The organic consumers' willingness to Pay for food produced with re-circulated nutrients, barriers and facilitators

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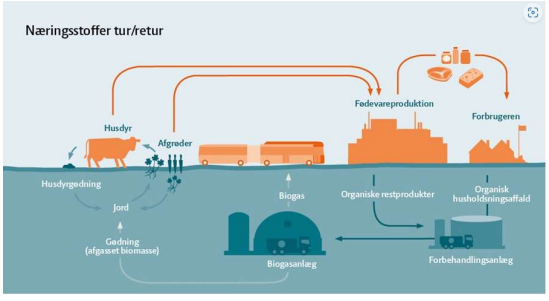
Why is recirculation a good idea?

- Nitrogen and phosphorous are essential for food production, but phosphorous reserves are declining, nitrogen production has huge environmental and climatic consequences
- As organic food production is increasing there is an increasing need for "natural" fertilizers since artificial fertilizer are not allowed.
- Re-cycling of nutrients from urban-areas could solve some of these problems
- Gasified biological household waste, gasified biological waste from the food industry and sewage bio-solids are good candidates
- No proven risks to humans involved with the use of these for food production



Source: School material from Landbrug&Fødevarer Recirkulering af næringsstoffer i økologisk produktion (lf.dk)

What about the consumer?

- Consumers are found to have low awareness and knowledge about current fertilizer practices and methods in agriculture, to have low knowledge about hazards, but still to have strong opinions on the matter

- Consumer acceptance of re-circulation is not necessarily based on objective risks and benefits associated with the use of these

- Knowledge about consumers attitudes towards re-circulation of nutrients and how to communicate with the consumers is important

Research questions, this presentation

- RQ1: What is consumers' Willingness to Pay (WTP) for foods grown with recirculated nutrients as fertilizers? Does this change with level of organic consumption?

- RQ2: How does attitudes, as e.g. perceived risks and perceived benefits associated with recirculation affect this WTP. Does this differ between levels of organic consumption?

Consumer analysis - overview

Qualitative analysis (Spring 2021)
Preus, N, Mortensen F., and Vesterbæk P. (2022): Organic consumers' opinions about new types of re-circulation in organic production

$n = 1374$

Choice Experiment and survey
(Dec. 2021 – Jan. 2022)
WTP and attitudes towards organic, recirculation and sustainability

Household
$n \approx 2000$

Consumption
(2022)

- All staples
- All foods is registered as organic or conventional

Socio - demographics

- Age, education, place of living, family type etc.
- Attitude to food, sustainability and health in general
- Attitude to organic

Choice Experiment

Carrots and bread

Attributes and levels

Mode of production:	Organic Conventional
Type of fertilizer:	Manure Sewage sludge (biosolids) Biological waste from food industry Biological waste from households
Origin of fertilizer	Organic Conventional
Price:	Various price levels (8 – 10 levels)

Choice Experiment

Carrots and bread

Attributes and levels

Mode of production:

Type of fertilizer:

Origin of fertilizer

Price:

Manure: Manure is a mixture of livestock urine and excrement. The manure is stored in manure tanks until it is ready to be brought out onto the farmland. Livestock manure must be brought onto the field just before or at the start of the growing season

Biological household waste: Source-sorted biological waste from households (the green bio bin) and commercial kitchens. The waste is composted or has been through biogas production (gasification) before being used on agricultural land

Biological waste products from the food industry: The food industry has many residuals from the production of food. This can, for example, be fish waste, or peels and residues from vegetables. The residual products are composted or have been through a biogas production (gasified) before use
on the agricultural land.

