

The image features three large, weathered wooden barrels in a dark, dimly lit setting. The barrels are made of vertical wooden staves held together by metal hoops. The lighting is dramatic, highlighting the texture of the wood and the metallic sheen of the hoops. The background is a solid dark color, making the barrels stand out.

**Using next-generation hop  
breeding tools to develop  
more flavorful and  
sustainable cultivars**



**UNITED WE BREW™**

# Presenters

- Nicholi Pitra – Lead Research Scientist,  
Variety Development and Bioinformatics | Hopsteiner
- Dr. John Henning – Research Geneticist | USDA-ARS
- Dr. Ryan Christian – VP of Research | Yakima Chief  
Ranches
- Dr. Steve Strauss – University Distinguished Professor |  
Oregon State University





Three wooden barrels are arranged in a row, receding into the distance. The barrels are made of dark wood with metal bands. The background is dark, and the floor is made of light-colored wood.

# Potential for CRISPR/gene-editing in hop breeding

Prof. Steve Strauss | OSU (Presenting Author)  
Dr. Chris Willig | Postdoctoral Scholar – OSU  
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# Agenda

- What is CRISPR
- Where could it fit in breeding
- What are the challenges



# Gene editing defined

- “Stuff” you insert to change other genes
- Highly specific, efficient modification
- CRISPR main method
- Works everywhere!





