From sustainable diets to sustainable food systems: putting nutrition at the heart

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EUROPEAN WORKSHOP ON

BIOECONOMY

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From sustainable diets to sustainable food systems: putting nutrition at the heart

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What is said about nutrition and the environment?

(i) High contribution of food sector to greenhouse gas emissions GHGE (15-31%)

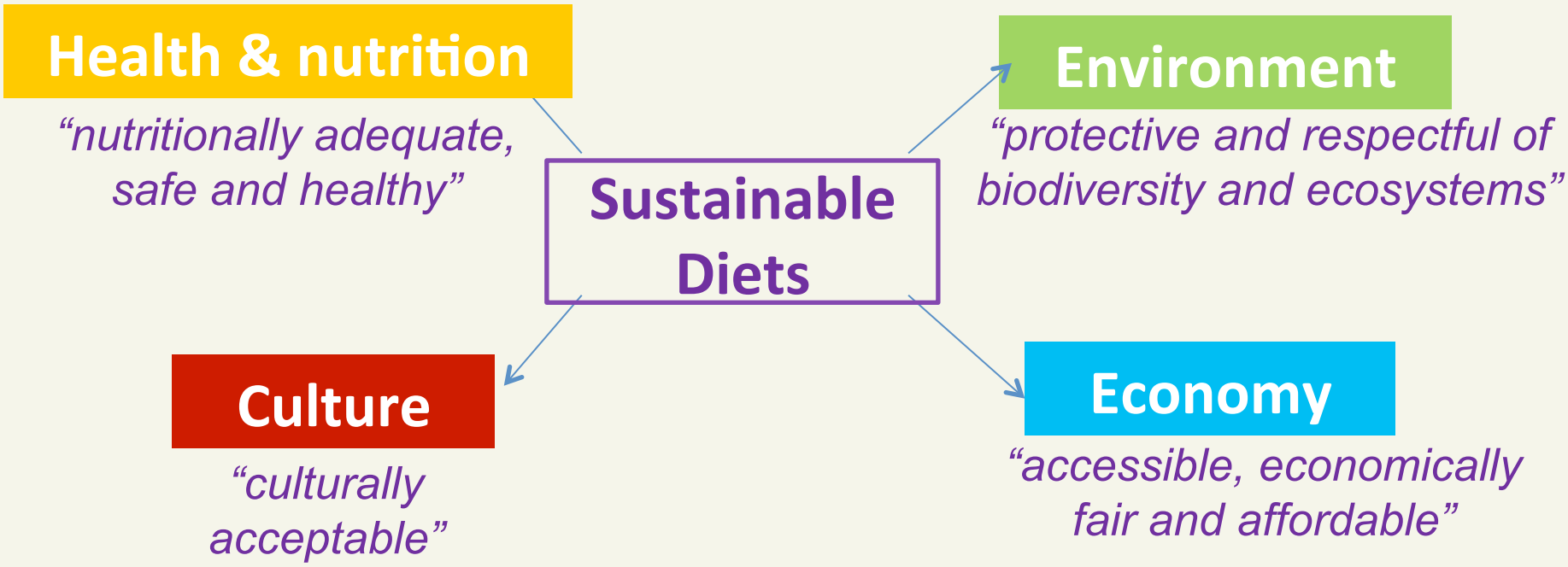
(ii) High GHGE of animal vs plant-based products:

(iii) Plant-based diets recommended for health

➔ Convergence between health and environmental objectives generally admitted

Definition of Sustainable diets

(FAO, 2010)



Sustainable diets: respect of the 4 dimensions

Sustainable diets metrics

Need for reliable indicators for each dimension

- Nutrient content of food
- Nutrient-based recommendations
- Energy Density, Nutrient density
- Nutritional quality scores

Health & Nutrition

- Greenhouse gas emissions (GHGE)
- Acidification, Eutrophication

Environment

Sustainable Diets

Culture

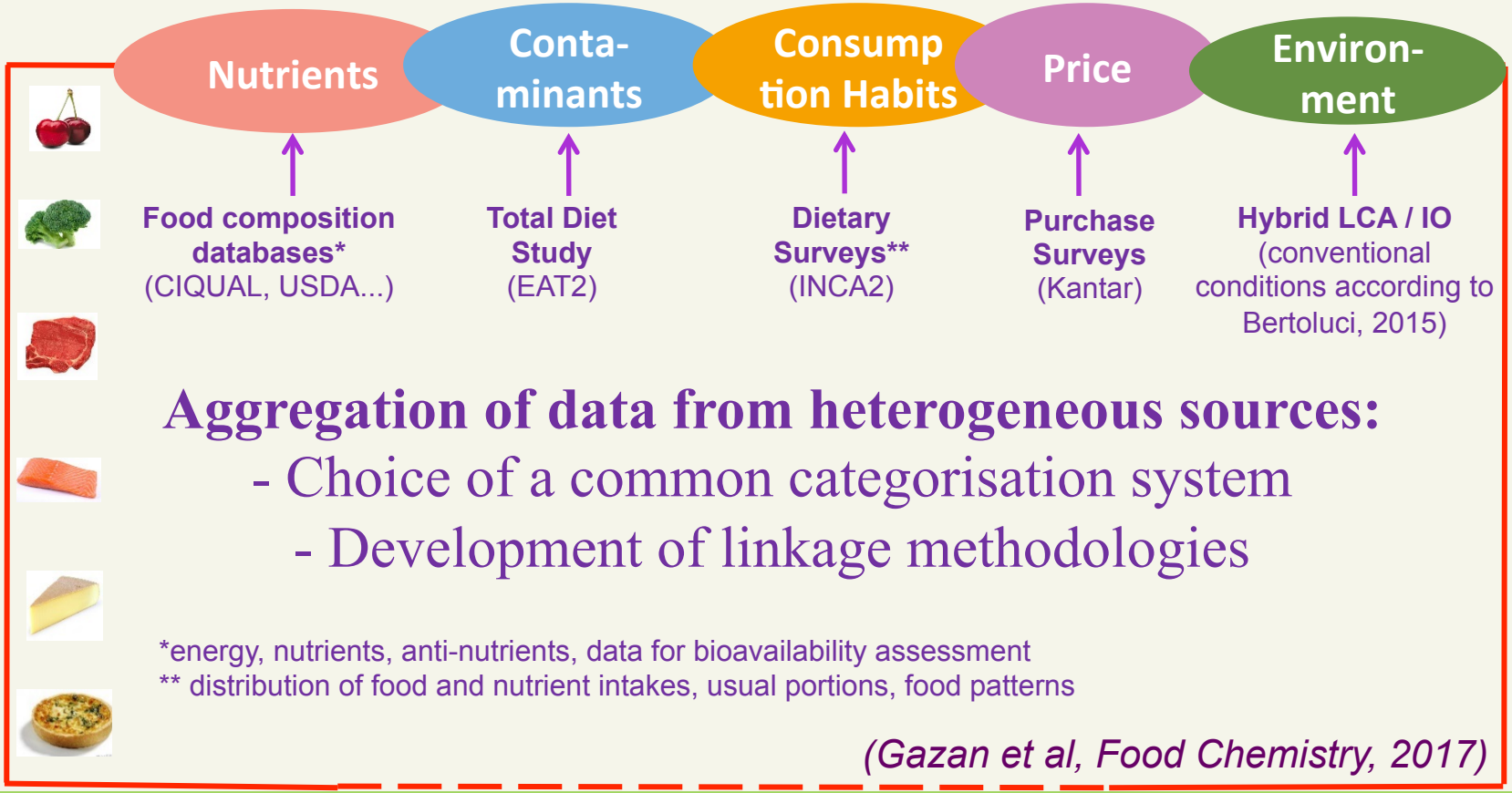
- Observed dietary intakes
- Commonly consumed food