Bio-solids from waste water: Bio-solids is purified biological material from waste water treat-ment, which is both mechanically, biologically and chemically treated, and has been through biogas production (gasified). Food crops must not be grown until at least one year after the fields have been fertilized

Choice cards

- Consumers are told to imagine an everyday situation in the supermarket and that there is three bundles of carrots/brown breads that are equal in terms of apperance and taste.
- The only difference is mode of production, what fertilizers has been used and the price

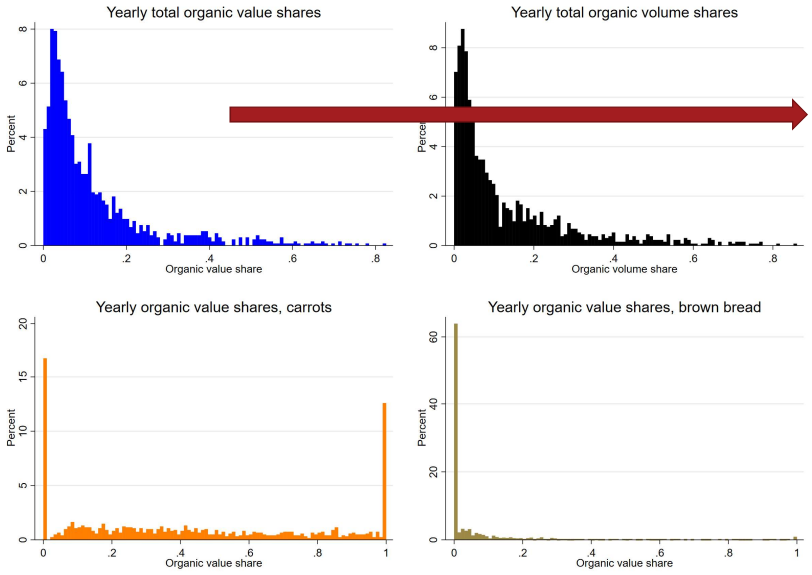
Examples of choice-cards

	Gulerodstype 1	Gulerodstype 2	Gulerodstype 3
Produktionsform	Økologisk	Økologisk	Konventionel
Gødningstype	Husdyrgylle	Organiske restprodukter fra fødevareindustrien	Organiske restprodukter fra fødevareindustrien
Gødningsoprindelse	Økologisk	Økologisk	Blandet
Pris	18 kr. per kg.	15 kr. per kg.	9 kr. per kg.
Vælg et produkt	☐	☐	☐

	Brødtype 1	Brødtype 2	Brødtype 3
Produktionsform	Konventionel	Økologisk	Konventionel
Gødningstype	Husdyrgylle	Organisk materiale fra spildevand	Organisk husholdningsaffald
Gødningsoprindelse	Blandet	Blandet	Blandet
Pris	21 kr. per brød	27 kr. per brød	18 kr. per brød
Vælg et produkt	☐	☐	☐

- 8 choices with carrots, 8 choices with brown bread
- We estimate a Random Parameter Logit with correlation and derive individual WTP for the respondents (conditionals)

Coupling with actual organic consumption



We use the organic budget-share to construct three groups of interest

Light users: < 2.5 % of the food budget on organic food

Medium users: 2.5 – 10% of the food budget on organic food

Heavy users: > 10 % of the food budget on organic food

- Results RQ1) WTP for foods grown with recirculated nutrients as fertilizers? Does this change with level of organic consumption?

