



Graham King

US²TS U.S. Semantic Technologies Symposium Series
4th U.S. Semantic Technologies Symposium

Food & Health I



Executive Director

<https://divseekintl.org/>



Professor



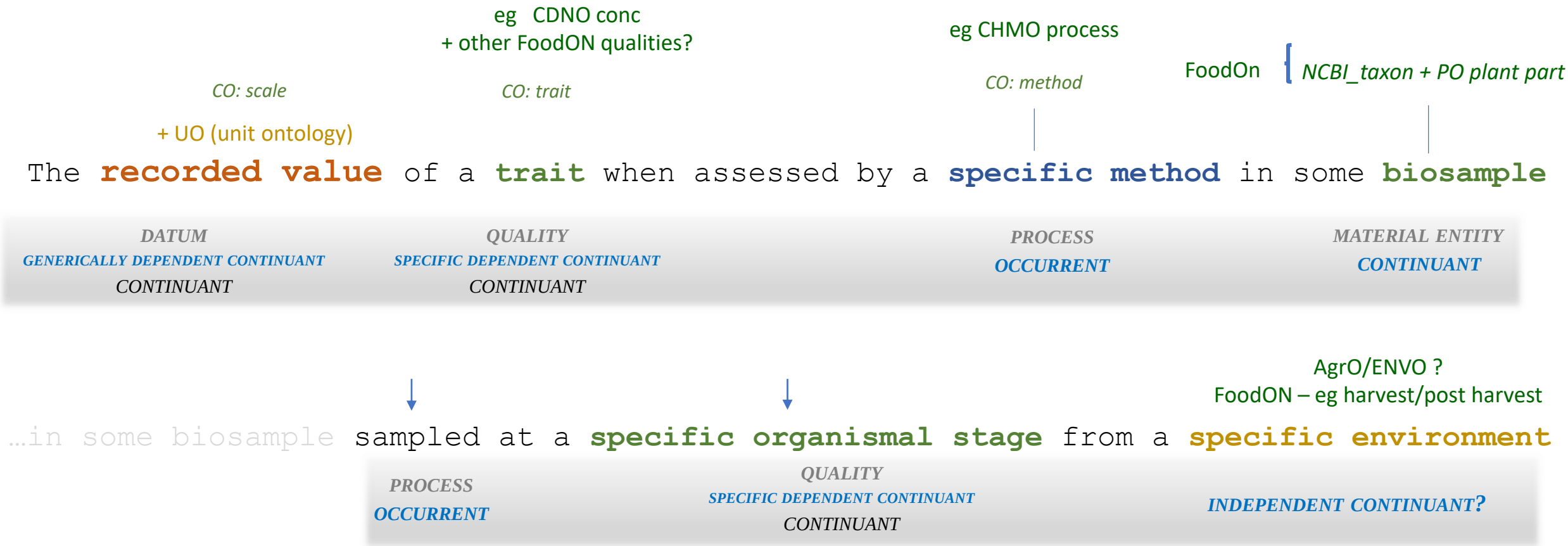
<http://cropsforthefutureuk.org/>

Research Associate

Generic Vocabularies required for: Crop Production, Supply Chain and Value-added Traits



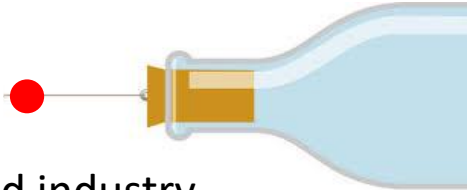
Proposed generic design pattern for annotating variables associated with biosamples :



Perspective: **global** value/spend



Crop
BioDiversity
\$? m



Seed industry
\$63 bn

*Aggregate benefit-cost
ratios ~1.94 to 17.26 (CropTrust)*

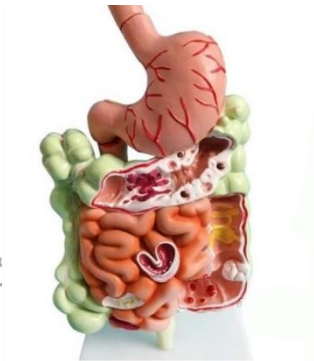
Ag.
\$2.4 tn

Food
\$8 tn

Health
\$8.3 tn



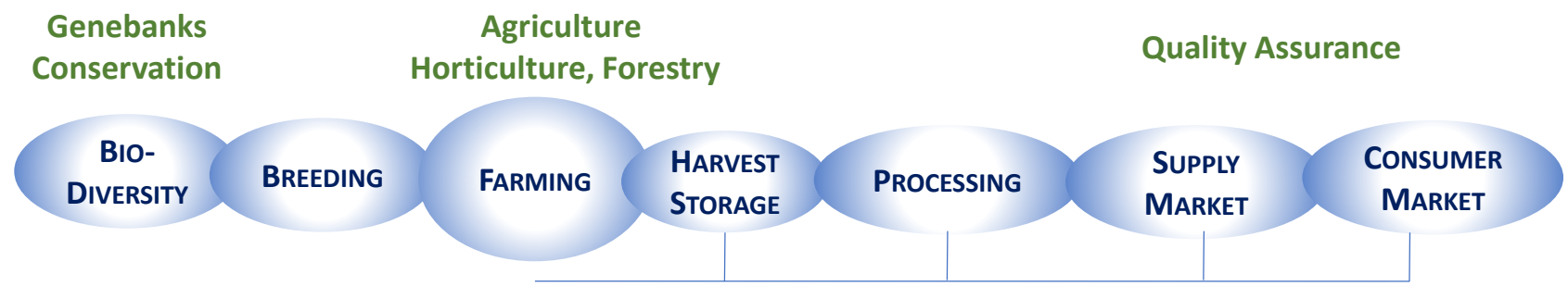
Nutritional Requirementsyou are what you eat



