Dairy Products:
Whole foods for the future

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CEP CNE
Durbanville Hills, 22 August 2019

Make today matter

Source: UN

DAIRY PRODUCTS

Whole foods

For the future

Food matrix

Sustainable diets

Part 1

Part 2

Part 1: FOOD MATRIX

Description

- *whole of chemical components (nutrients and non-nutrients) of food*

plus

- *their molecular & supra-molecular relationships*

plus

- *and the way those components are mechanically & structurally organised*
- *at micro-, meso-, and macroscopic scales*
- *as they appear in nature and change over time, or following food processing*

Adapted from: Capuano et al (2019); Kaufmann & Palzer (2011)

affecting the

- *release*
- *mass transfer*
- *accessibility*
- *digestibility*
- *stability*

of many food compounds
(cited by Aguilara et al, 2018)

The food matrix (consumer perspective) is the result of

- Raw materials
- Product processing (at home and/or industrial) & changes during shelf-life
- Consumption & digestion

Based on & extracted from Kaufmann & Palzer (2011)

“Raw materials”

The food as it comes from nature :

➡ “Traditional” / “conventional” foods

Many matrix differences

Natural differences in

bioaccessibility (*release of a nutritive compound from its food matrix into the digestive juices of the GIT*)

and

bioavailability (*proportion of nutritive compound that is absorbed and reaches systemic circulation*)

Turgeon & Rioux (2011)

“Raw materials”

Examples of natural (nutrient) matrix effects on nutrient bio-accessibility / bio-availability

MACRONUTRIENTS

- **Carbohydrates**:
  - Monosaccharides vs polysaccharides
  - Dietary fibre (soluble vs insoluble)
  - Glycemic response
  - Particle sizes (whole grain vs milled / solid food vs [home/natural] processed)
- **Proteins**
  - Amino acids vs peptides vs proteins
  - Biological value (quality) of proteins
  - Digestibility
- **Lipids**
  - Triglycerides …. Fatty acids… phospholipids… cholesterol…..

MICRONUTRIENTS

- Iron: Haem vs non-haem
- Vitamin A
- Calcium
- Vit C etc

Well-studied in plant-source foods
? Animal-source foods

Capuano et al (2019);
Turgeon & Rioux (2011)

“[Industrial] Food processing”

- Food structure engineering

includes

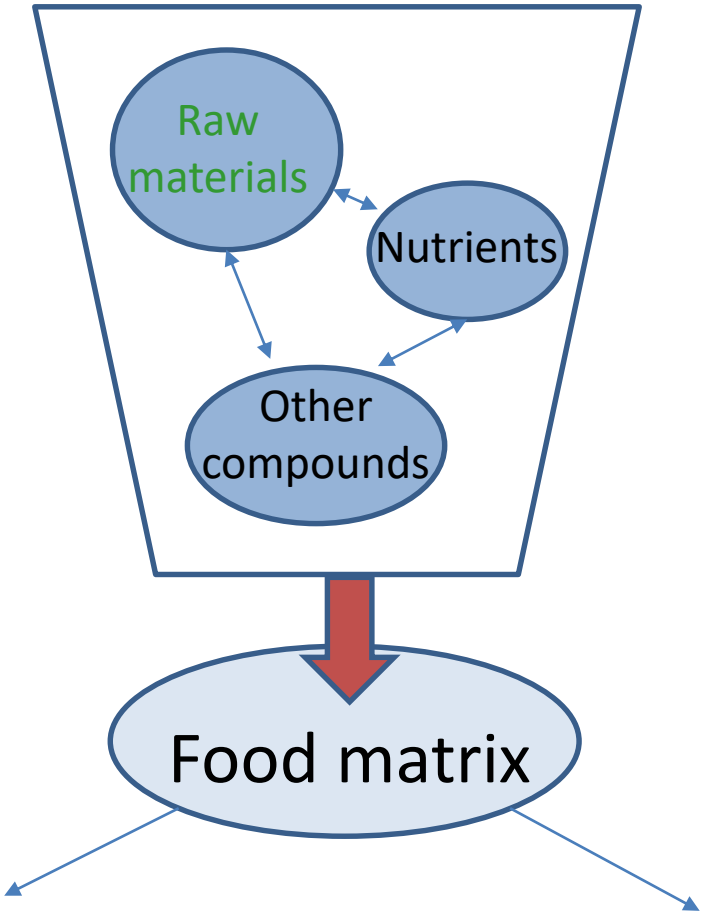
- Homogenisation, fractioning, separation, dehydration, concentration
- Heat, pressure, enzyme, membrane treatments
- Coagulation, thickening, gelling, foaming, emulsions

- Functional foods / Nutriceuticals

“**Tailoring**” of foods:

- ↓Energy (fat & sugar) density / salt reduction
- Stabilisation; ↑bioavailability of bioactive compounds; encapsulation of aroma compounds
- ↑ nutritional profile (e.g. additions e.g. bioactive compounds; fibre content)
- Modulated digestion

Kaufmann & Palzer (2011)
Udenigwe & Fogliano (2017)
Turgeon & Rioux (2011)



Processing

- Physical
- Chemical
- Biochemical

Food acceptance

- Sensory quality
- Convenience
- Self life
- Price

Nutrient bioavailability

Health effects

Adapted from: Turgeon & Rioux (2011)

“Consumption & Digestion”

Foods are usually not consumed in isolation (meals / snacks): food-food interactions

Food patterns (timing/intervals of intake)

Nutrition and health status effects on bioaccessibility / bioavailability

What about Dairy?

Role of **nutrients / dairy components**

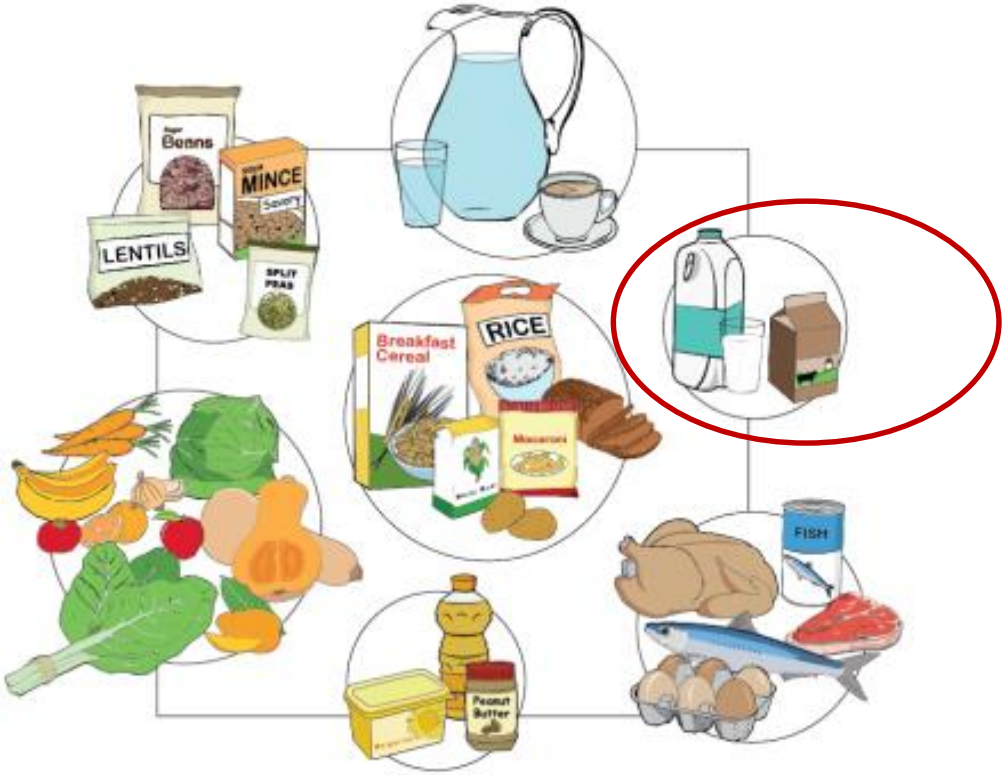
- Low and middle income countries (incl SA): Provision of *gap nutrients* known to be deficient or marginal (for meeting DRI's); → e.g addressing "Hidden Hunger" & need for high biological value proteins

