



PERIODIC
TABLE OF FOOD
INITIATIVE

Topic #1: Food Quality

National Academies

*Maximizing Agriculture to Enhance Nutrient Composition
to Better Fulfill Dietary Recommendations*

January 30th 2024

Session 1

Speaker: Selena Ahmed

*Global Director, Periodic Table of Food Initiative
American Heart Association*

Food Quality is a Pathway Connecting Agriculture + Nutrition



Agriculture

Food
Quality

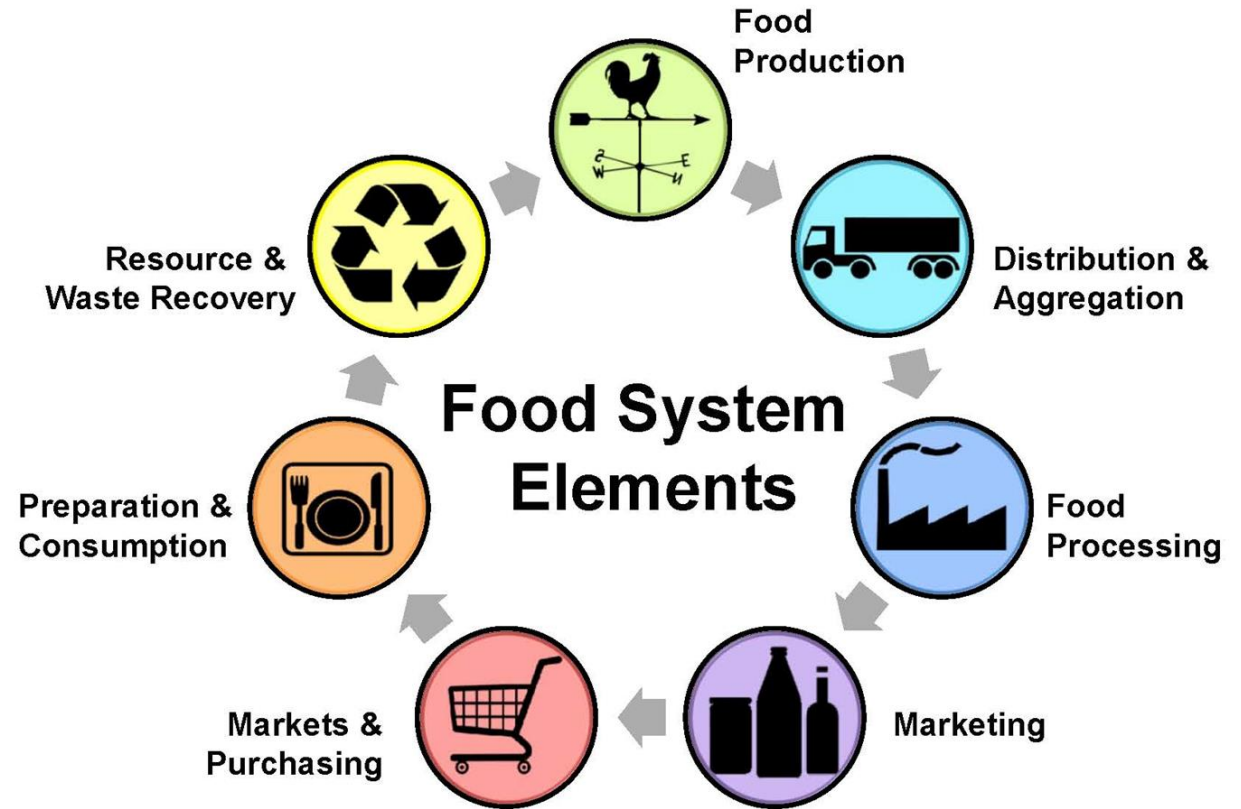
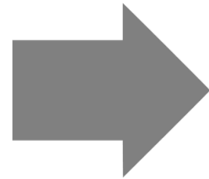


Human Nutrition + Health

Shifts in Food Systems + Food Supply

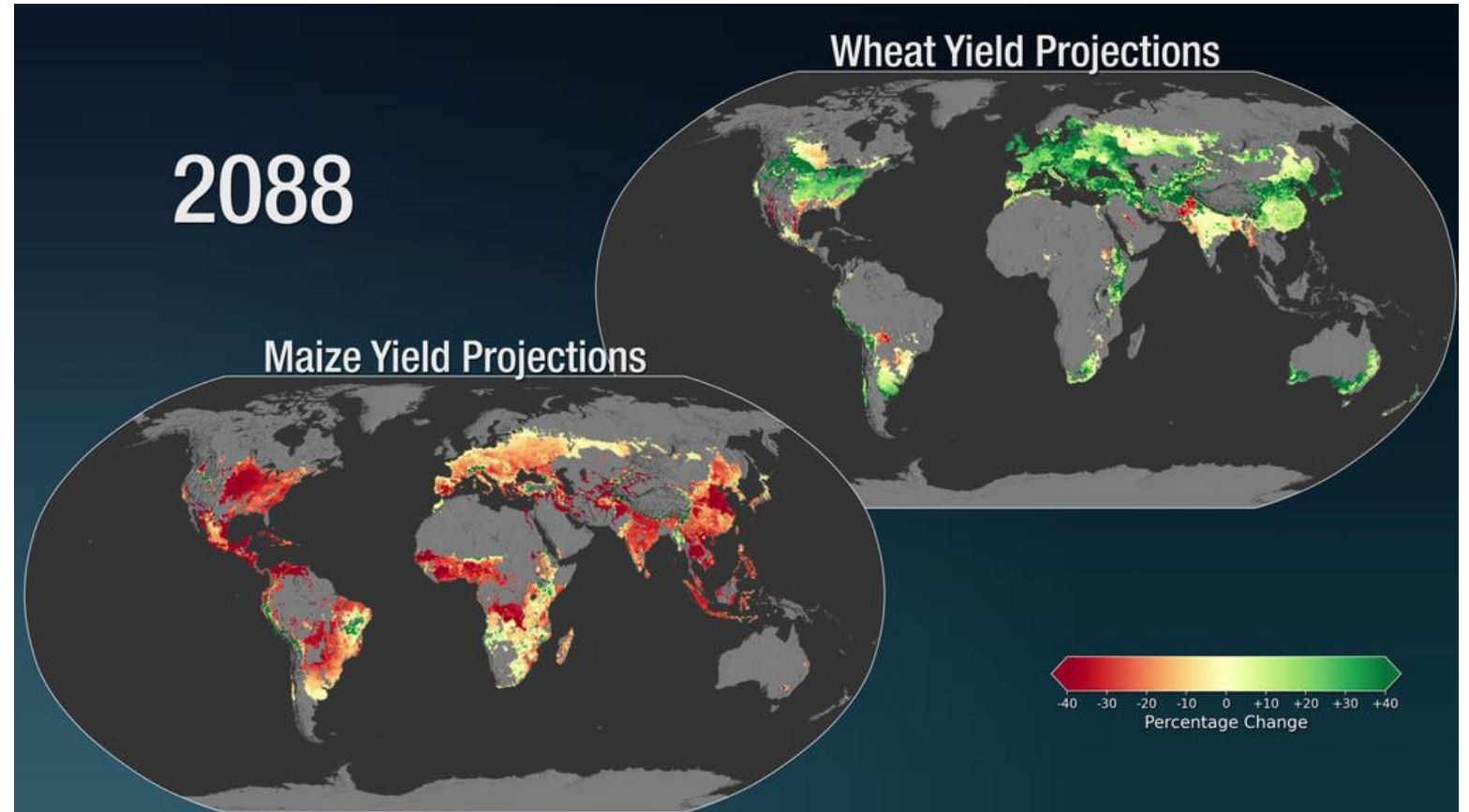
Drivers of Food System Change:

- Climate Change
- Globalization
- Innovation
- Conflict
- Pandemics



What do shifts in food systems and food supply mean for food quality?

