other islands can sell their fruit at a high price to Europe and Japan, and also on the mainland in places like Whole Foods, which do not like to sell GMOs. Meanwhile our Puna farmers get much less money for each fruit – some say it's less than the cost of growing the papayas. What's the point of saving a crop if you can't sell it?

4. Other farmers have rejected GMOs.

In 2003 taro growers decided GMOs would interrupt their cultural connection to the islands. After the state failed to pass bills to prevent GMO taro from being developed, they passed laws in Hawaii and Maui counties preventing GMO taro commercialization.

In 2004 the Hawaii Coffee Industry examined the papaya case and agreed to an industry-wide ban, shutting down three GMO coffee research projects. They knew that even faint association of Hawaiian coffee with GMO would do huge damage to their natural reputation. Again, after the state failed to pass bills to protect the industry, Hawaii County passed laws banning GMO coffee on the island.

Several other groups that depend on high-end markets, such as pineapple, banana and macadamia nut, decided not to pursue GMO research projects after seeing the struggles farmers have with selling their GMO papayas.

5. Cooperate with farmers.

We shouldn't be fighting with farmers. Our real enemies are the big corporations that want to turn Hawaii into a polluted laboratory, and make our farmers and ourselves slaves to their patented products. If you do the right thing and eradicate GMO contamination from

the island, we should also start working with our farmers to promote organic and sustainable practices across the whole island – help them with subsidies and training and help them develop better markets. This is the only way we can protect our island oasis.

Questions for others

1. To the scientist: Why haven't you been able to get the Rainbow papaya adopted in other places?

Don't let the answer be only about scientific/technical issues. The Rainbow papaya has been rejected in Thailand and other countries for political reasons and safety reasons. These need to be discussed.

2. To the scientist: Don't you have a conflict of interest here? Maybe you don't make money on Hawaiian Rainbow papaya, but what about if you get it sold in other places? Are they just going to give it away there?

The scientist will likely argue that they have made no money off of the Rainbow papaya; however, this is only because the GM papaya has not been widely adopted elsewhere. The fact that their strategy to market it outside of Hawaii failed does not let them off of the hook for trying to profit from disease-resistant papaya.

3. To papaya farmers: We have no problem with you. I know you are just trying to feed your families and get by. But do you think the Rainbow papaya has really helped you? Isn't it hard for you to sell? And don't you get a lower price? If you had it to do all over again, would you use Rainbow papaya or would you try something different?

Really hammer home that the Rainbow papaya has failed to make the papaya industry in Puna thrive. This is a major part of the argument for the Rainbow, and it is bogus.

4. To everyone in favor of the Rainbow papaya: If the experience has been so great with papaya, why do the taro, coffee, pineapple, macadamia and banana farmers all reject the technology?

Again, this undermines the argument that the Rainbow papaya has been the salvation of the local papaya industry.

5. To the seed company: Isn't your company giving away seeds for the GMO papaya really about getting access to Hawaii?

Answers to common questions

Q: If the Rainbow papaya is so bad for farmers, why do most of Puna's papaya farmers choose to use it? Why do you want to take away their choice?

A: Papaya farmers were desperate. They saw their crops being destroyed, and then a scientist who seemed to be out for their best interests came in and gave them magic seeds that would fight off the virus – for free! Of course, they were going to use them. And now they are locked in. They have invested time and money into the Rainbow papaya, and don't have the resources to switch to something else. But if you ask them, I bet they will tell you that, if they could go back in time, they would do something else.

Q: Would you support GMOs under any circumstance? What about if wheat or something else we depended on to feed ourselves was under threat and the only way to save it was a GMO? What if this GMO had been developed by the government and had no patents? And farmers were free to replant them. Would that be OK?

A: This is an impossible hypothetical question. The reason we oppose GMOs is that they ARE associated with big multinational corporations that are trying to destroy the island and take all of our money. Maybe if the perfect GMO had been made, we would be in favor of it – come back and ask when you make it – but right now, these GMOs are bad for us and should be banned.

Background reading

[Hawaii Seed \(www.hawaiiiseed.org\)](http://www.hawaiiiseed.org), an organization founded by local activists like you to fight GMOs in Hawaii, has a lot of information and resources on their website.

In particular, you should look at:

- [“Hawaiian Papaya: GMO Papaya Contaminated Report 2006” \(www.bit.ly/gmocontaminated\)](http://www.bit.ly/gmocontaminated).
- [“Exploring Coexistence of Diverse Farming Practices: Alternative Report 2007” \(www.bit.ly/exploringcoexistence\)](http://www.bit.ly/exploringcoexistence).
- [“Facing Hawaii's Future, p. 47, ‘Papaya and Coffee: GMO Solutions spell Market Disaster’ \(www.bit.ly/facingfuture\)](http://www.bit.ly/facingfuture).
- Patent [“Papaya ringspot virus genes” \(www.bit.ly/prvgenes\)](http://www.bit.ly/prvgenes) (US 7078586 B2, Dennis Gonsalves).

Scientist

Character background

You are a scientist who has spent your whole career working to apply the techniques of modern molecular biology to improve our food supply by helping farmers grow crops reliably and with less of an impact on the environment. But after decades of work you see your signature achievement — the Rainbow papaya — under attack by activists who do not even bother trying to understand the technologies you work with, or the reasons they are applied. You are frustrated and a bit indignant, but mostly you are worried about a world where people mistrust science and reject out of hand what it has to offer society. (Character modeled primarily on Dennis Gonsalves, who led the team that developed the Rainbow papaya).

Stance on banning GMO papaya

You are, obviously, very strongly opposed to the proposed ban, not only because you see the Rainbow papaya as an unambiguous good, but because you see it as the last stand against complete ban of GMOs.

Role in debate

To explain and defend the science behind the Rainbow papaya.

Talking points

1. The Rainbow papaya is perfectly safe to eat.

The change we made is a simple and natural way to take advantage of the papaya's natural immune system. We made a tiny modification to the DNA of the plant, inserting a single gene, essentially giving it a vaccine against the papaya ringspot virus. This kind of thing happens all the time in nature, and has happened repeatedly in all the plants we eat today. It almost certainly would happen naturally in papayas if we waited – all we did was speed up the process.

The gene we added to the papaya is only a small part of the virus – not the entire virus – and is already found in foods, including organic papayas, which are frequently infected with PRSV, and many other fruits that have naturally acquired immunity to related viruses.

