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Optimized sustainable diets for 2030: a comparison of different algorithms and the robustness of outcomes

Gerard Kramer

Blonk Consultants, The Netherlands

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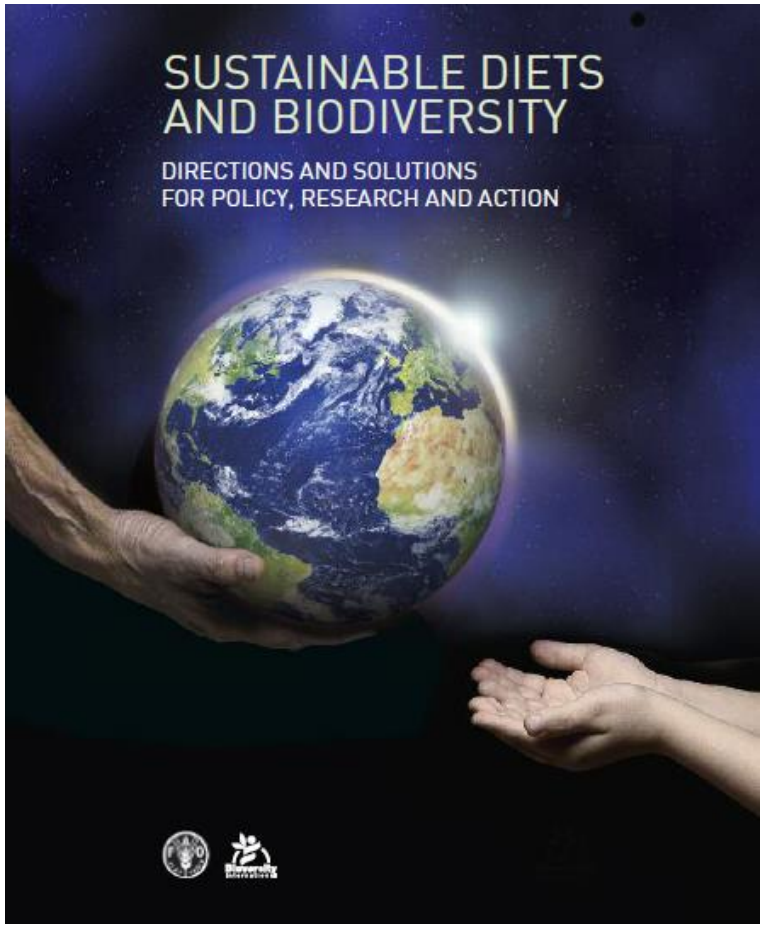
Sustainable Diets

Many constraints – Models needed



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.

Aim & scope

- Models used to define sustainable diets
  - Investigate sensitivity to choices in algorithm and settings
  - Investigate implications for product groups
  - Consumer acceptance: minimise changes to current diet
- Case: Dutch population aged 7-69, GHGe target 2030
- Optimisation tool: Optimeal®, also used for Dutch Food-Based Dietary Guidelines

Greenhouse Gas emissions target 2030

An equal share of the pie for all

		Present 2010		Scenario 2030	Scenario 2050	
Global GHGe	Gt CO2e	49.1		35.3	21.4	*IPCC (<2°C likely)*
GHGe Food System						
Fertilizer production	Gt CO2e	0.44	*1%*			*Vermeulen 2012*
Energy feed production	Gt CO2e	0.07	*0.1%*			*Vermeulen 2012*
Pesticide production	Gt CO2e	0.07	*0.1%*			*Vermeulen 2012*
Direct Agriculture	Gt CO2e	6.50	*13%*			*WRI*
Processing	Gt CO2e	0.20	*0.4%*			*Vermeulen 2012*
Packaging, logistics	Gt CO2e	0.41	*1%*			*Vermeulen 2012*
Cooling	Gt CO2e	0.55	*1%*			*Vermeulen 2012*
Retail	Gt CO2e	0.23	*0.5%*			*Vermeulen 2012*
Catering, home	Gt CO2e	0.16	*0.3%*			*Vermeulen 2012*
Waste treatment	Gt CO2e	0.07	*0.2%*			*Vermeulen 2012*
Indirect Agriculture	Gt CO2e	5.50	*11%*			*WRI*
Total Food System	Gt CO2e	14.21	*29%*	10.20	6.19	
Fair Share	kg CO2e/p/day	**5.63**		**3.32**	**1.78**	