Dominant Agri-food Paradigm Focused on Yields and Calories



Source: NASA Scientific Visualization Studio 2022

Food Quality

- What is food quality?
- How can food quality be measured?
- What are pathways between agriculture and human nutrition / health?
- What is an example of an initiative mapping food quality?
- What are promising prospects to maximize agriculture for enhancing food quality?

What is Food Quality?

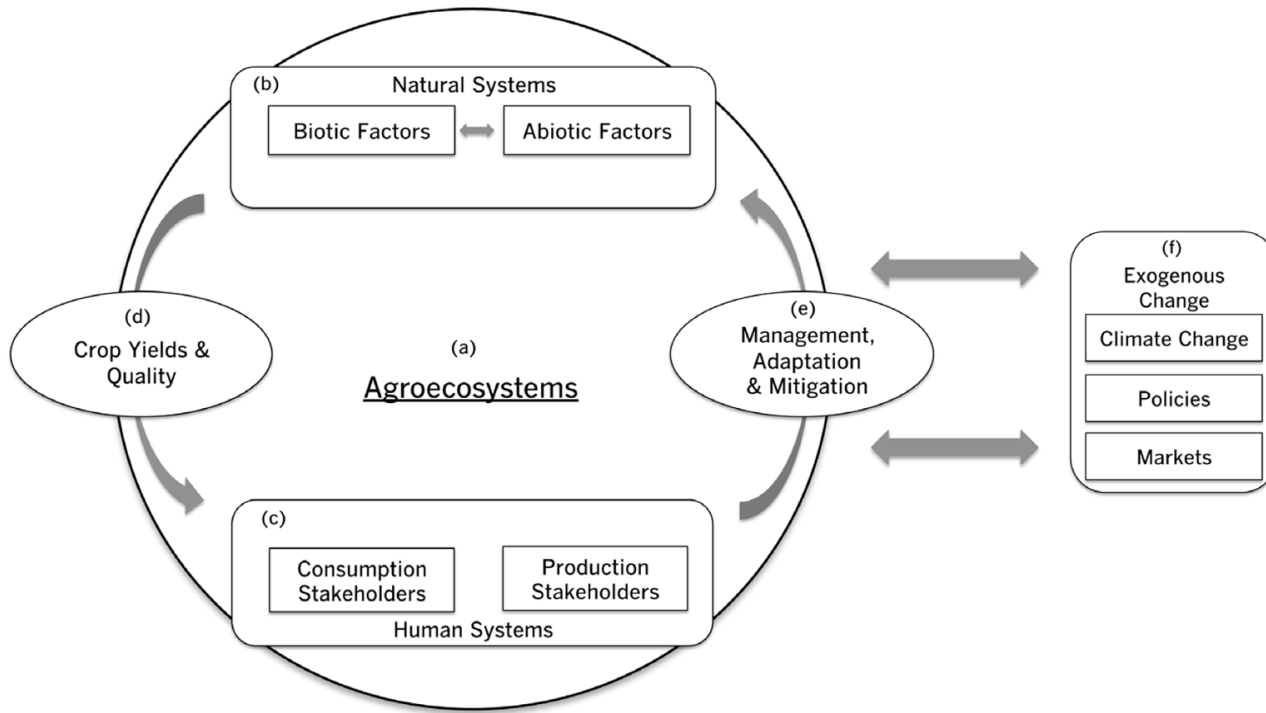
- Food Safety
- Nutritional and Phytochemical Composition
- Diversity
- Consumer Preference / Acceptance
- Organoleptic + Sensory Attributes
- Healthiness
- Freshness / Seasonality
- **Functionality:** Use value in recipes and in healing
- **Stability:** Resistance to degradation, storage ability
- **Psychosocial factors:** Convenience, ease of use, novelty
- **Authenticity + Traceability**
- **Provenance**
- **Labelling and Packaging**
- **Ethical + Sustainable production**



Cazes-Valettes, 2001.

Food quality is a multi-dimensional parameter that varies based on context / the environment and is a function of perspective / culture and socio-economics