The Rainbow papaya has now been consumed for nearly 15 years with no adverse effects. Furthermore, the Japanese government, which is highly skeptical, even paranoid, about GMOs and for years banned the import of the Rainbow papaya, recently approved it for import. The approval process involved a series of tests that go beyond what is required in

the US, including sequencing the entire genome of the plant, eliminating any reasonable grounds for concern about the safety of the fruit.

Many of the fears about the safety of the Rainbow papaya are not based on anything specific about this plant, but about general fears about the safety of GMOs. I would like to point out that, time and time again, major science organizations and regulatory bodies in the US and Europe, including the US National Academies of Science, the most prestigious science organization in the world, have declared that there is nothing intrinsically dangerous about GM foods, and that the ones that have been approved for sale to consumers are perfectly safe to eat.

2. The Rainbow papaya is safe to farm.

Growing the Rainbow papaya is just like growing any other papaya. You plant the seeds and when the tree is mature, you harvest the fruit. It does not require the use of any pesticide to fight either the virus or the insect that spreads it – it does the job itself.

Indeed, prior to the introduction of the Rainbow papaya, farmers who were still trying to grow papayas in Puna had to spray their trees with large amounts of pesticides in order to protect their trees. Now they don't have to. So people who are concerned about the effects of chemicals on the soil, or on farmers, or on them when they eat the products, should see the Rainbow papaya as a good thing, as it has reduced the amount of chemicals needed to grow papayas. And this is true of many other GMO crops on the market or in production.

3. The Rainbow papaya saved the papaya industry.

If we had not developed the Rainbow papaya, the industry in Puna would have disappeared. All the other tricks we had – spraying, cutting down infected trees, and abandoning infected farms – failed. The virus spread rapidly and destroyed the crop. It would be an ironic tragedy if, after we had developed a safe way to save the papaya industry in Puna, we let our irrational fears of biotechnology do what the virus was unable to do.

4. The Rainbow papaya is not Monsanto.

The Rainbow papaya was developed by academic and government researchers in New York and Hawaii. We used some technology patented by big seed companies, but we were able to convince them to let us give the seeds out for free. The only people making money off of the Rainbow papaya are our papaya farmers, and the people of Hawaii through taxes.

5. Genetic modification is a natural part of agriculture.

Humans have been genetically modifying the foods we eat for as long as we have been engaging in agriculture. When the first farmers picked wheat or corn or other plants with the best seeds to eat, or which grew best in their fields, or which resisted diseases, they were starting a process of modifying the DNA of plants that has gone on for 15,000 years.

The only difference is that now we can do it faster and more precisely. If you reject genetic modification of foods, you are rejecting all agriculture.

Questions for others

1. To opponents of Rainbow papaya: What, specifically, do you object to about the Rainbow papaya? It has none of the characteristics that people always complain about GMOs. It was made by university and government researchers, not by Monsanto. The seeds are given away for free. It wasn't engineered either to make a pesticide or to allow the use high levels of an herbicide. All it does is harness the plant's natural immune system to fight off a virus. Why do you object to it?

Don't let people make a general case against GMOs in answering – force them to discuss the papaya – reminding them that this is about the papaya, not about GMOs in general.

2. To opponents of Rainbow papaya: Do you oppose the use of GM under any circumstances? What about drought-resistant maize, flood-tolerant rice, biofortified crops that provide vitamins to people who don't get them in their diet, and other disease-resistant plants?

Hammer home the point that not all GMOs are the same. You may not think it's important to save the papaya industry in Hawaii, but are opponents willing to let people starve because they reject GMOs that let crops be grown in places or conditions where they currently can't be, or prevent blindness by providing vitamins, or fight of diseases that could affect staples like rice, corn, wheat or soy?

3. To opponents of Rainbow papaya: Why do you think most scientists – including those who have nothing to do with GMOs – are in favor of them?

Opponents will try to argue that the scientists who speak out in favor of GMOs are all industry shills. Ask them for evidence. And point out that most of the members of the National Academy have nothing to do with GMOs. Make it clear that opposition to GMOs is rejecting science – it's the logical equivalent to rejecting climate change.

4. To opponents of Rainbow papaya: The Rainbow papaya was made with first generation plant genetic engineering technology. New technology allows us to precisely edit the papaya genome. If we could produce a papaya that used pieces of its own DNA to give it resistance to PRSV, with no extra bits of DNA from another species, would this be OK with you?

This is an important question for everyone in the field. A lot of the objections raised to the Rainbow papaya are based on things – the presence of an antibiotic resistance gene, extra insertion sites for the plasmid – that would not be there with the new "CRISPR" technology.

Scientists say that, in principle, they could create the PRSV gene inserted in Rainbow entirely out of DNA from the papaya itself.

Answers to common questions

Q: Scientists have said all sorts of things were safe that turned out not to be. How do you know we won't find out 10 or 20 years from now that GM crops were poisoning us? Isn't it better to be safe than sorry? Is a papaya really worth dying for?

A: There is always a theoretical risk any time we do something new. But we are introducing new varieties of foods we eat all the time, most bred conventionally. There is no reason to think GM crops are any riskier than these other new food varieties. Indeed, GM crops are more carefully tested than any other foods, and they have repeatedly been shown to be safe.

Q: Why not do real tests for safety? Prove they're safe before introducing them.

A: GM crops are more heavily tested than any other kind of food. If I found a new variety of papaya in the rainforest and started growing and selling them, there would be no safety tests, no regulation, even though we know that many naturally occurring fruits are not safe to eat. GM crops are tested on animals, which conventionally bred crops are not. What do you propose? Long-term feeding trials on humans? This isn't practical.

Q: If the Rainbow papaya is so great, why hasn't the Rainbow papaya been adopted in other countries?