-41%

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Sustainable Diets

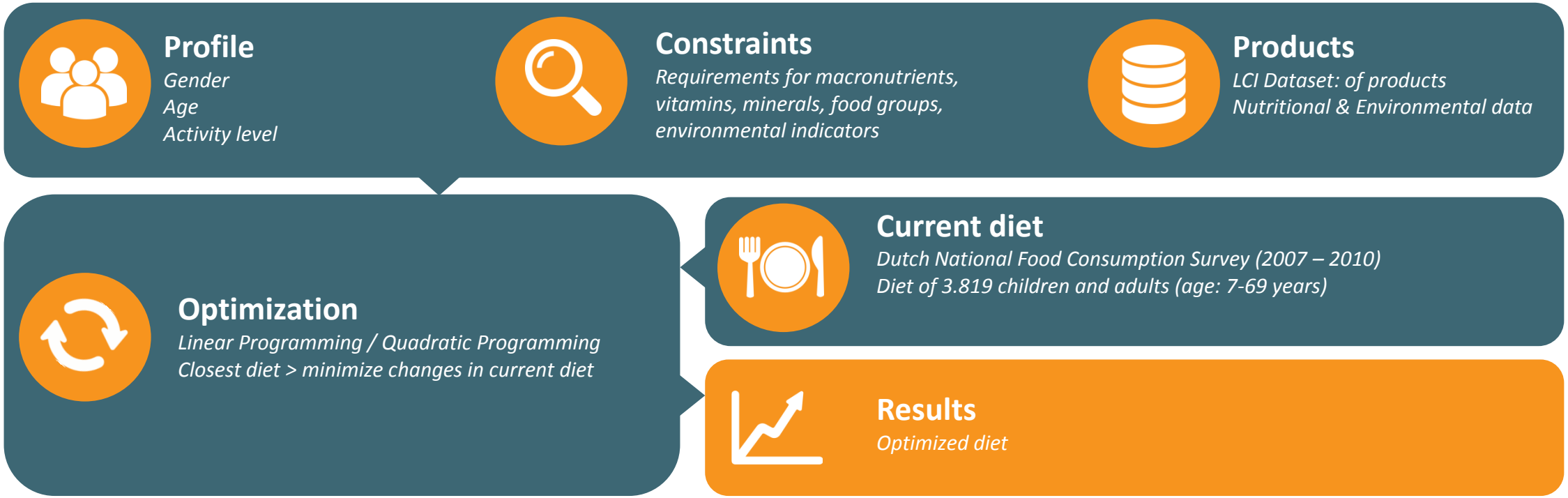
Examples of previous and current research applying optimisation

Implementation of acceptability	Reference	Technique
Constraints on food groups	MacDiarmid *et al*, AJCN, 2012	LP
Minimise changes to diet	Thompson *et al*, report for WWF, 2013	LP
None	Wilson *et al*, PLOS one, 2013	LP
Minimise changes to diet	Tyszler *et al*, IJLCA, 2015	LP: Optimeal®
Minimise changes to diet	Kramer *et al*, report for N&M, 2015	QP: Optimeal®
Minimise changes to diet	Horgan *et al*, IJBNPA, 2016	LP
Minimise changes to diet	Kramer *et al*, report for WWF currently running	QP: Optimeal®

LP: Linear Programming
QP: Quadratic Programming

How does it work?