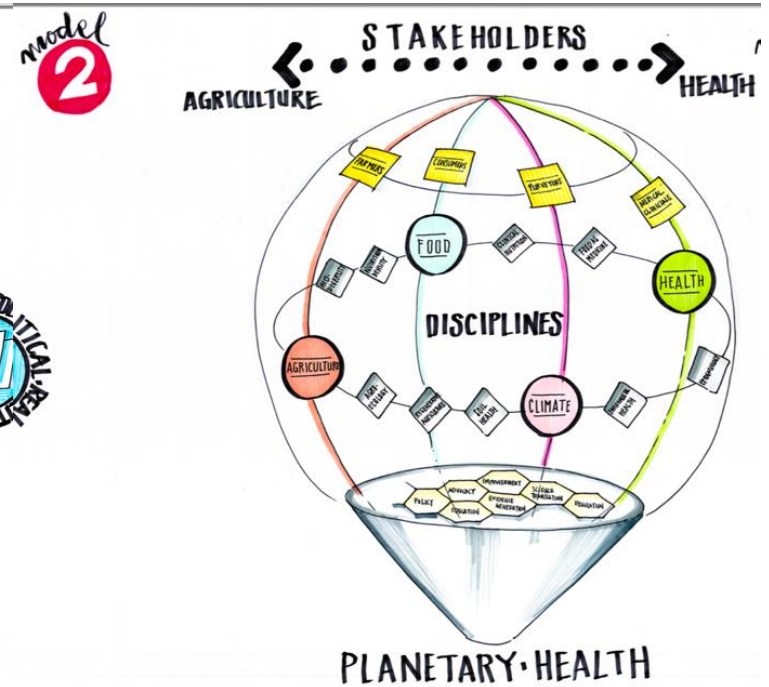
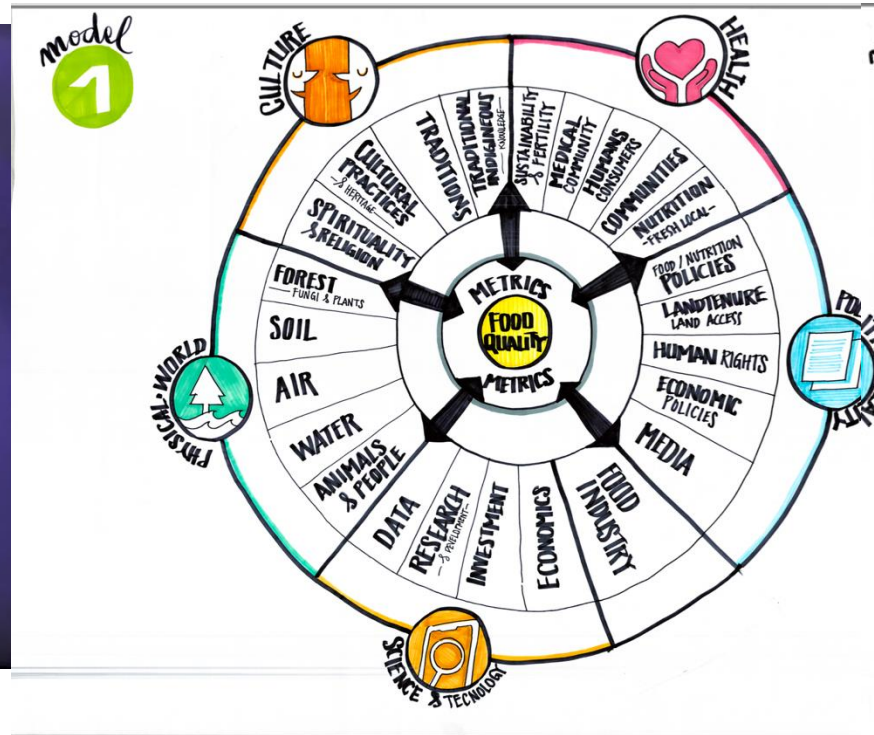
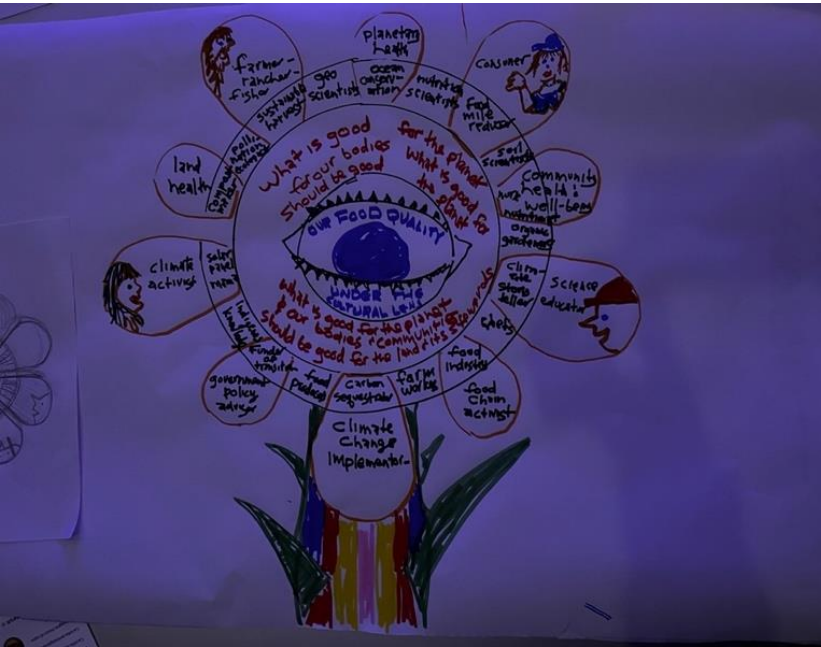
Food Quality Frameworks



Chemical Ecology Plant Defense Theory



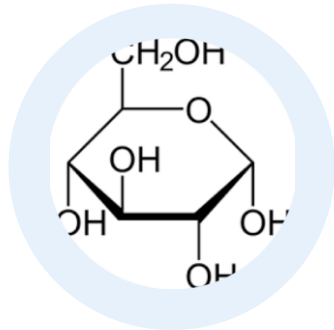
Food Quality is in the Eye of the Beholder



How Can Food Quality be Measured?

Food Biomolecular Components

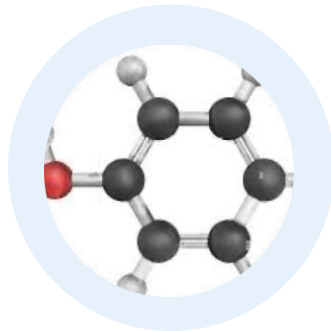
Food Attributes



Macronutrients and derivatives
Proteins, fats
carbohydrates,
nucleotides and their
metabolites



Micronutrients
Vitamins, minerals



Specialized metabolites
Flavonoids, terpenoids (ex:
carotenoids), alkaloids,
steroids

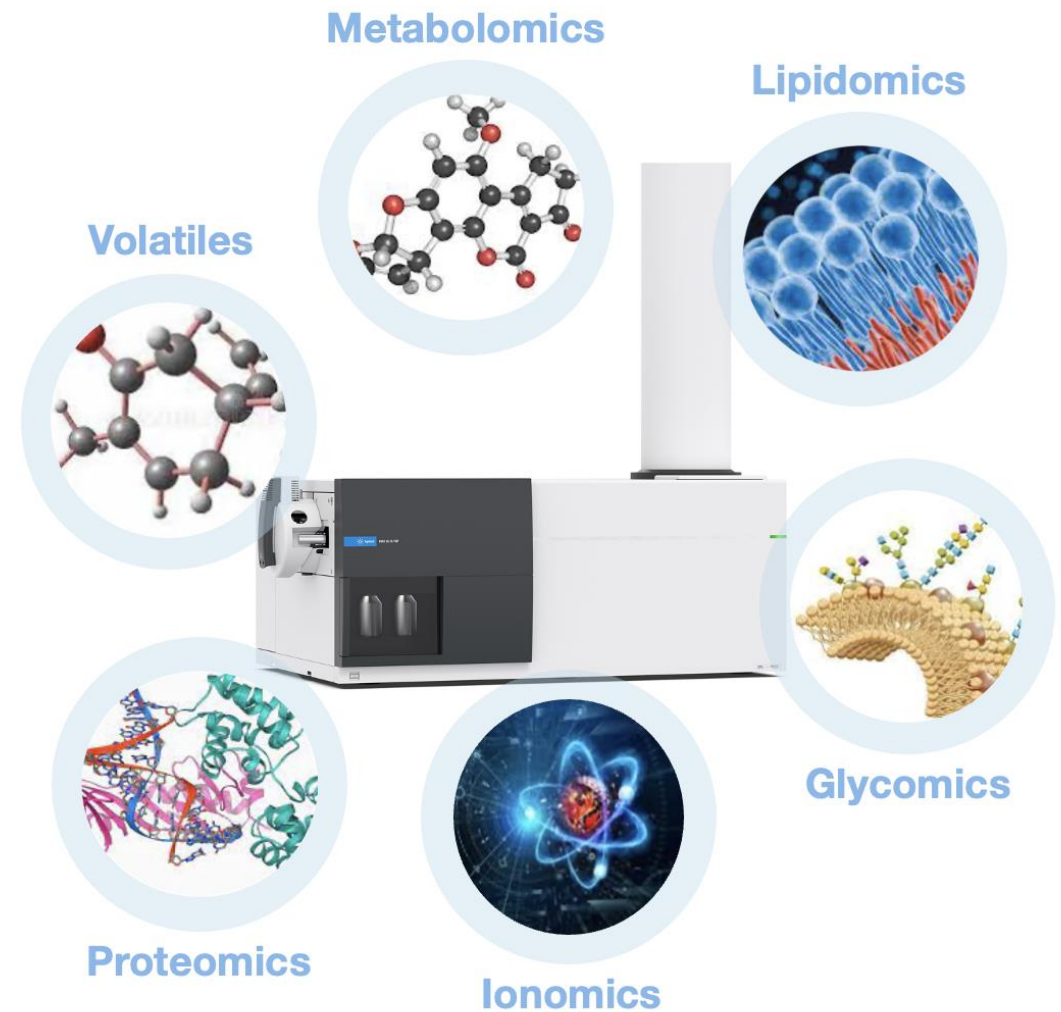
Flavor (Aroma +
Taste)