A: The Rainbow papaya itself was generated to fight off the Hawaiian strain of PRSV and would not be effective in other countries that have different strains of the virus. They also grow different varieties of papaya. However, we have worked extensively with scientists from other countries to develop PRSV resistant versions of their papayas that are resistant to local strains of PRSV. Unfortunately, activists — primarily from the West — who have a zero-tolerance policy towards GMOs have delayed the testing and introduction of these strains time and time again. They campaigned aggressively against GM papaya, employing a lot of disinformation to make local farmers and consumers afraid of the technology. It's a real shame, as these very poor people are being denied a chance to improve their economic situation, all to satisfy the agenda of Greenpeace. You can read [Sarah Davidson's account of the situation in Thailand](http://bit.ly/forbiddenfruitthailand) (<http://bit.ly/forbiddenfruitthailand>) to understand what has happened. You should look at this not as a problem of the Rainbow papaya, but of activists more concerned with fundraising in the US and Europe than with the plight of farmers and consumers in developing countries.

Q: Isn't the Rainbow papaya a "gateway crop" meant to convince people in developing countries that GMOs are good for them, to be followed by the introduction of crops whose goal is seed company profits?

A: The question contains its own answer. If the Rainbow papaya is good for farmers in the developing world, doesn't it stand to follow that other GMOs might be too? I am not arguing that every GMO is good for every farmer in every situation. But it is the worst kind of patronizing Western attitude – the kind we have felt over and over here in Hawaii – to suggest that we know better than farmers in Thailand or any other country what is good for them.

Q: I have heard that some studies have shown that the Rainbow papaya can cause people to have allergic reactions. Is that true?

A: You are likely referring to a [paper](http://www.bit.ly/screeningproteins) (www.bit.ly/screeningproteins) by Kleter and Peijnenburg published in 2002 that did a database search and showed some overlap between transgenic proteins and known allergens. We have [extensively evaluated](http://www.bit.ly/allergenicity) (www.bit.ly/allergenicity) the allergenicity of the Rainbow papaya, using far more extensive methods and have established the safety of Rainbow papaya.

Q: What about the CMV promoter gene segment that's been implicated in cancer and wasn't known to regulators when the Rainbow papaya was approved?

A: Again, there is no basis for this concern. There is no credible basis that the CMV promoter is involved in cancer. Also, the 35S promoter is not a "hidden gene" as has been suggested. The cauliflower mosaic virus 35S promoter was known to be a segment of Gene VI of Cauliflower Mosaic Virus before it was used in transgenic plants. The researcher who isolated and showed the effectiveness of the 35S promoter actually knew that it was part of the Gene VI of the virus. This was well known and researched before they were used in commercial transgenic plants.

Q: Does the fact that you used an antibiotic resistance gene increase the chances of developing antibiotic resistant bacteria? What about people who are allergic to antibiotics?

A: Antibiotics are used in the generation of the transgenic plant but are not used in the growth of the plants, so there is no risk for people who are allergic to the antibiotics. These antibiotic resistance genes are already widely found in nature, and it is highly unlikely that the Rainbow papaya would contribute any new antibiotic resistance to bacteria.

Q: I've heard that transgenic foods are less nutritious than their conventional or organic counterparts?

A: This makes no sense: Why would the insertion of a single gene that fights off a virus make the fruit less nutritious? Indeed, the fact that these fruits are healthier suggests that they would be more – not less – nutritious. In any case, we have analyzed this as part of the regulatory approval for export to Japan and found Rainbow papaya to be nutritionally equivalent to conventional papaya. This work was published in a peer review journal: Tripathi S, Suzuki JY, Carr JB, McQuate GT, Ferreira SA, et al. 2011. "[Nutritional Composition of Rainbow papaya, the first commercialized transgenic fruit crop](http://www.bit.ly/nutritionalcomposition)" (www.bit.ly/nutritionalcomposition) *Journal of Food Composition and Analysis* 24:140-7.

Background reading

Paul Voosen (2011), "[Crop Savior Blazes Biotech Trail, but Few Scientists or Companies Are Willing to Follow](http://www.bit.ly/cropsavior)" (www.bit.ly/cropsavior). *New York Times*, 9/21/2011.

Jennifer Mo (2012), "[The man behind the Rainbow](http://www.bit.ly/manbehindrainbow)" (www.bit.ly/manbehindrainbow), Biofortified blog, 6/21/2012.

Papaya farmer

Character background

You come from several generations of papaya farmers and remember the devastation of the crops in the 1990s, and how the Rainbow papaya rescued the industry. Not only do you not want to lose the right to grow your trees, but you also fear that the debate around GM crops in general, and the papaya in particular, has made it more difficult for you to sell your products, and has kept prices low.

Stance on banning GMO papaya

You are strongly opposed to the ban.

Role in debate

To represent papaya farmers and to defend your right to grow the Rainbow papaya.

Talking points

1. The Rainbow papaya saved your business and family.

I came to Hawaii in 1970 from the Philippines with my wife to make a better life. My parents had grown papayas in the backyard, and so I worked hard for several years to get enough money to buy a small plot of land and I began to plant papayas – mostly Solo papaya. We worked hard, and after a few years, I had a good business. We were not rich, but I could feed my family, and we raised two kids who are now helping us on the farm.

Many of you don't remember what it was like when PRSV came to Puna. I heard about it from other friends in 1992. The affected farms were far away, so I didn't worry much. Then, the next year, it came to my farm. We did everything we could to stop it. I cut down the affected trees. I sprayed lots of insecticide to keep the aphids away. But nothing worked. In one year, nearly all of my trees were affected, and I could barely sell enough papayas to cover the cost of harvesting them, let alone feed my family. I had to get another job working in a store. I was about to sell my land and give up farming when I heard about the Rainbow papaya.

I didn't know anything about GMOs. All I knew was that the scientists told us the trees were resistant to the virus. I wasn't sure I believed them, but they gave us the seeds for free if we would promise not to sell the seeds to anyone else, and my wife, children, and I planted them. And that year, we had our beautiful farm back. The trees were all healthy and the fruits were beautiful.

The Rainbow papaya saved my farm. It saved my business. And it saved my family.

2. Give farmers a choice

You don't have to eat the Rainbow papaya if you don't want to. But people keep saying this is about protecting Hawaii from outsiders. From poison. But I am not an outsider. I am a Hawaiian and I am a papaya farmer. I have lived here for 45 years. I raised my children here. So long as I am not hurting other people, why can't I choose what crops I can plant on my farm? You have already made it harder for farmers to make a living by banning other GMOs, but please don't ban my farm, and my way of life.

3. Anti-GMO activism has made it harder for you to sell crops.

Although the Rainbow papaya is a great plant, with great fruit, it is hard to sell. For years our best market – Japan – was closed to us because they did not trust GMO crops. I cannot sell them to Europe, another big market. And the markets on the mainland are becoming harder and harder, driving our prices down as we have to compete with GMO-free varieties from other countries.

