



THE CENTER FOR
FOOD INTEGRITYSM

Gene Editing

What it is, how it works and
what's being developed

August 2023

HELPING TODAY'S FOOD SYSTEM BUILD CONSUMER TRUST



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FOOD INTEGRITYSM

Trust is every organization's most valuable intangible asset





CFI Project Partners



Helping Today's Food System Build Consumer Trust

RESEARCH &
INSIGHTS

EMERGING
TRENDS &
ISSUES

STRATEGIC
SOLUTIONS

CONNECTIONS &
COALITIONS



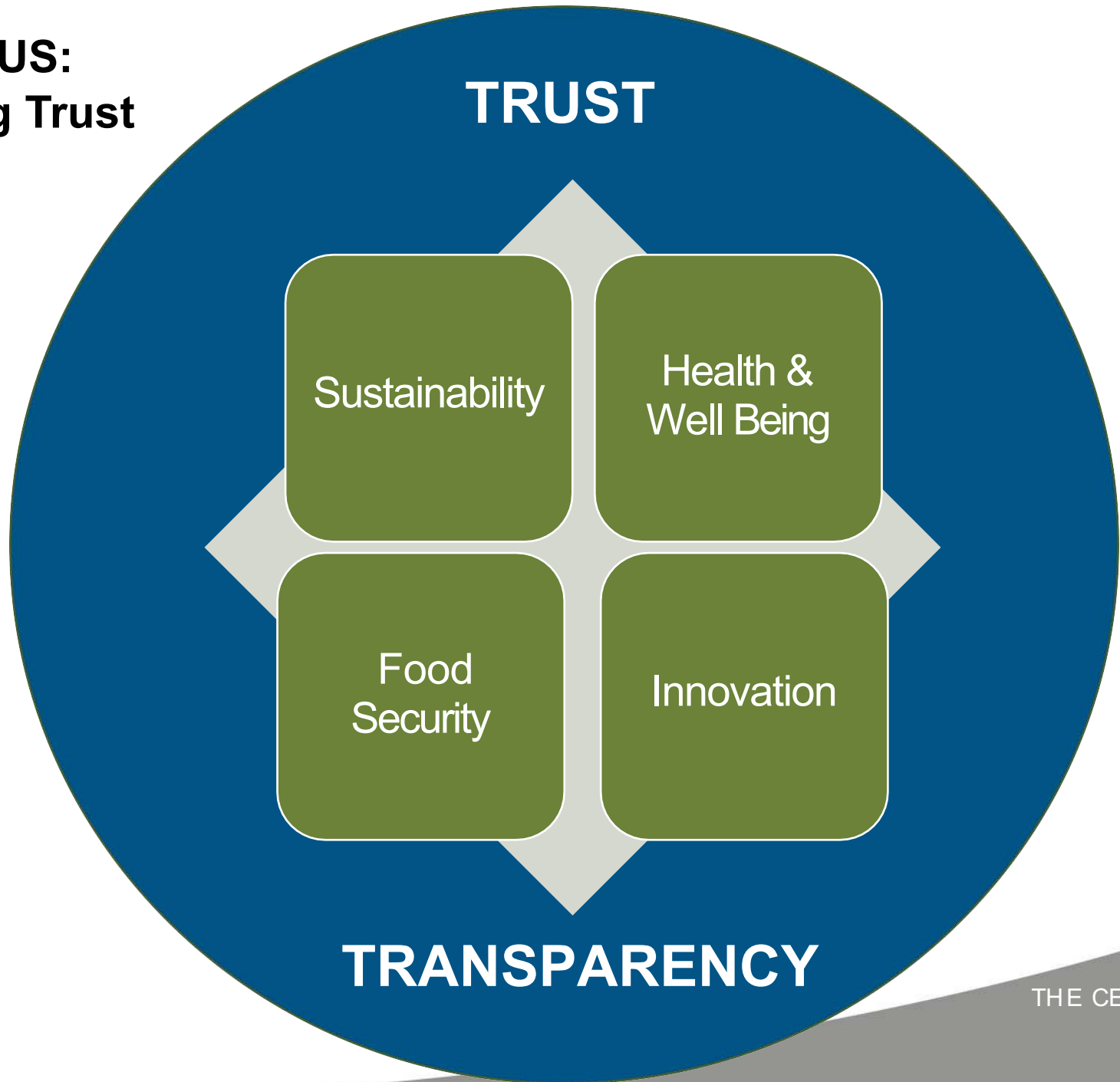
Scan to learn more about the benefits and opportunities of
CFI Membership



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**CFI PROGRAM FOCUS:
Key Areas Impacting Trust**



A Critical Time For Innovation in Agriculture

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Why We Need Ag Technology

- Historically, there has been low felt need for new technologies in food and ag
- That has changed due to:
 - COVID-19 pandemic
 - Global supply chain disruptions
 - Food inflation
 - War in Ukraine
 - Climate change and localized severe weather events
 - Concerns about animal welfare
 - Farm sustainability



Gene Editing Defined

Gene editing encompasses a suite of technologies that can be designed to cut, or otherwise alter predetermined DNA sequences in the genome and result in targeted insertions, deletions or other changes for genetic improvement.

(Definition from the CFI Coalition for the Responsible Use of Gene Editing)





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Plants, Animals and Microbes



Pivot Bio PROVEN[®] 40

A BETTER NITROGEN FOR CORN



The Nitrogen You Need.
Now On-Seed.