Shelf Life

Visual Appeal +
Texture

Health Attributes

Foodomics



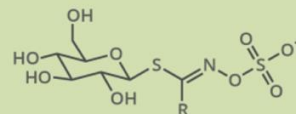
Foodomics leverages technological innovations to characterize food quality by identifying the diverse known and unknown components in food towards understanding their role in nutrition, health, and ecosystem functioning

Surveys on Sensory Attributes + Preferences

Foods Perceived With Higher Quality May Increase their Desirability and Chance of Consumption

THE CHEMISTRY OF BRUSSELS SPROUTS

THE BITTER TASTE OF SPROUTS

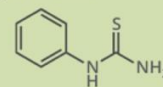


GLUCOSINOLATES

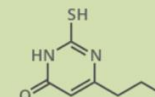
Family of compounds in cruciferous vegetables

Glucosinolates are a class of compounds found naturally in a range of green vegetables, including brussels sprouts. They are broken down into compounds called isothiocyanates when the plant is damaged or cooked.

These isothiocyanates have similarities with the synthetic compounds PTC & PROP. PTC only tastes bitter to around 70% of people. To the other 30%, it is completely tasteless. Although it is not the only factor in dislike of brussels sprouts, ability to taste PTC & PROP and sensitivity to bitter vegetables appear to be strongly correlated, and has a heritable genetic basis.



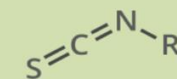
PHENYLTHIOCARBAMIDE
(PTC)



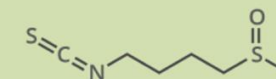
PROPYLTHIOURACIL
(PROP)



POTENTIAL BENEFITS OF SULFORAPHANE



ISOTHIOCYANATES
Breakdown products of glucosinolates



SULFORAPHANE
Formed from glucosinolates

One of the isothiocyanates that glucosinolates can be broken down into is sulforaphane. This compound is partly responsible for the bitterness of overcooked brussels sprouts, but it is also being studied for its antioxidant properties. Additionally, it has been suggested that it could have a protective effect against neurodegenerative disorders, but more research is required to investigate this.

What are Pathways Between Agriculture and Human Nutrition / Health?

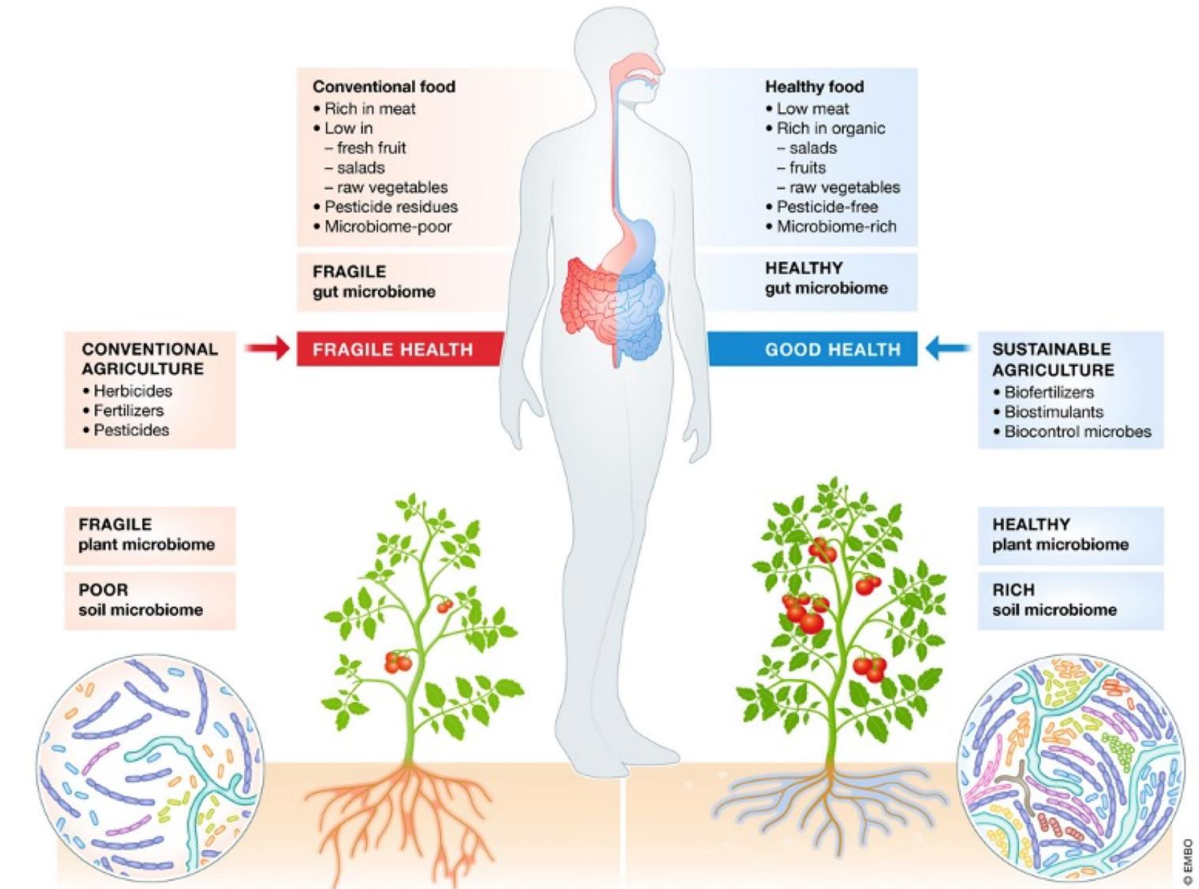
Food quality is a pathway connecting agriculture and nutrition

Soil nutrients provide crop nutrients

Soil organic matter impacts the regulation of crop nutrient intake and specialized metabolites that impact human consumption and the gut microbiome

