Studying dietary shifts to improve nutrition and sustainability: how do we best measure it?

Nicole Darmon
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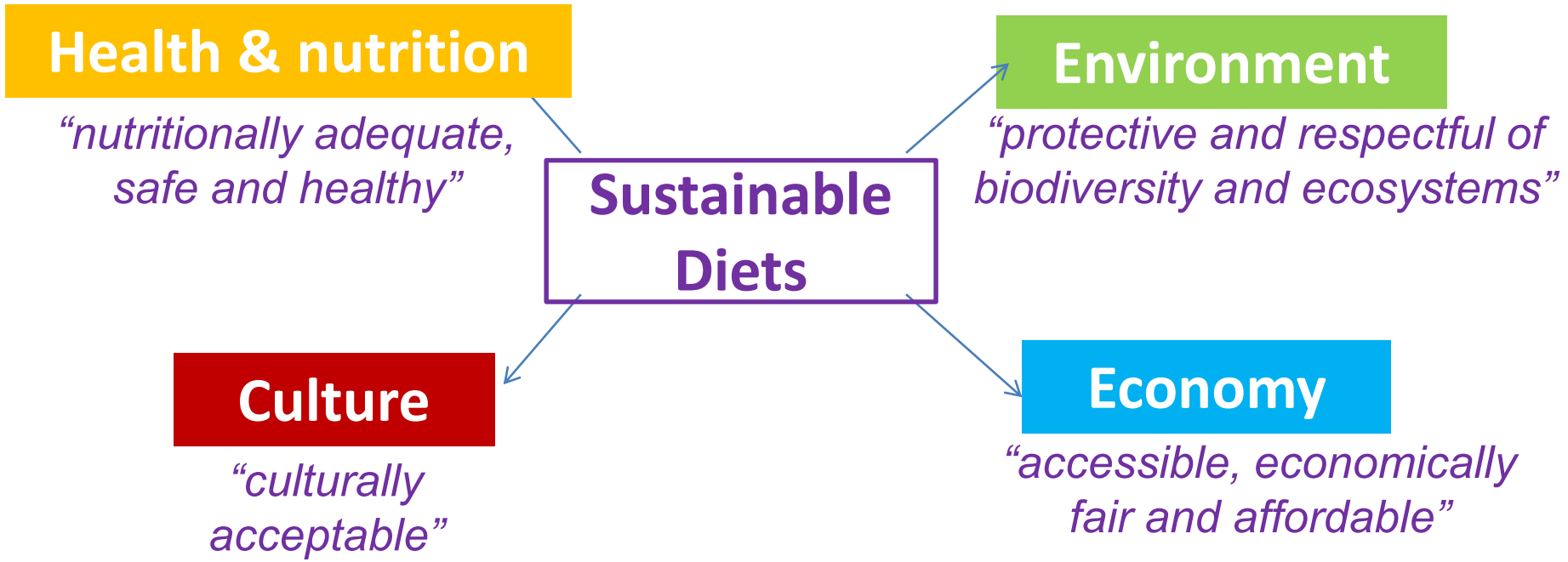
Sustainable diet concept

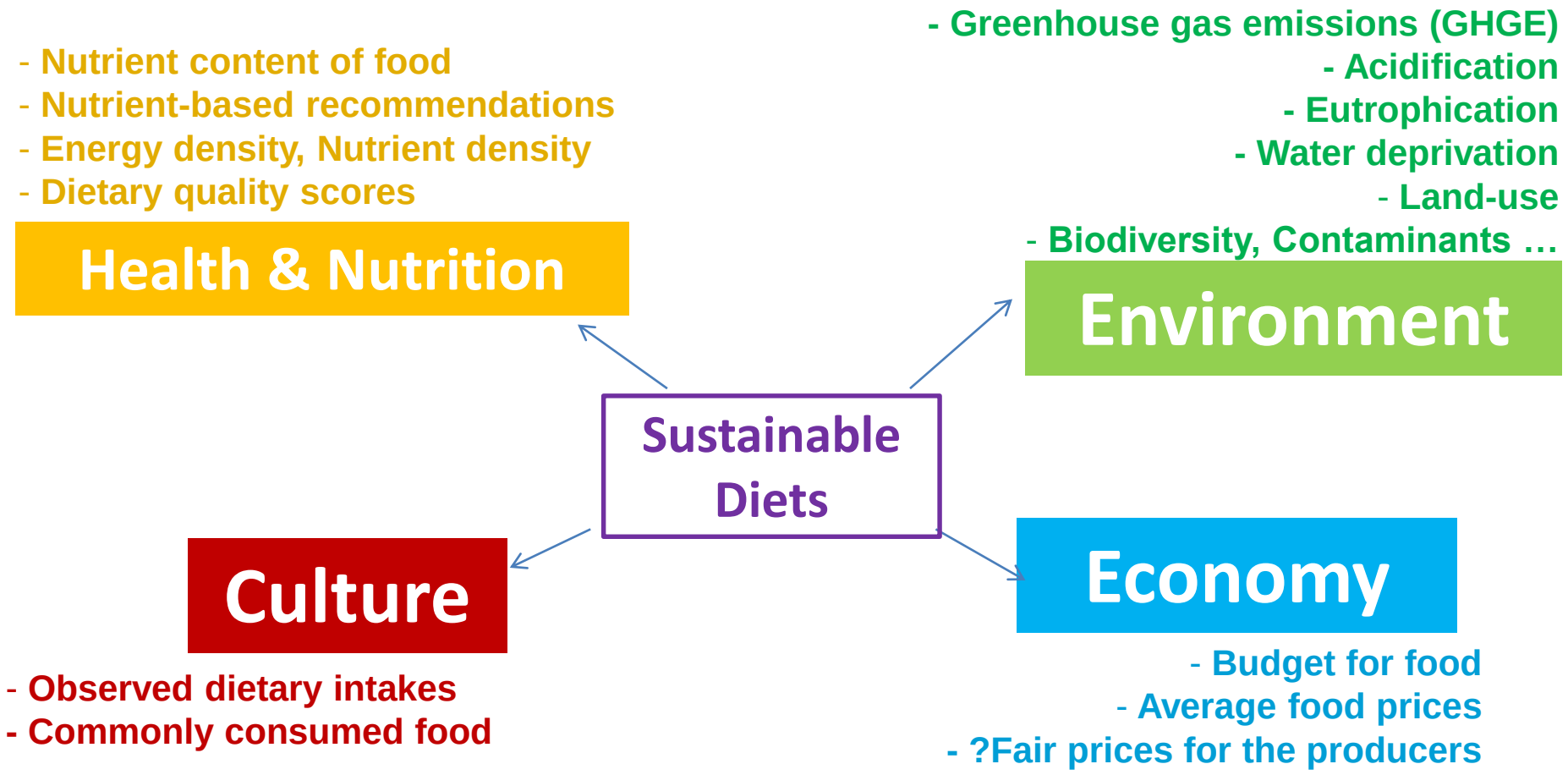
(FAO, 2010)