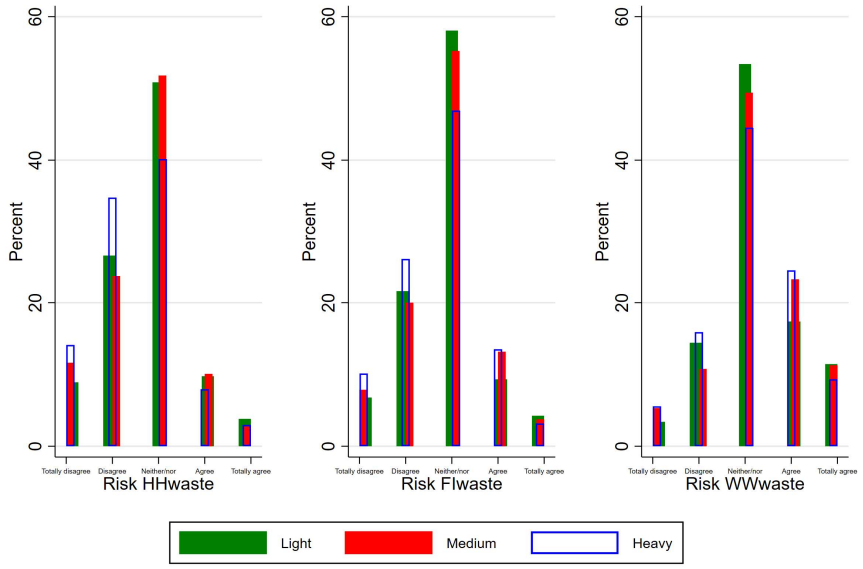
	MNL		RPL		RPL w. corr.		Cond.
	Parm	Rob.s.e.	Parm	Rob.s.e.	Parm	Rob.s.e.	Parm
ASC	0.02	0.03	-0.2297	0.23	-0.45	0.25	
β_org	2.87 ***	0.31	2.50 ***	0.37	2.66 ***	0.40	2.69
std._org			11.75 ***	0.56	2.01 *	1.61	
β_HHwaste	4.31 ***	0.51	3.12 ***	0.49	4.16 ***	0.50	4.32
std._HHwaste			11.09 ***	0.63	7.27 ***	1.35	
β_FIwaste	-1.00 ***	0.31	-1.26 ***	0.32	-0.83 ***	0.33	-0.72
std._FIwaste			8.08 ***	0.43	5.70 ***	0.81	
β_WWwaste	-2.28 ***	0.37	-3.97 ***	0.45	-3.46 ***	0.46	-3.30
std._WWwaste			11.79 ***	0.60	12.28 ***	0.64	
β_fert._org	0.45	0.33	1.09 ***	0.24	0.03	0.27	0.06
std._fert._org			5.84 ***	0.37	5.63 ***	0.36	
LogLik	-9926		-8198		-7818		
Rho sqr.	0.1008		0.2574		0.2918		
Adj. Rho sqr.	0.1002		0.2563		0.2898		
AIC	19866		16419		15680		
BIC	19917		16506		15839		

	MNL		RPL		RPL w. corr.		Cond.
	Parm	Rob.s.e.	Parm	Rob.s.e.	Parm	Rob.s.e.	Parm
ASC	0.07	0.05	0.23	0.25	-0.50 **	0.23	
β_org	3.24 ***	0.28	3.93 ***	0.39	4.73 ***	0.38	4.47
std._org			12.25 ***	0.53	9.48 ***	0.70	
β_HHwaste	1.08 ***	0.34	0.59 *	0.32	0.37	0.31	0.33
std._HHwaste			6.52 ***	0.30	3.54 ***	1.13	
β_FIwaste	-0.73 ***	0.35	-1.01 ***	0.32	-1.98 ***	0.31	-1.96
std._FIwaste			6.15 ***	0.46	4.58 ***	0.68	
β_WWwaste	-1.80 ***	0.33	-3.19 ***	0.36	-3.72 ***	0.34	-3.64
std._WWwaste			6.62 ***	0.35	5.80 ***	0.44	
β_fert._org	1.93 ***	0.27	1.76 ***	0.21	0.70 ***	0.21	0.66
std._fert._org			3.54 ***	0.29	3.41 ***	0.34	
LogLik	-10214		-8200		-7829		
Rho sqr.	0.0963		0.2745		0.3073		
Adj. Rho sqr.	0.0.0957		0.2735		0.3053		
AIC	20442		16424		15703		
BIC	20493		16510		15863		

Brown bread					
	Hwaste	Iwaste	Wwaste	Organic	Fert. Org
Light users	3.84	0.42	-1.61	-4.53	-3.47
Medium users	3.58	-1.04	-3.55	0.20	-1.15
Heavy users	5.22	-0.98	-4.06	9.34	3.29
Carrots					
	Hwaste	Iwaste	Wwaste	Organic	Fert. Org
Light users	-2.10	-2.41	-1.62	-2.52	-0.66
Medium users	-0.86	-2.32	-3.11	1.31	0.00
Heavy users	2.82	-1.29	-5.01	11.08	2.00

- WTP for food produced with biological household waste is positive (significant for bread) and increase with the level of organic consumption
- WTP for food produced with biological waste from the food industry is negative and does not vary systematically with the level of organic consumption
- WTP for food produced with bio-solids is large and negative and decrease with the level of organic consumption
- It is only for heavy users of organics that there is a positive WTP for fertilizer of organic origin

Results RQ1)



From the questionnaire we find that organic consumers:

- To a larger degree disagree with that there is health risks associated with the use of household waste as fertilizer for food production
- To a larger degree agree with that there are health risks associated with the use of bio-solids as fertilizer for food production

Results RQ2):How does attitudes, as e.g. perceived risks and perceived benefits associated with recirculation affect WTP. Does this differ between levels of organic consumption?