# Crispr is a big deal in science

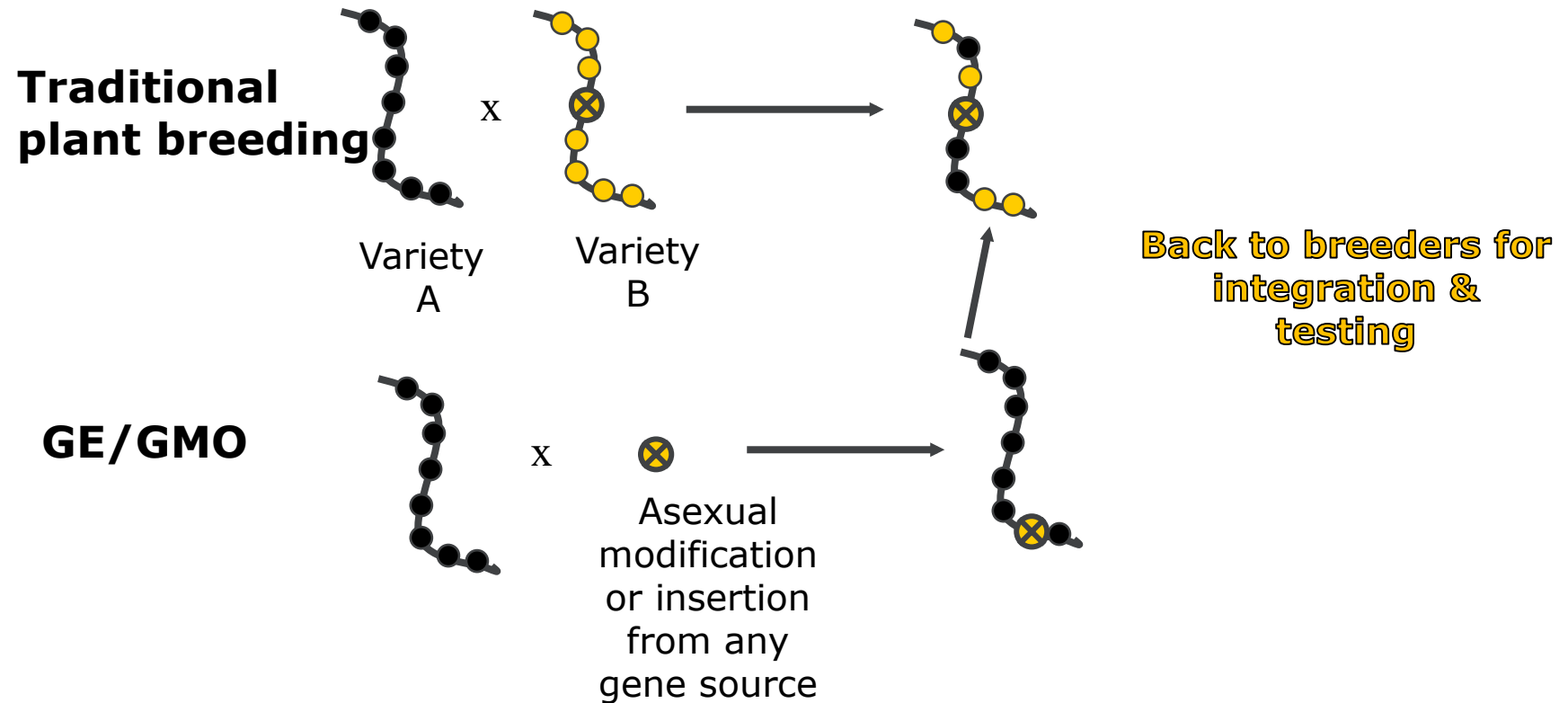


**Nobel Prize in Chemistry  
2020**

Emmanuelle Charpentier &  
Jennifer Doudna

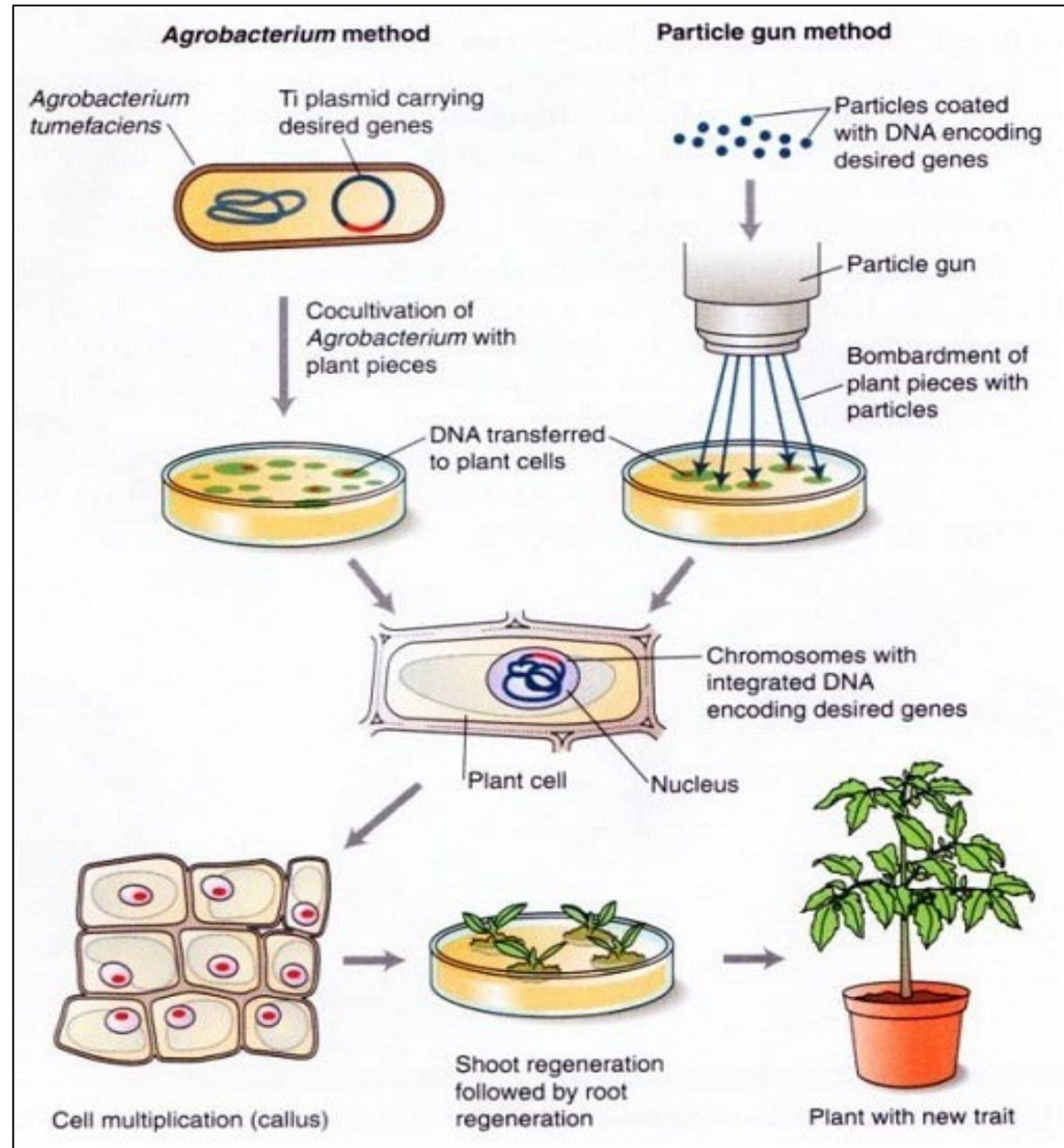


# Concept: Gene edit or engineering (GE) vs. breeding



# Steps to create an edited plant

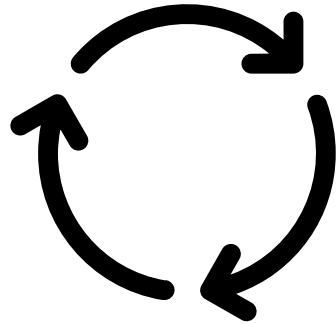
- Editing genes added to cells by biological agent or “gene gun”
- Find modified cells using bio-tricks!
- Regenerate cells into uniform modified plant with edits
- Segregate or excise the gene-editing agents away, if desired