You might say this is a sign that the GMO papaya is bad. But it is not. This is a problem created by people who go around scaring others about GMOs. The bill passed last year told the world that even the people of my own island think my crops are bad. If things do not get better, I might have to consider selling my farm again. If my children cannot sell the papayas we grow, what point is there in passing the farm on to them? It would be sad in the end if, after surviving PRSV, activists who don't really understand farming are the ones who destroy my farm.

4. Patents and restrictions on seeds are bad, but this is not just a GMO problem.

Like many people who are opposed to GMOs like the Rainbow papaya, I am worried about patents on seeds that make it harder for me to work my farm. But someone needs to point out that this is not just a problem with GMOs. My son grows wheat and corn on a piece of land next to ours. He buys the latest hybrid seeds. They are not GMOs but we also have to sign a license for them saying they will not replant seeds or give them to anyone else. Banning GMOs won't stop patents on seeds.

5. Hawaii should welcome GMOs on our own terms.

I am a farmer and a parent and a Hawaiian. I want to keep a beautiful Hawaii that keeps our culture and keeps it safe for everyone. But if farmers can't make a living, this is bad for the island. We will have to sell our land to people who will build vacation houses for people from LA. And what good is that?

The Rainbow papaya showed me that GMOs could be good for farmers and good for Hawaii. Instead of banning these crops, we should embrace them, but make sure they come here on OUR terms. Tell the seed companies that if they want to sell their GMOs here, they can't make us sign away our rights to replant. They can't sue people when their fields get

contaminated with other people's GMOs. Instead of banning GMOs because we are afraid of pesticides and herbicides, ban dangerous pesticides and herbicides and make the companies come up with crops that are good for us. We can't run away from the future, but we can make sure that it serves us.

Questions for others

1. To people who want to ban Rainbow papaya: I have heard a lot about how terrible the Rainbow papaya is for papaya farmers. But don't you think that's something that should be left up to papaya farmers to decide, not the county council? Why do you feel it's okay for you to make decisions about how I run my farm when you know much less about growing papayas than I do?

This is your central issue. It's about choice. Don't let other people tell you what is or isn't good for papaya farmers.

2. To global environmental activist: You say there are other ways for people to grow food than GMOs, but what if I told you that the Rainbow papaya was the only way for my farm to survive? Would you want me to stop being a farmer just to promote your agenda?

This is their weakness. They say they are out to protect the little people from the perils of big corporations, but you are a little person and their actions here are hurting you without protecting anyone.

3. To local activist: Do you know who chopped down thousands of our trees in July 2011 and Sept. 2013, when the GMO debates were particularly heated?

They will say no of course, but the point is to highlight the extremism of the activists. They are hostile to GMOs and the people who grow them.

Answers to common questions

Q: What do you do to prevent your Rainbow papaya from contaminating other papayas across the island?

A: Papaya come in three sexes: male, female and hermaphrodite. Males do not produce fruit and produce a lot of pollen that can spread off the farm, so we cut them down before they can do so. We only let hermaphrodite trees grow and fruit. These plants self-fertilize and release far less pollen into the air.

But I also do not think it's a real problem for organic farmers. They only need to plant non-GM seed, which they can easy buy or make for themselves. If they only let hermaphrodites grow, then they will self-pollinate and are essentially immune to cross-pollination. Also, even if they do get cross-pollinated by GM pollen the fruit itself will not be GM.

Q: Haven't you had to start using lots of toxic fungicide because the Rainbow papaya is more susceptible to fungal disease?

A: We have started to have some problems with blackspot, and we spray to control it. But we had problems with it before PRSV appeared and we were growing non-GMO trees. It is not new to the Rainbow papaya, although Rainbow papaya is a bit more susceptible than the varieties we grew before.

Q: Weren't you economically better off when papayas were non-GMO?

A: In some ways, yes. The main challenge is the price we can get for our papaya. But this is not the fault of the Rainbow papaya, it is the fault of people who have scared consumers into thinking that the Rainbow papaya is dangerous for them.

Background reading

“[The Rainbow papaya story](http://www.bit.ly/rainbowstory)” (www.bit.ly/rainbowstory), from the Hawaii Papaya Industry Association.

Sophie Cocke, “[Papaya nightmares: A Farmer Struggles Amid Hawaii's GMO Debate](http://www.bit.ly/papayanightmare)” (www.bit.ly/papayanightmare) *Honolulu Civil Beat*, 8/4/2013.

Organic farmer

Character background

You believe in food that is grown naturally, with the primary additive being your labor—not herbicides and pesticides, which you think are killing the soil, and making people sick. You're not a scientist, but the scary things people write about GMOs resonate with you. You also see the decks stacked against you, as multinational companies that get huge government subsidies come in and undercut your business. You have a friend who grew organic papaya but now she can't because of the cross-contamination. You also think having Hawaii known as a GMO-free oasis will help your exports.

Stance on banning GMO papaya

Ban them now. They may well be poison. In any case we don't know, and it's not worth the risk.

Role in debate

To raise safety concerns about GMOs in general and the Rainbow papaya in particular.

Talking points

1. GMOs are dangerous for consumers, farmers and the planet.

Humans did not evolve to eat pesticides, herbicides and genetically modified crops. Doesn't it make sense that chemicals that are meant to kill plants and other animals might be bad for us, too? I find it hard to read the news these days, as every time I do I hear about how some disease is increasing - autism, cancer, asthma, allergies - things that you didn't hear about when I was a kid. And what's the biggest thing that's changed since then? Our food. Doesn't it make sense that we're having all these problems because we are putting poisons into our bodies that we've never seen before?

How can we let scientists and big seed companies put these things on the market without testing them? We've let ourselves become a giant science experiment for chemical and seed companies. And we already know the results! They're bad! I read about a study done by French scientists that showed that rats fed GMOs get huge tumors. If there were some drug people were taking that gave rats tumors, they'd pull it off the market immediately. But when it's a GMO, the seed companies attack the scientist, and the story goes away without any changes.

We need to stop this experiment now and go back to traditional ways of growing our food. Organic farmers like me produce beautiful food that's better for you and better for the land,

without using chemicals or GMOs. Is it hard work? Yes. But we shouldn't take dangerous shortcuts when our health and our survival as a species are at risk.

