

**ANTICIPATORY GOVERNANCE AND  
CONFLICTING FUTURES:  
INSIGHTS FROM THE NEXT GENERATION OF  
GENETIC ENGINEERING**

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Adam Kokotovich<sup>1</sup> & Jennifer Kuzma<sup>2</sup>

<sup>1</sup> PhD Candidate, Natural Resources Science and Management Program  
Research Assistant, Center for Science, Technology and Public Policy  
University of Minnesota

<sup>2</sup> Associate Professor of Science, Technology and Public Policy  
Humphrey School of Public Affairs  
University of Minnesota

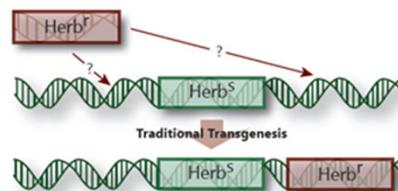
S.NET Meeting 2012

## Outline

- Introduction to plant targeted genetic modification (TagMo)
- Anticipatory governance
  - Conflict
  - Insights from future studies
- Conflicting futures of plant TagMo
  - TagMo governance futures

## First generation techniques

- Random insertion of gene via agro-bacterium or gene gun
- Low success rates of insertion
- Concern over unintended effects from insertion

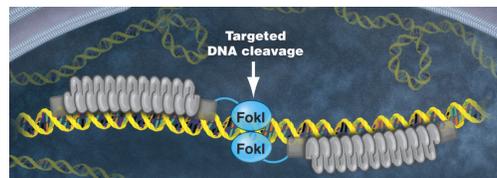


## Targeted genetic modification

(Porteus 2009, Bogdanove and Voytas 2011)

### Three current platforms:

- Zinc-finger nucleases
- Meganucleases
- TALENs (transcription-activator like effector nucleases)



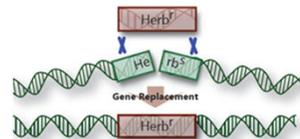
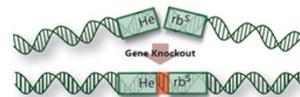
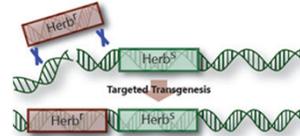
### Key steps in targeted genetic modification:

1. DNA binding molecules find desired location in DNA
2. Cleaving mechanism creates double-strand DNA break
3. Double strand break starts cell's own repair pathways:
  - a) Non-homologous end joining – rejoined imprecisely
  - b) Homologous recombination – break site repaired with DNA template

## Targeted genetic modification

(Porteus 2009, Bogdanove and Voytas 2011)

- Modifications possible:
  - Delete genes or create small insertions
  - Insert foreign DNA or swap DNA sequence
- Stackable
- Increases ease and speed of genetic modifications
- Engineer current traits and organisms
- Potential for new traits & organisms presently not feasible
  - Nutritional, response to stress, etc.



## Governance issues (Kuzma and Kokotovich 2011)

- Existing regulatory triggers may exclude TagMo techniques
  - USDA definition: Created using, or may become, "plant pest"
- Uncertain how oversight systems will address TagMo
- Through FOIA, learned that in 2004 & 2010 USDA granted unregulated status to TagMo plant products

## Why anticipatory governance?

- Anticipatory Governance (Barben et al. 2008, Sarewitz 2011)
  - Built upon critiques of reactionary technology assessment
  - Guide technology R&D and governance towards desired outcomes and away from undesired ones
  - Principles: Foresight, Engagement, and Integration
- Plant targeted genetic modification
  - Early stages of development
  - Little agreement on what it is, its possible futures, and its desired futures
  - Little agreement on how it could and should be governed
- Key considerations
  - Conflict and conflicting futures

## Conflict in Anticipatory governance

Conflict within the goals of anticipatory governance:

“...The aim of such exercises [is to]... **(a)** increase dialogue about and current understanding of the range of possible technological trajectories and respective alternative governance frameworks, and to **(b)** elaborate how these two future projections should develop interactively.”

(Karinen and Guston 2010, 228)

- **(a)**: Expand number and types of futures taken into consideration – *minimal explicit conflict*
- **(b)**: Determine what types of futures are desirable – *narrowing of desired futures, frequent explicit conflict*

**How does AG ensure narrowing is successful?**

## *Reflexivity* in Anticipatory governance

- Highlight and question the assumptions behind technological and governance futures

(Karinen and Guston 2010, Barben et al. 2008)

Where to find insights on how to question the assumptions of futures?

## Future studies (Selin 2008, Lopez 2008, McGrail 2010)

“...expectations are both the cause and consequence of material scientific and technological activity.”

(Borup et al. 2006)

- How we think about, discuss, and give meaning to the future influences how it materializes
- Futures legitimize, inspire, enroll actors, mobilize resources and dampen dissent
- Futures influence how we study and govern technology

## Future studies (Selin 2008, Lopez 2008, McGrail 2010)

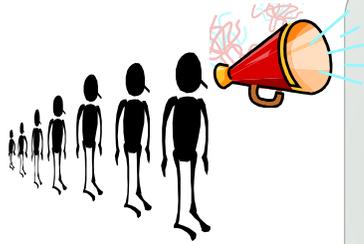
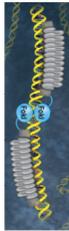
“Every future is predicated on others to be avoided”  
(Tutton 2011)

- Conflict
  - Futures privilege and reinforce certain experiences, values, and meanings at the expense of others
  - Cannot assume futures will converge in a complementary way
- Discourse
  - Futures are constituted through existing discourses and narrative strategies
  - Can analyze discourse to reveal assumptions behind a future and their implications

## Insights for reflexivity and conflicting futures

- What assumptions underlie each future?
- What are the implications of differing assumptions?
- Which experiences, values, and meanings are considered and which are not?
- How do futures draw upon or challenge privileged discourses?