Optimeal®



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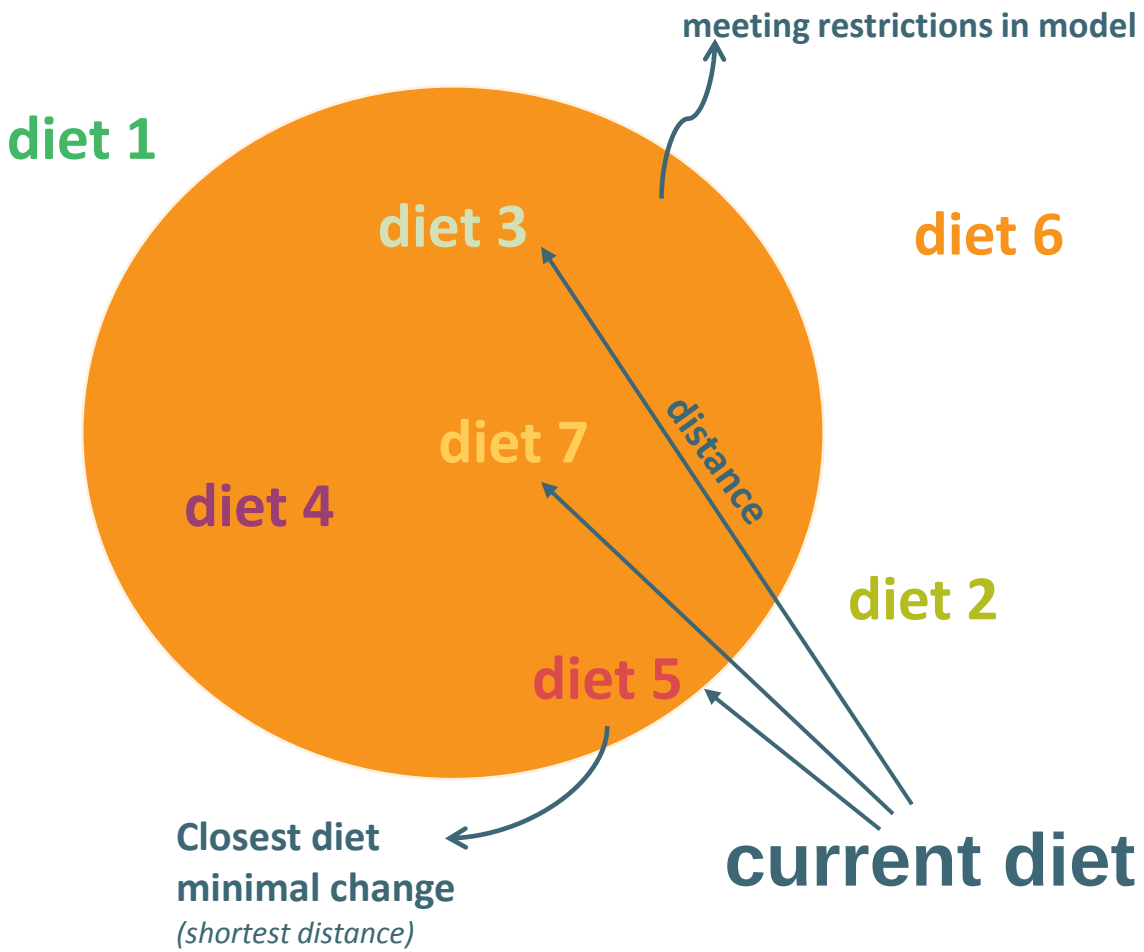
Definition of change?