We use more herbicides and pesticides than ever before – and we know that they are bad for you. Plus, we introduced GMOs into the market and all these things started to go up. There are scientific papers – in peer-reviewed journals – that show that rats that eat GMOs get huge tumors. And instead of calling for more research, the seed companies attacked the scientist. This is the way they work. They know their products are dangerous and they don't want us to learn about the ways they are killing us.

2. The Rainbow papaya is unhealthy.

People keep saying that the Rainbow papaya is different. That it's a good GMO. But this isn't true.

- The piece of DNA inserted into the papaya contains an antibiotic resistance gene. Some scientists think that if these genes are in our food they will get into the bacteria in our stomachs and make them resistant to antibiotics as well. If they make you sick, there will be nothing to do about it.
- In 2002 Dutch scientists showed that the supposedly safe “coat protein” used in making the Rainbow papaya is probably an allergen. We don't know if people are having allergic reactions to the Rainbow papaya since the fruit is not labeled in a way that people could tell if it is causing the reactions.
- Rainbow papaya contains a hidden gene “Gene VI” that has been linked to cancer.
- Puna schools have a very high rate of asthma, usually an indicator of environmental cause. Could be due to pollen from GMO papaya trees?
- Rainbow papaya is susceptible to blackspot fungus, that can only be treated with toxic fungicides that are not supposed to be sprayed when wind is over 3mph, but wind is almost always over 3mph on Puna.

3. The Rainbow papaya contaminates non-GMO crops.

The papaya reproduces by releasing pollen into the air. Since the pollen produced by the Rainbow papaya contains the genetic modification, it can easily contaminate nearby conventional and organic trees. A study carried out by Hawaii SEED showed that 50% of trees on Hawaii are contaminated, including on organic papaya farms. This has had a serious negative effect on sales of Hawaii papayas to countries that do not allow the import of GMOs and in the US market where GMOs are increasingly unpopular. What's more, this contamination can't be undone easily. Even if we cut down every commercial papaya tree on the island, there would still be a lot of feral papayas that contain the GMO gene cassette.

4. No long-term safety studies have been carried out on GMOs.

If you want to introduce a new drug onto the market you have to prove it is safe by testing it in animals and then extensively in humans. If you want to introduce a new GMO into the

market, you don't have to do anything like this. In fact, no GMOs have ever been subjected to long-term safety studies even in laboratory animals! And this is despite the fact that many studies have shown them to be harmful to animals and people. Even 15 years after the introduction of the Rainbow papaya, we still don't know it is safe. At the very least we should stop production until the safety of GMO papayas has been established in long-term studies.

5. The precautionary principle should apply here.

The precautionary principle approach to risk management, which is part of European law, states that if an action or policy has a suspected risk of causing harm to the public or to the environment, the burden of proof that it is not harmful falls on those taking an action. This burden has clearly not been met. Since the potential harms are so great – the destruction of our health and planet – and the gains so small, shouldn't we be cautious?

6. GMOs are bad for business.

Even if you are not swayed by any of these arguments, and all you care about is Hawaiian farming business, you should still oppose the GMO papaya. Rainbow papaya fruit is not very profitable, nor is the development of other GMO crops to the people of Hawaii. Organic crops, on the other hand, are. It would be a huge lift to Hawaii's organic farmers if the island were declared completely GMO-free. It would erase consumer fears of contamination and would boost our reputation as a source of safe, natural foods for consumers.

Questions for others

1. For the scientist: Can you really assure us that the Rainbow papaya is safe to eat? How do you know the antibiotic gene won't transfer to bacteria in our guts and make it so we can't kill them? How do you know the coat protein doesn't cause allergies like the Dutch scientists showed? Why didn't you disclose "Gene VI" in your safety application and how do you know it won't cause cancer? How do you know people don't get sick when they breathe GMO contaminated pollen?

Make them say that they can never be sure the Rainbow papaya is safe. No matter how confident they are or seem, they can't be 100% sure. And if they're not 100% sure, how can they proceed?

2. For the papaya farmer: Have you tried to grow organic papayas on your land? It is more work, but you can also grow mango and other fruit and get more money.

The papaya farmer is not your enemy. You want to convince him that organic farming is good for his farm.

Answers to common questions

Q: All of the seeds used today resulted from crossbreeding, selection, and, in some cases, even irradiation to generate new traits. Do you think these practices, even when used in organic agriculture, are “unnatural”?

A: There is a fundamental difference between crossing different varieties of the same (or closely-related) species through natural breeding processes, and in using human-invented techniques to transfer traits between distantly related species. The latter is unnatural.

Q: You use Bt to control insects on your crops – the same insecticide made by corn and other plants that have been engineered to repel insects. Why is it okay for organic farmers but not GMOs?

A: There’s a huge difference between spraying Bt ON crops and embedding the toxin IN crops. The former can be washed off before you eat it, the latter cannot.

Q: If GMOs are as dangerous as you believe, why do think so many scientists and scientific organizations believe that GMOs are safe?

A: A lot of those scientists get money from Monsanto and other companies like them to fund their research, and the rest of them are seduced by the belief that science can do no wrong. But look at all the mistakes they have made – things they said were safe that weren’t. These people may be good scientists, but it doesn’t mean they know what’s good for our bodies or the planet.

Q: You seem genuinely concerned about the environment – don't you worry that organic agriculture is less efficient and therefore consumes more precious resources than conventional farming?

A: I would worry if it were true, but it isn’t. Sure, if you pump chemicals into crops for a few years you can get higher yields, but if you take care of the soil and the animals and plants that live around it, you get better yields over the long run.

Background reading

[Institute for Responsible Technology](http://www.responsibletechnology.org/) (<http://www.responsibletechnology.org/>), a major anti-GMO organization led by anti-GMO spokesperson Jeffrey Smith, who testified on the original GMO bill.

Michael Hansen and Jean Halloran, “[Why We Need Labeling of Genetically Engineered Food](http://www.bit.ly/whyweneedgmolabeling)” (www.bit.ly/whyweneedgmolabeling).

