Preventing Food Waste with Behavior Change Tools and Education

Final Report - Eureka Recycling - June 29, 2012

COMPOST
Make dirt, not waste.

Index

(651) 222-SORT (7678)
www eurekarecycling org

EUREKA! RECYCLING

Our mission is to reduce waste today through innovative resource management and to reach a waste-free tomorrow by demonstrating that waste is preventable, not inevitable.

June 29, 2012

Colleen Hetzel
Minnesota Pollution Control Agency
520 Lafayette Rd. N.
St. Paul, MN 55102

CC: Sherry Enzler, University of Minnesota's Institute on the Environment

Dear Colleen:

On behalf of Eureka Recycling and our project partners, I am pleased to submit this final report to you for the Preventing Food Waste with Behavior Change Tools and Education grant (FY 2010, ID#1702 for $50,000).

As you know, prevention is the most important part of composting because it results in significantly more environmental, financial and social benefit to eat food than to compost it.

However, Americans are currently wasting more food than ever before. According to a recent study, we throw away 50% more food than 40 years ago. The majority of this wasted food occurs at the consumer level. Several recent reports are quantifying the avoidable wasted food, including its economic cost and environmental impacts. For example, 20% of vegetables produced are never eaten and wasted by consumers. This represents significant financial waste for consumers. In fact, we estimate that the average Saint Paul wastes $96 per month in preventable wasted food. But this is just a part of the story. Much more is wasted than just the money spent on purchasing the food at the store. The impacts of our food system are significant, and it requires a great deal of resources to get food from the field to our refrigerators.

Waste food is an accident – no one goes to the store and buys food with the intention of composting it! The exciting news is that the solutions are easily accessible, affordable, and low-tech. Simple actions like menu planning and proper food storage can go a long way towards significantly reducing the amount of food that people accidentally waste at home.

We're pleased to present this toolkit which is the culmination of our work with behavioral psychologist Christie Manning to address food waste at the source in a meaningful way, and investigating the information and motivation people need to prevent food from being wasted. This project included research about how and what types of food people waste in Minnesota (and the U.S.) and their attitudes, practices, and barriers to preventing wasted food. Using this data, social marketing tools, and the psychology of sustainable behavior, this project generated and tested tools, messages, and strategies to engage the community is wasting less food. The toolkit that is published on our website consolidates some of these resources and links to two new interactive web-based tools to help people waste less food.

2828 Kennedy Street NE \ Minneapolis, MN 55413 \ (651) 222-7678 \ Fax (612) 623-3277 \ www.eurekarecycling.org

We are excited to put these tools to use in the city of Saint Paul as part of a plan in front of the City Council for this coming budget year. If the plan is included in this year's budget, education on preventing wasted food, backyard composting training and curbside composting collection will roll out city-wide starting in 2013.

We also look forward to continuing to work with the MPCA to share this toolkit broadly with our colleagues, partner organizations and other interested groups and individuals beyond Saint Paul in the coming months in hope it inspires other communities to take action on this issue as well.

Thank you for your support. If you have any questions, please call me at 651-222-7678.

Sincerely,

Lynn Hoffman
Associate Director of Communications

GRANT AGREEMENT
ATTACHMENT B

CONTINUAL TRACKING REPORT

(All reports should reflect an on-going, rolling status update of the project. Never delete previous information, but always add additional information at each phase of progress and always submit electronically.)

[ ] INTERIM REPORT [X] FINAL REPORT

Project Title: Preventing Food Waste with Behavioral Change tools and Education

- **Focus Area B:** Source Separated Composting
- **Preferred project proposal B2:** Residential Composting (focused on developing an educational toolkit to reduce food waste and increase residential composting)
- **Goal Statement:** Will reduce the amount of food being wasted through creation of new research about wasted food and the development of tested behavior change tools, messages and strategies that will be consolidated in a toolkit.
- **Project Evaluation Plan and Outcomes:** Will be using waste sorts to determine the amounts and types of food being wasted (currently unknown), to establish baseline data prior to the application of tools and to inform us about the effectiveness of the tools because we will measure the amount of wasted food again after the application of tools. The climate change impact of the amount of reduced food waste will be calculated; will use a variety of methods such as surveys, focus groups, interviews to develop initial tools, messages and strategies, to evaluate people's reaction to the initial tools, and to continue to get feedback on the final toolkit. By following the tenants of the psychology of sustainable behavior we will be using the feedback to create the most effective tools, messages and strategies to reduce food waste; will use and track the partnerships we develop to increase the impact of the project results and the toolkit. Success of this project relies on our ability to successfully tap into partner networks for the dissemination of the tools, messages and strategies to prevent wasted food; will track the compile a list of places/audiences where Eureka Recycling, Consultant and other project partners present results, as well as track visits to the website, as well as users' comments about the toolkit for the final report.

Work Plan

Objective 1 of 9 – Baseline Data Collection Waste Composition

Task 1A: Eureka Recycling will collect baseline data collection (waste sorts for waste composition).
Timeframe: Completed March 2010
Person(s) Responsible: Eureka Recycling project manager and staff
Estimated Funds: EA Grant: $0 Match (Eureka Recycling): $0 Total: $0
**Prior to grant award, not included in this budget.
Estimated Funds: EA Grant: $0 Match: $0 Total: $0

Progress Update/Lessons Learned: In April and May of 2010 we sorted a total 929 pounds of garbage, looking to measure and categorize preventable food waste. Some of our learning included ways to determine what is "preventable" (broccoli stems? bread crusts?) and how to measure it (subtract the average tare weight of a jar, or scoop just out the peanut butter? Cut the flesh off an apple but leave the core?). In addition, we learned about the limitations of sorting waste as an aggregate, as opposed to individual households, because we lose the ability to discount outliers that can skew numbers. Unfortunately the base-line sorts conducted in March had too many data integrity issues to be used reliably so we were unable to do comparative analysis pre and post-pilot.

Objective 2 of 9– Develop Tools to Prevent Wasted Food

Task 2A: Research Wasted Food
Timeframe: December 2010
Person(s) Responsible: Eureka Recycling project manager
Estimated Funds: EA Grant: $0 Match (Eureka Recycling): $1,400 Total: $1,400

Interim Report - Actual Expenditures: EA Grant $ 0 Match $1,400 Total Expenditures: $1,400
Date: 12/30/2010
Progress Update/Lessons Learned: Eureka Recycling staff has conducted extensive research into the impacts of wasting food. We are learning more and more about the impacts of the entire food production system, and the embedded energy and resources in food products that make it all the way to household refrigerators.

Most notably we uncovered the lack of statistical information available about the actual amounts of preventable food waste ending up in our landfills and incinerators. Most United States numbers being used in publications have been intensely extrapolated from limited data attached to studies conducted many years ago. It would take a significant amount of resources and political will to conduct the necessary studies that would resulting in current and statistically significant data on preventable food waste. (This is evidenced by the data gathered in the UK as part of the "Love Food Hate Waste" program, which entailed the sorting of garbage from 2,138 households.)

In addition, our research has focused on messages, tools, and techniques used around the world by the many movements and sectors overlapping with this issues - including health care, homesteading, saving money, saving time, local and organic food, etc. Tips and tools coming from these movements include meal planning, recipes, tips for optimal food storage, directions for long terms storage like canning and freezing, portion size calculators, etc. Many of these messages and tools were included or tweaked to be a part of our tool-testing pilot.

Final Report - Actual Expenditures: EA Grant $_____ Match $_____ Total Expenditures:_____
Date: June 2012 **Progress Update/Lessons Learned:** *(See Appendix B for research summary and documents)*

Task 2B: Determine project partners/grant administration. The University of Minnesota (Institute on the Environment) will be partnering with Eureka Recycling and will provide grant administration and leads for additional potential project partners. Throughout the research process, Eureka Recycling will meet with other interested organizations and individuals to research wasted food, assess their interest in supporting this project, brainstorming potential tools and dissemination networks, etc.
Timeframe: November 2011
Person(s) Responsible: Institute on the Environment, Eureka Recycling project manager and director
Estimated Funds: EA Grant: $5,000 Match (Eureka Recycling): $3,350 Total: $8,350

Interim Report - Actual Expenditures: EA Grant $3,500 Match $2,150 Total Expenditures: $5,650
Date: 6/28/2011
Progress Update/Lessons Learned: The Lao Family Center in Saint Paul has partnered with Eureka Recycling to engage Hmong households in the pilot and help gather their input and feedback. Community Organizer Sheronda Orridge is partnering with us to engage the African American community, specifically in and around the Rondo and Frogtown neighborhoods of Saint Paul. Eureka Recycling continues to be in dialog with additional community organizations and individuals about potential involvement and partnership.
The Institute on the Environment continues to be the primary grant administrator.

Final Report - Actual Expenditures: EA Grant $ 1,500 Match $1,200 Total Expenditures: $2,700
Date: July 2011-June 2012 **Progress Update/Lessons Learned:** The University of Minnesota (Institute on the Environment) performed the expected role of primary grant administrator. Through community partnerships in the Frogtown neighborhood and east side of Saint Paul the scope and reach of this project was significantly broadened and diversified, providing rich insight into the personal and cultural nature of food habits.

Task 2C: Research and design data collection methods to investigate the barriers to changing food waste habits.
Timeframe: December 2010
Person(s) Responsible: Consultant
Estimated Funds: EA Grant: $2,500 Match: $0 Total: $2,500

Interim Report - Actual Expenditures: EA Grant $2,500 Match $0 Total Expenditures: $2,500
Date:12/30/2010
Progress Update/Lessons Learned: Christie Manning designed and managed an initial set of interviews, conducted with 26 residents in the originally identified area of the Macalester-Groveland neighborhood. The results of these interviews highlighted the impact that culture and socio-economic conditions have on food habits and decisions, which influenced the decision to expand the tool-testing program to include African American and Hmong households as well. Dr. Manning also guided the development of the interactive elements of the tool-testing program designed to capture perceptions, experiences, and behaviors of each participant throughout the pilot. At the conclusion of the 6-week testing period, Dr. Manning advised the design of focus groups and interviews to gather additional data from pilot participants, intentionally crafting details such as questions, locations, and incentives to be appropriate to the community participants and the project goals.

Final Report - Actual Expenditures: EA Grant $_____ Match $_____ Total Expenditures:_____

Date:___ June 2012 ____ Progress Update/Lessons Learned: *(See Appendix C for methodology, interview questions, and Dr. Manning's observations and recommendations.)*

Objective 3 of 9 – Pilot test tools and strategies

Task 3A: Apply tools for testing. During the testing, continue to generate food reduction messages and tools based on wasted food research and psychology of sustainable behavior approach. The number of people who receive the tool during the pilot will depend on the type of tool, the feedback needed to determine its effectiveness, the number of tools being applied, etc.
Timeframe: December 2010-March 2011
Person(s) Responsible: Eureka Recycling project manager and staff, Consultant
Estimated Funds: EA Grant: $7,000 Match: $4,000 (Eureka Recycling) Total: $11,000

Interim Report - Actual Expenditures: EA Grant $7,000 Match $4,000 Total Expenditures:$11,000
Date: May & June, 2011
Progress Update/Lessons Learned: Eureka Recycling, with the help of our partners at Lao Family Center and Sheronda Orridge, recruited 90 families total (30 primarily Caucasian families in the Macalester-Groveland neighborhood of Saint Paul, 30 African American families near the Rondo neighborhood of Saint Paul, and 30 Hmong families primarily on the east side of Saint Paul) to participate in a pilot test of tools and messages designed to help prevent wasted food.

Tools were developed based on research, and included meal planning, shopping tips, food storage tips, recipes for using up leftovers, and access to a website linked to more in-depth information about topics ranging from canning to freezing to building root cellars for cold storage. Participants were asked to apply these tools at home for 6 weeks, answer specific questions in their journal each week, take notes on the usability of the content and tools, and be willing to share their feedback in a focus group or individual interview. Participants also gave permission for their waste to be collected and sorted during the pilot. All three groups of participants have completed the 6-week pilot testing phase, and feedback and results have begun to be collected (see objective 4), but have not yet been analyzed or summarized.

Final Report - Actual Expenditures: EA Grant $_____ Match $_____ Total Expenditures:_____
Date: June 2012 Progress Update/Lessons Learned: *(See Appendix D for copies of tools tested)*

Objective 4 of 9 – Gather feedback

Task 4A: Gather feedback (i.e. survey, focus groups, interviews, etc.) on applied tools. Collection of other types of data to be determined.
Timeframe: March-April 2011
Person(s) Responsible: Consultant, Eureka Recycling project manager and staff
Estimated Funds: EA Grant: $2,500 Match: $0 Total: $2,500

Interim Report - Actual Expenditures: EA Grant $2,000 Match $0 Total Expenditures:$2,000
Date: As of June 28, 2011
Progress Update/Lessons Learned: With the guidance of Christie Manning, Eureka Recycling has conducted four focus groups with 26 pilot participants. Due to Dr. Manning's schedule, we are still collecting data via interviews from the remaining participants who could not attend focus groups, and will soon begin analysis of all the data collected in order to inform the recommendations and development of the web-based toolkit.

Final Report - Actual Expenditures: EA Grant $ 500 Match $_____ Total Expenditures: $500
Date: July 2011 **Progress Update/Lessons Learned:** Through our existing community partners, we coordinated one-on-one interviews to gather feedback from participants who could not (or did not feel comfortable) attending larger group focus groups. This feedback in conjunction with the focus groups gave valuable insight to the personal and cultural aspects of food habits, and the needs our specific audience had for tool content, structure, and format, which strongly informed the development of the tools and recommendations for the toolkit. *(See Appendix C for survey, focus group and interview questions, and the recommendations being made available as part of the toolkit.)*

Task 4B: Eureka Recycling will conduct follow up waste sort and analyze data compared to a baseline data waste sort conducted by Eureka Recylcing in April/May 2010 to determine the waste reduction impact of the tested tools.
Timeframe: March-April 2011
Person(s) Responsible: Eureka Recycling project manager
Estimated Funds: EA Grant: $0 Match (Eureka Recycling): $6,100 Total: $6,100

Interim Report - Actual Expenditures: EA Grant $0 Match $5,185 Total Expenditures: $5,185
Date: June 2011
Progress Update/Lessons Learned:
In June of 2011, we sorted 862 pounds of material from households participating in the tool-testing pilot.

The scope of this grant will not produce large-scale, statistically significant data about the composition of the average households' trash, but can reveal trends specific to these communities and provide critical learning about the methods used during waste sorts to determine what is and is not "preventable food waste." Further analysis will be completed in the coming weeks, including evaluation in context of the baseline data to identify any relevant comparisons between waste sorts, as well as comparison to results of focus groups and interviews, and individual households' participation in backyard composting, to help us identify common barriers and possible solutions.

Final Report - Actual Expenditures: EA Grant $_____ Match $915 Total Expenditures:$ 915
Date: July – Aug 2011 **Progress Update/Lessons Learned:** Although the scope of this grant could not produce large-scale, statistically significant data about the composition of the average households' trash, the waste sorts we conducted gave us insight into the food that is wasted in the three separate communities that we studied, which we examined in conjunction with the focus-group and interview feedback we collected from those communities.

Most importantly, we were able to learn—and now share—a great deal about *how* to conduct a waste sort that will produce usable numbers and show an accurate portrayal of the scale of wasted food in residential trash, which we believe requires a different approach from the industry standard. These findings will be presented as part of the waste sort recommendations in the toolkit. *(See Appendix E for waste sort recommendations being made available on the web-based toolkit.)*

Finally, this study highlighted the need for regional large-scale waste sorts that can provide an accurate baseline measure of preventable food waste in residential trash. Smaller-scale community projects focused on preventing wasted food (like this one) cannot afford to create this baseline data for themselves, but could use regional data to measure the effectiveness of their efforts. Eureka Recycling will submit a letter to EPA Region 5 (and copy the MPCA) requesting a focus on and an investment in developing regional baseline measures for preventable food waste currently in residential trash.

Objective 5 of 9 – Evaluation/Analysis of Data to Determine Effectiveness

Task 5A: Analyze feedback from applied tools and waste sorts
Timeframe: May 2011
Person(s) Responsible: Consultant
Estimated Funds: EA Grant: $1,000 Match: $0 Total: $1,000

Interim Report - Actual Expenditures: EA Grant $_____ Match $_____ Total Expenditures:_____
Date:_____ **Progress Update/Lessons Learned:**_____

Final Report - Actual Expenditures: EA Grant $1,000 Match $_____ Total Expenditures: $1,000
Date: July 2011 **Progress Update/Lessons Learned:** Due to Dr. Christie Manning's schedule she was unavailable to fully conduct the evaluation and analysis of the waste sorts and focus groups about the applied tools. Eureka Recycling's staff completed this work and consulted with Dr. Manning about the results. *(See Appendix C for summary of findings.)*

Objective 6 of 9 – Develop and present recommendations

Task 6A: Provide written anlaysis and recommendations regarding feedback from residents and tools. These recommendations include tested food waste prevention messages, as well as a determination of most effective channels for disseminating messages (large scale media, community media, interpersonal networks, other community-based networks, other). Apply recommendation to tools and strategies and offer suggestions to adjust tools, messages and strategies based on feedback on the recommendations. Advise on the development of a web-based toolkit.
Timeframe: May 2011
Person(s) Responsible: Institute on the Environment, Consultant, Eureka Recycling project partners
Estimated Funds: EA Grant: $2,000 Match: $0 Total: $2,000

Interim Report - Actual Expenditures: EA Grant $_____ Match $_____ Total Expenditures:____
Date:_____ **Progress Update/Lessons Learned:**_____

Final Report - Actual Expenditures: EA Grant $2,000 Match $_____ Total Expenditures:$2,000
Date: July 2011 – June 2012 **Progress Update/Lessons Learned:** Dr. Christie Manning prepared a report of recommendations based on general principles of behavioral psychology and in light of the specific data, research and feedback we gathered through this project. This report was an influential piece in the evolution and design of the final tools, and will be made available as part of the on-line toolkit. *(See Appendix F for report.)*

Task 6B: Present finding and recommendations to Eureka Recycling, Institute on the Environment, the MPCA, and other project partners for feedback.
Timeframe: July 2011
Person(s) Responsible: Consultant, Institute on the Environment, Eureka Recycling, project partners.
Estimated Funds: EA Grant: $1,000 Match: $0 Total: $1,000

Interim Report - Actual Expenditures: EA Grant $_____ Match $_____ Total Expenditures:_____
Date:_____ Progress Update/Lessons Learned:_____

Final Report - Actual Expenditures: EA Grant $1,000 Match $_____ Total Expenditures:$1,000
Date: September-December 2011 **Progress Update/Lessons Learned:** Eureka Recycling presented our findings to date to the MPCA on December 29. Christie Manning and the staff of the Institute on the Environment did not participate in the meeting, but provided feedback and insight on the information that was presented.

Objective 7 of 9 –Develop toolkit to be published on website and finalize tools

Task 7A: Create, modify, and/or design final tools, messages, and strategies. Consolidate research, data, reports, resources, tools, messages and strategies into one user-friendly website toolkit. This will require working with web/electronic information developers.
Timeframe: June-October 2011
Person(s) Responsible: Tool/website developers, Eureka Recycling, other project partners
Estimated Funds: EA Grant: $29,000 Match: $1,000 Total: $30,000

Interim Report - Actual Expenditures: EA Grant $ 1,190.50 Match $___ Total Expenditures: $ 1,190.50
Date:as of June 29, 2011
Progress Update/Lessons Learned: The tools that were designed and printed to be tested in the six-week pilot were preliminary drafts of pieces we hope to evaluate and potentially revise and recommend as part of the final web-based tool-kit, such as searchable storage tips, recipe index, etc. The content being discussed now during evaluation will inform decisions made about the final tool-kit.

Final Report - Actual Expenditures: EA Grant $27,809.50 Match $1,000 Total Expenditures:$28,809.50
Date: January – June 2012 **Progress Update/Lessons Learned:** Final versions of the two tools will be live on Eureka's composting website in June 2012: a collection of food storage tips and a menu planner. These were identified as the two most important tools in our pilot. The original tools, which were used by pilot participants, have been altered and expanded based on the feedback we collected during the pilot. The final versions incorporate interactive and community-building elements, and are being produced in multiple formats: printable and on-line, with portions being developed in a way that allows users to view them on their cell phones. *(See Appendix G for print copies of the Food Storage Guide and the Menu Planner)*

The web-based toolkit is located on Eureka Recycling website, alongside results from pervious Eureka Recycling work supported by the PCA (best practices for multifamily recycling and public space recycling) and includes a research summary, recommendations for gathering community feedback, recommendations for conducting waste sorts with a focus on examining preventable wasted food, Dr. Christie Manning's report on the application of behavior psychology principles to developing programs about this issue, links to the two fully developed tools: the Food Storage Tips and the Menu Planner, and a brainstormed list of recommendations for future tool development. *(See Appendix G for a print out of the webpages)*

Objective 8 of 9 – Wide dissemination of Tools

Task 8A: Raise awareness about the toolkit through statewide (and national) networks. Present project findings and tools for source reduction of food waste at appropriate events, conferences, meetings, media outlets, etc. In October 2011, Eureka Recycling will meet with project partners to solicit their ideas for how to disseminate the final toolkit and project results. Eureka Recycling will compile a list of places/audiences where results are presented and will track visits to the website, as well as users' comments about the toolkit for the final report.
Timeframe: March 2012

Person(s) Responsible: Institute on the Environment, Eureka Recycling project manager
Estimated Funds: EA Grant: $0 Match (Eureka Recycling): $525 Total:$525

Interim Report - Actual Expenditures: EA Grant $_____ Match $_____ Total Expenditures:_____
Date:_____ Progress Update/Lessons Learned:_____

Final Report - Actual Expenditures: EA Grant $_____ Match $525 Total Expenditures:$525
Date: June 2012 Progress Update/Lessons Learned: With feedback from project partners, the MPCA, and community members, Eureka Recycling has prepared a list of local and national organizations and individuals to share the toolkit with when it is live June 2012 *(See Appendix G for the dissemination plan.)* As other appropriate venues come up over the next year (for example, meetings of the association of recycling managers) we will continue to present these findings. Additionally, we will continue to track traffic on both the web-based tool kit and the web-based tools.

Objective 9 of 9 – Reporting

Task 9A: Submit an Interim Report within 1 year of the execution of the grant agreement or at 50% completion of the project, whichever occurs first.
Timeframe: July 2011
Person(s) Responsible: Institute on the Environment, Eureka Recycling project manager
Estimated Funds: EA Grant: $0 Match (Eureka Recycling): $1050 Total: $1050

Interim Report - Actual Expenditures: EA Grant $_____ Match $700 Total Expenditures:
Date: as of June 28, 2011
Progress Update/Lessons Learned: An interim report was submitted to the MN PCA on June 28th, 2011. Additional work will be required in the following weeks to coordinate and communicate with project partners about the report and funding pass through, as well as providing additional documentation as needed.

Final Report - Actual Expenditures: EA Grant $_____ Match $350 Total Expenditures:$350
Date: June 2011 **Progress Update/Lessons Learned:** All final documentation, reporting, and communicating with project partners was completed in the week following the submission of the interim report.

Task 9B: Submit a Final Report 1 month prior to the end of the grant agreement or at 100% completion of the project, whichever occurs first. Final Report to include electronic submission of Web-ready version of toolkit for placement on the MPCA website.
Timeframe: May 2012
Person(s) Responsible: Institute on the Environment, Eureka Recycling project managers
Estimated Funds: EA Grant: $0 Match (Eureka Recycling): $1,050 Total: $1,050
Interim Report - Actual Expenditures: EA Grant $_____ Match $_____ Total Expenditures:_____
Date:_____ Progress Update/Lessons Learned:_____

Final Report - Actual Expenditures: EA Grant $_____ Match $1050 Total Expenditures:$1050
Date: June 2012 **Progress Update/Lessons Learned:** At the mid-project presentation on December 29, 2011, the MPCA agreed to a small extension of the grant timeline, putting the final report and toolkit release at the end of June 2012. The MPCA will be able to immediate link to the Waste Food Toolkit from its website.

Measurable Outcomes

Quantity of waste reduced or diverted from land disposal – Interim Report

Measurable Objective	Project Goals	Baseline Measurement	Project Final Measurement	Waste Reduction	GHG Emissions Avoided (metric ton of carbon dioxide Equivalent)
# Community Composters engaged			>90 to date	TBD	TBD
Organics diverted to backyard composting(lbs/tons)				TBD	TBD
Organic diverted to commercial composting (lbs/tons)				TBD	TBD
Amt. Food Waste reduced/household (lbs/tons)				TBD	TBD

Quantity of waste reduced or diverted from land disposal – Final Report

Measurable Objective	Project Goals	Baseline Measurement	Project Final Measurement	Waste Reduction	GHG Emissions Avoided (metric ton of carbon dioxide Equivalent)
# Community Composters engaged			90 households *	2281.5 lbs	.65 MTCO2E
Organics diverted to backyard composting(lbs/tons)	n/a	n/a	n/a	n/a	n/a
Organic diverted to commercial composting (lbs/tons)	n/a	n/a	n/a	n/a	n/a
Amt. Food Waste reduced/household (lbs/tons)			2281.5 lbs*	2281.5 lbs	.65 MTCO2E

*This amount is an estimate for 90 average households in Saint Paul, because actual amounts are not able to be measured. The estimate is based on data from recent studies estimating preventable food waste in the average household's trash, and the proven results of percentage avoided through applied education in programs in Great Britain. These numbers also assume the participating households that began this program will continue to apply the habits for at least a year. The Greenhouse Gas analysis was calculated using the Measuring Environmental Benefits Calculator (MEBCalc™).

Future Applications and Further Diversion:
While only 90 households applied this education during the course of this project, the education and messaging developed will be applied to the entire City of Saint Paul beginning in 2013 (given the passage of the Saint Paul Composting Plan in 2012), resulting in an estimated 997 tons of wasted food being prevented, which will avoid 569.8 MTCO2E of Green House Gases.

Additionally, when the toolkit is live and the tools are distributed the widely, the above numbers and impacts will only continue to grow.

Budget

Budget and Expenditures Report

Cost Category	Unit Cost		Qty. (Hours/Amnt) Exp./Budget		I. Grant Funds	II. Match Cash	III. Match In-kind	IV. Total Budget	V. Expended Previous Periods	VI. Expended This Period	VII. Cumulative Expenditure (V + VI)	VIII. Budget Balance (IV - VII)
OBJECTIVE 1 of 9: Baseline Data Collection Waste Composition												
Task 1A) Collect Baseline Data												
Prior to grant award, not included in this budget												
SUBTOTAL					0	0	0	0	0	0	0	0
OBJECTIVE 1 - TOTAL					**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
OBJECTIVE 2 of 9: Develop Tools to Prevent Wasted Food												
Task 2A) Research Wasted Food												
ER Project Manager	$35	/hr	40	hrs		0	$1,400	$1,400	$1,400	$0	$1,400	$0
SUBTOTAL					**0**	**0**	**$1,400**	**$1,400**	**$1,400**	**$0**	**$1,400**	**$0**
Task 2B) Determine Project Partners and Grant Administration												
ER Project Manager	$35	/hr	50	hrs		0	$1,750	$1,750	$1,250	$500	$1,750	$0
ER Project Director	$40	/hr	40	hrs		0	$1,600	$1,600	$900	$700	$1,600	$0
Institute on the Env - Grant Admin					$5,000	0	0	$5,000	$3,500	$1,500	$5,000	$0
SUBTOTAL					**$5,000**	**0**	**$3,350**	**$8,350**	**$5,650**	**$2,700**	**$8,350**	**$0**
Task 2C) Research and Design Data Collection Methods												
Consultant and ER Staff	$50	/hr	50	hrs	$2,500	0	0	$2,500	$2,500	$0	$2,500	$0
SUBTOTAL					**$2,500**	**0**	**0**	**$2,500**	**$2,500**	**$0**	**$2,500**	**$0**
OBJECTIVE 2 - TOTAL					**$7,500**	**0**	**$4,750**	**$12,250**	**$9,550**	**$2,700**	**$12,250**	**$0**
OBJECTIVE 3 of 9: Pilot Test Tools and Strategies												
Task 3A) Apply Tools for Testing												
Consultant and ER Staff	$50	/hr	20	hrs	$1,000	0	0	$1,000	$1,000	0	$1,000	$0
ER Project Manager	$35	/hr	120	hrs	$4,200	0	0	$4,200	$4,200	0	$4,200	$0
ER Staff	$20	/hr	240	hrs	$800	0	$4,000	$4,800	$4,800	0	$4,800	$0
Focus Group and Survey Materials					$1,000	0	0	$1,000	$1,000	0	$1,000	$0
SUBTOTAL					$7,000	0	$4,000	$11,000	$11,000	0	$11,000	$0
OBJECTIVE 3 - TOTAL					**$7,000**		**$4,000**	**$11,000**	**$11,000**	**0**	**$11,000**	**$0**

Cost Category	Unit Cost		Qty. (Hours/Amnt) Exp./Budget		I. Grant Funds	II. Match Cash	III. Match In-kind	IV. Total Budget	V. Expended Previous Periods	VI. Expended This Period	VII. Cumulative Expenditure (V + VI)	VIII. Budget Balance (IV - VII)
OBJECTIVE 4 of 9: Gather Feedback												
Task 4A) Gather Feedback												
Consultant and ER Staff	$50	/hr	50	hrs	$2,500	0	0	$2,500	$2,000	$500	$2,500	$0
SUBTOTAL					**$2,500**	**0**	**0**	**$2,500**	**$2,000**	**$500**	**$2,500**	**$0**
Task 4B) Conduct Follow-Up Waste Sort and Analyze												
ER Project Manager	$35	/hr	60	hrs	0	0	$2,100	$2,100	$1,785	$315	$2,100	$0
ER Staff	$20	/hr	200	hrs	0	0	$4,000	$4,000	$3,400	$600	$4,000	$0
SUBTOTAL					**0**	**0**	**$6,100**	**$6,100**	**$5,185**	**$915**	**$6,100**	**$0**
OBJECTIVE 4 - TOTAL					**$2,500**	**0**	**$6,100**	**$8,600**	**$7,185**	**$1,415**	**$8,600**	**$0**
OBJECTIVE 5 of 9: Evaluation and Analysis of Data												
Task 5A) Analyze Feedback												
ER Staff	$50	/hr.	20	hrs	$1,000	0	0	$1,000	0	$1,000	$1,000	$0
SUBTOTAL					$1,000	0	0	$1,000	0	$1,000	$1,000	$0
OBJECTIVE 5 – TOTAL					**$1,000**	**0**	**0**	**$1,000**	**0**	**$1,000**	**$1,000**	**$0**
OBJECTIVE 6 of 9: Develop and Present Recommendations												
Task 6A) Develop and Write Recommendations												
Consultant and ER Staff	$50	/hr.	40	hrs	$2,000	0	0	$2,000	0	$2,000	$2,000	$0
SUBTOTAL					$2,000	0	0	$2,000	0	$2,000	$2,000	$0
Task 6B) Present Recommendations												
Consultant and ER Staff	$50	/hr.	20	hrs	$1,000	0	0	$1,000	0	$1,000	$1,000	$0
SUBTOTAL					$1,000	0	0	$1,000	0	$1,000	$1,000	$0
OBJECTIVE 6 – TOTAL					**$3,000**	**0**	**0**	**$3,000**	**0**	**$3,000**	**$3,000**	**$0**
OBJECTIVE 7 of 9: Develop Toolkit												
Task 7A) Final Toolkit & Website Design and Development												
Website and Tool Development Consultants					$25,000	0	0	$25,000	$662.50	$24,337.50	$25,000	$0
ER Project Manager	$35	/hr.	120	hrs	$3,200	0	$1,000	$4,200	0	$4,200	$4,200	$0
Materials and Printing					$800	0	0	$800	$528.00	$272.00	$800	$0
SUBTOTAL					$29,000	0	$1,000	$30,000	$1,190.50	$28,809.50	$30,000	$0
OBJECTIVE 7 - TOTAL					**$29,000**	**0**	**$1,000**	**$30,000**	**$1,190.50**	**$28,809.50**	**$30,000**	**$0**

Cost Category	Unit Cost		Qty. (Hours/Amnt) Exp./Budget		I. Grant Funds	II. Match Cash	III. Match In-kind	IV. Total Budget	V. Expended Previous Periods	VI. Expended This Period	VII. Cumulative Expenditure (V + VI)	VIII. Budget Balance (IV - VII)
OBJECTIVE 8 of 9: Wide Dissemination of Tools												
Task 8A) Raise Awareness of Toolkit Statewide												
ER Project Manager	$35	hr	15	hrs	0	0	$525	$525	0	0	0	$0
SUBTOTAL					0	0	$525	$525	0	0	0	$0
OBJECTIVE 8 - TOTAL					**0**	**0**	**$525**	**$525**	**0**	**$525**	**$525**	**$0**
OBJECTIVE 9 of 9: Reporting												
Task 9A) Submit an Interim Report												
ER Project Manager	$35	hr	30	hrs	0	0	$1,050	$1,050	$700	$350	$1,050	$0
SUBTOTAL					0	0	$1,050	$1,050	$700	$350	$1,050	$0
Task 9B) Submit Final Report												
ER Project Manager	$35	hr	30	hrs	0	0	$1,050	$1,050	0	$1,050	$1,050	$0
SUBTOTAL					0		$1,050	$1,050	0	$1,050	$1,050	$0
OBJECTIVE 7 - TOTAL					**0**	**0**	**$2,100**	**$2,100**	**$700**	**$1,400**	**$2,100**	**$0**
Project Total Cost					**$50,000**	**$0**	**$18,475**	**$68,475**	**$29,625**	**$38,850**	**$68,475**	

Summarized Budget and Expenditures by Objectives Report

Summarized Budget by Objectives	I. Grant Funds	II. Match Cash	III. Match In-kind	IV. Total Budget	V. Expended Previous Periods	VI. Expended This Period	VII. Cumulative Expend. (V + VI)	VIII. Budget Balance (IV - VII)
OBJECTIVE 1 – TOTAL	$0	$0	$0	$0	$0	$0	$0	$0
OBJECTIVE 2 - TOTAL	$7,500	$0	$4,750	$12,250	$9,550	$2,700	$12,250	$0
OBJECTIVE 3 - TOTAL	$7,000	$0	$4,000	$11,000	$11,000	$0	$11,000	$0
OBJECTIVE 4 - TOTAL	$2,500	$0	$6,100	$8,600	$7,185	$1,415	$8,600	$0
OBJECTIVE 5 - TOTAL	$1,000	$0	$0	$1,000	$0	$1,000	$1,000	$0
OBJECTIVE 6 - TOTAL	$3,000	$0	$0	$3,000	$0	$3,000	$3,000	$0
OBJECTIVE 7 - TOTAL	$29,000	$0	$1,000	$30,000	$1,190.50	$28,809.50	$30,000	$0
OBJECTIVE 8- TOTAL	$0	$0	$525	$525	$0	$525	$525	$0
OBJECTIVE 9 - TOTAL	$0	$0	$2,100	$2,100	$700	$1,400	$2,100	$0
GRAND TOTAL	$50,000	$0	$18,475	$68,475	$29,625.50	$38,849.50	$68,475	$0

Eureka Recycling

Preventing Food waste with Behavior Change Tools and Education

Final Report: June 28, 2011

Receipts for Task 7A: Develop toolkit to be published on web and finalize tools

Website Design		
Content, Tool & Messaging development	$6,000.00	Good Work Group
Web-based tool programing	$19,500.00	Triangle Park Creative
Design for print format tools	$1,755.00	Elevate Design
TOTAL	**$27,255.00**	

Printing Costs		
Images for tools	$75.00	I-stock Photo
Printing	$31.00	Impressive Print
Images for tools	$153.00	I-stock Photo
Food to photograph tips	$19.62	Target & Cub Foods
TOTAL	**$278.62**	

Sources for Information on Wasted Food

June 2012

COMPOST
Make dirt, not waste.

