




Pairwise

Concept to market for a GEEd product

Dan Jenkins
Vice President, Regulatory and Government Affairs

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PAIRWISE WAS FOUNDED AND IS LED BY FOOD, AGRICULTURE, AND GENOMICS EXPERTS



ABOUT PAIRWISE

Powered by its best-in-class technology, Pairwise is creating a new consumer-centric category of novel, nutritious foods under its Conscious™ Foods brand.

An early innovator in applying CRISPR and gene editing to plants and plant-based systems, Pairwise holds exclusive licenses from Harvard and Massachusetts General Hospital to base editing and high-fidelity enzymes.

THE DETAILS:

- Headquartered in Durham, North Carolina, USA, In the vibrant innovation community of the Research Triangle Park
- Employs 140+ people across the nation

CO-FOUNDERS



Tom Adams, PhD
Chief Executive Officer



Haven Baker, PhD
Chief Business Officer



Feng Zhang, PhD
MIT, Broad Institute



David Liu, PhD
Harvard



J. Keith Joung, PhD
Mass General Hospital



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PAIRWISE IS A PURPOSE-DRIVEN COMPANY

MISSION

To build a healthier world through better fruits and vegetables

VISION

To build a food company that uses technology to break down the barriers keeping us from eating fruits and vegetables



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WHY OUR MISSION MATTERS

Shifting diets to increased fruit and vegetable consumption creates healthier people and a healthier planet



HEALTHIER PEOPLE

A broad sweeping Harvard School of Public health study published in 2021 found that those who ate **5 servings of fruits and vegetables a day** had the lowest risk of death, even after adjusting for other factors



HEALTHIER PLANET

If American diets shifted just 10% to a plant-forward model defined by the USDA by 2030, **we could avoid ~30M MT of CO₂e emissions per year**; that's the amount of CO₂e sequestered by ~35M acres of forest – more than all the forest in California¹ – in a year



Sources: <https://www.ahajournals.org/doi/10.1161/CIRCULATIONAHA.120.048996#d1e2796>, https://ucanr.edu/sites/forestry/California_forests/

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GENE EDITING CAN MAKE MAJOR IMPROVEMENTS OUR FOOD SYSTEM



Plant Architecture

Fruit Bushes:
Stone fruit grown
on bushes



Harvest

Mechanical:
Largely automated
production/harvest



Shelf Life

Flavorful:
Longer shelf-life
varieties with great
flavor



Availability

Year-Round:
Quality fruit
available nationally
all year



Fruit trees:
Orchards that take
years to mature
prior to fruit
production



Manual:
Labor-intensive
production,
harvested by hand



Shippable:
Low flavor varieties
optimized for cross-
country shipments

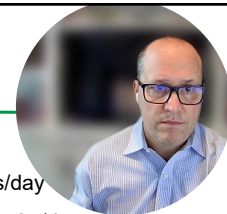


Seasonal:
Supply dependent
on time of year and
location



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Snacking, once a rare activity for most Americans, is now a daily habit for almost all



On average for US adult

- 20% consumed 1 or more snacks/day
- Calories from snacks: 424 (21%)

On average for US adult

- 94% consumed 1 or more snacks/day
- More than 50% consumed 2-3 snacks/day

Late 1970s

1990s

2010s

2019

Pandemic

On average for US adult

- 10% consumed 1 or more snacks/day
- Calories from snacks: 224 (12%)

On average for US adult

- 56% consumed 1 or more snacks/day
- Calories from snacks: 620 (25%)

For adults, globally, during the pandemic

- 88% are snacking more or the same
- 54% have relied on snacks for nourishment

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New, consumer focused produce have expanded markets and consumption



BLUEBERRY available year-round



- Blueberries grew the market by 4x



BABY CARROT snack size, convenient

- Today: 80% of retail carrot sales are baby carrots
- Increased U.S. fresh carrot consumption by:
 - 30% after 1 year
 - 100% within 10 years



