How to reduce climate impact while enhancing nutritional value and preserving existing food culture?

Experiences from using the positive deviance and diet optimization approaches on French dietary survey data. Criteria and metric issues. Data management and data sources.

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“Sustainable diets are those diets with low environmental impacts which contribute to food and nutrition security and to healthy life for present and future generations.

Sustainable diets 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.”

(FAO, 2010)
Operationalization of the sustainable diet concept

Sustainable Diets

Health & nutrition: “nutritionally adequate, safe and healthy”

Environment: “protective and respectful of biodiversity and ecosystems”

Culture: “culturally acceptable”

Economy: “accessible, economically fair and affordable”

Sustainable diets: respect of the 4 dimensions
Sustainable diets metrics

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

Health & Nutrition

- Greenhouse gas emissions (GHGE)
  - Acidification
  - Eutrophication
  - Water deprivation
  - Land-use
- Biodiversity, Contaminants

Environment

- Budget for food
  - Average food prices
  - Fair prices for the producers

Culture

- Observed dietary intakes
- Commonly consumed food

Culture

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

(Gazan et al, Food Chemistry, 2018)
Strong positive correlation between quantities and GHGE
Eat less (and waste less) to impact less
Environmental dimension

**GHGE of food-groups, as consumed in the French diet**

(Vieux et al, Am J Clin Nutr 2013)

- **MFPE:** highest GHGE, per 100g or per 100 kcal
- **Other food groups:** ranking depends on the calculation basis
- **GHGE/100kcal:** F&V similar to dairy, HFSS low impact
# Studies on sustainable diets in France: insights from 2 research projects

<table>
<thead>
<tr>
<th>Project Name</th>
<th>Country</th>
<th>National dietary survey (adults)</th>
<th>Environmental data (hybrid methods)</th>
</tr>
</thead>
</table>
| **Ocad**     | France  | INCA2 (2006–2007, 7-d records n = 4079) | - GHGE  
- Eutrophication  
- Acidification  
→ 402 foods |
| **Sus-Diet** | France, UK, Italy, Finland, Sweden | INCA2 (2006–2007, 7-d r, n=4079)  
NDNS (2008-2012, 4-d r., n=4156)  
INRAN-SCAI (3-d r., n = 33)  
FINDIET 2012 (2*48h-r., n=1708)  
Riksmaten 2010 4-d r., n=1797) | GHGE  
→ 151 food items from the FoodEx classification system |
Methods for studying sustainable diets:

The Positive Deviance approach

Identification of more sustainable diets among existing ones:

General Population

Self-selected diets:
- 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 ‘more sustainable’:
- GHGE reduced by 20% (vs mean)
- they eat less (minus 200kcal vs mean)
- they eat differently

High inter-individual variability of dietary GHGE
(Vieux et al, Ecol Econ 2012)

RESULTS with the positive deviance approach in France (OCAD project)
Diets of ‘positive deviants’ in France (OCAD project)
(Masset et al, AJCN 2014)

Energy contribution of food groups

- Higher amount of plant-based products (58% vs 53%);
- Lower amount of animal products (dairy excepted);
- 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
RESULTS with positive deviance in Europe
(France, UK, Italy, Finland, Sweden, SusDiet project) (Vieux et al, J Clean Prod, 2020)

➔ 18% of more sustainable diets with GHGE decreased by 21% (vs population mean)
➔ Decrease of animal/plant ratio
  (less bovine meat, less processed meat, more F&V, more starchy foods);
➔ Less soft drinks, less alcoholic drinks

On average, the daily diet of positive deviants in Europe contains:

1 kg plant-based foods:
  400 g F&V,
  100 g juice
  500 g other plant-based foods (incl. 200g mixt dishes and 20g of nuts)

400 g animal-based foods
  100 g meat/fish/eggs (incl. 20g ruminant meat),
  50 g mixt dishes
  250 g dairy products (incl. 30g cheese).

➔ To improve diet sustainability, exclusion of entire categories of foods is not a necessity;
➔ Moderate meat reduction: 1st step can be achieved right now ➔ Next step?
Design of theoretical diets with mathematical optimization

**CONSTRAINTS**
- Iso Energy
- All nutritional recommendations
- Environ. impact reduction (10% steps)
- Realism and acceptability (maximum portion sizes, balance between food-groups….), based on observed intakes
- Cost

**OBJECTIVE FUNCTION**
Minimizing departure from the food and food-group content of the observed diet

(Gazan et al., Adv Nutr, 2018)
Until 30-40% of environmental impact 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.
RESULTS with diet optimization in France

(OCAD project)