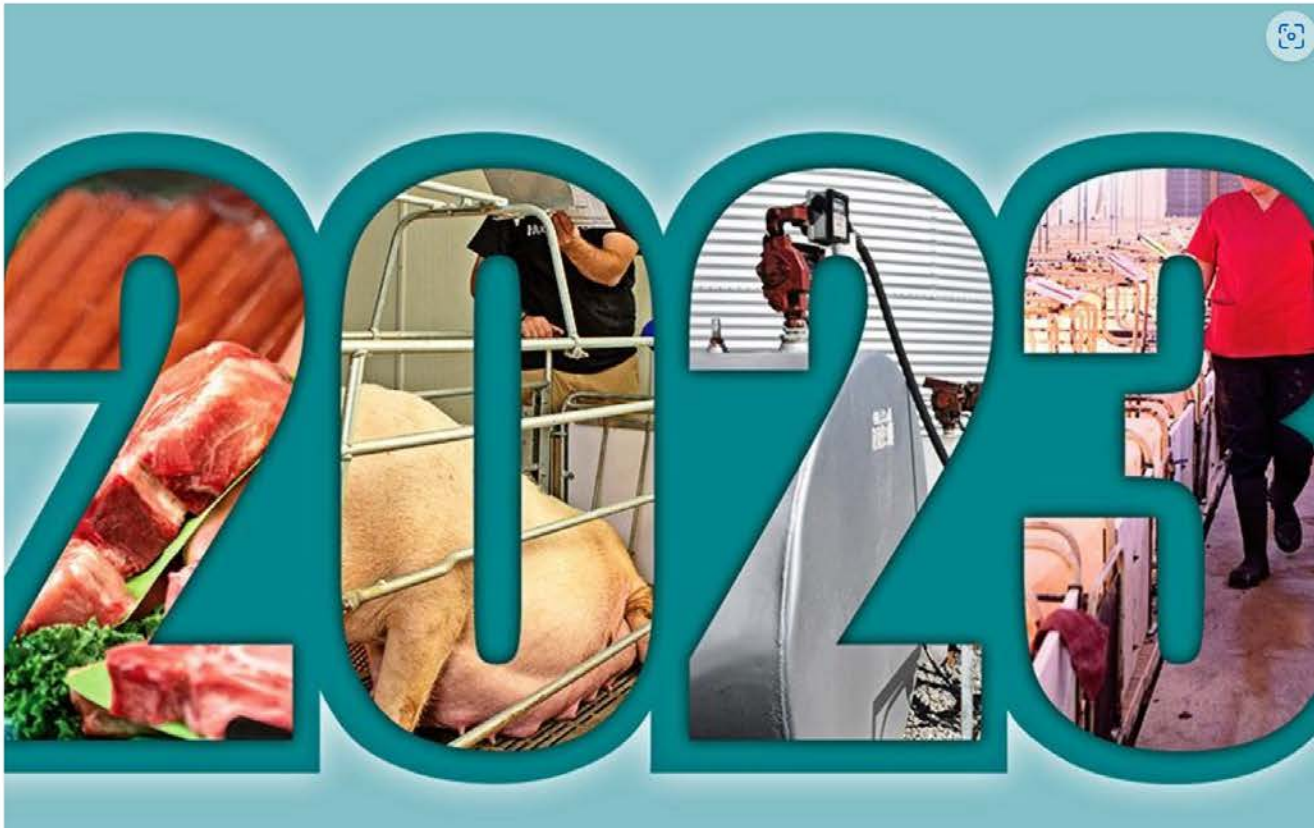


Predictable Nitrogen for
Your In-Furrow Program.



PRRS Resistant Pig

What's Driving the Pork Industry in 2023?



Acceligen™





INTRODUCING CONSCIOUS™ FOODS

Whether it's the food you eat or the causes you support,
you consciously make decisions that feel right for you.

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SUBMIT

Gene Editing Democratizes Biotech

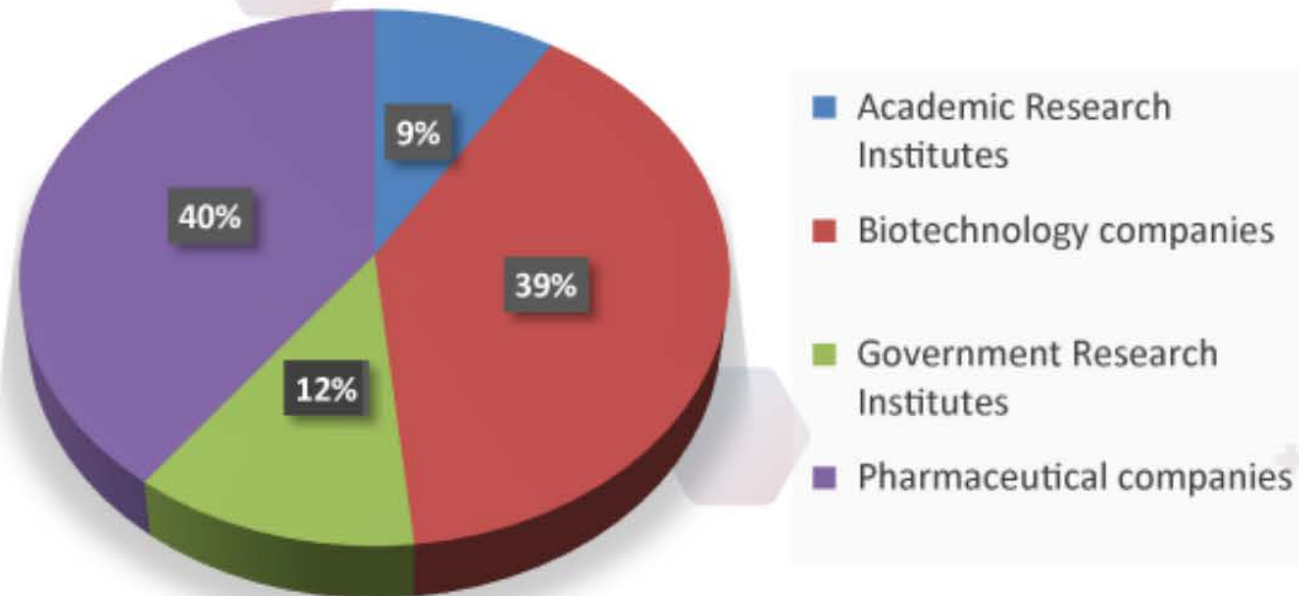
- First generation biotech in agriculture was expensive to develop and took a decade or more to clear regulatory hurdles. The total cost of bringing a biotech crop to market often exceeded \$100 million.
- The high cost of development and approval meant only the largest companies were involved in development.
- The economics of development meant that new varieties were limited to the largest commodities with a singular focus on agronomic traits.



Gene Editing Democratizes Biotech

Global Genome Editing Market (2021 - 2030)

Based on End-user



- The relative affordability of gene editing technology is stimulating development and investment across sectors.
- In 2021 alone, more than \$1.3 billion was invested in gene editing research and development.
- Researchers are developing new applications to address a wide range of challenges in human medicine and agriculture.

Source: SM Strategic Market Research



Gene Editing Democratizes Biotech



- Gene therapy in human medicine holds promise for treating a wide range of diseases, such as cancer, cystic fibrosis, heart disease, diabetes, hemophilia and AIDS.