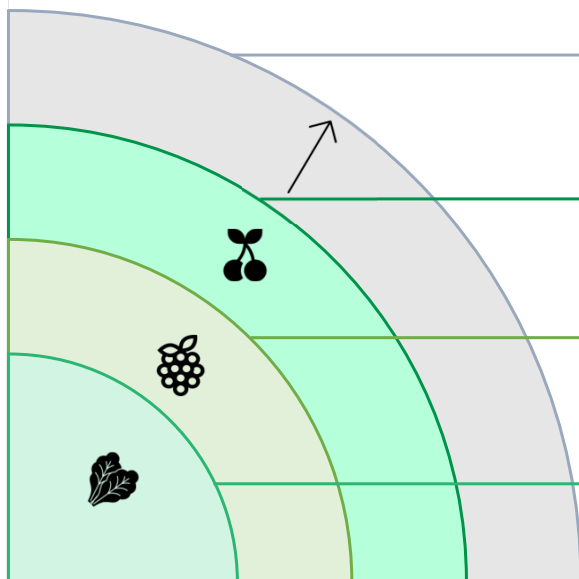
HALOS MANDARIN seedless, easy peel

- Captured 50%+ of U.S. mandarin market in 5 years
- Increased total citrus consumption by 30%
- Ranked #1 healthy snack brand by parents and kids



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OUR PORTFOLIO OF HEALTHY, CONVENIENT PRODUCTS WILL TRANSFORM WHAT AMERICANS EAT



Conscious™ Foods

A number of current POCs could turn into future Conscious Foods products – stay tuned!

Conscious™ Cherries

Launches 2031
Expands 2033 Onward

Conscious™ Berries

Launches 2025
Expands 2026 Onward

Conscious™ Greens

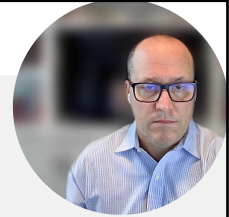
Launches 2023
Expands 2024 Onward



1 | Retail sales only. 2 | Includes strawberry, blueberry, blackberry, and red raspberry.
3 | Includes assumed retail + food service split returns to pre-Covid 50/50 split

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Continued Innovation



Launching great tasting seedless blackberries in 2026

Pairwise believes caneberry consumption will rise by increasing **consistency** of quality and **convenience**



In the US, ~85% of consumers like berries and more than half state that berries are among their favorite fruit, but only ~25% of households buy blackberries

Berries are great snack, but the taste is inconsistent, and most people do not like the seeds

Pairwise is developing berries that will deliver to consumers seeking fresh, healthy snacking options



Source: Proprietary Fruit Concepts Study, N=1,250, March 2019 and The Packer Fresh Trends

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What if new types of fruits were widely available for healthy snacking?



Black raspberries are native to North America, but plant architecture makes them difficult to cultivate for large-scale production. Pairwise is developing seedless black raspberries with an “easy-pick” architecture using CRISPR / gene editing; we expect to sell them in grocery stores within five years.

In addition to their novelty, seedless black raspberries are:

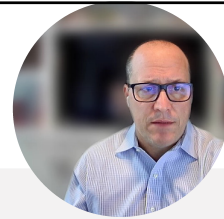
- ❑ A source of anthocyanins: 214-589 mg / g¹
- ❑ Excellent, unique taste
- ❑ Change color when ripe (thus, always harvested when ripe)



Source: Oregon Raspberry and Blackberry Commission

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OUR FIRST PRODUCT ADDRESSES SIGNIFICANT UNMET NEEDS WITH



Pre-Packaged Salad Greens represent a \$15B market in the U.S., yet **half of category buyers are unhappy with current options.**¹

Consumption of nutrient-dense leafy greens in the US is low, with current options like spinach and kale making up only 7% of all greens tracked.²

Pairwise is developing **new varieties of edited leafy greens** which eat like lettuce but have superior nutrition.



Source: 1: N=734, P6M Pre-Packaged Salad Buyers, Proprietary Study, June 2020;
2: USDA ERS, Vegetables and Pulses Yearbook, July 2021



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INTRODUCING



A portfolio of exciting, nutrient-dense leafy green blends coming to grocery stores and restaurants in 2023.

WHAT ARE CONSCIOUS™ GREENS?

They're not another boring salad. They're leafy greens **made better**.

We pair the latest tech with tried and true farming to grow purposeful produce uniquely curated for you.