More information about the issue of wasted food in all parts of the food chain is now emerging frequently. The links below are some of the sources that Eureka Recycling has found most interesting or useful as we explore the impacts and opportunities of preventing wasted food at the household "consumer" level. We have also added our newly developed program materials and resources to this list.

Programs and Blogs

1. **Love Food Hate Waste**
   Love Food Hate Waste is an education program based in the UK focused on helping residents prevent wasted food at home. The website is full of information, tips, and tools. Love Food Hate Waste is a program of the nonprofit organization WRAP, which works in England, Scotland, Wales, and Northern Ireland to help businesses and individuals reap the benefits of reducing waste, develop sustainable products, and use resources in an efficient way. WRAP has released many robust reports on the results and data collected during their wasted food initiatives, such as:
   - New Estimates for Household Food & Drink Waste in the UK: A report presenting updated estimates of food and drink waste from UK homes, alongside supporting evidence. (November 2011)

2. **Jonathan Bloom's Blog: Wasted Food**
   Jonathan Bloom writes a blog covering many topics about why we waste food, why it matters, and what we can do about it. This is his blog. Bloom also wrote a book on the topic called American Wasteland.

(651) 222-SORT (7678)
www eurekarecycling org

3. **Be Resourceful Portland**
   The City of Portland's "Be Resourceful" campaign includes a page on preventing wasted food with a few tips and tools on shopping and meal planning. There are other wasted food prevention programs emerging in Portland as well, via USO's extension services, a company called LeanPath, and others.

4. **Eureka Recycling's Make Dinner Not Waste campaign**
   Eureka Recycling Make Dirt Not waste education program and website provide information, tips, and tools about composting. We created "consumer" level resources as part of this campaign to help people prevent wasted food (make *dinner*, not waste!) before it even needs to be composted, saving money and providing more environmental benefit.

Articles, Reports, and Factsheets

(Experts from article abstracts included)

- **The Climate Change and Economic Impacts of Food Waste in the United States, 2011**
  **Note: This paper has been submitted to a journal for publication and is available here in the interim as a working paper for informational purposes only.*
  Kumar Venkat, CleanMetrics Corp., 2011
  - This study analyzes the climate change and economic impacts of food waste in the United States. Using loss-adjusted national food availability data for 134 food commodities, it calculates the greenhouse gas emissions due to wasted food using life cycle assessment and the economic cost of the waste using retail prices.

- A factsheet by Dana Gunders of the National Resources Defense Council: **Your Scraps Add Up: Reducing Food Waste Can Save Money and Resources, 2012**

- **Global Food Losses and Food Waste, 2011**
  - "This publication is based on studies carried out from August 2010 to January 2011 by The Swedish Institute for Food and Biotechnology (SIK) on request from the Food and Agriculture Organization of the United Nations (FAO)....The study highlights the losses occurring along the entire food chain, and makes assessments of their magnitude. Further, it identifies causes of food losses and possible ways of preventing them... The study revealed that there are major data gaps in the knowledge of global food loss and waste. Further research in the area is urgent."

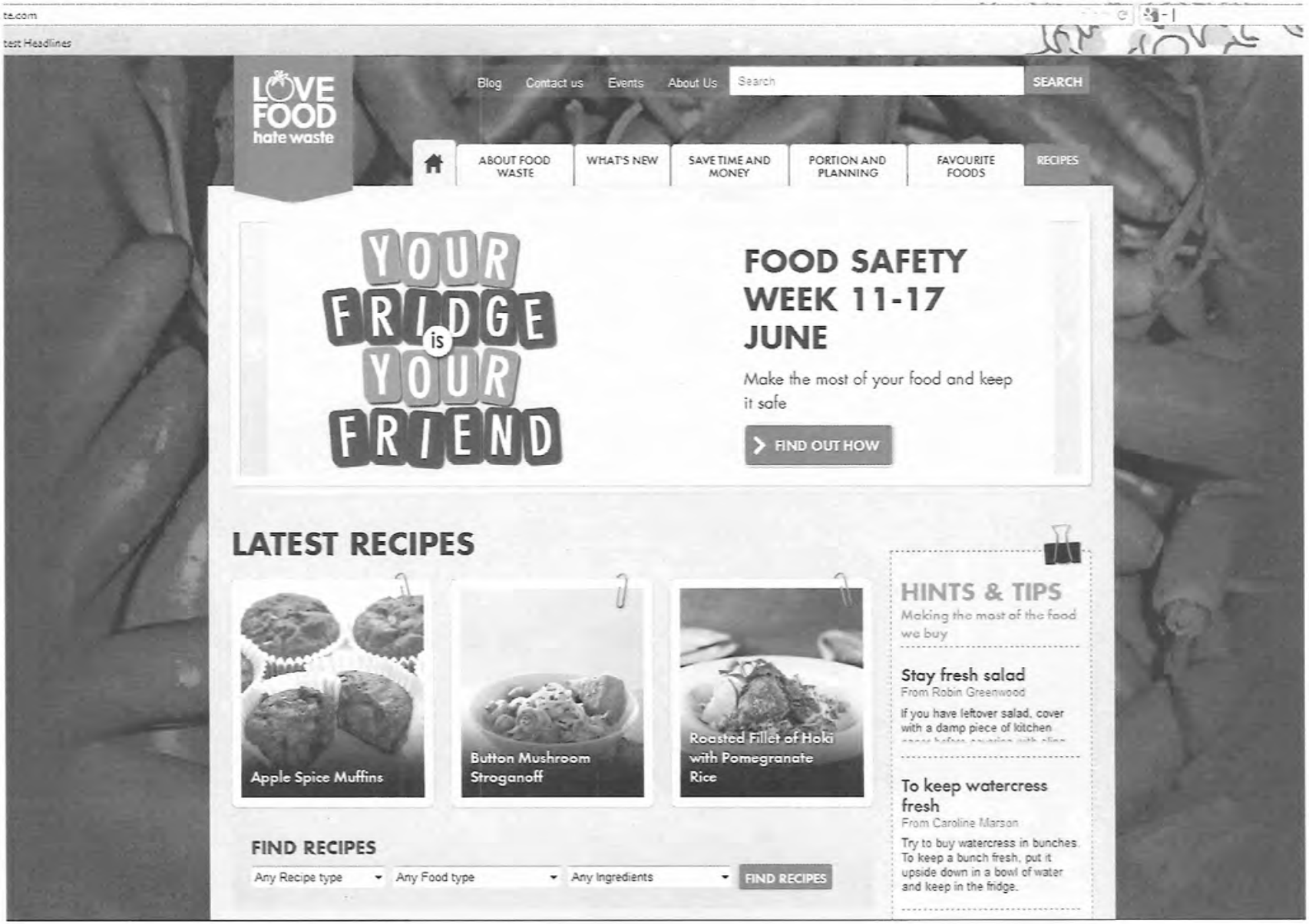
- **Food Wastage Footprints, 2012**
  - Jonathan Bloom recently worked with the UN Food and Agriculture Organization to create a fact sheet on food waste.

- **Saving Water: From Field to Fork, 2008**
  Lindquist, J., C. de Fraiture, and D. Molden, Stockholm International Water Institute
  - This report highlights the losses and waste in the food chain from field to fork, with a focus on water.

- **Estimating and Addressing America's Food Losses, 1997**
  Linda Scott Kanto, Kathryn Kipton, Alden Manchester, and Victor Oliveira, USDA
  - USDAs Economic Research Service (ERS) undertook a review of the current data on food waste and built on this knowledge to generate new estimates of food loss by retailers, consumers, and food-service establishments.

- **Gathering Community Input on Preventing Wasted Food, 2012**
  Using Waste Sorts to Learn About Preventing Wasted Food, 2012
  Eureka Recycling
  - Zero-waste organization Eureka Recycling conducted research, waste sorts, focus groups, and interviews to develop tools to help people prevent wasted food. These two sets of recommendations were a result of that process. Additional findings and results of this work, which was supported by the Minnesota Pollution Control Agency, can be found on Eureka Recycling's website.

www.lovefoodhatewaste.com



wrap

Material change for
a better environment

Final report

New estimates for household food and drink waste in the UK

A report presenting updated estimates of food and drink waste from UK homes, alongside supporting evidence.

Date: November 2011

WRAP's vision is a world without waste, where resources are used sustainably.

We work with businesses and individuals to help them reap the benefits of reducing waste, develop sustainable products and use resources in an efficient way.

Find out more at www.wrap.org.uk

Written by: Tom Quested and Andrew Parry (WRAP)

Front cover photography: An illustration of some of the types of food waste generated by households (avoidable, potentially avoidable and unavoidable

Executive summary

Food is a valuable resource and yet UK households throw away millions of tonnes every year, most of which could have been eaten. Since 2007, helping consumers prevent food waste[1] has been a major focus for WRAP, its funders and partners. Preventing this food waste can save consumers and local authorities millions of pounds each year and deliver significant environmental benefits, in terms of landfill avoidance, the mitigation of climate change and a reduced burden on key natural resources, including water[2].

This report presents new estimates of food waste from UK homes. Estimates were last updated in 2009[3], based on a combination of original WRAP research (from 2007/8), and a 2006/7 synthesis of local authority compositional studies. This established a baseline against which progress in terms of waste prevention could be measured. This report describes work undertaken to update the UK estimate of household food waste, to determine what progress has been made and the scale of the challenge remaining.

There were an estimated 7.2 million tonnes of household food waste in the UK in 2010. This represents a decrease of 1.1 million tonnes from the estimate from 2006/7 of 8.3 million tonnes. Table ES1 shows the breakdown of this most recent estimate by disposal route, compared to the previous estimate.

Table ES1: Split of 2010 household food and drink estimates by disposal route

	Local authority collected food waste*	Sewer†	Home composting & fed to animals†	Total
Previous estimate	5.8 mt	1.8 mt	0.69 mt	8.3 mt
New estimate	4.6 mt	1.9 mt	0.70 mt	7.2 mt
% difference	–20%	+2%	+2%	–13%

*Updated information available for 2010 (§2.0)

†No new data available for these streams, so increase in line with population has been assumed (§3.0)

An estimate of the split between avoidable, possibly avoidable and unavoidable food waste has been made (§4.0) and suggests that the majority of the decrease in food waste has occurred, as might be expected, within the avoidable category (Table ES2).

Table ES2: Split of 2010 household food and drink estimates by avoidability

	Avoidable	Possibly Avoidable	Unavoidable	Total
Previous estimate	5.3 mt	1.5 mt	1.5 mt	8.3 mt
New estimate	4.4 mt	1.4 mt	1.4 mt	7.2 mt
% difference	–18%	–5%	–5%	–13%

The financial value (retail price) and environmental impact of the avoidable food waste have also been updated. For instance:

- Greenhouse gas emissions of around 17 million tonnes of CO_2 equivalent are associated with the manufacture, distribution, storage, use and disposal of **avoidable** food that is wasted in the UK (previously 20 million tonnes of CO_2 equivalent).
- Avoidable food waste is associated with 4% of the UK total water footprint (4.3%; against a previous figure of 5%).

[1] Within this report, 'food' is used as a short hand for 'food and drink'. This includes food and drink waste: home compostable and non-home compostable; avoidable, possibly avoidable and unavoidable.

[2] http://www.wrap.org.uk/retail_supply_chain/research_tools/research/report_water_and.html

[3] Household Food and Drink Waste in the UK:
http://www.wrap.org.uk/retail_supply_chain/research_tools/research/report_household.html

- Given food inflation of ca 20% over this period, and ca 18% less avoidable food waste, the retail value of avoidable food waste remains unchanged (when expressed to two significant figures) at £12 billion in 2010. However, consumers are spending at least £2.5 billion a year less on wasted food than they would have, had waste levels remained at previous higher levels.
- Of the 38 million tonnes of food and drink brought into UK homes, 19% is thrown away (previously 22%). Of the 38 million tonnes, 12% becomes avoidable waste (previously 14%).

The observed decrease in the amount of household food waste is broadly consistent with decreases in the quantity of food and drink purchased for consumption within the home (§8.0). This decrease is also discussed in light of possible influences (§9.0), including:

- Positive changes in practices and behaviours in the kitchen and whilst shopping, and changes to products and packaging, that can reduce food waste;
- Food price inflation;
- Changes to income levels; and
- How waste is collected from homes.

As no new information has been collected on the categories and types of food and drink that are wasted, it is not possible to determine which food categories have contributed most to the decline in waste. It is also not possible to determine which types of household may have reduced their food waste the most.

Contents

Acknowledgements

The authors would like to thank Robert Pocock (M•E•L) for useful comments from the peer review and Viktoria Salisbury at Worcestershire County Council for sharing impact data.

1.0 Introduction

Food is a valuable resource and yet UK households throw away millions of tonnes every year, and most of this could have been eaten. Over the last few years, helping consumers prevent food waste has been a major focus for WRAP, its funders and partners. In late 2007, Love Food Hate Waste was launched, and early 2008 saw the publication of ground-breaking research on the large amount of food waste in the UK. WRAP has subsequently built up a comprehensive evidence base which has raised awareness of the issue, developed a strong case of change, and given focus to the areas where consumers need the most help, where business and local authorities can benefit, and where the biggest impacts can be made.

Preventing this food waste could save consumers and local authorities millions of pounds annually and deliver significant environmental benefits, in terms of landfill avoidance, the mitigation of climate change and a reduction in the burden on key natural resources including water.

Influencing behaviours and decisions around food design, production, purchase and use is challenging, and WRAP has worked with a wide range of partners to develop a credible, integrated and consistent approach.

Estimates for UK household food waste were last updated in 2009, based on a combination of original WRAP research (from 2007/8) and a 2006/7 synthesis of local authority compositional studies. This established a baseline against which progress in terms of waste prevention could be measured. This report describes work undertaken to update the UK estimate of household food waste, to determine what progress has been made, and the scale of the challenge remaining.

2.0 Household food waste collected by local authorities

A research report[4] published alongside this one contains a new estimate for local authority collected food waste (residual and separately collected) for the UK (Table 1). The report presents two alternative estimates for food waste arisings, obtained using different methods to scale up results from individual local authority analyses of the composition of waste streams. Full details of the methods can be found in that report. In short, information on the proportion of waste streams that is food, is taken from local authority compositional analyses and this is applied to WasteDataFlow[5] estimates for the total quantity of waste within relevant streams.

For consistency of methodology with previous work (notably *Household Food and Drink Waste in the UK* and Defra's *Municipal Waste Composition* study), the 'standard' methodology has been used to derive these new estimates of household food waste arisings for the UK. The two methods give very similar results for the UK – the standard method gives a figure 27,000 tonnes lower than the alternative method (or 0.6% of the total).

Table 1: Updated local-authority collected food waste estimate for the UK

	LA collected food waste in 2010 (tonnes)	95% Confidence Interval*
UK	**4,620,000**	**±160,000**

*Confidence intervals include sampling errors

This method, used to obtain estimates for the UK, is slightly different from that presented in *Household Food and Drink Waste in the UK*. In that research, the amount of food waste collected by local authorities in England was used to estimate UK arisings, as relevant data was not available for the other nations. If a similar approach were applied to the data underpinning the current report, the results would differ by only 50,000 tonnes or 1.1% of the total (Table 12). The closeness of these two results is due to similar levels of food waste per household in all nations of the UK. Previous extrapolation of English data to the UK level is likely to have had a negligible impact on results.

[4] *Synthesis of Food Waste Compositional Data 2010; www.wrap.org.uk/hhfwfacts*

[5] *Local-authority waste data reporting; http://www.wastedataflow.org/*

Table 2: Comparison of different scaling-up methodologies to obtain UK estimates

UK estimate for 2010	[illegible] collected food waste (million tonnes)
... as presented in this report	4.62
... calculation consistent with previous report	4.57

The reduction in household food waste collected by local authorities has been more pronounced than the reduction in all waste. Between 2006/7 and 2009/10, **total** household waste (as reported by WasteDataFlow) fell by 2.5 million tonnes in the UK, which is an 8% reduction of the total. This compares to a reduction in food waste collections by local authorities from households of 1.2 million tonnes (or a 20% reduction in food waste). This means that food waste has reduced more rapidly than total household waste. Therefore, the reduction in food waste makes up around 45% of the total reduction in household waste.

3.0 Household food waste *not* collected by local authorities

In addition to food waste collected by local authorities, food and drink is disposed down the sewer (mainly via the kitchen sink), home composted and fed to animals. Previous estimates of these waste streams (for 2006/7) were published in *Household Food and Drink Waste in the UK*. Since this report, there has been no primary research to update these estimates, although WRAP hopes to carry out new research in 2012/2013 to enable them to be updated (dependent on funding). In the absence of new data, different options and assumptions could be used:

- **Option 1: Apply the percentage decrease from local authority collected waste to non-local authority collected waste streams.** This option is based on the assumption that the reduction in local authority collected food waste is driven largely by changes in behaviour in the kitchen and whilst shopping. In such a situation, this behavioural change would lead to similar reductions in food waste irrespective of where the food waste is disposed, and so the same percentage decrease should be applied.
- **Option 2: Use the level of waste from 2006/7.** This option is based on the assumption that there has been only negligible change in the amount of food waste poured down the sewer, home composted or fed to animals and, therefore, the amount of food waste as estimated in 2006/7 is applied to 2010.
- **Option 3: No change in total food waste arisings across all streams.** This option assumes that all reductions in local authority collected food waste are the result of this material still being wasted but now being poured down the sink, home composted or fed to animals.

Given the evidence of lower food and drink sales (§8.0), option 3 is unlikely – the reductions in food and drink purchases suggests that the reduction in local authority collected food waste is not the result of diversion to other streams. Furthermore, an estimate of the change in home composting level obtained in 2009[6] suggested that additional diversion since 2006/7 was likely to be negligible in comparison to the magnitude of change in local authority collected food waste (this suggested that home composting diverted around 23,000 tonnes). There is limited data on the distribution and use of sink disposal units in the UK, but they are thought to be present in a small percentage of households (≤6%) and there is no evidence to suggest a marked increase in their use over this time period[7].

In light of this, and a desire to produce a conservative estimate of reduction, option 2 has been used in this report. Specifically, the waste arisings per capita in non-local authority collected waste streams have been held constant. Given an increase in the population of 2.1%[8], an uplift factor equal to this amount has been applied to the two categories 'Sewer' and 'Home composting and fed to animals'. This leads to a reduction in total food and drink waste in the UK of 1.1 million tonnes between 2006/7 and 2010 (Table 3).

[6] http://www.wrap.org.uk/retail_supply_chain/voluntary_agreements/courtauld_commitment/phase_1/index.html

[7] *Domestic kitchen furniture market report uk, 2011-2015 analysis, AMA Research Ltd;* http://www.guardian.co.uk/money/2006/aug/08/ethicalmoney.leohickmanonethicalliving

[8] *Based on comparison of mid-year UK population estimates for 2007 and 2010 (Office of National Statistics).*

Table 3: Split of food and drink estimates between sources

	Local authority collected food waste	Sewer	Home composting & fed to animals	Total
Previous estimate	5.8 mt	1.8 mt	0.69 mt	8.3 mt
New estimate	4.6 mt	1.9 mt	0.70 mt	7.2 mt
% difference	–20%	+2%	+2%	–13%

4.0 How much of the decrease in waste arisings is associated with avoidable food waste?

WRAP has categorised food and drink waste by how avoidable it is:

- **Avoidable** – food and drink thrown away that was, at some point prior to disposal, edible (e.g. slice of bread, apples, meat).
- **Possibly avoidable** – food and drink that some people eat and others do not (e.g. bread crusts), or that can be eaten when a food is prepared in one way but not in another (e.g. potato skins).
- **Unavoidable** – waste arising from food or drink preparation that is not, and has not been, edible under normal circumstances (e.g. meat bones, egg shells, pineapple skin, tea bags).

In the absence of representative, detailed information from compositional analysis on the types of food waste, it is not possible to state for certain how avoidable food waste has changed relative to unavoidable and possibly avoidable food waste over the relevant time period. Given this, a modelling approach based on food purchase data has been used to obtain this information. Details of the approach are given in this section.

The model assumes that levels of unavoidable and possibly avoidable waste vary in proportion to the amount of food brought into the home. For instance, if the number of eggs brought into the home increases by 5%, then it is assumed that unavoidable egg waste (i.e. the egg shells) also increases by the same amount. This assumes that all other factors are equal (in this example, the weight of shell per egg).

Table 4 details the arisings of unavoidable and possibly avoidable food waste in *Household Food and Drink Waste in the UK* and the expected change in these fractions if waste levels changed in proportion to sales levels. Data for food purchases brought into the home between 2006 and 2009[9] are based on Defra's Family Food Survey[10].

This calculation indicates that the reduction in possibly avoidable waste is approximately 73,000 tonnes and 77,000 tonnes for unavoidable waste, a total of around 150,000 tonnes. Given the overall reduction seen in total arisings of 1.1 million tonnes (Table 1), this indicates that 950,000 tonnes of this total reduction comes from avoidable food and drink waste.

[9] *These years have been selected as, at the time of publication, 2009 data is the most recent available, 2006 closely corresponds to the year of the previous estimates while still giving time-series data over three years.*

[10] http://www.defra.gov.uk/statistics/foodfarm/food/familyfood/

Table 4: Estimates of change in unavoidable and possibly avoidable food and drink waste

Category	Waste (tonnes; 2006/7)		Change in food sales 2006-2009 (%)	Estimated change in waste arisings (tonnes)	
	Possibly avoidable	Unavoidable		Possibly avoidable	Unavoidable
Fresh vegetables & salads	811,358	253,406	-6.2%	-50,304	-15,711
Drink	-	426,530	-2.5%*	-	-10,663
Fresh fruit	81,122	517,856	-6.2%	-5,030	-32,107
Bakery	117,838	-	-3.3%	-3,889	-
Meat and fish	83,361	236,432	-8.9%†	-7,419	-21,042
Dairy and eggs	243	53,772	+5.7%‡	14	3,065
All other categories	373,599	9,392	-1.6%	-5,978	-150
Total	**1,467,521**	**1,497,388**	-	**-72,605**	**-76,609**

*The majority of this waste is teabags, so the figure for tea sales has been used.

†The majority of this waste is from carcase meat, so this sales figure has been used.

‡Similarly, the majority of this waste is egg shells, so the sales figure for eggs has been used.

In *Synthesis of Food Waste Compositional Data*[11], five compositional analysis studies were identified that had measured the split of avoidability in the food waste sampled. However all of these came from one geographical area. Furthermore, the studies did not separately classify possibly avoidable waste, but recorded it within either the avoidable and unavoidable fractions. However, it was possible to adjust the results of *Household Food and Drink Waste in the UK* to try and account for this difference in classification. A comparison between the studies suggested that there was around 800,000-900,000 tonnes less avoidable food waste collected by local authorities compared to 2006/7. This is broadly consistent with the reduction indicated from the analysis of purchase data and this leads to confidence that the actual reduction is close to these estimates.

However, the small number of compositional studies that detail avoidable waste and their geographical clustering mean that caution should be exercised in drawing conclusions from this analysis. For this reason, we have chosen to use the estimate from the purchasing model as the basis for further calculations.

Taking the reduction derived from purchasing data means that avoidable food waste is estimated to have reduced from 5.3 million tonnes to 4.4 million tonnes, which equates to an 18% reduction in avoidable food waste. The associated changes on UK food waste arisings (to 2 significant figures) are shown in Table 5.

Table 5: Impact of food price inflation and changes in waste level on retail value of food waste

	Avoidable	Possibly Avoidable	Unavoidable	Total
Previous estimate	5.3 mt	1.5 mt	1.5 mt	8.3 mt
New estimate	4.4 mt	1.4 mt	1.4 mt	7.2 mt
% difference	–18%	–5%	–5%	–13%

The fact that the majority of the overall reduction in food waste comes from avoidable waste is consistent with positive changes in behaviour (§9.1). In addition, reductions in possibly avoidable and unavoidable food waste are consistent with consumers having to buy less food as they waste less of what is bought. These estimates rely on indirect data and modelling and should be viewed as approximate. The figures will be updated when more detailed waste compositional data are available that quantify the proportion of food waste which is avoidable.

Without further research, it is not possible to quantify the change in waste associated with different food and drink types (e.g. fresh fruit and vegetables, bakery, leftovers from meals) or the split between how much of this waste is food and how much is drink.

[11] www.wrap.org.uk/hhfwfacts

In the next two sections, the impact on the retail value and environmental impact of this decrease in avoidable food waste is estimated.

5.0 Updating the retail value of avoidable food and drink waste

The approach adopted for updating the retail value of avoidable food waste is to inflate the cost per tonne by the retail price index (RPI) for food and drink[12] for the appropriate time period, which is related to when the data where collected:

- For waste collected by local authorities (LAs): October 2007 to December 2010
- For waste going down the kitchen sink: March 2008 to December 2010
- For waste home composted or fed to animals: February 2007 to December 2010

The overall figure is a weighted average of the three different disposal routes in proportion to the total retail price of avoidable food waste disposed of to these routes[13] (Table 6).

Table 6: Food inflation from research date to December 2010

Food and drink waste:	Start date	RPI at start date	RPI in Dec 2010	Change in RPI %
Collected by LAs	Oct 2007	167.4	201.7	20.5%
Going down kitchen sink	March 2008	172.0	201.7	17.3%
Home composted or fed to animals	Feb 2007	161.4	201.7	25.0%
Overall	-	-	-	**19.9%**

Applying these inflation figures to the original estimates of the retail value of food waste, and assuming the majority of the reduction in arisings has occurred within the local authority collected streams (consistent with §2.0 and §3.0), leads to a change from £12.2 billion to £11.8 billion (Table 7). Had the reduction in food waste not occurred, consumers would have been spending around £2.5 billion a year more on food and drink bought but thrown away.

Table 7: Impact of food price inflation and changes in waste level on retail value of food and drink waste

Food and drink waste stream:	Retail value (£ million) of:		
	Previous estimate	2006/7 waste levels; 2010 prices	2010 waste in 2010 prices
Collected by LAs	£8,700	£10,500	£7,500
Going down kitchen sink	£2,700	£3,200	£3,200
Home composted or fed to animals	£800	£1,000	£1,000
Overall	**£12,200**	**£14,700**	**£11,800**

Given the small change in the retail value of food waste and the uncertainties around these new estimates, WRAP will continue to use existing financial messages in communications with consumers.

[12] *From Office of National Statistics website (indicator = CHBA)*

[13] *It would be possible to use RPI information for individual food categories, but given the uncertainty in the relative amounts of waste between categories, this approach is unlike to obtain a more accurate answer.*

6.0 Greenhouse gas emissions associated with avoidable food waste

The greenhouse gas emissions relating to the production, manufacture, storage, distribution, retail sale, in-home use and disposal of food and drink that is wasted was calculated in *Household Food and Drink Waste in the UK* (Appendix E). For food and drink waste, it was calculated that for every tonne of avoidable food and drink waste, 3.8 tonnes CO_2 equivalent of greenhouse gas were emitted[14].

Applying this factor to the updated quantity of avoidable food waste leads to an estimate of 17 million tonnes of CO_2 eq. in 2010, or equivalent to the emissions of 1 in 5 cars on UK roads.

7.0 Water footprint associated with avoidable food waste

The water footprint of the UK is the amount of water used to produce goods and services consumed in the UK: the sum of direct (e.g. household water use) and indirect (water used along the supply chains of goods and services) water use. Research published by WRAP and WWF[15] found that the water footprint of avoidable food waste was 5,400 million cubic metres per year representing around 5% of UK water requirements, based on information in *Household Food and Drink Waste in the UK.*

If the water footprint associated with avoidable food waste has decreased in line with arisings, this would mean that the water footprint has reduced to 4,500 million cubic metres per year representing around 4% (4.3%) of UK total water requirements.