- We use the theory of planned behaviour (TPB) that consists of three components; attitude, subjective norms, and perceived behavioral control that shape an individual's behavioral intentions and leads to actual behaviour

$$WTP = \beta_0 + \beta_1 limit_i + \beta_2 antro_i + \beta_3 balance_i + \beta_4 organic_i + \beta_5 sust_i + \beta_6 sust_r ec_i$$
$$+\beta_7 soc\_eat_{ij} + \beta_8 oth\_sust_i + \beta_9 imp\_all_i + \beta_{10} FDscale_i + \beta_{11} + \beta_{12} Gen\_bene_i$$
$$+\beta_{13} Gen\_risk_i + \beta_{14} spec\_risk_{ij} + \beta_{15} trust\_inf\_aut_i + \beta_{16} trust\_saft\_aut_i$$
$$+\beta_{17} trust\_inf\_fi_i + \beta_{18} trust\_saft\_fi_i + \beta_{19} Pro\_org_i + \beta_{20} Con\_org_i$$
$$+\beta_{21} Inc\_eq_i + \beta_{21} Female_i + \beta_{22} Age_i + \beta_{23} Age^2{}_i + \beta_{24} Capital_i + \beta_{25} Urban_i$$
$$+\beta_{26} Voc\_edu_i + \beta_{27} Short\_edu_i + \beta_{28} Medium\_edu_i + \beta_{29} Long\_edu_i + u_{ij}$$

- Trust in food industry and in the authorities and trust in information from these bodies (insignificant)

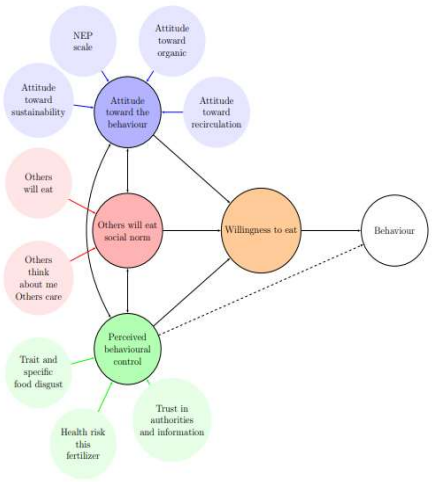
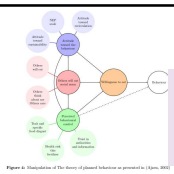


Figure 4: Extension of the Theory of Planned Behaviour as presented in (Ajzen, 2002)

How the questionnaire matches the elements in the TPB

Question battery	
1 and 2	Warm up questions
Choice Experiments (16 choices)	
3, 4 and 5	Validation questions in relation to Choice Experiments
6	Questions concerning the consumers attitudes to the specific fertilizer type that are applied in this project
7	Questions concerning organic
8	Questions concerning sustainability
9	Questions concerning the consumers' general attitude to re-circulation
10	The 10 item Food Disgust Scale (Hartmann and Siegrist, 2018)
11	The 15 item New Ecologial Pardigm scale (Dunlap et al., 2000)
12	Questions concerning the consumers trust in authorities, the food industry and in other humans.
13	Questions concerning social acceptance and how important this is for own behaviour

Attitudes and values



- Factor analysis on NEP scale, finding three factors (value orientations), limits to growth, human domination of nature and balance of nature
- Factor analysis on sustainability finding three factors, one interpreting sustainability to be in balance with nature, one that relates sustainability to organic production and a last that sustainability is related to fairness
- Another variable concerns the relationship between sustainable and recycling of nutrients, which is used as it is