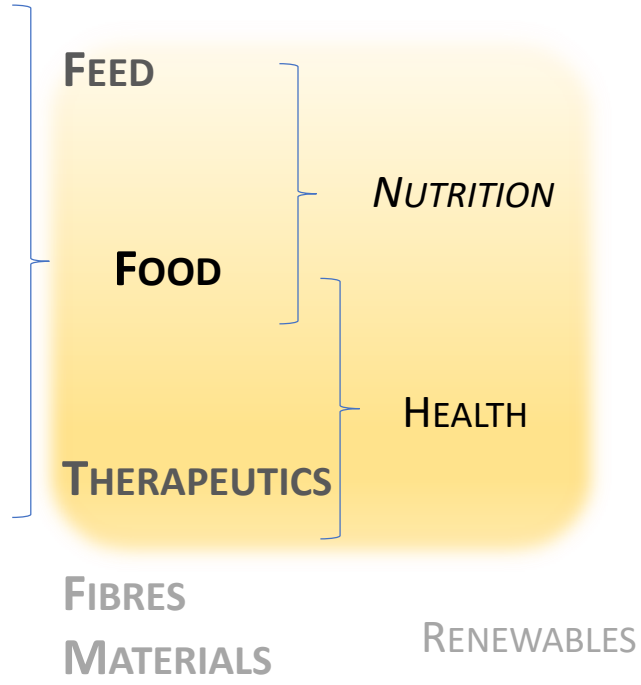
Plant Genetic
Resources
BIODIVERSITY



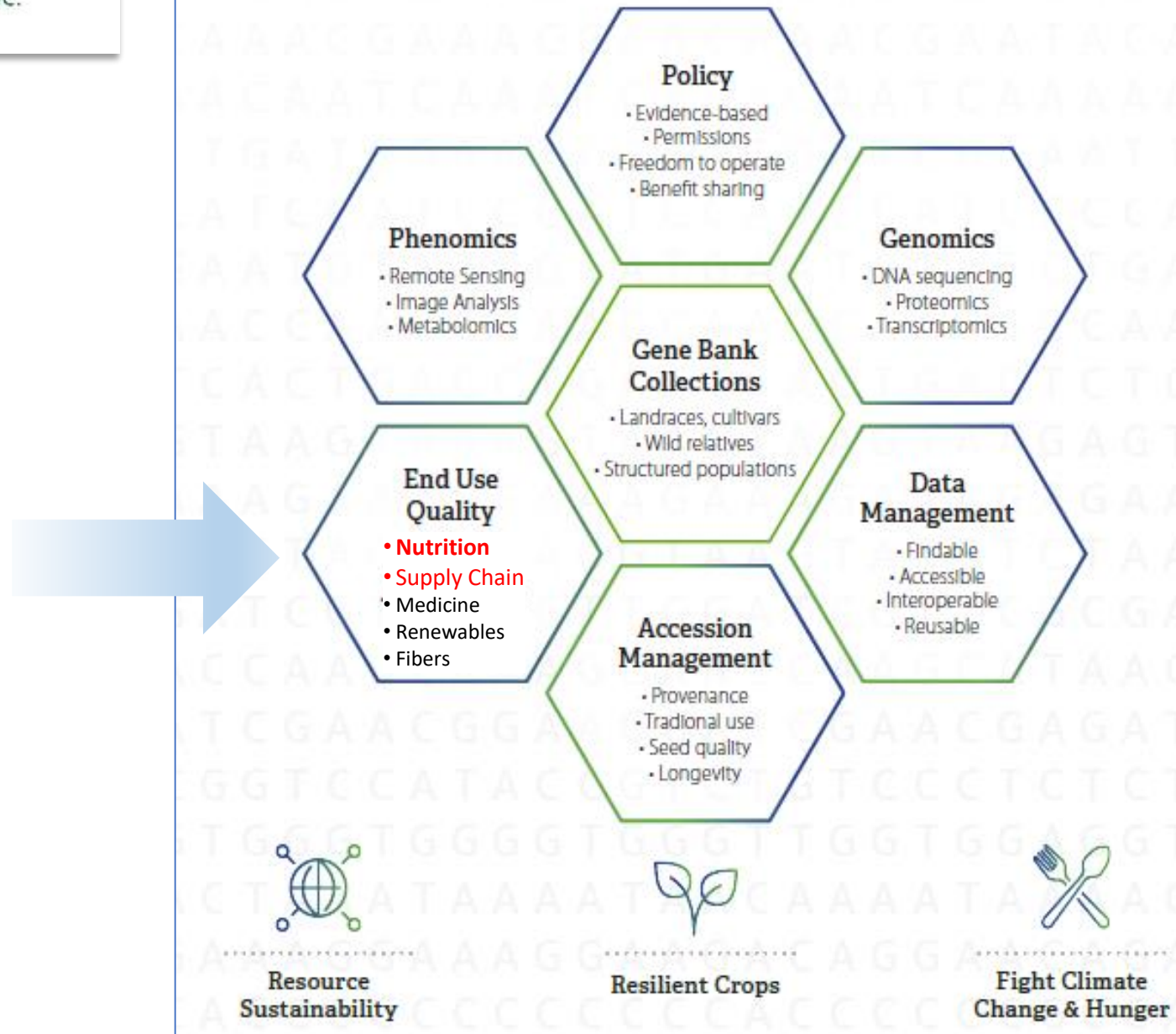
Impact
BIO-ECONOMY



Phenotype/ \$ performance
=
Genotype
X
Environment
X
Management



Characterization of Plant Genetic Resources



Standards
FAIR data
Interoperable tools
Best Practices

Additional relevant Networks - Ag and beyond



<https://www.ag2pi.org/>



<https://www.usda.gov/oce/sustainability/spg-coalition>

<https://www.usda.gov/oce/sustainability/spg-coalition>



AgBioData

Toward enhanced genomics, genetics, and breeding research outcomes through standardization of practices and protocols across agricultural databases