Gene Editing Democratizes Biotech

- Currently there are 3,649 gene therapies being developed for human medicine – 49% targeting cancer. 32 gene therapies are currently approved for people.
- In agriculture, more than 500 products are being developed globally in crops of interest, with the private sector responsible for 43% of product development.
- 5% of products are in pre-commercialization with 49% in the advanced research phase.
- 55% of products being developed are grains or oilseeds.
- 23% vegetables, 7% fruit, 3% each for ornamentals, legumes and forages and grasses.



Source: SPGlobal & American Society
for Gene and Cell Therapy



Gene Editing is Software for Agriculture

HARDWARE AND SOFTWARE



- Gene editing allows developers to make precise changes in the genome to achieve a beneficial outcome without introducing foreign DNA.
- Like software, farmers can choose to use gene edited plants, animals or microbes based on their markets and needs.
- Food companies can work with their supply chain to order the “software” that can help them meet specific needs.



Illustrations of How Gene Editing is Being Applied



Our Panel



**Sarah Davidson
Evanega**
Pairwise



Lucina Galina
PIC



Marc Cool
Corteva



Christi Dixon
Benson Hill





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Gene Editing Consumer and Market Acceptance

August 2023



Current and emerging technologies offer many solutions for farming and food production.

Market and consumer acceptance is imperative to realize the benefits they deliver.



When Acceptance Fails...



Technologies that Failed to Achieve Potential



- U.S. Army developed irradiation in 1950s to kill germs that cause food-borne illness. FDA approved for use on red meat in 1997.
- CDC estimates irradiating half of all ground and processed meat would prevent **900,000 cases of foodborne illness and 350 deaths each year.**¹
- Irradiated ground beef sales never took off because consumers associated it with radiation.



- Approved by USDA in 2014, The Simplot Innate Potato produces less acrylamide, a potential carcinogen formed when potatoes are fried. (Industry average cost for GMO product development - \$136 million)
- Before approval, McDonald's announced it would not use the potatoes, even though Simplot supplies the vast majority of McDonald's fries.



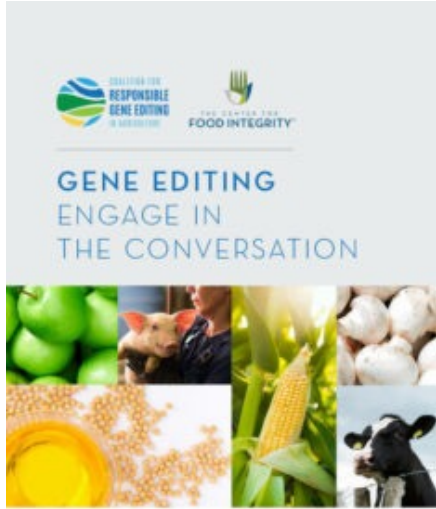
Technologies that Failed to Achieve Potential



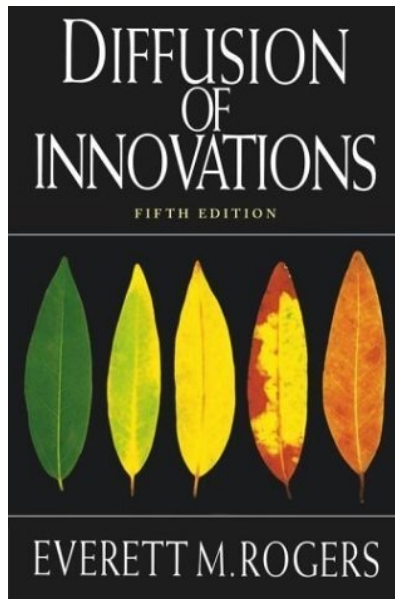
- Improvest developed by Zoetis, approved by FDA in 2011 as a chemical alternative to physical castration in pigs.
- Improvest can also affect humans. Men and women of childbearing age should use extreme caution and use protective equipment.
- Improvest is not widely used due to concerns of worker safety and consumer perceptions.²



CFI Research & Expertise



Gene Editing, FoodIntegrity.org
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2 How Do We Establish Human Health Connection?

CRISPR 3-part Video Series on Best Food Facts

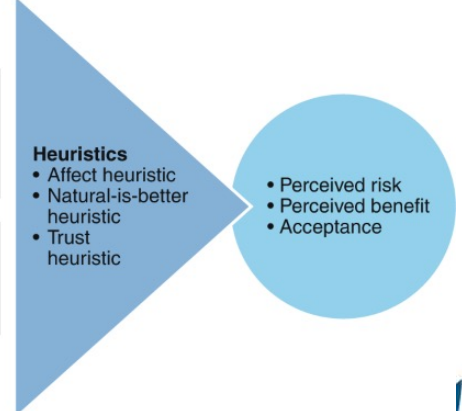
 Hosted by Digital Influencer Lynne Feifer 365 Days of Baking & More	 Part I What is CRISPR Technology? Dr. Rudolphe Barrangou North Carolina State University	 Part II How Can CRISPR Treat Disease? Dr. Nazia Tabassum Shakir Cannon, advocate Erin Brenneman, farmer	 Part III How Can CRISPR Improve Food? Dr. Jessica Lyons University of CA - Berkeley
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- Food technology aspects**
- Voluntary exposure
 - Perceived naturalness
 - Perceived dread
 - Perceived control

- People's characteristics**
- Disgust sensitivity
 - Food technology neophobia
 - Cultural values



What Drives Consumer/Food System Acceptance?

Trust in Ag Technology, Consumer Quantitative Study, 2021 Funded by

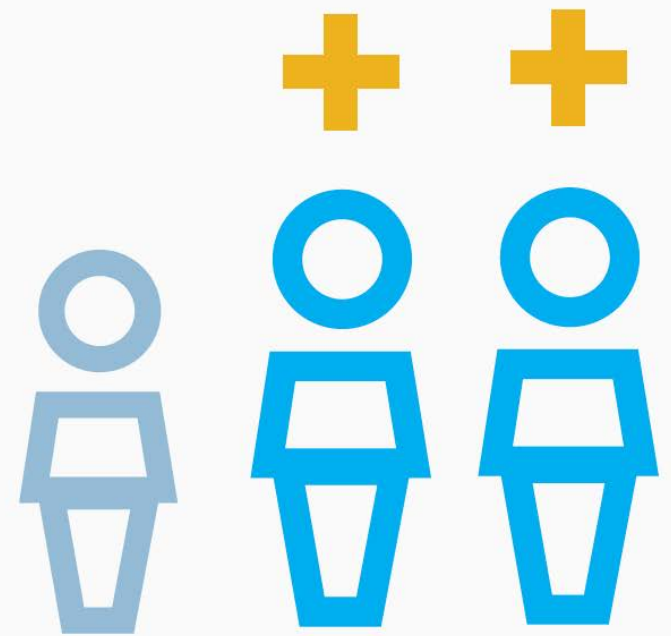


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**Very positive or
somewhat positive
impression of use of
technology to grow
food in the U.S. today**

