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New paradigms on how to achieve zero food waste in future cities: optimizing food use by waste prevention and valorization”

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Content

- Context of the food waste problem in cities
- Inra foresight study « food biomass and urban systems » :
 - objectives, method
 - Key results on food waste prevention and valorization
- Research perspectives and outlook



Context of the food waste problem in cities

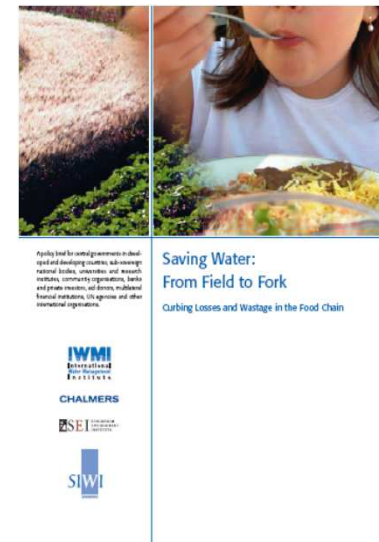
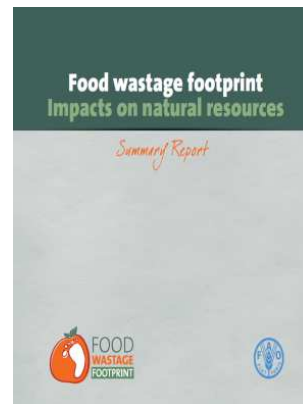
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Food loss and waste reduction, a promising means to increase sustainability of food systems

- Moral imperative with regard to food insecure people
- Preservation of resources (energy, water, etc.) and reduction of environmental impacts
- Preservation of purchasing power (data US, UK: some hundreds of euros per household per year)
- Less pressure on agriculture to increase production

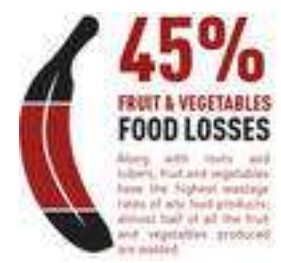
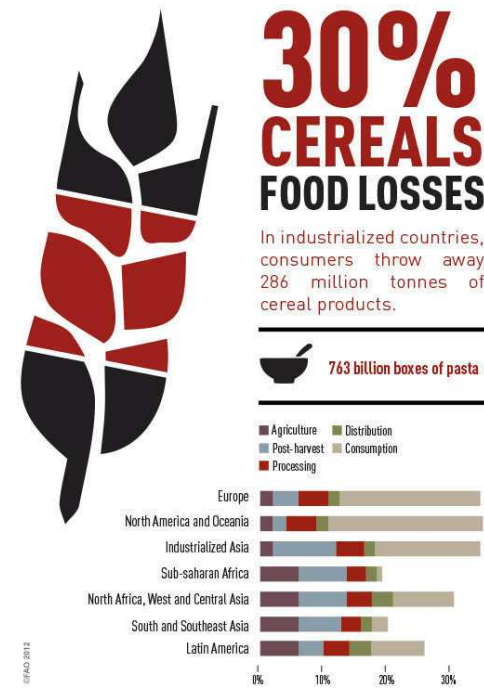
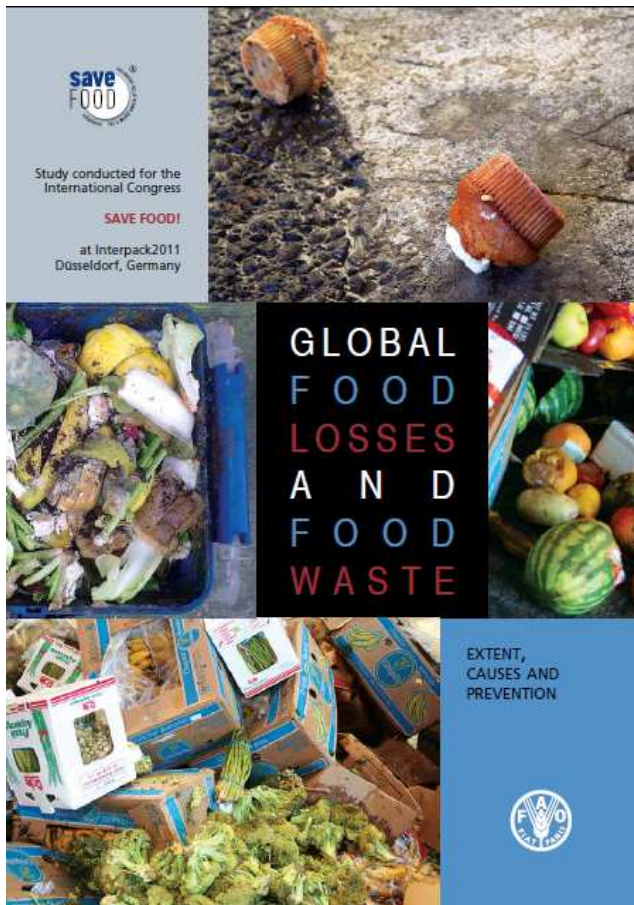
access to adequate food all year round	100%
stunted children less than 2 years	Zero
food systems are sustainable	All
increase in smallholder productivity and income	100%
loss or waste of food	Zero