Global environmental activist

Character background

You are from the US mainland – this is your first trip to Hawaii. You are here because fear of GMOs is a tool you are using to fight the multinational corporations and excess globalization that you see as the primary culprit behind global warming and a general loss of individual autonomy. You see anti-GMO sentiment as an opportunity that you both believe in and try to exploit as a source of raising funds for your organization .

Stance on banning GMO papaya

You support a complete global ban on all GMOs, including the Rainbow papaya.

Role in debate

The environmental activist serves to highlight the positive global, environmental impact of fighting the Rainbow papaya on Hawaii and supporting the ban.

Talking points

1. Genetic engineering is unnatural.

Genetic engineering is fundamentally unnatural in that it allows scientists to create plants, animals and microorganisms by manipulating genes in ways that do not occur normally. GMO scientists argue that what they do is not that different than what happens with conventional breeding and genetic exchange between species, but if this were true, then genetic engineering would not be necessary.

2. GMOs are genetic pollution.

We cannot perfectly control how plants in nature breed with each other. GMOs in a managed field can interbreed with wild organisms, thereby contaminating environments and future generations in an unforeseeable and uncontrollable way. Once released into the environment, GMOs cannot be recalled. They are genetic pollution. Genetic engineering of food is intrinsically risky process. Scientists do not fully understand the consequences of putting new genes into complex organisms and ecosystems. Biological diversity must be protected and respected as the global heritage of humankind, and one of our world's fundamental keys to survival.

3. GMOs are tools of corporate control of food.

GMO crops are treated as intellectual property worldwide, and thus the spread of GMO crops is accompanied by the increasing control of our food supply by multinational

corporations. Food is both a product of nature and a fundamental human right. It should be beyond the control of intellectual property, which serves only the interests of the people who make and profit from the creation of GM crops. It is crazy to force life forms and our world's food supply to conform to human economic models rather than their natural ones; we do so at our own peril.

4. GMOs are gateway crops.

Seemingly “good” GMOs like the Rainbow papaya and “golden” rice are being pushed by the GMO lobby to convince the public that GMOs are good, and to pave the way for the introduction of more lucrative and less beneficial crops. We oppose even these GMOs because we believe that the same goals – providing health and nutritious food for the planet – is a problem of politics and will, and that the biggest threat to the global food supply is the corporate takeover of the means of food production.

Questions for others

1. “Do you have five minutes for the environment?”

2. For papaya farmer: How much have you explored ecological farming methods as alternatives to GMOs?

One problem with arguments in favor of GMOs is that people sometimes claim they are the only way to solve problems in agriculture, even though alternatives may not have considered.

3. For scientist: Do you really think you can stay ahead of the pathogens by creating new varieties every time resistance arises? Isn't that what we tried to do with antibiotics and bacteria? Look where that got us.

4. For supporters of Rainbow papaya: Why don't you worry about the release of GM papayas into the wild?

Answers to common questions

Q: Your campaign is based on the idea that GMOs are dangerous, but so many scientists say they are safe. Do you really think they're lying?

A: Some of them are lying – they are being paid by big seed companies. But many others just don't know. Scientists are great at developing new things, but they are historically bad at assessing the risks of their inventions. Mary Shelly saw this two centuries ago when she wrote *Frankenstein* – the same thing is true today with “Frankenfoods”.

Q: Do you find anti-GMO activism to be helpful in fundraising?

A: Yes. Because people are afraid of GMOs and don't want to see the big multinational corporations that peddle them get control of our food supply. The fact that they're willing to give us money to fight this fight is not a bad thing – it shows that people are afraid and rightfully so.

Q: How can you be categorically opposed to GMOs under any circumstances? Do you not see a situation where they would be OK?

A: We do not believe that GMOs are ever necessary — all of the “solutions” offered by today's GM crops are really solutions to problems of industrial agriculture. If you change farming practices, GMOs become unnecessary. And given that, they are never worth the risk.

Q: You're not from Hawaii. Aren't you and other Greenpeace-types being awfully paternalistic coming here and telling our farmers what they can and cannot grow? Isn't activist-imperialism just as bad as corporate-imperialism?

A: I understand your concern. I grew up on a farm in upstate New York and hated it when people came in and told us what to do. But it's important to understand that the G in GMO stands as much for globalization as it does genetics. The big seed companies that market and sell GMOs don't care about Hawaii or anywhere else. They want the whole world to become one giant farm growing crops that they tax at a heavy rate. We're here not to tell you what you can and cannot grow, but to help protect your right to choose. It may seem ironic that taking away one choice actually helps protect your freedom, but in this case it does. If GMOs take over, you will have fewer choices, not more. And once they control the seed supply, they'll milk every last penny out of farmers. So, we are here to help, and we are here to offer resources of people from the mainland [that](#) want to help protect Hawaii from companies like Monsanto that are a problem everywhere.

Background reading

Greenpeace on [Genetic Engineering](http://www.bit.ly/greenpeacege) (www.bit.ly/greenpeacege).

Conventional farmer

Character background

You like the convenience and economic benefits of GM crops but haven't planted them because you don't grow corn or soybeans. Now you fear that a Hawaii ban on GM crops will make it even harder for you to compete against mainland farmers who already benefit from lower fuel and fertilizer costs. You also resent non-farmers telling you how to farm.

Stance on banning GMO papaya

Opposed to the ban.

Talking points

1. GM crops are good for farmers and the environment.

Farmers across America have embraced GM crops. For example, in 2013, 93 percent of the US soybean crop was made up of herbicide tolerant GMOs. Obviously, farmers wouldn't be choosing to use this and other popular GMO varieties if they were bad for their business. A recent study provided compelling support for this claim. Analyzing a wide range of studies of the yields, chemical use and costs of GM crops, the authors found that:

On average, GM technology has increased crop yields by 21%. These yield increases are not due to higher genetic yield potential, but to more effective pest control and thus lower crop damage. At the same time, GM crops have reduced pesticide quantity by 37% and pesticide cost by 39%. The effect on the cost of production is not significant. GM seeds are more expensive than non-GM seeds, but the additional seed costs are compensated through savings in chemical and mechanical pest control. Average profit gains for GM-adopting farmers are 69%. (Klümper & Qaim, 2014).

It's simply no longer plausible to argue, as many opponents of GMOs do, that GMOs are bad for farmers. Farmer actions and data tell a different story. It makes no sense to deny farmers the choice to use GM crops, especially as they have led to a reduction in the use of chemical inputs – something all farmers aspire to do.