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Social Norms

- It is important to me that others consider me as someone who care a lot about sustainability (soc_sustain)
- I think that people that are important to me don't mind eating foods fertilized with .....(soc_others)

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Perceived behavioural control, risk and benefits

Question battery	
1	Warm up questions
	Choice Expe
3	Validation questions in relation to Choice Experiments
6	Questions concernir type that are applie
7	Questions concernir
8	Questions concernir
9	Questions concern
10	The 10 item Food I
11	The 15 item New E
12	Questions concern humans.
13	Questions concern own behaviour

Health risks

Disgust

Residuals

Benefit

General risk

6. To which extend do you agree with?

	Totally disagree	Disagree	Neither/nor	Agree	Totally agree
I believe that this type of fertilizer poses a health risk when used for food production	❑	❑	❑	❑	❑
It is disgusting to use this type of fertilizer for food production	❑	❑	❑	❑	❑
This type of fertiliser contains to many residuals to be used on agricultural land	❑	❑	❑	❑	❑
I do not mind eating food produced with this fertilizer	❑	❑	❑	❑	❑

9 To which extend do you agree with?

	Totally disagree	Disagree	Neither/nor	Agree	Totally agree
Re-circulation of nutrients is sustainable	❑	❑	❑	❑	❑
Re-circulation of nutrients is an important element in the green transition	❑	❑	❑	❑	❑
It is a waste of resources not to recirculate nutrients	❑	❑	❑	❑	❑
There is too many risks involved in recirculation of nutrients	❑	❑	❑	❑	❑

Perceived behavioural control

Question battery	
1 and 2	Warm up questions
	Choice Experiments (16 choices)
3, 4 and 5	Validation questions in relation to Choice Experiments
6	Questions concerning the consumers attitudes to the specific fertilizer type that are applied in this project
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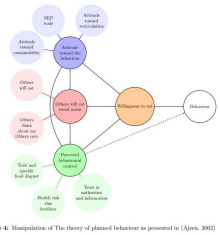

Figure 4: Manipulation of The theory of planned behaviour as presented in (Ajzen, 2002)

- Food Disgust scale
- Trust in information from authorities and from the food industry
- Trust in authorities, farmers and food industry

Results - WTP

Table 3: Household waste

VARIABLES	(1) Light	(2) Medium	(3) Heavy
NEP-limits	-1.10	0.20	-1.06*
	(0.860)	(0.579)	(0.592)
NEP-antro	0.01	0.72	0.57
	(0.853)	(0.542)	(0.606)
NEP-balance	-0.84	-0.16	0.33
	(0.728)	(0.471)	(0.552)
SUST-holistic	-1.52*	-0.68	0.55
	(0.890)	(0.551)	(0.717)
SUST-org	1.23	1.45**	-1.28*
	(1.185)	(0.630)	(0.757)
SUST-rec	0.37	-0.91	-0.67
	(1.658)	(0.946)	(1.050)
SOC-eat	-1.01	1.79***	1.02
	(1.003)	(0.606)	(0.706)
SOC-sustain	0.05	0.17	-0.67
	(0.808)	(0.573)	(0.579)
SOC-imp-all	-0.95	-0.42	2.18**
	(1.247)	(0.684)	(0.848)
FDscale	0.02	-0.09	-0.10
	(0.096)	(0.057)	(0.073)
REC-bene	0.54	-0.20	-0.31
	(0.759)	(0.416)	(0.462)
REC-risk	0.80	-1.14	-0.92
	(1.263)	(0.701)	(0.755)
Risk-HHwaste	-2.41***	-0.97*	-0.66
	(0.848)	(0.499)	(0.561)
Trust-info-aut	1.40	-0.44	0.65
	(1.315)	(0.788)	(0.859)
Trust-safe-aut	-1.57	1.24	-0.25
	(1.295)	(0.757)	(0.804)
Trust-safe-FI	1.81	-0.15	0.19
	(1.519)	(0.858)	(0.913)
Trust-info-FI	-2.01	-0.52	-1.11
	(1.533)	(0.853)	(0.955)
Observations	181	493	414
R-squared	0.197	0.116	0.093