With all the crunch and flavor of romaine, but with superior nutrition, Conscious Greens Blends:

- Have delightful flavors
- Come in beautiful, vibrant colors
- Are fresh and crisp
- And stand up to dressings and toppings alike



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Conscious Greens deliver the best of both worlds



TEXTURE



Iceberg



Romaine



Mustard Greens

There are hundreds of unique varieties

NUTRITION



Kale

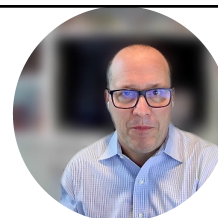


Spinach



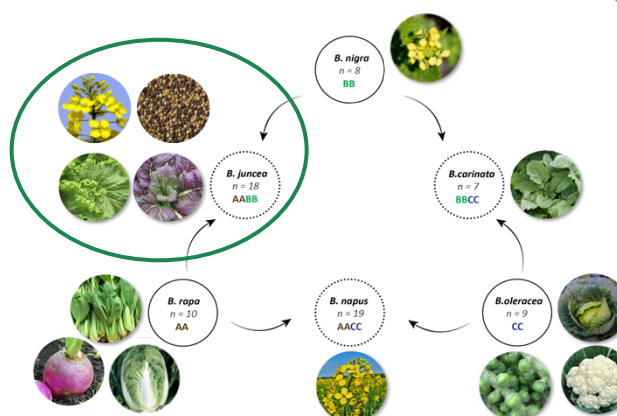
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HISTORY OF SAFE USE AND CONSUMPTION OF MUSTARD GREENS (BRASSICA JUNCEA)



Use as food and/or feed depends on variety:

- Fresh/cooked leaves
- Ground spice
- Canola oil
- Root
- Fodder
- Crop waste / residue



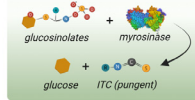
Source: Kang et al., 2021. Genomic insights into the origin, domestication and diversification of *Brassica juncea*. *Nature Genetics*; Cekander, 2016. Incorporating forage Brassicas into a grazing system. Cornell Small Farms Program. <https://smallfarms.cornell.edu/2016/07/incorporating-forage-brassicas-into-a-grazing-system/>

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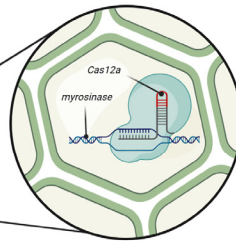
Loss of function mutation occurs naturally in *B. juncea*

1 Highly nutritious but low palatability (pungent) mustard greens

Nutrition Facts	
2 servings per container	
Serving size 2 cups (85g)	
Amount per serving	% Daily Value*
Calories 25	
Total Fat 1g	2%
Saturated Fat 1g	2%
Trans Fat 1g	2%
Cholesterol 1mg	2%
Sodium 15mg	1%
Total Carbohydrate 4g	1%
Dietary Fiber 3g	11%
Total Sugars 1g	2%
Includes 1g Added Sugars	2%
Protein 1g	2%
Vitamin D 0mg	0%
Calcium 10mg	2%
Iron 1mg	2%
Potassium 300mg	6%



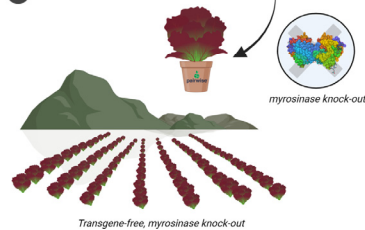
2 Edit multi-copy myrosinase genes



4 Highly nutritious and high palatability (non-pungent)



3 Myrosinase knockout eliminates pungency



- Equivalent to what happens when cooking the green
- Regulatory determinations that it is equivalent to conventional breeding in US, Canada, Colombia, Guatemala and Honduras

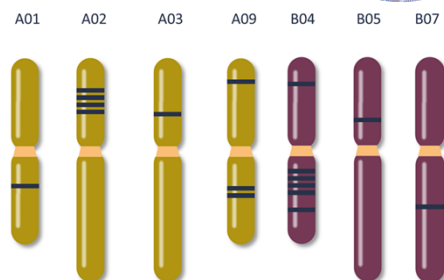


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COMMERCIAL PHASE PRODUCT: DESIGN OF EDITING STRATEGY AND SUBSEQUENT BREEDING REDUCED LIKELIHOOD OF UNINTENDED CHANGES

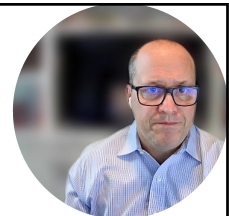
- **Target specificity** was considered during design of guide RNAs, coupled with high fidelity Cas12a.
- **Selfing** to fix edits and segregate out T-DNA.
- **Line selection** to ensure no off-types.
- **Edits characterized** in commercial lines (GT22, GT23, GT24, GT28, GT29, GT30)*.
- **Absence of foreign DNA** confirmed by target capture next generation sequencing.