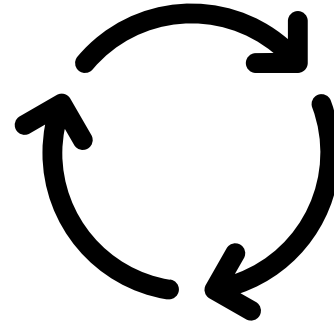
# Relationship of breeding and biotech

**Breeding populations**



*Polygenic:  
Growth rate and  
adaptation, many traits*

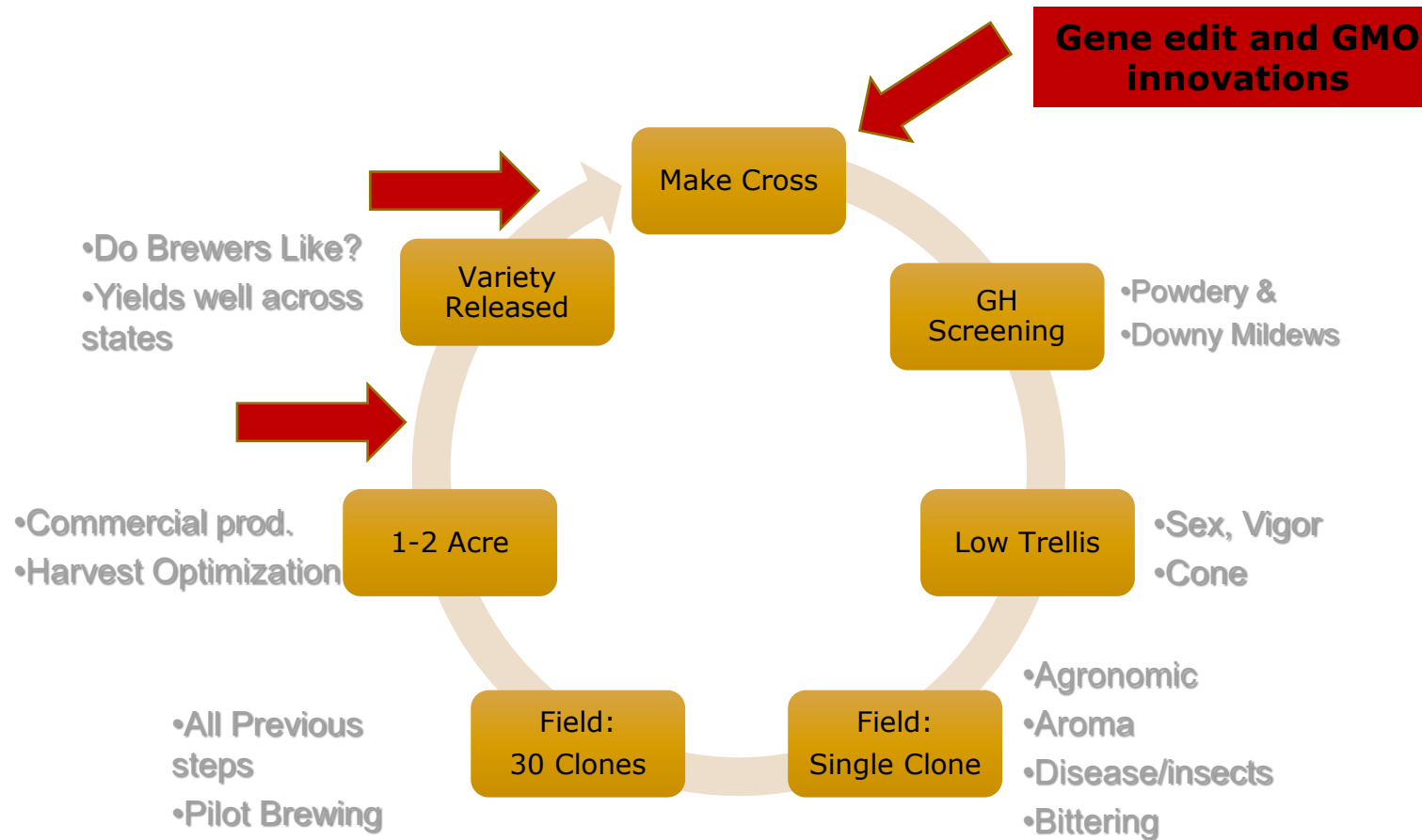
**Biotech innovations**



*Oligogenic:  
Specific modifications  
and novel traits*



# Life cycle of hop variety development (12-15 Yr)



(Courtesy of John Henning)