Economy

- Budget for food
- Average food prices

Nutrition | Culture | Economy | Environment

Need for reliable and connected data



→ **Compilation of multiple metrics into a single database of generic foods for the study of sustainable diets in France**

Culture

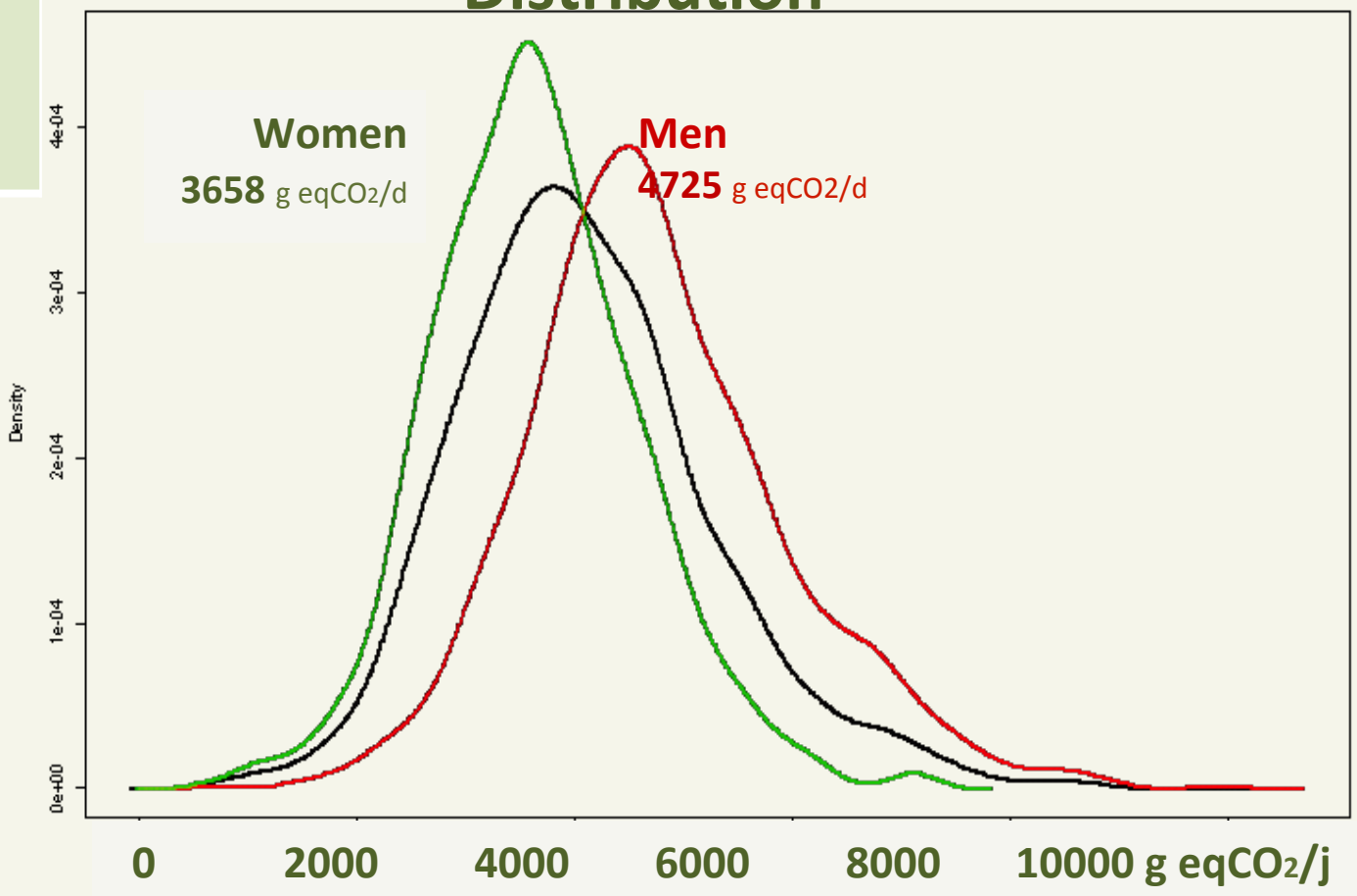
Environment

GHGE of self-selected diets in France

(Vieux et al, Ecol, Econ 2012)

