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# Regulating Ag Innovation without Killing it

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# Pennycress --as harvestable cover crop

Winter cover  
crop



Oilseed  
harvested in  
spring

No-till  
soybeans  
planted after  
harvest



Target  
30 million  
acres



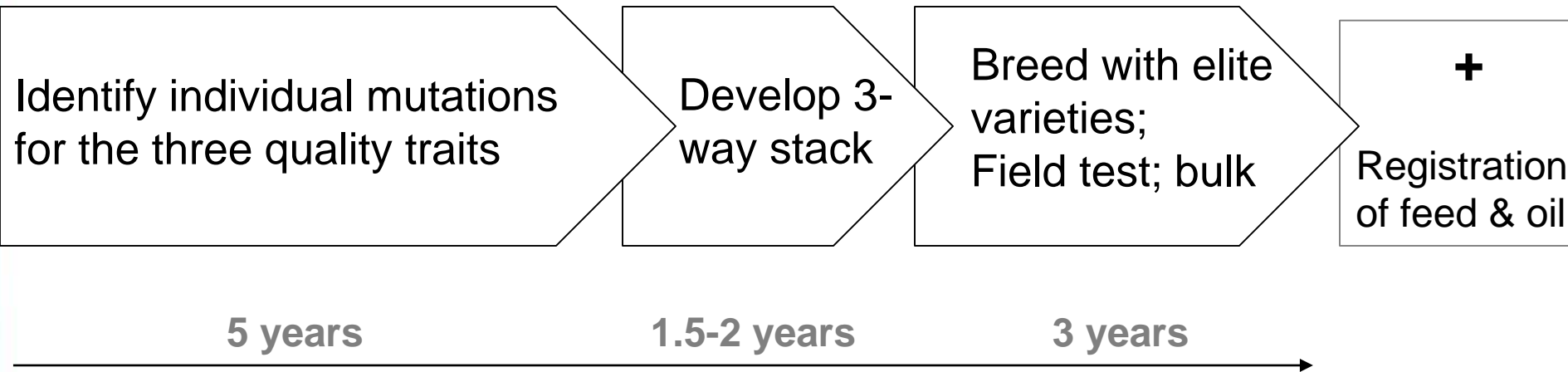
# Pennycress domestication & “canola moment”

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- Lower seed fiber
- Lower glucosinolates
- Lower erucid acid
  