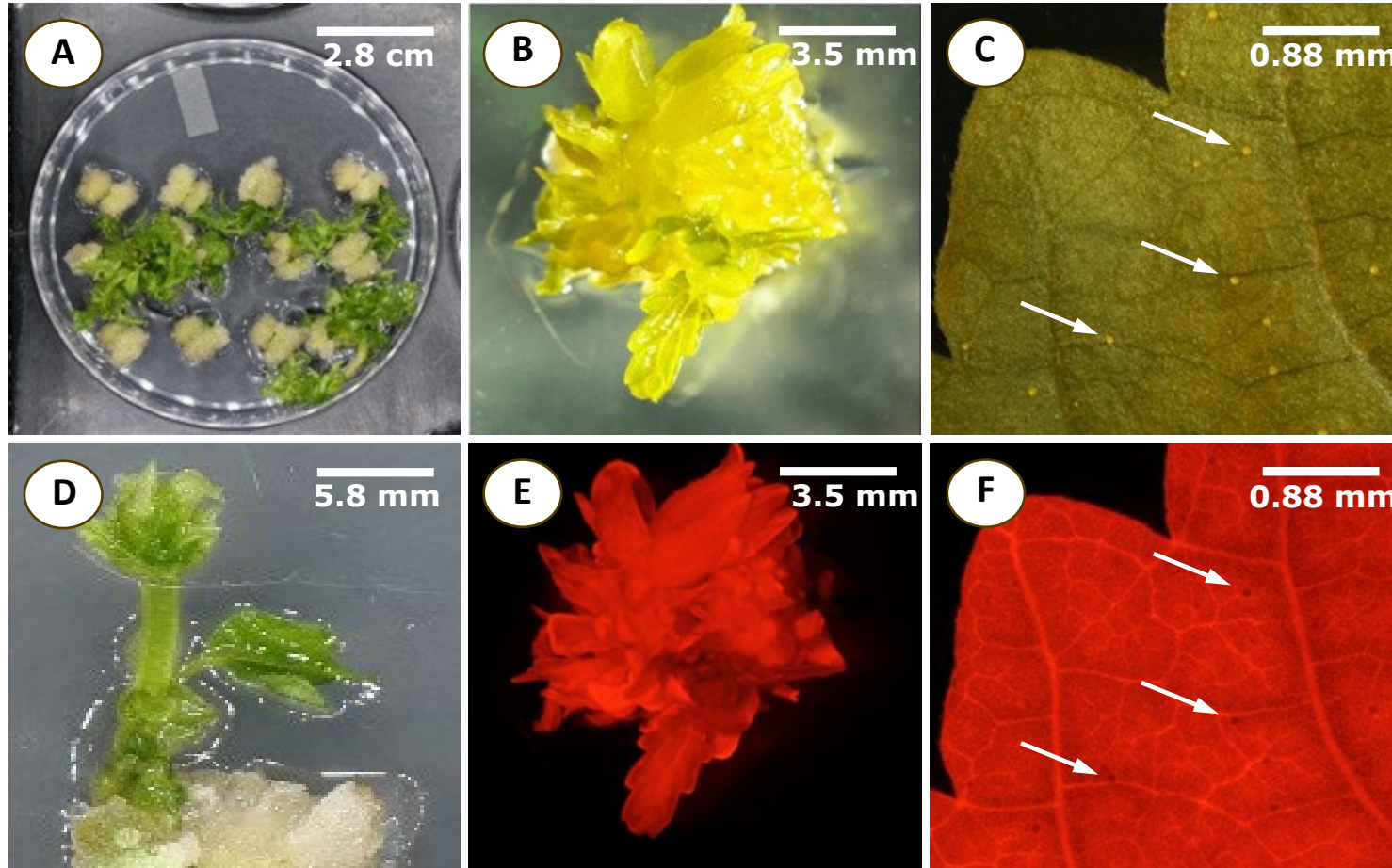
# Biological challenges

- What genes control key traits?
  - Often unknown, but CRISPR a great way to find out
- Better, faster, and less genotype-specific gene transformation methods needed
  - Important for integration with breeding, maintaining diversity
- Desire to remove or avoid CRISPR genes in final product
  - Makes the transformation, regeneration methods more challenged



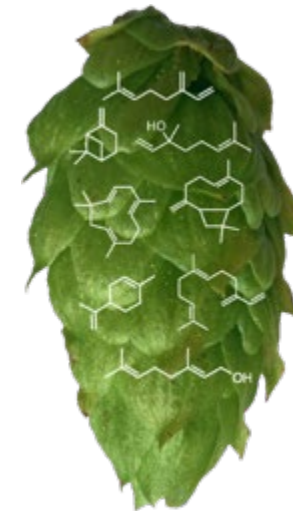
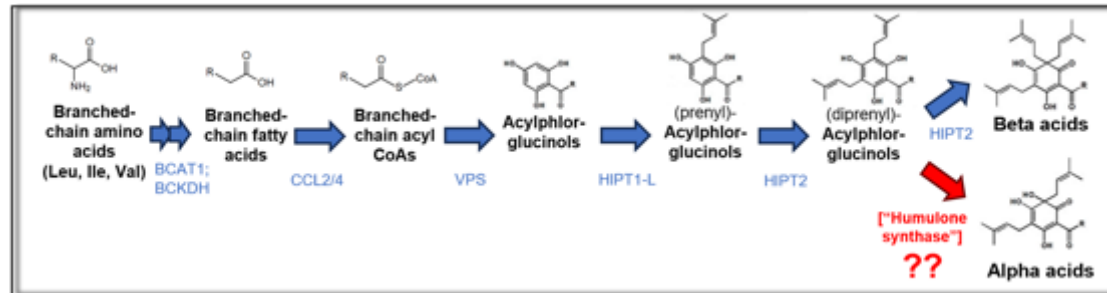
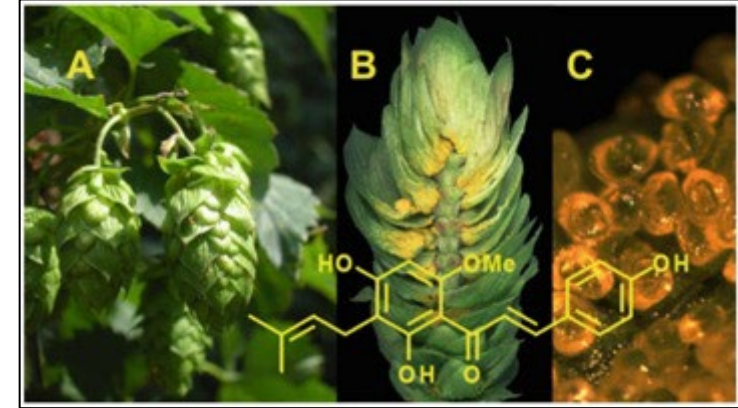


# TRANSGENIC CASCADE PRODUCED AT OSU – KEY TOOL FOR GENE EDITING IS IN HAND



# Some of our GRANT-proposed gene editing goals

- Mildew resistance
- Enhanced xanthohumol as a pharmaceutical source
- Gene/s controlling alpha-acid levels



- Modified terpene levels

# Social challenges

- Economics
  - Cost of research
  - Financial benefits
- Legal
  - Regulatory approvals (USA, trade)
  - Patent licenses
- Market
  - “GMOitis” even if not or hardly GMO?





# Thank you

- USDA-NIFA grant #2021-67013-34739
- Our hop research team



Steve  
Strauss



John  
Henning



David  
Gent



Michele  
Wiseman



Tanner  
Whiting



Cathleen  
Ma



Greg  
Goralogia



Chris  
Willig