➡ Sustainable diets: respect of the 4 dimensions

Sustainable diets metrics

(Gazan et al, Food Chemistry, 2018)



➔ Study of sustainable diets made possible by the compilation of multiple sustainable metrics within a single database


Special Article
Advantages and limitations of the methodological approaches used to study dietary shifts towards improved nutrition and sustainability
Marlène Perignon and Nicole Darmon Nutr Rev, 2022)

Methods used to explore diet sustainability

n°1: Designing theoretical diets based on *a priori* scenario

⇒ Theoretical diets fulfilling a priori scenarios (*eg* meat replaced by plant products, …)

⇒ Theoretical diets meeting guidelines (*eg* Mediterranean pyramid, FBDGs, EAT Lancet …)

n°2: Describing the sustainability characteristics of existing diets

⇒ Existing diets classified by nutritional quality, by GHGE …

n°3: Identifying the best existing diets

⇒ Positive deviance approach

n°4: Designing theoretical diets without a *priori*

⇒ Mathematical optimization of diets fulfilling sustainability constraints

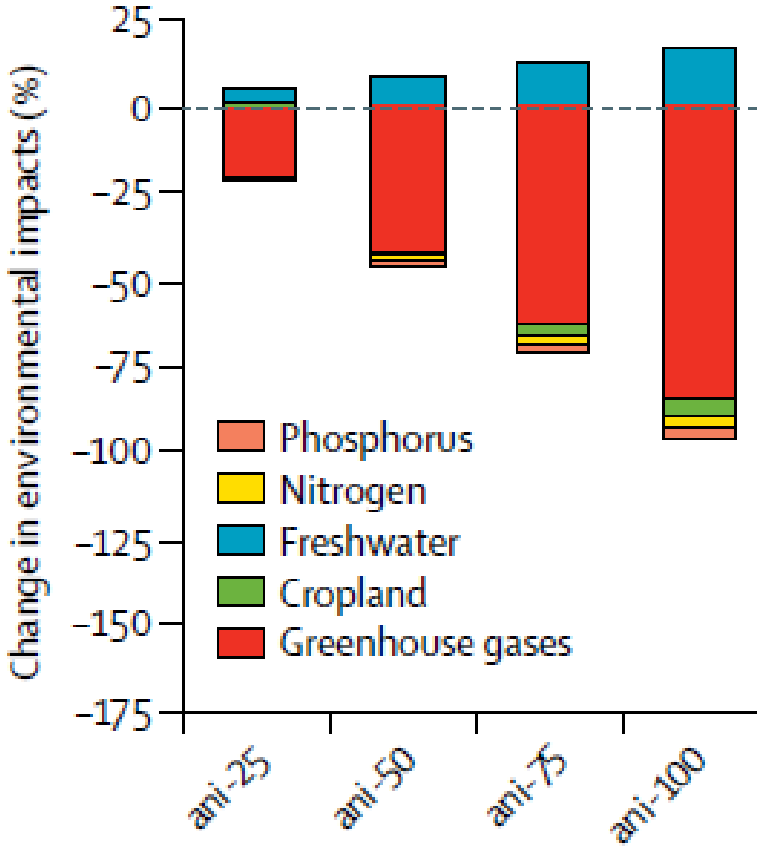
Approach n°1: Designing theoretical diets based on a priori scenario

⇒ Theoretical diets fulfilling a priori scenarios (eg meat replaced by plant products, …)

⇒ Theoretical diets meeting guidelines (eg Mediterranean pyramid, FBDGs, EAT Lancet …)

Example for approach 1: meat replaced by plants *(Springmann et al (2018) The Lancet Planetary Health)*

Environment



➔ Most environmental metrics improved

➔ But water deteriorated

Nutrition

Nutrient	Recommendation	Scenarios			
		ANI-25	ANI-50	ANI-75	ANI-100
Calories, kcal	2084	2257	2257	2257	2257
Protein, g	>52	67·9	66·6	65·3	64·1
Carbohydrates, g	<391	341	356	371	386
Fat, g	…	62·7	56·4	50·1	43·8
SFA, g	<23	19·3	16·0	12·7	9·5
MUFA, g	…	23·7	20·7	17·7	14·6
PUFA, g	>14	16·7	16·8	16·8	16·8
Vitamin C, mg	>42	124	147	170	192
Vitamin A, µg	>544	622	680	733	786
Folates, µg	>364	410	504	598	692
Calcium, mg	>520	546	518	489	460
Iron, mg	>17	18·1	19·3	20·5	22·6
Zinc, mg	>6,1	10·8	10·6	10·5	10·4
Potassium, mg	>3247	2951	3283	3614	3945
Fibres, g	>29	31·5	36·1	40·7	45·4
Copper, mg	>0.8	1·8	2·1	2·3	2·5
Phosphorus, mg	>757	1334	1347	1361	1374
Thiamin, mg	>1.1	1·4	1·5	1·6	1·6
Riboflavin, mg	>1.1	0·9	0·9	0·9	0·9
Niacin, mg	>14	18·6	18·4	18·1	17·9
Vitamin B6, mg	>1.2	5·2	4·3	3·3	2·4
Magnesium, mg	>205	489	528	567	606
Pantothenate, mg	>4.7	6·4	6·1	5·8	5·5
Vitamin B12, µg	>2.2	2·8	1·8	0·9	0

➔ Proteins OK, adequacy not ensured for all nutrients

➔ Iodine, vit D, omega-3 fatty acids, sugar, Na: not assessed

Approach n°1: Designing theoretical diets based on a priori scenario

⇒ Theoretical diets fulfilling a priori scenarios (eg meat replaced by plant products, …)

⇒ Theoretical diets meeting guidelines (eg Mediterranean pyramid, FBDGs, EAT Lancet …)