- For industrialised and emerging economies (nutrition transition): Prevention of non-communicable diseases. Focus on
  - calcium
  - protein (type & amount)
  - fat (total, type and milk fat globule membrane: "MFGM")
  - CHO (fermentation)

BUT diets consist of foods (<u>not</u> nutrients & other components in isolation)

⟹ <u>Food</u> Based Dietary Guidelines

Have milk, maas or yoghurt every day



BUT: Dairy is not a homogenous food group

Composition:

Dairy product	Calcium (mg/100g)	MFGM (mg/100g)	Protein (amount [mg/100g]; type)	Fer-mented	Fat structure	Protein network
Milk, skimmed	124	15	3.5; Whey/casein	No	Tiny native MFG/ potential MFGM	Liquid
Milk, 3.5% fat	116	35	3.4; Whey/casein	No	Native MFG or homogenised milk fat droplets/potential MFGM	Liquid

Adapted from: Thorning et al (2017)

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Adapted from: Thorning et al (2017)

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Cheese (25% fat)	659	150	23.2; Casein	Yes	MFG/aggregates/free fat	Solid / viscoelastic

Adapted from: Thorning et al (2017)

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Cream (38% fat)	67	200	2; -	No	Native MFG or homogenised milk fat droplets/potential MFGM	Liquid
Butter	15	-	<1; -	No/Yes	Continuous fat phase (water in oil emulsion) / MFGM residue traces	-

Adapted from: Thorning et al (2017)

The health effects of dairy products differ

- Different research questions, e.g.
  - **Total dairy** vs **dairy products**
  - Dairy **components** (e.g. Ca) separately vs components within dairy matrix
  - Dairy within a whole diet

"Exposure"

- Different health effects (end points :"outcomes") studied
- Different **study designs**

Health effects of dairy : Total vs products

Study	End point	Findings
Meta-analyses of observational studies	Stroke risk	**Total** dairy intake: Not associated **Specific products**: • Total milk: Per 200g/d increment in intake: 7% ↓ risk • High-fat milk: Direct association • Cheese: Per 40g/d intake marg. inverse association • Yoghurt: No association. • Combining ≥2 dairy products: Per 200g/d: 9% ↓lower risk
	Hyper-tension	**Total** dairy, low-fat dairy and milk: Linear inverse association **Specific products**: • Low-fat dairy: Per 200g/d: 4% ↓risk • High-fat dairy, fermented dairy, yoghurt: no association.
	T2DM	**Total** dairy intake: Inverse relationship per 200g/d increment **Specific products**: • Yoghurt: For 80g vs 0g/d: RR: 0.86 • Cheese, cream, total milk, low-fat milk, high-fat milk, total high-fat dairy: Not associated

Adapted from Thorning et al, 2017)

Health effects of dairy products vs components

Study	End point	Findings
Intervention studies comparing dairy products to components	Weight loss / Body compos	Weight loss • Cow's milk: 5.8% • Control: 4.3% • Ca-fortified soy milk: 3.8% • Ca-suppl: 4.8% } Dairy matrix effect related to the **Ca** & **protein** Skimmed milk vs casein vs whey protein compared with water: Skimmed milk & milk proteins ↑ lean and fat mass (Dairy protein effect)
	Cardiovas risk	Ca from milk & low-fat yoghurt attenuated postpran lipaemia, in contrast to Ca supplement. Ca supplement vs meal with supplement vs dairy product meal vs Ca-fortified juice: Largest delay in serum Ca ↑ in dairy product meal.
	Bone health	Ca supplement vs Ca + Vit D vs cheese: Cheese had higher % change in cortical thickness of tibia in 10-12 year old girls. Dairy products vs Ca suppl vs control: Dairy products consumers: greatest ↑ pelvis and spine density and total bone mineral density.

Adapted from Thorning et al (2017)

Health effects of dairy products vs components

Study	End point	Findings
Intervention studies controlling for within-dairy product differences	Blood lipids	Cheese, milk and butter in whole diets made "equivalent" through addition of fat, protein and lactose: No difference between cheese and milk in terms of effect on blood lipids, yet butter still increased LDL-cholesterol. Thus protein and lactose do not explain difference between cheese and butter on blood lipids. Meals including 45g fat in sour cream, whipped cream, butter or cheese resulted in different post-prandial effects on serum triglycerides and HDL cholesterol

Adapted from Thorning et al, 2017; Hansson et al, 2018)

Health effects of dairy products in a full diet

Study	End point	Findings
Intervention studies with full diet designs	Blood lipids	Cheese vs butter: Fat delivered as butter has a different effect than fat delivered in cheese matrix. Cheese vs full-fat yoghurt: No difference. Buttermilk (rich in MFGM) vs skimmed milk with same amount of fat vs butter: Buttermilk and skimmed milk similar, but butter increased total cholesterol.

Adapted from Thorning et al, 2017)

In summary

- Nutrients from dairy food group are not forgotten
- The matrix of dairy products differs
- Dairy products are unique, and should be studied accordingly
- The matrix
  - adds to our understanding of dairy-disease relationships
  - Explains some previous contradictory findings

Remember

- The matrix of dairy products is the result of the
  - original product (food production)
  - processing
  - consumption