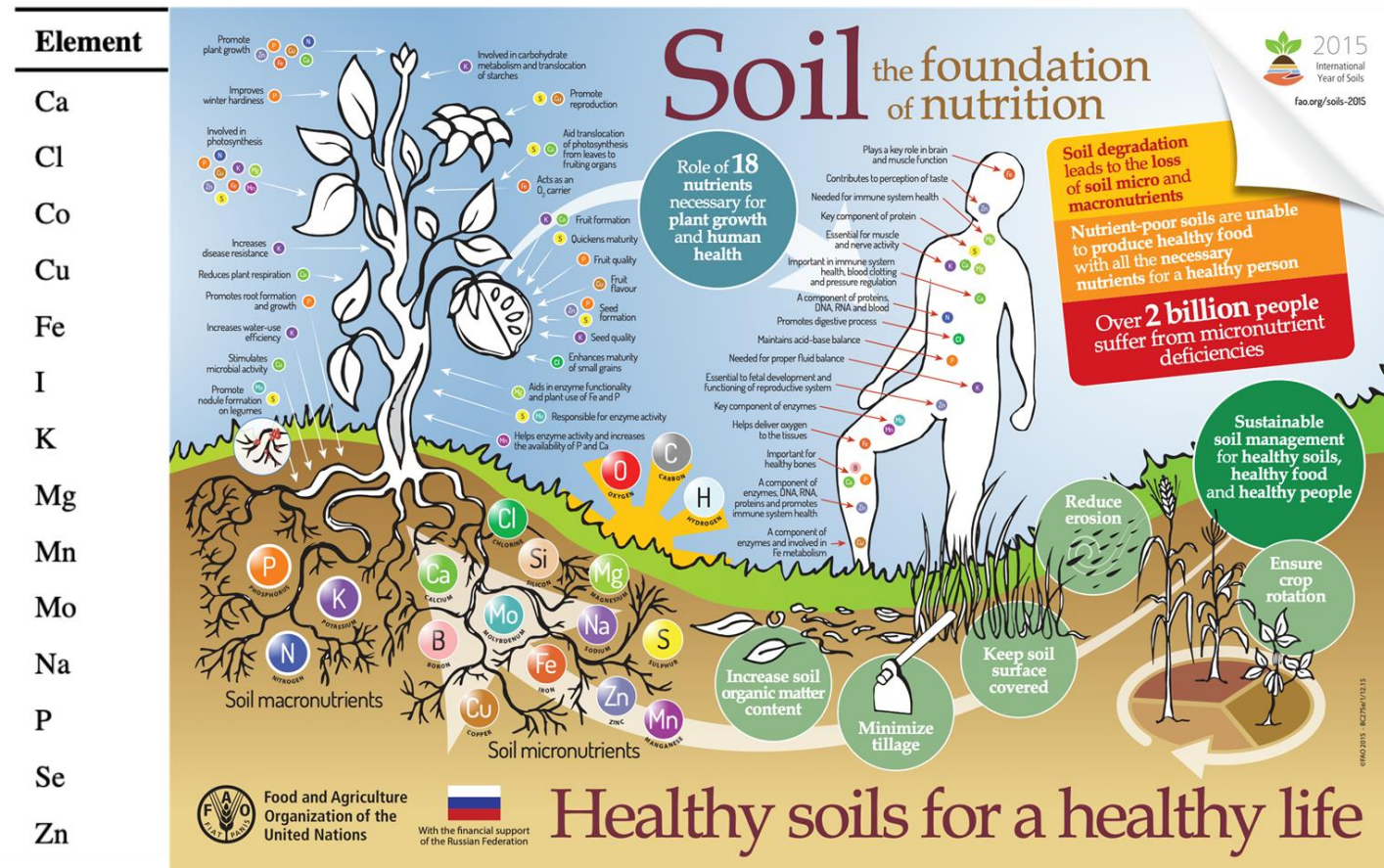
Use of herbicides, fungicides and pesticides can decrease soil and plant microbiomes and thus impact the food composition of crops

Microbes associated with crops and their metabolites impact food quality and its impact of the human gut microbiome



Soil Fertility Determines Crop Nutrient Density

- Soils are the source for ~18 essential nutrients for crop health
- Human health is also dependent on these essential nutrients from our foods either directly through crops or indirectly through animal products
- Human micronutrient deficiencies (Fe, Se, Zn) linked to agriculture + consumption



“Soils that provide a healthy, nutrient-rich growth medium for plants will result in plant tissues that contain most of the elements required for human life when the plants are consumed” (Brevic et al. 2014)

Agricultural Practices Impact Food Quality

CROP COMPOSITION: HIGHER PHENOLICS + ANTIOXIDANT CAPACITY

- ▶ Multiple systematic reviews provide evidence that organic food has modestly **higher content of phenolic compounds** up to 14-25% more for many crops¹.
- ▶ Phenolic compounds have been linked to reduced risk of chronic diseases, including CVD and neurodegenerative diseases and cancers in dietary intervention and epidemiological studies.
- ▶ Conditions of high nitrogen availability are linked to decreased content of phenolic compounds in plants².
- ▶ Conditions with higher pathogens are linked to increased content of phenolic compounds in plants³.

ORGANIC VS.
CONVENTIONAL
AGRICULTURE

REFERENCES

¹Barański M, Średnicka-Tober D, Volakakis N, Seal C, Sanderson R, Stewart GB, Benbrook C, Biavati B, Markellou E, Giotis C, et al. Higher antioxidant and lower cadmium concentrations and lower incidence of pesticide residues in organically grown crops: a systematic literature review and meta-analyses. Br J Nutr. 2014;112(05):794-811.

²Treutter D. Managing phenol contents in crop plants by Phytochemical farming and breeding—visions and constraints. Int J Mol Sci. 2010;11(3):807-57.

³Johansson et al. Int J Environ Res Public Health. 2014 Apr 8;11(4):3870-93

What is an Example of an Initiative Mapping Food Quality?



Tools

Data

Training

The **Periodic Table of Food Initiative** is providing **standardized** tools, data, and training to empower global partners to **map food quality** based on **diverse food components** and **associated meta-data** towards informing data-driven solutions for people and the planet

PTFI MANAGING SECRETARIAT:

Alliance



American
Heart
Association



International Center for Tropical Agriculture
Since 1957 Science to cultivate change

PTFI TECHNOLOGY DEVELOPMENT:



VERSO BIOSCIENCES

PTFI FUNDING PARTNERS:



FOUNDATION FOR
FOOD & AGRICULTURE
RESEARCH



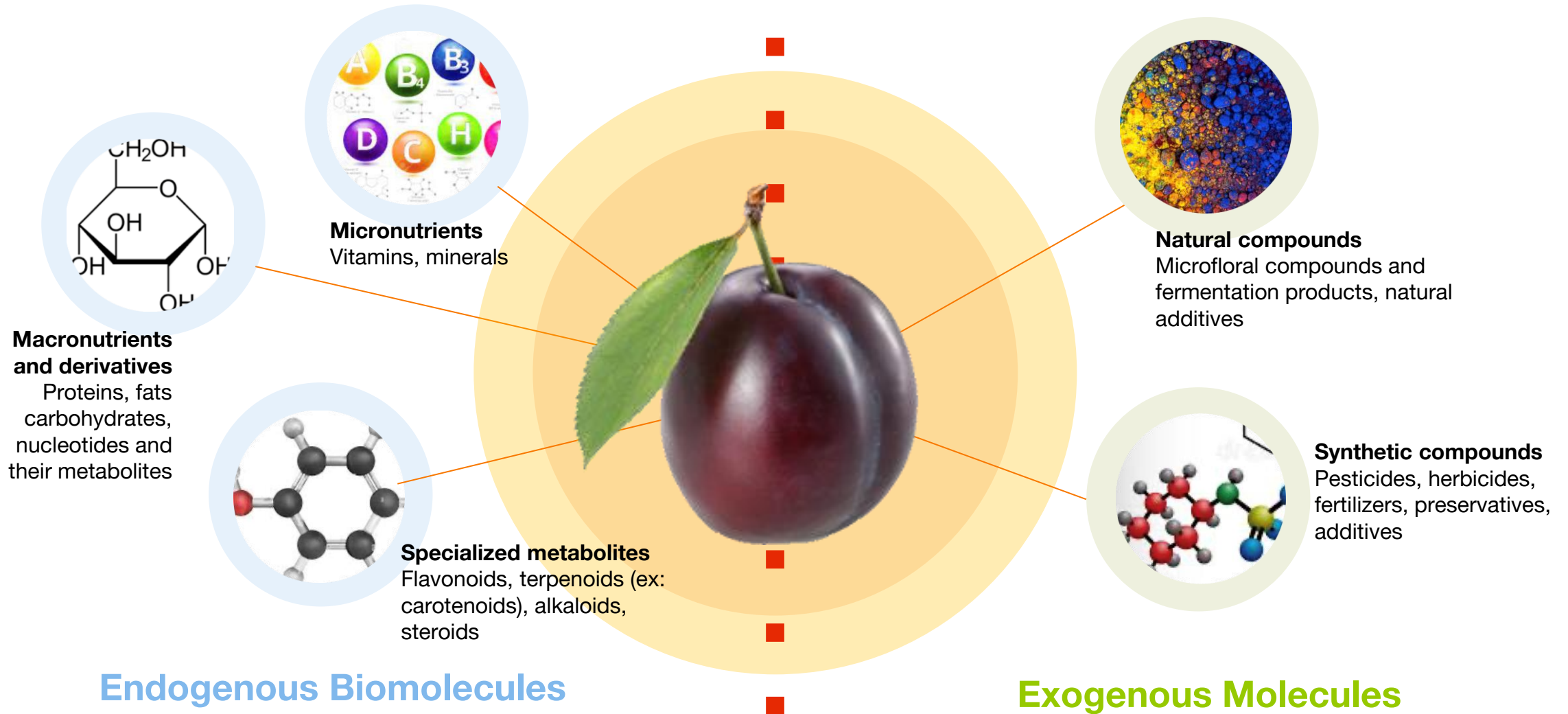
SEERAVE
FOUNDATION

atria

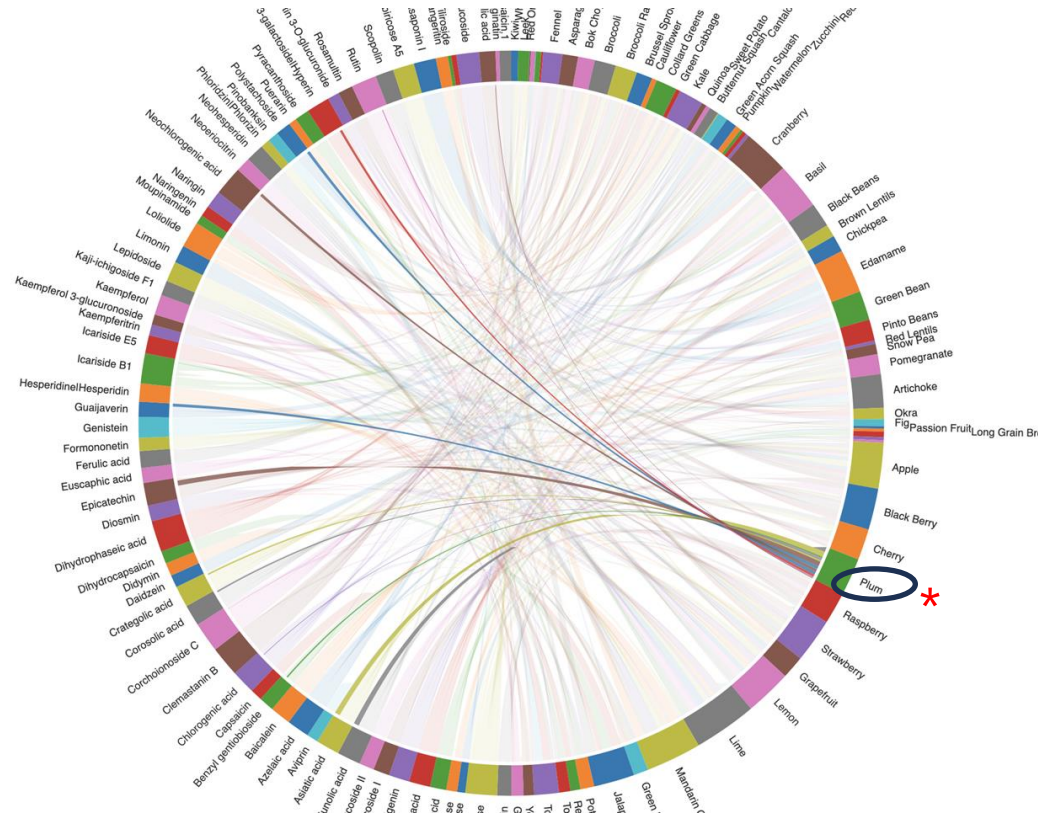
Health
Collaborative

Fourfold

Food Composition is Diverse



Emerging Evidence on Specialized Metabolites



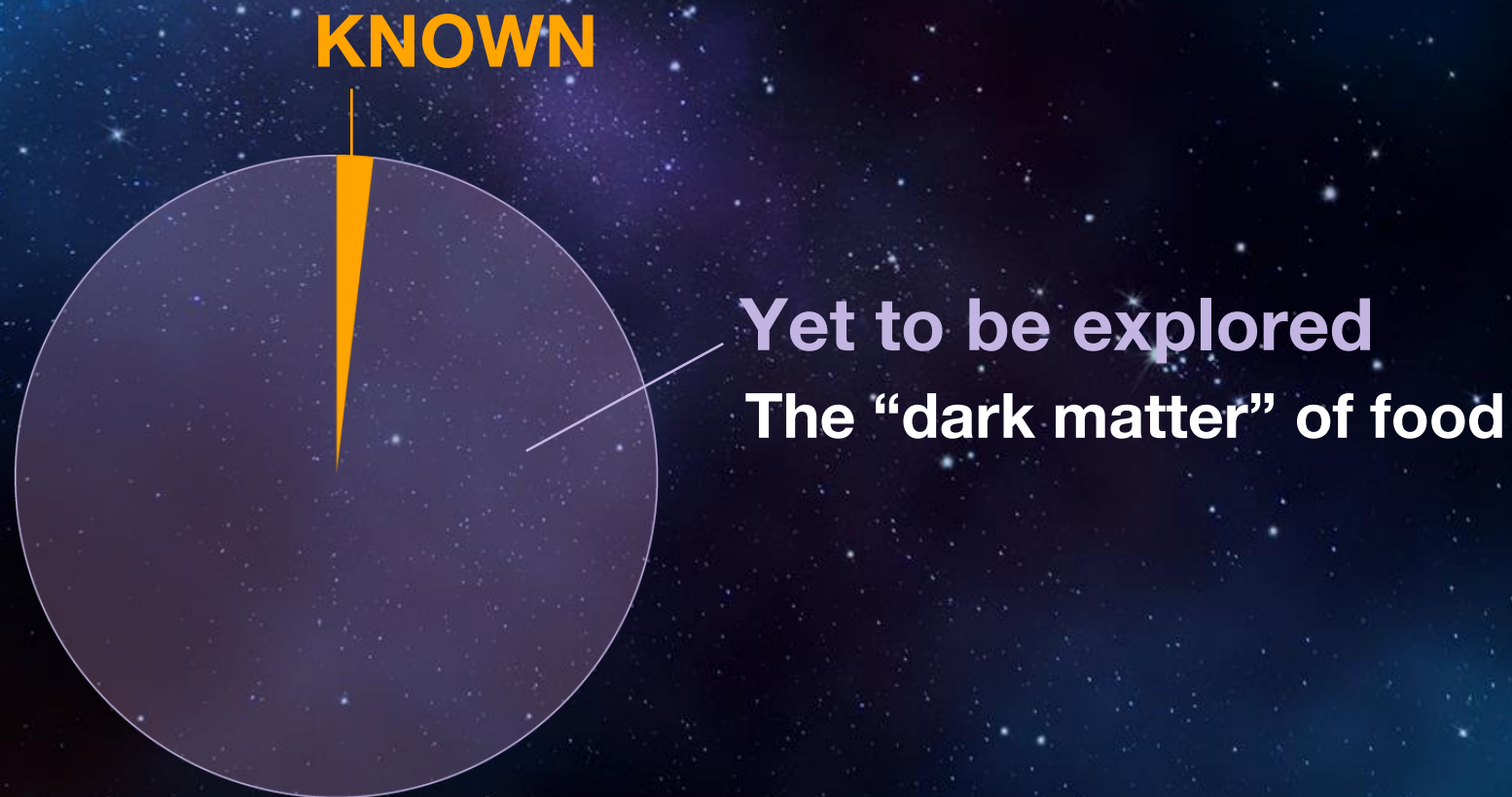
Specialized metabolites

Flavonoids, terpenoids
(ex: carotenoids),
alkaloids, steroids