8.0 Comparison with food-purchases data

Data on purchases of food and drink brought into the home, and purchases made out of the home, have been used to see if they provide corroborative (or conflicting) evidence for a reduction in household food waste.

There are many possible sources for such data; the most useful for this purpose are from Defra's Family Food Survey. These provide a weight-based measure of food and drink purchases, rather than the number of sales units or monetary value of sales. Furthermore, the datasets separate food and drink eaten outside of the home from that brought into the home. The latter includes food and drink bought in supermarkets, corner shops, takeaways, and also produce from allotments, gardens and other 'free food'.

WRAP have used these data to estimate the quantity of food and drink purchases that are brought into the home, and separately purchased out of the home[16]. The most recent data from the Defra Family Food Survey are for the calendar year 2009. As can be seen from Table 8, the food and drink purchases brought in to the home for 2009 are 553g per person per week lower than in 2006, a decrease of 4.5%. This reduction is evenly split between food (247g / person / week) and drink (283g / person / week).

Between these years, the population of the UK has increased by 2.0% and therefore the total percentage reduction in purchases over the whole UK is 2.6% (see bottom half of Table 8). This equates to around 1 million tonnes less food and drink being brought into the home in 2009 compared to 2006. The weight of fresh fruit and vegetable purchases have reduced by around 6% between 2006 and 2009 (i.e. faster than the reduction in food purchases). As well as the impact on avoidable food waste, this reduction in purchases will also have an impact on possibly avoidable and unavoidable food waste (e.g. citrus peel, banana skins) – see §4.0.

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[14] *This estimate excludes the impact on greenhouse gas emissions of land-use change relating to food production. For more information see: The Water and Carbon Footprint of Household Food and Drink Waste in the UK:* http://www.wrap.org.uk/downloads/Water_and_Carbon_Footprint_report_22_Aug_11_Final.433c5f26.10610.pdf

[15] The Water and Carbon Footprint of Household Food and Drink Waste in the UK: http://www.wrap.org.uk/retail_supply_chain/research_tools/research/report_water_and.html

[16] *For food and drinks reported in the Family Food Survey in millilitres, conversion from volumetric measures to weight-based has been made by WRAP.*

These figures suggest that of the 38 million tonnes of food and drink brought into the home (Table 8), 19% is thrown away (previously 22%). Of the 38 million tonnes, 12% becomes avoidable waste (previously 14%).

Table 8: Food and drink purchases **brought into the home**

	2006	2007	2008	2009	Change 2006-2009	% change 2006-2009
Purchases (g / person / week)						
Food & drink (total)	12,348	12,059	11,757	11,795	-553	-4.5%
Food (excluding milk)	7,049	6,971	6,826	6,803	-247	-3.5%
Drink (excluding milk)	3,489	3,309	3,184	3,206	-283	-8.1%
Milk	1,809	1,779	1,747	1,786	-23	-1.3%
Fresh fruit and veg	2,206	2,183	2,084	2,028	-178	-8.1%
UK Population (000s)	**60,584**	**60,986**	**61,398**	**61,792**	**1,208**	**2.0%**
Purchases (000 tonnes per annum)						
Food & drink (total)	**39,007**	**38,349**	**37,638**	**38,004**	**-1,003**	**-2.6%**
Food (excluding milk)	22,269	22,167	21,852	21,918	-351	-1.6%
Drink (excluding milk)	11,022	10,524	10,194	10,330	-691	-6.3%
Milk	5,716	5,658	5,592	5,756	40	0.7%
Fresh fruit and veg	*6,968*	*6,940*	*6,672*	*6,535*	*-434*	*-6.2%*

It is also useful to look at the amounts of food purchased out of home, as changing economic conditions are likely to have affected the amounts of meals consumed out of home, which in turn would affect the amount of food purchased for in-home consumption (Table **89**).

683,000 tonnes less food and drink was purchased outside the home in 2009 compared to 2006. The majority of this decrease was seen in drink (547,000 tonnes less) and over half the total decrease was alcoholic drinks (352,000 tonnes less, or a 19% reduction in total purchases).

Taking the data from both in and out of home purchases, around 1.7 million tonnes less food and drink was purchased in 2009 compared to 2006 – drink is associated with 1.1 million tonnes of this decrease and food with 0.5 million tonnes. Although WRAP's household food waste prevention work has focused largely on food, many of the messages are relevant to drinks such as juice, and the drinks industry have responded positively to help consumers reduce drink waste (shelf-life extension, pack size availability, better reclosable functionality etc).

Although there are undoubtedly other influences on the amounts of food and drink purchased, such as healthy eating messages, these reductions are of a similar magnitude to the reduction in food waste as described in §3.0 and §4.0. As such, the trend in purchasing data is broadly consistent with the trend in waste arisings. In addition, it must be remembered that the purchase data shown here only covers 2006-2009, and 2010 data are required to fully assess the consistency of waste and purchasing data.

These results are discussed in light of modelling work on the impact of food prices and income levels in §10.0.

Table 9: Food and drink purchases for consumption **out of the home**

	2006	2007	2008	2009	Change 2006-2009	% Change 2006-2009
Purchases (g / person / week)						
Food & drink (total)	1,652	1,540	1,423	1,408	-244	-14.8%
Food (excluding milk)	590	568	544	535	-54	-9.2%
Drink (excluding milk)	1,043	954	863	853	-190	-18.2%
Milk	19	17	16	19	-0	-0.3%
Alcoholic drinks	*587*	*526*	*464*	*466*	*-121*	*-20.6%*
Hot beverages	*129*	*133*	*124*	*120*	*-9*	*-6.8%*
Juice	*18*	*17*	*17*	*16*	*-2*	*-11.8%*
Other beverages	*309*	*277*	*258*	*251*	*-58*	*-18.9%*
Purchases (000 tonnes per annum)						
Food & drink (total)	5,219	4,898	4,556	4,536	-683	-13.1%
Food (excluding milk)	1,863	1,808	1,743	1,725	-138	-7.4%
Drink (excluding milk)	3,295	3,035	2,762	2,749	-547	-16.6%
Milk	61	55	51	62	1	1.7%
Alcoholic drinks	*1,854*	*1,674*	*1,485*	*1,502*	*-352*	*-19.0%*
Hot beverages	*407*	*424*	*396*	*387*	*-20*	*-4.9%*
Juice	*58*	*55*	*54*	*52*	*-6*	*-10.0%*
Other beverages	*977*	*881*	*827*	*808*	*-169*	*-17.3%*

9.0 Other Evidence of Impact

The analyses presented above indicate that the quantity of food waste has reduced between 2006/7 and 2010. This section explores other, relevant information sources to see if they provide conflicting or corroborating evidence for a reduction of household food waste. This additional evidence suggests that there have been changes in the way people plan, shop and cook food that are likely to have led to less waste.

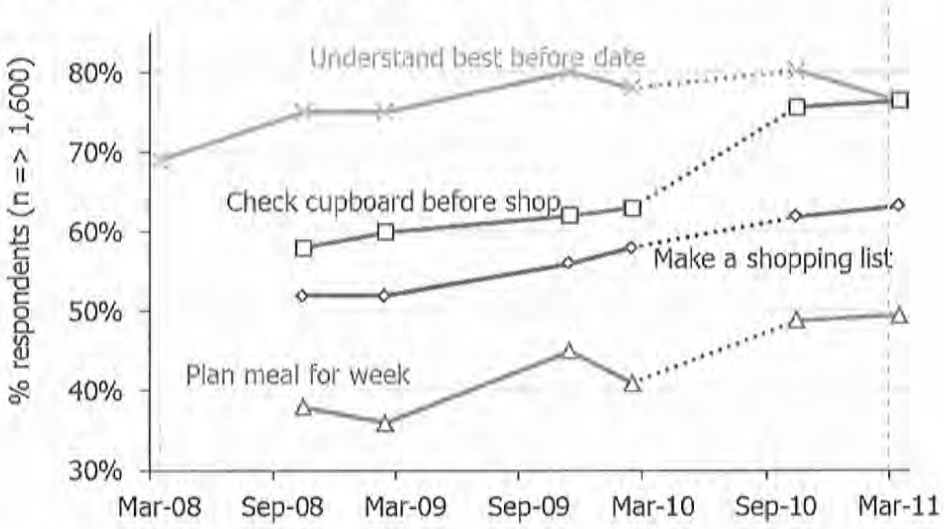
9.1 Self-reported behaviours that reduce food waste

There are many actions that people can take to reduce food waste in the home. Due to the complexity of food waste generation, these behaviours encompass food planning, the way people shop, store, prepare and use of food.

Three behaviours have been tracked consistently over the last few years, all associated with planning[17]. Figure 1 gives the proportion of the population claiming to perform these behaviours, as measured by the regular questionnaire survey commissioned by WRAP. In general, these have increased over time: in particular, before changes to the questions in October 2010, the levels of the behaviours that were tracked increased by six, five and three percentage points (the first two of these increases are significant at the 95% level). Furthermore, further small increases in these behaviours (not individually significant at the 95% level) were seen with the new behavioural questions between October 2010 and March 2011. In addition the understanding of the 'best before' date has increased between 2008 and 2011, reflecting increased knowledge that could help reduce the likelihood that food is wasted.

[17] *In autumn 2010, WRAP updated the behavioural questions asked in its regular household food waste questionnaire and the questionnaire also moved on-line (previously it was performed face-to-face). Results from these questions will provide consistent time-series data from autumn 2010 onwards. Two waves of the questionnaire containing the new questions have been carried out.*

Figure 1: Trends in food-waste reducing behaviours (% reporting all of the time or most of the time) and those understanding best-before dates (note that *y*-axis does not start at zero).



Questions and mode of questionnaire changed between February and October 2010 and therefore increases between these two dates are methodological (dotted lines are a guide for the eye).

However, it should be noted that these behaviours constitute a minority of those that WRAP is targeting. Although questions have been asked about other food waste reduction behaviours, they have not been asked to all respondents and/or the method of measurement has changed significantly over the time period of interest. It should also be noted that these are all self-reported levels of behaviour.

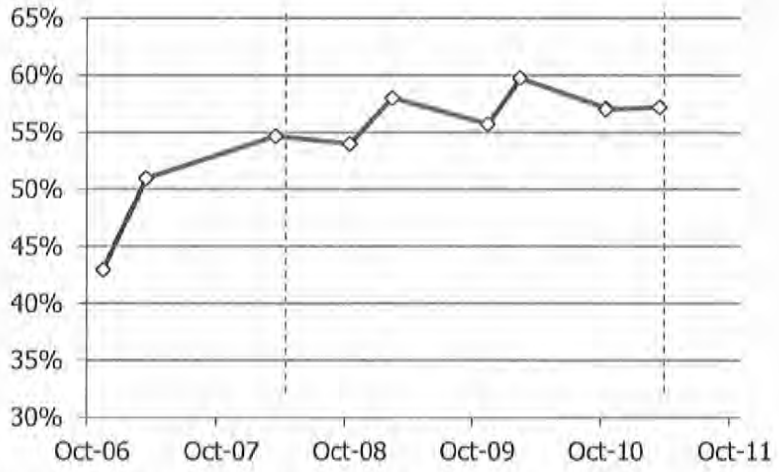
9.2 Self-reported levels of food waste

There is a strong correlation between the quantities of food waste generated by a household, as measured via compositional analysis, and self-reported levels of food waste, as determined by questionnaire survey[18]. Despite this strong correlation, there was a general trend of under-estimation of the amount of food waste generated.

The results of this self-reported question are given in Figure 2. It can be seen that there has been a 14% increase (significant at the 95% level) in the proportion of responses of 'none' or hardly any' since 2006, with a 2% increase (**not** significant at the 95% level) during WRAP's last business plan (April 2008 and March 2011), as indicated by the dotted lines.

[18] From: *The Food We Waste*, WRAP (available on request).

Figure 2: Trends in self-reported levels of food waste (% answering 'none' or 'hardly any'). Note that the *y*-axis does not start at zero.



Question: Thinking about the different types of food waste we have just discussed, how much uneaten food, overall, would you say you generally end up throwing away? Options = i) Quite a lot; ii) A reasonable amount; iii) Some; iv) A small amount; v) Hardly any; vi) none; vii) Don't know. Asked to all respondents with some responsibility for food shopping, or food cooking and preparation. Minimum base size = 1663. Although the mode of questionnaire changed from face-to-face to online between February 2010 and October 2010, a comparative study was performed in October 2010 suggesting negligible difference (0.2%) relating to mode.

It should be noted that the stated level of food waste could be affected by factors other than actual levels of food waste, such as how aware respondents are of their food waste. This relationship between stated and actual levels of food waste could change over time (e.g. as a response to WRAP's awareness raising activity), thus influencing the results.

Given the backdrop of large reductions in food waste and increased (self-reported) levels of food-waste-reducing behaviours, the recent decrease in Figure 2 illustrates the difficulty in interpreting the results of this question.

The Food and Drink Federation have recently published the results of a consumer survey[19], where half of the respondents to the survey of over 1,000 people claimed to be throwing away a 'lot less' or a 'little less' food compared to a year ago. 43% thought the amount they were throwing away was about the same, whilst only 4% thought it had increased. In response to a similar question asked by WRAP in a February 2010 survey, 33% of respondents thought they were wasting less than a year before. This could reflect a real shift since in the last 18 months, but of course the differences might also be influenced by the position of the question in the survey and what has been asked beforehand (i.e. priming people on sustainability issues).

9.3 Local studies to determine impact

Many local authorities and waste partnerships have run Love Food Hate Waste activities. For budgetary reasons, most do not directly measure the quantity of food waste before and after this activity[20]. However, Worcestershire County Council did perform compositional analysis before and after their work in spring 2011. This showed that there was around 15% less avoidable household food waste was collected by the authority after their Love Food Hate Waste intervention (May 2011) compared to before it (February 2011) – a decrease which is significant at the 95% confidence level.

This demonstrates that Love Food Hate Waste activities can have a substantial impact on food waste over a relatively short period of time.

The information in this section – taken as whole – is consistent with the downward trend reported in household food waste arisings. In particular, the population is reporting higher levels of waste preventing behaviours in the

[19] http://www.fdf.org.uk/news.aspx?article=5518&newsindexpage=1#

[20] *Usually self-reported information is obtained via questionnaire surveys.*

home and lower self-reported levels of waste. Furthermore, there is evidence that local interventions – of which there have been many (§10.0) contribute to this trend.

10.0 Activities by WRAP and its partners to reduce household food waste

Helping consumers prevent food waste has been a major focus for WRAP, its funders and partners: with the launch of Love Food Hate Waste, publication of ground-breaking research and inclusion of household food and drink targets within both the first phase of the Courtauld Commitment and its successor.

Major retailers and brands have supported Love Food Hate Waste and its objectives, and also made changes to the way foods are packaged, labelled and sold. In 2008, Sainsbury's introduced new storage guidance to customers both in-store and on its website, advising shoppers to store their loose fruit and vegetables in the fridge to keep it fresher for longer, and in the same year launched their campaign: *Love Your Leftovers*. In 2009, Morrison's launched its own campaign (*Great Taste Less Waste*) to help its customers waste less food, including 'best kept' labelling to inform customers how best to store products, and promotion of effective meal planning through recipe suggestions that use the same core ingredients. The Co-operative was the first UK retailer to print storage advice on their bags for loose fresh produce.

Examples of activities delivered by brands include Warburtons and Kingsmill introducing different loaf sizes, whilst Warburtons and Hovis both improved on-pack labelling to make it easier for customers to know how to store their bread in the best way, and when to eat it by. Heinz launched an innovative "Fridge Pack" for baked beans in 2010, which could be kept in the fridge for up to 5 days after opening, giving consumers longer to eat the product. Birds Eye introduced re-closable packs for both frozen peas and fish-fingers, to help reduce waste.

By the end of 2010 all of the major retailers and many of the major food and drink brands had delivered relevant messages and/or innovative products to their customers to help them reduce waste.

Joint working between WRAP, the Food Standards Agency, UK Governments and the food and drink industry has led to significant progress in simplifying date labels, and ensuring storage guidance is clearer and more consistent.

WRAP has also supported 22 local Love Food Hate Waste campaigns involving more than 300 local authorities. These initiatives have helped local people reduce food waste and have included road shows, cookery demonstrations and recipe competitions, working with community groups, housing associations, and businesses. The South West Waste and Recycling Forum, for example, prevented an estimated 8,000 tonnes of food waste going to landfill through their local campaign, which was awarded the 2010 Gold Green Apple Award for partnership working and the Food Waste Award 2010 from the Plant & Waste Recycling Show. In the West Midlands region, WRAP worked with Improvement and Efficiency West Midlands and the 33 local authorities on a jointly funded Love Food Hate Waste campaign to help tackle food waste.

Community groups and individuals have taken action to help prevent food waste locally. WRAP's partnership with the Women's Institute demonstrated that local groups can make big reductions in food waste, saving money in difficult financial times.

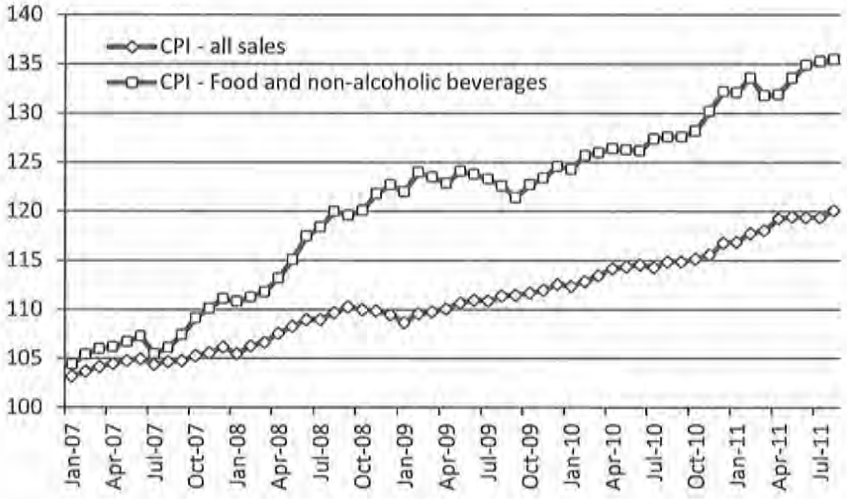
WRAP has also worked extensively with the media to ensure that positive food and drink waste prevention messages are spread widely, including local and national radio and print media, consumer magazines and TV.

11.0 Other influences on food waste

There are a number of factors – other than the work of WRAP and its partners – that could have influenced household food waste. These include (but are not limited to) food prices, income levels and the collection system for waste.

For example, consumer food prices have undergone high levels of inflation – most notably in the second half of 2007 and 2008 during which prices rose by 16% (Figure 3). This compares with a 4% rise in consumer prices (as measured by the Consumer Price Index) over the same period.

Figure 3: Consumer price index for food and non-alcoholic beverages compared to overall consumer price index (CPI); 100 = 2005 level



Source: Office of National Statistics.

As a result of price rises and other economic changes, food expenditure patterns have shifted, not only in terms of quantities and types of food, but also the proportion of food eaten in the home. It is possible that changes in behaviours related to food waste (Figure 1) have been triggered – at least in part – by these economic factors.

There is evidence that the method of collection type, of household waste, has an impact on the quantities and composition of waste collected. The evidence connecting food waste arisings and the collection type is currently incomplete[21]. Nevertheless, changes in food waste collection schemes should not be ruled out as one possible driver for the observed trend in reduced food waste arisings.

It is extremely difficult to separate the impact of different factors for a number of reasons:

- Past modelling of the impact of income and prices on food sales usually focuses on value of food purchased rather than the quantity. New models based on weight of food are being developed, but results are semi-quantitative given the sparse data on levels of food waste. Specifically, it is difficult to estimate the impact of these economic conditions because time series data on food waste arisings is not known with accuracy during previous food price rises or recessions.
- The influence of price rises and changes in income level are hard to separate fully from the influence of WRAP and its partners. For example, communications around reducing household waste were tailored to the economic situation: e.g. many websites and articles detailing how people could make financial savings cited food waste reduction as a possible route, and directed people to the Love Food Hate Waste website. This type of communication is likely to have been more effective because of the economic situation at the time, and it would be almost impossible to quantitatively attribute the impact between the economic situation and WRAP's contribution.

It is unlikely that all of the reduction in food waste is the result of the work of WRAP, its partners and others active in the field of food waste reduction. However, the evidence provided in this report would suggest that WRAP – and the work with its partners – has been a key influence on food waste levels.

[21] *Literature Review - Relationship between Household Food Waste Collection and Food Waste Prevention*, WRAP: http://www.wrap.org.uk/downloads/Impact_of_collection_on_prevention_FINAL_v2_17_8_11.b13e1fe5.11159.pdf

12.0 Conclusion

There is strong evidence from both waste and purchasing data that there has been a substantial reduction in the amount of food waste generated by households in the UK, which will have delivered huge benefits to the environment, in terms of reductions in CO_2 e emissions (3.6 million tonnes less per year), water usage (1 billion litres less per year)and the amount of material sent to landfill (around 1 million tonnes). Although food price inflation means that the value of the lower level of avoidable food waste is similar to that in 2007, without this reduction, consumers would be spending around £2.5 billion a year more on food and drink that ends up as waste.

Determining the extent to which different factors have triggered, and then enabled, this reduction in household food waste is difficult. The tough economic times and rising food prices have undoubtedly contributed to the desire to maximise the value out of the food that is bought, and reduce food waste, and changes to the way waste is collected from households may also have helped raise awareness of the amount of food being thrown away. Work is in progress by WRAP to develop new approaches to help understand how all of these factors interact to motivate and bring about changes in food waste levels.

Although the findings presented in this report are extremely positive, it is important to recognise that household food waste remains the single largest contributor to overall UK food waste (around 50% of the total). Continued effort is required to bring about further significant reductions in the £12 billion worth of avoidable food waste associated with around 17 million tonnes of CO_2 e and a water footprint of 4.5 billion m^3.

Further work is required to understand the detail behind these changes in household food waste, in particular around the types of food being thrown away, by different types of household. In addition, future research to track changes in household food waste will rely on there being a significant number of compositional studies carried out across the UK.

Waste & Resources Action Programme

The Old Academy
21 Horse Fair
Banbury, Oxon
OX16 0AH

Tel: 01295 819 900
Fax: 01295 819 911
E-mail: info@wrap.org.uk

Helpline freephone
0808 100 2040

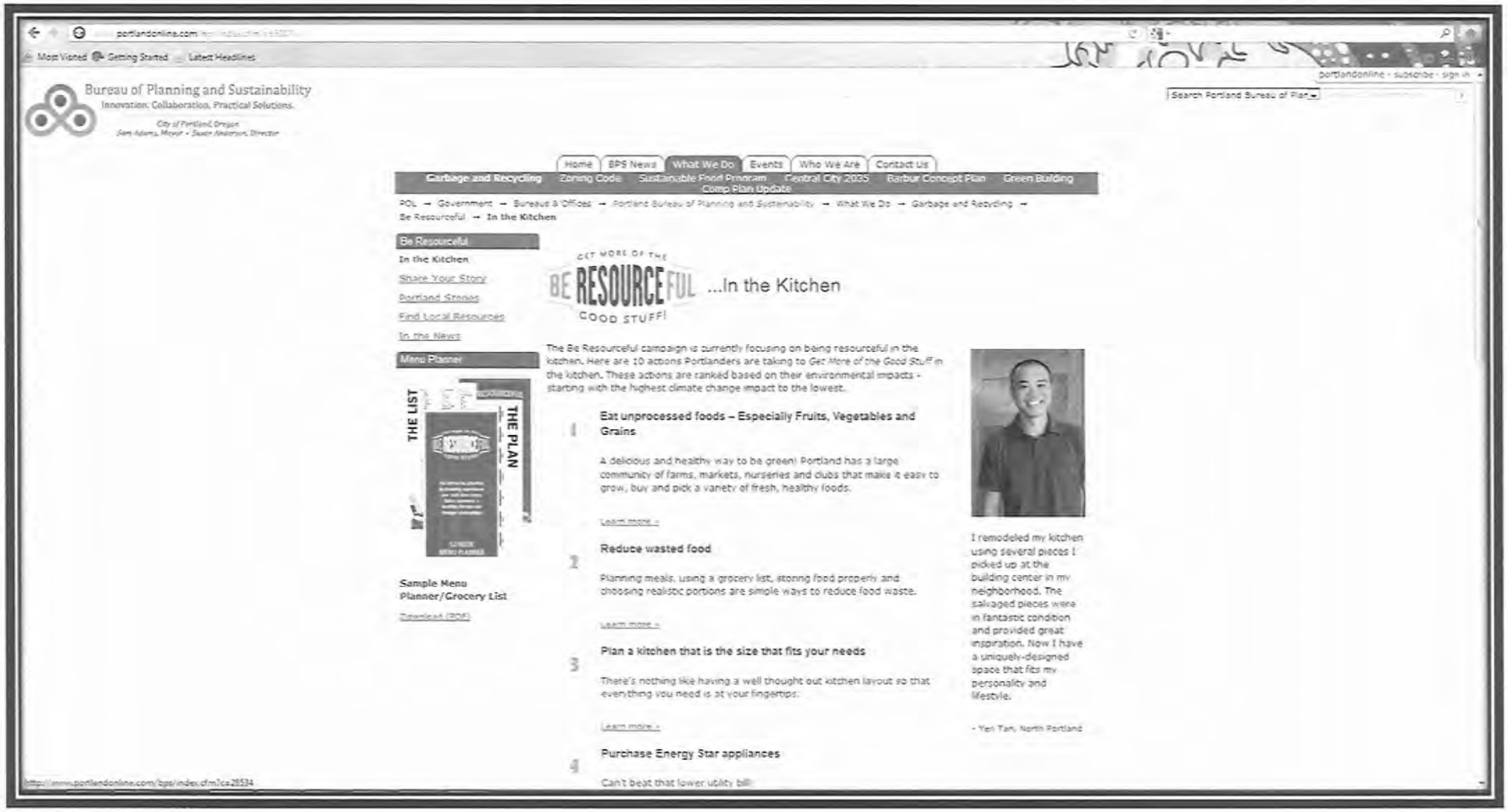
www.wrap.org.uk

recycle

www.wastedfood.com

Be Resourceful Portland

http://www.portlandonline.com/bps/index.cfm?c=53171



OregonLive.com
Everything Oregon

Waste: Composting just nibbles at problem

Published: Thursday, June 14, 2012, 5:00 AM

By **Special to The Oregonian**

View full size Motoya Nakamura/The Oregonian

OREGON CITY, OREGON -- June 01, 2012 -- Delores Ellis, a volunteer, helps Maria Garcia and her granddaughter Lona, 3, at food basket distribution at Park Place Evangelical Church in Oregon City. The OSU Extension program shows up to provide info and pamphlets on stemming food waste and stretching food dollars by cooking what's in the baskets smarter.

Kimberly Smith will do her best not to waste anything from the Oregon Food Bank box she picked up in Oregon City. She can't afford to.

A round of donated cheese bread will become pizza for her husband and son after she slices it in half and spreads it with the two cans of crushed tomatoes allotted her. She knows exactly what's in her pantry and how to mix and match it with what she receives.

Her "stoup" (half stew, half soup) is made with typical food box ingredients: canned pumpkin, corn, green beans, black beans and sweet potato, to which she adds sautéed ground beef.

"If you're hungry, you find a way to use it," said Smith, 32, who works part time at a salon. "You become very resourceful -- that's the only thing you can do sometimes."

She composts rinds but usually little else. The rest she eats or freezes.

The country could take a lesson from Smith. Americans generated more than 34 million tons of food waste in 2010 -- roughly 14 percent of the municipal solid waste stream -- most of which was thrown away, according to the U.S. Environmental Protection Agency. CleanMetrics of Portland estimated that avoidable food waste in the U.S. actually exceeded 60 million tons, creating life-cycle greenhouse gas emissions of 124 million tons, or 2 percent of national emissions. A family of four has avoidable food waste totaling $1,600 annually.

Efforts to reduce food waste are wide-ranging in the Portland metropolitan region -- from the OSU Extension Service's efforts to teach people how to cook with, can and freeze summer's abundance to a company that helps institutions nationwide measure and reduce the

Tips for reducing food waste

Check your refrigerator, freezer and pantry before grocery shopping.

Plan at least two or three meals for the week.

amount of food thrown away.

"It takes time and thought and effort to cut the waste and save the money," said Kumar Venkat, who formerly ran CleanMetrics. "If it became an ingrained habit, it would help."

While Portland's new curbside kitchen-scrap composting program is a positive change, composting is just a step above throwing food in the landfill, according to the EPA's food recovery hierarchy. The best thing people can do for their budget and the planet is reduce the food waste generated, then feed hungry people, then animals, then use what's left for things like fuel.

But often big food service operators like colleges, hospitals and casinos mistakenly believe composting is the only answer, said Andrew Shakman, president and co-founder of LeanPath in Portland. And while it's great in its way, that's akin to mopping up a leak while the water continues to run.

"With food waste, people aren't doing anything to lower the volume," he said.

His company provides food-based tracking systems that allow institutions such as the University of California at Berkeley and Linfield College to weigh and track what they're throwing away.

"Once you can measure food waste, you can dramatically reduce it," he said.

Clackamas County has struggled to launch a commercial composting program because Oregon has few facilities that take food scraps. So reducing food waste has become the main focus, said county sustainability analyst Rosalynn Greene.

She's in the beginning stages of figuring out how to connect commercial food service providers with nearby food pantries so people like Smith, who picked up an Oregon Food Bank box, can benefit from food that might otherwise be thrown away.

While Metro's Fork It Over! program helps do just that, Greene wants to create a more hands-on, user-friendly system for her county.

"We're decreasing the amount of food waste that has to be processed, but we're also giving back to the community," she said.

Fork It Over! has struggled with a low profile among businesses and food rescue agencies, which say they need increased and more reliable pickup of food donations. Another concern: As composting ramps up, that could affect the food available to rescue agencies. So Portland State University has agreed to revamp and operate the program for two years and then determine its usefulness, said Metro senior planner Jennifer Erickson.

Make a grocery list and stick to it.

Try cooking foods that take similar ingredients so you don't have a pantry full of exotic items that may go bad.

Be creative: Use leftover chicken in a stir-fry one night and a stew the night after that.

Freeze things well: To prevent freezer burn for a half-eaten bag of frozen peas, for instance, add a second vapor- and moisture-proof layer by putting it in another plastic bag or a container with a snap-on lid.

Freeze in meal-size packages.

For more: **extension.oregonsta /food-preservation**

Sources: OSU Extension Service, city of Portland

Why so much waste?

Portion size is one reason. Think about this: A 3-inch-diameter bagel was once the norm and now it's 6 inches, according to the National Heart Lung and Blood Institute.

It might be different if food were more expensive. But for many Americans it's cheap, making up just 6 percent of the average total U.S. household expenditure compared with 35 percent in India, according to the Bill & Melinda Gates Foundation.

And the true cost of food is hidden.

"It's expensive when you look at the environmental and health impacts, but that's not in the dollar figures because there are large (federal) subsidies for certain foods" such as corn and wheat, said Lauren Norris, Portland's sustainability outreach manager.

The city's Be Resourceful campaign distributes 52-week menu planners with grocery list templates. Planning, whether for a family or hospital kitchen, is key to reducing waste.

Smith said that often the fresh food she receives at pantries is near its expiration date, which makes it a challenge to eat it before it goes bad.

If her parents in West Linn invite her family over for dinner, she will still try to cook the nearly expired food and freeze it.