Mean
daily GHGE
4090 g eq.CO_2

Distribution



➔ **High inter-individual variability**

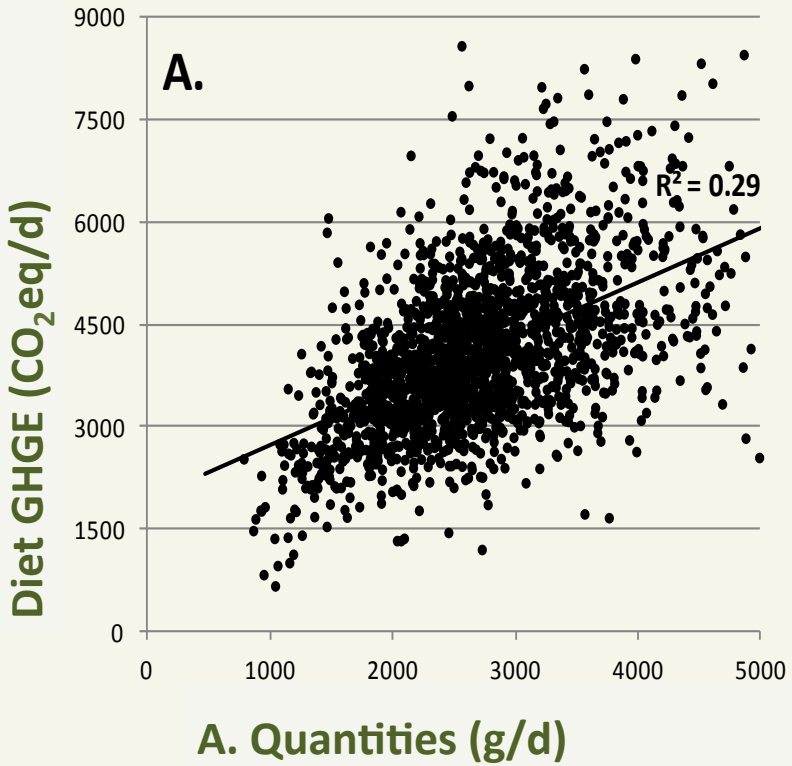
➔ **Diet-related GHGE higher for men than for women**

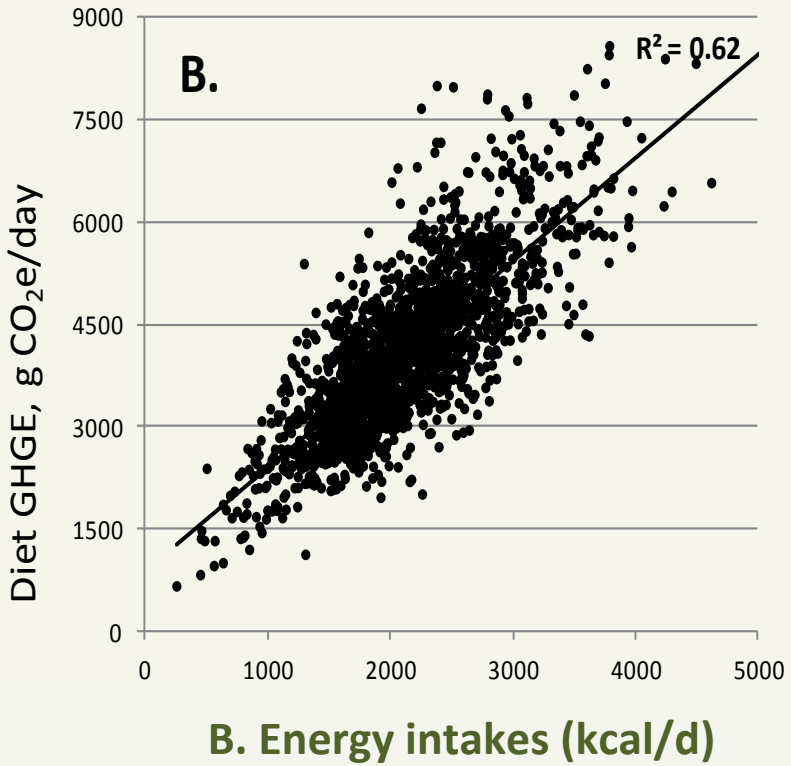
Culture

Environment

GHGE of self-selected diets in France

(Vieux et al, Ecol, Econ 2012)





➔ Strong positive correlation between quantities and GHGE

➔ Waste less and eat less for a lower environmental impact

Nutrition
Culture
Environment

Nutritional adequacy and GHGE of self-selected diets

(Vieux et al, AJCN 2013)

Correlation between nutritional quality indicators and diet-related GHGE

	MAR Mean Adequacy Ratio	MER Mean Excess Ratio	ED Energy Density
Diet GHGE	0.27	-0.14	-0.33

(age, sex and energy-adjusted)

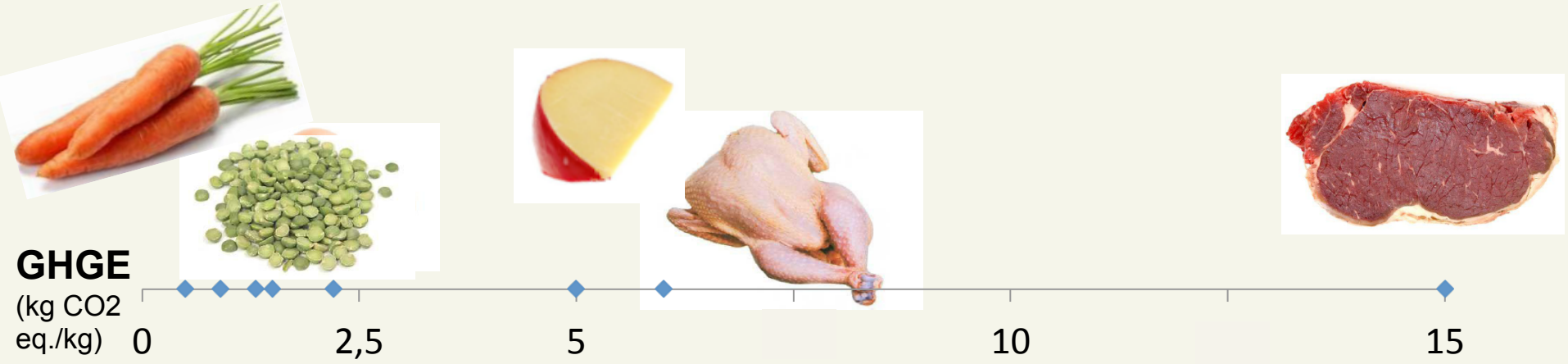
➔ Unexpectedly, in self-selected French diets, higher nutritional quality was associated with higher GHGE

➔ WHY? Answer at the food level?