For example, plums have diverse flavonoids that are associated with alleviation diseases ranging from diabetes to cancers to high blood pressure.

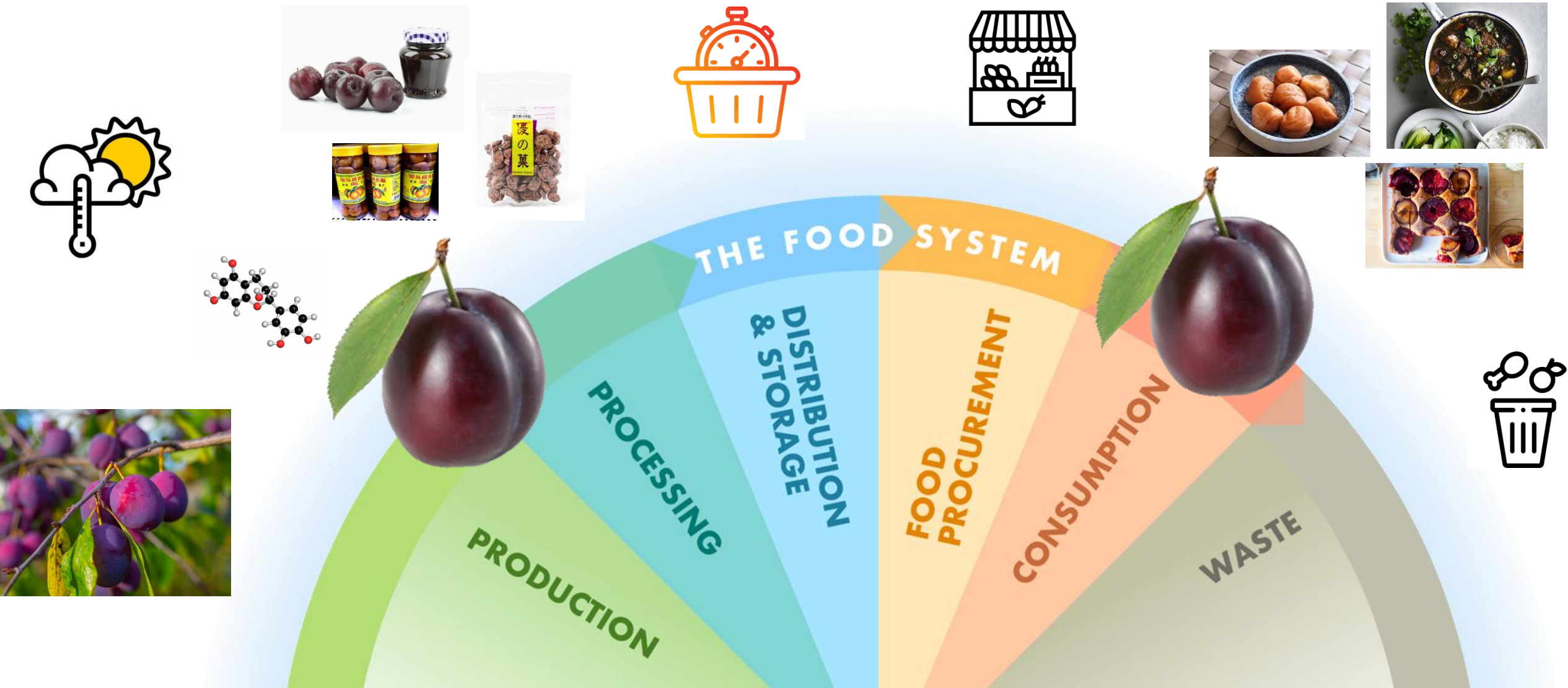


Specialized metabolites are increasingly recognized for their potential role in promoting health and preventing disease



In addition to known components, discovery data indicates there are thousands of unknown components in food