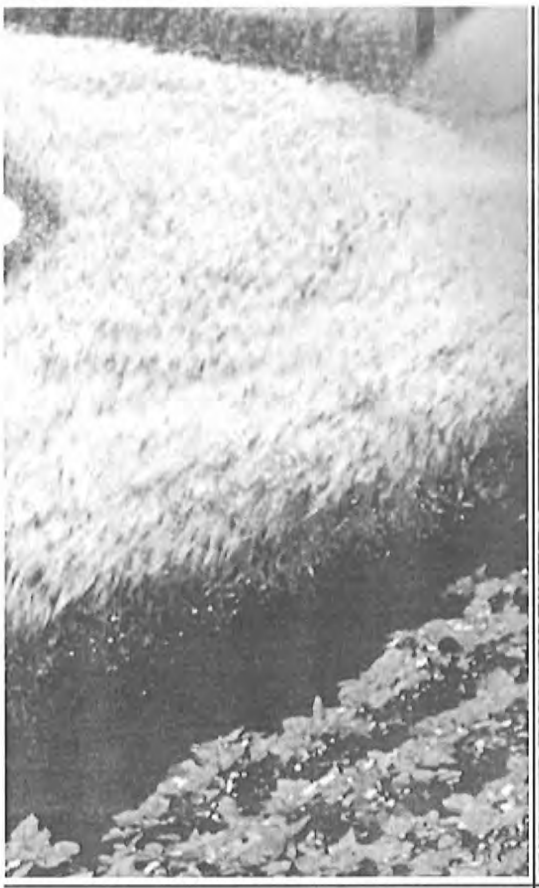
Occasionally, a meal goes to waste.

For the most part, Smith is a model for what Kelly Streit with OSU Extension Service tries to teach in Clackamas County: Smith looks at what's in her pantry, decides what to make with it and then generates a grocery list so she doesn't buy random food. It's basic meal planning, but many don't do that because it seems overwhelming. Streit advises that people start small: Plan just two or three healthy breakfasts a week.

She also tries to empower people to stray from recipes -- as Smith does with her "stoup" -- so they can cook with what they have and not let it go to waste. She teaches classes on "skillet cooking" that mix sauces, veggies and cans of, say, tuna or chicken, to make tasty, creative meals.

"No matter your income strata, everyone has a degree of food waste in their world," she said.

-- **Carrie Sturrock**



A policy brief for central governments in developed and developing countries, sub-sovereign national bodies, universities and research institutes, community organisations, banks and private investors, aid donors, multilateral financial institutions, UN agencies and other international organisations.

Saving Water: From Field to Fork

Curbing Losses and Wastage in the Food Chain

IWMI
International Water Management Institute

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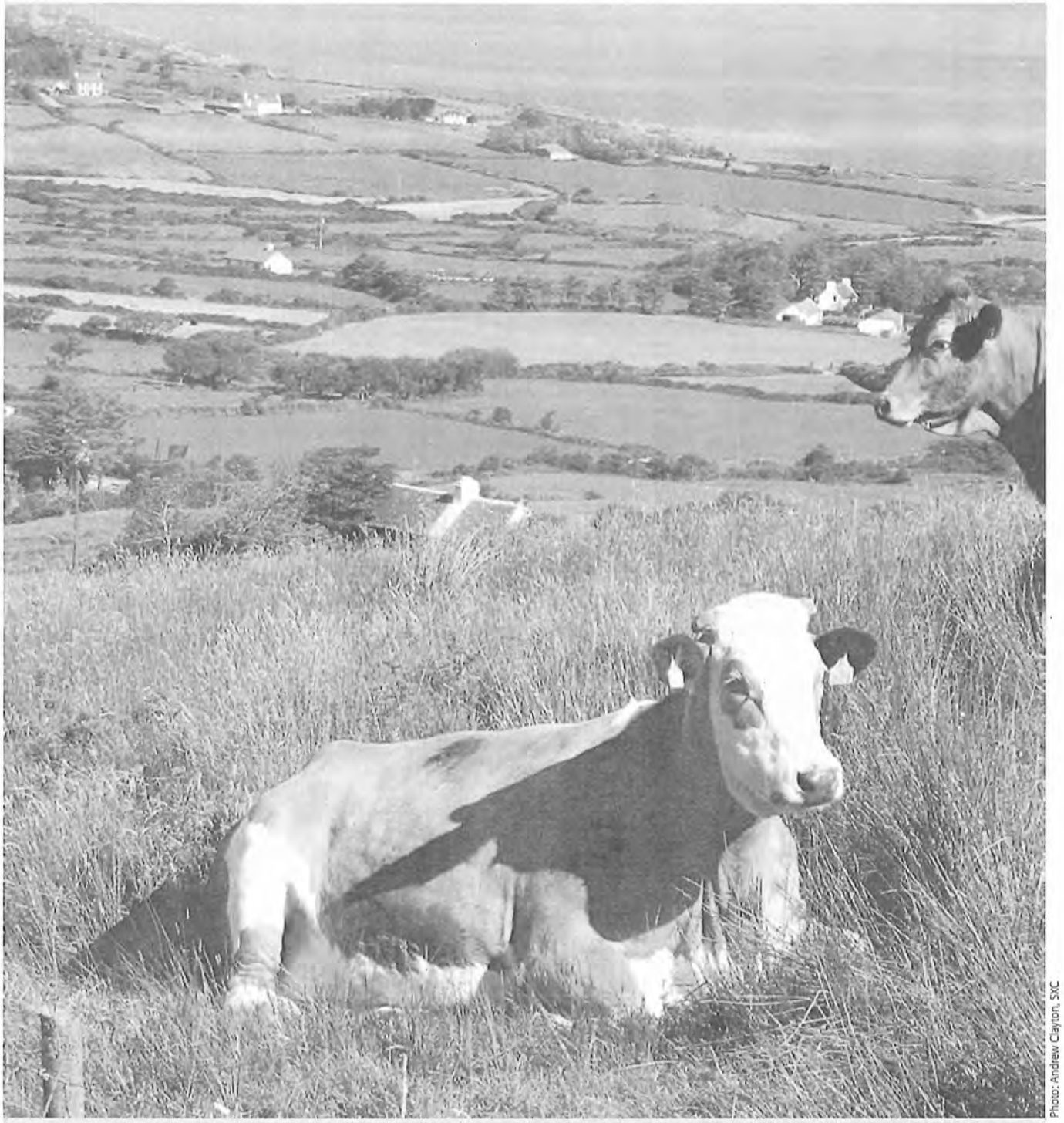

Photo: Andrew Clayton, SMC

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Note to the Reader:

This report and the Side Event at CSD 16, May 5–16, 2008, are following up reports that have been prepared for two previous CSD meetings, "Water – More Nutrition per Drop" (2004*) and "Let it Reign: The New Water Paradigm for Global Food Security" (2005**). The topics addressed in the previous reports, and also in this report, are the links between water, food and development, which are high on the agenda for Swedish international development collaboration. This report highlights the magnitude of losses and wastage in the food chain, i.e. from field to fork. It is shown that a reduction of losses and wastage would save water and facilitate the achievement of multiple development objectives.

The views put forward in this report are expressed solely on behalf of International Water Management Institute, Chalmers University, Stockholm Environmental Institute and Stockholm International Water Institute.

Lead authors: Jan Lundqvist, Stockholm International Water Institute; Charlotte de Fraiture, International Water Management Institute and David Molden, International Water Management Institute. Contributing authors: Göran Berndes, Chalmers University of Technology, Sweden; Anders Berntell, Stockholm International Water Institute; Malin Falkenmark, Stockholm International Water Institute; Hans Holmen, Linköping University; Louise Karlberg, Stockholm Environment Institute and Mats Lannerstad, Linköping University.

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* http://www.siwi.org/documents/Resources/Policy_Briefs/CSD_More_nutrition_per_drop_2004.pdf
** http://www.siwi.org/documents/Resources/Policy_Briefs/CSD_Let_it_Reign_2005.pdf

Photo: Getty Images

Executive Summary

Food Wastage is Water Wastage

We need to use our water prudently – no one will argue with this statement. But in fact we are wasteful. This need will become more pronounced, and the cost of bad water management will get higher in the future with increasing water demands from increasing population, cities, agriculture, and the environment. Moreover water management will become more difficult with climate change. New solutions and fast actions are required now.

Agriculture is the largest human use of water. Clearly, agricultural practices need to be targeted to reduce wastage of water. This has been the center of attention for water saving practices for years. But there are additional ways to save water.

Food consumers and businesses have a key role. Losses of food between the farmers' field to our dinner table – in food storage, transport, food processing, retail and in our kitchens – are huge. This loss of food is equivalent to a loss in water. Reducing food loss and wastage lessens water needs in agriculture. We need to pay more attention to this fact.

Our Key Message: Make the Food Chain More Efficient to Save Water to Facilitate the Achievement of Multiple Development Objectives

Making the food chain more efficient means saving water that would have been used to produce that food. More than that, a reduction of losses and wastage can serve the interests of farmers, consumers and society at large.

The amount of food produced on farmers' fields is much more than is necessary for a healthy, productive and active life for the global population. Clearly, distribution of food is a problem – many are hungry, while at the same time many over eat. A hidden problem is that farmers have to supply food to take care of both our necessary consumption and our wasteful habits. This problem can be turned into an opportunity. Targeting losses and wasteful habits may generate multiple gains, including the saving of water. In addition to saving water by a reduction of losses and wastage in the food chain, agricultural water management practices could be much more productive.

As indicated in Figure 1, losses and wastage may be in the order of 50 percent between field and fork. Inefficient harvesting, transport, storage and packaging make a considerable dent in the potential availability of food. Additional and significant losses and wastage occur in food processing, whole sale, retail and in households and other parts of society where

food is consumed. The estimate is dependent upon how the conversion of food in terms of grains used for feed to produce animal foods is interpreted.

It is important to recognise that agricultural products that are harvested but that do not reach our dinner plates are not necessarily wasted. Agricultural produce and residues are used for various purposes at farm level or within the agricultural system – for feed, bioenergy and soil amelioration. This is a typical situation among small holder agriculturalists in developing countries.

Situations differ from industrialised countries to those with weak economies and a strong agricultural base, and between rich and poor producers and consumers. Generally, the losses in the first part of the food chain, which result of poor harvesting technologies, lack of transport and poor storage in combination with climatic circumstances, are relatively more important in developing countries. In industrialised countries, where a high percentage of the population live in urban centres, wastage is quite high. Trends in diet composition, towards a higher fraction of animal food items, fruits and vegetables tend to shorten the durability of food and could increase the risk of losses and wastage.

In fact, the entire picture is complex, and the knowledge to guide policy pertaining to various parts of the food chain needs to be improved. However, there is enough evidence that the magnitude of food and water losses are large enough and that we must pay close attention. Strategies that focus on reducing losses from field to fork can facilitate the achievement of multiple development objectives: food security, improvement of livelihoods of farmers, meet the growing demand for non-food agricultural products and safeguarding environmental resilience.

A New Era for Water and Food Management

Warnings about severe water scarcity come at the dawn of a new era for agriculture. For an increasingly affluent world population the demand for a range of agricultural products is rapidly increasing, while the poor have to bear the brunt of price hikes and lack of access to food and water supplies. An estimated 1.4 billion people already live in areas where there is not enough water available to meet all needs from sectors of society, let alone the need of aquatic ecosystems.

Over the past 50 years, food supply has increased more rapidly than populations have, and under nourishment, a lingering threat throughout history, has been reduced. Until very recently, the real price of food has been fairly stable or declined, benefiting both national and household economies although it has been detrimental to farmers. The situation now is characterised by rapidly increasing prices on food with dramatic repercussions for the poor, rates of inflation and, generally, for the stability of society.

Several coinciding circumstances contribute to this quite serious situation, which may increase the number of people

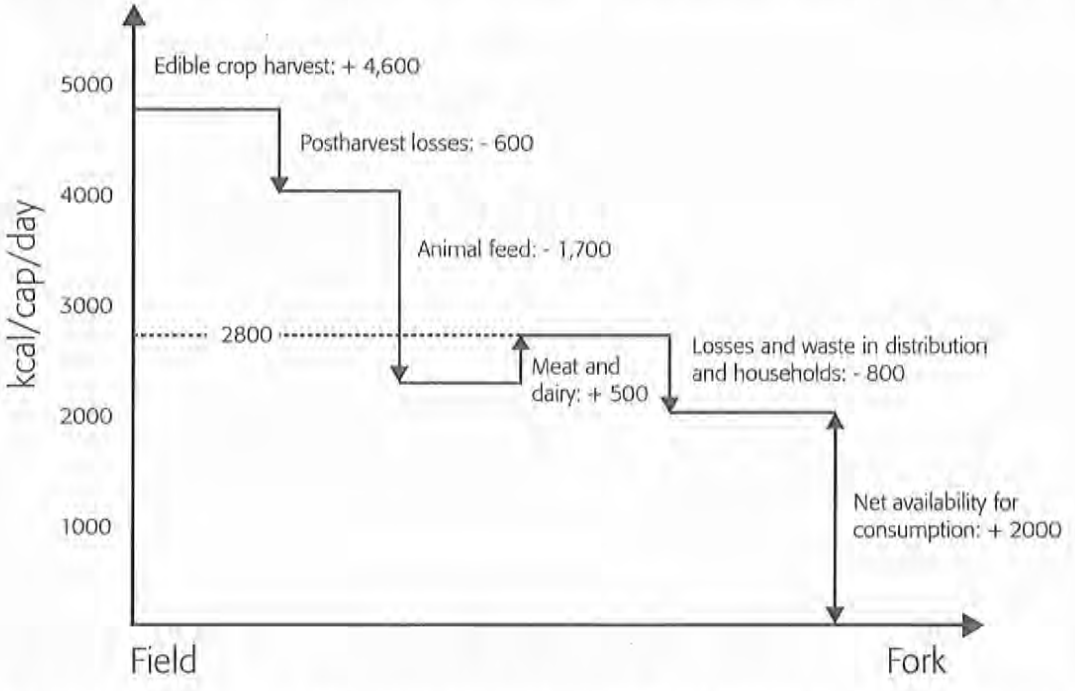

Figure 1. A schematical summary of the amount of food produced, globally, at field level and estimates of the losses, conversions and wastage in the food chain. Source: Smil (2000). Illustration: Britt-Louise Andersson, SIWI.

Photo: Mats Lannerstad

who are under nourished. Faced with this threat and with the escalating water scarcity and increased competition for land and water resources for a range of uses, increases in water productivity are necessary especially in areas where production and productivity are low and where there is a need for more food and improved livelihood for the producers. But it also makes sense to ensure that as much as possible of the food produced is accessible for consumption across social groups of society.

Access to food is very much conditioned by socioeconomic circumstances in society. Under nourishment is largely perpetuated by poverty and conflict. However, with losses and wastage in different stages of the food chain, the overall food security in society is compromised One reason for losses in the food chain is an increasing distance between the places where food is produced and where it is consumed. Whereas in the past, many people produced their own food, now various parts of our meal come from food grown in many places in the world. Parallel and closely associated with this trend, is the involvement of a growing number of actors and interests along the food chain. Apart from farmers, transporters, store keepers, food processing industry, shopkeepers, supermarkets, among others, are involved. We therefore need to look at the stakeholders and drivers in various segments of the food chain and to what extent interests either coincide or are at odds across major groups. Enhancing efficiency in one part of the chain, e.g. in production, can be nullified if losses and wastage occur, or increase, in other parts of the chain.

All of these changes have implications on water resources. More food is likely to come at a cost of more water use in agriculture. Further, distance to market, and a more complicated food chain and changes in composition and variety of food supply, open the possibility of more food and water wastage. Water will be a key constraint to food security, unless we change the way we think and act about the whole chain, from production to consumption.

Key Issues for Policy Debate

Support to Farmers

Actions are needed to support farmers, especially small farmers, to curb losses of water and food and to facilitate that their produce meets the growing demands for food as well as other agricultural commodities. Growing expectations on the agricultural sector is an opportunity that needs to be properly harnessed through:

- Improved seeds, harvesting technologies, better transport and storage.
- Innovative ways to capture and beneficially use the rain falling on farmers' fields to increase the fraction of the rains that can be productively used and to lessen stresses on rivers and groundwater. With current practices and strategies, a large fraction of the rainfall is lost in terms of unproductive evaporation in many parts of the world.
- Financial and institutional arrangements to realise productivity improvements.

- Co-management of land and water management, preferably in a basin context is much needed. In many cases, government institutions do not integrate these two sectors.

Food Processing and Supply

The business community should take action to minimise water wastage through reducing food wastage in their processing and transport:

- Benchmarking standards should be set by industry to indicate water use, including water use in the entire food chain, not just in their factory.
- The business community should take action to minimise water wastage through food wastage in their processing and transport systems.
- Businesses can raise publicity about their water use, and the need to save water.

Sensitise Consumers

Raise awareness amongst consumers about the water implications of their diets, overeating and food wastage. We as consumers need to be careful about food wastage in our homes. Over eating and throwing food away is like leaving the tap running:

- Raise awareness amongst consumers about the water implications of their diets, overeating, and food wastage.
- Incentives and practical guidance and well designed campaigns may be required to reduce food wastage in our homes and how to combine home economics with sound food habits. Concrete examples of how to avoid or reduce the throwing away of food need to be used.
- Explore the opportunities to include information of losses and wastage as part of a labelling system or as information on strategic consumer food items.

Basic Data and Information

We lack factual information about different types, size and implications of losses and wastage of food. An important step is therefore to improve knowledge:

- International organisations, businesses and agencies for research at national and international levels should initiate studies that will reveal the different types and magnitude of losses and wastage in the food chain in different parts of the world, and identify steps that can be taken to minimise these.
- Quantify information on the costs of losses and wastage as well as what are the benefits and who will benefit with a reduction in losses and wastage. Costs and benefits should be estimated in monetary terms but also in terms of water savings, environmental aspects and other suitable parameters.

A Strategy for Action

Governments, international organisations and NGOs have major roles to play to drive the policy agenda and its implementation. Following the call from World Economic Forum in January 2008, it is appropriate that the resources represented by the businesses are part of a coordinated action. A suitable next step is the forming of a broad collaboration across the business community and between the research community, the private sectors, NGOs, civil society and government.

A consortium of policy makers, representatives from industry, academia and civil society could lead the way to design effective, acceptable and practical actions to reduce losses and wastage by half by 2025.

Photo: Jan Lundqvist, SIWI

Photo: Michael Moore, SIWI

1. Drivers of Food Demand

1.1 Water Costs of Past Achievements

Remarkable improvements in food security have been one of the most positive characteristics of development in large parts of the world over the last half a century. At the dawn of the Green Revolution, at the beginning of the 1960s, the average global crop yield was about 1.4 tonnes/hectare. Thirty years later, in the mid-1990s, it had doubled to about 2.8 tonnes/hectare (Molden et al, 2007 a). In the mid-1960s, total global cereal production was about 0.9 billion tonnes, and in 1995 about 1.7 billion tonnes. The 2 billion tonne mark was passed in 2004, when total cereal production was estimated at 2254.9 million tonnes (FAO, 2005).

Largely as a result of these developments, the number of under nourished people in the world has been reduced, in relative and absolute terms, although there are signs of setbacks (FAO, 2006; von Braun, 2007). One reason for a slight increase in food insecurity recently is persistent and extreme poverty in combination with conflicts notably in parts of sub-Saharan Africa (Ahmed et al., 2007, cited in von Braun, 2007). Food insecurity and hunger is, however, also experienced in rich countries.

Achievements in terms of an augmented food production have come at a cost. Increased pressure on freshwater resources, due in large part to the rapid expansion of irrigation systems, has had repercussions on aquatic ecosystems (Falkenmark, et al., 2007) and for people in downstream areas. River basins around the world are closing, that is, there is no more water for additional water allocations, because water has already been fully allocated, or even over-allocated (Falkenmark and Molden, 2008). But demand and competition for water continues to increase unabated, and concerns are being heard from key people and organisations, including from the UN Secretary-General and representatives of industry.[1]

1.2 Income Improvements and Changing Diets

Poverty reduction remains the number one development goal. Economic development promotes poverty reduction and the prospects for this today are very bright. In the year 2000, 800 million people lived in regions with a mean annual GDP per capita above USD 10,000. Economic growth projections based on so called demographic dividend projections, where economic behaviour is linked to age composition, foresee about 7 billion people, or about 80 percent of the world's population, living in such regions by 2050 (Malmberg, 2007; Lind & Malmberg, 2007). If the envisaged massive economic growth will unfold, a significant reduction of poverty is possible. It will make considerable public and private investments in infrastructure, research and human development conceivable. It is an opportunity to build a better future for broad groups of people. A vital question, however, here is how can the associated growth in demand be met and still reconciled with the concomitant increased pressure on natural resources and the environment during the coming decades? And how will the poor, who may still be counted in hundreds of millions, be faring in a context

[1] Water scarcity was a major issue at the World Economic Forum, Davos, January 2008, with no less than nine events addressing various consequences of worsening water stress. UN Secretary-General, Mr Ban Ki-moon, told the meeting: "What we did for climate change last year, we want to do for water and development this year" Andrew Edgecliffe-Johnson, Financial Times, 25 January 2008 http://r.smartbrief.com/resp/jCoccSoRcsixtWCiaKqZvIHE?format=standard

of increasing resource pressure and competition? Experience tells us that even at higher levels of income and consumption, people tend to want more, knowingly or unknowingly about the implications for natural resources and the environment. Apart from poverty alleviation, sustainable lifestyles are increasingly an issue. Changes in diets towards an increasing demand for meat and seafood is one of the vital issues in such discussions (Jackson, 2008, Halweil and Nierenberg, 2008).

Even if rates of poverty are reduced, a very large segment of the world's population is still poor or extremely poor. Recent price hikes on food is a most serious change for them. For the billion plus of people who are forced to survive on the equivalent of an average per capita income of a dollar per day, a very large part of their disposable money and resources are spent on food and other basic necessities of life. For them, even comparatively small increases in the price of food are causing extreme hardship. On the other hand, a growing middle class in various parts of the world contribute to increasing the demand for a range of goods, including food and other agricultural products. Prices of commodities are naturally affected and what food items are produced. People who are well off are comparatively less affected by price hikes on food. To avoid widespread social unrest and negative repercussions on inflation and the economy it is vital for Governments and international organisations to consider the interests and concern of the population as a whole. At the recent National People's Congress in Beijing, Premier Wen Jiabao promised that the government would boost production of daily necessities such as grain, vegetable oil and meat and/or increase imports of consumer products that are in short supply (Wang 2008), with the twin objective to reduce threats of inflation and dam up against social grievances.

With rising incomes and urbanisation, demand for food will increase. Furthermore, consumers' tastes are changing towards more nutritious and more diversified diets, which tend to boost the consumptive use of water. A shift in consumption patterns among cereal crops and away from cereals toward animal products and high-value crops can be anticipated (CA, 2007) For example, in South East Asia rice supply peaked at around 120 kg/capita/year during the 1980s while per capita wheat demand more than tripled between 1961 and 2002 and is still increasing. Meat demand grew by a factor of 7, from 6 to 40 kg/capita/year. Demand for high-value crops – such as fruit, sugar and edible oils – also increased substantially and projected increases in demand vary from 70 percent to over 100 percent (Fraiture et al., 2007).

Changes in food habits as incomes rise are illustrated in Figure 2. The general trend is in favor of more nutritious and more diversified diets with a higher proportion of animal products and high-value crops and away from "traditional" cereals, e.g. various varieties of sorghum. There are pronounced regional and cultural differences. While changes in diets as a result of income growth follow similar patterns, regional and cultural differences are pronounced – and may remain so for some time (Lundqvist et al., 2007). For example, meat demand in (mostly vegetarian) India rose much slower than in China, for comparable income increases, but demand for milk products increased more rapidly (Figure 2). Per capita supply of meat in India seems to remain relatively low, projected at 15 kg/capita/year by 2050, while China is projected to supply six times more. China's meat demand is projected to be 83 kg/capita/year by 2050 (de Fraiture et al., 2007).

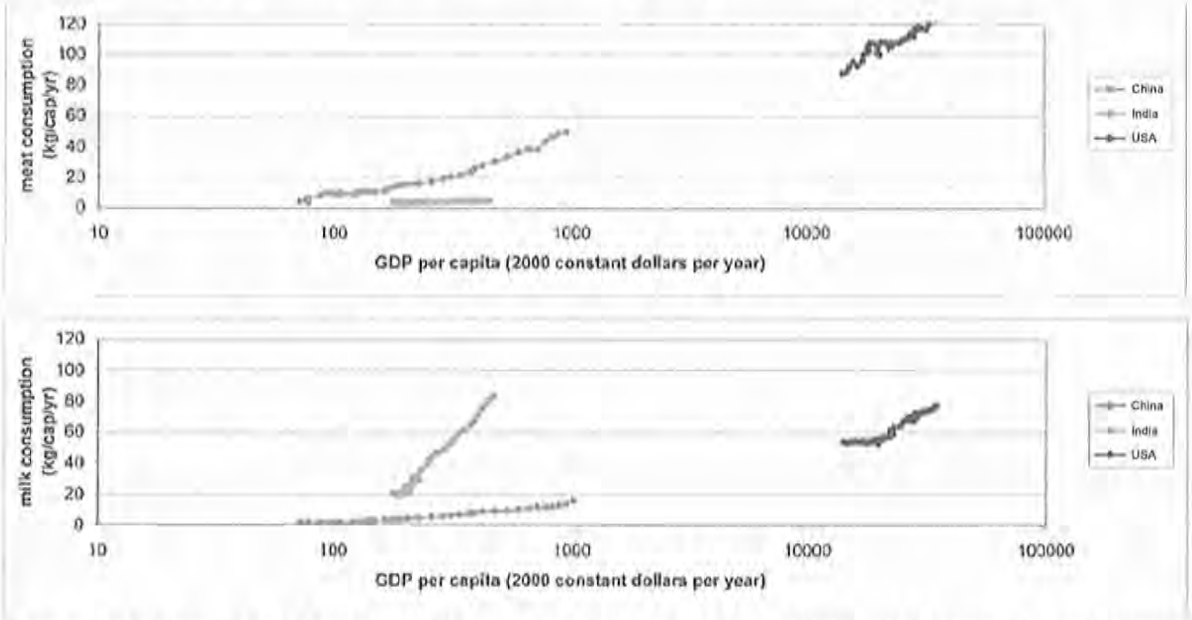

Figure 2. Trends in meat and milk demands and GDP per capita in China, India and the USA (1961–2000). Source: GDP data from World Bank WDI online; consumption data from FAOSTAT.

Cereal demand projections are in the range of 2,800–3,200 million tonnes by 2050, an increase of 55–80 percent compared with today. Much of the future increase will be fed to animals to satisfy the demand for meat (Fraiture et al., 2007). Today some 650 million tonnes of grain – nearly 40 percent of global production – is fed to livestock, and this may reach 1100 million tonnes by 2050.

Although general trends toward more diversified and meat-based diets are well documented (e.g. Molden et al, 2007 a; Steinfeld et al., 2007), considerable uncertainties remain regarding some of the major factors driving future food composition and feed requirements. Projections for world meat demand are uncertain, varying from 375 to 570 million tonnes by 2050, that is, an increase of 70–160 percent compared to 2000 (Fraiture et al., 2007). Environmental concerns and emerging health problems related to obesity may promote counter trends, particularly in high-income countries. But the problem of overweight and obesity is increasing in other parts of the world, too.[2] Outbreaks of diseases such as mad cow disease and avian flu, together with the industrial nature of meat production, may deter some people from increasing meat consumption.

Much uncertainty surrounds the feed grain requirements per kg of meat, milk and eggs. In many parts of the world there is the potential to increase the efficiency of feed systems (Peden et al, 2007; Wirsenius et al., forthcoming). Livestock are fed by a combination of grazing, crop residues, and feedstuffs (primarily grains). In OECD countries, where cattle are raised largely on feed grains, two-thirds of average grain production is devoted to cattle feed, some of which is imported. In contrast to an industrial character of agriculture that is expanding in many parts of the world, in sub-Saharan Africa and South Asia a large part of the livestock is typically fed on crop residues, grazing lands and by-products from local sources, with less than 10 percent of grain supply is used for feed. This kind of integration between the cropping system and animal rearing, which is a characteristic feature in many small holder systems, contributes to diversity of social and natural resource use systems and can therefore be benign both with regards to resilience and efficiency. These kinds of aspects must be considered in discussions of how livestock will be fed in the future (Peden et al, 2007).

In addition to uncertainties and opportunities on the supply side, projections about the drivers of demand, like the growth in GDP and income vary widely. The four emission scenarios of the Intergovernmental Panel on Climate Change (IPCC, 2000), use estimates of GDP growth during the 21st century that vary from a tenfold to a massive twenty-six-fold increase compared to 2000 – a staggering multiplication in size of the world economy. Similarly, there is a 2.5 times difference between the most optimistic and most pessimistic income projections for 2050 in the Millennium Ecosystem Assessment (2005). On a per capita basis, world real incomes may rise by 4.5 times by 2050 (Sachs, 2008).

Admitting that the pace and magnitude of economic growth cannot be predicted with a high degree of certainty, there is still a widespread view that the world economy, including most economies in Asia, Latin America and large parts of Africa, will continue to expand (Lind and Malmberg, 2007). Even if GDP projections are based on purchasing power parity calculations, the future effective demand for food and the mix of food items is extremely difficult to assess. It is, however, plausible that the economic factor is potentially a more forceful driver than population growth *per se*.

Photo: Getty Images

[2] Reliable statistics are hard to find about the situation and trends of overweight and obesity and their causes. In a newspaper article in 2007, almost 40% of the population of Malaysia are obese according to the Health Minister Mr Chua Soi Lek. In an effort to deal with the epidemic, the Government is considering a "sin tax" on junk food in line with the tax on alcohol. International Herald Tribune, 16 February 2007. http://www.iht.com/articles/ap/2007/02/17/asia/AS-GEN-Malaysia-Fast-Food-Ban.php

Photo: Mats Lannerstad

1.3 Diets and Water

What kind of food is demanded and how much, determine to a large extent how water for agriculture is allocated and used. As elaborated in chapter 3, it is most relevant to also make a distinction between the amount of food demanded and bought, or otherwise acquired, on the one hand, and the amount of food actually eaten, on the other. Food supply directly translates into consumptive water use, that is, how much water is transpired and evaporated from the field during the production of a specific amount of food (see Molden et al, 2007b for a discussion). Unlike water use in industry, the high proportion of consumptive use in agriculture means that this water is effectively lost for re-use or re-circulation in society, that is, until it returns as precipitation. Consumptive use means that the ability to respond to water demand for other activities is inevitably reduced. Generally, water resources in areas located downstream of a consumptive use area are negatively affected.

What do the envisaged changes in diet mean for water demand? While estimates of water requirements for crop and livestock products vary widely, most studies agree on the main points. Higher value crops, such as sugar and vegetables, typically require more water per calorie than staple cereal crops. Meat and dairy production is more water-intensive than crop production. For example, 500–4,000 liters of water are evaporated in producing one kilogram of wheat, depending on climate, agricultural practices, variety, length of the growing season and yield. However, to produce one kilogram of meat takes 5,000–20,000 liters, mainly to grow animal feed. In terms of the energy content of food, approximately 0.5 m^3 of water is needed to produce 1,000 kcal of plant-based food, while for animal-based food, some 4 m^3 of water is required (Falkenmark and Rockström, 2004).

The production of meat from animals fed on irrigated crops has a direct impact on water resources, much more so than if the meat is derived from grazing animals and animals fed on residues. Irrigation water, withdrawn from rivers or other water bodies and returned back to the atmosphere by crop consumptive use, will not be available for cities, industry or the environment. As noted above, projections suggest a doubling in the amount of grain used for feed upto 2050 from rainfed and irrigated systems. The amount of cereals used today for feed varies between regions, ranging from 20 percent in sub-Saharan Africa to 70 percent in OECD countries (FAOSTAT, 2000).

Food preferences, such as the ratio between plant- and animal-based products, vary greatly between countries at the same level of GDP/capita (Figure 3). This means that there are very different implications for water demand in different countries.