What is said about nutrition and the environment

(i) High contribution of food sector to GHGE (15-31%)

(ii) High GHGE of animal vs plant-based products:

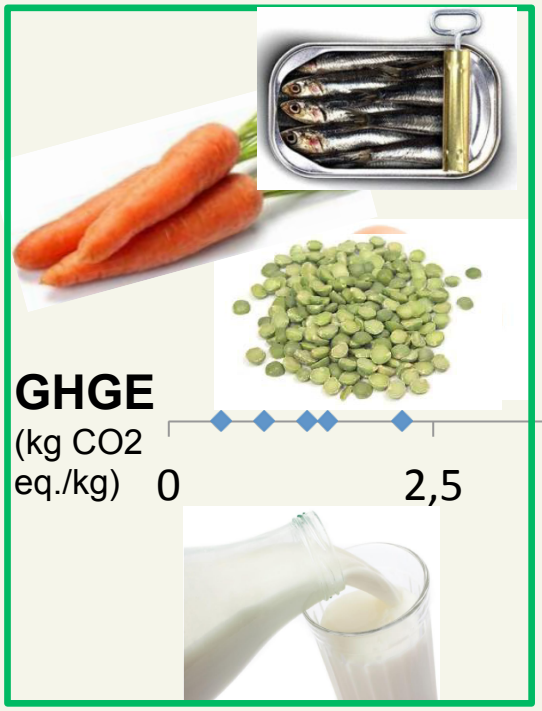


CO_2 data: Bertoluci, 2016

(iii) Plant-based diets recommended for health

Something wrong with current reasoning?

(ii) High GHGE of animal vs plant-based products?

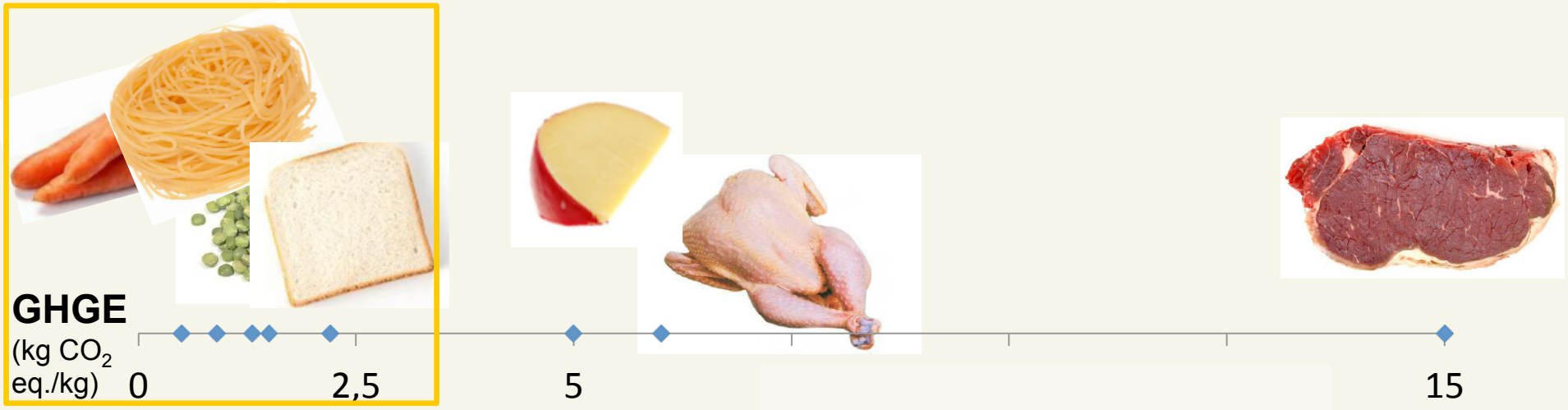


CO_2 data: Bertoluci, 2016

➔ Not all animal products have high carbon impact

Something wrong with current reasoning?

(iii) Plant-based diets recommended for health?



CO_2 data: Bertoluci, 2016

➔**The most consumed** (and the cheapest) **plant-based products have low environmental impact but aren't the most recommended for health**

Something wrong with current reasoning?

(iii) Plant-based diets recommended for health?

CO_2 data: Bertoluci, 2016

➔ **The least healthy plant-based products are among the least impacting ones** (and the cheapest calorie sources)

Nutrition | Culture | Economy | Environment

Reconciling the 4 dimensions within a diet?

Quantity for 2300 kcal

0,75 kg → 1,45 kg ← 1,85 kg

THE FRENCH *SUSTAINABLE* DIET?

Energy density

300 kcal/100g → 160 kcal/100g ← 125 kcal/100g

(WRCF/IARC recommendation)

➔Need to act both on food choice and quantities

- ➔ Nutritional epidemiology to identify positive deviants
- ➔ Diet modelling to design sustainble diets

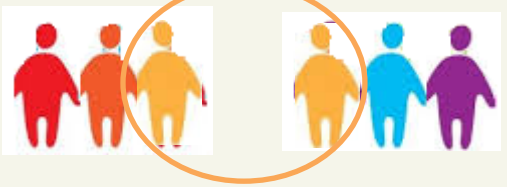
Identification of 'positive deviants'

(Masset et al, AJCN 2014)

General Population

Dietary survey (INCA2)

Catégorisation of individual diets



PANDiet > median + GHGE < median

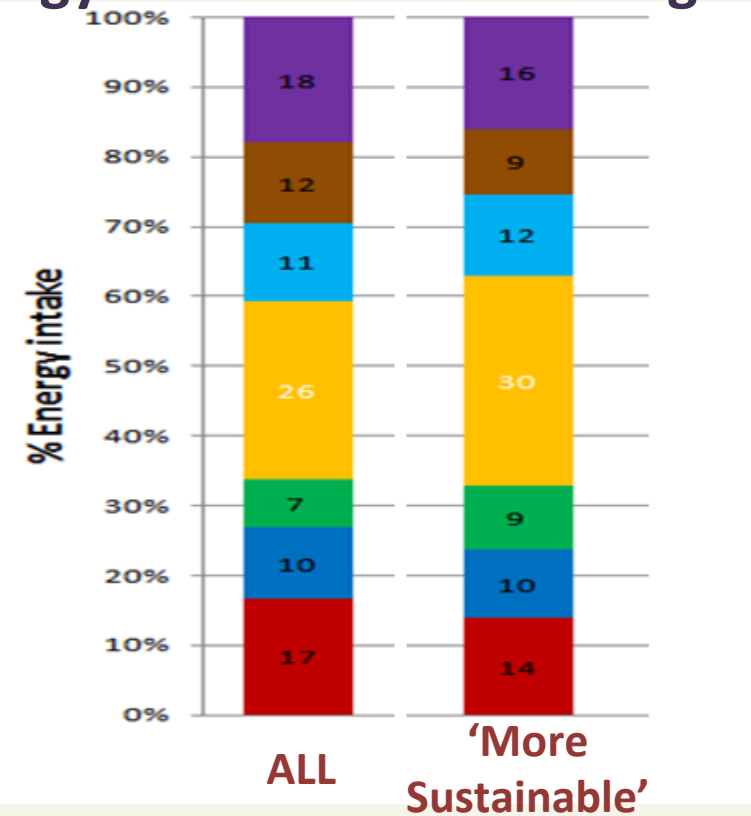
➔Positive deviants have dietary-GHGE 20% lower vs mean:

- **Half because they eat less** (200 and 300 kcal less for M&W respect.)
- **Half beause they eat diferently**

Nutrition | Culture | Economy | Environment

Energy contribution of food groups

(Masset et al, AJCN 2014)



- Snacks, sweets, desserts ↘
- Mixed dishes ↘
- Fats, condiments =
- Starchy foods ↗
- Fruit, vegetables, nuts ↗
- Dairy products =
- Meat, fish, eggs ↘

% weight from plants : 53% => 58%

Diet cost : 6,7€/d => 6,2 €/d

➔ More sustainable self-selected diets (GHGE reduced by 20%): small decrease of animal products and small increase of plant-based products

Is it possible to reduce GHGE ***by more than 20%*** *while reaching nutritional adequacy?*

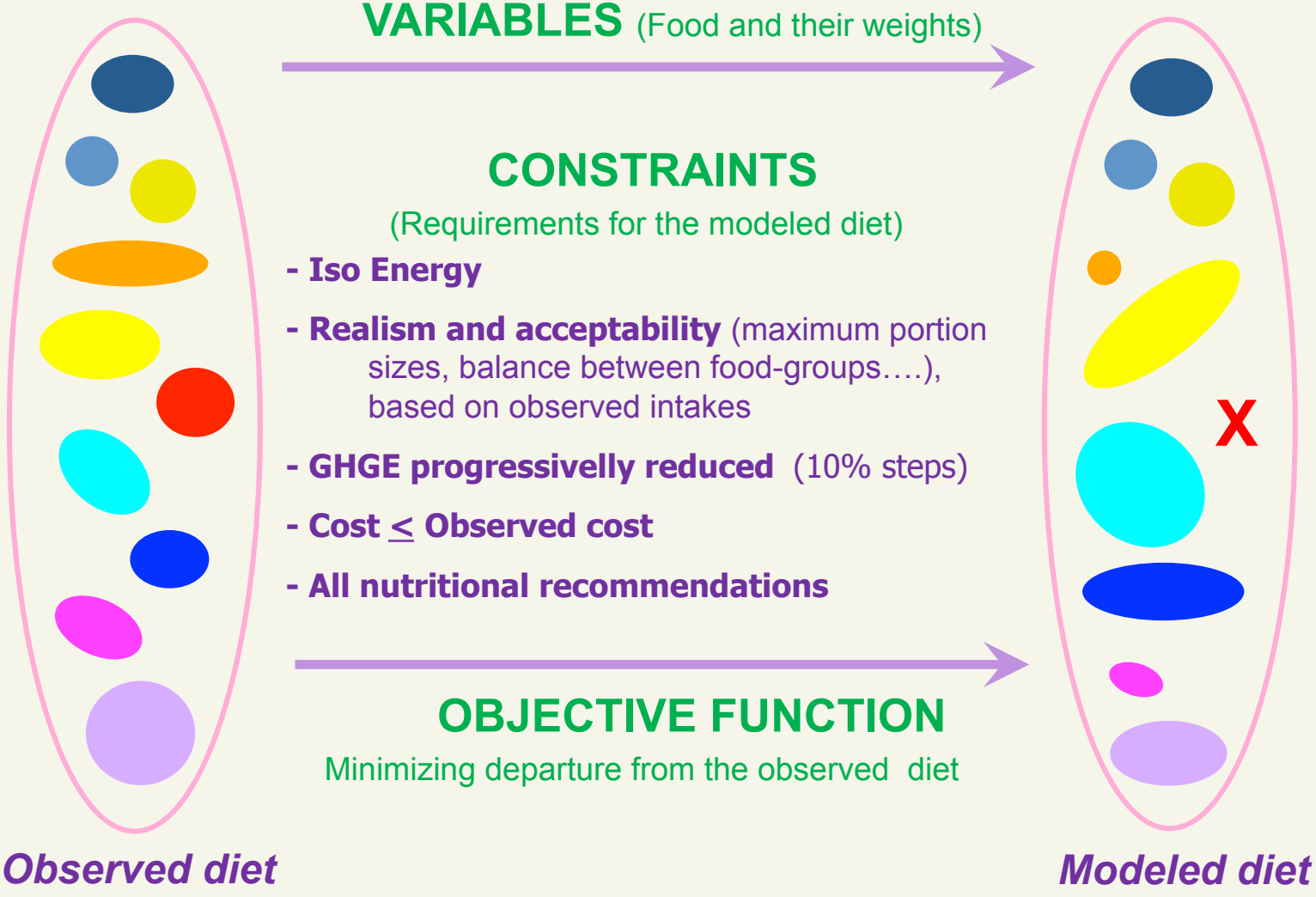
ANSWER WITH:

➔ **Diet modeling with linear programming (LP)**

Nutrition Economy Environment Culture

➔ Diet modelling with LP

Perignon et al, Pub Health Nutr 2016



Nutrition
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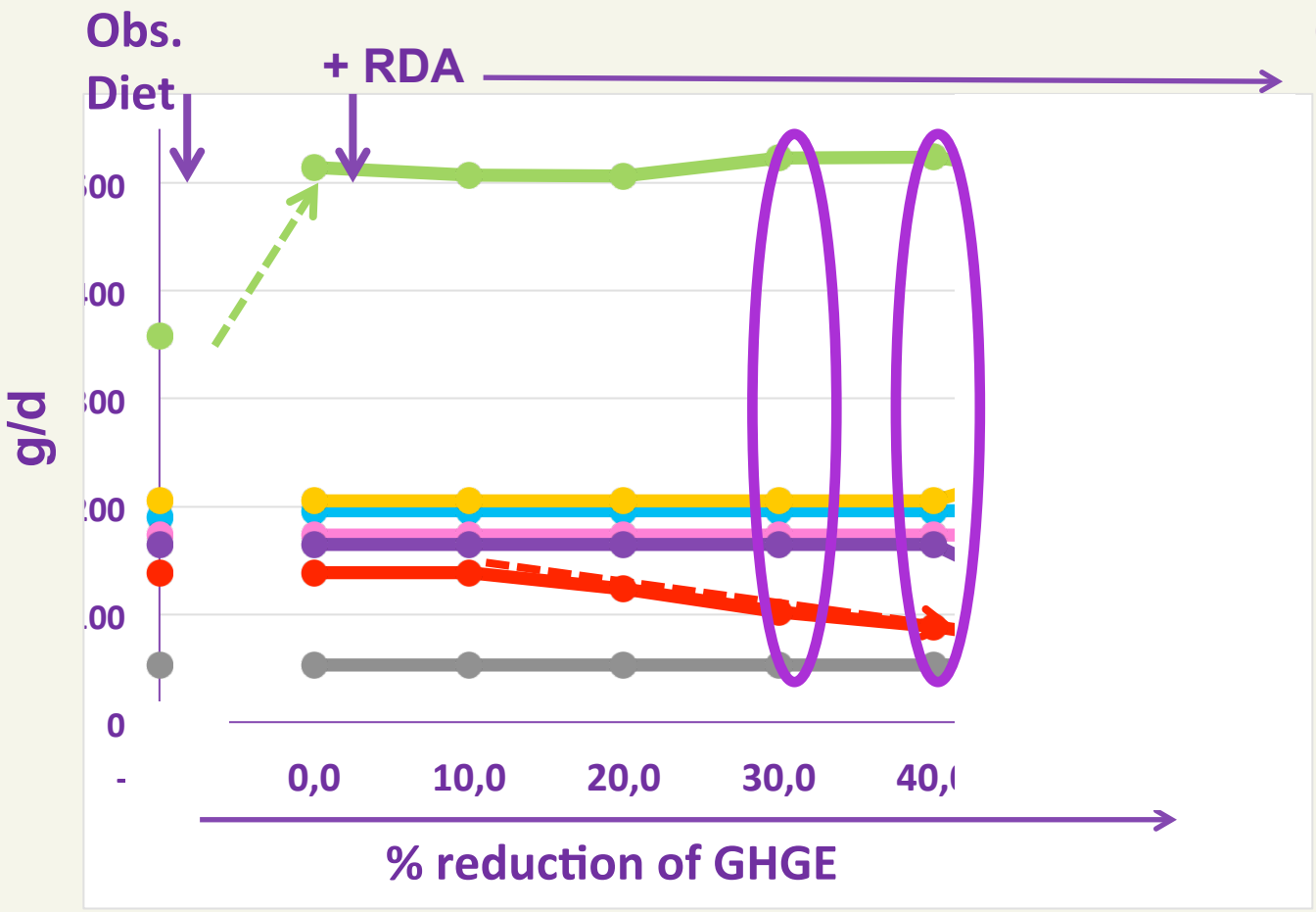
Culture

→ The ADEQ model



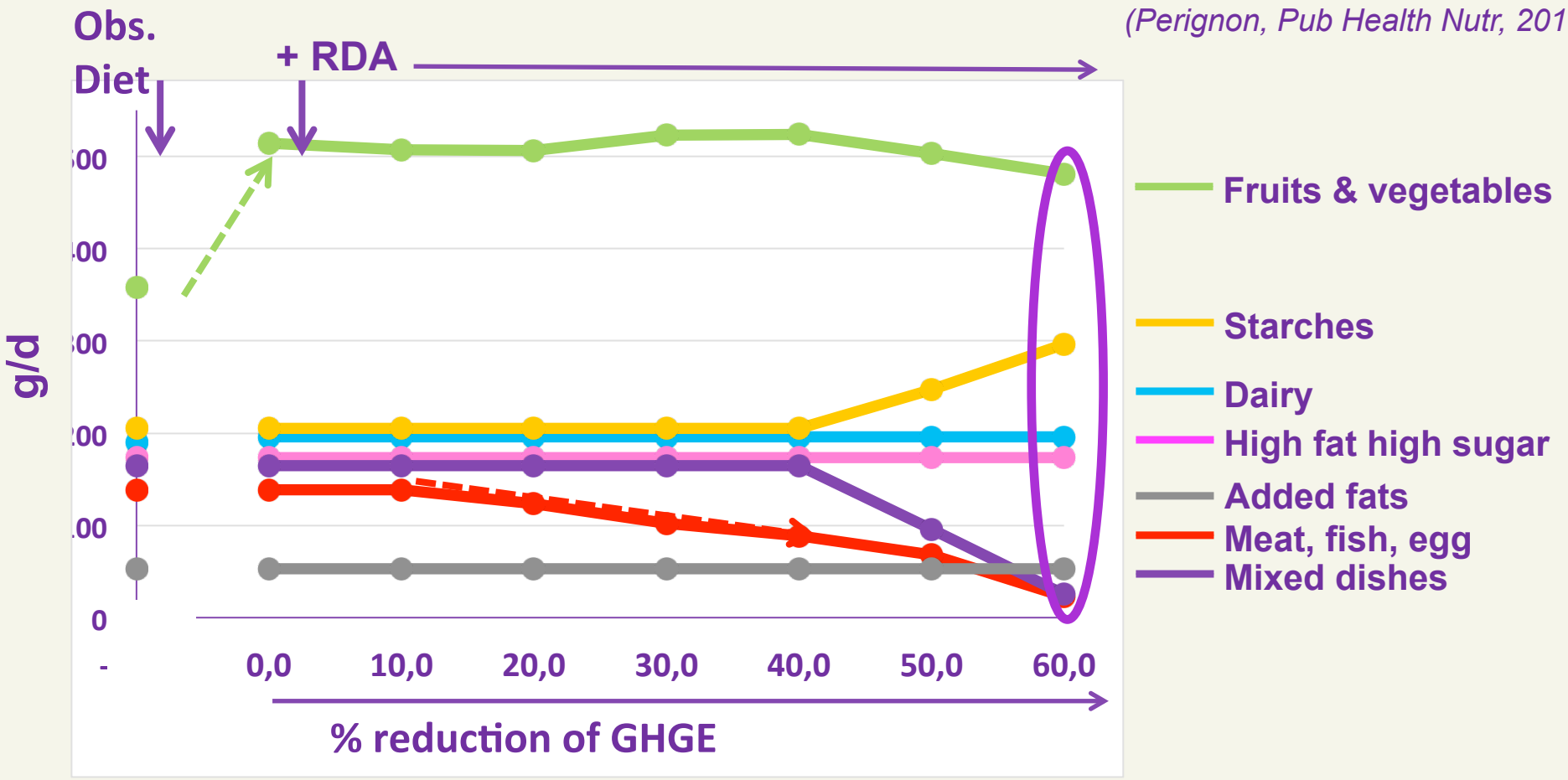
(Perignon, Pub Health Nutr, 2016)

→ 30-40% GHGE reduction: possible to design a nutritious diet without increasing cost, with moderate deviation from current intakes

=> More F&V, Less Meat (proteins decreased from 150% to 125%RDA)

