Good afternoon.

The name of the talk I will give today is "GMOs in regulation and the marketplace: Informed by, or distorted with, science?"

1. Genetic modification, often called genetic engineering or GE, with it's living products called genetically modified organisms or GMOs, is the direct, asexual modification of DNA. In conventional breeding we of course modify DNA all the time, often radically. With GE we do it consciously and specifically, after we have extensive knowledge of how genes control important traits like pest resistance and nutrition. Commonly we use GE methods to tweak genes already in crop

species, in other cases we create or transfer in new functions.

2. It's no secret that GE is controversial, as the National Geographic cover behind me clearly suggests. There are many reasons for that, perhaps the most important is that it's disruptive. It provides new ways to do things and solve problems that can have big impacts. The extensive uptake of GE crops in more than two dozen countries that have allowed their cultivation demonstrates this. GE creates challenges to existing businesses, legal frameworks, and ways of thinking.
3. I am not concerned that GE is controversial, or that there is extensive debate about it's many different facets.

People can disagree about what types of traits, in what species and geographies, how carefully screened and managed, and owned by whom, make sense for specific applications. What concerns me as a scientist is when the social controversy blatantly abuses or distorts what science has found about them.

4. We have done a lot of science about GE crops, around 30 years worth, conducted all over the world. Many high level scientific committees, regulatory agencies, and groups of our best scientists have published thoughtful and careful reviews and syntheses. The published meta-analysis in the image behind me, as well as the

field trial of GE virus resistant papaya in Haiwaii above it, are examples.

5. These scientific findings have shown that the GE method itself is generally no more harmful or beneficial to organisms than are the many methods of non-GE genetic modification. In fact GE methods are often more precise and less disruptive, and new tools such as AAAS' innovation of the year -- 'CRISPR gene editing' -- are making them even more so. But the point is that it's the products, not the method, that matter. Many scientific bodies have in fact declared this in various forms. <u>The most direct abuse of science by regulation and commerce is to treat all GMOs as a</u>

category, with little discrimination, in its policies, labels, and communications.

6. Numerous studies have shown that GE crops can have very large economic, environmental, social, and health benefits. However, in regulations and increasingly in commerce we seem to ignore these large benefits, and focus dominantly on risks and possible harms. Despite very large regulatory and market barriers in most of the world, the diversity of GE crops has been growing, further underlining the illegitimacy of generic regulations and labels. However, a even greater diversity of products, with applications that range from malnutrition to climate change adaptation, is waiting in the science

pipeline, limited by investment, regulations, and market blockages. These crops could provide tools to help deal with some of our most pressing social and environmental problems.

7. Pest management traits, such as herbicide and insect resistance, whether they are GE or non-GE, have seen tremendous uptake in agriculture both in the developed and developing worlds. They have been prized by millions of farmers and have often had large benefits in terms of reductions in pesticide usage or toxicity, and reduced tillage of soil. However, they require prudent management, as well as continued innovation, if they are to provide sustainable tools for agriculture.

There is high quality science showing that results to date have been decidedly mixed. New approaches are badly needed, which demands research at the ecological, agronomic, and genetic levels.

8. GMO-free products and labels have proliferated in the marketplace in many countries, including in the USA. Under both voluntary and mandatory labeling, together with highly organized anti-GMO activism and threatened boycotts of companies, the ability to use GE methods seems to be contracting, not growing, in many sectors. In spite of scientific findings about benefits, safety, and trait diversity, generic marketplace labels, and powerful anti-GMO

messages delivered in the online world, seem to be stigmatizing GE products in the eyes of many consumers.

9. The consequences of this trend are worrisome. They include: calls for even tighter regulation of GE crops, constricting the diversity of products and companies that can afford to market them; reduced investment in research, product development, and training of a scientific workforce that is capable of future innovation. And, consumer choices made out of fear or ignorance, often at considerable economic cost, based on generic labels that do not accurately communicate scientific knowledge of safety or environmental impact.

10. Changes that I think would help ameliorate this situation include smarter regulations that are based on traits and their familiarity, not on the method used to produce them; stronger enforcement and standardization of laws against misleading labels that are already on the books in the USA and many other countries; and much expanded outreach from public sector scientists, which is now limited primarily by a lack of investment at universities and scientific societies.
11. In closing, I think it's obvious to you that I think that science is being misrepresented in this domain, especially in commerce. It is my hope that groups such as AAAS, which has

taken many bold stances for science throughout its history, more strongly advocate for science in this sector, especially in education and outreach to the public.

12. Thank you very much.