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4: Foodindustry waste

VARIABLES	(1) Light	(2) Medium	(3) Heavy
NEP-limits	0.13	-0.24	-0.35
	(0.669)	(0.439)	(0.441)
NEP-antro	0.61	0.29	0.50
	(0.674)	(0.411)	(0.452)
NEP-balance	-0.10	-0.08	-0.07
	(0.566)	(0.356)	(0.415)
SUST-holistic	-1.63**	-0.93**	0.33
	(0.696)	(0.419)	(0.538)
SUST-org	1.53*	0.90*	-0.58
	(0.926)	(0.478)	(0.568)
SUST-rec	0.42	-1.35*	-0.53
	(1.282)	(0.721)	(0.790)
SOC-eat	0.06	2.29***	1.76***
	(0.870)	(0.453)	(0.525)
SOC-sustain	-0.08	-0.37	-1.02**
	(0.625)	(0.430)	(0.434)
SOC-imp-all	-1.66*	-0.50	1.32**
	(0.952)	(0.516)	(0.636)
FDscale	-0.00	-0.11**	-0.14***
	(0.075)	(0.043)	(0.054)
REC-bene	0.34	0.28	-0.16
	(0.585)	(0.318)	(0.349)
REC-risk	0.07	-0.05	-0.51
	(1.046)	(0.524)	(0.573)
Risk-FIwaste	-0.98	-1.58***	-1.16***
	(0.793)	(0.384)	(0.441)
Trust-info-aut	0.11	-0.31	-0.04
	(1.027)	(0.602)	(0.646)
Trust-safe-aut	-0.26	-0.01	-0.19
	(1.011)	(0.574)	(0.606)
Trust-safe-FI	0.66	-0.17	-0.03
	(1.181)	(0.651)	(0.687)
Trust-info-FI	0.00	0.39	-0.25
	(1.181)	(0.651)	(0.687)
Observations	181	493	414
R-squared	0.166	0.198	0.174

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5: Biosolids

VARIABLES	(1) Light	(2) Medium	(3) Heavy
NEP-limits	-0.52	0.13	-0.36
	(0.985)	(0.650)	(0.602)
NEP-antro	-0.19	0.68	1.16*
	(0.998)	(0.605)	(0.614)
NEP-balance	-0.57	-0.26	0.20
	(0.834)	(0.523)	(0.566)
SUST-holistic	-1.08	-0.61	0.21
	(1.036)	(0.622)	(0.734)
SUST-org	0.09	0.70	-1.02
	(1.372)	(0.706)	(0.775)
SUST-rec	-0.67	-1.15	0.02
	(1.883)	(1.067)	(1.083)
SOC-eat	1.55	3.07***	1.88***
	(1.254)	(0.620)	(0.663)
SOC-sustain	-0.40	-0.32	-1.41**
	(0.922)	(0.636)	(0.589)
SOC-imp-all	-2.88**	-1.03	2.27***
	(1.395)	(0.757)	(0.860)
FDscale	-0.05	-0.09	-0.13*
	(0.110)	(0.063)	(0.073)
REC-bene	0.58	0.18	-0.29
	(0.855)	(0.465)	(0.478)
REC-risk	0.42	-1.40*	-0.77
	(1.489)	(0.769)	(0.768)
risk-biosolids	-3.21***	-1.50***	-1.42**
	(1.038)	(0.568)	(0.573)
Trust-info-ant	1.27	-0.53	-0.19
	(1.522)	(0.880)	(0.883)
Trust-safe-ant	-0.72	0.45	0.17
	(1.492)	(0.844)	(0.821)
Trust-safe-FI	1.58	0.13	0.12
	(1.774)	(0.956)	(0.934)
Trust-info-FI	-1.52	-0.09	-0.92
	(1.807)	(0.950)	(0.980)
Observations	181	493	414
R-squared	0.265	0.211	0.169