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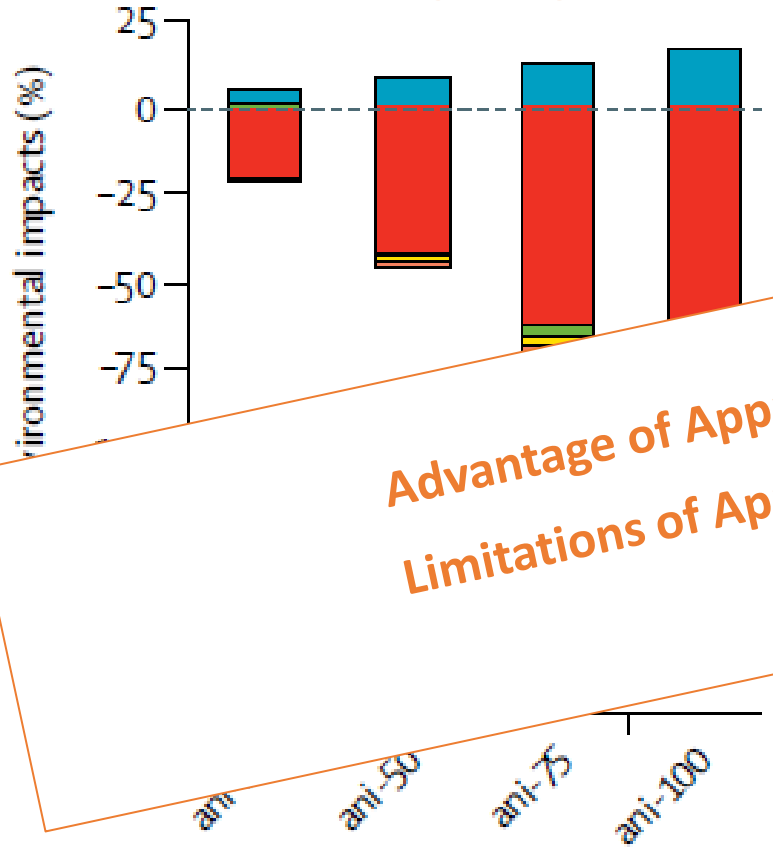

➔ Most environmental metrics improved

➔ …not water

Nutrition

Nutrient	Recommendation	Scenarios			
		ANI-25			
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➔ Proteins OK, adequacy not ensured for all nutrients

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Advantage of Approach n°1 ➔ Simple, easy to communicate

Limitations of Approach n°1 ➔ No consideration of cultural acceptability

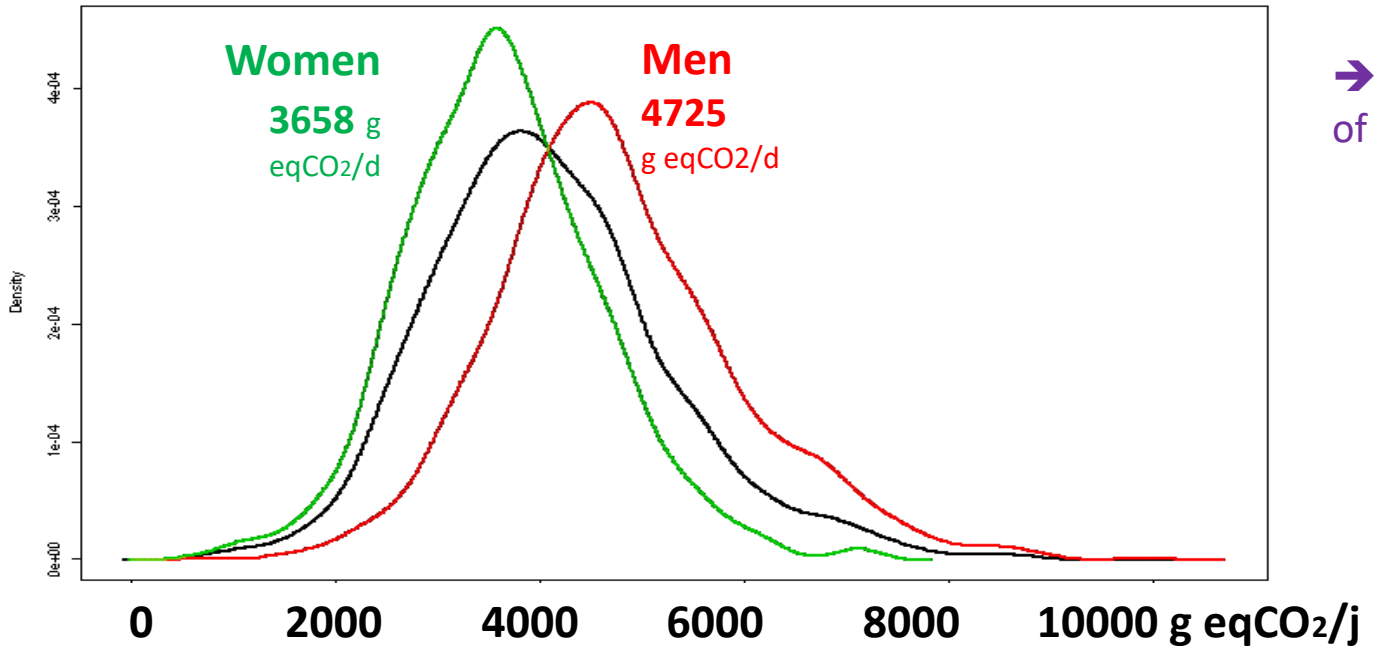
➔ Improved sustainability is not ensured

Approach n°2: Describing sustainability characteristics of existing diets

⇒ Existing diets classified by nutritional quality, by GHGE …

(Vieux et al, Ecol, Econ 2012)