Amounts of main food groups in OBSERVED and MODELED diets

**Obs. Diet**

- **Fruits & vegetables**: began to increase
- **Starches**: began to increase
- **Dairy**: remained stable
- **Meat, fish, poultry, eggs**: continuing decreasing trend

**(Perignon, Pub Health Nutr, 2016)**

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** continuing decreasing trend
RESULTS with diet optimization in France: (OCAD project)

Focus on diet cost

(cost based on mean food prices)

- Cost first increased to fulfill all nutrient based recommendations
- Then cost progressively decreased with strengthening constraints on environmental impacts
RESULTS with diet optimization in France:
(OCAD project)

Focus on animal products:
(Perignon, Pub Health Nutr, 2016)

- Delimeat and Ruminant meat decreased (for both nutrition and env.),
- Fish increased (for nutrition),
- Porc/poultry/eggs first maintained and then decreased for env. reductions >40% for environmental reductions > 40%: substitution between milk and yoghurt

% Departure vs observed amounts in modeled diets
Meat, Fish, Poultry, Eggs
(general decreasing trend)

% Env. impact reduction

Dairy products
(general trend = stability)

% Departure vs observed amounts in modeled diets
Cheese, Milk, Yoghurt
(40% env. red.)
(40% env. red.)
(40% env. red.)

% Env. impact reduction
RESULTS with diet optimization in Europe
(SusDiet project)

Energy (kcal) provided by different food groups in OBSERVED and MODELED (nutritionally adequate, GHGE -30%) diets

- General trends:
  - More F&V, More starch,
  - Less HFHS, Less alcohol
  - Decrease of Animal/Plant ratio
  - Less delimeat, less bovine meat

- Cultural specificities:
  - Fish: more in France & Italy, less in Finland
  - Dairy: more in France and Sweden, other countries: more for M, less for W

- Similar trends for different populations with some country- or sex- specificities
Adressing the limits: taking into account nutrient Bioavailability (NE-B) and Co-Production links (NEB-CP) vs previous model NE (Nutrition + 30% reduction Env. impact)

Whatever the model, energy & proteins from animal origin have to decrease

Meat content (women)

<table>
<thead>
<tr>
<th>Meat content</th>
<th>OBS</th>
<th>NE</th>
<th>NEB</th>
<th>NEB-CP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total meat² plus fish (g/d)</td>
<td>140</td>
<td>54</td>
<td>66</td>
<td>96</td>
</tr>
<tr>
<td>Total meat² (g/d)</td>
<td>110</td>
<td>25</td>
<td>36</td>
<td>74</td>
</tr>
<tr>
<td>Total ruminant meat³ (g/d)</td>
<td>36</td>
<td>6</td>
<td>5</td>
<td>26</td>
</tr>
</tbody>
</table>

➔ Meat reduction with all models, ➔ But lower reduction when co-production links are considered
Adressing the limits: taking into account nutrient Bioavailability (NE-B) and Co-Production links (NEB-CP) vs previous model NE (Nutrition + 30% reduction Env. impact)

Food groups content in observed and optimized diets

(Barré, PLOS one, 2018)

Whatever the model:
- F&V and Starch increased
- Dairy stable, High fat/sugar/salt also!
- Meat/fish/egg decreased
Adressing the limits: taking into account nutrient Bioavailability (NE-B) and Co-Production links (NEB-CP) vs previous model NE (Nutrition + 30% reduction Env. impact)

(Barré, PLOS one, 2018)

- Whatever the model, meat is decreasing
- Replacement of animal-based mixed dishes by plant-based ones
Adressing the limits:

→ Variability of environmental impacts

Variation in GHGE and land use within and between foods groups (protein-rich foods)

✓ High variation among products
  (impacts of the lowest-impact animal products exceed those of plant products)
  → Dietary changes needed: promote flexitarianism

✓ High variation among producers
  → Need to improve production practices, focusing on the most impacting producers

(Consolidated data from 38,700 farms; 1600 processors, packaging types, and retailers)

(Poore and Nemeck, Science, 2018)
Reaching Nutritional Adequacy Does Not Necessarily Increase Exposure to Food Contaminants: Evidence from a Whole-Diet Modeling Approach¹⁻³

Tanguy Barré,⁴ Florent Vieux,⁵ Marlène Perignon,⁴ Jean-Pierre Cravedi,⁶ Marie-Josèphe Amiot,⁴ Valérie Micard,⁷ and Nicole Darmon⁴

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.
At 30-40% env. impact reduction: eating less meat common lever

At > 50% env. impact reduction: priority to eggs, milk, fish (within animal products)

When considering nutrient bioavailability and co-production links: same conclusions but studies are needed for other populations (children, elderly, pregnant women…)

For very high reductions of environmental impacts: cultural acceptability is not ensured, actions on the food supply are required