Zero Hunger Challenge



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1/3 of our food produced worldwide is lost or wasted, 1.3 billion tonnes

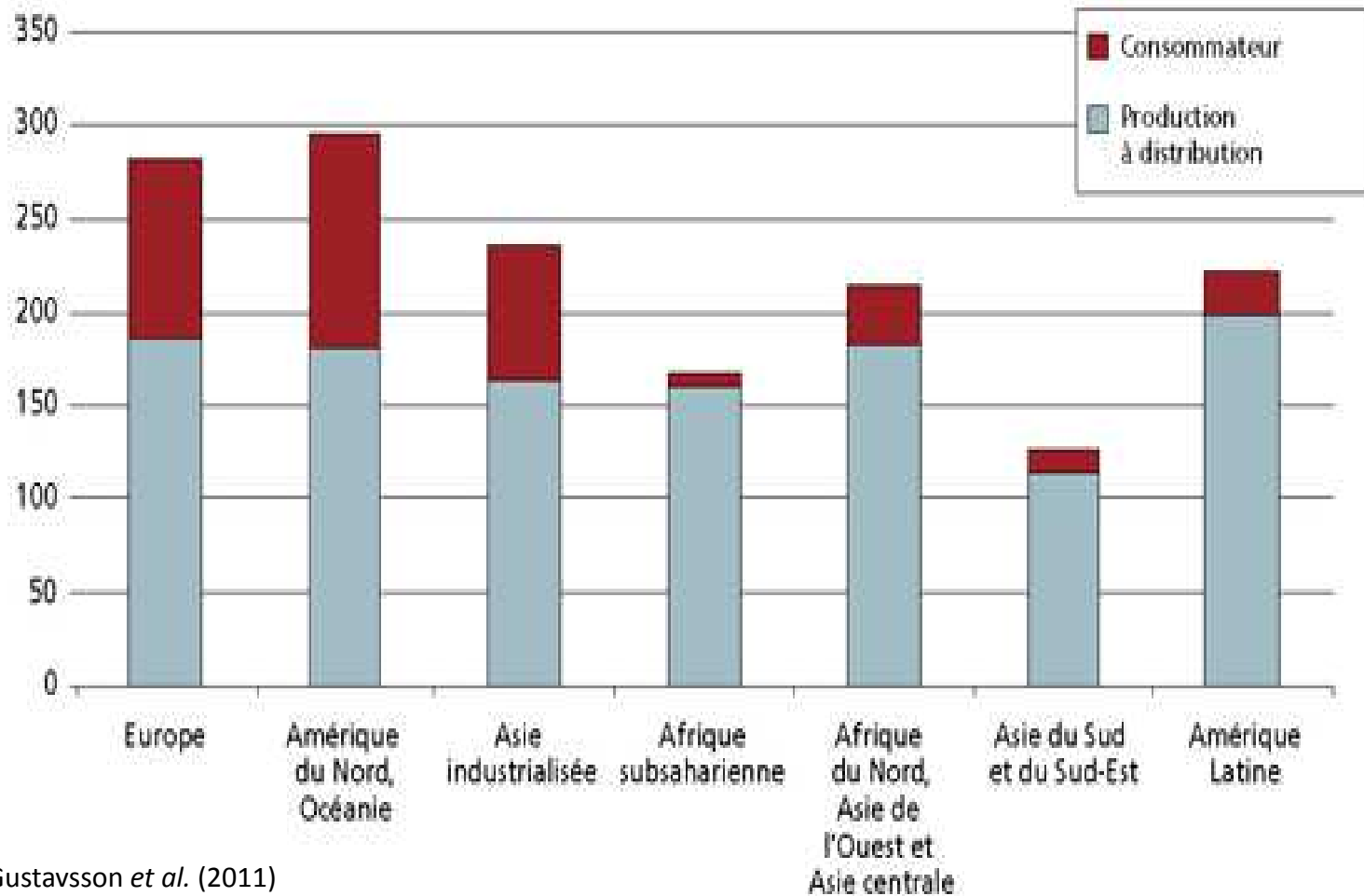