Adapted from: Kaufmann & Palzer, 2011

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→ Food System

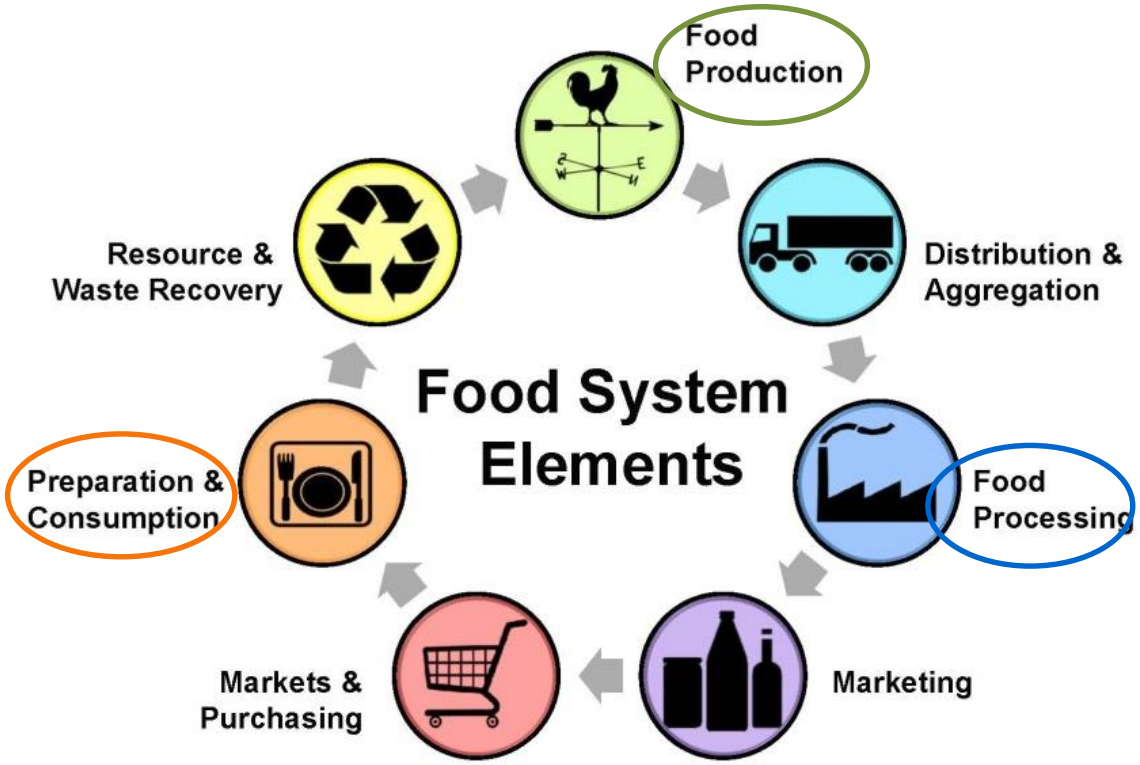

Image source:
Wilkins & Eames-Sheavly

Part 2
DAIRY AS PART OF A SUSTAINABLE DIET

Source: UN

Background

HEALTH & NUTRITION

Global nutrition situation:
>820 million people lack enough food (Food insecurity)
2 billion: Micronutrient deficient (Hidden hunger)
Many more consume too much food of poor quality (Rockström et al, 2019)
→ Overweight/obesity (Callahan et al, 2019):
In 2016:

- 50 million girls + 390 million women
- 74 million boys + 281 million men

→ Nutrition transition & Double burden of disease

Global **Burden of Disease** Study 2017 (Lancet, 2018):
Diet-related risk factors have largest impact on Disease Burden
"Unhealthy diets pose a greater risk to morbidity and mortality than does unsafe sex, and alcohol, drug and tobacco use combined"

Background

ENVIRONMENT

Food production

Among the largest drivers of environmental change, including:

- Climate Δ
- ↓Biodiversity
- Freshwater use
- Interference in N_2 and P cycles
- Land-system Δ

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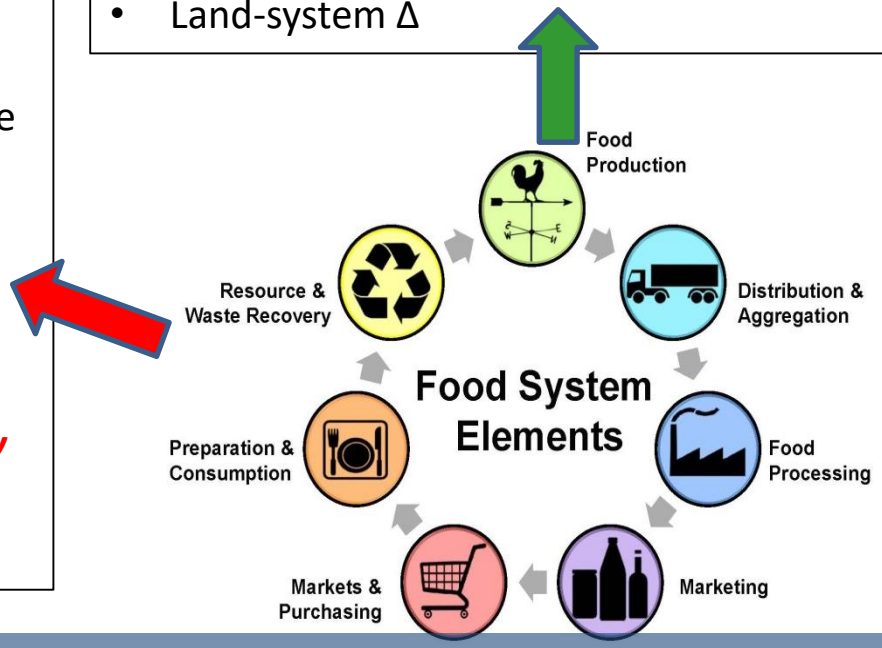


EAT Lancet (2019): ***"The food system drives poor health and environmental degradation"***

Background

Additional factors:

- Changes in size and age distribution of population:
  - By 2050 world must increase food energy by about 70%, without additional land use conversion for food
- Urbanisation
- Income growth
- Globalisation of diets; changing food preferences
- Competition for natural resources…. etc, etc, etc

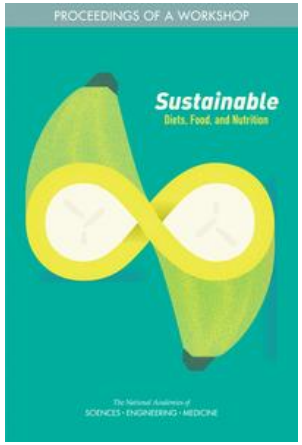
We live in **anthropocene**, i.e. a "*geological epoch that is characterised by humanity being the dominating driver of change on Earth*".

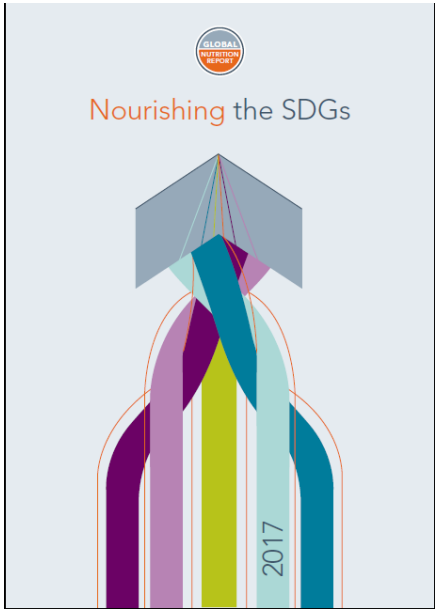
Sustainable Development Goals (SDG)

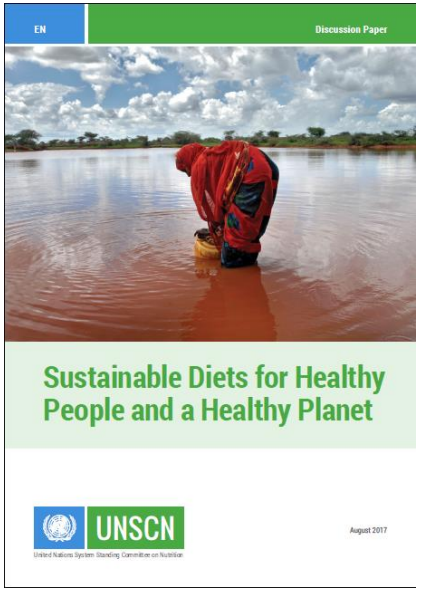
Food Systems & Diets related to most SDG