*Used as variety ID in countries where required (e.g., Health Canada, SAG Chile).



Genomic location of 17 type-I myrosinase genes in mustard greens (*Brassica juncea*) distributed across the A and B genomes (Karlson et al., 2022).

Source: Karlson, et al., 2022. Targeted mutagenesis of the multicopy myrosinase gene family in allotetraploid *Brassica juncea* reduces pungency in fresh leaves across environments. *Plants*.



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NEW SALADS WITH TASTY, NUTRIENT-DENSE GREENS

Gene Editing



- Varieties are selected for **nutrient-dense** and texture qualities.
- Varieties are edited by Pairwise for improved taste.

Field Trials

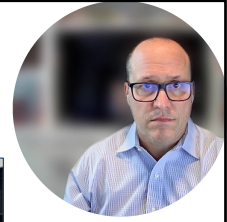


- First POC completed in 6 months
- Edited field trials in progress
- Lack of susceptibility to INSV

Consumer Experiences



- Broad scale excitement and acceptance in 3 real world tasting events



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Societal perceptions of Food+Tech are changing

79% of produce buyers want more information on gene edited produce

77% 77% of Gen Z adults are "likely to try food grown with technology"¹



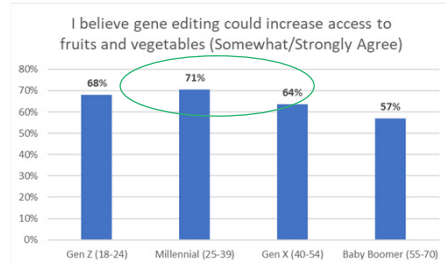
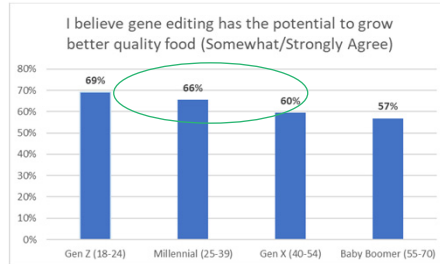
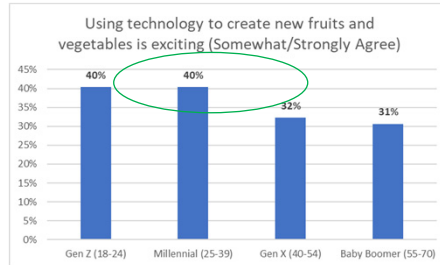
Source: Pairwise Survey, May 2021, N=1014; Ketchum, 2019; Consumer Events, Jul-Sept 2022, N=3,112

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Our research indicates that younger adults think differently about gene edited products than older adults



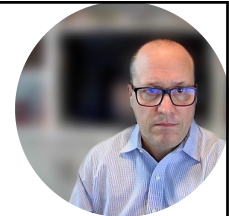
Younger generations are more accepting of technology – 77% of Gen Z adults are “likely to try food grown with technology”¹



Source: Pairwise Quantitative Survey, May 2021; N=1,014

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Last summer, we sampled Conscious Greens in three U.S. cities



Seattle, WA



Palo Alto, CA



Austin, TX



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We shared information about our technology in three ways



Wall Signage



Table Tents with QR Codes Linked to Our Website



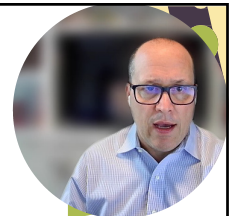
Brand Ambassadors Shared Verbally with each Guest



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VOICE OF THE CONSUMER

- Q3: What, if anything, do you **like** about the greens?



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VOICE OF THE CONSUMER

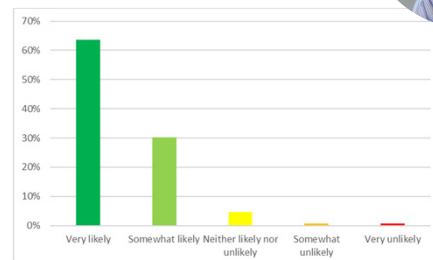
- Q4: What, if anything, do you **dislike** about the greens?