2. Hawaii's farmers need GMOs.

Although many non-farmers view Hawaii as a farmer's paradise, with year-round warm temperatures and ample rainfall, Hawaii's farmers face a series of unique challenges. We are far from the mainland, and thus have high shipping costs even for domestic markets. Fuel and labor costs are also higher than they are on the mainland and we have year-round problems with pests and plant diseases, many of them imported from elsewhere. If we

continue to be denied access to GMOs that can increase our yields and profits, we will suffer, and Hawaii will lose its farming community.

Questions for others

1. To those who want to ban GMO papaya: If you are concerned about pesticides and herbicides, why don't you ban them instead of GMOs?

Answers to common questions

Q: Why do you prefer farming with synthetic pesticides and herbicides when you could be using organic farming practices that are better for the planet and consumers?

A: People make a huge mistake in thinking that organic farming is necessarily better for the farm or consumers. Organic practices are just that – practices. Organic farmers use chemicals too – they just use ones that are somewhat arbitrarily deemed “natural”. And many of these are more dangerous than the “synthetic” pesticides I use on my farm. The biggest difference between an organic farmer and me is that I have more options, and in my case, I use these options carefully, choosing ways of managing my crops that are healthy. After all, I live and work on my farm, and my children and I eat the food we grow. I want them to inherit my farm. If I thought organic farming was safer and better I'd do it in a heartbeat. But I don't. It's a myth.

Q: So long as conventional farmers don't use GMOs, you can co-exist pretty easily with organic farmers. Why are you siding with the GMO producers?

A: I don't currently grow GM crops on my farm, but I don't want to lose the right to use this technology if I think it's good for my farm, family and customers.

Q: As a farmer, don't you want control over your own seeds?

A: Yes. I don't like when someone tells me what I can and cannot grow. But I also realize that seed companies put a lot of money and effort into generating these crops, and sometimes I don't mind paying extra or accepting restrictions if the seeds are right for me. I don't see why this is a GMO question though. Plenty of non-GM seeds are covered by patents and come with 30-page licensing contracts. I'd like to see this change, but it's a different question.

Background reading

Klümper W, Qaim M (2014) “[A Meta-Analysis of the Impacts of Genetically Modified Crops](http://www.bit.ly/metaanalysisgmo)” (www.bit.ly/metaanalysisgmo). PLoS ONE 9(11): e111629.

Jennie Schmidt in “[Forum: The Truth About GMOs](http://www.bit.ly/truthgmos)”, *Boston Review* (www.bit.ly/truthgmos).

GMO/organic farmer

Character background

You are a mainland organic farmer who shares the belief with many other organic farmers that many of the chemicals used in conventional farming are bad for farm workers, the soil, animals in the environment, and consumers. But unlike most organic farmers, you believe that the best way to reduce chemical inputs is through biotechnology.

Stance on banning GMO papaya

The GMO/organic farmer sees the Rainbow papaya as a prime example of where organic farming could benefit from the use of biotechnology due to its promise to reduce pesticide use. Therefore, you are opposed to the ban.

Role in debate

To promote the idea of an alliance between organic farmers and genetic engineers to reduce the use of chemicals.

Talking points

1. The Rainbow papaya is an environmental good.

The Rainbow papaya is exactly the kind of product that people who care about the environment should want to see more of. Prior to its introduction, papaya farmers were forced to use large amounts of pesticides to kill the aphids that spread PRSV. Now they don't have to. Anyone who is concerned about the use of pesticides should see this as a victory.

2. Reducing chemical use in farming requires the best technology.

Farmers across the world rely on chemical herbicides, pesticides and fertilizers because they are cheap and highly effective. If we are going to reduce or eliminate their use, we can't rely on traditional farming practices – we are going to have to use the best technology at our disposal, and genetic modification will be crucial.

There is a widely held belief that the most widely used GMOs lead to increases in the use of chemicals. But this is not true. Bt corn and cotton have led to a massive reduction in the use of chemical pesticides, and while Roundup Ready crops have increased the use of the herbicide glyphosate, to which they are insensitive, they have reduced the use of other, more dangerous herbicides.

We can wield biotechnology to achieve the goals of organic farming: to reduce the use of herbicides, pesticides and fertilizers, while protecting the environment. The biggest challenge in doing so is not technological, but social. So long as the organic movement remains opposed to GMOs, it is blocking one of the most important paths towards its success.

3. All GMOs are not the same.

It's important that we stop treating all GMOs as if they are the same thing. Even staunch opponents of GMOs like Michael Pollen and Mark Bittman now agree that GMOs *per se* are not dangerous or bad, but that the ones that are on the market have been used to do things that they don't think are beneficial. So the challenge now is to create GMOs that are clearly beneficial to everyone, and what could be better than using GMOs to enable real organic farming (not what the USDA currently says organic farming is) that combines traditional practices with new technology to make farms and foods that are safe and good for the environment.

Questions for others

To organic farmer and other opponents of GM crops: If someone made GM crops that radically reduced the need for pesticides, herbicides or fertilizer, without harming the soil, would you use them? Are you so afraid of new technology that you would reject it even when its benefits are clear?

This is a hard sell in such a polarized environment, so your main job is to try to not just convince people that this is a good idea, but to try to also reframe the debate. Try to do this – move beyond GMOs.

Answers to common questions

Q: Organic farming is about doing things naturally, and GMOs aren't natural, so how can you push this idea?

A: Sorry, but there's nothing natural about organic farming. The seeds have been bred by humans for millennia, and have been improved by modern breeding techniques, including irradiation to induce mutations, and marker assisted breeding. Many are hybrids of plant species that are never found together in nature. Plus the chemicals used in organic farming, while not synthetic, are extracted from plants and the Earth. The only thing that's different about GMOs is that they're new, and some people find them scary.

Q: Are GMOs the best way to solve the problem of excessive chemical use on our farms?

A: There are other options, of course – including polyculture and ecological farming practices. But maybe GMOs are the best way to do it, and if they are, we shouldn't arbitrarily decide not to take that path just because the technology is unfamiliar to people

and has been demonized in the media and on the Internet. We should decide what kind of farms we want – how we want our agriculture system to work – and we should use the best tools in our arsenal to make it happen. I don't think we're as far apart on this as it seems. We all have the same goals – a safe and secure food supply for everyone on the planet, a healthy environment and productive, economically viable farms that preserve the land they exist on.