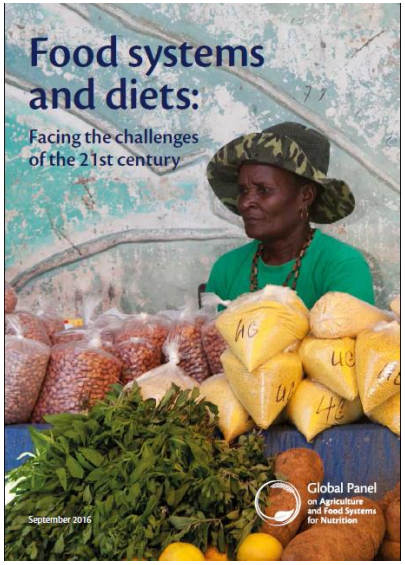
Sustainable diets

Many recent publications: Books, reports, articles, conference proceedings









Sustainable Diets

"Diets that are

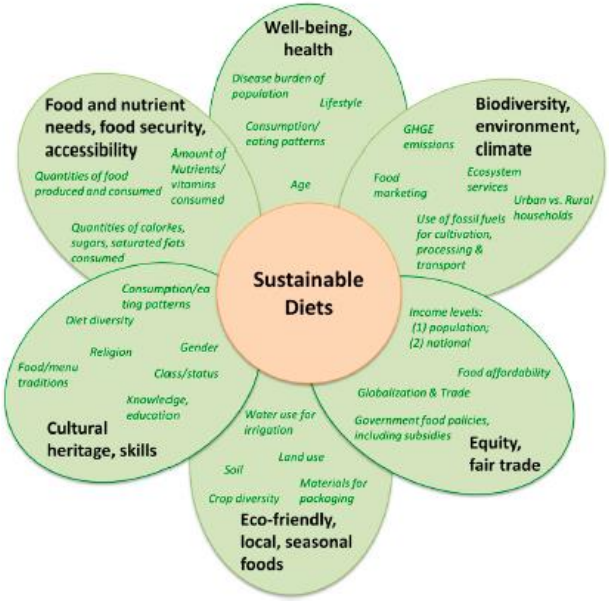
- Protective and respectful of biodiversity and ecosystems
- Culturally acceptable
- Accessible
- Economically fair and affordable;
- Nutritionally adequate
- Safe and
- Healthy;
- while optimizing natural and human resources"

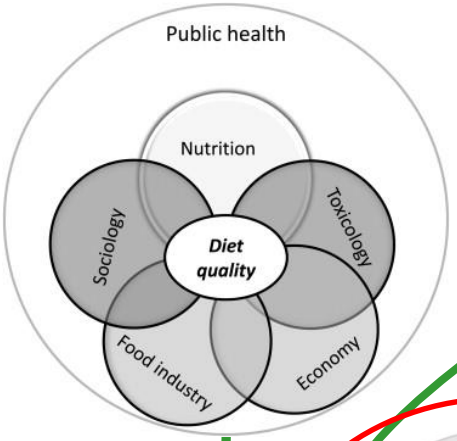
Environment

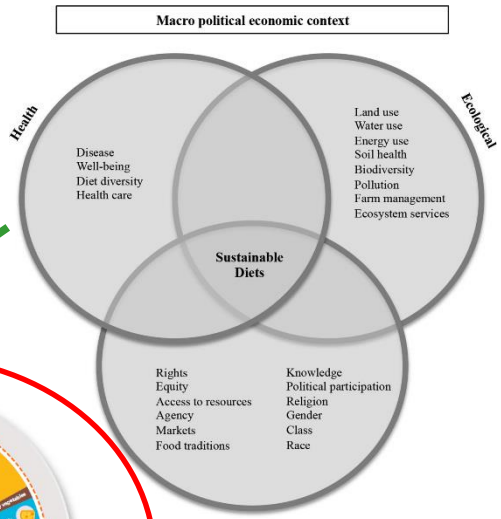
People-centered

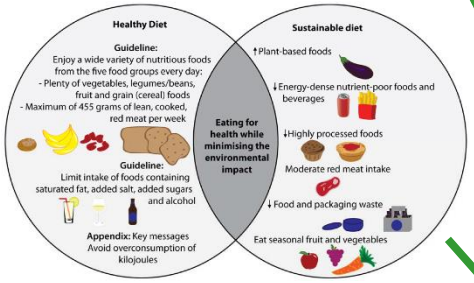
Health

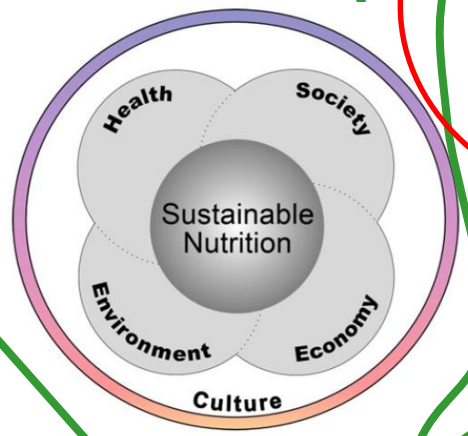
Burlingame et al, 2012 (FAO)

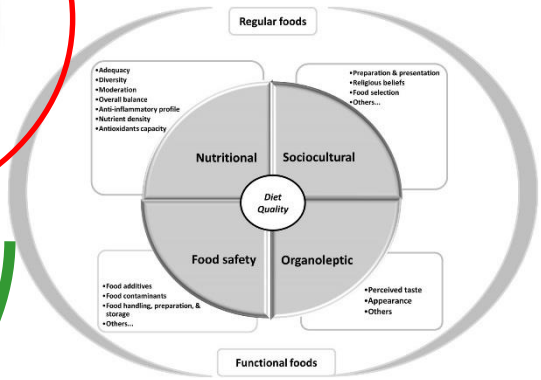












Good health

Good nutrition status

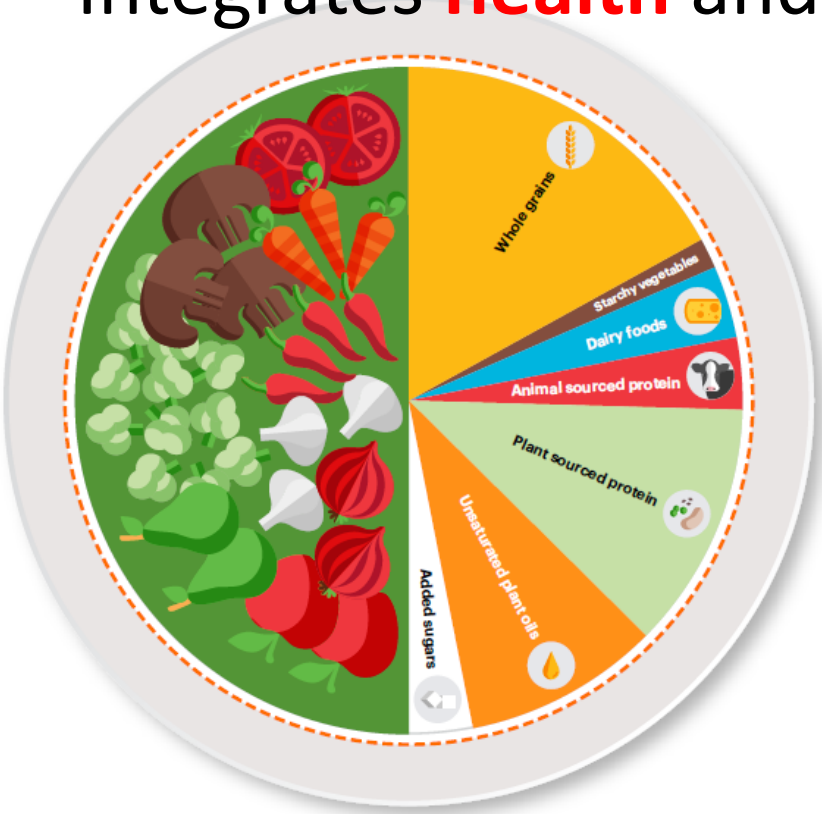
Sustainable diets

Sustainable food systems

Food & nutrition security

Sustainable diets:
Many models !