Distance between diets

Possible Diets



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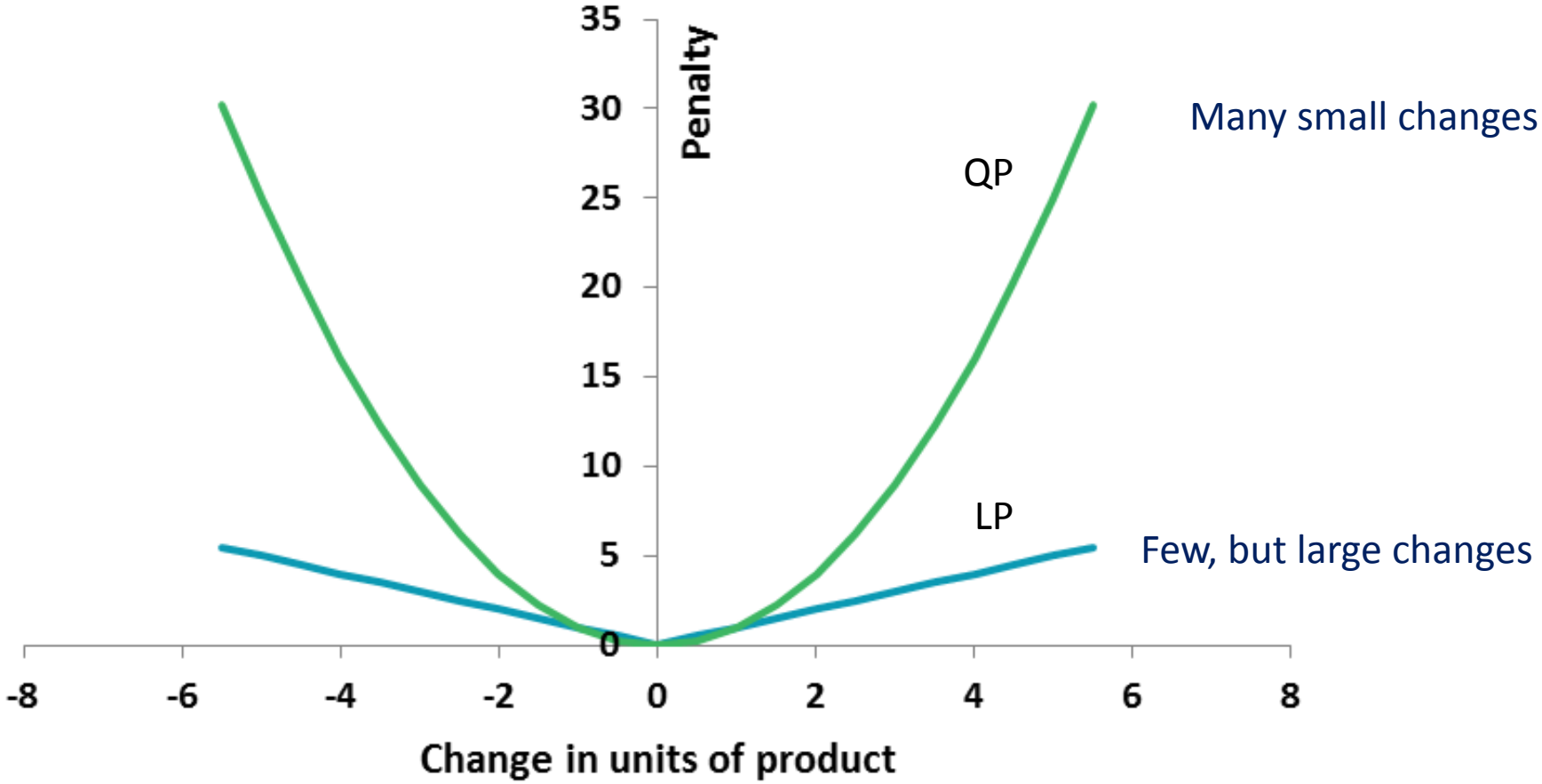
Sensitivity to choices in algorithm