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Results - WTP

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SOC-eat	-1.01	1.79***	1.02
	(1.003)	(0.606)	(0.706)
SOC-sustain	0.05	0.17	-0.67
	(0.808)	(0.573)	(0.579)
SOC-imp-all	-0.95	-0.42	2.18**
	(1.247)	(0.684)	(0.848)
FDscale	0.02	-0.09	-0.10
	(0.096)	(0.057)	(0.073)
REC-bene	0.54	-0.20	-0.31
	(0.759)	(0.416)	(0.462)
REC-risk	0.80	-1.14	-0.92
	(1.263)	(0.701)	(0.755)
Risk-HHwaste	-2.41***	-0.97*	-0.66
	(0.848)	(0.499)	(0.561)
Trust-info-aut	1.40	-0.44	0.65
	(1.315)	(0.788)	(0.859)
Trust-safe-aut	-1.57	1.24	-0.25
	(1.295)	(0.757)	(0.804)
Trust-safe-FI	1.81	-0.15	0.19
	(1.519)	(0.858)	(0.913)
Trust-info-FI	-2.01	-0.52	-1.11
	(1.533)	(0.853)	(0.955)
Observations	181	493	414
R-squared	0.197	0.116	0.093

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Observations	181	493	414
R-squared	0.166	0.198	0.174

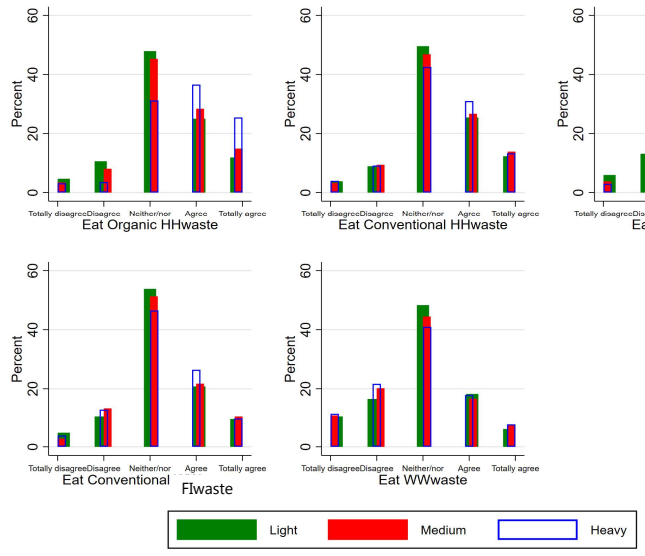
Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Observations	181	493	414
R-squared	0.265	0.211	0.169

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

- Value orientations have no systematic effect on WTP
- Attitudes towards recirculation or sustainability have no systematic effect on WTP
- Social norms have a positive effect
  - The perception that important others will eat food produced with the specific fertilizer has a strong and positive effect for all, but decreasing in level of organic consumption
  - The attitude that it is important that we all contribute to the green transition has a positive effect for heavy users –(bio-solids and food industry waste)
  - That it is important that others see me as someone that care about sustainability has a negative effect for heavy users (bio-solids and food industry waste)
- The food disgust scale has a negative effect for medium and heavy users (food industry waste and bio-solids)
- General risk and benefits of recirculation has no effect
- Specific risks has a high and significant effect, which is larger for food industry waste and largest for bio-solids and has a tendency to be more important for light users

Results RQ2)



If we consider stated behaviour this follow the WTP results

- Organic consumers agree to a larger degree that they are willing to eat food produced with organic household and food industry waste, but also conventional household waste.
- When we estimate the model based on the TPB with the 5 stated willingness to eat statements as the explained variables we find that it is specific risk and the social norms that has an effect, hence stated and "revealed" behaviour is somewhat similar.

Concluding remarks

- There seem to be a market for food produced with biological household waste, especially for organic foods
- It is only for heavy organic consumers that it is of importance that the waste is of organic origin
- Food produced with food industry waste need some kind of subsidy to be viable as a market as there is a negative WTP. This is universal across levels of organic consumption
- There is a negative WTP for food produced with bio-solids which is especially pronounced among organic consumers
- Value orientations and attitudes have no systematic effect on WTP for food produced with recirculated fertilizers, however perceived risks and social norms do
- Increasing consumers' acceptance of recirculated nutrients should therefore focus on changing the norms regarding recirculation and communicating about the absence of risks by using recirculated fertilizers.