1. What are the futures of plant TagMo?
2. How do they conflict?



### Futures

Governance

Environmental Impact

Impact on plant science

#### 31 Expert-stakeholders

- What is plant TagMo?
- Potential impacts?
- Key concerns?
- Desired governance?
- How will plant TagMo be regulated in United States?
- What are the assumptions behind these understandings?

## Overview of findings

1. *TagMo futures are formed by conflicting discourses*
  - a) Meaning of increased precision for GE plants
  - b) Concerns about TagMo
2. *TagMo futures reveal divergent ways of understanding and governing plant TagMo*
  - a) How plant TagMo will impact the environment
  - b) How plant TagMo will influence plant science
  - c) How plant TagMo will be regulated

Findings	
<b>How plant TagMo will be regulated</b>	
<ul style="list-style-type: none"> <li>• Regulated as conventional plants</li> <li>• Reduced burden for approval</li> <li>• Kept in current form</li> <li>• Incrementally strengthened</li> <li>• Reconfigured to make more rigorous</li> </ul>	

Findings	
<b>How plant TagMo will be regulated</b>	
<b>Regulation</b>	<b>Regulated as conventional plants</b>
<b>Understandings</b>	<ul style="list-style-type: none"> <li>• Many TagMo products are equivalent to those obtained by methods deemed non-GM and will not require the scrutiny given to first generation GM plants</li> </ul>
<b>Assumptions</b>	<ul style="list-style-type: none"> <li>• New TagMo produced traits will pose no significant ecological risk</li> <li>• TagMo is fundamentally different than first generation GM</li> <li>• Techniques considered non-GM are adequately regulated</li> </ul>

Findings	
How plant TagMo will be regulated	
Regulation	Reduced burden for approval
Understandings	<ul style="list-style-type: none"> <li>• GM plant governance is too stringent and the environmental risks from plant TagMo will be similar to those of first generation GM plants</li> <li>• GM plant governance is adequate but plant TagMo will increase predictability and safety</li> </ul>
Assumptions	<ul style="list-style-type: none"> <li>• Existing risk paradigm will be able to adequately assess risk from TagMo</li> </ul>

Findings	
How plant TagMo will be regulated	
Regulation	Kept in current form
Understandings	<ul style="list-style-type: none"> <li>• GM plant governance is adequate and the environmental risks from plant TagMo will be similar to those of first generation GM plants</li> </ul>
Assumptions	<ul style="list-style-type: none"> <li>• Existing governance is adequately addressing first generation GM plants and TagMo will not challenge it</li> <li>• Risks from TagMo derived plants will be the same in kind</li> </ul>

Findings	
How plant TagMo will be regulated	
Regulation	Incrementally strengthened
Understandings	<ul style="list-style-type: none"> <li>• GM plant governance is inadequate due to poor interagency coordination and lack of resources</li> <li>• GM plant governance is adequate, but new traits and plants are likely to stress regulatory system</li> </ul>
Assumptions	<ul style="list-style-type: none"> <li>• With enough resources and coordination agencies could adequately assess risks and regulate TagMo plants</li> </ul>

Findings	
How plant TagMo will be regulated	
Regulation	Reconfigure to make more rigorous
Understandings	<ul style="list-style-type: none"> <li>• GM plant governance is inadequate because environmental safety testing is too narrowly defined and not independent</li> <li>• Newly engineered traits and plant species and the increased ease of GMO production will significantly worsen the problems present within the governance of first generation GM plants</li> </ul>
Assumptions	<ul style="list-style-type: none"> <li>• Who completes testing influences its outcome</li> <li>• First generation GM plants are causing problems not being addressed by existing governance</li> </ul>

## Discussion

Examining assumptions reveal following questions to help further interrogate futures:

- Is existing risk based regulatory paradigm adequate?
  - Hilbeck et al. (2011) highlight conflicting approaches to risk assessment
- What types of ecological risks could new traits pose?
- How well will ecological risk assessment paradigm respond?
  - Most risk work has examined just HT and IR traits
- How well will regulatory agencies deal with increased number of new products?
- What form would TagMo need to take to address concerns about first generation GM plants?

## Discussion

- Consensus & conflict minimization vs. critique & challenge  
(Genus 2006)
  - Focus on consensus may neglect certain values and lead influential actors and experts not to “reflect on, or to make explicit, their own deep-seated values or assumptions about technology”  
(Genus 2006, p. 19)
- Analysis of discourse can help highlight factors that reproduce dominant discourse

## Discussion

Insights for anticipatory governance

- Understanding how futures differ and their key assumptions can inform additional AG practices
- Examining conflicting futures can facilitate reflexivity
  - Conflict should be more explicitly addressed
- Role for examining discourse in an analysis of futures

## Thank you

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