"PLANETARY HEALTH DIET":
Integrates **health** and **environmental** dimensions



One GOAL (EAT-Lancet, 2019):
"To achieve **planetary health diets** for nearly 10 billion people by 2050"

Food in the Anthropocene: the EAT–*Lancet* Commission on healthy diets from sustainable food systems

Walter Willett, Johan Rockström, Brent Loken, Marco Springmann, Tim Lang, Sonja Vermeulen, Tara Garnett, David Tilman, Fabrice DeClerck, Amanda Wood, Malin Jonell, Michael Clark, Line J Gordon, Jessica Fanzo, Corinna Hawkes, Rami Zurayk, Juan A Rivera, Wim De Vries, Lindiwe Majele Sibanda, Ashkan Afshin, Abhishek Chaudhary, Mario Herrero, Rina Agustina, Francesco Branca, Anna Lartey, Shenggen Fan, Beatrice Crona, Elizabeth Fox, Victoria Bignet, Max Troell, Therese Lindahl, Sudhvir Singh, Sarah E Cornell, K Srinath Reddy, Sunita Narain, Sania Nishtar, Christopher J L Murray

“PLANETARY HEALTH DIET”

	Macronutrient intake grams per day (possible range)	Caloric intake kcal per day
Whole grains		
Rice, wheat, corn and other	**232**	**811**
Tubers or starchy vegetables		
Potatoes and cassava	**50** (0–100)	**39**
Vegetables		
All vegetables	**300** (200–600)	**78**
Fruits		
All fruits	**200** (100–300)	**126**
Dairy foods		
Whole milk or equivalents	**250** (0–500)	**153**
Protein sources		
Beef, lamb and pork	**14** (0–28)	**30**
Chicken and other poultry	**29** (0–58)	**62**
Eggs	**13** (0–25)	**19**
Fish	**28** (0–100)	**40**
Legumes	**75** (0–100)	**284**
Nuts	**50** (0–75)	**291**
Added fats		
Unsaturated oils	**40** (20–80)	**354**
Saturated oils	**11.8** (0-11.8)	**96**
Added sugars		
All sugars	**31** (0–31)	**120**

Emphasised foods

Limited intake

Emphasised foods

Emphasised foods

Optional foods

Limited intake

Optional foods

Emphasised foods

PLANETARY HEALTH DIET

Whole grains
Rice, wheat, corn and other

Tubers or starchy vegetables
Potatoes and cassava

Vegetables
All vegetables

Fruits
All fruits

Dairy foods
Whole milk or equivalents

Protein sources
Beef, lamb and pork
Chicken and other poultry
Eggs
Fish
Legumes
Nuts

Added fats
Unsaturated oils
Saturated oils

Added sugars
All sugars

Make starchy food part of most meals

Eat plenty of vegetables and fruit every day

Have milk, maas or yoghurt every day

Eat dry beans, split peas, lentils and soya regularly

Fish, chicken, lean meat or eggs could be eaten daily

Use fat sparingly; choose vegetable oils rather than hard fats

Use sugar and food and drinks high in sugar sparingly

SA FBDG

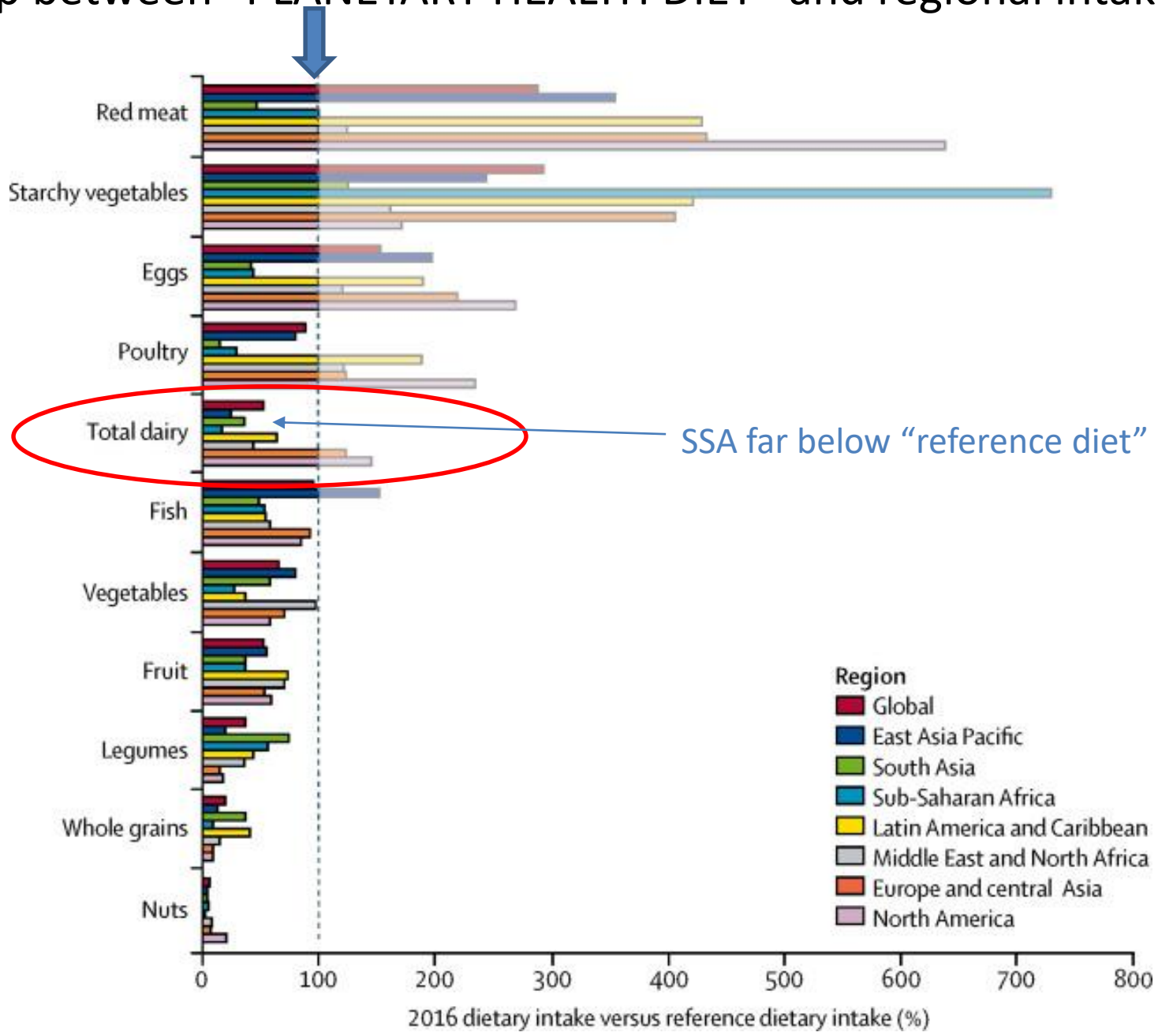
Be active!