Source: FAO

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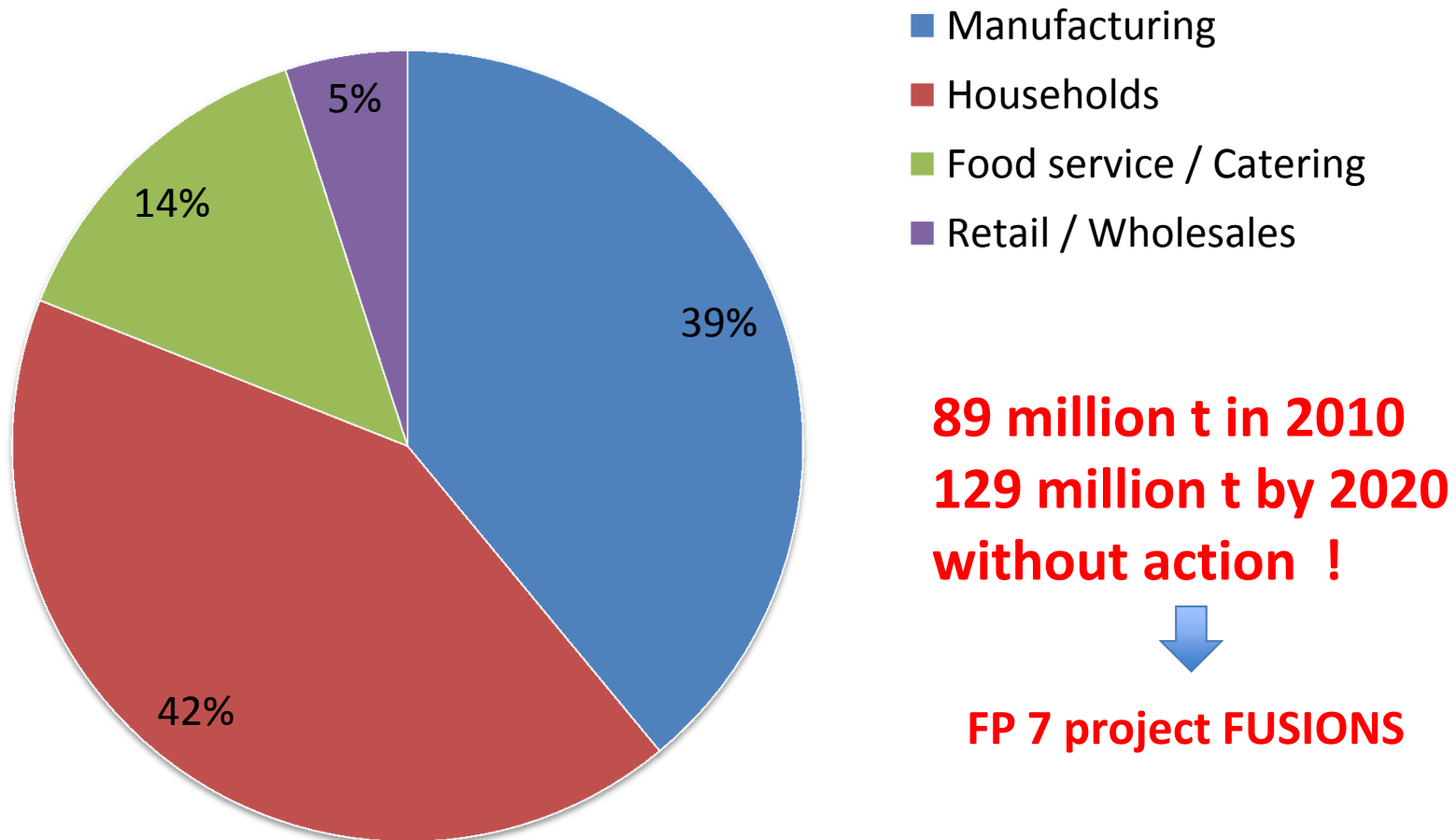
Per capita, industrialized countries are those who lose or waste most...