Meta-data to Capture Variation of Food Quality Across the Food System



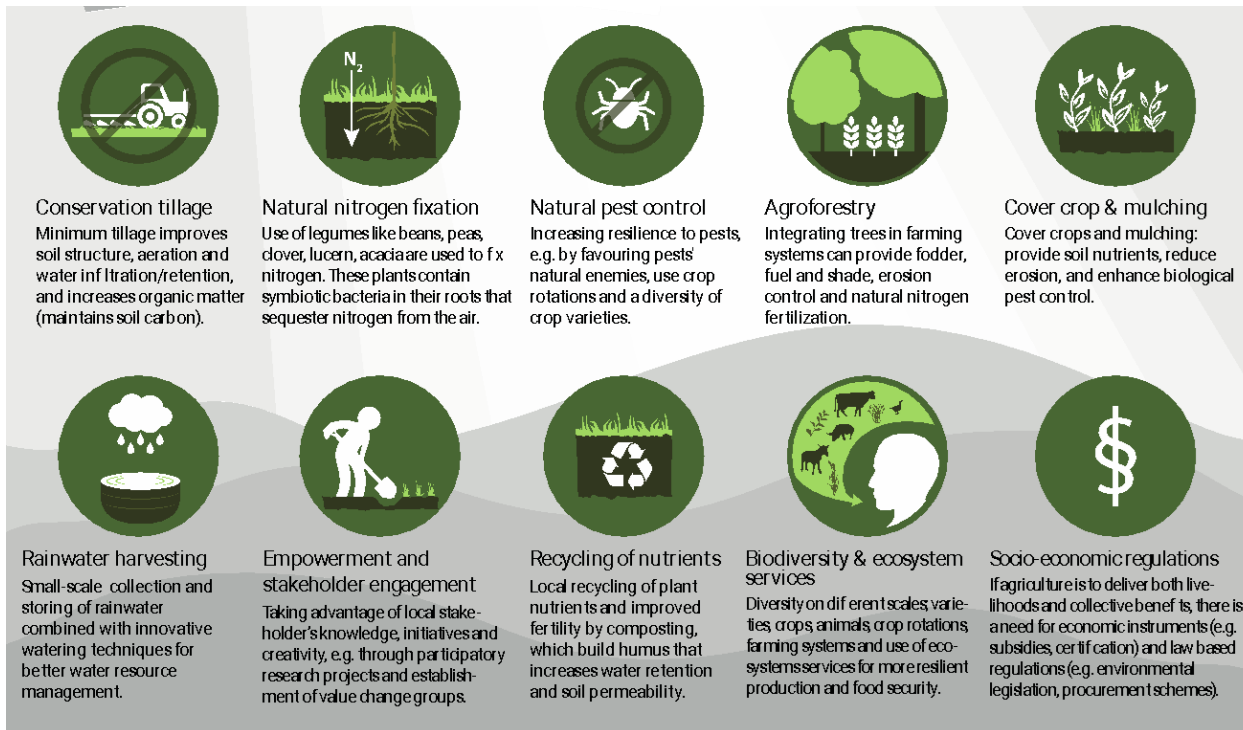
Towards Developing Global Food Quality Standards



**PERIODIC
TABLE OF FOOD
INITIATIVE**

Food quality is a contested domain and can benefit from globally accepted standards.

What are Promising Prospects to Maximize Agriculture for Enhancing Food Quality?



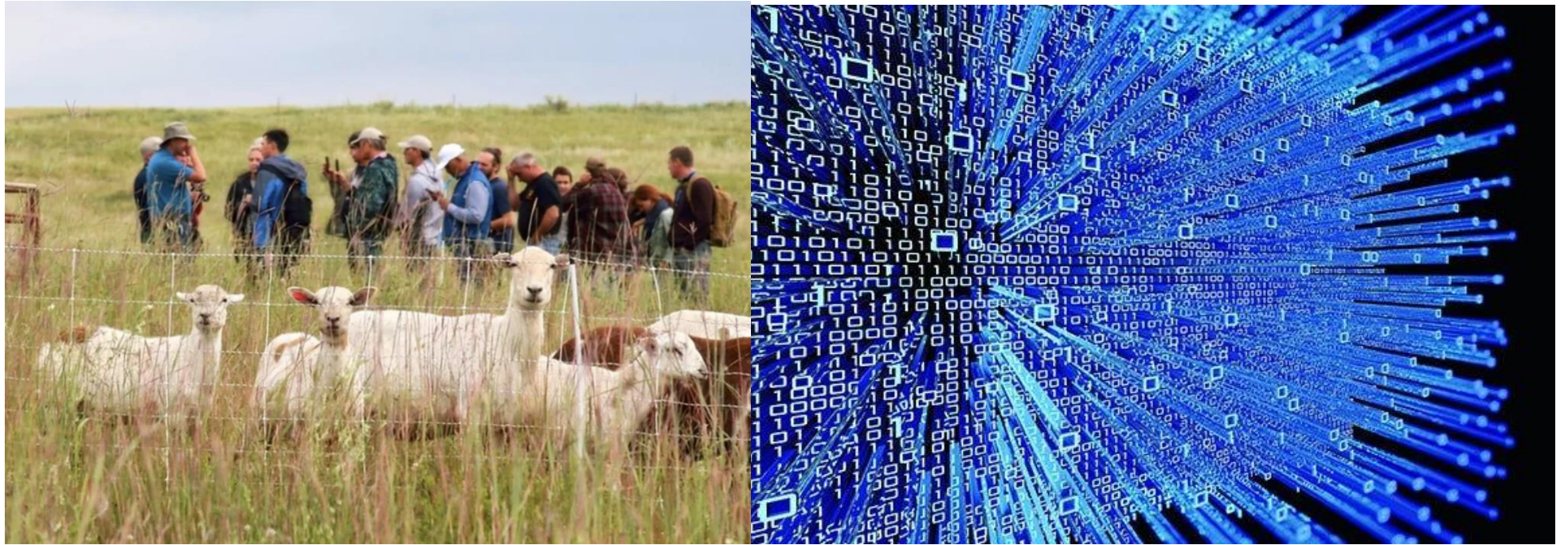
Diversified Farming /
Agroecology

6 Core Principles of REGENERATIVE AGRICULTURE



Regenerative Agriculture

Opportunities with AI to Scale Evidence on Agriculture Impacts on Food Quality for Nutrition + Health



Education + Incentivizes to Promote Food Quality for Human + Planetary Health

- Farmers should be supported with education, incentives, and agency in managing agricultural systems as the foundations for food food quality and modifiers of human nutrition and health.
- Healthcare practitioners, policymakers and consumers should be supported with education, incentives, and agency to promote and select food with high food quality from nourishing agricultural systems in ways that are accessible, affordable, and desirable.



Key Take-home Points

- Food quality is a multi-dimensional parameter that varies based on context and is a function of perspective / culture and socio-economics.
- Food quality can be measured using foodomics to identify diverse food components and surveys.
- Food quality provides a direct pathway between agriculture and human nutrition / health
- The PTFI is an example of an initiative mapping food quality using foodomics and meta-data
- Regenerative / diversified / sustainable agriculture are promising prospects to maximize agriculture for enhancing food quality
- We need education and incentives for diverse food system stakeholders to promote food quality in ways that are accessible and desirable.

By better knowing food quality, can we better manage agricultural systems, food environments, and diets for enhanced human and planetary health?



Foodomics, applied in a holistic way to complement other ways of knowing food and diets, can inform evidence-based decisions and solutions in unprecedented ways



**PERIODIC
TABLE OF FOOD
INITIATIVE**

Thank you

www.foodperiodictable.org