Enjoy a variety of foods

Drinks lots of clean, safe water

Use salt and food high in salt sparingly

Gap between “PLANETARY HEALTH DIET” and regional intakes in 2016



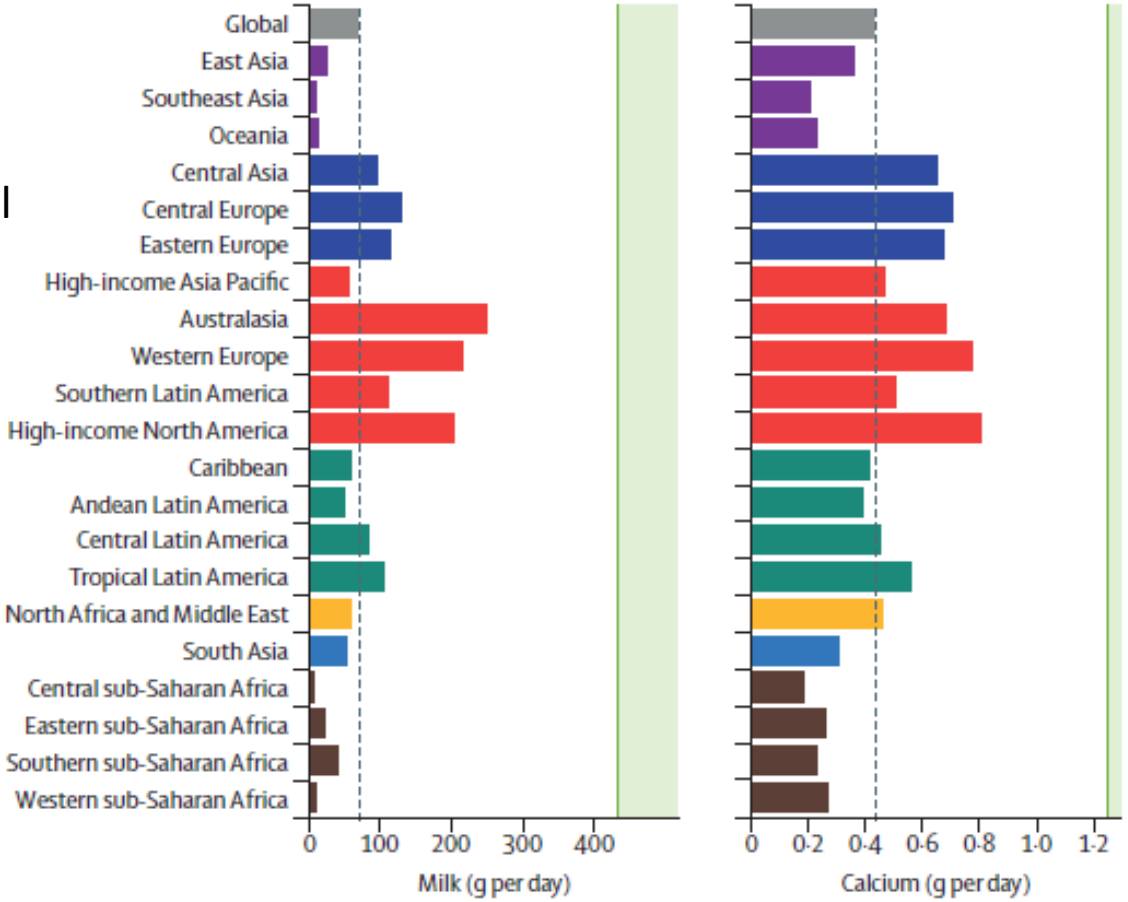
The Lancet 2019 393, 447-492DOI: (10.1016/S0140-6736(18)31788-4)

GBD Study: Health effects of dietary risks in 195 countries

(Lancet, 2019)

Optimal level of intake:

Milk: 435g (350-520g)



Optimal level of intake:

Calcium: 1250mg (1000-1500mg)

Sustainable diets:
How do we get there?

EAT-Lancet (2019):

Five *Global* Strategies for "Great Food Transformation by 2050"

1. "Seek international and national commitment to shift toward healthy diets"
2. "Reorient agricultural priorities from producing high quantities of food to producing healthy food"
3. "Sustainably intensify food production to increase high-quality output"
4. "Strong and coordinated governance of land and oceans"
5. "At least halve food losses and waste (align to SDG)"

Sustainable diets:

How will we (in South Africa) get there?

Promoting "healthy" nutrients / foods / diets

Government-driven:

- Food-based dietary guidelines

Challenges (SA):

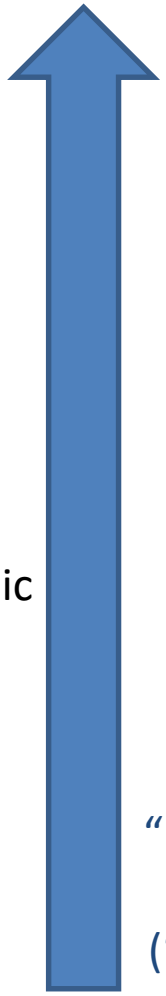
- ? Non-quantitative (how to measure progress?)
- ? Environmental considerations
- ? Economic (vested) interests

Consumer-driven:

- Empowered/nutrition-literate and environmentally aware public

Challenges:

- Cost / affordability
- Culture-sensitivity and -specificity
- Preferences; Resistance to change (old habits); Diverse society (Stages in Nutrition transition)
- Convenience



von Koerber et al(2017), adapted; Meybeck & Gitz (2017)

Other consumer / food-related suggestions from around the world → for debate (? Local relevance)

Regional and seasonal products

Organic foods

Minimally processed foods (Whole food system to be considered)

Fair trade products

Enjoyable eating

Resource-saving housekeeping

- Switch to renewable energy
- Saving energy & water in the kitchen (eg energy-efficient appliances)
- Plan shopping trips
- Prevent food waste
- Prevent packaging waste etc

(Von Koerber et al, 2017)

The other (non-food-related) factors

Sustainable food production

Earth system process	Control variable*
Climate change	Green house gas (GHG) emissions
Land system change	Cropland use
Freshwater use	Water use
Nitrogen cycling	N application
Phosphorus cycling	P application
Biodiversity loss	Extinction rate

* Each with boundary (cut-off range)

EAT-Lancet, 2019

Some (founded and unfounded) concerns:

"Centralised control of dietary choices" / "Decisions cast from above"

"One size does not fit all" / Rejection of "Global Dietary Guidelines"

"Nutritional inadequacy"

"Economic implications for producers and consumers"

"Local and regional preferences /cuisine and realities"

Industry does not want any food disparaged

Dietary guidance may move from a food group to an individual food approach (Sustainable diets vs Sustainable foods?)