- Increase yield
- Earlier maturity
- Reduced shattering

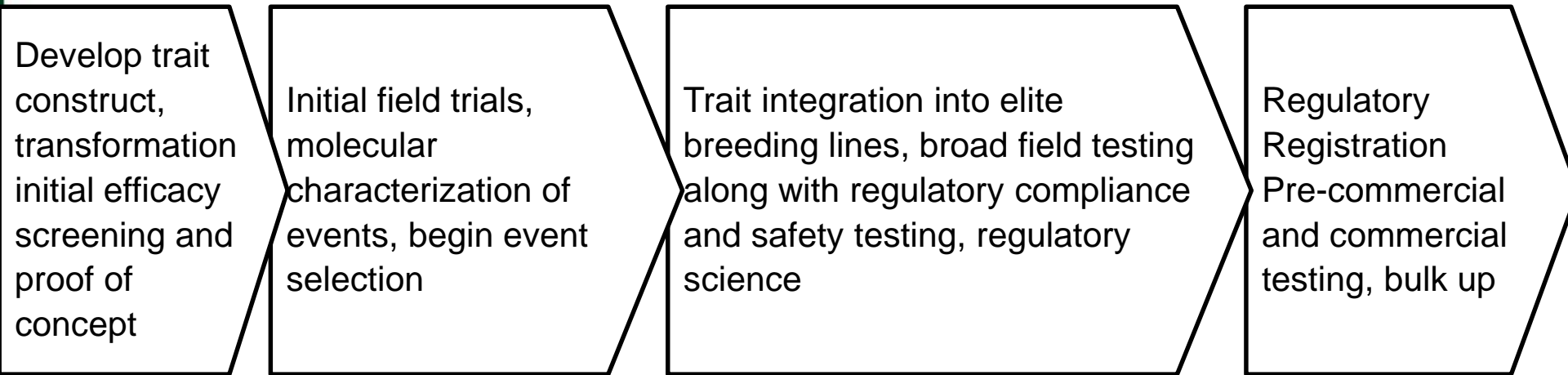
# Potential development path

## Conventional Breeding?



# Potential development path

## Genetic Engineering?



±10 years

+ registration  
of feed and oil

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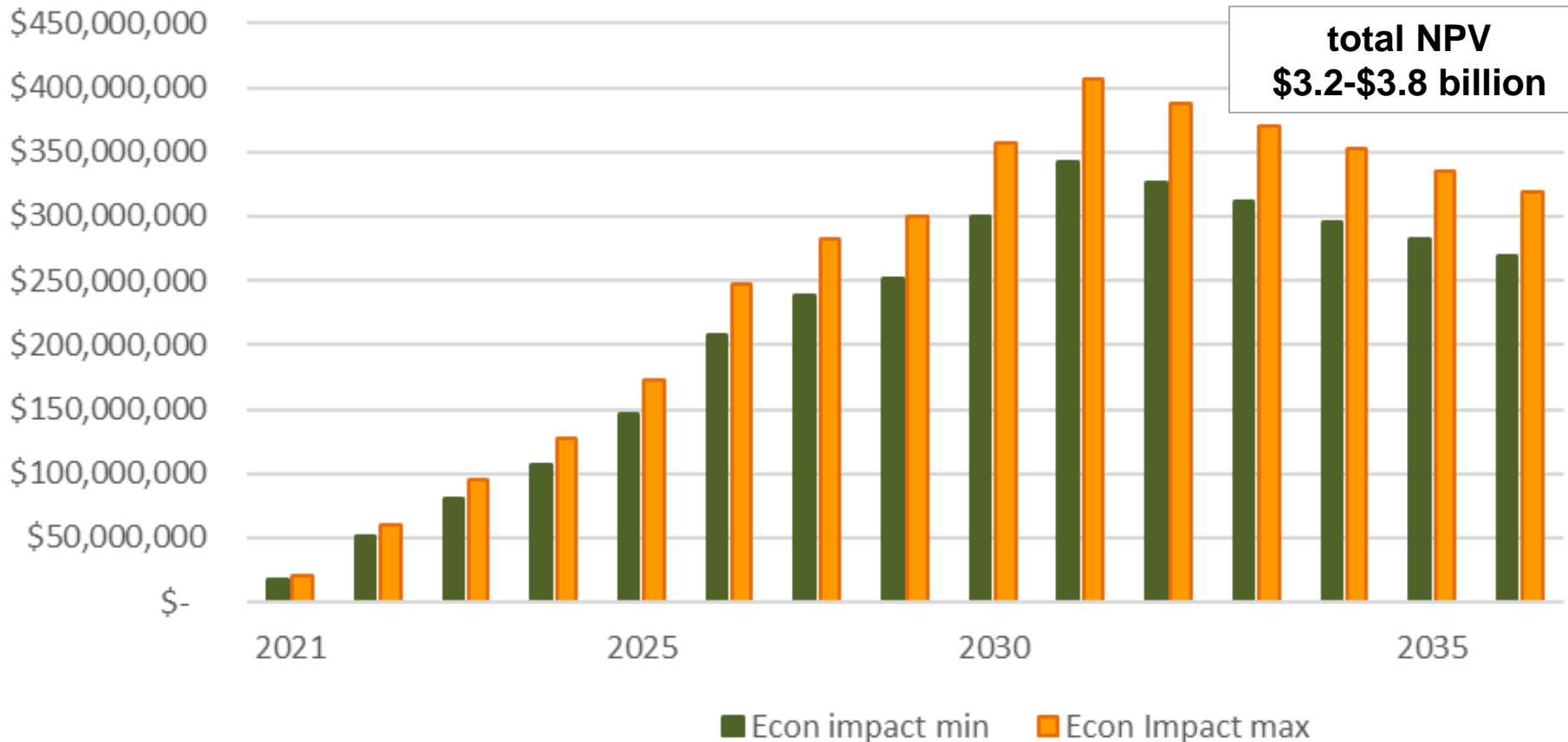
# The economics of editing:



	DISCOVERY Gene/Trait Identification	PHASE I Proof Of Concept	PHASE II Early Development	PHASE III Advanced Development	PHASE IV Pre-launch
	<b>2013-14: First wild accessions</b>	<b>Identify desired traits, design editing cassette</b>	<b>Perform edits, early field trials</b>	<b>Extensive field trials</b>	<b>2020: Preparing for product launch</b>
	Sample plants gathered from the wild. Collaboration with universities & USDA breeding programs	Three traits: --Seed coat --Low glucosinolates --Low erucic acid	Multiplex editing allowed modification of all traits at one time. Development of transformation	AIR  Breeding edited varieties with elite varieties	Field work continues.  Seed bulk up  Meal: testing and
<p><b>6-7 years development &amp; less than \$7 million in spending</b></p>					
	Arabidopsis, canola, etc.	Parallel breeding for agronomics	Parallel breeding for agronomics	Parallel breeding for agronomics	
	<b>Funding Rounds:</b>	<b>2015: \$2.5 M Series A</b>	<b>2017: \$2.4 M Venture Capital</b>	<b>2018: \$2.0 M Venture Capital</b>	<b>Total: \$6.9 M</b>