<https://www.agbiodata.org/>



PERIODIC TABLE OF FOOD INITIATIVE

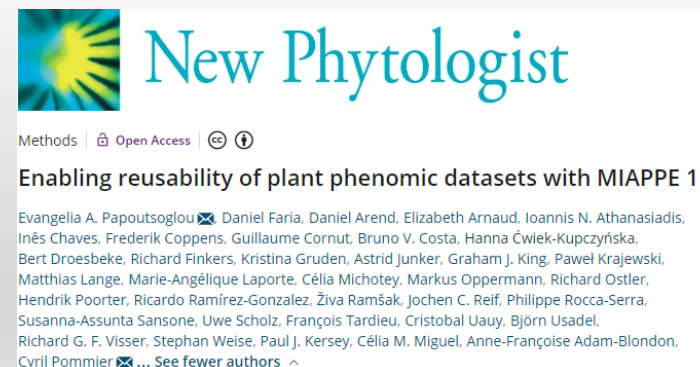
<https://foodperiodictable.org/>

Existing meta-data standards frameworks

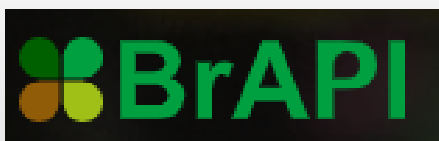
Minimum Information About Plant Phenotyping Experiments



<https://www.miappe.org/>



The Breeding API



<https://brapi.org/>



Generic Vocabularies required for: Crop Production, Supply Chain and Value-added Traits

Need for generic ontologies – facilitate data comparison from biodiversity, to farm, to fork, to follicle



CHMO

Chemical Methods Ontology

TO

Plant Trait Ontology

A controlled vocabulary to describe phenotypic traits in plants.

PATO - the Phenotype And Trait Ontology

An ontology of phenotypic qualities (properties, attributes or characteristics).

[quality]