1.4 A Bleak Water Future?

If diet continues to be correlated with income, as in Figure 3, water requirements will increase significantly in the future as a result of GDP growth. Researchers agree that per capita food supply and the share of animal-based food items in the food basket are both increasing (e.g. Bruinsma, 2003; Fraiture et al, 2007; Steinfeld et al., 2007, McMichael et al., 2006). In rich countries, food supply is currently well above 3,000 kcal/capita/day with an animal food fraction of about a third, whereas the global average food supply is about 2,800 kcal. In poor countries, both food supply and the fraction of animal-based foods are significantly lower (FAO, Food Balance Sheets).[3]

[3] http://faostat.fao.org/site/502/default.aspx

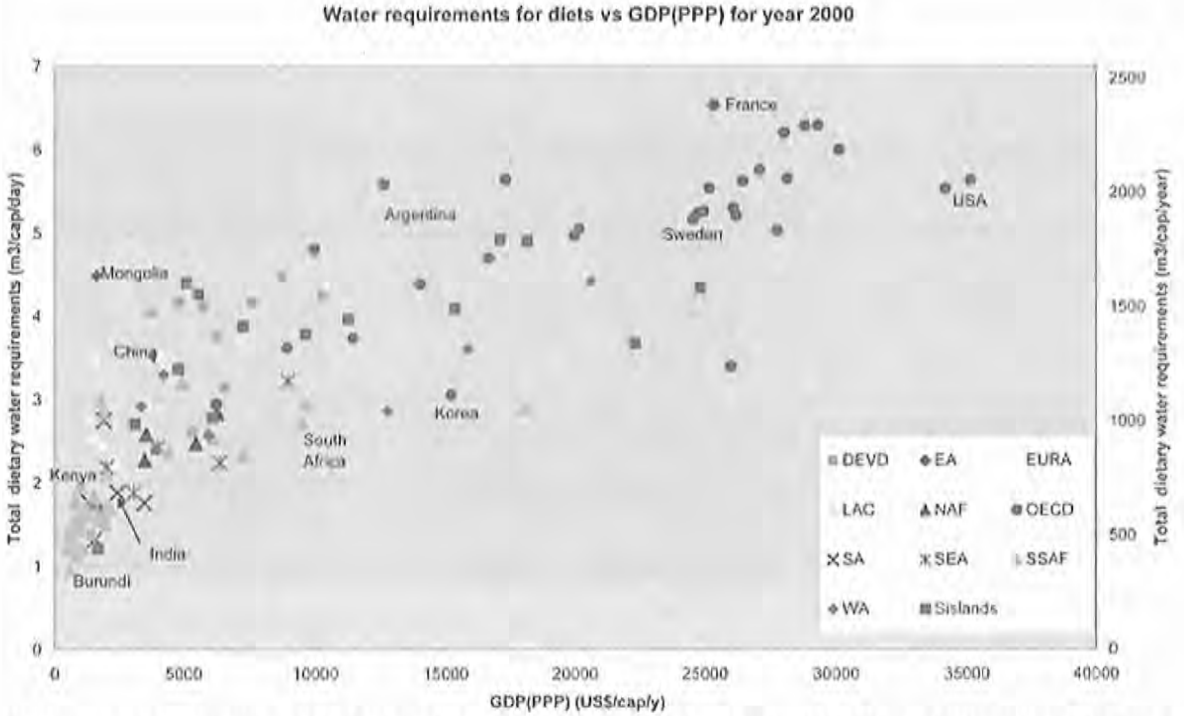

Figure 3. Consumptive use of water for food supply as a function of GDP (Lundqvist et al., 2007). PPP: purchasing power parity. Source: GDP data from the World Bank (2006); food supply data from FAOSTAT (2006).

Regional groups: DEVD=transition countries Europe, EA=East Asia, EURA=transition and developing former USSR, LEC=Latin America and Caribbean, NAF=North Africa, OECD=Members of the Organisation of Economic Cooperation and Development, SA=South Asia, SEA=South-East Asia, SSAF=Sub-Sahara Africa, WA=West Asia, Sislands=Small Islands.

It takes enormous amounts of water to produce our food. Yearly some 7,000 km³ of water[4] are evaporated and transpired in connection with the production of crops to meet the global food demand at the beginning of this century. Assuming a projected high level of average food supply of 3,000 kcal/capita/day, with 20 percent animal and 80 percent plant food, the consumptive water use will be above 3 m³/capita/day – 1,300 m³/capita/year, (Falkenmark and Rockström (2004). Similarly, the Comprehensive Assessment (CA, 2007) estimated that cereal and water demands could both double with present production practices by the year 2050. Considering water scarcity constraints, it's vitally important to consider what are realistic levels of food production and the desirable levels and composition of food consumption. Depending on how food is produced, and assumptions on population and diet, future water requirements to meet food demand by 2050 have been estimated at between 10,000 to 13,500 km³/year (de Fraiture et al., 2007; Lundqvist et al., 2007).

The increase in water needed to meet the demand for food is a major concern given the growing water scarcity and related environmental problems in many parts of the world. Already 1.4 billion people live in places where water is physically scarce (CA, 2007). Another 1.5 billion people live in places where water is available in nature but infrastructure to access it is lacking.

It's probable that if today's food production and consumption and environmental trends continue, crises will occur in many parts of the world (CA, 2007). The challenges become even greater when we include newly emerging issues such as climate change and its implications for water variability and scarcity, and the demand for agricultural produce for bioenergy and industry.

Improvements of water productivity and agricultural productivity in general, are therefore urgent and necessary. Similarly, reductions of losses and wastage in the food chain could significantly contribute to ensure a reasonable diet for a growing population over the next 50 years. It is not possible to tell how much more food can be produced from our land and water resources, but the cost and effort has to enhance production will have to be inceased. As discussed under 2.4, below, land and water will be demanded also for other purposes than food.

[4] Each year, on average about 110,000 km³ of rain falls on the earth's surface. A large part of this infiltrates and forms the green water resource (see Box 4) and another part results in about 40,000 km³ of streamflow, which is a major part of the blue water resource. Geographic and temporal variation is considerable. The fraction of streamflow that can be withdrawn depends on a number of circumstances and development objectives. Currently some 4,500 km³ are withdrawn with about 2,700 km³ for irrigation systems. This can be compared with an estimated 7,000 km³ or slightly more that are evapotranspired in the process of total food production, i.e. from irrigated and rainfed land.

2. A New Type of Water Scarcity

2.1 Climate Change Amplifies Water Scarcity

Climate change will radically change conditions for cultivation. In the context of rising populations and fast-growing economies, these changes need to be considered in the quest for food and water security.

Agricultural production will be significantly affected by a combination of changes in the pattern of rainfall and higher temperatures (IPCC, 2007). Even small temperature increases (1–2°C), will reduce potential yields and overall food production in the tropics and sub-tropics. IPCC scenarios suggest that climate change will affect 75–250 million people in Africa, where potential yields in rainfed systems in some areas may decline by up to 50 percent by 2020 (IPCC, 2007). Agriculture in countries in Central, South and South East Asia, which are largely dependent on river water for irrigation will be hit by a projected drop in river levels (IPCC, 2007).

Scenarios do, however, vary in the literature and in official statements. For densely-populated areas in South Asia and southern Africa, Lobell et al. (2008), estimated that sizeable reductions in potential yields of major crops are likely. Effective mitigation or adaptation measures need to be implemented to counter the likely effects of climate change. For instance, if agricultural practices do not drastically change, potential reductions in maize production may be in the order of about a third by 2030. In areas that are already susceptible to food insecurity and where population will continue to grow, this is a drastic scenario. Dr Jacques Diouf, Director-General of FAO[5], has recently warned of a 5 percent decline in cereal production in many developing countries by 2020, and that some countries may lose a much higher percentage of their cereal harvest. According to Dr Diouf, 65 countries, representing about half of the world's population, will experience falls in cereal production. Among the most severely hit will be India, losing 18 percent of its current cereal harvest.

At the same time, yields are far below their potential in many areas of sub-Saharan Africa and South Asia. The figures just quoted should therefore not be interpreted as a prediction of a real reduction in yields. A major climate change adaptation measure is to harness this potential through improved integrated land and water management practices and to regain the momentum of support to agricultural research and activities. In this manner the predicted negative effects of climate change could be countered.

On the other hand, in temperate zones, a temperature increase of 1–3°C may improve conditions for agriculture (IPCC, 2007). Climate change is therefore likely to accentuate regional differences in preconditions for agricultural production and food security.

Food security can be achieved through a combination of local and domestic production and imports in combination with a more efficient food chain management. Given the above scenarios, local and national food self-sufficiency will be increasingly difficult unless effective measures are implemented. The possibility to produce food for a growing population will be significantly curtailed. Rockström et al. (2008) have assessed how many countries will be able to produce food for their populations at 3,000 kcal/capita/day (20 percent animal and 80 percent plant food) by 2050. The assessment was based on a dynamic global vegetation and water model (Gerten et al. 2004) and the IPCC's A2 scenario[6] (IPCC, 2000). About

Photo: Mats Lannerstad

[5] Statement by Dr Jacques Diouf at a conference organised by the Swedish International Development Agency "Climate change, food security and poverty reduction. Ensuring food security by adapting to climate change" (http://www.fao.org/english/dg/2007/sida.htm).

[6] The underlying theme of the A2 storyline is self-reliance, a continuously increasing global population and relatively slow per capita economic growth (IPCC, 2000).

one-third of the projected population of 10.5 billion will be living in water-abundant countries where such production levels would be possible. But most will be in countries suffering various degrees of water constraint. More than half the population could be in countries with severe water constraints (too dry and with difficulties of expanding irrigation). These water-constrained countries include China, India, Ethiopia, Egypt, Iran, Jordan and Pakistan (Rockström et al., 2008). We therefore need to consider realistic levels of future food supply with regard to production constraints, on the one hand, and consumption requirements, on the other.

2.2 Variability in Water More Pronounced

Climate change will increase risk and unpredictability for the farmer. Extreme events will occur more often and high temperatures will speed up the flow of water back to the atmosphere, disrupting the water balance. But variability is nothing new to farmers. Throughout history, the monsoon in Asia has had devastating effects and the climate has dictated livelihoods in the tropics and sub-tropics. Box 1 gives an account of serious water scarcity in two districts of Tamil Nadu, southern India that resulted in famine, sickness and death 17 times over 100 years from 1804.

Box 1. In the Farmer's Field, There is No Such Thing As an Average

At the global, regional, and local level, water availability and rain is usually given as an average value. However, the average isn't usually the real water availability that the farmer has to deal with. In tropical monsoon climates, in particular, the average often conceals considerable annual or seasonal variations; an example being agriculture in Coimbatore and Erode Districts, in Tamil Nadu, southern India. The area relies mainly on the unpredictable and erratic northeastern monsoon of October–December, characterised by cyclones, and short and heavy downpours. In historical records the area is described as "of exceptional dryness" where the marked variation in rainfall resulted in a situation where "not less than two-thirds of the seasons" were "unfavourable" (Madras Presidency, 1902).

During the years 1804–05, 1806, 1808, 1812, 1813, 1823, 1831, 1832, 1834, 1836, 1861, 1866, 1876–78, 1891–92, 1892–93, 1894–95, 1904–05 and 1905–06 the area experienced serious water scarcity and these years were described as times of "scarcity, desolation and disease" or "famine, sickness and death". In 1808 failure of both monsoons caused a famine "that carried off half the population", while the "The Great Famine" in 1876–78 is described as "more disastrous in effect than any of its predecessors" (Madras Presidency, 1902; Balinga, 1966 p. 17). Famines continued to occur during the first half of the 20th century.

Immediately after independence in 1947 the new National Government sanctioned the construction of the Lower Bhavani Reservoir (capacity 900 Mm^3) across the Bhavani River. The river is the only reliable, perennial surface water resource in the area and the dam is supposed to even out variation in flow and hold sufficient water for one year. But as shown in Figure 4, the river flow and thus the inflow to the reservoir vary greatly. Over time, there is a tendency of reduction in average flow/inflow. Despite the reservoir, a large part of the farmers in the Lower Bhavani Project Command Area (84,000 ha) do therefore not receive the amounts of irrigation water they were supposed to get. In fact, they regularly receive less water than they had planned (or hoped) for. Over the last 90 years (before and after dam construction), the flow at the reservoir site shows that there is no such a thing as an average in terms of river flow for an individual year. Even during years with the same annual flow, monthly and daily variations can result in peak inflows that overflow the reservoir, with less water available to distribute over the cropping year than the average would seem to imply.

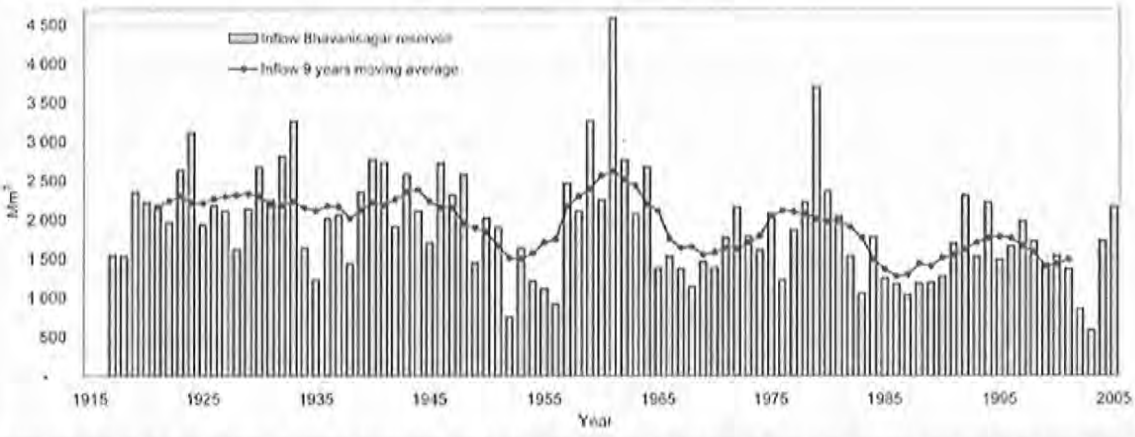

Figure 4. Flow at the site of Lower Bhavani Reservoir, Tamil Nadu, India (1917–2005). Sources: pers. comm. Executive Engineer, PWD (Public Works Department), Bhavanisagar, Tamil Nadu, India, 2004-2006; Government of Madras (1965).

Photo: Getty Images

2.3 Water Scarcity: Competition and Environmental Concerns

Present production patterns are unsustainable in many places: for instance, they involve overexploitation of groundwater, and appropriation of stream flow resulting in widespread river depletion and damage to aquatic ecosystems, fisheries and biodiversity (CA, 2007, Postel, 1999). About 1.4 billion people live in closed basins, that is, where all water flow (for an average year) is already committed and where environmental flow is not considered. In addition, pollution from agricultural chemicals and hormones, water logging and salinisation pose threats both to the environment and to crop production.

Reduction in water bodies and changes in water flow affect aquatic ecosystems in several ways (Smakhtin et al., 2004; Smakhtin and Anputhas, 2006; Falkenmark et al., 2007; Molle et al., 2007). River depletion and changes in hydrologic regimes by dam building disrupt downstream aquatic ecosystems. Groundwater over-exploitation damages groundwater-dependent ecosystems. Overuse or unwise use of nutrients and agricultural chemicals affect both aquatic and terrestrial ecosystems due to polluted return flow from crop lands. Drainage of wetlands for agricultural use leads to loss of habitat and affects ecosystem characteristics such as fisheries, flood retention and groundwater recharge. Changes in these characteristics can have severe consequences for the poor who depend on ecosystems for their livelihoods.

Growing demand for water increases competition and/or the cost to supply water. With rapid urbanisation, the agricultural sector will increasingly compete for water with the urban sector. Substantial trans-basin diversion schemes have been planned or are being constructed (e.g. Three Gorges in China, or the Linking Rivers project in India). Competition for water from the urban sector means increasing water stress for farmers and the rural sector since economic, social and political arguments for increasing supply to urban areas will be hard to counter. At the same time, urban expansion intensifies demand for food and other agricultural produce. Growing numbers of urban dwellers enjoy increased disposable incomes, part of which will be spent on food and other agricultural produce. The demand for agricultural products will not only accelerate but will also be more varied. Apart from food, the urban sector demands raw materials for industry, commercial products and bioenergy. All of these demands present the receptive farmer with new opportunities. Some of these new products fetch a higher price than staple food crops, so these new opportunities may stimulate investments in rural areas, including investments in the water sector. Even if these efforts and investments will improve performance in the agricultural sector, food production will have to compete with other agricultural products. Improved food security for a growing world population will remain a tremendous challenge.

2.4 Land and Water for Bioenergy and other Non-food Produce

Although we think of food as the most important agricultural product, there is a marked increase in demand for other products, which will compete for land and water resources, investments, manpower, etc. (Rosegrant et al. 2008). With the price of oil currently (mid 2008) close to the 140 dollar per barrel level, the "peak oil" discussion, and geopolitical and climate change concerns attached to a reliance on fossil fuels, an increased demand for bioenergy is expected (Berndes 2002). For farmers, a more diversified and increasing demand is an opportunity after of a long period of falling prices paid for staple food items.

Biomass is an important source of energy in developing countries, mainly combustion of wood and agricultural residues, with severe negative impacts. The combustion in confined spaces leads to indoor air pollution to which women

and children are primarily exposed with severe health consequences, including respiratory illnesses and premature death (WHO 2002). There is a strong motive to substantially improve and increase the supply of energy services in developing countries (Takada and Porcaro 2005, UNDP 2005).

One of the consequences of an expansion of bioenergy is a significant increase in the pressure on land and water resources (see Box 2). During the coming decades, the water requirements for bioenergy may add substantially to the total water requirements. Latin America and sub-Saharan Africa are among the regions commonly suggested to become major biofuel suppliers on a prospective global biofuel market. It is well motivated to investigate the consequences of large biofuel production levels in these regions (Figure 5).

Box 2. Bioenergy, Food and Water Pressure

The present global energy system is dominated by the use of fossil fuels with environmental effects such as eutrophication, acidification and climate change. Around the world, food production also relies to various degrees on fossil fuels and petroleum-based chemicals, including synthetic fertilisers.

Concerns about human-induced climate change and oil/gas import dependency drive the search for radical changes in the global energy system. There are compelling arguments for keeping atmospheric CO_2 concentrations below 400 ppm. Assuming a global population of 10 billion people in 2100, average global emissions would need to drop to about 0.2 tonnes of carbon per capita per year. This is below the prevailing level in India today. At the same time, global energy consumption is expected to more than double during the 21st century.

Possible future energy sources include solar and wind energy, bioenergy, nuclear fission and fusion, and fossil fuels with carbon capture and sequestration. Bioenergy ranks as one of the few technological options capable of tackling climate change today. However, it is not the panacea for solving future energy systems.

Biofuels for transport (mainly ethanol and biodiesel) at present use traditional starch, sugar and oil crops. Second generation biofuels (e.g. Fischer Tropsch fuels, dimethyl ether and lignocellulose-based ethanol) will become increasingly competitive when more abundant and cheaper lignocellulosic feedstocks can be used..

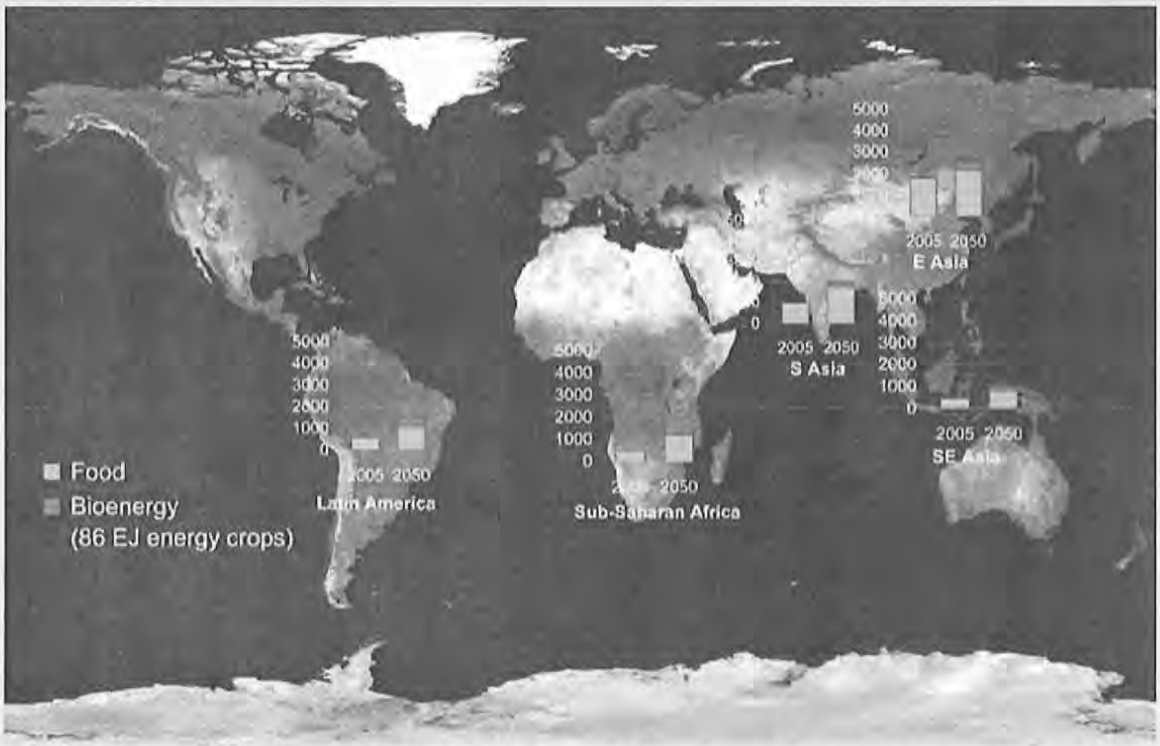

Figure 5. Estimated water requirements for food today and hypothetical water requirements for food and bioenergy around year 2050. The vertical axis is crop evapotranspiration in km^3/year. It is assumed that lignocellulosic crops will mainly be used for bioenergy with an average water use efficiency (WUE) of 2.5 kg biomass per m^3 of evapotranspiration. This is a high average WUE compared to that presently achieved for agricultural crops. However, calculations are based on a possible situation almost 50 years ahead, when WUE will likely be higher than today as a result of plant breeding and improved agronomic practices. See Lundqvist et al. (2007) for further information.

Photo: Getty Images

It is relevant to note that although bioenergy may become a major component in the future pressure on land and water resources there are other important drivers as well. As discussed above, the demand for animal based food products is significantly adding to overall water pressure. Concerning the bioenergy sector, there are considerable uncertainties about its role in the future. The biomass use for energy[7] assumed in Figure 5 is not very high compared to the supply potentials reported in various resource assessments focusing on land rather than water as the constraining factor.

An important question is also where the production of biomass for energy purposes can and will expand. Depending on the type of feedstock, it is possible to cultivate biomass for energy purposes in areas where conventional food production is not feasible, for instance, due to water constraints. Such a strategy is, for example, being attempted in parts of India where about 13 million hectares of wasteland are being earmarked for cultivation of feedstocks that can grow in areas with a low rainfall, e.g. Jatropha and sweat sorghum (Wani, pers. Com. 2008). Another important option is efforts to promote multi-functional production and social systems. In Brazil, for instance, efforts are made to combine crops for bioenergy, sugarcane, and other agricultural produce, e.g. milk production through arrangements for small farmers (Sparovek et al., 2007). For farmers and rural communities, an enhanced demand for their produce provides an opportunity and could stimulate investments in rural development. Tenure, access to credits and markets to cater for social development objectives will be very important.

Social and environmental challenges and opportunities must be continuously identified and evaluated. For example, analysing the water implications of increased production of biofuels for transport for selected countries/regions (de Fraiture et al., 2008) found that globally, irrigation is not likely to be a major water source for biofuel production (at the assumed production levels, which varied among regions and globally reached 7.5 percent of transport fuel use by 2030). But locally, it could cause severe water stress. Using irrigation for biofuel production would add significantly to the water stress in contexts where water availability is constrained but where food cultivation is possible.

Other non-food crops (such as cotton) occupy only 3 percent of the cropped area, and 9 percent of the irrigated area (Molden et al. 2007 a). Even if the importance of cotton and other non-food crops were to increase in the future, which might be good for the farmer, in terms of resource pressure these crops are comparatively much less significant than food, feed and biomass for energy purposes.

[7] About 86 EJ per year (EJ, or exajoule, is equal to 10^{18} joules), which can be compared to the 390 EJ (60 GJ/capita) of fossil fuels that were commercially traded globally in 2005 (BP 2007).. Projections about energy demand in the future vary substantially: for 2050 ranging from about 800 EJ to 2,000 EJ. Modelling studies of long range energy system development commonly see biomass use for energy reaching several hundred EJ per year (BP 2007. Statistical review of world energy 2007. (http://www.bp.com/statisticalreview)

Photo: Frida Lanshammar

2.5 Under Nourishment and Over Eating: Changing Perspectives on Food Security

Discussions about food security refer either to the amount of food supply, usually at national level, or the nutritional requirements. The common denominator is the objective to minimise the risk of under nourishment. According to the 1996 Rome Declaration: "Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life." (FAO, 1996). Naturally, the food requirements vary depending age, physical activity etc. The most commonly used international norm for food security refers to a food supply where the energy requirements of the national populations are supposed to be met. In addition to the energy requirements, a proper diet must contain essential proteins and micro-nutrients. Figures about dietary energy requirements vary in literature, but a common reference is to a national average food supply of 2,700 kcal/capita/day. Slightly higher figures have also been used, 2,800 (CA, 2007) and 3,000 (Bruinsma, 2003).

An analysis of food supply data[8] and the incidence of under nourishment in the world reveal a direct and linear reduction in the number of under nourished people with increased food supply. The risk that some of the population may be under nourished is very low if food supply is approaching 3,000 kcal/capita/day (SEI, 2005); this comparatively high level of food supply corresponds to projections in FAO reports (Bruinsma, 2003).

While the risk of under nourishment is reduced with increasing supply of food – provided that access is ensured – the risk for over eating and wastage is likely to increase when food becomes more abundant in society. With the very high levels of food wastage in society and the large number of people who are suffering from being overweight or obese, it is time to pay attention to not only under nourishment but also overeating and wastage. It is important to differentiate between figures that refer to food supply and figures that refer to intake or consumption of food. Generally, the amount of food produced must be higher than the amount of food supplied, which in turn must be higher than food consumed. From a nutritional point of view, the energy intake should be about 1,900–2,200 kcal/capita/day (FAO, 1996; Schäfer-Elinder, 2005; Smil, 2000; MSSRF, 2002). A sound diet must, of course, also contain other nutritional components. If energy intake is lower, the risk of under nourishment increases[9] and if it is higher, the risk of overweight and obesity increases. Consequently, level of food supply and composition of diets have direct consequences for water pressure and the environment as well as for public

[8] The most comprehensive database for such calculations is FAO's Food Balance Sheets (see note 3), which provide information for individual countries on production, net exports or imports and non-food use of food. Quality of data depends on reports from the individual country. These sets of data can be used to estimate the supply of food on a country basis. They do not, however, show how much food is lost, wasted or eaten.

[9] For the poor and under nourished, the need of increased access to and intake of food up to a certain basic level is an overriding issue. Attempts have been made to estimate what is the Minimum Dietary Energy Requirement. According to FAO, for instance, these estimates vary from 1,730 to about 2000 kcal/capita/day for various countries (http://www.fao.org/es/ess/faostat/foodsecurity/Files/MinimumDietaryEnergyRequirement_en.xls). In MSSRF (2002) it is mentioned that an average food intake that is 70% of the international norm for food security, i.e. 0.7 x 2700 = 1890 kcal/capita, day may be acceptable. What is generally acceptable must be related to nutritional and medical criteria. It is also related to the age and occupational structure of the population, among other things. Smil (2000) provides examples showing that food intake at levels below 2000 kcal/capita/day have not resulted in documented signs of under nourishment.

health. It is therefore very important to look at the critical link between production and supply and the actual food intake (please see chapter 3).

Food supply refers to the amount of food available on the market, and also to food supplied through other channels, including schools, hospitals and other public distribution systems. Socioeconomic factors mean that access can vary significantly between groups of people, also within a household. Even if there is sufficient food available in society, for many people access is restricted mainly because of poverty and conflicts in society. In countries or regions where lack of water or other factors prevent food production, access can be secured through imports, i.e. if the means and conditions make imports possible. Poverty implies that purchasing and bargaining power is limited.

An estimated 830–850 million people in the world are under nourished (FAO, 2006) primarily because members of the household do not have the means to buy food or are unable to grow the food they need. There is a striking correlation between areas with a high proportion of under nourished people and a high proportion of the population who are extremely poor, indicating that poverty means that people do not have the means to produce for themselves nor can they afford to purchase the food they need (Lundqvist 2008). Similarly, there is a correlation between areas with a dry climate and water scarcity and the level of under nourishment (Falkenmark and Rockström, 2004).

Surprisingly, food insecurity is most prevalent among rural populations (von Braun, 2007), that is, in areas where food is, or could be, produced. A relatively large percentage of the food producers are net buyers of food. Recent increases in the price of food as well as inputs that are necessary for food production will therefore hit a wide spectrum of people. Even with a public distribution system in place and food available in stores, there may be people who are food insecure. This is the case in India where food grains have accumulated in the godowns of the Food Corporation of India. In the Public Distribution System, there is currently a problem managing a food surplus rather than a shortage, while at the same time there are large numbers of under nourished people (Gaikwad et al., 2004).

At the other end of the spectrum, the number of overweight and obese people is an increasing problem, not only in developed countries but also in developing countries. The reasons for overweight and obesity are complex. A high intake of energy dense foods is, however, one of the factors. Globally, there are roughly 50 percent more people who are overweight and obese (1.2 billion) than there are malnourished (860 million). Over eating together with wastage of food contribute to natural resource depletion and has environmental implications, for instance, in terms of green house gas emissions. As discussed in sections 3.2 to 3.5 below, it is important to recognise that all food that is produced, whether it is consumed, wasted or not, has consumed water and contributed to pressure on other natural resources. Overeating leads to poor health and increased costs to individuals, family and society. Food security is thus not only a matter of food production or food supply.

Discussions about food security must rightly focus on access to food. It is relevant to address the problems related to the proportion of the food from cereals and other plant based foods and food derived from animals. While livestock products and fish are important in a nutritious diet, in many countries the consumption of livestock products, sugar and oil is significantly higher than what is required for human health. In other countries, this part of the diet is quite low (McMichael et al., 2007; cf. Figure 2 above). Apart from the high consumptive use of water for livestock products, they also contribute significantly to the generation of greenhouse gas emissions (Steinfeld et al., 2007; McMichael et al., 2007).

Emerging challenges related to sustainable resource management and changing perspectives on food security mean that a narrow focus on production and food supply is no longer valid. A broader view incorporating the full chain from food production to consumption is warranted.

Photo: Iker, SXC

3. Taking a Food Chain Perspective: From Field to Fork

The emerging challenges facing the food sector include growing water scarcity, unacceptably high levels of under nourishment, and at the same time the proliferation of people who are overweight or obese and of food that is lost or wasted in society. All these challenges mean that a narrow perspective on food security in terms of production and supply is no longer sufficient. It's time to take a broader perspective incorporating the steps from growing crops in the field to consuming a meal at home, that is, a field to fork perspective.

3.1 Stages and Actors in the Food Chain

There are many stages and actors in the chain from producing crops in the field to consuming a meal at home or in a restaurant (Figure 6).