**2 OUT OF 3
CONSUMERS**



Millennials and Early Adopters are more positive



Target Market Influences Acceptance

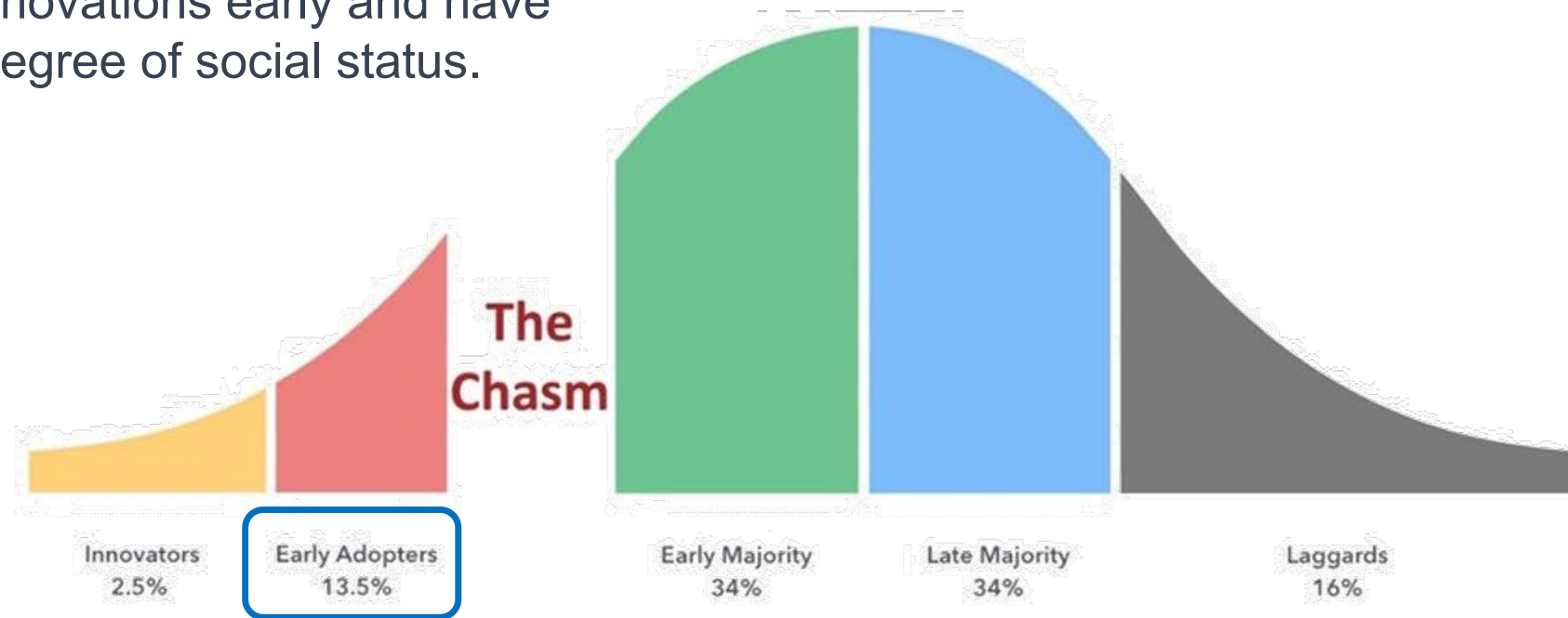


A Higher Bar



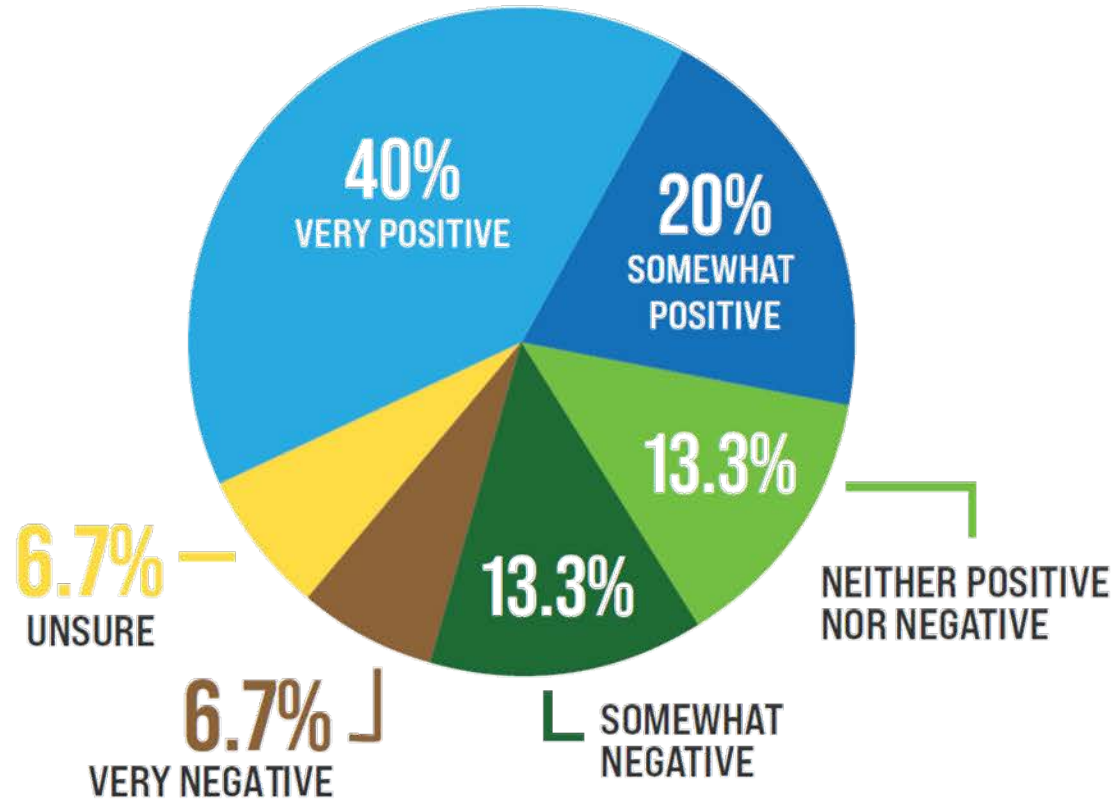
Rogers' Model - Adoption/Diffusion of Innovation

Early Adopters - Opinion leaders and influencers who adopt innovations early and have a high degree of social status.