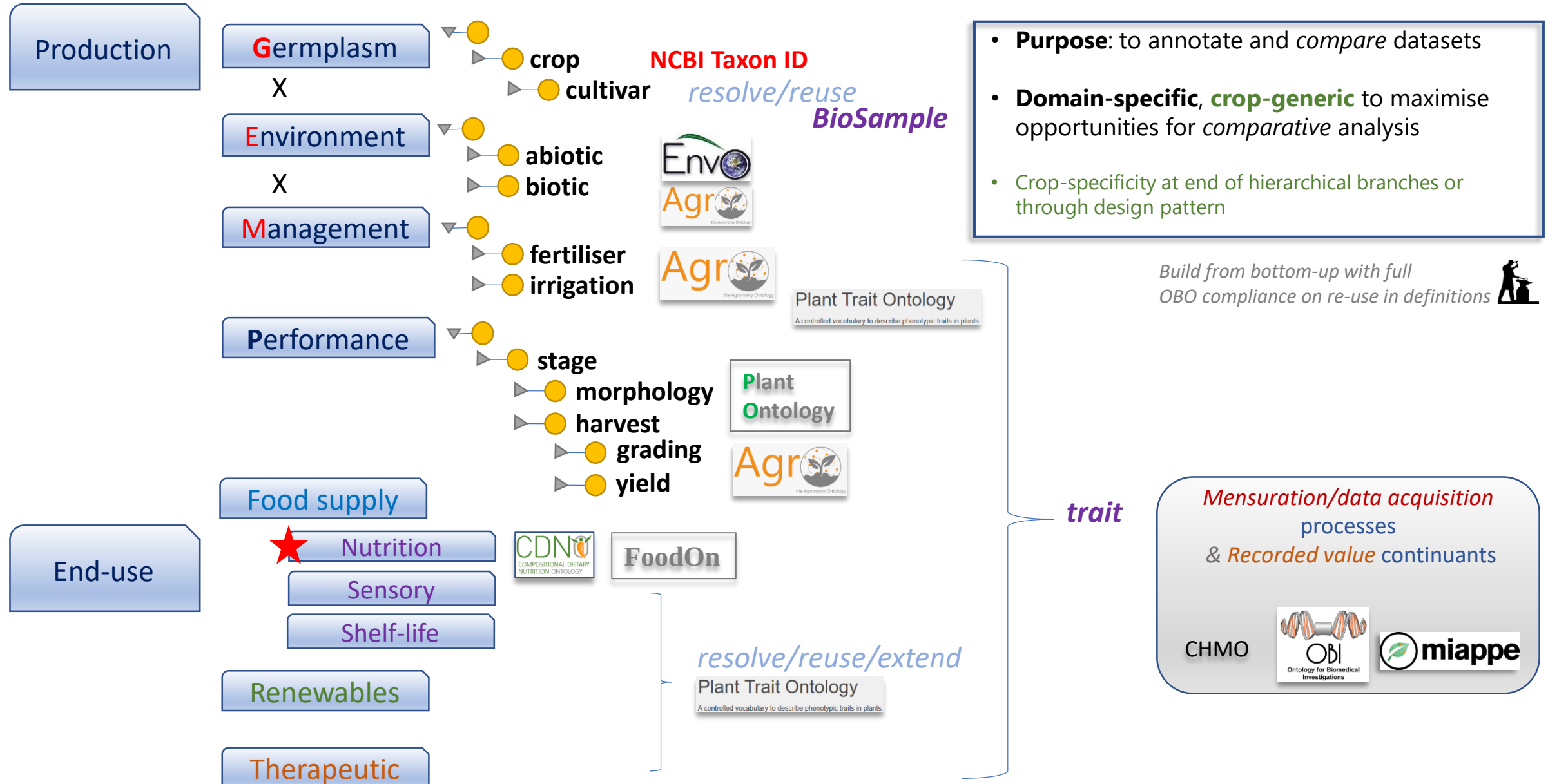


30+ distinct ontologies, **1 per crop**/group

Aim – harmonize trait dictionaries *within* crops for breeders/R&D

[quality + method]

Generic Vocabularies required for: Crop Production, Supply Chain and Value-added Traits



Wheat ontology:

Flour protein content

CO_321:0000067

http://www.cropontology.org/rdf/CO_321:0000067

Total protein content (corrected to 12.5% moisture basis) in refined flour.

Ontology: [Wheat ontology](#)

CO_321

Also in:

CO_321



Bambara groundnut ontology:

Seed protein content - Measurement

CO_366:0000026

https://cropontology.org/rdf/CO_366:0000026

Standard chemical method for seed protein content method.

Ontology: [Bambara groundnut ontology](#)

CO_366

Maize ontology:

Grain protein content

CO_322:0000122

http://www.cropontology.org/rdf/CO_322:0000122

Whole-grain protein content.

Ontology: [Maize ontology](#)

CO_322

Also in:

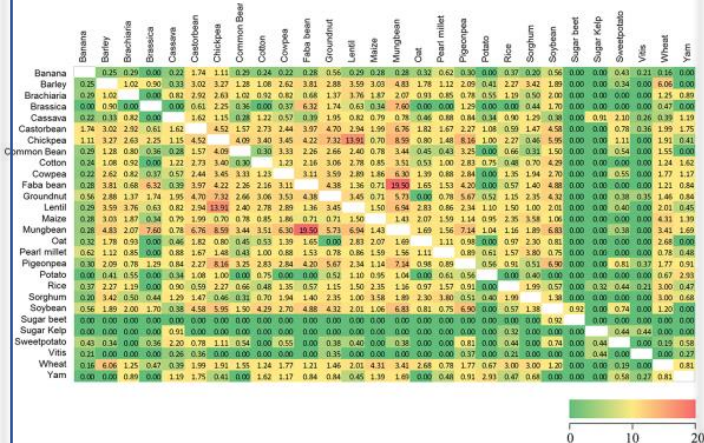
CO_322



Database, 2021, 1–11
doi:10.1093/database/baab028

Challenges for FAIR-compliant description and comparison of crop phenotype data with standardized controlled vocabularies

Liliana Andrés-Hernández¹, Razlin Azman Halimi¹, Ramil Mauleon¹, Sean Mayes², Abdul Baten² and Graham J. King^{1,2}



Brassica ontology:

Meal protein content

CO_348:2000026

http://www.cropontology.org/rdf/CO_348:2000026

The concentration of proteins in the meal.

Ontology: [Brassica ontology](#)

CO_348

Also in:

CO_348

Seed protein content

CO_348:2000023

http://www.cropontology.org/rdf/CO_348:2000023

The concentration of proteins in seeds.