At the beginning of the chain are the farmers producing the crops. Crop production takes place under many different climatic and socioeconomic regimes, so the efficiency of water use (irrigation and rainwater) varies enormously. At the next stage the crops are harvested, where a range of harvesting techniques are used, from manual to highly mechanised. In rural areas of poor countries, typically households themselves process food for immediate or later consumption. But generally, the links between production and consumption have become quite complex with many actors and interests involved. A significant stage in the food chain dynamics consists of converting vegetal feed items into livestock products. The production of animal-based produce, such as meat and milk, requires different amounts of water depending on the particular animal and the feeding strategy. Different animal species have different conversion rates. Producing 1 kg of beef meat requires roughly 8 kgs of feed, while 1 kg of chicken meat requires only a couple of kgs of feed. As a global average, about 40 percent of total global cereal production is fed to animals to produce meat, milk, cheese and other foods derived from animals. Converting vegetal to animal foods means a substantial 'loss' of energy.

Storage is necessary to balance supply and demand over time and to withstand the climate and other factors, such as pests and trade limitations, which can influence food availability in a country or region. A characteristic feature of economic development and urbanisation is that, increasingly, food is not consumed in same place as it is produced. A decreasing fraction of the world's population is involved in the primary food production, i.e. at farm level (SIWI et al. 2005). In developing countries, food is typically transported over relatively short distances. With globalisation and with decreasing transport costs, food is increasingly transported around the world, involving different transport companies using different modes of transport. Another trend is the development of food industries,

6a	Food Production		Processing and Distibution		Food Supply	Consumption Unit
Activities	Crop cultivation	Harvest	Vegetal foods Feed animal foods	Storage, transport, processing, packing Storage, transport, processing, packing	Access: Food exposure, Food purchase; Food outlets and super- markets	Storage, Cooking, Consumption, Throwing food away
Tpe of Loss	Water losses	Crop Losses	Conversion losses	Distribution losses and spoilage during storage and processing	Spoilage and Wastage	Wastage, Overeating

6b	Food Production		Processing and Distibution		Food Supply	Consumption Unit
Key Issue for Policy	Water and land manage- ment practices	Technical and management issues	Choice of production of animal foods or vegetarian foods	Technical infrastructure	Business marketing, Food regulation, Consumer behaviour	Individual and collective consumer behaviour

Figure 6. Schematical overview of losses and wastage in the main stages of the food chain (6a), and factors contributing to these losses and wastage (6b).

Photo: Stephanie Blenckner, SIWI

meaning that food often goes through several processing steps in different factories before being marketed. Supermarkets play an increasing role in this regard. In this new context, the difficulties of the small producer to get access to market channels tend to increase (Reardon et al. 2003; Dugger, 2004).

Rising incomes, urbanisation and the felt need for convenience in food preparation and the quest for variety, have promoted the role of food-processing industries, and increased the importance of packaging. With an increasing distance from sites of production to where food is marketed, it becomes rational to prolong the life span of perishable products and ensure that the quality and appearance of food items will correspond that what consumers have come to expect. Once food is processed and packaged, it is marketed in local shops and supermarkets. Big supermarkets offer the consumer a wide range of foods, but not all perishable products can be sold before their expiry date. With consumers increasingly concerned about food safety and demanding high quality fresh produce, this inevitably leads to food being thrown away even before it's sold and often while it is still perfectly fit for eating. This is a bigger problem in developed than in developing countries. However, with improved living standards and changes in attitudes, habits and living conditions, and with more food outlets like supermarkets, the problem is increasing in developing countries, too.

The final stage in the food chain is a combination of consumption at home, in restaurants and in institutions (such as schools, offices and hospitals) and a discard of part of the food in terms of through aways.

Because more and more of the world's population are moving out of agriculture and into urban centers, the food chain is becoming longer and more complex. The increasing complexity in distribution and supply systems and the increasing geographical distances between production and consumption are natural and driven by consumers' expectations of variety and convenience. At the same time, the increasing demand for animal products, fruits, vegetables and other sensitive and perishable food items, leads to an increased risk of loss, in both quality and quantity. For many food items that are in increasingly high demand, it may be a matter of days before quality declines and they become less attractive. Apart from being less attractive, other concerns, such as public health, environmental and ethical issues, are becoming increasingly important in the food chain. Stricter rules and labelling of food in combination with consumers' increasingly exacting standards mean that part of the food supply will remain unsold or be withdrawn (Box 3).

Production by farmers will, of course, continue to be a vital precondition for food supply to meet increasing demand, but due to resource constraints and the demand for land and water for other types of agricultural products, it is essential that the field to fork chain is as efficient as possible.

For a proper analysis of food security, the complexity of the food chain may be reduced to four important levels:

- the amount of food produced, that is, at the field level
- the amount of food available on the market, that is, the produce "at the field level" minus losses before the food reaches the shop or supermarket, losses during conversion from vegetal to animal foods, plus/minus changes in stocks, that is, the food supply
- the amount demanded or bought by households, public institutions and other buyers
- the actual intake of food, that is, the amount of food eaten.

The first level refers to the amount of food in terms of edible crops. Since about 40 percent of the crops are used for feed, and some are lost through poor harvesting technologies, transport and storage deficiencies, the supply of food to the market is much less than the food at the field level, but it is typically more varied than the produce at the field level. Because of wastage in the retail chain, and in restaurants and households, the amount of food that people actually eat is much less than that produced.

Many food demand projections and major food databases such as FAOSTAT does not distinguish between these four phases. Consumption or "national average apparent food consumption" are often-used concepts when, in fact, food supply would be the appropriate term. The figures used are usually derived from Food Balance Sheets and refer to food supply rather than actual food intake (e.g. in Bruinsma, 2003). Yet, because of the losses along the food chain, quantities coming from the field are very different from quantities supplied, which, in turn, are different from the amount of food actually consumed.

3.2 Losses, Spoilage, Conversions and Wastage

Reductions in the amount of food between the field to the fork are of quite different kinds. In the literature, various concepts are used for these kinds of reductions.

Losses generally refer both to quantitative and qualitative reductions in the amount of and the value of the food. At the field level, part of the crop is lost due to rodents, pest and diseases. Similarly, a part of the produce is lost during transport and storage due to the same type of problems. Poor water and land management will increase the risk for water losses. The lack of effective harvesting, transport and storage technologies will augment the losses at the farm level and during latter stages in the food chain.

In this report, we have also argued that part of the rain water resource that is potentially available for food production is lost in terms of unproductive evaporation.

Spoilage is another term used to highlight problems with the harvested crops and other food items during transport, storage, processing and packaging.

Conversion refers to the use of cereals and other plant based products as feed to produce animal foods.

Wastage generally refers to the deliberate discarding and through away of food that is "fit for purpose and perfectly good to eat" (Knight & Davis, 2007). This occurs in the latter part of the food chain, in food companies, wholesaling, retailing and households.

Generally, a hot and humid climate will increase the risk for these types of losses. Vulnerability of food increases with the trend towards high-value food items and greater transport distances.

Figure 7 depicts a gross estimate of the global picture of losses, conversion and wastage at different stages of the food chain. As a global average, farmers produced the equivalent of 4,600 kcal/capita/day in the late 1990s (Smil, 2000), i.e. before conversion of food to feed. Counting down the losses,

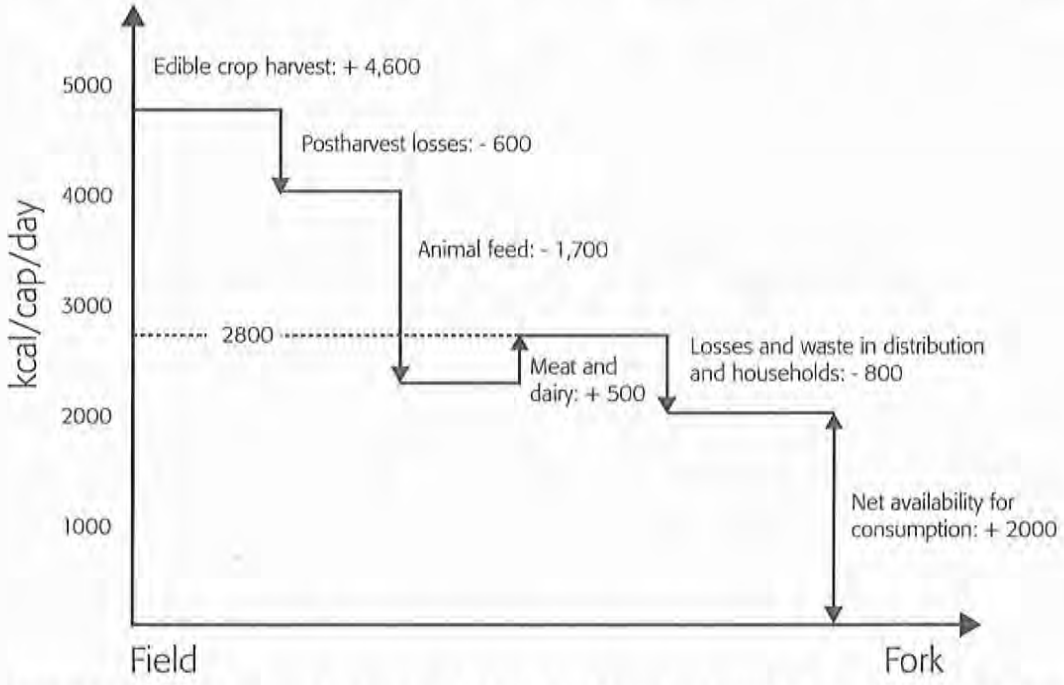

Figure 7. Energy losses, conversions and wastage in the food chain. Source: Smil (2000). Illustration: Britt-Louise Andersson, SIWI.

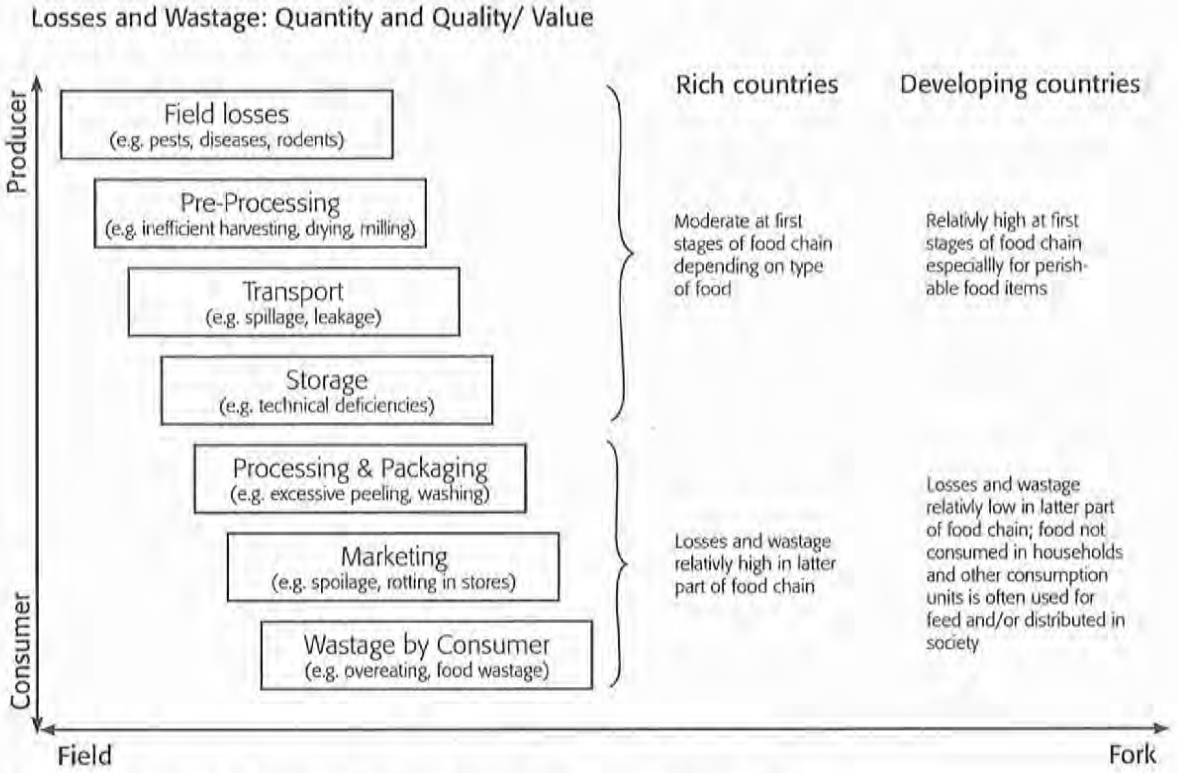

Figure 8. Main types of food losses and wastage. Illustration: Britt-Louise Andersson, SIWI.

conversions and wastage at the various stages, roughly 2,800 kcal is available for supply (mixture of animal and vegetal foods) and, at the end of the chain, 2,000 kcal on average is available for consumption.

The orders of magnitude of losses, wastage and spoilage differ by location and stage of the food-chain. Very broadly speaking, in developing countries most losses occur at the beginning of the food chain: in the field due to poor harvesting technologies, and as a result of poor storage and transport facilities. In hot and humid regions especially, losses of food, including a deterioration in quality, are most pronounced during the first part of the food chain.

In developed countries, harvesting, transport and processing are often comparatively efficient, but with significant variations between different crops. However, towards the end of the food chain significant amounts of food are wasted in wholesaling, retailing and among consumers – who tend to throw away a significant fraction of the food they have paid for and taken home. As incomes in middle-income and less developed countries continue to rise, and the distance from the site of production to places where food is prepared and eaten increase, the energy losses associated with converting grains into livestock products will become more important as diets shift from vegetal to animal foods.

According to Kader (2005) losses in the field (between planting and harvest) could be as high as 20–40 percent of the potential harvest in developing countries due to pests and pathogens (Figure 8). Losses in processing, transport and storage are conservatively estimated at 10–15 percent in quantity terms, but could amount to 25–50 percent of the total economic value because of reduced quality (Kader, 2005). Lastly, substantial losses and wastage occur during retail and consumption, due to discarding excess perishable products, product deterioration and food not consumed.

3.3 Significant Losses and Spoilage in Less Developing Countries

Many factors contribute to substantial losses and wastage of food. In many of the less developed countries, the adverse climate, with high humidity and high temperatures, and attacks from rodents, insects, mold and other agents constitute a significant problem. Many poor farmers have to rely on inefficient harvesting, transport and storage facilities, with substantial losses. Swaminathan (2006) mentions that the post-harvest infrastructure is weak in large parts of India "... even now, paddy is spread on the roads drying in many places. The spoilage can be as high as 30 percent in the case of vegetables and fruits". Losses for grains and oil seeds are lower, about 10–12 percent, according to the Food Corporation of India. Some 23 million tonnes of food grains, 12 of fruits and 21 of vegetables are lost each year, with a total estimated value

Photo: Mats Lannerstad

of 240 billion Rupees. A recent estimate by the Ministry of Food Processing is that agricultural produce worth 580 billion Rupees is wasted in India each year (Rediff News, 2007).

Inferior and inefficient technologies do, of course, present difficulties when planning the supply chain. The challenge is greatly compounded by poverty, both at the level of the small producer as well as the consumer. In India, the Public Distribution System has been organised to ensure food supply to the needy outside ordinary market channels. Recent reports show that food grains have been accumulating in the godowns of the Food Corporation of India, far beyond the prescribed buffer stocks, with the result that a considerable proportion is lost.

Available figures from Africa reveal similar problems and relative losses. In many countries the post-harvest losses of food grains are estimated at 25 percent of the total crop harvested. For some crops such as fruits, vegetables and root crops, being less hardy than grains, post-harvest losses can reach 50 percent (Voices Newsletter, 2006). Economic losses in the dairy sector in East Africa and the Near East due to spoilage and waste could average as much as USD 90 million per year (FAO, 2004). In Kenya, each year around 95 million liters of milk, worth around USD 22.4 million are lost. Cumulative losses in Tanzania amount to about 59.5 million liters of milk each year, over 16 percent of total dairy production during the dry season and 25 percent in the wet season. In Uganda, approximately 27 percent of all milk produced is lost, equivalent to USD 23 million per year (FAO, 2004). In Ghana post-harvest losses can account for 35 percent of total agricultural output (Ghana Business News, 2003).

Without proper storage and transport facilities, perishable food items are particularly vulnerable in hot and humid climates. The high losses in developing countries are mainly due to a lack of technology and infrastructure as well as other intrinsic and extrinsic factors such as high insect infestations, unwanted microbial growth, injuries and blemishes due to improper handling or transportation and prevailing high temperatures and humidity during growth and harvesting (Buys and Nortje, 1997).

3.4 High Rates of Losses and Wastage in Developed Societies

Food losses in rich countries are different to those in the developing parts of the world. Generally, the kinds of losses in developed countries are referred to as wastage, i.e. food is discarded even if it's "perfectly good to eat."

But there are also significant losses in the first segments of the food chain in the rich countries depending upon what food is being produced. For instance, quite significant volumes of food are lost and wasted in the US. According to Jones (2004), losses at the farm level are probably about 15–35 percent, depending on the industry. For the fresh vegetable industry, losses are naturally higher at 20–25 percent. For fruits like apples and citrus losses vary around 10–40 percent. The retail industry has comparatively high rates of loss at about 26 percent, while supermarkets, surprisingly, only lose about 1 percent. "Overall losses amount to somewhere around USD 90 to USD 100 billion a year" (Jones, 2004) and "...households alone, in the US alone, throw away USD 48.3 billion worth of

food each year" (Jones, 2006). According to a recent article in New York Times, an average family of four persons in the US, throw away 112 pounds of food per month (Martin, 2008).

Losses and wastage vary, depending on type of food, among other things. Kantor et al. (1997) estimated the US total retail, foodservice, and consumer food losses in 1995 to be 23 percent for fruits and 25 percent for vegetables. Fresh fruits and vegetables accounted for nearly 20 percent of consumer and foodservice losses, from product deterioration, excess perishable products that are discarded, and food not consumed by the purchaser (Kader, 2005). In the US, losses of fresh fruits and vegetables are estimated at 2–23 percent, depending on the commodity, with an overall average loss of about 12 percent between production and consumption sites (Kader, 2005). According to a guide presented by the Environmental Protection Agency in cooperation with Department of Agriculture, "... more than a quarter of all food produced for human consumption in America is currently discarded" (USDA and US-EPA, n.d).

Similar levels of food losses and wastage are reported from Europe. In the UK, for instance, Knight and Davis (2007) estimate that "...about 5 million tonnes of food goes into household waste". Other UK studies estimated "...total consumer and industrial food waste reaching 17 million tonnes [annually]". A part of this, or about 4 million tonnes, is still "fit for purpose and perfectly good to eat". An assessment made in 1997 of the monetary value, or annual cost of food wasted by supermarkets and catering outlets in the UK was GBP 386 million (Knight and Davis, 2007 p.4). Findings in a recently launched detailed study in the UK confirm the magnitude of the wastage and provide a number of details. For instance, one third of the food bought is thrown away. An amazingly high percentage of the food thrown away is untouched and often in its original packaging. The value of this part of the discarded food is about GBP 2.3 billion, which can be compared with the value of the food waste in UK as a whole, GBP 10.2 billion, or GBP 420 for an average household (WRAP, 2008).

Reports on food waste in Sweden suggest that families with small children throw away about 25 percent of the food they have bought and carried home and that total losses and wastage in the food chain are close to 50 percent (KSLA, 2007; Ennart, 2007). Figures are, however, uncertain. Other studies suggest lower wastage in households, whereas wastage in units for collective food consumption, such as schools and hospitals, is comparatively large (Naturvårdsverket, 2007).

The figures quoted here give an indication of the average annual losses and wastage of food. In addition to the generally high levels of losses and wastage, incidents involving huge losses or wastage regularly occur. Due to strict safety standards, animal food items are especially vulnerable. The recall in the US of about 65 million kg of raw and frozen beef products at the beginning of February 2008 (see Box 3) highlights several important characteristics of the food sector (Rano, 2008).

Box 3. Water Costs of Beef Recall

Earlier this year, the Hallmark/Wetland Meat Packing Company, California, voluntarily recalled approximately 143,383,823 pounds or about 65 million kgs, of raw and frozen beef products, following an investigation by USDA's Food Safety and Inspection Service (Rano 2008).

What reached the headlines were stories of the undercover investigation by the Humane Society of the United States, and the resulting footage of plant employees mistreating cattle. The video led to fears that the use of crippled cattle could increase the risk of human exposure to mad cow disease or pathogens such as E. coli.

The news has spurred fiery debate amongst industry and consumer safety groups, with the latter claiming that the incident supports growing consumer fears that the US government is not properly regulating meat safety.

The unreported side of the story is about the water wastage of this and similar incidents. As mentioned in chapter 1 of this report, the consumptive use of water to produce beef varies significantly between countries and production systems, but a conservative average is about 5 to 10 tonnes of water per kilo beef. To produce the 65 million kgs of beef, will thus require an estimated of 650 billion liters of water that is evaporated and transpired, mainly to grow the fodder for the animals. This is enough water to irrigate about 100,000 ha of dry land for a year, or supply more than enough for Las Vegas annual supply (the present demand is 870 liters per capita per day, BBC news, Vegas heading for 'dry future', July 29, 2005) which extracts about 350 billion liters from Lake Mead (from Wekpedia).

Photo: Jelmer Rozendal, SIC

Photo: Julio Silveira, SXC

Even with a recall of such magnitude, there were no reported shortages in society. This shows that a tremendous volume of food is available in rich countries. Since the recall was to ensure the safety of the meat supply, the example also shows that the fear of the transmission of mad cow disease or other pathogens harmful to human health, may significantly affect both supply and, as in this case, demand.

3.5 Implications and Dimensions of Losses and Wastage of Food

Losses and wastage are important in other respects than from a pure food security perspective. It is important to recognise that losses and wastage look quite different depending upon socio-economic and other conditions (Figure 9). For the farmer, shop owner and consumer, the economic implications are significant. For the producer, income is reduced, while for the consumer it means higher than necessary spending on food.

From a natural resources and environmental perspective, it's important to recognise that food production is resource intensive and has significant environmental consequences. Few people seem to be aware of the fact that agriculture is associated with a high proportion, about 22 percent, of all greenhouse gas emissions. This is at about the same level as industry but higher than the transport sector. Livestock production alone accounts for about 18 percent of total global greenhouse gas emissions (McMichael et al., 2007; Steinfeldt et al., 2007), so the beef recall was also a loss in terms of the added cost of greenhouse gas emissions (Box 3).

These figures refer to the environmental consequences of production. In addition, there are substantial environmental costs associated with subsequent stages of the food chain. Transport, storage, processing, packaging and improper disposal of discarded food must also be considered for a proper understanding of the total food bill. If discarded food is used for landfills rather than being properly disposed of, for instance, in composts or for biogas production, the organic content will generate gases, including methane, which is a very potent greenhouse gas (Knight and Davis, 2006; WRAP, 2008; Martin, 2008). Importantly, the public understanding of the magnitude and the consequences of the food waste is poor. According to studies done by wrap (2008), the very majority of people in the UK describe the amount of food they throw away as "some, a little, hardly any or none" as compared to the actual through aways that are equivalent to about a third of the food bought, most of which could have been eaten. The worth of this wasted food is more than 10 billion pounds retail value (about 14 billion USD). Similarly, the consumers do not recognise the green house gas emissions that are generated both in connection with growing, transport, processing and storage. Most of the food wasted by UK households, or close to 6 million tonnes, are used for landfill. The environmental impact of this disposal is high: every kilo or tonne of food generates the equivalent of about 4.5 times that amount of carbon dioxide. Altogether, it is estimated that some 18 million tonnes of CO_2 are generated in the UK from food that could have been eaten but that is thrown away (WRAP, 2008).

It's time we move beyond thinking how we meet quantities, and start looking at the type of foods we produce and how we benefit from them. As food consumers, we all play a role.

Figure 9. A schmatical presentation of the combination of losses and wastage in different contexts. Illustration: Britt-Louise Andersson, SIWI.

4. The Smart Approach to Water Saving

Photo: Dan Shirle, SXC

4.1 The Need to Act on a Broad Scale

Recent global price spiral on food and repeated reports about palpable social unrest in a large number of countries and fears of an 'agflation' (Economist, 2007) reveal the strategic and basic importance of the agricultural sector for social and economic stability and for environmental sustainability. Given its fundamental role in society, prime importance should be placed on taking all necessary steps to ensure sustainable use of water resources. Challenges now are different from a few decades ago. Climate change will make water availability more variable and scarce. Environmental concerns become increasingly more urgent and costly (The Economist of 15 March 2008 estimates that environmental damage in China may be as much as 10 percent of its GDP). The need for reducing pressure on water resources is real. On the other hand demand for biomass and agricultural products is increasing because of increased income and demand for a range of food as well as non-food products.

So far, the discussion on reducing water demand has centered on how to produce more food with less water, without questioning if the food produced can be used more efficiently. Expressed in kilocalories, global food production at the field level is about double that required to meet the "... dietary needs and food preferences for an active and healthy life of all people at all times" (FAO, 1996). A promising pathway to reduce the need for an increase in gross food production – and therefore water – is minimising losses and wastage along the food chain. Together with measures to produce food with less water, enormous amounts of water can be saved for other uses and the environment. Less waste in the food chain saves water, money and increases consumers' disposable incomes. It's time to take a broad perspective on water savings and to explore the scope for improvements along the entire food chain, from field to fork. We propose a two-pronged approach combining water savings in the field by producing more food with the same or even less water with measures to reduce losses and wastage of food produced in the various stages of the food chain, and thus ease pressure on water resources.

4.2 More Food with Less Water: Reducing Unproductive Losses of Rainwater

Large quantities of water are lost in the field. Roughly there are two ways of capturing this water. First, capturing a larger share of the rainfall and make it accessible for productive transpiration. This strategy might however impact negatively on downstream water users. Upstream runoff generation is only a loss to the upstream farmer, while it may be used beneficially by downstream ecosystems or water users. Second, changing the way water is used in crop production by maximising the benefits per unit of water consumed in rainfed and in irrigated agriculture (Molden et al 2007 b). For example, rapid rates of evaporation mean that a considerable fraction of rainfall is lost as return flow to atmosphere without being beneficially utilised. Several strategies to improve the water productivity, or "crop per drop", are available. Related to this option, it will be increasingly important to have a strategy for where food is best produced. Climate change and the associated escalated water scarcity will make agricultural production very difficult or very costly in large parts of the world whereas opportunities will be improved in areas blessed with a water abundance of dependable water availability.

It is, however, very important to increase food production also in areas where needs and demands may increase the most. For large parts of Africa, prevailing levels of production and productivity are low and quite uneven, indicating that there is a potential to increase production with the right incentives and supportive measures (Box 5). Trade can help mitigate

water scarcity if water-short countries can afford to import food from water-abundant countries. Cereal trade from rainfed areas in the temperate zones (USA, EU, Argentina) to arid areas (Middle East) reduces current global irrigation water demand by 11–13 percent. But political and economic factors are stronger drivers and barriers than water.

Generally, only 30 percent of rainfall that hits the ground is converted into productive transpiration, necessary for crop growth and food production. By shifting non-productive evaporation to productive transpiration through an integration of crop and soil management, more food can be produced with the same amount of rainfall (Falkenmark and Rockström, 2004). This is an important opportunity to improve agriculture through better utilisation of local rainfall. The crucial challenge is to reduce unproductive evaporation losses so that the impact on downstream water users is as small as possible (Box 4).

Box 4. Reducing Unproductive Losses of Rainwater

The renewable potential freshwater resource is equal to the total amount of precipitation over land. As precipitation reaches the ground, it is split into a number of flows (Figure 10). One fraction is aboveground and groundwater flows; these contribute to the blue water in lakes, rivers, reservoirs and the acquifer. Another fraction of the precipitation infiltrates the soil and is stored in the soil profile, forming the green water resource.

In all agricultural systems, some of the potential water resource is inevitably lost as non-productive evaporation. The fraction of rainfall available for productive transpiration is generally less than 30 percent, but varies between agroecological systems and climatic zones (Rockström, 2003). In arid regions with little rainfall, only some 10 percent of the total rainfall is consumed as productive transpiration, while most of the precious drops are lost as non-productive flows (Oweis and Hachum, 2001). In semi-arid parts of sub-Saharan Africa, this may be in the order of 15–30 percent. In temperate regions, productive transpiration is around 45–55 percent of rainfall (Rockström, 2003). An overriding challenge in sub-Saharan Africa and other areas suffering from water scarcity is to increase the fraction of rainwater available for productive transpiration.

Non-productive water losses can be minimised by mulching, weed and pest management, early plant vigor, optimal planting density and no-tillage systems. Crop choice can also influence plant water uptake capacity and thus water productivity.

It's important to recognise that cropping under pure rainfed systems is fairly risky and yields tend to be low. In many of these areas, conventional irrigation is not feasible, either because it is too costly or simply because water availability is a constraint. In these situations it can, however, be done with some kind of supplementary irrigation, such as from water harvesting systems, for instance a small hand-dug dam. Such systems have been successfully used in small-scale agricultural systems to bridge dry-spells. If local run-off is applied to the plants during dry periods, the risk of crop failure is substantially reduced. The aim of supplementary irrigation is not to meet the plant's full water demand, but to ensure that the plant gets enough water during critical growth stages. In combination with fertilisers, small amounts of additional water can lead to high yields and water productivity, particularly where yields are low (Rockström et al., 2007).

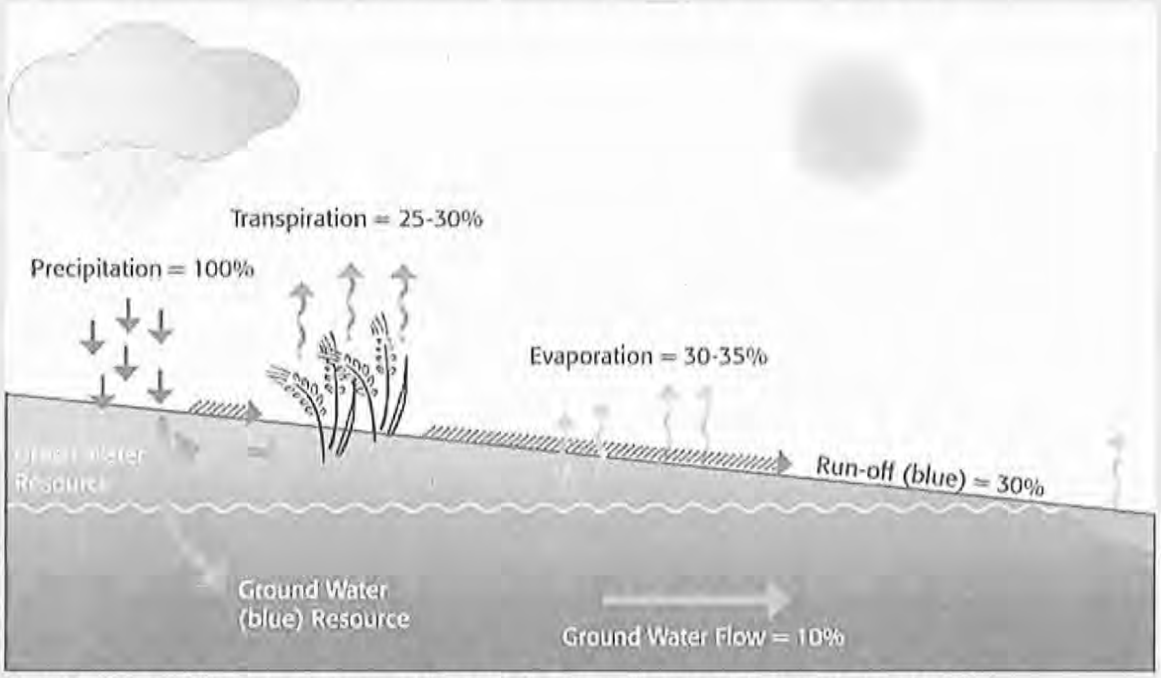

Figure 10. Green and blue water resources and flows in the landscape. Illustration: Britt-Louise Andersson, SIWI.