Example for approach 2: distribution of GHGE of French adults diets

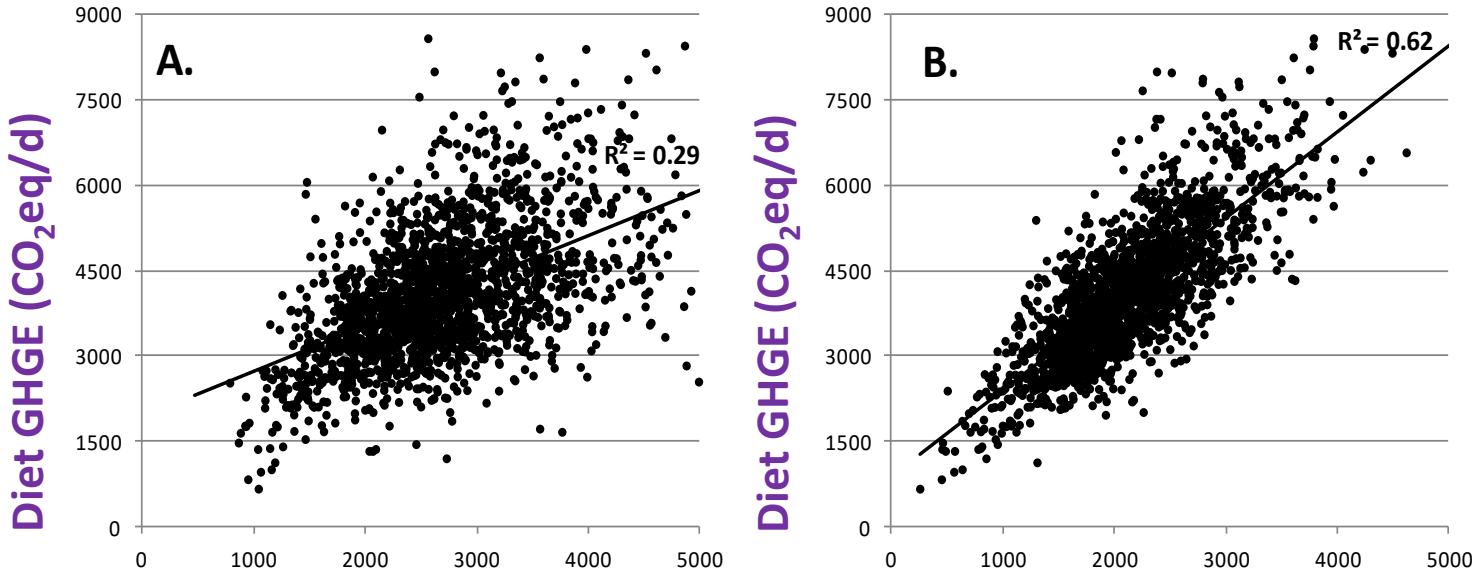


➔ High inter-individual variability of dietary GHGE

➔ **Need to understand the determinants of this variability**

Example for approach 2: association between quantities (or kcal) and dietary GHGE

(Vieux et al, Ecol, Econ 2012)



A. Quantities (g/d) **B. Energy intakes (kcal/d)**

➔ Strong positive correlation between quantities and GHGE

➔ Even stronger correlation between energy intakes and GHGE

➔ **Need to be clear on the energy content of diets or to adjust for energy content**

➔ **Not always done**

Example for approach 2 (describing existing diets)➔ determinants of dietary GHGE

(Vieux et al, AJCN, 2013)

Correlating nutritional quality indicators and dietary GHGE

MAR, Mean Adequacy Ratio = mean % recommended intakes for 20 essential nutrients, per day
MER, Mean Excess Ratio = mean % of maximal recommended values Na, SFA and free sugars, per day
ED, Energy density (solid foods), kcal/100g consumed

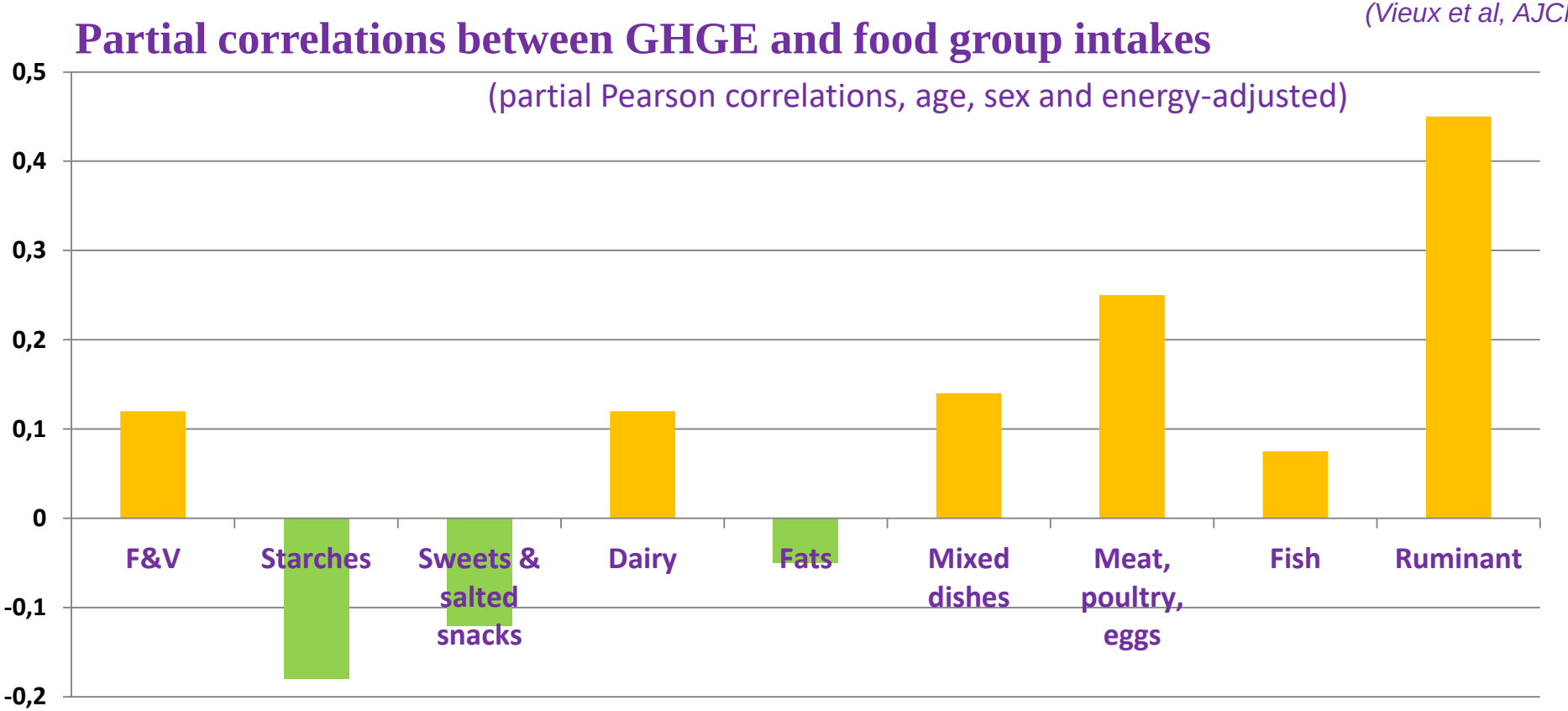
	MER Mean Excess Ratio	ED Energy Density	MAR Mean Adequacy Ratio
Dietary GHGE	**-0.14**	**-0.33**	**0.22**