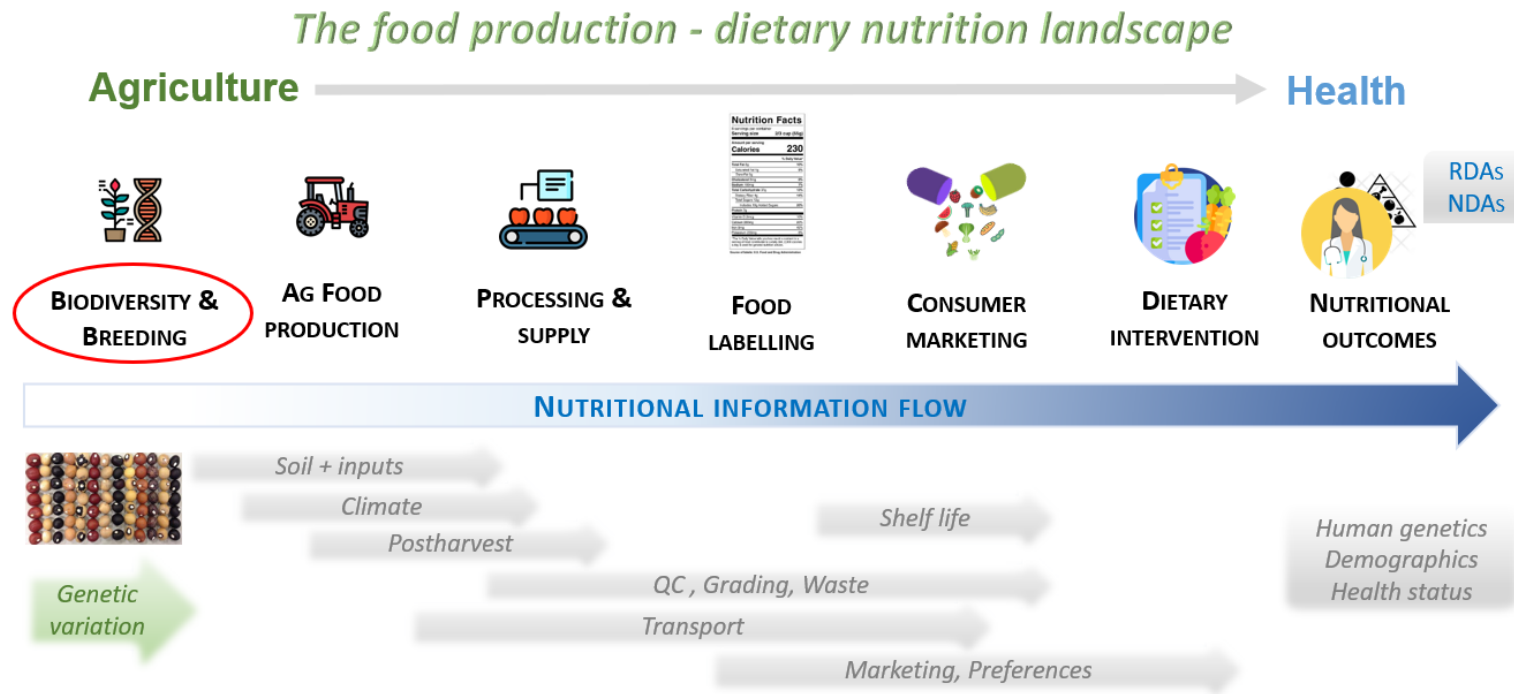
Ontology: [Brassica ontology](#)

CO_348

Also in:

CO_348

A common vocabulary of nutritional terms, definitions and structured relationships – to help in consistent 'FAIR' annotation and navigation of datasets



CDNO
COMPOSITIONAL DIETARY
NUTRITION ONTOLOGY

Home ▾ Facets ▾ Design ▾ Resources ▾ Relevance ▾ Contact

Compositional Dietary Nutrition Ontology (CDNO) *you are what you eat*
Structured terminologies to describe nutritional attributes contributing to human diet.

Featuring

An OBO Foundry Ontology

CDNO is registered with OBO Foundry, and has been developed in conjunction with other OBO Foundry ontologies.

Dietary Nutritional Components

Ten upper level subclasses and hierarchical classification for >500 terms used to describe chemical food composition.

Nutritional Concentration

The starting point for CDNO - quantifying food composition

Harvest to Health

Use cases focusing on variation in plant genetic resources and agricultural supply chains.

Dietary Roles

A biological role may be assigned to a dietary nutritional component based on evidence that supports a function defined at different levels

Nutritional Attributes

Attributes that inhere in a food material or any nutritional component and may contribute to a dietary role.

CDNO resources on

GitHub

frontiers | Frontiers in Nutrition

published 21 June 2022
doi: 10.3389/fnut.2022.908037

Establishing a Common Nutritional Vocabulary - From Food Production to Diet

Liliana Andrés-Hernández¹, Kai Blumberg², Ramona L. Walls^{2,3}, Dámon Dooley⁴, Ramil Mauleon¹, Matthew Lange⁵, Magalie Weber⁶, Lauren Chan⁷, Adnan Malik⁸, Anders Møller⁹, Jayne Ireland¹⁰, Lucia Segovia¹¹, Xuhuiqun Zhang¹¹, Britt Burton-Freeman¹², Paul Magelli¹³, Andrew Schriever¹⁴, Shavawn M. Forester¹⁵, Lei Liu¹ and Graham J. King^{1,16}

¹Southern Cross Plant Sciences, Southern Cross University, Lismore, NSW, Australia, ²Department of Biotechnology Engineering, University of Arizona, Tucson, AZ, United States, ³Center for Food Safety and Food Security, University of Arizona, Tucson, AZ, United States, ⁴Faculty of Health Sciences, Simon Fraser University, Burnaby, BC, Canada, ⁵International Center for Food Ontology/Operability (Data & Semantics) (IC-FOODS), Davis, CA, United States, ⁶INRAE, UR1614, Nantes, France, ⁷Nutrition Department, College of Public Health and Human Sciences, Oregon State University, Corvallis, OR, United States, ⁸European Bioinformatics Institute, European Molecular Biology Laboratory (EMBL-EBI), Hinxton, United Kingdom, ⁹Danish Food Informatics, Roskilde, Denmark, ¹⁰London School of Hygiene and Tropical Medicine, University of London, London, United Kingdom, ¹¹Illinois Institute of Technology, Chicago, IL, United States, ¹²WISNoodle LLC, Plano, TX, United States, ¹³Nutrient Institute LLC, a Non-profit, Plano, TX, United States, ¹⁴School of Biosciences, University of Nottingham, Sutton Bonington, United Kingdom

OPEN ACCESS

Edited by: Haythe Stadium Haras,

Nutritional Component



Class **protein (CHEBI:36080)**

Component

protein

CHEBI:36080

Concentration

CDNO:0200040

- Root: CDNO:0000001
 - ash (ENVO:02000090)
 - carbohydrate (CHEBI:16646)
 - dry plant matter (CDNO:0000002)
 - lipid (CHEBI:18059)
 - mineral nutrient (CHEBI:167164)
 - plant secondary metabolite (CDNO:0000001)
 - protein (CHEBI:36080)**
 - salt (CHEBI:24866)
 - vitamin (CHEBI:33229)
 - water (CHEBI:15377)

