Sociotechnical Imaginaries for Gene Editing in Agriculture: Implications for Governance

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- Gene editing hailed as powerful new tool in agriculture
- Gene editing techniques (e.g. CRISPR-Cas9, TALENs) delete, substitute, insert strand of organism's own DNA to produce desired traits (NAS 2016)



DNA double-helix model simulating gene editing

** Does **not** necessarily require foreign genetic material

- Potential to create variety of novel changes to crops and livestock quickly, easily, cheaply
 - Resistance to pesticides, herbicides, diseases, insects, drought, flooding
 - Improve nutritional composition, yields, etc.
 - Non-browning mushroom
 - Gluten-reduced wheat
 - Citrus greening resistant oranges
 - Virus resistant pigs
 - Hornless cattle
 - Disease resistant cassava



Non-browning mushrooms

Proponents concerned about regulations

Its potential hinges on how it's governed



Cassava field

"Now is the time to opine on questions that need to be addressed in regard to how CRISPR-based technologies should be implemented and regulated"

Rodolphe Barrangou, Editor, The CRISPR Journal

Regulatory Status

Agencies currently engaged in effort to update biotech regulations to include gene editing

USDA

- Will not regulate "plants that could otherwise have been developed through traditional breeding techniques as long as they are not plant pests or developed using plant pests" (USDA, March 28, 2018)
 - Seeking stakeholder engagement/feedback

FDA

 2018 assembles Biotech Working Group to create Action Plan for "flexible regulatory framework for evaluating the safety of products that also supports plant and animal biotechnology innovation" (Gottlieb and Abram, June 6, 2018)

Our Goal:

- Identify key socio-technical imaginaries constructed by proponents
 - Aim to shape and legitimize regulatory framework

Socio-technical Imaginaries

- Social and technical imaginaries implicit assumptions, values, visions of key actors - that shape research, innovation, policy trajectories
- Frame science and technological trajectories as being in the public interest... what is desirable and good
 - Often counterposed against risks and hazards of not realizing these futures

(Burnham et.al, 2017; Eaton et.al, 2014; Jasanoff and Kim 2009; Levidow and Papioannou 2013; Macnaghten, 2005; 2009)

Sociotechnical Imaginaries

- Imaginaries can be identified and examined through texts to explore how actors:
 - Frame perceived risks, benefits, modes of governance to be taken
 - Link sociotechnical imaginaries and technological pathways in certain ways
- Why some linkages are more persuasive

(Burnham et.al, 2017; Eaton et.al, 2014; Jasanoff and Kim 2009; Levidow and Papioannou 2013; Macnaghten, 2005; 2009)

Methods

Content analysis

- Docket FDA-2016-N-4389 "Genome Editing in New Plant Varieties used for Food" (1/19/2017)
 - Questions pertaining to regulation requirements and safety assessment of gene edited foods
 - Received 583 comments
 - Sample frame: 26 submissions by entities supporting gene editing in food
 - Excluded individual comments, 2 NGO opponents

| Type of Entity | Name |
|---------------------------------------|---|
| Agriculture Advocacy | American Farm Bureau Federation |
| | American Soybean Association |
| | American Sugarbeet Growers Association |
| | Iowa Corn Growers Association |
| | Minnesota Soybean Research and Promotion Council |
| | National Corn Growers Association |
| | National Cotton Council of America |
| | National Council of Farmer Cooperatives |
| | Oklahoma Farm Bureau |
| | Corn Refiners Association et al. |
| Technology Advocacy | Information Technology & Innovation Foundation (ITIF) |
| Agribusiness, Biotech, Seed Companies | Benson Hill Biosystems |
| | Betaseed Incorporated |
| | DuPont Pioneer |
| | J.R. Simplot |
| | KWS SAAT SE |
| | Monsanto |
| Biotech Research Centers | Donald Danforth Plant Science Center |
| | Maize Genetics Executive Committee |
| Science Societies/ Organizations | AACC International |
| | Crop Science Society of America |
| | Society for In-Vitro Biology |
| Industry Trade Associations | American Seed Trade Association (ASTA) |
| | Biotechnology Innovation Organization (BIO) |
| | CropLife America |
| | Grocery Manufacturers Association (GMA) |

RESULTS

1. New Green Revolution

Problem

Feeding growing (and wealthier) world population in context of natural resource limits, pervasive pests, diseases, yield plateaus, climate change is "daunting yet essential task" (CAST 2018: 2) and "one of the great social problems of the next generation" (Shaw 2018: 44)

Solution

- Gene editing can be a panacea
 - social, economic, and environmental benefits



With **9.7 billion people to feed** by 2050, we must continue to pursue technological advancements in agriculture, including genome editing in plants. We need to continue to **improve technologies that make us more efficient and better stewards of the environment**.

- American Soybean Association

[T]he **only way** soybean growers can rapidly adjust to the ever-changing landscape of **crop production, environmental sustainability, climate change and human nutrition** is through genome editing.

- Minnesota Soybean Research and Promotion Council

2. Traditional Plant Breeding (only better!)

Problem

GMOs: difficult, costly, fueled public opposition



Solution

- Gene editing substantially equivalent to (natural) traditional breeding
 - No additional food safety risks
- Fast, precise, flexible, cheap, easy to use
 Fewer "off target [unintended] effects"
 - Facilitate greater public acceptance and trust

Several ...products of genome editing applications could also be accomplished, albeit more slowly and with less precision, through more **traditional plant breeding methods**.

- American Seed Trade Association

Gene editing... Allows scientists to more precisely and efficiently improve a plant that could be obtained using **traditional breeding methods** or found in nature.

- DuPont Pioneer

3. Democratize Technology

Problem

GMOs dominated by multinational biotech companies, narrow set of profitable traits, undermining public trust, acceptance of biotechnology

Solution

- Gene editing allows for democratization of technology
 - ensure development of products with broad public benefits
 - bring the "little guys" in

...promise to democratize crop improvement. This will enable individual researchers in academia or in small businesses to solve arguably society's most pressing issue: ensuring adequate nutrition and calories to a growing global population.

- Maize Genetic Executive Committee

With less burdensome regulation, smaller companies could attract investment capital, creating job opportunities and addressing niche issues or crops unsuited to larger agribusiness enterprises. Democratizing the technology in this way would also enable not-for-profit groups to take advantage of the latest scientific advances, further boosting public trust.

-Crop Science Society of America

Regulation

Imaginaries aimed at shaping policy trajectory

- Potential to deliver broad public goods hinges on:
 - avoiding costly, time-consuming, regulatory burden associated with GMOs

Regulatory framework

risk assessment, sound science, product not process, traditional breeding equivalency By creating a scientific and risk-based regulatory environment that is not burdensome, we can ensure that even small firms have the opportunity to contribute to the monumental task of feeding the world.

- American Soybean Association

If the United States does not lead the way, **other countries certainly will**.

- Minnesota Soybean Research and Promotion Council

Conclusion

We identified three key imaginaries:

- New Green Revolution
- Traditional plant breeding equivalency
- Technological democracy
- Not distinct but interconnected
- Extent to which gene editing can deliver these imaginaries is an empirical question

Conclusion

- Imaginaries powerful because they "shape practices, relationships, and commitment (which are often rendered irreversible)"
 - Macnaghten, 2005:279
 - Policy trajectories, application, acceptance
- Create vision social order where gene editing can deliver broad array of benefits
 - Feeding the world to small business opportunities
- Also convey potential risks of "burdensome" regulations

Conclusion

Role of sociologists not just to assess technological impacts but to unpack how new technologies are "imagined" and assess what other imaginaries are left out or backgrounded

Thank you! Questions?

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