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Survey results indicate very high acceptance of Conscious Greens, with notably low concerns about technology used

- Over 6,000 curated salad samples were consumed across Seattle, Bay Area, and Austin.
- Over 3,000 consumers completed an online survey



Only 1%

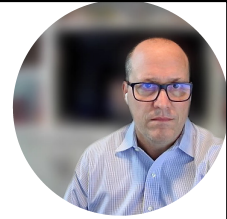
of sampling consumers who completed a survey cited the technology

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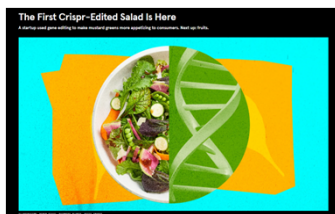
Pairwise Quantitative Survey, July-Sept 2022, N=3,112

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CONSCIOUS™ GREENS IN FOOD SERVICE WITH PERFORMANCE FOOD GROUP



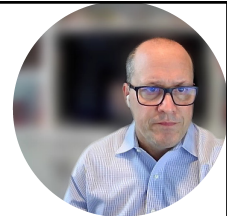
- In partnership with Performance Food Group, Pairwise's Conscious™ Foods brand will be the first food made with CRISPR technology in the U.S. market
- Conscious Greens Purple Power Baby Greens Blend, co-branded with Performance Food Group's Peak Fresh Produce® brand, with up to double the nutrition of romaine.*
- Available in select restaurants and outlets in the PFG operator network, including locations in Springfield, Mass., Minneapolis-St. Paul, and St. Louis.



<https://www.wired.com/story/wired30-crispr-edited-salad-greens/>

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We Demonstrate Transparency by Being Forthright about Technology on our Packaging



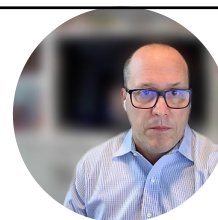
Consumers told us that our "Better Flavor by CRISPR" icon provided valuable information about our technology and was easy to find on the package.



Consumers who want more information about our products and process can scan this code to visit ConsciousFoods.net to find out more.

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...And by participating in public notification



Transparency Initiative (TI) Product Information Form ¹	
Administrative Information	
1. Developer name	Pairwise Plants Services, Inc.
2. Contact information	807 East Main Street, Suite 4-100 Durham, NC 27701 USA Attn: Nicole Juba, Ph.D., Associate Director, Regulatory NJuba@pairwise.com +1 (919) 321-0820
3. Earliest Entry to Market Date	2023
Information regarding the product	
4. Crop	Brassica juncea (mustard greens)
5. Intended use of the product	Food consumption as leafy greens
6. Characteristic(s)	Altered pungency leading to the phenotype of reduced pungency to improve flavor.
7. Technology used to create the new product	CRISPR/Cas
8. Mechanism(s) of action underlying the introduced characteristics	Myrosinase enzymes break down glucosinolates resulting in a pungent flavor. Targeted edits introduced loss of function deletions, insertions, and/or inversions in the myrosinase coding sequences, leading to reduction in myrosinase activity, reduced glucosinolate breakdown, and therefore improved flavor profile.
Rationales for the non-novel status of the product As per Health Canada Guidance on the Novelty Interpretation of Products of Plant Breeding, a product of plant breeding is considered to be not novel if it meets the criteria of the following five (5)	



Health
Canada

[List of non-novel products of plant breeding for food use - Canada.ca](#)



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Summary of Determinations

USDA (old regulation)

- Review time: 60 days
- Conclusion: Not regulated



United States
Department of
Agriculture

Health Canada

- Review time: 10 hours
- Conclusion: Not Novel



Health
Canada

MAGA

- Review time: 17 days
- Conclusion: Conventional



MINISTERIO DE
AGRICULTURA,
GANADERÍA Y
ALIMENTACIÓN

SAG-SENASA

- Review time: 73 days
- Conclusion: Conventional



AGRICULTURA
Y GANADERÍA

Sanidad e Inocuidad
Agroalimentaria
SENASA

ICA

- Review time: 94 days
- Conclusion: Conventional



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Where to Commercialize: Market Considerations



Regulatory
• Import/Export • R&D • Determination process • Post-market

Growing Environment
• Proper climate

IP
• UPOV

Growers
• High Quality • Year-round supply

Cost of Goods
• Freight • Production • Labor

Supply Chain
• Harvest • Cooling • Packaging • Shipping



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twitter.com/pairwisepl 
facebook.com/pairwisePL 
instagram.com/pairwiseproduce 
linkedin.com/company/pairwise-plants 



THANK YOU



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