Food Composition Tables

Canada

No change from USDA

Food state

- ☒ All
- ☐ fresh
- ☐ raw
- ☐ fresh or raw
- ☐ boiled
- ☐ canned
- ☐ dried
- ☐ frozen

Food group

- ☒ All
- ☐ Fruits and fruit juices
- ☐ Legumes and Legume Products
- ☐ Nuts and Seeds
- ☐ Spices and Herbs
- ☐ Vegetables and Vegetable Products

Nutrient tag

PROTEIN

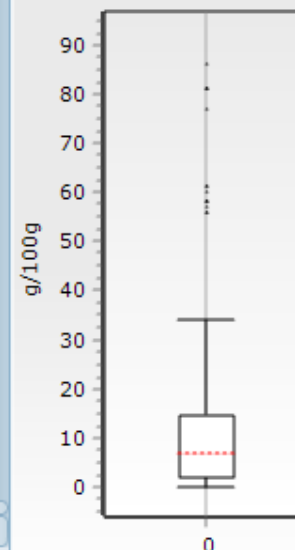
3058 Num. of food types

Food selected

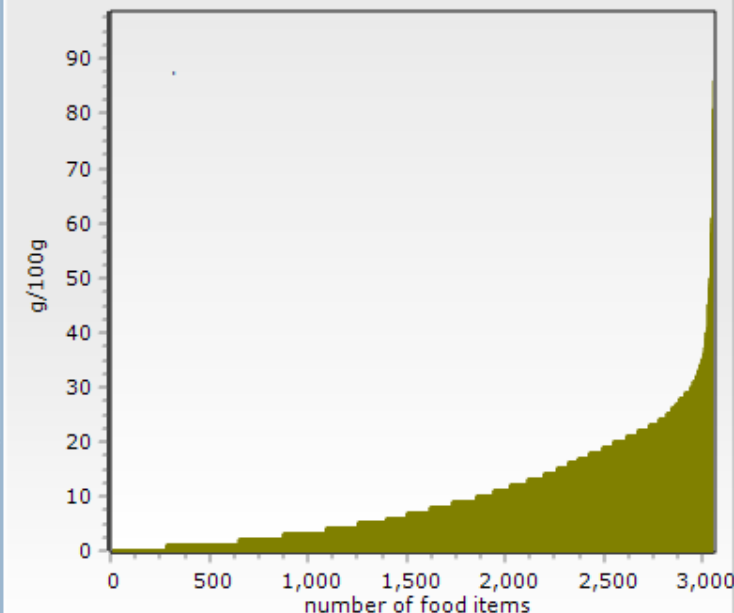
FOODON:00002775

food_description	# obs.	nutr. val.	nutrient_source_description
Fish, smelt, dried	1	56	No change from USDA
Seaweed, spirulina, dried	2	57	No change from USDA
Snacks, pork skins, barbecu	6	58	No change from USDA
Soy protein concentrate (pr	360	58	No change from USDA
Soy protein concentrate (pr	360	58	No change from USDA
Fish, herring eggs, native, P	1	60	No change from USDA
Snacks, pork skins, plain	20	61	No change from USDA
Fish, salmon, red (sockeye),	2	61	No change from USDA
Fish, steelhead trout, meat,	1	77	No change from USDA
Egg, chicken, white, dried	2	81	No change from USDA
Soy protein isolate (prepar	233	81	No change from USDA
Soy protein isolate (prepar	233	81	No change from USDA
Sweets, gelatin, dry powder	1	86	No change from USDA

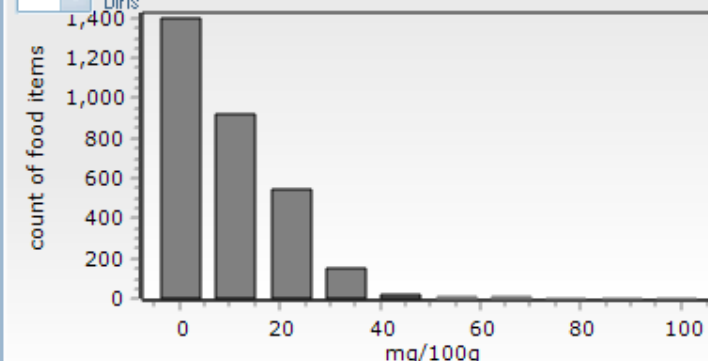
CHEBI:36080 conc.



CHEBI:36080 protein conc.



10 bins Freq. distribution of CHEBI:36080 protein conc.