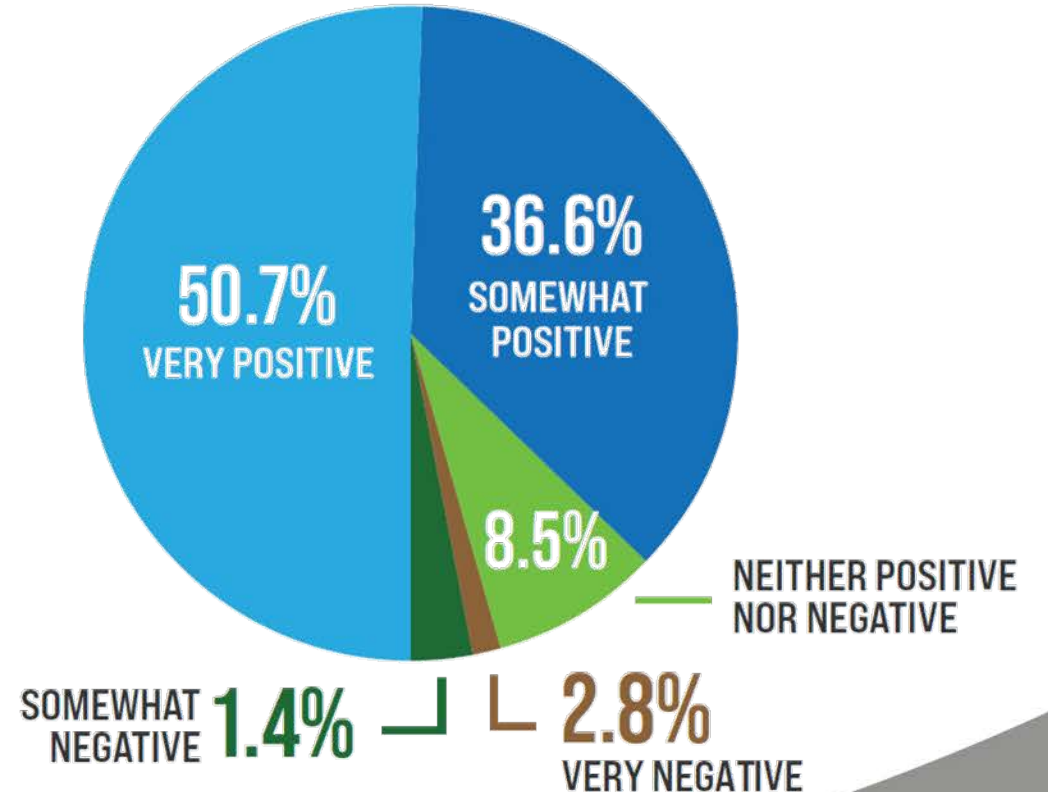
INNOVATORS

IMPRESSION OF TECHNOLOGY TO GROW FOOD



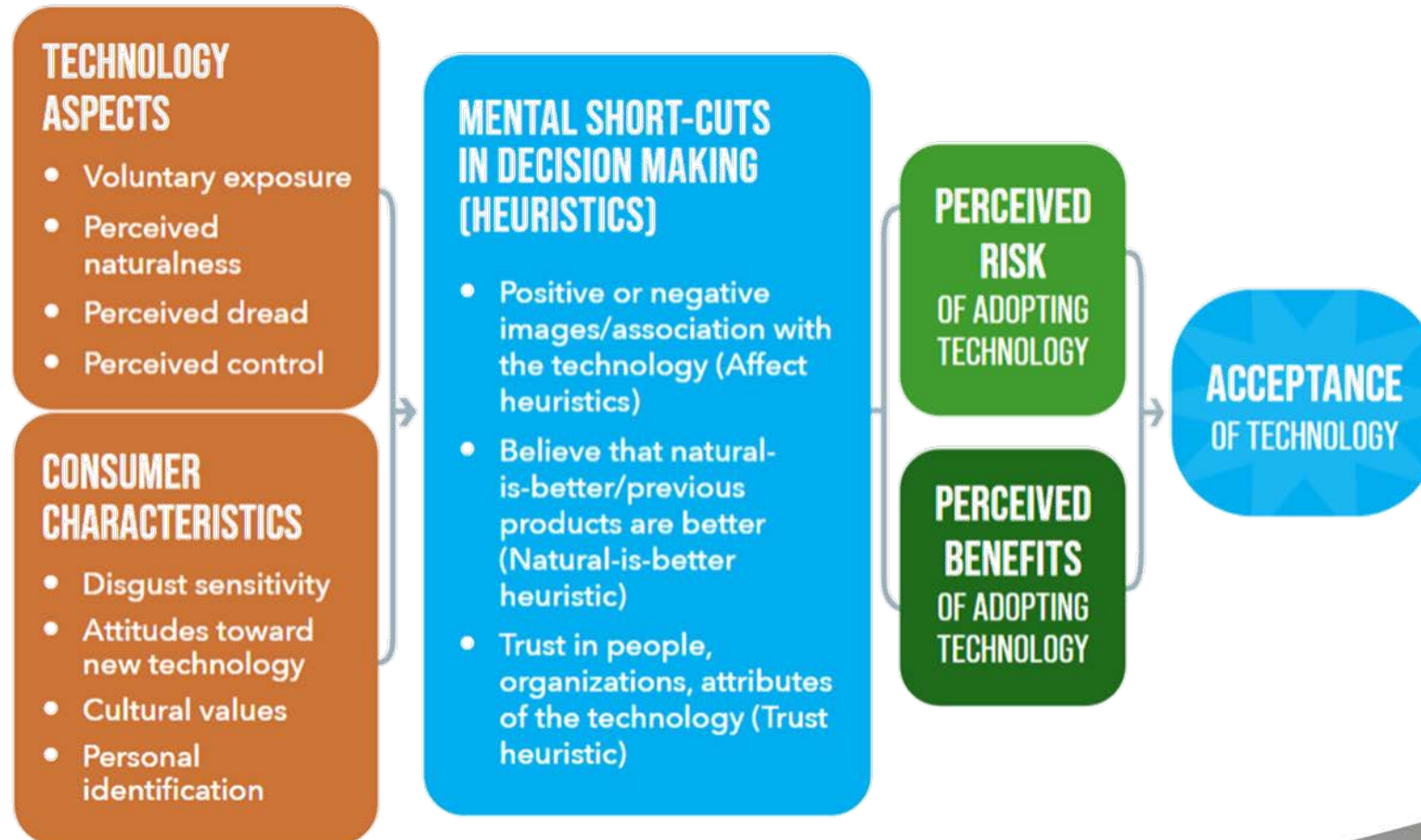
EARLY ADOPTERS

IMPRESSION OF TECHNOLOGY TO GROW FOOD



Highly Predictive Research Model

R² for all technologies tested was between .76 and .84



Factors Driving Consumer Acceptance



Belief that food resulting from technology use is safe to consume



Information on food produced through technology is readily available so consumers can make an informed, voluntary choice



Benefits outweigh perceived risks



Technology can help ensure a consistent supply of food



Technology promotes greater sustainability by making more with less environmental impact



Factors Driving Food System Acceptance

Likely to Increase Acceptance

- Consumers will accept it
- Improves profitability by increasing sales, reduces costs or improves efficiency
- Scalable to be commercially viable
- Aligns with company values
- Fills an existing market need
- Gives consumers more choices

Likely to Increase Rejection

- Consumers will not accept it
- Insufficient testing or proof that it is safe
- Potential supply chain problems
- Serves no clear purpose for the company – low “felt need”
- Lack of regulatory approval; not accepted in international markets
- Cost considerations

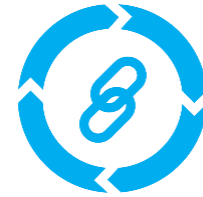


CFI Trust Building Strategies for Ag Tech Companies



CONSUMER
RESEARCH

Conduct research to better understand customer and consumer awareness, comprehension and opinions about an emerging application.



SUPPLY & VALUE
CHAIN BENEFITS

When engaging with food companies, emphasize how technology can help mitigate pain points like affordability, production costs, food shortages and supply chain disruptions.



CASE STUDIES