Pertes et gaspillages alimentaires par habitant (kg/an)



Source: FAO/Gustavsson *et al.* (2011)

In Europe : Breakdown of EU 27 food waste arising by sectors*

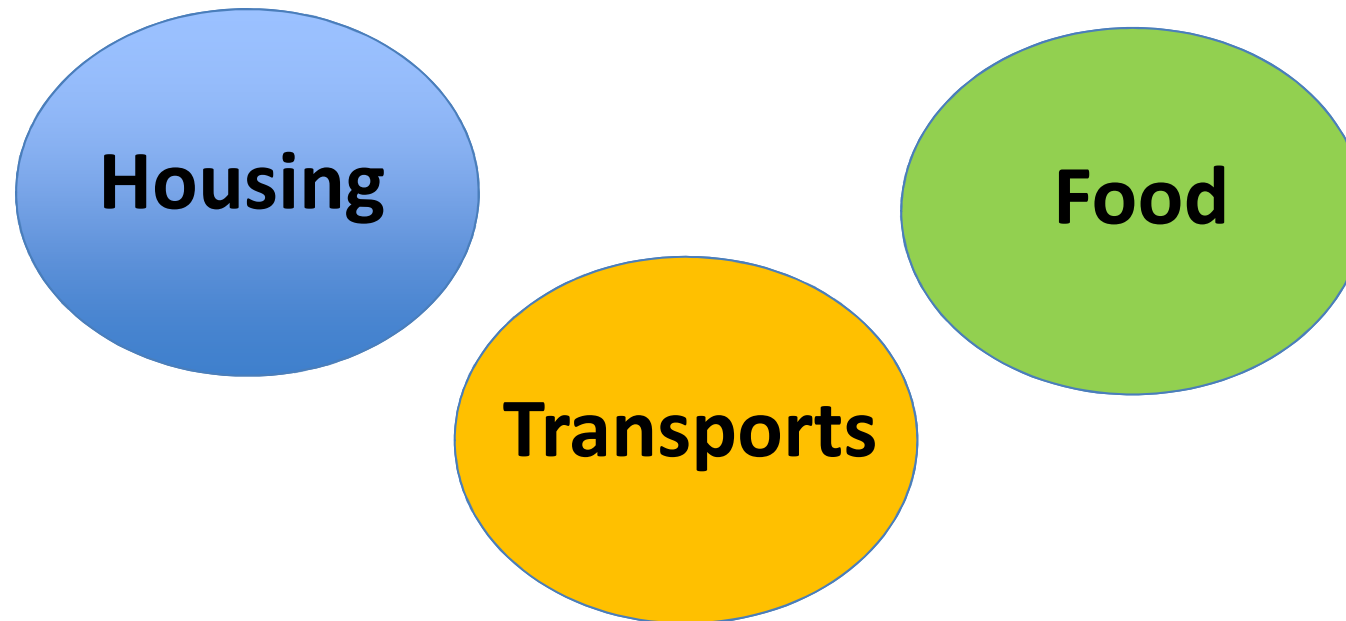


Source: Monnier et al., 2010. Source (EUROSTAT data, various national sources)

*Excluding Primary production

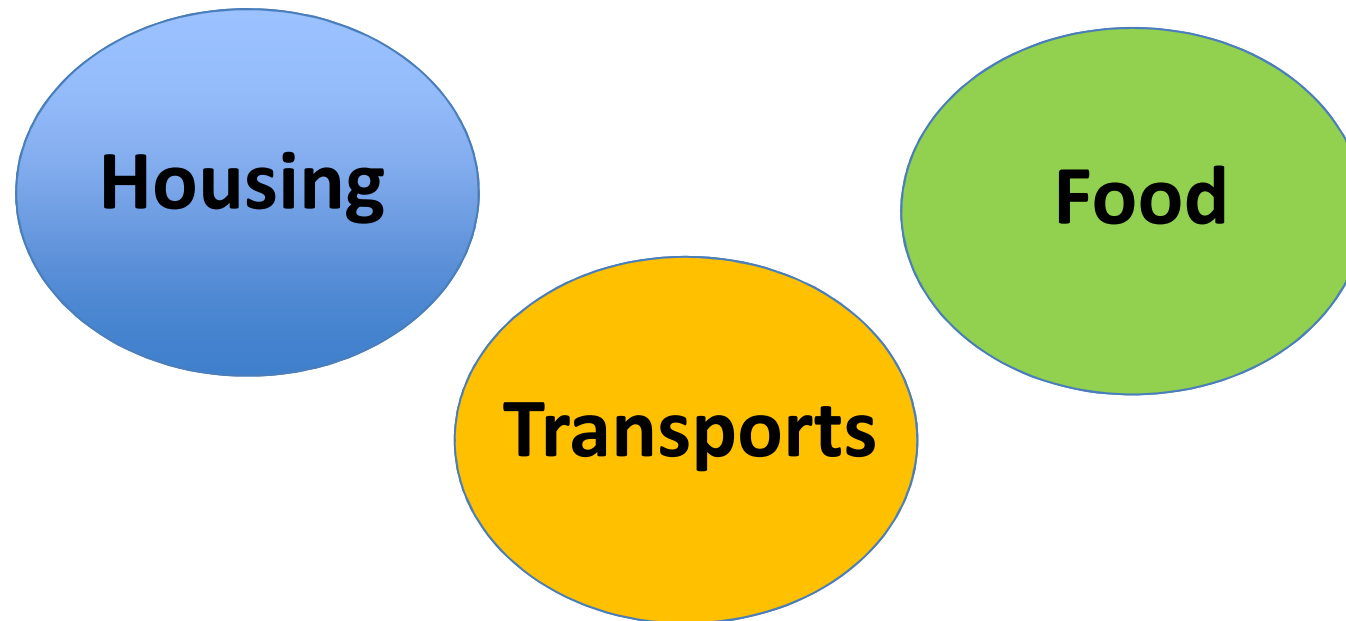
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Food is a major source of greenhouse gases (Tukker at al., Eipro, 2006)



- All 3 responsible for 70% of environmental impacts related to household consumption (life cycle perspective)
- **Food alone responsible for around 30% of household GHG in EU 25, and of more than 60% of eutrophication**

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Food waste prevention as priority :
Avoided : 1 t food waste \approx 4 – 4.6 t eq CO₂

The hierarchy of handling options of food waste is more than an ethical rule...