Photo: Diana Myrndorff, SXC

Box 5: The Need for a Green Revolution in Africa

The Green Revolution is a much misunderstood and maligned process of agricultural intensification. It has, for example, enabled India to feed its population which grew from some 450 million people in the 1960s to more than a billion today, and it has allowed a number of previously food-deficient Asian countries to become net exporters of food. Asian cereal production doubled between 1970 and 1995 while the total area under cereals only increased by 4 percent (Evensen and Gollin, 2003). Yield improvements are important. They have, for example, had a dramatic conservation effect in that they have limited agriculture's intrusion into marginal lands and hence preserved wildlife and biodiversity.

This has been partly due to new technologies – high-yielding crop varieties, inorganic fertiliser and irrigation – and the green revolution has commonly been seen as 'merely' a technology package. In reality it went far beyond technology. The Asian green revolution was a state-driven, market-mediated and smallholder-based strategy to increase national self-sufficiency in food grains. Supported by international crop research, governments took the lead but (unlike in China and North Korea) did not eliminate private traders. The technologies offered were suitable for smallholders and were backed by massive support systems including credit, subsidies, price policies, extension services and infrastructural investments, e.g. in schools, roads and canals (Djurfeldt et al., 2005).

Initially based on high-yielding, semi-dwarf varieties of rice and wheat, the Green Revolution is sometimes described as a one-shot-intervention. Since the 1960s, the Green Revolution has evolved to encompass a wide variety of staple crops (e.g. maize, beans, bananas, cassava) and the Consultative Group on International Agricultural Research (CGIAR) has released more than 8000 improved crop varieties during the last 40 years. Improvements are not limited to yield increases but also include characteristics such as drought tolerance, pest resistance, and fast maturation – innovations that make varieties suitable for other regions, too, notably sub-Saharan Africa where agricultural productivity is still low (Holmén, 2006).

Gaps between potential and actual yields are considerable among African smallholders even within the same local area, that is, within a similar land and water context, indicating that there is the potential to increase yields, even with the effects of climate change. Actually, output could double if poor farmers were given incentives and opportunity to adopt technologies, including improved seeds, fertilisers and better water management, already used by their better-off neighbours. Hence, an African Green Revolution would need to concentrate on the supportive measures. Implementing a Green Revolution in Africa would also, in theory, make room for considerable acreage to be devoted to bioenergy crops without jeopardising food security or marginal lands.

Photo: Frida Lanshammar

4.3 Water Savings Potential Throughout the Food Chain

The sheer magnitude of losses, wastage and over-consumption means that we have the ability and options to reduce gross food demand and agricultural water supply without affecting food security. Most losses occur after food is produced in the field. As water has already been evaporated, successive losses down the food chain add up to considerable unproductive water use. Globally, the amount of water withdrawn to produce lost and wasted food is quite substantial. It is reasonable to focus on the problems related to the expansion of irrigation facilities, since the abstraction of water from rivers, lakes and aquifers has repercussions for downstream communities and for in-stream functions. Losses of food produced in rainfed systems do not have the same negative effect on the water resources. A conservative estimate of the water losses caused by food losses and wastage could therefore be that about half of the water withdrawn for irrigation is lost. With a total withdrawal for irrigation in the order of 2,700 km^3, this means about 1,350 km^3 is lost: equivalent to about half the water volume of Lake Victoria. In the US, food production consumes about 120 km^3 of irrigation water. Presuming people throw away an estimated 30 percent of this food, that corresponds to 40 trillion liters of irrigation water, enough water to meet the household needs of 500 million people. The amount of water that can be saved by reducing food waste is much larger than that saved by low-flush toilets and water-saving washing machines. It's time for us to move beyond thinking about how we meet quantities, and to start looking at the type of foods we produce and how we benefit from them.

This is by no means easy. There are many stages and many actors from field to fork, such as farmers, agricultural workers, truck drivers, shopkeepers, government officials and consumers. Individually, some actors have little or no incentive to improve efficiency when the waste in their segment of the chain is relatively small and the costs or efforts of improvement outweigh the benefits. Other actors, like small farmers, would benefit from a reduction in post-harvest losses, as it could increase their income and food security. Too often, however, they lack the financial and other resources to make the necessary investments in improved technology.

With increasing disposable income, urban lifestyles and the influence of the food industry and supermarkets, the stages in the food chain beyond production are evermore important. Yet measures and policies to influence consumer behaviour are controversial and notoriously difficult to implement. Despite recent rises in world market prices, food is still a relative cheap commodity except for the very poor, and many consumers have little incentive to change their wasteful behaviour.

Studies carried out at the University of Arizona revealed that people living in cities in the US display an alarming level of ignorance with regard to food-related issues. Most urban consumers who were interviewed did not realise that meat, dairy and fruit come from living things that use natural resources to grow (Jones, 2004 and 2006). With increased distance between farms and food consumption sites and commoditisation of food, the level of ignorance may only increase, and unaware consumers are less likely to question and change their behaviour.

A combination of policy measures will be necessary: investment support in post-harvest technologies, scrutiny of the role of the food-processing industry and supermarkets, as well as pricing mechanisms and strategic efforts to visualise and educate the public on practically contributing to reducing food wastage. Schools and public institutions could be focused entry points for such a strategic effort, as general awareness campaigns have proved to be rather ineffective.

To successfully address losses in the food chain it will be necessary to involve various sectors and actors in the efforts to develop measures to adapt to the new type of water scarcity.

4.4 Involve Stakeholders

The Business Community

The business community increasingly sees the need to protect water resources to safeguard future production. Earlier this year, serious concerns about water scarcity affecting the industrial sector were expressed at the World Economic Forum. Attention was drawn to its potential negative ramifications on future economic wealth and political security. Special concern was raised to limits of sustainable water use being reached or breached in many world breadbasket regions. The meeting concluded with a "call for action" (Box 6). Several business leaders see a triangle of related issues critical to the sustainability of their businesses: climate change–water–food.

Consumers

With an increasing distance between field and fork, consumers are losing touch with farm practices, and often do not realise that food production comes from living things that require natural resources to grow. Food is undervalued as a commodity, and waste seems harmless. Awareness-raising and environmental education are crucial, with target groups such as schools, hospitals and offices a good point to start.

Price incentives also have a role to play. Recent hikes in food prices (due to, among other things, increased demand from strong growing economies such as China, growing demand for bioenergy, rising prices on energy etc.) raise concerns related to food security, particularly for poor consumers who buy food in the market. On the other hand, price increases are beneficial to farmers and send a clear signal to consumers that food is valuable and should not be unnecessarily wasted. It's time to curb wasteful behaviour, and as consumers we all have a role.

Policymakers

A first step is getting inefficiencies in the food chain onto the political agenda. In the 1970s and 1980s there were several studies conducted on global and regional post-harvest losses (Pariser, 1978) but the topic now seems to be off the agenda. There are relatively few people who deal with these issues. Recent studies are scarce and often refer back to older works, but sketchy evidence shows huge losses. To effectively reduce food losses, information on where, how much and why losses occur is essential. Without awareness backed up by good estimates, policy design will be difficult.

Photo: Getty Images

Box 6. Call to Action from Davos

Significant business disruptions due to water scarcity – across all sectors and geographies, and with all the associated technical, economic, political, environmental and social implications – are a reality today, and are projected to worsen in the future, as a result of changes in climate and demographics. Governments play an important role in helping to mitigate and adapt to the challenge, but so does the private sector, through individual company actions and through innovative public–private and multistakeholder partnerships. CEOs are called to catalyze holistic water management actions up and down their respective supply chains and throughout the existing and new networks of which they are a part.

The focus of actions should include:

- Water governance for transparent/fair allocation to users and sound incentives for efficient water use
- Water for agricultural use ("more crop per drop"; 70 percent of water withdrawn worldwide)
- Water for industry (water efficiency within operations)
- Water for energy (the deepening link between water resources and climate change)
- Water for human purposes (sustainable and affordable access to safe drinking water and sanitation)
- Water for the environment (to ensure sustained ecosystem security).

To assist the development of this set of actions, the signatories of this paper encouraged the Davos community to establish a wide coalition of businesses across different sectors. This coalition should create and collaborate with innovative partnerships on water management involving the research, development, farming, international non-governmental organisations (INGO) and government communities (World Economic Forum 2008).

Photo: Jorc Navarro, SXC

5. Conclusion

For an integrated and innovative strategy for saving water, a reduction of losses and wastage of food from field to fork is sound and rational. Reducing losses and wastage will ease pressure on water and other resources and free up land and water for other purposes than food production. A number of benefits are within reach for a cross section of people and interests in society. Livelihoods of producers could be enhanced, supplies to industry could be improved and consumers could benefit. Reducing losses of water and produce in the field and on the road to the market, presents tangible opportunities for farmers and their customers. Multiple gains across many sectors and at low cost are conceivable.

We need to set a target to reduce food losses and wastage. With reference to the targets for MDGs and with due consideration to the magnitude of losses and the potential gains, a reduction by 50 percent of losses and wastage in the entire food chain from field to fork – including agricultural and post harvest practices – seems realistic. As outlined in the policy suggestions, a number of actions will be necessary to achieve such a goal.

At this point in time, we are lacking the factual information about different types, size and implications of losses and wastage of food. We also need to better understand what is a true loss and what may appear to be losses: This is important in order to distinguish losses from the use and reuse of part of the food and farm residues. Informed decisions and effective policies will require a better terminology and more figures and facts. A major step to start the process for an effective strategy is to put the issue of losses and wastage on the political and research agenda. New and systematic knowledge about the food chain in academic curriculum and training programmes for people in, for example, food industry and trade are needed. With more and more people living far away from sites where food is produced, with food being processed and packed in various types of wrappings, and with growing affluence, this information becomes essential to the public at large.

By improving knowledge and through political initiatives, the necessary resources and driving forces for food and water security in a world of increasing water stress and competition need to be mobilised and set in motion.

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SAVE FOOD!

at Interpack2011
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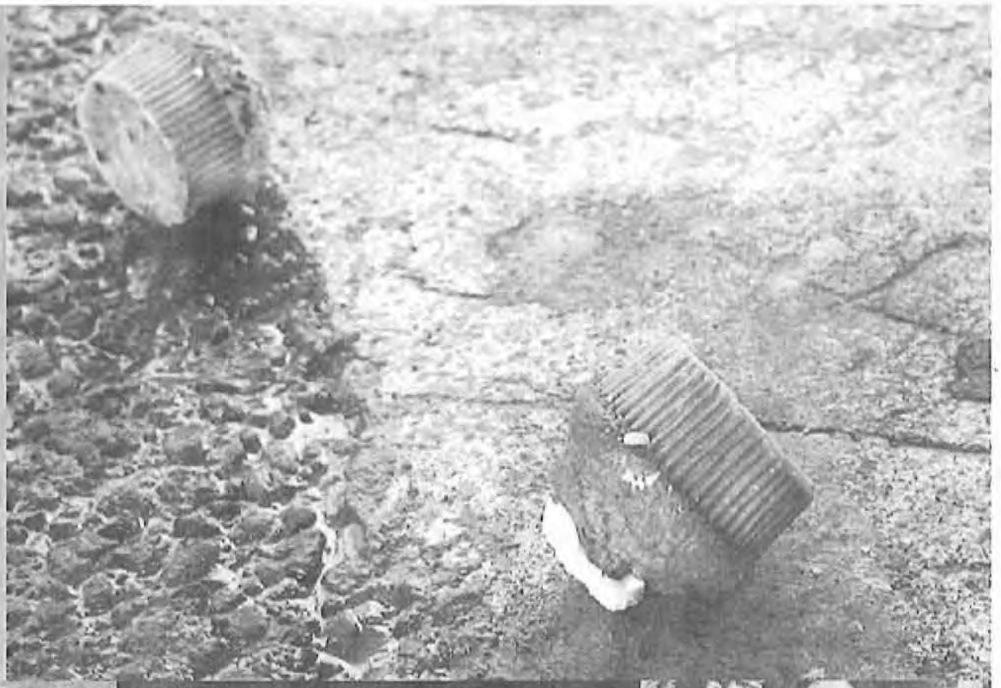

GLOBAL FOOD AND FOOD

EXTENT, CAUSES AND PREVENTION

FAO FIAT PANIS

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Jonathan Bloom and Nick Saltmarsh

Cover design:
Simone Morini

Study conducted for the International Congress

SAVE FOOD!

at Interpack2011
Düsseldorf, Germany

GLOBAL FOOD LOSSES AND FOOD WASTE

EXTENT, CAUSES AND PREVENTION

by
Jenny Gustavsson
Christel Cederberg
Ulf Sonesson
Swedish Institute for Food and Biotechnology (SIK)
Gothenburg, Sweden

and
Robert van Otterdijk
Alexandre Meybeck
FAO
Rome, Italy

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, 2011

Contents

Preface

This publication is based on studies carried out from August 2010 to January 2011 by The Swedish Institute for Food and Biotechnology (SIK) on request from the Food and Agriculture Organization of the United Nations (FAO).

The two studies on global food losses (one for high/medium-income countries and one for low income countries) have been carried out to serve as a basis for the international congress Save Food!, 16-17 May 2011, at the international packaging industry fair Interpack2011 in Düsseldorf, Germany. Save Food! has been co-organized by Interpack2011 and FAO. Save Food! aims at awareness raising on global food losses and waste, and on the impact of these on poverty and hunger in the world, as well as on climate change and on the use of natural resources.

The authors would like to thank Lisa Kitinoja, Adel Kader, Felicitas Schneider, Vaclav Smil and Jesper Stage among other researchers who have contributed helpful inputs throughout the project.

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Executive summary

The study highlights the losses occurring along the entire food chain, and makes assessments of their magnitude. Further, it identifies causes of food losses and possible ways of preventing them.

The results of the study suggest that roughly one-third of food produced for human consumption is lost or wasted globally, which amounts to about 1.3 billion tons per year. This inevitably also means that huge amounts of the resources used in food production are used in vain, and that the greenhouse gas emissions caused by production of food that gets lost or wasted are also emissions in vain.

Food is lost or wasted throughout the supply chain, from initial agricultural production down to final household consumption. In medium- and high-income countries food is to a significant extent wasted at the consumption stage, meaning that it is discarded even if it is still suitable for human consumption. Significant losses also occur early in the food supply chains in the industrialized regions. In low-income countries food is lost mostly during the early and middle stages of the food supply chain; much less food is wasted at the consumer level.

Overall, on a per-capita basis, much more food is wasted in the industrialized world than in developing countries. We estimate that the per capita food waste by consumers in Europe and North-America is 95-115 kg/year, while this figure in Sub-Saharan Africa and South/Southeast Asia is only 6-11 kg/year.

The causes of food losses and waste in low-income countries are mainly connected to financial, managerial and technical limitations in harvesting techniques, storage and cooling facilities in difficult climatic conditions, infrastructure, packaging and marketing systems. Given that many smallholder farmers in developing countries live on the margins of food insecurity, a reduction in food losses could have an immediate and significant impact on their livelihoods.

The food supply chains in developing countries need to be strengthened by, *inter alia*, encouraging small farmers to organize and to diversify and upscale their production and marketing. Investments in infrastructure, transportation, food industries and packaging industries are also required. Both the public and private sectors have a role to play in achieving this.

The causes of food losses and waste in medium/high-income countries mainly relate to consumer behaviour as well as to a lack of coordination between different actors in the supply chain. Farmer-buyer sales agreements may contribute to quantities of farm crops being wasted. Food can be wasted due to quality standards, which reject food items not perfect in shape or appearance. At the consumer level, insufficient purchase planning and expiring 'best-before-dates' also cause large amounts of waste, in combination with the careless attitude of those consumers who can afford to waste food.

Food waste in industrialized countries can be reduced by raising awareness among food industries, retailers and consumers. There is a need to find good and beneficial use for safe food that is presently thrown away.

The study revealed that there are major data gaps in the knowledge of global food loss and waste. Further research in the area is urgent.

Food security is a major concern in large parts of the developing world. Food production must clearly increase significantly to meet the future demands of an increasing and more affluent world population. This study illustrate that one of the first mean to fight imbalances and reduce tensions between the necessary increase in consumption and the challenging increase in production, is to also promote food loss reduction which alone has a considerable potential to increase the efficiency of the whole food chain. In a world with limited natural resources (land, water, energy, fertilizer), and where cost-effective solutions are to be found to produce enough safe and nutritious food for all, reducing food losses should not be a forgotten priority.

1. Introduction

The issue of food losses is of high importance in the efforts to combat hunger, raise income and improve food security in the world's poorest countries. Food losses have an impact on food security for poor people, on food quality and safety, on economic development and on the environment. The exact causes of food losses vary throughout the world and are very much dependent on the specific conditions and local situation in a given country. In broad terms, food losses will be influenced by crop production choices and patterns, internal infrastructure and capacity, marketing chains and channels for distribution, and consumer purchasing and food use practices. Irrespective of the level of economic development and maturity of systems in a country, food losses should be kept to a minimum.

Food losses represent a waste of resources used in production such as land, water, energy and inputs. Producing food that will not be consumed leads to unnecessary CO_2 emissions in addition to loss of economic value of the food produced.

Economically avoidable food losses have a direct and negative impact on the income of both farmers and consumers. Given that many smallholders live on the margins of food insecurity, a reduction in food losses could have an immediate and significant impact on their livelihoods. For poor consumers (food insecure or at-risk households), the priority is clearly to have access to food products that are nutritious, safe and affordable. It is important to note that food insecurity is often more a question of access (purchasing power and prices of food) than a supply problem. Improving the efficiency of the food supply chain could help to bring down the cost of food to the consumer and thus increase access. Given the magnitude of food losses, making profitable investments in reducing losses could be one way of reducing the cost of food. But that would, of course, require that financial gains from reduced losses are not outweighed by their costs.

How much food is lost and wasted in the world today and how can we prevent food losses? Those are questions impossible to give precise answers to, and there is not much ongoing research in the area. This is quite surprising as forecasts suggest that food production must increase significantly to meet future global demand. Insufficient attention appears to be paid to current global food supply chain losses, which are probably substantial.

For the international congress Save Food! at Interpack2011, FAO hired the services of the Swedish Institute for Food and Biotechnology (SIK) to carry out two studies on the extent and effects, as well as causes and prevention of food losses and food waste, one for high/medium-income countries, and one for low-income countries. The two studies highlighted the food losses occurring along food chains, and made assessments of the magnitude of these losses, focussing on quantitative weight losses. They compile, analyze and assemble data and reports produced on the topic of global food loss and waste during recent years. Where information was not available, assessments and assumptions have been made. Results of the two studies are combined in this paper.

2. Methodology

The Swedish Institute for Food and Biotechnology (SIK) has reconstructed mass flows of food aimed to human consumption, from production to consumption, using available data, in order to quantify food losses and wastes.

2.1 DEFINITION OF FOOD LOSSES AND FOOD WASTE

Food losses refer to the decrease in edible food mass throughout the *part of the* supply chain that specifically leads to edible food for human consumption. Food losses take place at production, post-harvest and processing stages in the food supply chain (Parfitt *et al.*, 2010). Food losses occuring at the end of the food chain (retail and final consumption) are rather called "food waste", which relates to retailers' and consumers' behavior. (Parfitt *et al.*, 2010).

"Food" waste or loss is measured only for products that are directed to human consumption, excluding feed and parts of products which are not edible. Per definition, food losses or waste are the masses of food lost or wasted in *the part of* food chains *leading to* "edible products going to human consumption". Therefore food that was originally meant to human consumption but which fortuity gets out the human food chain is considered as food loss or waste even if it is then directed to a non-food use (feed, bioenergy...). This approach distinguishes "planned" non-food uses to "unplanned" non-food uses, which are hereby accounted under losses.

2.2 TYPES OF FOOD LOSSES/WASTE

Five system boundaries were distinguished in the food supply chains (FSC) of vegetable and animal commodities. Food loss/ waste were estimated for each of these segments of the FSC. The following aspects were considered:

Vegetable commodities and products:

Agricultural production: losses due to mechanical damage and/or spillage during harvest operation (e.g. threshing or fruit picking), crops sorted out post harvest, etc.

Postharvest handling and storage: including losses due to spillage and degradation during handling, storage and transportation between farm and distribution.

Processing: including losses due to spillage and degradation during industrial or domestic processing, e.g. juice production, canning and bread baking. Losses may occur when crops are sorted out if not suitable to process or during washing, peeling, slicing and boiling or during process interruptions and accidental spillage.

Distribution: including losses and waste in the market system, at e.g. wholesale markets, supermarkets, retailers and wet markets.

Consumption: including losses and waste during consumption at the household level.

Animal commodities and products:

Agricultural production: for bovine, pork and poultry meat, losses refer to animal death during breeding. For fish, losses refer to discards during fishing. For milk, losses refer to decreased milk production due to dairy cow sickness (mastitis).

Postharvest handling and storage: for bovine, pork and poultry meat, losses refer to death during transport to slaughter and condemnation at slaughterhouse. For fish, losses refer to spillage and degradation during icing, packaging, storage and transportation after landing. For milk, losses refer to spillage and degradation during transportation between farm and distribution.

Processing: for bovine, pork and poultry meat, losses refer to trimming spillage during slaughtering and additional industrial processing, e.g. sausage production. For fish, losses refer to industrial processing such as canning or smoking. For milk, losses refer to spillage during industrial milk treatment (e.g. pasteurization) and milk processing to, e.g., cheese and yoghurt.

Distribution: includes losses and waste in the market system, at e.g. wholesale markets, supermarkets, retailers and wet markets.

Consumption: includes losses and waste at the household level.

2.3 QUANTIFICATION OF FOOD LOSSES AND WASTE

Physical mass of food produced for human consumption and of food lost and wasted throughout the food supply chain have been quantified, using available data, results from the literature on global food waste and SIK's own assumptions. For each commodity group a mass flows model was used to account for food losses and waste in each step of the commodity's FSC. Model equations are provided in Annex 5.

The production volumes for all commodities (except for oil crops and pulses) were collected from the FAO Statistical Yearbook 2009 (FAOSTAT 2010a). The production volumes for oil crops and pulses were collected from FAO's Food Balance Sheets (FAOSTAT 2010d).

Allocation factors have been applied to determine the part of the produce oriented to human consumption (and not for animal feed). Conversion factors have been applied to determine the edible mass (Annex 2). At each stage of the Food Supply Chain, losses and waste were estimated using FAO's Food Balance Sheets from the year 2007 and results from a thorough literature search on the topic of global food waste. Where there are gaps of knowledge, SIK has made own assumptions and estimations, based on food waste levels in comparable regions, commodity groups and/or steps of the FSC. The figures used are presented in Annex 4. The sources and assumptions behind these estimations are described in detail in the study reports from SIK.

3. Extent of food losses and waste

3.1 FOOD VOLUMES PRODUCED

Figure 1 illustrates the 2007 production volumes of all commodity groups in their primary form, including animal feed products (which are then factored out using allocation factors), in the regions of the world studied. The production volumes were compiled from the FAO Statistical Yearbook 2009, except for the production volumes of oil crops and pulses which were collected from FAO's FBS, 2007.

Meat production in Industrialized Asia was dominated by large pig (around 46 million ton) and chicken (around 12 million ton) production. Meat production in Europe was dominated by pig (around 27 million ton) while it was more diversified in North America and Oceania, with chicken (18 million ton), cattle (16 million ton) and pig (12 million ton).

In developing regions, meat in Latin America was dominated by large cattle (around 15 million ton) and chicken (around 17 million ton) production. Meat produced in South and Southeast Asia mainly consisted of pig (7 million ton) and chicken (9 million ton). Animal production in sub-Saharan Africa mostly consisted of cattle (around 4 million ton) and in North Africa, West and Central Asia it was mostly chicken (around 4 million ton) production.

3.2 EXTENT OF FOOD LOSSES AND WASTE

Roughly one-third of the edible parts of food produced for human consumption, gets lost or wasted globally, which is about 1.3 billion ton per year. Food is wasted throughout the FSC, from initial agricultural production down to final household consumption. In medium- and high-income countries food is to a great extent wasted, meaning that it is thrown away even if it is still suitable for human consumption. Significant food loss and waste do, however, also occur early in the food supply chain. In low-income countries food is mainly lost during the early and middle stages of the food supply chain; much less food is wasted at the consumer level.

Figure 1. Production volumes of each commodity group, per region (million tonnes)

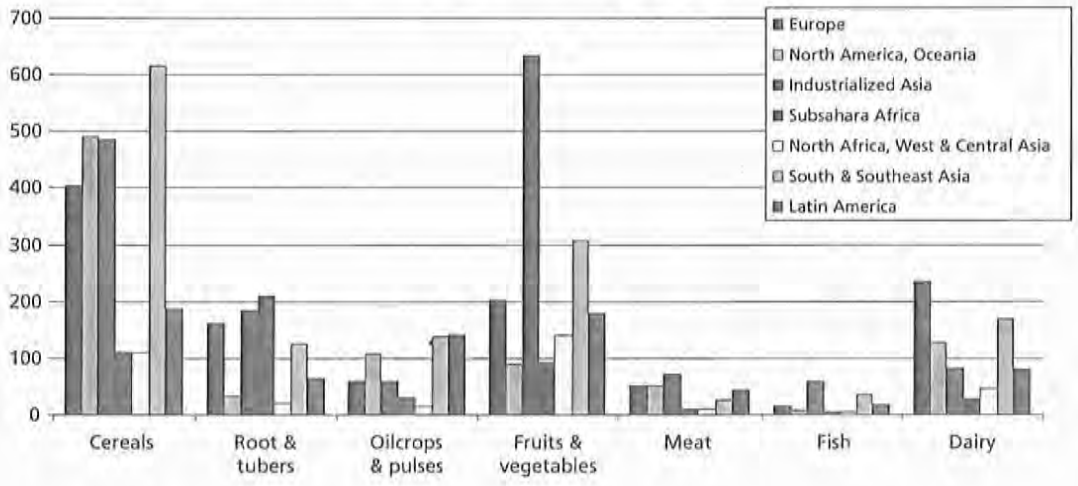


Figure 2. Per capita food losses and waste, at consumption and pre-consumptions stages, in different regions

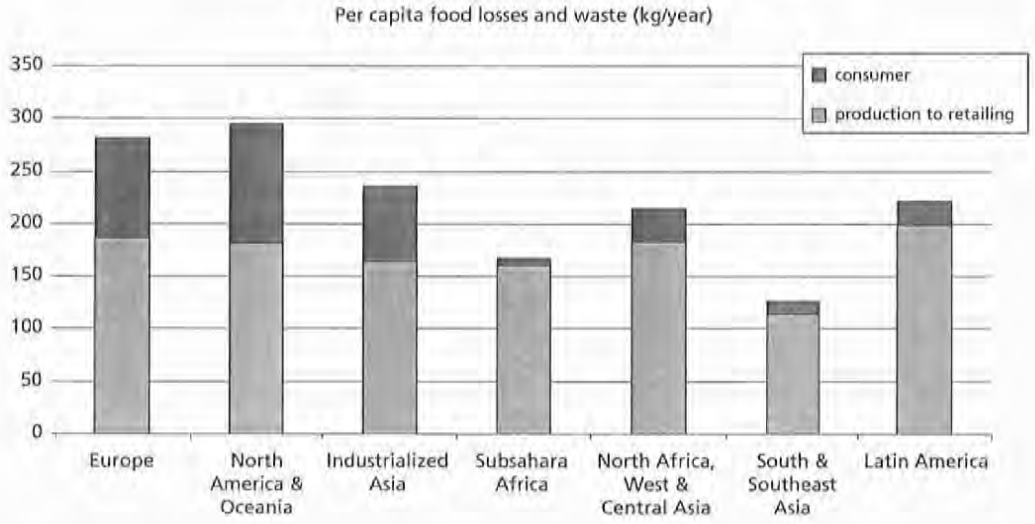


Figure 2 shows that the per capita food loss in Europe and North-America is 280-300 kg/year. In Sub-Saharan Africa and South/Southeast Asia it is 120-170 kg/year. The total per capita production of edible parts of food for human consumption is, in Europe and North-America, about 900 kg/year and, in sub-Saharan Africa and South/Southeast Asia, 460 kg/year.

Per capita food wasted by consumers in Europe and North-America is 95-115 kg/year, while this figure in sub-Saharan Africa and South/Southeast Asia is only 6-11 kg/year.

Food losses in industrialized countries are as high as in developing countries, but in developing countries more than 40% of the food losses occur at post harvest and processing levels, while in industrialized countries, more than 40% of the food losses occur at retail and consumer levels. Food waste at consumer level in industrialized countries (222 million ton) is almost as high as the total net food production in sub-Saharan Africa (230 million ton).

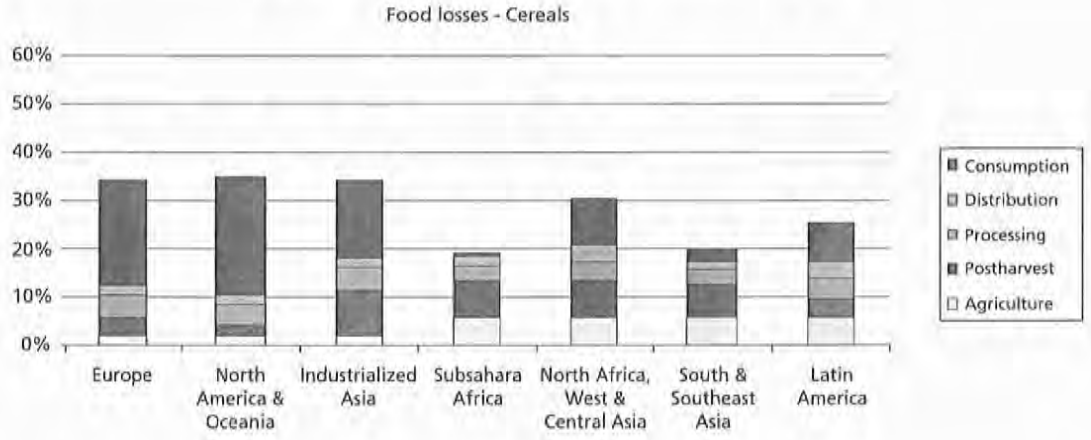
The graphs of the seven commodity groups below show the percentage food losses and waste of the edible parts of food products that were produced for human consumption.

In the case of *cereals* (Figure 3), wheat is the dominant crop supply in medium- and high-income countries, and the consumer phase is the stage with largest losses, between 40-50% of total cereal food waste.

In low-income regions rice is the dominant crop, especially in the highly populated region of South and Southeast Asia. For these regions, agricultural production and postharvest handling and storage are stages in the FSC with relatively high food losses, as opposed to the distribution and consumption levels.

In the *roots and tubers* group (Figure 4), potato (sweet potato in China) is the dominating crop supply in medium- and high-income countries. Results indicate that all three medium- and high-income regions loose the largest volumes during agricultural production. This mainly depends on postharvest crop grading, due to quality standards set by retailers. Food waste at the consumer level is, however, also high.

Figure 3. Part of the initial production lost or wasted, at different FSC stages, for cereals in different regions



Cassava is the dominant supply crop in SSA and LA and potato the dominant crop in North America, West Asia and Central Asia, and South and Southeast Asia. For these regions, agricultural production and postharvest handling and storage are stages in the FSC with relatively high food losses, as opposed to the distribution and consumption levels. One reason for this is that fresh roots and tubers are perishable, which make these products easily damaged during harvest and postharvest activities, especially in the warm and humid climates of many developing countries.

In the *oil crops and pulses* commodity group (Figure 5), sunflower seed and rape seed are the dominating crop supplies in Europe, while soybeans are the dominating crop supply in North America and Oceania and Industrialized Asia. Losses in all medium- and high-income regions are relatively large during agricultural production, contributing waste percentages between 6 and 12% during harvest.