Background reading

Pamela Ronald in "[Forum: The Truth about GMOs](http://www.bit.ly/gmotruthspamronald)" (www.bit.ly/gmotruthspamronald) in *Boston Review*.

["Solving the Food Crisis with an Unlikely Alliance"](http://www.bit.ly/solvingfoodcrisis) (www.bit.ly/solvingfoodcrisis).

Regulator

Character background

You work for the US Food and Drug Administration (FDA), one of three federal agencies charged with regulating the growth and sale of GMOs. You are here to explain the regulatory process that GMOs go through, and why the FDA believes they are safe to grow and eat.

Stance on banning GMO papaya

You have no official stance. You are here to provide information.

Role in debate

To explain regulations on GMOs and to answer questions about testing that was carried out for the Rainbow papaya and other GMOs.

Talking points

1. GMOs are heavily regulated and tested (note that this text is from the FDA)

Using a science-based approach, the Food and Drug Administration (FDA) regulates foods and ingredients made from genetically engineered plants to help ensure that they are safe to eat. Food and food ingredients derived from GE plants must adhere to the same safety requirements under the Federal Food, Drug, and Cosmetic (FD&C) Act that apply to food and food ingredients derived from traditionally bred plants.

The FDA encourages developers of GE plants to consult with the agency before marketing their products. Although the consultation is voluntary, developers find it helpful in determining the steps necessary to ensure that food products made from their plants are safe and otherwise lawful.

The developer produces a safety assessment, which includes the identification of distinguishing attributes of new genetic traits, whether any new material in food made from the GE plant could be toxic or allergenic when eaten, and a comparison of the levels of nutrients in the GE plant to traditionally bred plants.

FDA scientists evaluate the safety assessment and also review relevant data and information that are publicly available in published scientific literature and the agency's own records. The consultation is complete only when the FDA's team of scientists is satisfied with the developer's safety assessment and has no further questions regarding safety or other regulatory issues.

As of January 2015, the FDA has completed 158 consultations on genetically engineered crops (a [complete list](#) of all completed consultations and our responses are available at www.bit.ly/fdabiocon including the [Rainbow papaya](#) (www.bit.ly/fdabioconpapaya).

2. The process for the regulation of Rainbow papaya:

Briefly, Dr. Richard Manshardt of the University of Hawaii and Dr. Dennis Gonsalves of Cornell University initially consulted with the FDA regarding this product in December 1994. On January 3, 1997, they submitted a safety and nutritional assessment of their transgenic virus resistant papaya line 55-1, followed by additional information regarding the safety and nutritional assessment of their papaya line 55-1 on July 25, 1997.

They used standard molecular biology techniques to show that the event that led to the SunUp and Rainbow papaya involved the transfer of the PRSV coat protein gene, the beta-glucuronidase gene, and a gene conferring resistance to the antibiotic kanamycin.

Studies have raised the possibility that a compound - benzyl isothiocyanate (BITC) – found in papaya latex may have adverse health effects when consumed by humans and might be responsible for high rates of cancer and spontaneous abortions reported in papaya consumers. However, submission by the applicants showed that BITC levels were the same in line 55-1 as in conventional papaya.

The papaya developers conducted compositional analyses on the fruit of their transgenic papaya and control papaya plants for total soluble solids and vitamins A and C finding the transgenic fruit were equivalent to conventional varieties.

The report concluded that, “The developers of the transgenic papaya have concluded, in essence, that the PRSV resistant papaya they have developed is not materially different, in terms of food safety and nutritional profile, from red-pigmented papaya varieties with a history of safe use.”

The review process for the Rainbow papaya was completed in September 1997, prior to the introduction of the crop onto the market. Here, you can [read the FDA letter](#) (www.bit.ly/fdaletter) and [a more detailed summary](#) of our assessment (www.bit.ly/fdaassessment).

3. Additional safety studies:

Subsequent to approval by the US FDA, the Rainbow papaya has been approved for human consumption in Canada and Japan. The review in Japan was extensive, with significant independent analysis and public comment (an account of this review is available [here](http://bit.ly/1NZ8PBc) (<http://bit.ly/1NZ8PBc>) in Japanese – the portion of these review focused on risk to biodiversity, but containing information on other risks evaluated, is available in English [here](http://bit.ly/1K2K1aM) (<http://bit.ly/1K2K1aM>).

Questions for others

None. You are here to answer questions not ask them.

Answers to common questions

Q: The FDA relies on information provided by the companies that market GMOs. Why should we trust them?

A: The FDA relies on information provided by the manufacturers of most of the products we regulate. Our scientists work to ensure that the information is accurate and honest, and we engage in considerable feedback with the applicants. We also include any information available in the scientific literature that we feel is relevant, and monitor information as it becomes available after approval to see if our assessment needs to be reconsidered.

Q: Have you ever turned down a potential GMO?

A: No. However, not all proposals have advanced to the final stage. For example, a soybean modified to contain a protein from the Brazil nut was shown during studies conducted as part of the GRAS (“Generally Regarded As Safe”) process to contain a Brazil nut allergen, and the producer voluntarily withdrew the product.

Q: What about the revolving door between the FDA and the companies you regulate?

A: It is not unusual for experts who work in industry to engage in public service.

Background reading

[Regulation of GMOs in United States \(www.bit.ly/usgmoregulation\)](http://www.bit.ly/usgmoregulation).

Council chair

Special note on council chair

The role of the council chair in this case study is to act as a moderator for the discussion and debate, to ensure that questions are directed to the appropriate person and that the discussion and debate do not get sidetracked or bogged down in acrimony.

The person assigned to the council chair role should take extra care to familiarize themselves with the background and arguments from all sides prior to the discussion. The council chair should enter the discussion and debate as a neutral observer interested in getting to the bottom of the issue. When someone raises an issue, the chair should select the best speaker to answer it. When someone makes a point, the chair will identify the best person to counter it. The chair should view his or herself as on the side of truth.

To prepare for this role, the council chair should carefully read “[On Hawaii, a lonely quest for facts about GMOs](http://www.bit.ly/questforfacts)” (www.bit.ly/questforfacts), and imagine themselves as the city council member at the center of the story (Gregor Ilagan)—although one should not feel obligated to reach the same conclusion he did.