Table 1: Change in life cycle emissions from different waste management options

Route for management or disposal	Emissions incurred (+) or avoided (-) CO₂ equivalent emissions per tonne of food waste	Place in waste hierarchy
Redistribute to people from manufacture / retail	-3090 kg	Prevention
Redistribute to animals from manufacture	-220 kg	Prevention / Recovery
Anaerobic Digestion (AD)	-162 kg	Recovery
Incineration (with energy recovery)	-89 kg	Recovery
Composting	-39 kg	Recovery
Land spreading	-39 kg	Recovery
Incineration (without energy recovery)	0 kg ⁶	Disposal
Landfill	+536 kg	Disposal

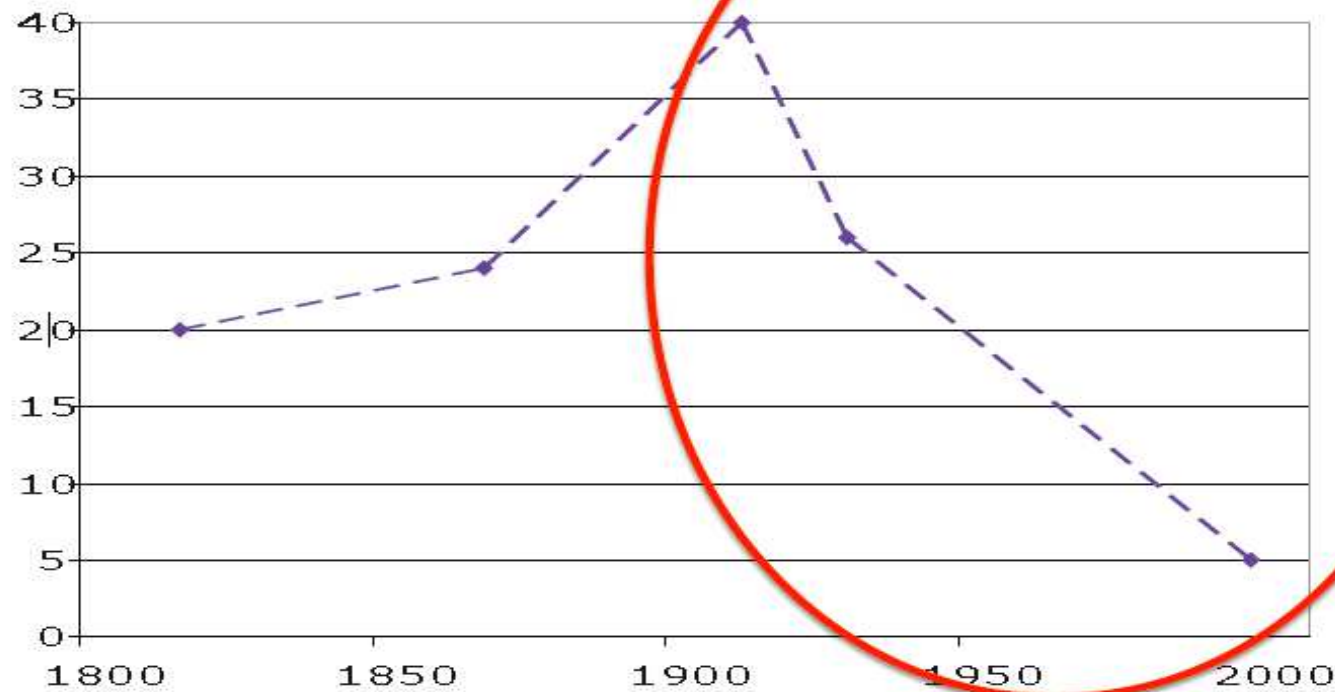
Source: WRAP Analysis

These are the emissions per waste management option and include avoided raw materials and energy (e.g. AD avoids some fertiliser and gas fired electricity generation) but exclude avoided emissions from alternative waste management options. This means that negative numbers are savings, positive numbers are net emissions. The relative impact of different options is the difference between the figures in each row. For comparison preventing a tonne of food waste would avoid between 4 to 4.6 tonnes of CO₂e.