Nutrition
Environment
Economy
Culture

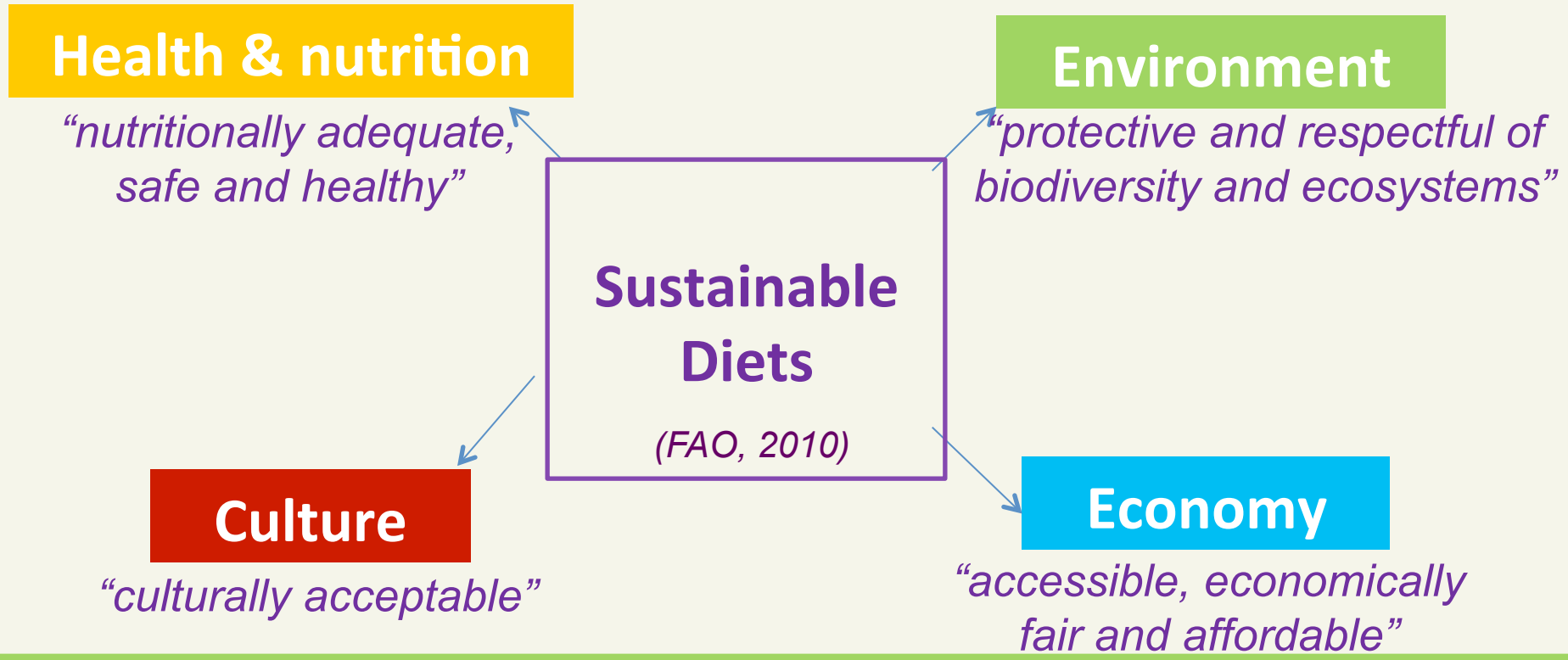
➔ The ADEQ Model



(Perignon, Pub Health Nutr, 2016)

➔60% reduction: greater departure from observed food intakes:
=> Perhaps not sustainable?

Conclusion



- ➔ Diet is the right "functional unit" to consider
- ➔ Extreme dietary scenarios aren't sustainable
- ➔ 30-40% GHGE reduction possible via food choices changes
- ➔ For greater reductions, actions on the food supply are required

Priority research for the next 10 years? INTEGRATION

Which tools for research & development are lacking? DATABASES

- Nutrient bioavailability
- Contaminants (heavy metals, pesticides, mycotoxins, PCBs, dioxin-like coumpounds)
- Toxicological references values

- Acidification, Eutrophication
- Land use, Water use
- Biodiversity
- Organic vs conventional
- Local vs global…

Nutrition

- Supplements
- New foods…

Environment

Sustainable Diets

Culture

- Individual food preferences
- Social and religious restrictions
- Norms and beliefs…

Economy

- Socio-economic position of consumers
- Income & working conditions of producers
- Actual food prices, 'Fair' price
- Co-production links

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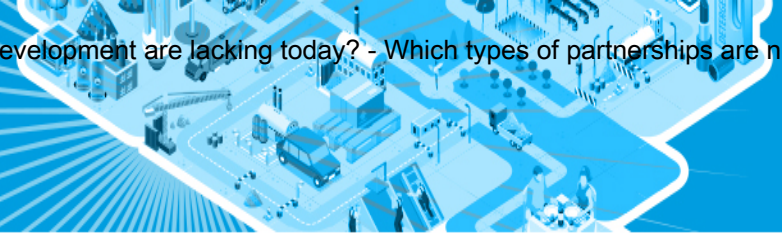


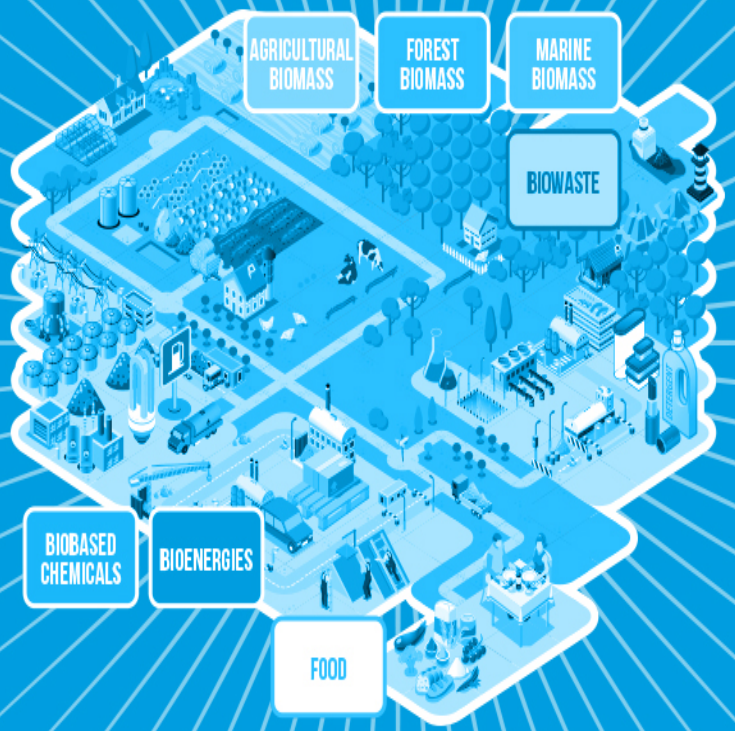
Which types of partnerships are necessary for the development of bioeconomy?