# Potential economic impact of innovation

Projected Economic Impact of Covercress -2021-2036



Author calculations

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# The impact of regulation

## Emerging Regulatory Environment for Genome Editing

	Type of Edit			
	yes	yes	yes	no
possible via conventional breeding?	yes	yes	yes	no
nucleic acid template?	no	short	long	yes
"Foreign" DNA	no	no	no	yes
Selected Countries	SDN-1	SDN-2	SDN-3 cisgenic	SDN-3 transgenic
Argentina	Not GE	Not GE	Likely not GE	GE
Brazil	Not GE	Likely not GE	Likely not GE	GE
US	Not GE	Depends	Depends	Depends
Australia	Not GE	GE	GE	GE
Japan (Environment)	Not GE	Not GE	Not GE	GE
Japan (Health)	Not GE	Not GE	GE	GE
EU	GE	GE	GE	GE

# The costs of regulation

- Bureaucratic cost
- Compliance cost
- Opportunity costs



# The case for **efficient regulation**

# Emerging regulatory environment & impact

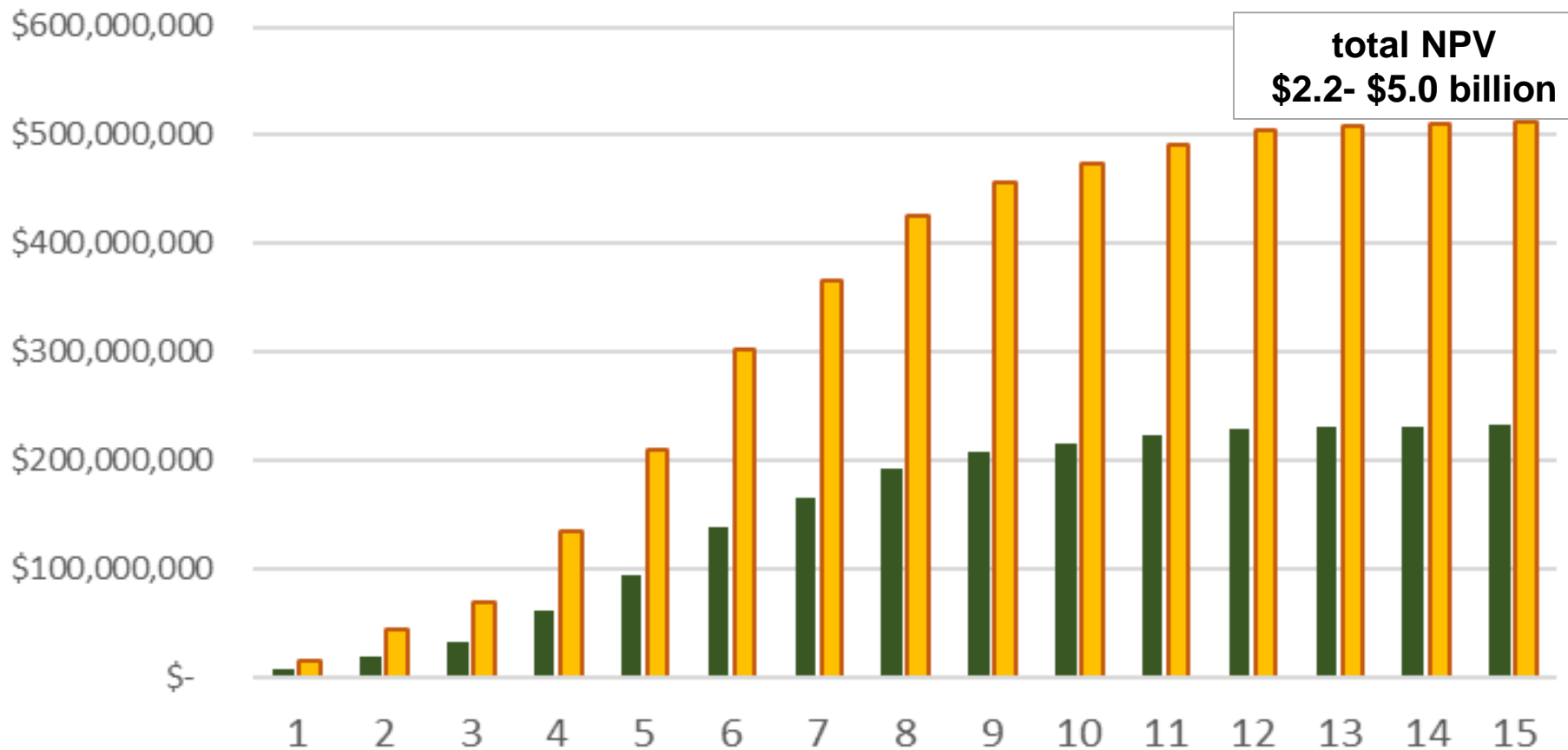
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Japan (Environment)	Not GE	Not GE	Not GE	GE
Japan (Health)	Not GE	Not GE	GE	GE
EU	GE	GE	GE	GE



# Impact of regulation on other genome editing innovation

Potential Economic Benefit of ASR Resistance Technology in Corn



# Concluding comments

- Agricultural innovation creates significant economic benefits for society
- Excessive, uncertain, complex regulations can undercut innovation and limit the potential benefits
- Foregone economic benefits are often the largest part of regulatory costs
- To maximize the benefits of agricultural innovation, regulations must be risk-proportional & efficient