Why focus on cities?

- In industrialized countries, most of the food waste happens close to consumption
- High population density
- Urban food waste management focused on disposal, nutrient recycling by farming is marginal
- Cities as catalysts of socio-technical innovations
- Global trend of urbanization (by 2050 66% of world population will be urban), population growth in urban centers in Asia and Africa

Urban agglomerations concentrate but don't restitute nitrogen...



**Taux de recyclage agricole de l'azote d'origine alimentaire,
Paris, 1817-2000 (%).**

NB. Estimation grossière pour 2000. (Barles, 2007 & 2009).



INRA foresight study « food biomass and urban systems »

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Objectives

- identify high potential socio-technological innovations in food waste prevention and valorization and
- extract research questions contributing to fostering and accompanying cities' breakthrough strategies towards zero waste sustainable food systems, specific to different urban settings worldwide (covering both industrialized and unindustrialized areas)
- Taking into account the questions raised by the development of megacities, of urban industrial ecosystems, of citizens' initiatives, the link with the "smart" or "sustainable" city approaches

Definitions of our study

- **Food waste** : food (edible and inedible parts) which leaves the supply chain meant for human consumption, and related biomass (e.g. by-products) (excluding wastewater, garden waste,...),
- **Food system**: Food supply chain, food production, processing, distribution and consumption as well as recovery and recycling of related by-products or bio-waste,
- **Urban system**: close to the concept of functional urban regions. Not political or administrative indicators determine “urban scale”, but the influence on activities and prescription of these (for example on farming practices or on waste management) coming from the city. Urban scale according to our definition can therefore include non-urban areas on which the city bears influence.

Foresight study method

- Status report, data analysis (indicators), detailed analysis and exploration of the acting variables and trends
- Individual interviews with experts, visits of companies (food production, retail, waste recovery,...), NGO, pilot cities, emblematic projects...
- Expert Group (20 experts from academia, business, NGOs with different background : environment, law, food science, organic waste management, aquaculture, urban farming, urban planning, industrial ecology etc.)
- Use of 3 food system scenarios and 3 urbanization scenarios
- Steering Committee INRA
- Project team
- Length : from oct 2014, ca. 12 months

Results

Inventory of food waste reduction and valorization initiatives classified by food system actors (1)

aim Supply chain stage	FOOD WASTE PREVENTION	FOOD WASTE VALORIZATION
Farming	<ul style="list-style-type: none"> - Better matching of supply and demand due to proximity of consumers with farming (including business and community-based urban farming) - Genetic selection of raw material - Information availability and access - Field gleaning - Urban garden gleaning - Connection between food donors and receivers - Marketing of surplus or of food not according to standards 	<ul style="list-style-type: none"> - Industrial synergies - On-farm composting and anaerobic digestion
Processing	<ul style="list-style-type: none"> - Optimization tools for stocks - More resistant packaging - Donation to charities - New products from discarded food 	<ul style="list-style-type: none"> - Animal feed
Logistics	<ul style="list-style-type: none"> - Better transport packaging 	<ul style="list-style-type: none"> - Inverse logistics to return food waste to farmers for composting or soil amendment
Distribution	<ul style="list-style-type: none"> - Better planning and shelf management - Collaborative management of stock and orders to match both better - Adjustment of sales promotions and sales campaigns - Adjustment/deletion of expiry dates - Stock clearance operators - Tools for matching demand and supply - Processing and delivery at order - Reduced transport duration - Donation to charities - New products from discarded food 	<ul style="list-style-type: none"> - Animal feed - Conversion to energy