CDNO

Nutritional Component



Class protein (CHEBI:36080)

Component

protein

CHEBI:36080

Concentration

CDNO:0200040

Root: CDNO:0000001

- ash (ENVO:02000090)
- carbohydrate (CHEBI:16646)
- dry plant matter (CDNO:0000002)
- lipid (CHEBI:18059)
- mineral nutrient (CHEBI:167164)
- plant secondary metabolite (CDNO:0000001)
- protein (CHEBI:36080)
- salt (CHEBI:24866)
- vitamin (CHEBI:33229)
- water (CHEBI:15377)

OLS

Food Composition

Food Composition Tables

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No change from USDA

Food state

- ☒ All
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Food group

- ☐ All
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- ☐ Legumes and Legume Products
- ☒ Nuts and Seeds
- ☐ Spices and Herbs
- ☐ Vegetables and Vegetable Products

Nutrient tag

PROTEIN

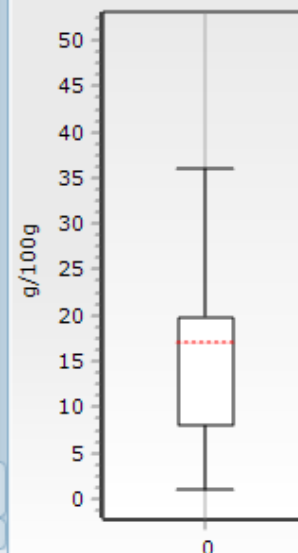
111 Num. of food types

Food selected

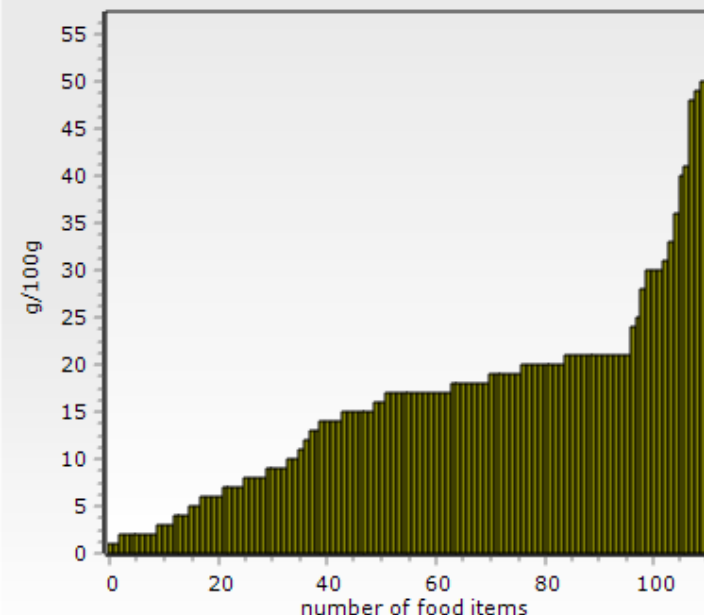
FOODON:00002775

food_description	# obs.	nutr. val.	nutrient_source_description
Seeds, watermelon seed ke	15	28	No change from USDA
Seeds, pumpkin and squas	1	30	No change from USDA
Seeds, pumpkin and squas	1	30	No change from USDA
Seeds, pumpkin and squas	3	30	No change from USDA
Seeds, sesame flour, high-f	1	31	No change from USDA
Seeds, cottonseed kernels,	2	33	No change from USDA
Seeds, safflower seed meal	1	36	No change from USDA
Seeds, sesame flour, partia	5	40	No change from USDA
Seeds, cottonseed flour, pa	1	41	No change from USDA
Seeds, sunflower seed flour	11	48	No change from USDA
Seeds, cottonseed meal, pa	1	49	No change from USDA
Seeds, sesame flour, low fa	2	50	No change from USDA
Seeds, cottonseed flour, lo	6	50	No change from USDA

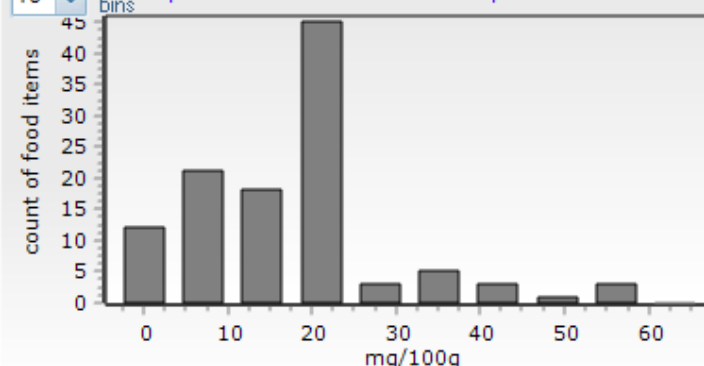
CHEBI:36080 conc.



CHEBI:36080 protein conc.



10 bins Freq. distribution of CHEBI:36080 protein conc.



nutritional component concentration *in* food material *that is a* plant food product

Dataset use:
Material
component
concentration

B
C
D

A CDNO: '*Dietary chemical component*' class

'amylopectin derived from starch' [CDNO:0100001]: ('amylopectin' [CHEBI:28057] *derived from* 'starch' [CHEBI:28017])

B CDNO: '*Chemical component concentration*' class

'concentration of amylopectin derived from starch in material entity' [CDNO: CDNO:0200468]:
(('concentration of' [PATO:0000033] 'amylopectin derived from starch' [CDNO:0100001] 'in material entity' [BFO:0000040])

in **C** FoodOn: '*Food Material*' class (crop production process)

'pre-harvested food material' [FOODON:00003402]

that is a **D** FoodOn: '*Plant food product*' class (organismal materials)

'bambara groundnut (whole)' [FOODON:00002775]:
(('seed' [PO:0009010] and *derives from* some 'Vigna subterranea' [NCBITaxon:115715])

Legend:

- Label

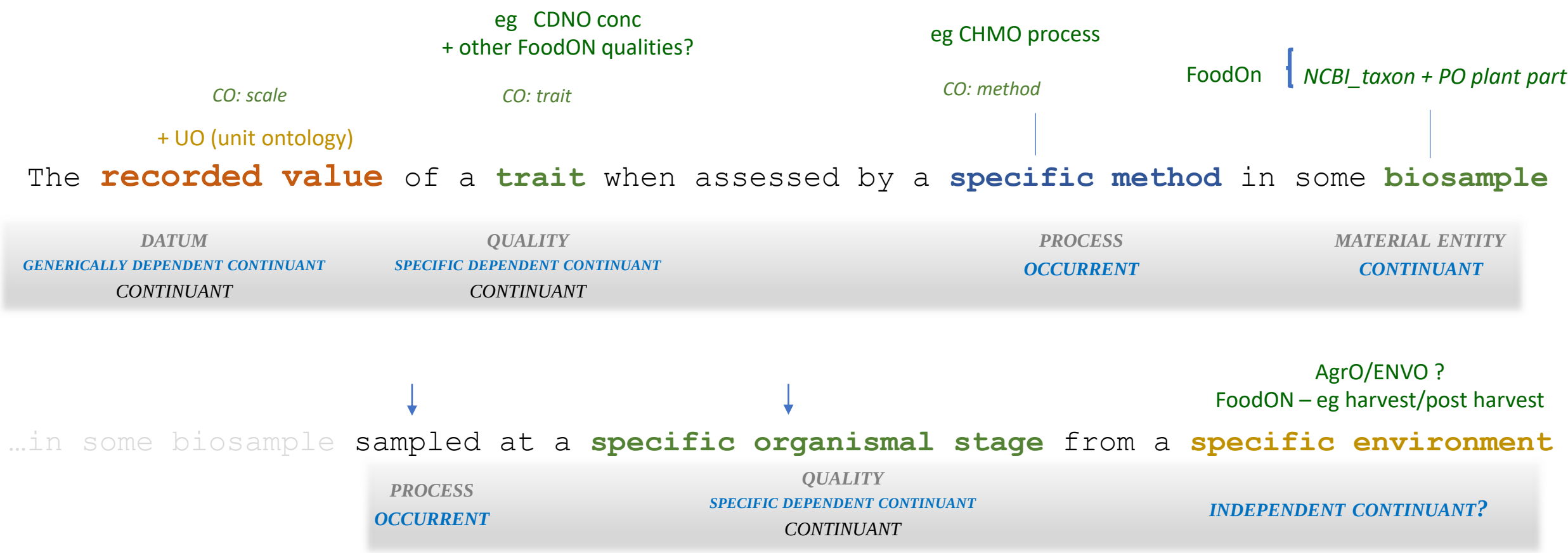
- 'term'

- [Ontology : ID]

Generic Vocabularies required for: Crop Production, Supply Chain and Value-added Traits



Proposed generic design pattern for annotating variables associated with biosamples :



Discussion Topics

1. Value of establishing **generic design pattern** from outset
 - flexible, extensible beyond nutritional concentrations
2. Pros and cons of proposed design pattern vs entity/quality approach
 - additional information content
3. Is **Recorded Value** (**continuent**) the agreed end-point and
 - a synonym of *measurement datum*?
4. Proposal for combinatorial **processes** (**occurrent**) for methods, with domain-relevant hierarchies
 - see Google Sheets
 - which OBO ontology should be adopted to modify?
5. Any **specific definitions** requiring input from wider community-consultation
6. How to **map onto** eg [AOAC](#) proprietary methods used in many analytical labs



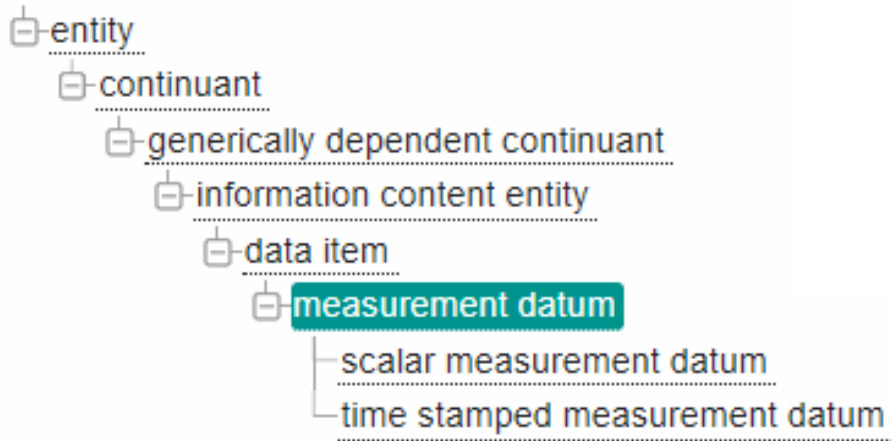
Administration

also for sessions II, III



- Where will these issues be discussed/open following this meeting?
 - GitHub (FoodOn and/or CDNO, AGRO etc)
- Funding opportunities/resources to develop further
 - interested parties in supply chain from PGR to Human Nutrition

Is **recorded value** a synonym of '**measurement datum**' ?



A **measurement datum** is an *information content entity* that is a *recording of the output* of a measurement such as produced by a device.

Measurement (*noun*)

a unit or standard of quantification (**continuant, quality**)

e.g. the **value** recorded, may be continuous or multi-state variable

Measurement (*verb*)

the act of measuring (**occurrent, process**)

e.g. by a particular (multi-step) **assay** method

can include by calculation, assay,

Assay (*noun*)

analysis carried out to determine the content or quality (

Assay (*verb*)

to determine the content or quality of something (*occurrent, process*)
e.g. planned process with objective to produce information about a material
entity that is the evaluant (analyte), by physical examination of it or its proxies.
(OBI definition)