Best way to understand something: modifying/improving it

Which new stakeholders?

In addition to producers, industry, retailers, consumers…

Health and diet professionals, urban planners and architects



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Merci pour votre attention

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THANK YOU
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Many thanks to:

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Gabriel Masset
Nestlé Research Center
Lausanne, Switzerland

LIMITS and PERSPECTIVES

➔ Food safety?

➔ Nutrient bioavailability?

- Supplements
- New food…

- Acidification, Eutrophication
- Land use, Water use
- Biodiversity
- Organic vs conventional
- Local vs global…

Nutrition

Environment

Sustainable Diets

Culture

Economy

- Individual food preferences
- Social and religious restrictions
- Norms and beliefs…

- Budget for food
- Socio-economic position of consumers
- Co-production links
- Income & working conditions for producers

…

Adressing the limits → Food safety

Which compatibility with nutritional adequacy?

JN THE JOURNAL OF NUTRITION

The Journal of Nutrition. First published ahead of print September 14, 2016 as doi: 10.3945/jn.116.234294.

The Journal of Nutrition
Methodology and Mathematical Modeling

Reaching Nutritional Adequacy Does Not Necessarily Increase Exposure to Food Contaminants: Evidence from a Whole-Diet Modeling Approach[1–3]

Tangui Barré,[4] Florent Vieux,[5] Marlène Perignon,[4] Jean-Pierre Cravedi,[6] Marie-Josèphe Amiot,[4] Valérie Micard,[7] and Nicole Darmon[4]*

Conclusions: Based on a broad range of nutrients and contaminants, this first assessment of compatibility between nutritional adequacy and toxicological exposure showed that reaching nutritional adequacy might increase exposure to food contaminants, but within tolerable levels. However, there are some food combinations that can meet nutritional recommendations without exceeding observed exposures. *J Nutr* doi: 10.3945/jn.116.234294.

Adressing the limits ➔ Bioavailability

How taking it into acount?

- **IRON absorption ➡ algorithm**[2] taking into account **inhibiters / enhancers** content in diet

*ln (non-heme iron absorption) = 6.294 + 0.119*ln (vitamin C) + 0.006*ln (Meat/Fish/Poultry + 0.1) – 0.055*ln(tea +0.1) – 0.247*ln(phytate) – 0.137*ln(Calcium) – 0.083*ln(non-heme iron) – 0.709*ln (serum ferritin)*

- **ZINC absorption ➡ algorithm**[3] taking into account **inhibiters / enhancers** content in diet

$$TAZ = 0.5 \cdot \left(A_{MAX} + TDZ + K_R \cdot \left(1 + \frac{TDP}{K_P}\right) - \sqrt{\left(A_{MAX} + TDZ + K_R \cdot \left(1 + \frac{TDP}{K_P}\right)\right)^2 - 4 \cdot A_{MAX} \cdot TDZ} \right).$$

*TDZ: **Total Dietary Zinc** ,*
*TDP: Total Dietary **Phytate**,*
A_{max}=0.13, K_r=0.10

- **PROTEIN quality ➡ score**[1] taking into account **amino acid content and protein digestibility**

Protein Digestibility Corrected Amino Acid Score (**PDCAAS**) =
% digestibility x amino acid score

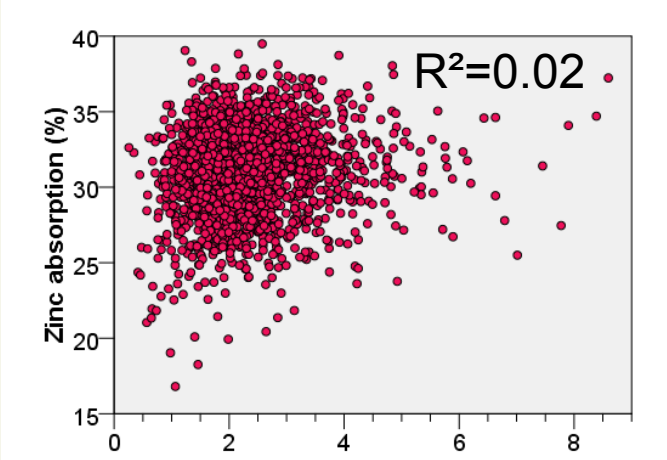
References:
[1]*FAO/WHO/UNU Expert Consultation (2007).* Protein and amino acid requirements in human nutrition: joint FAO/WHO/UNU expert consultation
[2]*Armah et al. (2013). A complete diet-based algorithm for predicting nonheme iron absorption in adults. The Journal of nutrition, 143(7), 1136–40*
[3]*Miller et al. (2007). A mathematical model of zinc absorption in humans as a function of dietary zinc and phytate. J Nutr, 137(1), 135–41*

Adressing the limits ➔ Bioavailability

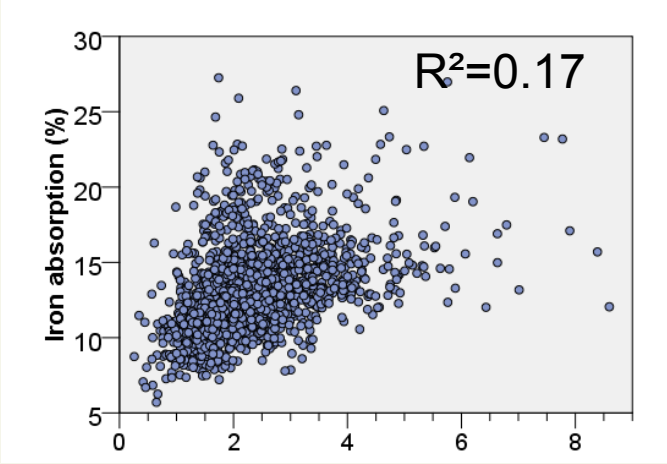
FIRST RESULTS:

(Perignon, submitted paper)

ZINC absorption
(French diets, n=1899)



IRON absorption
(French diets, n=1899)



➔ **Variation of bioavailability poorly explained by the animal-to-plant ratio**
➔ Large variability of bioavailability for a similar level of animal-to-plant protein ratio
➔ High bioavailability observed for A/P <1