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Inventory of food waste reduction and valorization initiatives classified by food system actors (2)

Catering, restaurants	<ul style="list-style-type: none"> - Incentives to leftover reduction - Price reductions close to shop closing hour - Management tools - Adjustment of plate sizes to clients' appetite - Removal of lunch tray at self-service (canteen and restaurant) - Meals based on "inedible" parts of food - Doggy bags 	<ul style="list-style-type: none"> - Frying oil recycling - Collection for composting and anaerobic digestion
Households	<ul style="list-style-type: none"> - Changes in food related habits (e.g. use of a shopping list) - Changes in use of preservation techniques (cupboard organization, freezing, use of canned food, etc...) - Donation - Distribution of food amongst other households 	<ul style="list-style-type: none"> - Use of hens for recycling kitchen waste - Individual or community composting or drying
Technologies	<ul style="list-style-type: none"> - Higher yielding technologies at processing - Longer shelf-life - Remaining shelf-life indicator - Analysis and monitoring of consumption data (big data) - For food use (new products, extraction of valuable compounds for food) 	<ul style="list-style-type: none"> - For feed use - Biorefinery - Drying of organic waste - Composting - Anaerobic digestion of food waste

Inventory of food waste reduction and valorization initiatives classified by food system actors (3)

Overarching tools	
Politics & regulation	<ul style="list-style-type: none"> - Landfill ban for organic waste - Waste taxation - Obligation in handling of organic waste (separate collection, valorization, ...) - Changes in regulation of product standards - Obligations for food donation to charities - Reduced tax payment schemes due to food donation to charities, recovery of VAT - Certification, labelling - Support to the use of hens as food waste recyclers
Awareness raising, education, training to professionals	<ul style="list-style-type: none"> - Awareness raising campaigns - Recommendations for food waste reduction (households, catering, ...) - Education et formation - Networking tool and exchange of experience

Key actions

- 1) Education of public and training of professionals
- 2) More flexible supply chain specifications,
- 3) Collaborative use of data, flow monitoring and smart sensors,
- 4) Regulation, taxation and financial tools,
- 5) Gradual withdrawal of food from market, selling off, stock clearance, on-site processing and donations,
- 6) Breakthrough manufacturing and packaging technologies,
- 7) Urban practices and urban planning,
- 8) Biomass valorization and biorefinery,
- 9) Fair distribution of responsibility between stakeholders



Research perspectives and outlook

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General knowledge needs, tools, methods and questions for research on Food waste prevention and valorization

- Society (food practices and evaluations of public and private policies)
- Chains, food cycles and systems
- Animal health, public health, environment, safety and nutrition
- Technological processes, closure of economic cycles and associated models
- ICTs, data processing and applied mathematics

Research perspectives on the link between cities and food waste

- **Adapt innovative logistics** to urban requirements and limits (small-scale collection and recycling, supply/demand monitoring, reversed logistics)
- **Scale ?** Down-scaling to urban small scale? for which activity?
- **Role of urban planning** to support food waste reduction?
- **Waste for agriculture:** stakeholder perception, contamination risks;
- **Social acceptability** of prevention/valorization innovations (lifestock in cities, packaging/processing technologies, digital city management)
- **Public health issues** (e.g. infectious diseases from lifestock in cities)

Outlook

- Further in-depth analysis of food waste key actions for a better understanding of assets, drawbacks, potential and implementation
- Collect data on food life cycle flows including food waste
 - Inra/Cirad started August 2015: fieldwork on urban food metabolism in four cities (Montpellier, Chicago, Dakar, Antananarivo)
- Progress on Modeling of the urban metabolism concept including food waste
- Include industrializing countries in the analysis

➔ Contribution from research to develop coherent concepts of food waste prevention and valorization in different urban contexts



Thank you!