?New political coalitions

Yet:

- Planetary diet = First *quantitative* set of targets that integrate "Healthy diet" with environmental concerns to create "Reference diet" (… for all people & for the planet)
- "*High level of certainly*" that global adoption will result in ↑global health **and** environmental benefits
- Ongoing debate encouraged for *global* commitment: Environment matters cannot be individualised
- Some uncertainties remain: Science & research remains self-correcting
- This is only the beginning of integrative research, but time is running out for the planet/environment

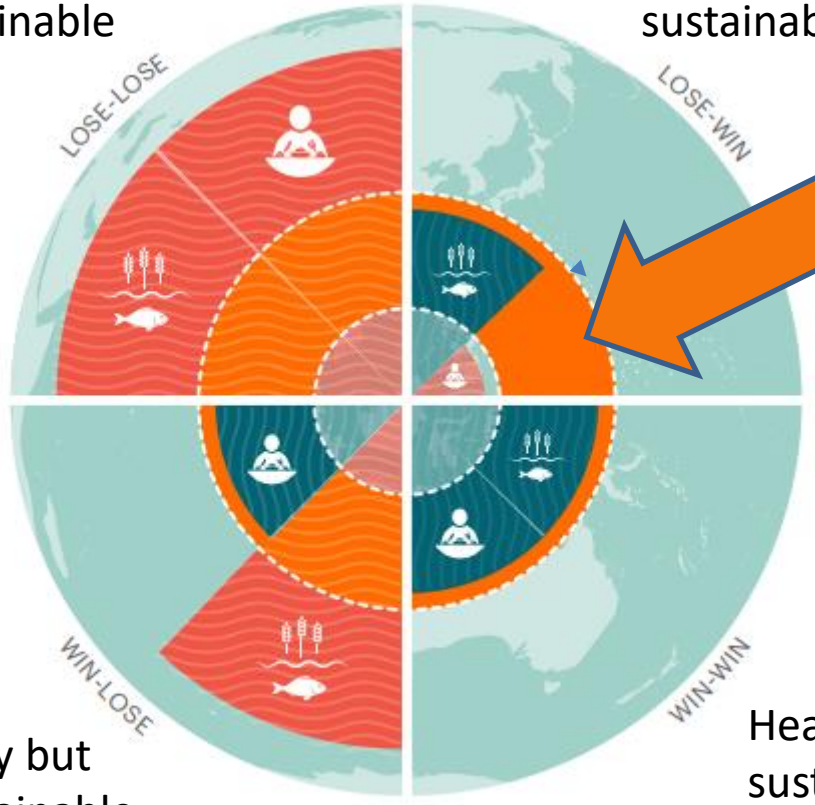
- Beware of "soufflé" arguments (they tend to deflate)

→ Invest in scientifically sound and ethical arguments …

The options….

Unhealthy and unsustainable

Unhealthy and sustainable



Orange ring = Safe operating space (boundary)

Healthy but unsustainable

Healthy and sustainable

Source (adapted): EAT-Lancet

The Future

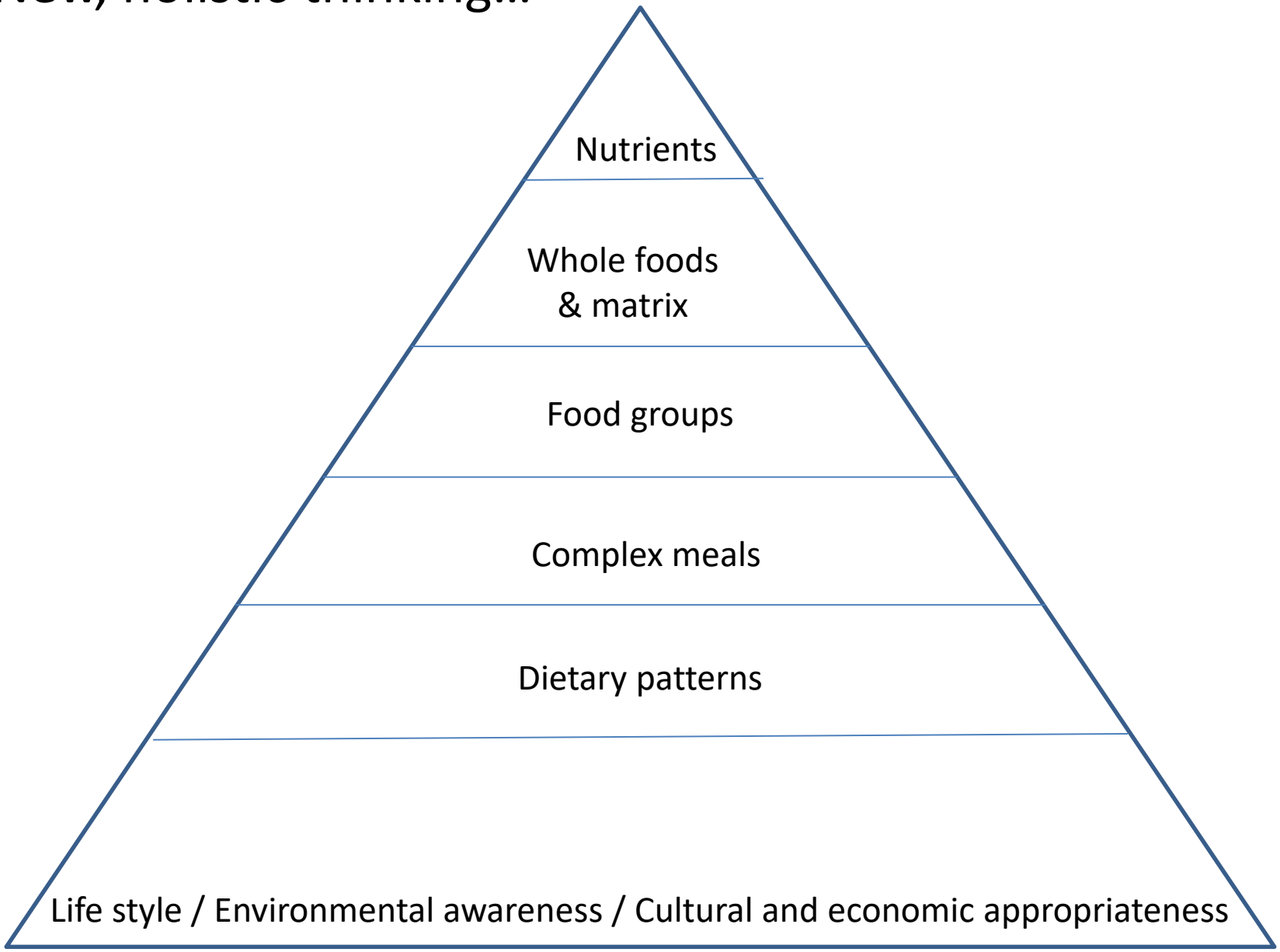
Towards mathematical / nonlinear optimisation modelling to design Sustainable diets through integration of

- adequacy / **H**ealth,
- **A**ffordability,
- (cultural) acceptability / **P**reference,
- environmental
- **R**eliable (safe & stable) criteria

(Chaudhary & Krishna, 2019; Donati et al, 2016; Gazan et al, 2018; Herforth et al, 2014; Mertens et al, 2016)

"**SHARP**"

New, holistic thinking…



DAIRY in HEALTH & NUTRITION

Complexity replaces reductionist simplicity:

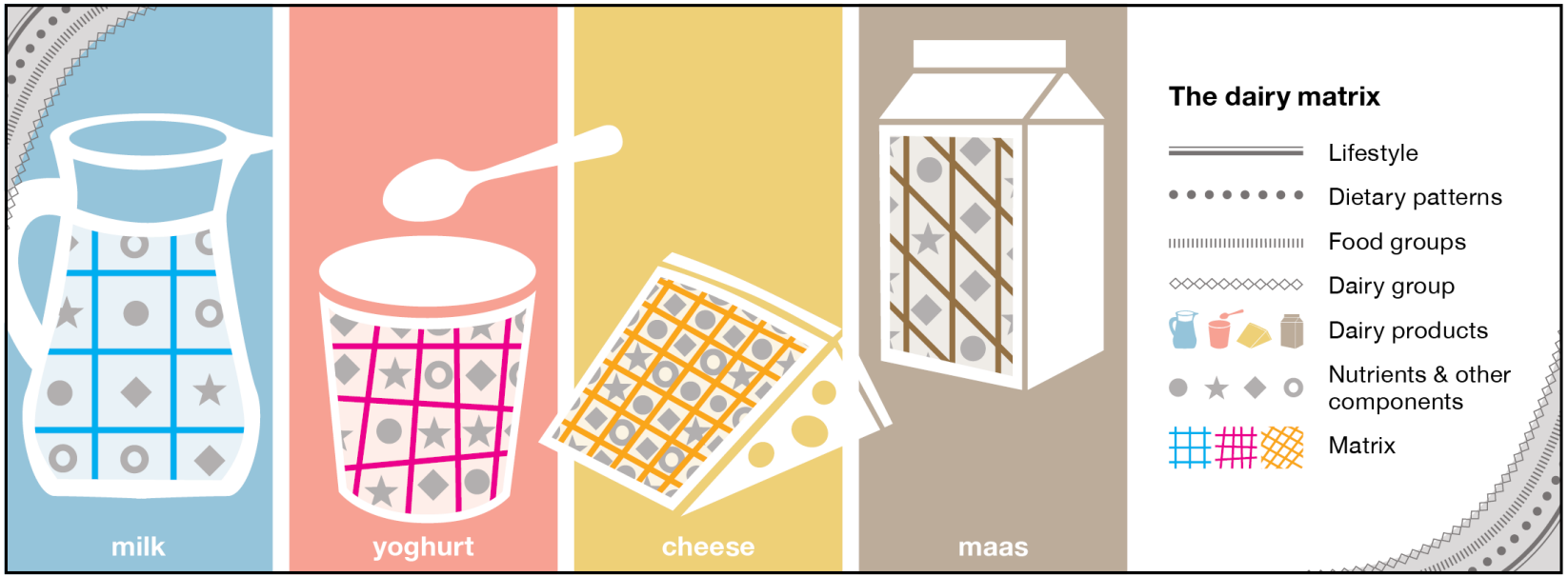
From nutrients,

to whole foods and their unique matrices

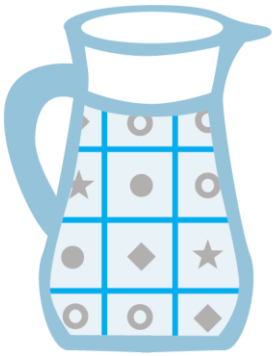
to dietary patterns & lifestyles…

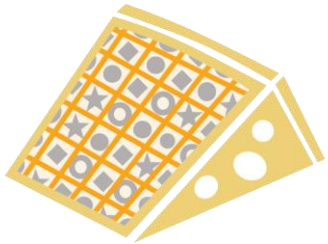
Taking people, the whole food system and the environment into consideration !

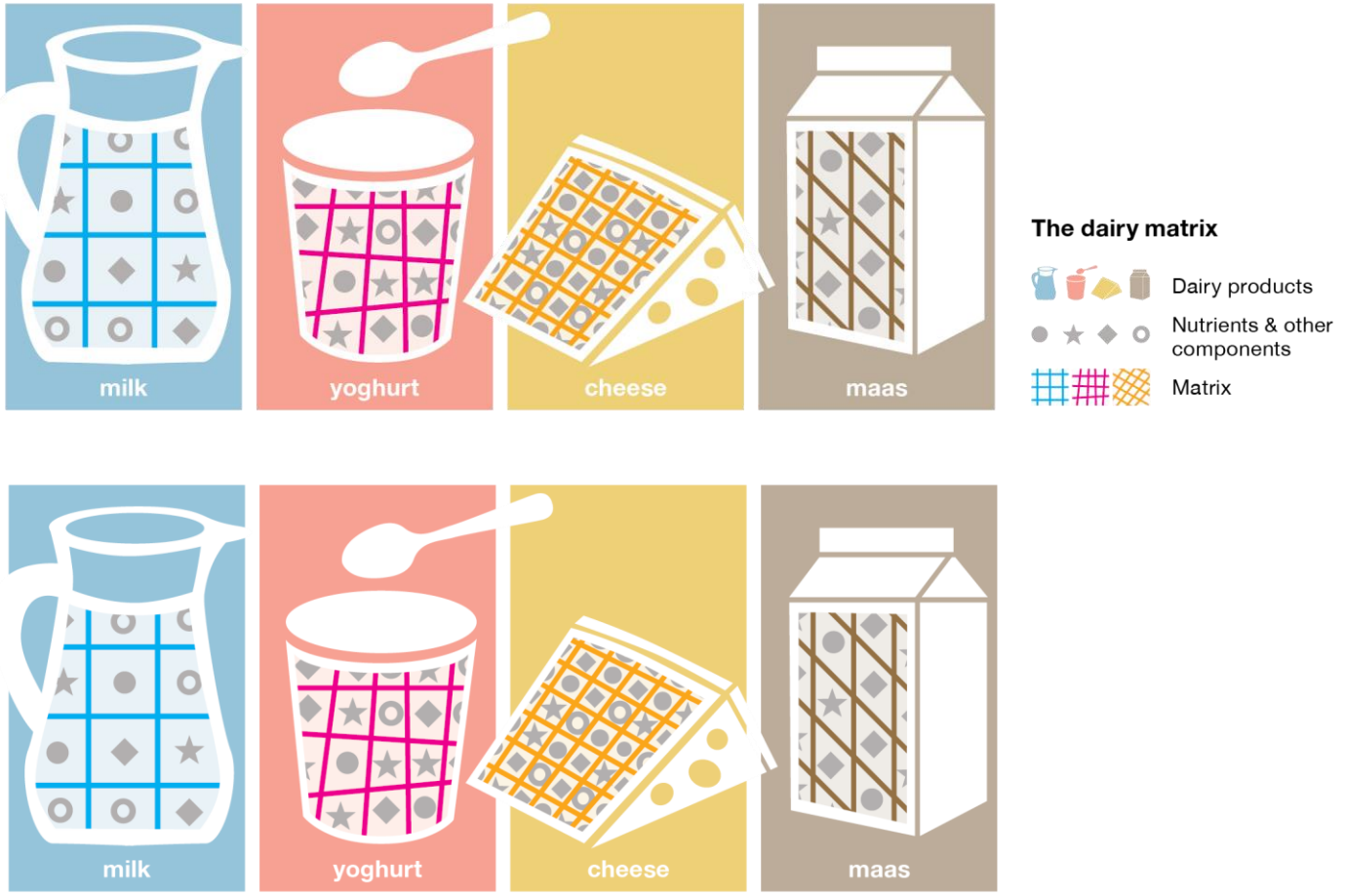
The choice and responsibility is yours!



Thank You






milk
yoghurt
cheese
maas
The dairy matrix
Dairy products
Nutrients & other components
Matrix
milk
yoghurt
cheese
maas