(age, sex and energy-adjusted)

➔ **In self-selected diets, lower nutritional quality associated with lower GHGE**

Example for approach 2: role of food groups to determine dietary GHGE

(Vieux et al, AJCN, 2013)



- Ruminant meat: positive and strong association with GHGE,
- Dairy: positive but *weak* association
- F&V : weak but *positive* association
- Starches, sweets & salted snacks, fats : *negative* association

➔ **Explains why low GHGE is associated with low nutritional quality**

Approach n°2: Describing the sustainability characteristics of existing diets

Advantage of Approach n°2

- ➔ Better consideration of cultural acceptability (existing diets)
- ➔ Better understanding of trade-offs between sustainability dimensions

Limitations of Approach n°2

- ➔ Improvement of one sustainability dimension does not ensure improvement of the others (eg, improved nutritional quality not necessarily associated with lower environmental impact)

Improved sustainability can't be ensured with uni-dimensional approaches because sustainability is intrinsically a multi-dimensional concept.

Approach n°3: Identifying the best existing diets

⇒ Positive deviance approach

Example for approach 3

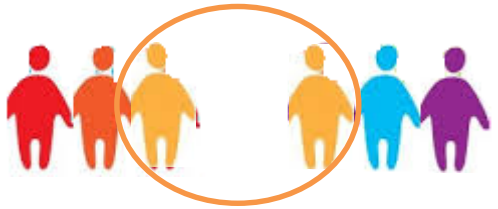
(Masset et al, AJCN 2014)

(dietary data from French adults)

General Population

Self-selected diet's:
- Nutritional quality
- Environmental impact
- Cost

Selection of more sustainable diets, i.e. with:
- good nutritionnal quality
- low environmental impact

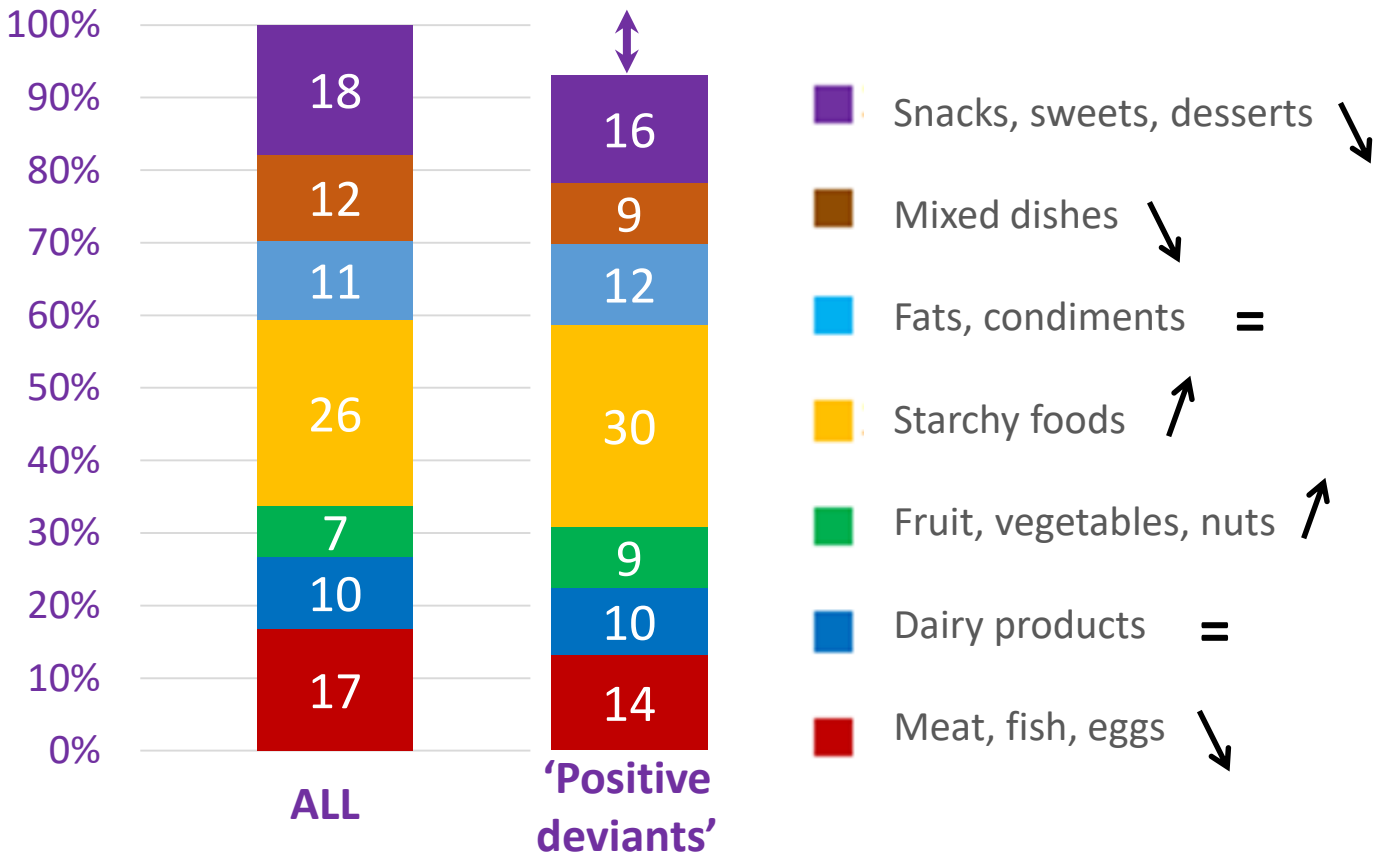


➔ **20% of self-selected diets identified as 'positive deviants':**
- **GHGE reduced by 20%** (vs mean)
- **they eat less** (minus 200kcal vs mean)
- **they eat diferently**

Example for approach 3 (identifying the best existing diets)**: the French case**

Energy contribution of food groups:

(Masset et al, AJCN 2014)



➔ **Higher amount of plant-based products (58% vs 53%*);**

➔ **Lower amount of meat/fish/eggs (due to meat),**

➔ **Dairy products: no difference**

➔ **Lower cost (6.2 vs 6.7 €/d)**

*without counting high fat high sugar foods and without counting plants in mixed dishes containing animal products