Quadratic v.s. Linear

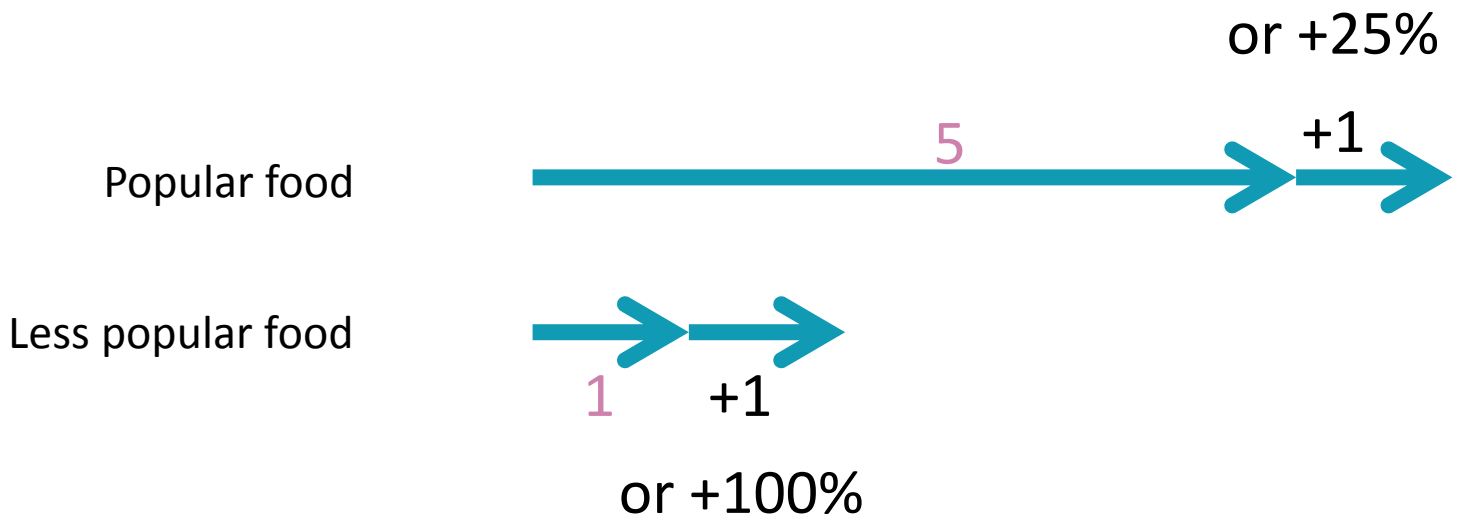


Many small changes

Few, but large changes

Sensitivity to choices in algorithm

Relative v.s. Absolute



Relative: does not introduce new foods

Absolute: new foods possible

Sensitivity to product unit

Grams v.s. Grams Dry Matter

- Solid foods: low amounts in diet, more nutrients per gram
- Beverages: high amounts in diet, less nutrients per gram

RATIONALE: for a sustainable diet IMPACT/NUTRIENTS is the essential parameter

Results

Dutch population aged 7-69; scenario for 2030

LP v.s. QP

REL v.s ABS

GR v.s. DM

Food Group	Current	lin_gr_abs	lin_gr_rel	lin_dm_abs	lin_dm_rel	qdr_gr_abs	qdr_gr_rel	qdr_dm_abs	qdr_dm_rel	Avg Δ	Avg Δ
	gr/d	Δgr/d	Δgr/d	Δgr/d	Δgr/d	Δgr/d	Δgr/d	Δgr/d	Δgr/d	g/d	%
Alcoholic and non alcoholic beverages	**1957**	-1	-791	-566	-791	-35	-837	-660	-837	-526	-29
Bread	**154**	40	121	0	121	71	118	15	118	69	49
Cheese	**36**	-22	-29	-22	-29	-15	-28	-11	-28	-22	-64
Eggs	**12**	0	38	0	38	0	38	0	38	16	152
Fish	**16**	4	4	4	4	4	4	5	4	4	26
Fruits	**110**	0	0	-10	0	-6	35	19	35	5	8
Legumes	**3**	74	0	81	0	29	1	19	1	29	875
Meat, meat products and poultry	**108**	-94	-64	-50	-64	-78	-70	-43	-70	-66	-62
Milk and milk products	**373**	-10	126	-32	126	-27	107	-143	107	21	9
Nuts and seeds	**4**	50	0	10	0	45	2	7	2	16	353
Potatoes	**98**	0	246	0	246	1	252	3	252	107	128
Savoury bread spreads	**4**	0	0	0	0	5	0	1	0	1	22
Soy products and vegetarian products	**5**	0	0	0	0	8	1	7	1	2	40
Sugar, sweets and sweet sauces	**35**	-5	-13	0	-13	-18	-17	5	-17	-9	-28
Vegetables	**127**	29	11	158	11	64	22	294	22	84	60
∑abs(Δgr/day)		**376**	**1543**	**983**	**1543**	**490**	**1623**	**1298**	**1623**		

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Main findings

- Outcome very sensitive to choices in algorithm and settings
- LP v.s. QP few large steps v.s. many small steps (individual foods)
- Relative large shifts in foods with a high initial amount: beverages, milk
- Absolute changes in concentrated products: crispbread, legumes, nuts
- Grams+Absolute lowest sum of total changes
- Grams DM large shift in water-rich foods: beverages, vegetables

Implications

For business and policy makers

- Conclusions on meat, beverages and cheese seem robust
- Conclusions on many products sensitive to choices in algorithm:
  - e.g. milk, fruit, legumes, potatoes,…….
- Advice to the public:
  - Consume less: meat, cheese, beverages
  - Consume more: fish, vegetables

Thank you

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Gerard Kramer

Manager Sustainable Nutrition

gerard@blonkconsultants.nl

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