Study successful tech introductions and use these case studies to inform product development, launch and external strategies.



PRICE POINT

Introduce the technology – or resulting products – at a price point that aligns with benefits and value to the marketplace.



STAKEHOLDER
ENGAGEMENT

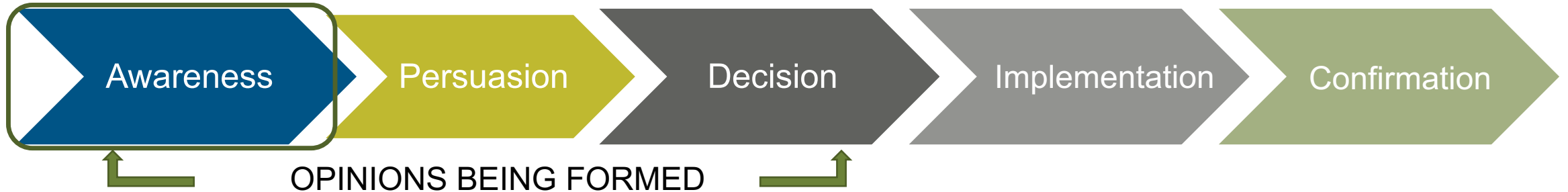
Engage with key influencers early in the process.



Adoption/Diffusion Stages + CFI Research & Insights



Adoption/Diffusion + CFI Insight



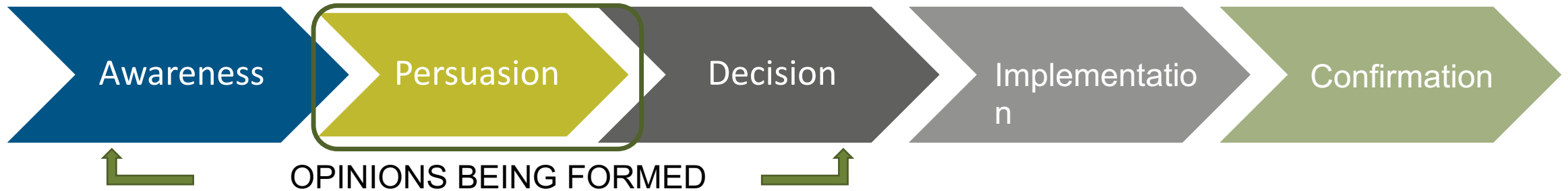
CFI Research and Insights – Factors Impacting Acceptance

Individual is exposed to new product or idea

1. Communication channels
 - Identify the channels most relevant to your target.
 - Channels vary widely. Hyper-targeting allows for efficient impact.
2. Content
 - Create concise, compelling content that aligns with values of target to create felt need.
 - Focus on impact. What are the benefits to your target and those downstream?
3. Leverage Early Adopters/Opinion leaders
 - Cultivate relationships and secure content to leverage their credibility and influence.
 - Transfer the credibility and trust in these individuals to your technology.



Adoption/Diffusion + CFI Insight



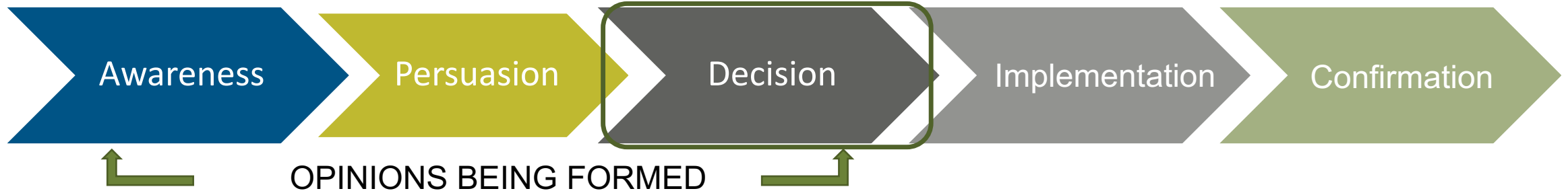
CFI Research and Insights – Factors Impacting Acceptance

Interest in learning more

1. Relative advantage
 - Is it better than current option?
 - Belief that previous/natural is better.
2. Compatibility
 - Does it fit with existing tech, values, beliefs or lifestyles?
 - Is it aligned with cultural values/personal identification?
3. Complexity
 - Is it easy to use or understand?
 - Attitudes toward new technology?
4. Trialability
 - Can I try it before I buy it?
 - Voluntary exposure/perceived control.
5. Observability
 - Can I see or experience the benefits or results?
 - Positive or negative images associated with the technology.