Example for approach 3 (identifying the best existing diets)**: 5 European countries**

SUSDIET European project (Sweden, Finland, Italy, UK, France)

(Vieux et al, J Clean Prod 2020)

➔ GHGE reduced by 21% *(vs mean)*

➔ Decrease of animal/plant ratio

➔ Dairy products unchanged

➔ Decrease of: soft drinks, hot drinks, alcoholic drinks

On average, more sustainable existing diets in Europe contained:

1 kg/d of plant-based products

400 g/d animal-based products

- 100 g meat/fish/egg (including 20g ruminant meat),
- 50 g mixed dishes
- 250 g dairy products (incuding 30g cheese)

➔ **To improve sustainability, exclusion of entire categories of foods is not a necessity**

➔ **Rebalancing plant-based vs animal-based products consumption**

Approach n°3: Identifying the best existing diets (positive deviance)

Advantage of Approach n°3

- ➔ Cultural acceptability ensured (existing diets)
- ➔ Improvement of several sustainability dimensions/criteria simultaneously

Limitations of Approach n°3

- ➔ Magnitude of improvements might be too small (eg, improving nutritional quality does not mean reaching nutritional adequacy; reduction of GHGE might be modest…)

Approach n°3: Identifying the best existing diets (positive deviance)

Advantage of Approach n°3

➔ Cultural acceptability ensured (

➔ Improvement of s… …multaneously

Limitati…

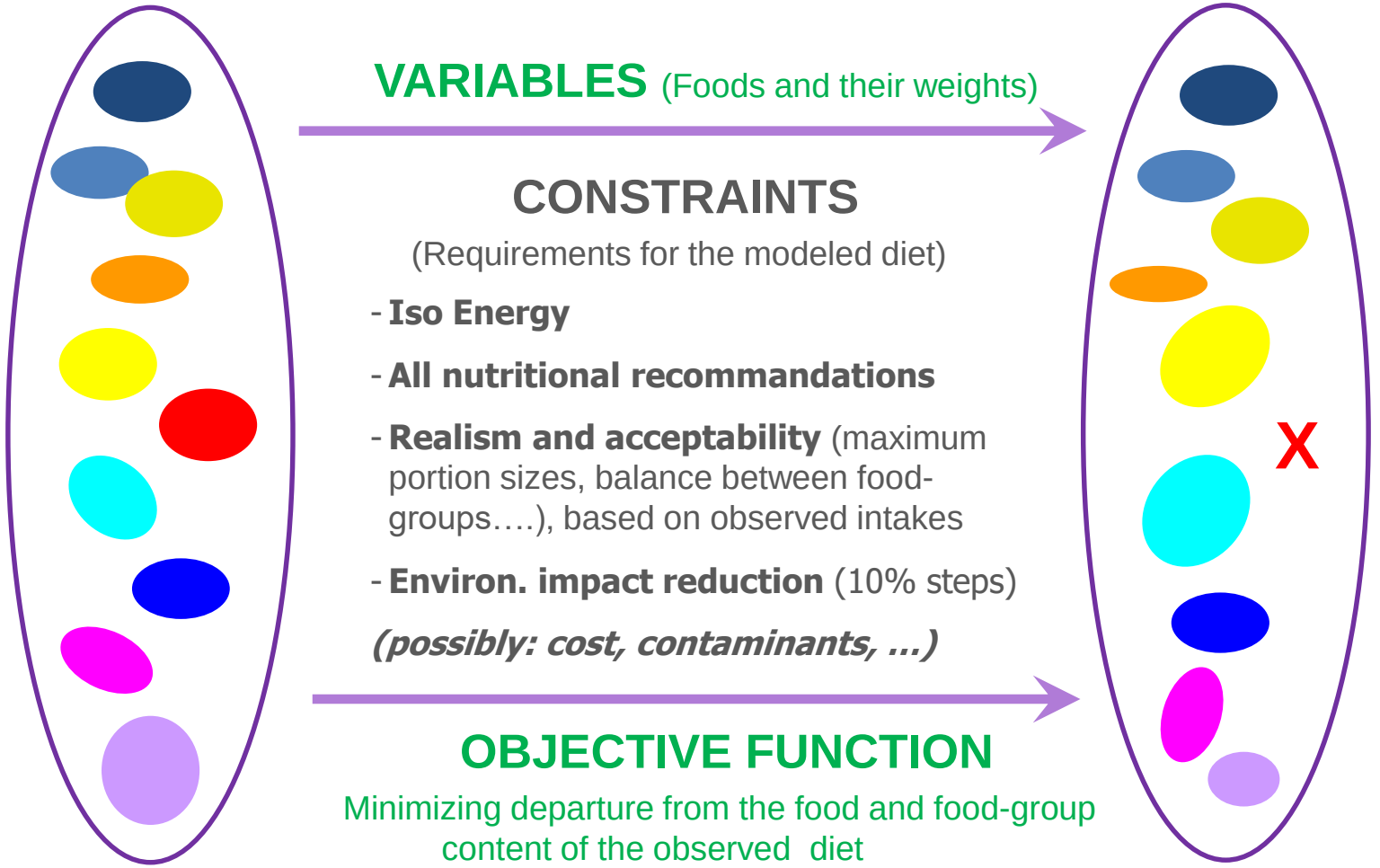
…mproving nutritional …adequacy; reduction of GHGE

➔ **How to design tomorrow's sustainable diets?**

Approach n°4: Designing theoretical diets without *a priori*

Principle of approach 4: mathematical optimization of diets fulfilling sustainability constraints

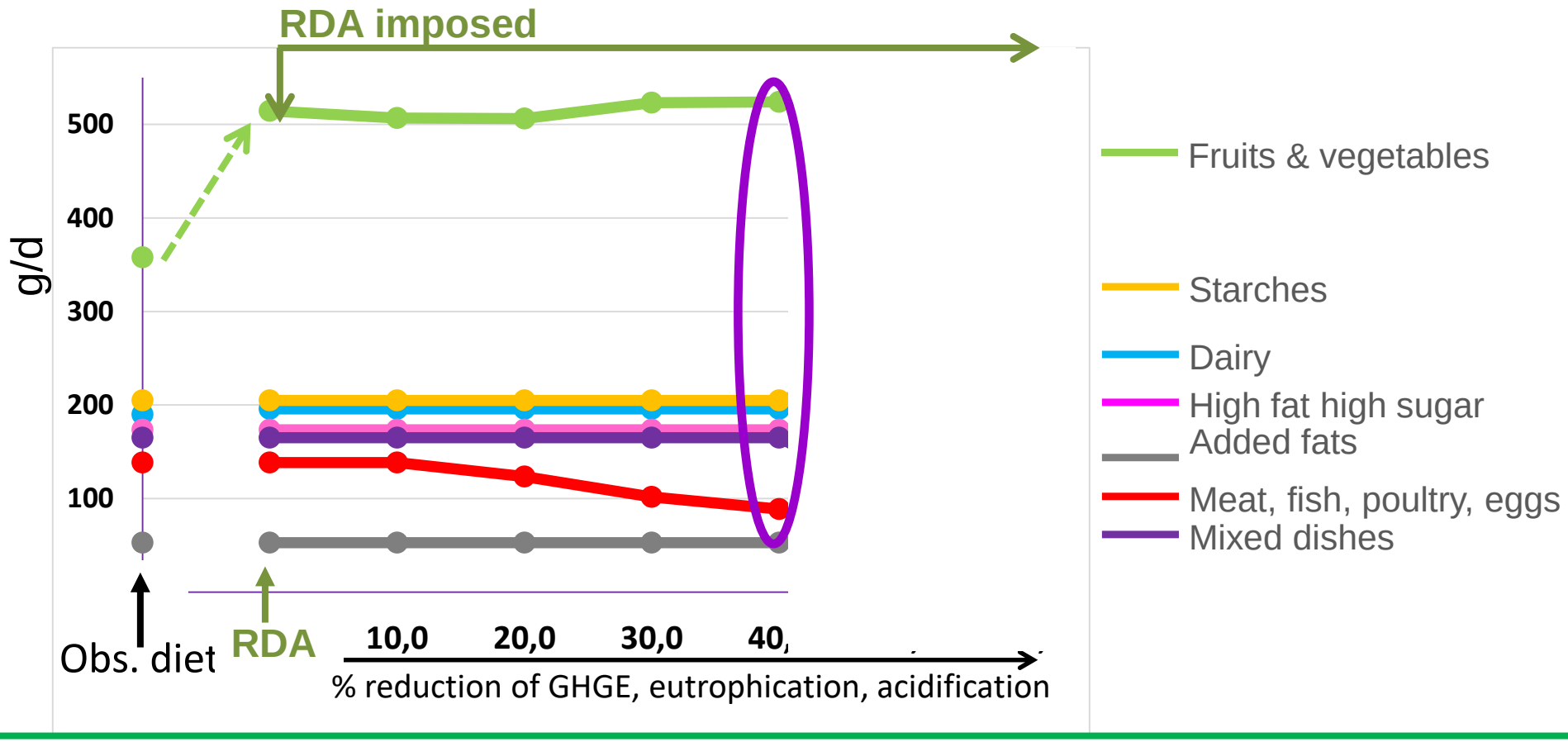
(Gazan et al., Adv Nutr, 2018)



Example for approach n°4 (designing theoretical diets without *a priori*): the French case

Food groups in OBSERVED and nutritionally adequate MODELED diets:

(Perignon, Pub Health Nutr, 2016)



➔ **Until 30-40% of GHGE reduction, nutritional adequacy can be achieved by changing only the quantities of 2 food groups: important F&V increase; moderate M/F/P/E decrease**

Example for approach n°4 (Designing theoretical diets without *a priori*): the French case

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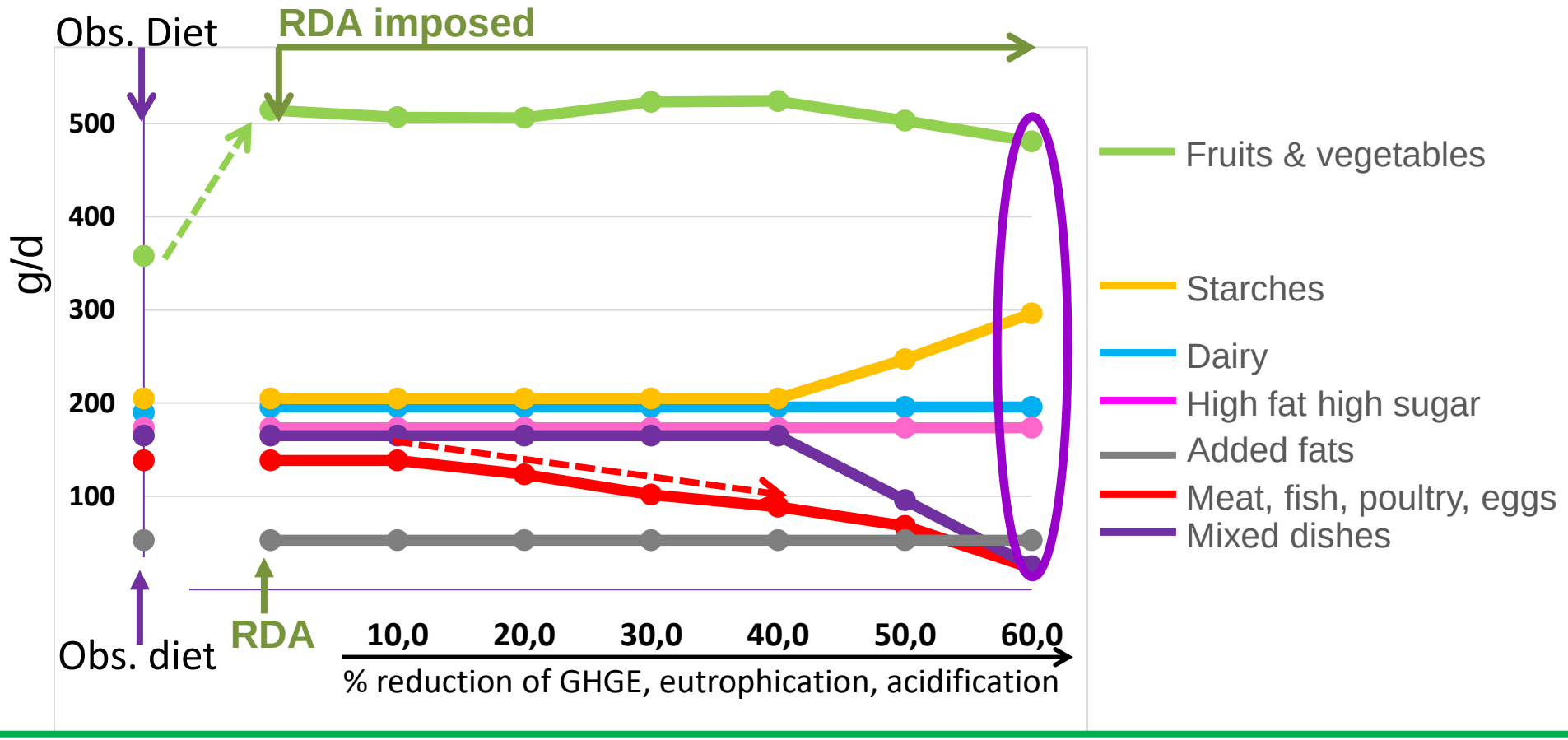