Adoption/Diffusion + CFI Insight



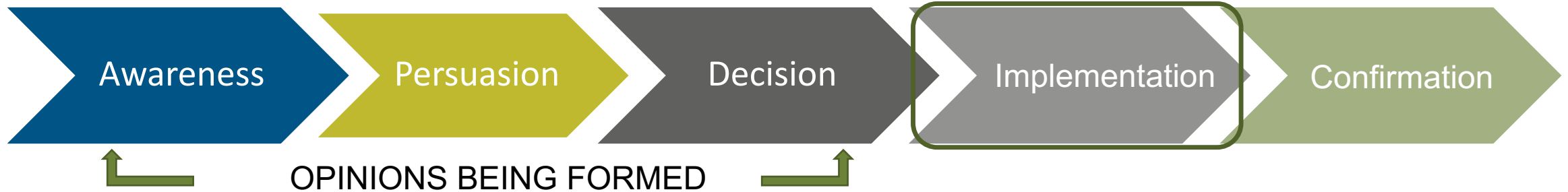
CFI Research and Insights – Factors Impacting Acceptance

Analysis and consulting with others to determine whether to accept or reject

1. Information availability
 - Assure accurate information is easily accessible to support informed decisions.
 - Transparency is the foundation of trust.
2. Comparative advantage
 - Is this better than the current option(s) for MY needs?
 - Consider the advantage in cultural context? What constitutes “better” for your target?
3. Social proof
 - Do peers, influencers and others I respect endorse or use?
 - Leverage testimonials and case studies from influencers.



Adoption/Diffusion + CFI Insight



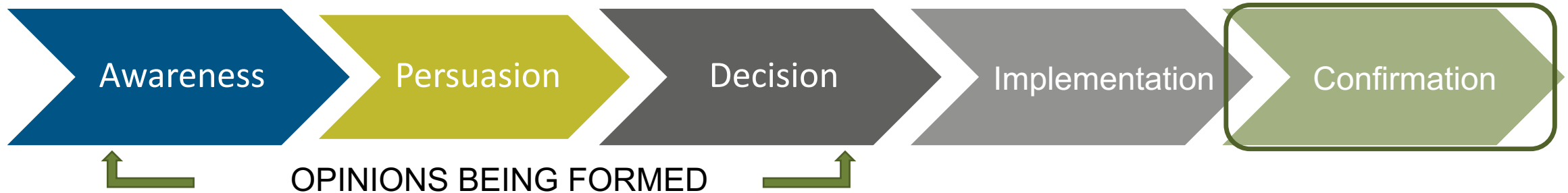
CFI Research and Insights – Factors Impacting Acceptance

Product, service or subscription purchased

1. Training, education and technical support
 - Hands-on training, user manuals, online tutorials. Assuring adequate resources are available for successful implementation builds confidence in the new application. That includes consistent technical support and the flexibility to customize if possible.
2. Change management
 - Comprehensive strategy and adequate support to implement new processes and procedures.
 - Enthusiasm from internal champions inspires others. Regular evaluations and feedback will increase the likelihood of success.



Adoption/Diffusion + CFI Insight



CFI Research and Insights – Factors Impacting Acceptance

Finalizes and affirms decision

1. Performance feedback
 - Provide metrics, success stories, testimonials etc. that demonstrate the value of the innovation.
 - Providing feedback reinforces the decision to purchase and encourages continued use.
2. Continuous support
 - Provide further training and upskilling to empower and increase confidence.
 - Creating platforms, or social networks where adopters connect and share experiences, encourages continued engagement.
3. Reinforcement of benefits
 - Highlight new features and benefits to maintain interest and enthusiasm.
 - Reinforce satisfaction by reminding users of the value of the innovation.



Framework for Responsible Use of Gene Editing in Agriculture

About the Coalition



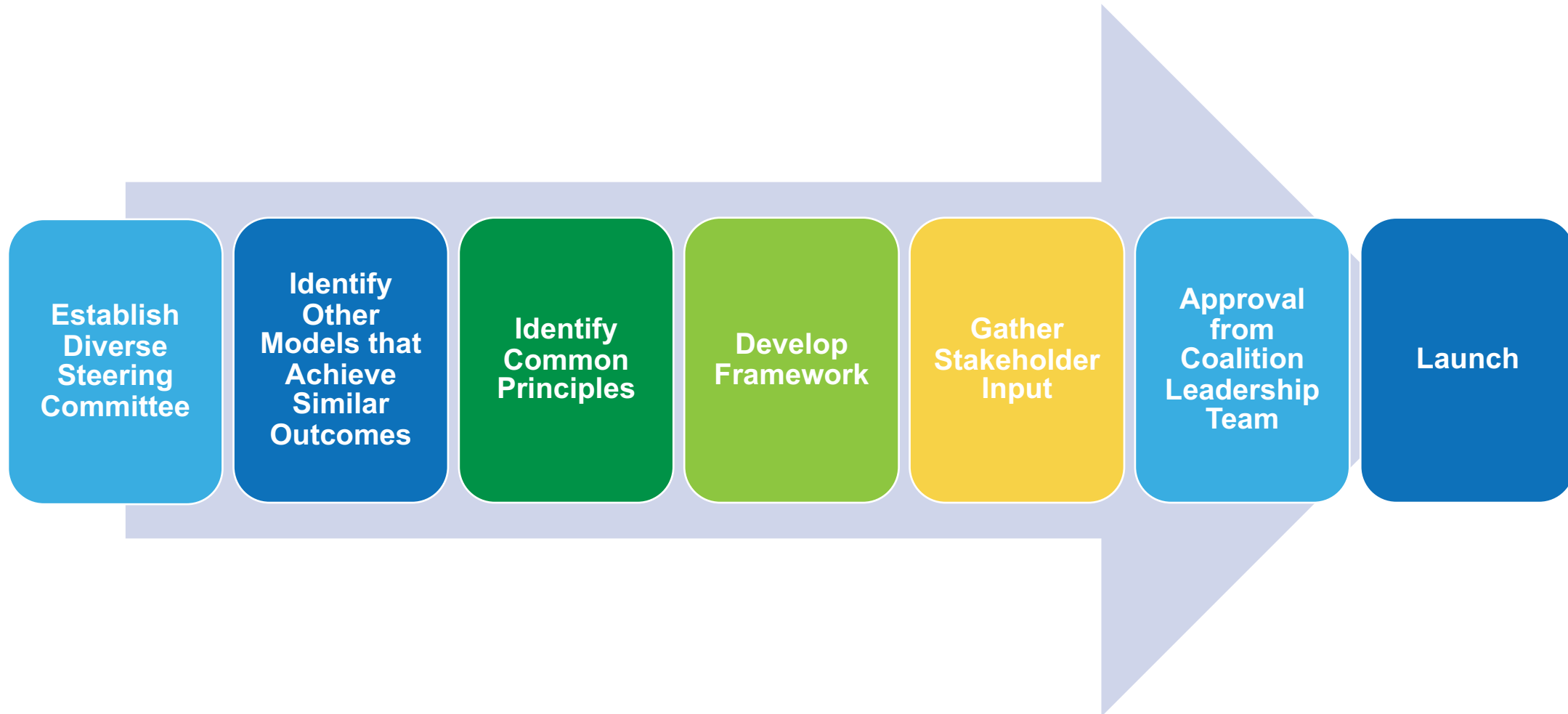
Vision:

Global acceptance and support for the responsible use of gene editing technology in agriculture and food.

Mission:

To cultivate support for the responsible use of gene editing in agriculture through the development and adoption of trustworthy guidelines for the responsible use of gene editing, effective stakeholder outreach and engagement, and broad-based involvement and collaboration of those engaged in gene editing.

Developing the Framework



Framework Steering Committee



Civil Society

- Center for Science in Public Interest
- The Nature Conservancy
- World Wildlife Fund

Academic

- Cornell University
- Creighton University

Food Companies

- Costco Wholesale
- PepsiCo

Tech Developers

- BASF Agricultural Solutions
- Benson Hill Biosystems
- Corteva AgriScience
- Genus
- Pivot Bio

Associations

- American Seed Trade Assoc.
- FMI – The Food Industry Assoc.

Farmers

- Good Cattle Co. (soybeans)
- Paustian Enterprises (pork)

**Participation in the Steering Committee does not imply endorsement by the individuals or their organizations.*

Principles

Reviewed other voluntary governance models and identified seven major Principles.



Transparency



Continuous Improvement



Safety & Quality



Verification



Trade & Market Considerations



Stakeholder Engagement



Social Considerations

Commitments and Guidance

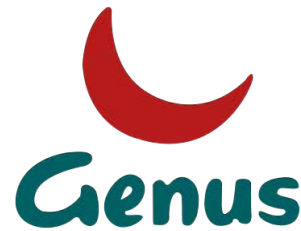
- Each principle within the Framework includes commitments and guidance that provide objective evidence that an organization is operating in conformance with the Framework.
- Organizations must meet 75% of the applicable commitments to achieve verification.
- Specific commitments that are foundational to a principal are mandatory to achieve verification.

Transparency Commitments
Framework participants commit to:

Commitments	Res	Dev	Comm	Life
<ul style="list-style-type: none"> Publicly pledge support for/commitment to the framework. <p>Guidance:</p> <ul style="list-style-type: none"> Framework participants will be publicly listed on the Coalition for Responsible Gene Editing website as supporters of the Responsible Gene Editing Framework and in the process of being verified. Once a participant completes the Verification Process, the organization will be listed on Responsible Gene Editing website as in full conformance with the framework. Applicants will create and post a statement of support for Coalition values and principles as they apply to their organization. 	X	X	X	X
<ul style="list-style-type: none"> Identify, and if lacking, establish policies and practices that support the framework principles of Transparency, Stakeholder Engagement, Safety and Quality, Trade and Market Considerations and Social Considerations. <p>Guidance:</p> <ul style="list-style-type: none"> Examples include policy statements, Standard Operating Procedures (SOPs), Quality Management Systems, best practices and other written policies and procedures relating to the principles. 	X	X	X	X
<ul style="list-style-type: none"> Make summary of policies and practices relevant to conformance with framework principles available to interested stakeholders on a publicly available website. <p>Guidance:</p> <ul style="list-style-type: none"> More detailed information about each policy or practice will be available upon request, subject to confidential business information constraints. For universities, information may be published on a college, school or department website (vs. a laboratory-specific site) and may include university policies as well as requirements to qualify for government research funding. 	X	X	X	X
<ul style="list-style-type: none"> Communicate the advantages and disadvantages of gene editing and the benefits of resulting products or applications. <p>Guidance:</p> <ul style="list-style-type: none"> When sharing application or product information, the expectation is that it will be at a species/crop/organism and trait combination level. Organizations are not required to share information at the individual hybrid or variety level. 		X	X	X

Res = Commercial research | Dev = Commercial development stage
Comm = Commercial sale stage | Life = Product lifecycle stage

Formal Endorsements to Date



Verification and Market Requirements



Costco Wholesale is the first retailer/food service company to require verification. They have started to train all their buying staff so they can confirm with suppliers that the developer of any gene edited product or ingredient derived from gene editing technology in the Costco supply chain has achieved verification and is in conformance with the Framework for Responsible Use.



Corteva Agriscience is the first company to achieve verification in the Framework. Two other companies are preparing for the process.

Learn more

Website: www.geneediting.foodintegrity.org

Email: geneediting@foodintegrity.org

Build Trust in Ag Tech Resources



Transparency Summit

November 14-15, 2023

Loew's Chicago O'Hare Hotel | Chicago, IL

- ❖ The CFI Transparency Summit brings together leaders and stakeholder organizations from across the food/ag value chain.
- ❖ The Summit will feature learning sessions and workshops, keynote presentations and networking opportunities
- ❖ A shared interest in building trust through transparent practices and balanced discussion.

Transparency As the Currency of Trust

- ❖ **Build Trust & Drive Relevant Change**
- ❖ **Speed Progress Towards Climate Goals**
- ❖ **Build a More Sustainable & Resilient Food System**



250+ Attendees | 20+ Speakers | 10+ Sessions



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