➔ **Possible to reduce env. impacts by 60% while achieving nutritional adequacy but requires greater departure from observed intakes:**

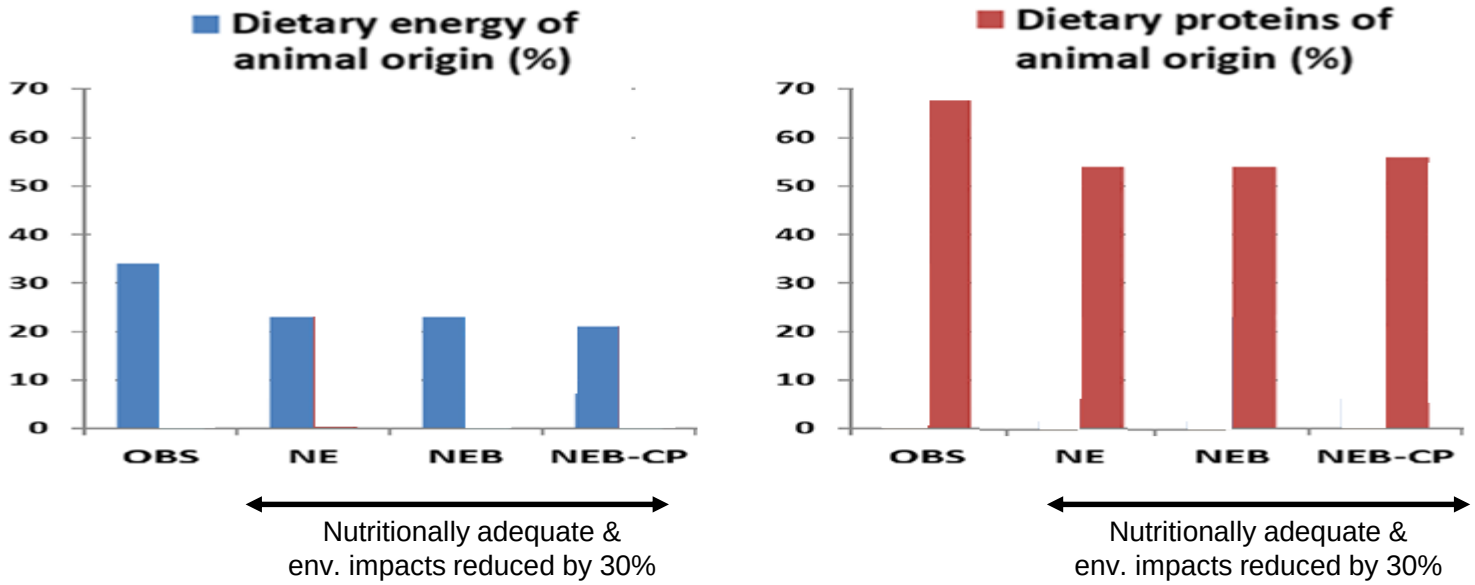
➔ **Dairy** remained stable, **starches** began to increase, **meat** decreasing trend

➔ Similar results with data from 5 european countries *(Vieux Eur J Clin Nutr, 2018)*

Strength of approach n°4 (theoretical diets without *a priori*): taking into account complex considerations

(Barré, PLOS one, 2018)

Example: introduction of nutrient Bioavailability (NE-B) and Co-Production links (NEB-CP)
in addition to nutrient-based recommendations and 30% reduction environmental impacts (NE models)



➔ **Whatever the model, energy & proteins from animal origin had to decrease** (lower reduction when co-production links were considered)

➔ *In fact, a recent study shows that 50% of animal proteins are needed for nutritionnal adequacy (Vieux, J Nutr, 2022)*

Approach n°4: Designing theoretical diets without *a priori*

Advantage of Approach n°4

- ➔ Good understanding of trade-offs between sustainability dimensions
- ➔ All targets met simultaneously
- ➔ The only approach able to ensure nutritional adequacy
- ➔ Can be applied to different type of dietary data (meals, population diet, individual diets…)

Limitations of Approach n°4

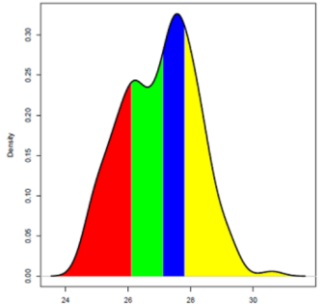
- ➔ When targets are too severe or incompatible: no solution (or unrealistic ones)
- ➔ Deviation from existing diets => acceptability not ensured

Main advantages of each approach

n°1: Designing theoretical diets based on *a priori* scenario

➔ **Communication first**

n°2: Describing existing diets



➔ **Understanding trade-offs**

n°3: Identifying the best existing diets

➔ **Only approach to guarantee acceptability** (i.e. individuals already consume this way)

n°4: Designing theoretical diets without a *priori*

$$\min \sum_{j=1}^{n} c_j x_j = Z$$

$$\sum_{j=1}^{n} a_{ij} x_j = b_i \quad , i = 1, \ldots, m$$

$$x_j \geq 0 \quad , j = 1, \ldots, n$$

➔ **Only approach to guarantee the simultaneous and strict respect of many different goals**

Common limits

➔ **Food consumption data:** their availability, representativeness and precision limit and orient the type of approach

➔ **Food databases** (nutrition, environment, price, contaminants…): their availability and accuracy determine the robustness and relevance of the results.

➔ **Genericity** can't be avoided

Common conclusions

- ➔ nutritional quality and low environmental impacts not spontaneously aligned
- ➔ it is possible to reduce environmental impacts while improving nutritional quality
- ➔ meat should be reduced (‘global North’ studies)
- ➔ entire food categories don’t need to be eliminated
- ➔ balance between animal- and plant-based products needed for nutrition

Well-known messages about

diversity and moderation

are still relevant for sustainable diets


Thank you for your attention!
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