Figure 4. Part of the initial production lost or wasted at different stages of the FSC for root and tuber crops in different region

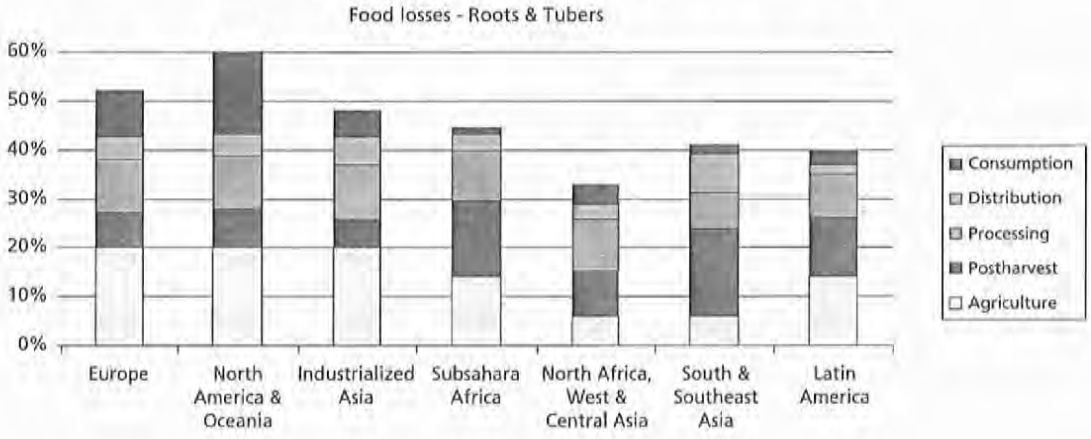
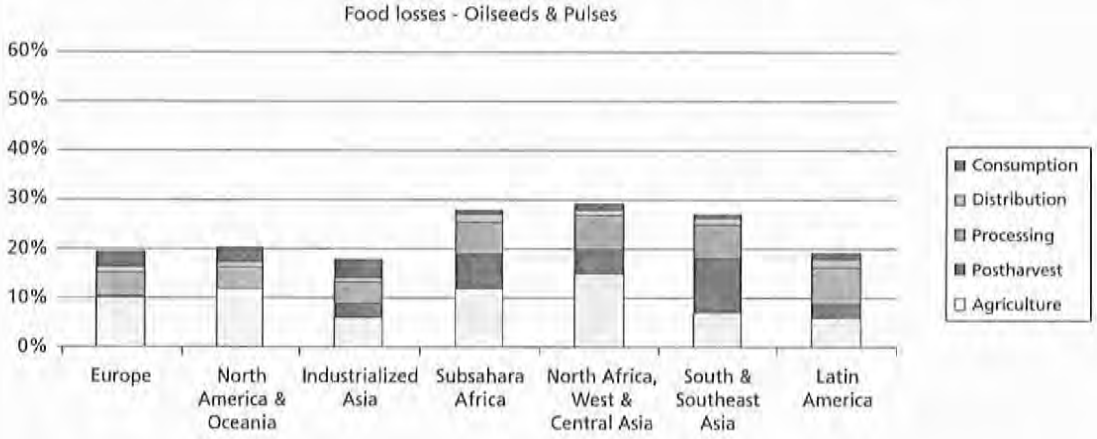


Figure 5. Part of the initial production lost or wasted at different stages in the FSC for oilseeds and pulses in different regions



Groundnut is a dominant oil crop in SSA; soybean and olives in North America, West and Central Asia; soybean and coconut in South and Southeast Asia and soybean in Latin America. Losses in these regions are largest in agricultural production and during postharvest handling and storage. This is, however, also due to the fact that oil crops in the distribution and consumption stages are mainly consumed as vegetable oils, products which are wasted relatively little compared to fresh products.

In the *fruits and vegetables* commodity group (Figure 6), losses in agricultural production dominate for all three industrialized regions, mostly due to postharvest fruit and vegetable grading caused by quality standards set by retailers. Waste at the end of the FSC is also substantial in all three regions, with 15-30% of purchases by mass discarded by consumers.

In developing regions losses in agricultural production dominate total losses throughout the FSC. Losses during postharvest and distribution stages are also severe, which can be explained by deterioration of

Figure 6. Part of the initial production lost or wasted at different stages of the FSC for fruits and vegetables in different regions

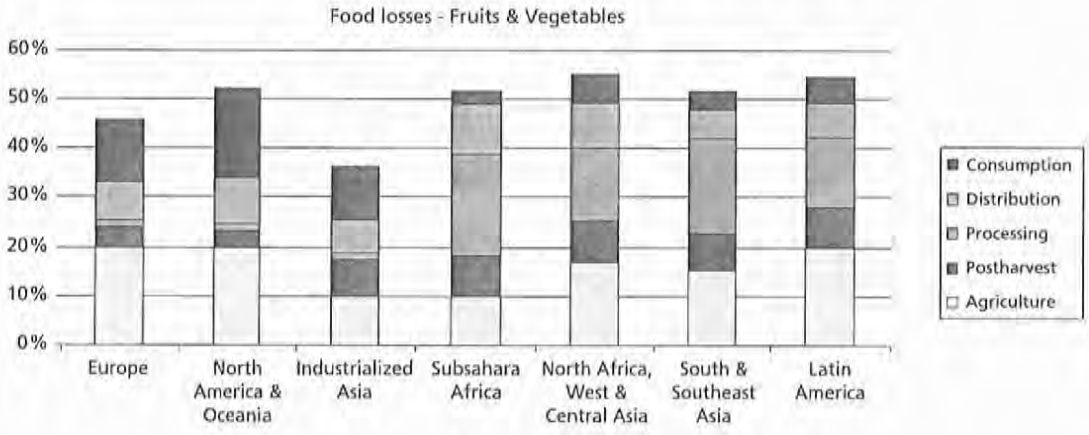
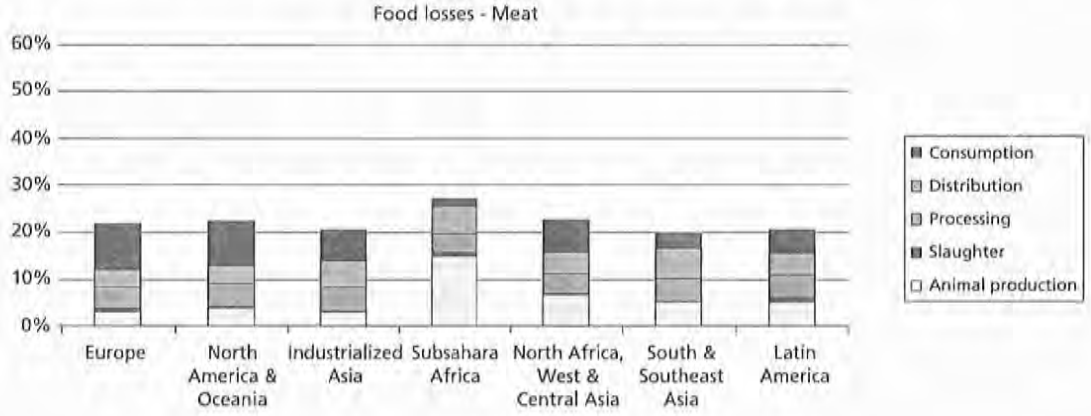


Figure 7. Part of the initial production lost or wasted for meat products at different stages in the FSC in different regions

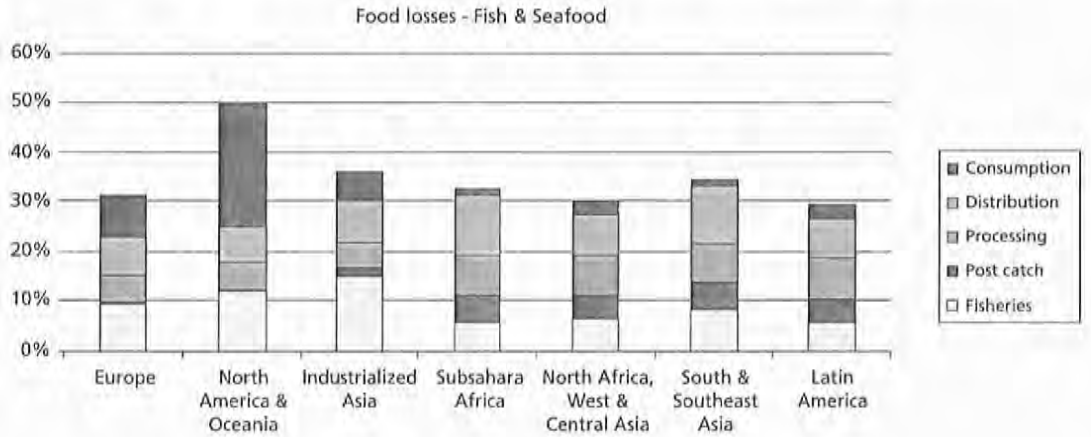


perishable crops in the warm and humid climate of many developing countries as well as by seasonality that leads to unsaleable gluts.

In the case of *meat and meat products* (Figure 7): losses and waste in industrialized regions are most severe at the end of the FSC, explained by a high per capita meat consumption combined with large waste proportions by retailers and consumers, especially in Europe and the U.S. Waste at the consumption level makes up approximately half of total meat losses and waste. The relatively low levels of waste during agricultural production and postharvest handling and storage can be explained by relatively low losses due to animal mortality during breeding and transportation to slaughter.

Losses in all developing regions are distributed quite equally throughout the FSC, but notable is the relatively high losses in agricultural production in SSA. This is explained by high animal mortality, caused by frequent diseases (e.g. pneumonia, digestive diseases and parasites) in livestock breeding.

Figure 8. Part of the initial catchings (fish and seafood harvested) discarded, lost and wasted in different regions and at different stages in the FSC



Box 1. Snapshot case: fish discards

Fish discards as potential human consumption

Discards, the proportion of total catch that is returned to the sea (in most case dead, dying or badly damaged), represent a significant part of the world's marine catches and is generally considered a wasteful misuse of marine resources. The first global assessment was published in 1994 and it identified a total discard of 27 million ton (Alverson *et al.*, 1994). The latest global study conducted by FAO in 2005 suggests that discard have dropped to 7.3 million but the figures are not totally comparable. Even if the first was overestimated and the latter underestimated, reductions seem to have been significant. The latest assessment corresponds to a weighted global discard ratio of 8%. However, large variations among fishing methods and regions exist (Kelleher, 2005).

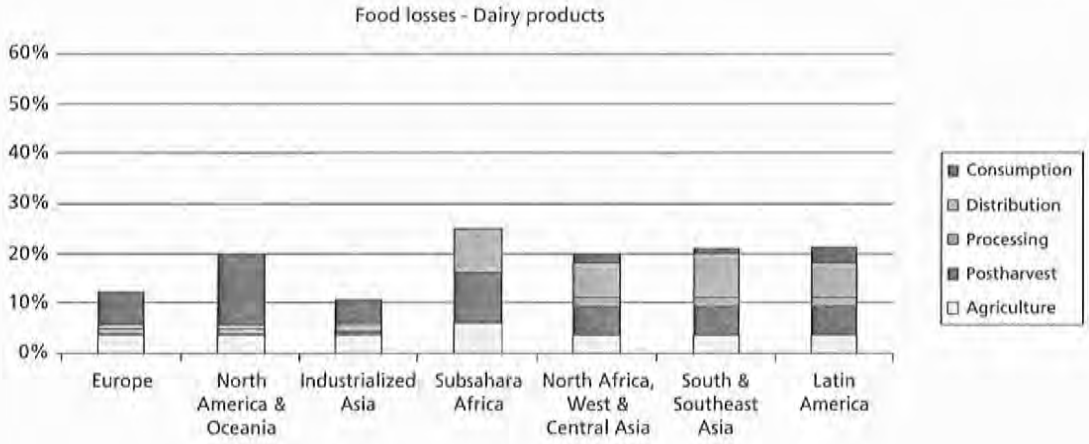
For all three industrialized regions, losses in primary *fish and seafood* (Figure 8) production are significant due to discard rates of between 9-15% of marine catches. A large proportion of purchased fish and seafood is also wasted by consumer households.

In developing countries, losses in primary production mostly depend on discard rates between 6-8% of marine catches. High losses at the distribution level can be explained by high levels of deterioration occurring during fresh fish and seafood distribution.

For *milk* (Figure 9): waste at the consumption level makes up approximately 40-65% of total food waste in all three industrialized regions. Losses in agricultural production are significant since dairy cow illness (mostly mastitis infections) causes an approximate 3-4% decrease in milk yield.

For all developing regions, waste of milk during postharvest handling and storage, as well as at the distribution level, is relatively high.

Figure 9. Part of the initial milk and diary production lost or waisted for each region at different stages in the FSC



4. Causes and prevention of food losses and waste

Food is wasted throughout the FSC, from initial agricultural production down to final household consumption. In medium- and high-income countries food is to a high extent wasted, meaning that it is thrown away, even if it is still suitable for human consumption. Significant food loss and waste do, however, also occur earlier in the food supply chain. In low-income countries food is mostly lost during the production-to-processing stages of the food supply chain.

In industrialized countries food gets lost when production exceeds demand. In order to ensure delivery of agreed quantities while anticipating unpredictable bad weather or pest attacks, farmers sometimes make production plans on the safe side, and end-up producing larger quantities than needed, even if conditions are "average". In the case of having produced more than required, some surplus crops are sold to processors or as animal feed. However, this is often not financially profitable considering lower prices in these sectors compared to those from retailers.

Prevention: Communication and cooperation between farmers. Cooperation among farmers could reduce risk of overproduction by allowing surplus crops from one farm to solve a shortage of crops on another (Stuart, 2009).

In developing countries and, sometimes, developed countries, food may be lost due to premature harvesting. Poor farmers sometimes harvest crops too early due to food deficiency or the desperate need for cash during the second half of the agricultural season. In this way, the food incurs a loss in nutritional and economic value, and may get wasted if it is not suitable for consumption.

Prevention: Organizing small farmers and diversifying and upscaling their production and marketing. Small resource-poor farmers can be organized in groups to produce a variety of significant quantities of cash crops or animals. In this way they can receive credit from agricultural financial institutions or advance payments from buyers of the produce.

Box 2. Snapshot case: *appearance quality* standards

Carrot quality standards, by the supermarket chain Asda

As research for the book 'Waste – understanding the global food scandal' (2009), Tristram Stuart visited several British farms in order to understand how quality standards affect the level of food waste. Among others, Stuart visited M.H. Poskitt Carrots in Yorkshire, a major supplier to the supermarket chain Asda. At the farm, the author was shown large quantities of out-graded carrots, which, having a slight bend, were sent off as animal feed. In the packing house, all carrots passed through photographic sensor machines, searching for aesthetic defects. Carrots that were not bright orange, had a blend or blemish or were broken were swept off into a livestock feed container. As staff at the farm put it: "Asda insist that all carrots should be straight, so customers can peel the full length in one easy stroke" (Stuart, 2009). In total, 25-30% of all carrots handled by M.H. Poskitt Carrots were out-graded. About half of these were rejected due to physical or aesthetic defects, such as being the wrong shape or size; being broken or having a cleft or a blemish.

High 'appearance quality standards' from supermarkets for fresh products lead to food waste. Some produce is rejected by supermarkets at the farm gate due to rigorous quality standards concerning weight, size, shape and appearance of crops. Therefore, large portions of crops never leave the farms. Even though some rejected crops are used as animal feed, the quality standards might divert food originally aimed for human consumption to other uses (Stuart, 2009).

Prevention: Consumer surveys by supermarkets. Supermarkets seem convinced that consumers will not buy food which has the 'wrong' weight, size or appearance. Surveys do however show that consumers are willing to buy heterogeneous produce as long as the taste is not affected (Stuart, 2009). Consumers have the power to influence the quality standards. This could be done by questioning them and offering them a broader quality range of products in the retail stores.

Prevention: Sales closer to consumers. Selling farm crops closer to consumers without having to pass the strict quality standards set up by supermarkets on weight, size and appearance would possibly reduce the amount of rejected crops. This could be achieved through, e.g., farmers markets and farm shops (Stuart, 2009).

Poor storage facilities and lack of infrastructure cause postharvest food losses in developing countries. Fresh products like fruits, vegetables, meat and fish straight from the farm or after the catch can be spoilt in hot climates due to lack of infrastructure for transportation, storage, cooling and markets (Rolle, 2006; Stuart, 2009).

Prevention: investment in infrastructure and transportation. Governments should improve the infrastructure for roads, energy and markets. Subsequently, private sector investments can improve storage and cold chain facilities as well as transportation (Choudhury, 2006).

Unsafe food is not fit for human consumption and therefore is wasted. Failure to comply with minimum food safety standards can lead to food losses and, in extreme cases, impact on the food security status of a country. A range of factors can lead to food being unsafe, such as naturally occurring toxins in food itself, contaminated water, unsafe use of pesticides, and veterinary drug residues. Poor and unhygienic handling and storage conditions, and lack of adequate temperature control, can also cause unsafe food.

Prevention: develop knowledge and capacity of food chain operators to apply safe food handling practices. Food chain operators should be skilled and knowledgeable in how to produce safe food. Foods need to

Box 3. Snapshot case: poor postharvest facilities

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Lack of facilities for rice threshing, drying and winnowing, Tajikistan
A farmer winnowing rice in Tursunzade, Tajikistan in 2010. Sun drying exposes rice to rodents and parasites, which may eat or damage the harvested crops. Proper storage facilities are also important in order to reduce the amounts of food lost during postharvest handling and storage.

Box 4. Snapshot case: food safety at risk

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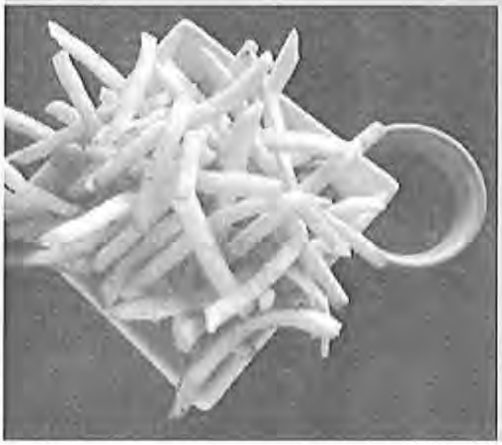
Rickshaws transporting milk in Bangladesh
Rickshaws transporting milk from the countryside to processing plants in Baghabarighat, Bangladesh. Transporting milk in the warm and humid climate of Bangladesh without a proper cold chain may cause milk losses. The rickshaw transportation on narrow and winding roads prolongs the time milk is handled in warm temperatures.

be produced, handled and stored in accordance with food safety standards. This requires the application of good agricultural and good hygienic practices by all food chain operators to ensure that the final food protects the consumer.

'Disposing is cheaper than using or re-using' attitude in industrialized countries leads to food waste. Industrialized food processing lines often carry out trimming to ensure the end product is in the right shape and size. Trimmings, in some cases, could be used for human consumption but are usually disposed of. Food is also lost during processing because of spoilage down the production line. Errors during processing lead to final products with the wrong weight, shape or appearance, or damaged packaging, without affecting the safety, taste or nutritional value of the food. In a standardized production line these products often end up being discarded (Stuart, 2009; SEPA, 2008).

Prevention: develop markets for 'sub-standard' products. Both commercial and charity organizations could arrange for the collection and sale or use of discarded 'sub-standard' products that are still safe and of good taste and nutritional value (SEPA 2008).

Box 5. Snapshot case: disposing is cheaper than using or re-using



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French fries production in The Netherlands
During his thesis, D. Somsen interviewed a Dutch french fries producer to better understand the causes of food waste in the french fries production line (Somsen, 2004). The company reported several steps in the production line where raw material was lost and wasted, e.g. during the size reduction in which potatoes are cut into strips. French fries are fragile and easily break when transported during processing as well as when packaged. The unwanted products are sorted out and occasionally end up wasted. In addition to this, some potatoes are sorted out prior to entering the factory, due to damage during loading, transport from producer to factory and/or during storage.

Box 6. Snapshot case: poor market facilities

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Central wholesale market in Pakistan
Central wholesale market in Lahore, Pakistan. These bananas are traded among unsanitary conditions, causing major health hazards since food is handled and piled on the ground close to the gutter. This kind of market environment also causes food waste, since the unsanitary conditions and rough handling cause deterioration of fragile fresh products.

Lack of processing facilities causes high food losses in developing countries. In many situations the food processing industry doesn't have the capacity to process and preserve fresh farm produce to be able to meet the demand. Part of the problem stems from the seasonality of production and the cost of investing in processing facilities that will not be used year-round.

Prevention: develop contract farming linkages between processors and farmer. Governments should create a better 'enabling environment' and investment climate, to stimulate the private sector to invest in the food industry and to work more closely with farmers to address supply issues.

Large quantities on display and a wide range of products/ brands in supply lead to food waste in industrialized countries. Retail stores need to order a variety of food types and brands from the same manufacturer to get beneficial prices. Consumers also expect a wide range of products to be available in stores. A wide range of products does, however, increase the likelihood of some of them reaching their "sell-by" date before being sold, and thereby wasted. When shopping, consumers expect store shelves to be well filled. Although certainly beneficial for sales statistics, continually replenished supplies mean that food products close to expiry are often ignored by consumers. This is particularly difficult for small retail stores (SEPA, 2008).

Inadequate market systems cause high food losses in developing countries. To minimize losses, the commodities produced by farmers need to reach the consumers in an efficient way. There are too few wholesale, supermarket and retail facilities providing suitable storage and sales conditions for food products. Wholesale and retail markets in developing countries are often small, overcrowded, unsanitary and lacking cooling equipment (Kader, 2005).

Prevention: Marketing cooperatives and improved market facilities. Marketing cooperatives are organizations providing a central point for assembling produce from small farmers and preparing commodities for transportation to markets and other distribution channels. The marketing cooperatives should be able to reduce food losses by increasing the efficiency of these activities. Although the development of wholesale and retail markets should preferably be done by the private sector, local governments and marketing cooperatives can be instrumental in establishing and improving market facilities (Kader, 2005).

Food wasted at consumer level is minimal in developing countries. Poverty and limited household income make it unacceptable to waste food. A contributing factor is that consumers in developing countries generally buy smaller amounts of food products at the time, often just enough for meals on the day of purchase.

Box 7. Snapshot case: public awareness raising

Voluntary initiatives

'Stop Wasting Food' in Denmark give guidance to consumers on how to avoid wasting food by shopping according to daily needs of households, and promotes better household planning and shopping patterns in order to encourage a movement away from impulsive to rational food shopping and consumption patterns

In the UK, the Waste Reduction Action Plan (WRAP) encourages leading retailers, brand owners and their supply chains to identify collaborative approaches towards reducing the amount of food and packaging waste that ends up in the household bin and ultimately in landfill. WRAP aims at reducing packaging waste and consumer food waste by carrying out R&D work, by guidance on best practices and by promotion. WRAP partners with packaging manufacturers, retailers, brands, suppliers, research institutes, universities, design agencies and environmental and design consultants.

Abundance and consumer attitudes lead to high food waste in industrialized countries. Perhaps one of the most important reasons for food waste at the consumption level in rich countries is that people simply can afford to waste food. The amount of available food per person in retail stores and restaurants has increased during the last decades in both the USA and the EU. A lot of restaurants serve buffets at fixed prices, which encourages people to fill their plates with more food than they can actually eat. Retail stores offer large packages and "getting one for free" bargains. Likewise, food manufactures produce oversized ready to eat meals (Stuart, 2009).

Prevention: Public awareness. Education on these matters in schools and political initiatives are possible starting points to change people's attitudes towards the current massive food waste.

5. Conclusions

This study has compiled and analyzed a magnitude of data and reports on food losses and waste. Waste levels and waste volumes in each step of the food supply chain were estimated. Causes of and possible ways to prevent food losses and waste in each step of the food supply chain were reported.

Due to lack of sufficient data, many assumptions on food waste levels at foremost the distribution and consumption levels had to be made. Therefore, the results in this study must be interpreted with great caution.

The studies first reveal the major data gaps in available knowledge of global food waste, especially with regard to the quantification of food losses by individual cause, and the cost of food loss prevention. And when data are available, they are often accompanied with major uncertainties.

Further research in the area is urgent, especially considering that food security is a major concern in large parts of the developing world.

While increasing primary food production is paramount to meet the future increase in final demand, tensions between production and access to food can also be reduced by tapping into the potential to reduce food losses. Efficient solutions exist along the whole food chain, for reducing total amounts of food lost and wasted. Actions should not only be directed towards isolated parts of the chain, since what is done (or not done) in one part has effects in others. In low income countries, measures should foremost have a producer perspective, e.g. by improving harvest techniques, farmer education, storage facilities and cooling chains. In industrialized countries on the other hand, solutions at producer and industrial level would only be marginal if consumers continue to waste at current levels. Consumer households need to be informed and change the behavior which causes the current high levels of food waste.

Another point to be stressed is that the food supply chain of today is more and more globalized. Certain food items are produced, transformed and consumed in very different parts of the world. The impact of growing international trade on food losses still has to be better assessed.

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Annex 1. Grouping of world regions

Countries included in world regions 1-3 – Medium/High-income countries.

Region 1: Europe		
Albania	France	Netherlands
Armenia	Georgia	Norway
Austria	Germany	Poland
Azerbaijan	Greece	Portugal
Belarus	Hungary	Romania
Belgium	Iceland	Russian Federation
Bosnia & Herzegovina	Ireland	Serbia
Bulgaria	Italy	Slovakia
Croatia	Latvia	Slovenia
Cyprus	Lithuania	Spain
Czech Republic	Luxemburg	Sweden
Denmark	Macedonia	Switzerland
Estonia	Moldova	Ukraine
Finland	Montenegro	United Kingdom

Region 2: USA, Canada, Oceania	Region 3: Industrialized Asia
Australia	Japan
Canada	China
New Zealand	South Korea
United States of America	

Countries included in world regions 4-7 – Low-income countries.

Region 4 sub-Saharan Africa		Region 5 North Africa, West and Central Asia	Region 6 South and Southeast Asia	Region 7 Latin America
Angola	Liberia	Algeria	Afghanistan	Argentina
Benin	Malawi	Egypt	Bangladesh	Belize
Botswana	Mali	Iraq	Bhutan	Bolivia
Burkina Faso	Mauritania	Israel	Cambodia	Brazil
Burundi	Mozambique	Jordan	India	Chile
Cameroon	Namibia	Kazakhstan	Indonesia	Colombia
Central African Rep	Niger	Kuwait	Iran	Costa Rica
Chad	Nigeria	Kyrgyzstan	Laos	Cuba
Congo-Brazzaville	Rwanda	Lebanon	Malaysia	Dominican Rep
Congo-Kinshasa	Senegal	Libya	Myanmar	Ecuador
Cote d'Ivoire	Sierra Leone	Mongolia	Nepal	El Salvador
Equatorial Guinea	Somalia	Morocco	Pakistan	Guatemala
Eritrea	South Africa	Oman	Philippines	Guyana
Ethiopia	Sudan	Saudi Arabia	Sri Lanka	Haiti
Gabon	Swaziland	Syria	Thailand	Honduras
Gambia	Tanzania	Tajikistan	Vietnam	Jamaica
Ghana	Togo	Tunisia		Mexico
Guinea	Uganda	Turkey		Nicaragua
Guinea-Bissau	Zambia	Turkmenistan		Panama
Kenya	Zimbabwe	Utd Arab Emirates		Paraguay
Lesotho		Uzbekistan		Peru
		Yemen		Suriname
				Uruguay
				Venezuela

Annex 2. Commodity groups

The different commodities addressed are grouped according to FAOSTAT's Food Balance Sheets (http://www.fao.org/corp/statistics/en/):

1. Cereals (excluding beer): wheat, rice (milled), barley, maize, rye, oats, millet, sorghum, other cereals.
2. Roots and Tubers: potatoes, sweet potatoes, cassava, yams, other roots.
3. Oilseeds and Pulses (including nuts): soybeans, groundnuts (shelled), sunflower seeds, rape and mustard seed, cottonseed, coconuts (incl. copra), sesame seed, palm kernels, olives, other oil crops.
4. Fruit and Vegetables (including bananas): oranges and mandarins, lemons and limes, grapefruit, other citrus, bananas, plantains, apples (excl. cider), pineapples, dates, grapes (excl. wine), other fruit, tomatoes, onions, other vegetables.
5. Meat: bovine meat, mutton/goat meat, pig meat, poultry meat, other meat, offals.
6. Fish and seafood: freshwater fish, demersal fish, pelagic fish, other marine fish, crustaceans, other mollusk, cephalopods, other aquatic products, aquatic mammal meat, other aquatic animals, aquatic plants.
7. Dairy products: milk.

Annex 3. Additional references for quantifying food losses/waste

NB.: Conversion factor determines the part of the agricultural product that is edible.
Allocation factor determines the part of the agricultural produce that is allocated for human consumption.
LIC: low-income countries; MHIC: medium/high income countries; FBS: food balance sheets.

Cereals:
Conversion factors: wheat, rye = 0.78; maize, millet, sorghum =0.79 (LIC), =0.69 (MHIC); rice = 1; oats, barley, other cereals = 0.78. Source: Wirsenius (2000)

Allocation factors for losses during agricultural production and postharvest handling and storage:
Europe = 0.35; NA&Oce = 0.50; Ind. Asia = 0.60; SSA = 0.75; NA,WA&CA = 0.60; S&SE Asia = 0.67; LA = 0.40.

Roots & Tubers:
Proportion of roots and tubers utilized fresh:
Assumed average proportion of cassava utilized fresh in SSA = 50%. Source: Westby (2002). In LA = 20%. Source: Brabet (1998).

Assumed average proportion of potato utilized fresh in Europe and NA&Oce = 27%. Source: USDA (2010b). In NA,WA&CA = 81%. Source: Potatoes South Africa (2010). In S&SE Asia = 90%. Source: Pendey (2009) and Keijbets (2008). In Ind. Asia = 85%. Source: Keijbets (2008) and FAOSTAT (2010a).

Conversion factors: Peeling by hand = 0.74; Industrial peeling = 0.90. Source: UNICEF (1990), Mattsson (2001).

Oil crops & pulses:
Allocation factors: SSA = 0.63; NA,WA&CA = 0.12; S&SE Asia = 0.63; LA = 0.12 ; Europe = 0.20; NA&Oce = 0.17; Ind. Asia = 0.24. Source: FAOSTAT (2010d)

Fruit & Vegetables:
Proportion of fruit and vegetables utilized fresh:
Assumed average proportion of fruit & vegetables utilized fresh in SSA = 99%. Source: Mungai (2000). In NA,WA&CA = 50%. Source: Guajardo (2008). In S&SE Asia = 95%. Source: FAO (undated). In LA = 50%. Source: Guajardo (2008). In Europe and NA&Oce = 40%. Source: USDA (2010c). In Ind. Asia = 96%. Source: Cheng (2008)

Conversion factors: peeling by hand = 0.8; industrial peeling = 0.75; mean = 0.77. Source: own investigation and UNIDO (2004c)

Fish & Seafood:
Proportion of fish and seafood utilized fresh:
Assumed average proportion of fish & seafood utilized fresh in LIC = 60%; in MHIC = 4 %. Source: FAO (2009)

Conversion factor: Average conversion factor for fish & seafood = 0.5. Source: FAO (1989).

Annex 4. Weight percentages of food losses and waste (in percentage of what enters each step)

Estimated/assumed waste percentages for each commodity group in each step of the FSC for Europe incl. Russia.

	Agricultural production	Postharvest handling and storage	Processing and packaging	Distribution: Supermarket Retail	Consumption
Cereals	2%	4%	0.5%, 10%	2%	25%
Roots & Tubers	20%	9%	15%	7%	17%
Oilseeds & Pulses	10%	1%	5%	1%	4%
Fruit & Vegetables	20%	5%	2%	10%	19%
Meat	3.1%	0.7%	5%	4%	11%
Fish & Seafood	9.4%	0.5%	6%	9%	11%
Milk	3.5%	0.5%	1.2%	0.5%	7%

Estimated/assumed waste percentages for each commodity group in each step of the FSC for North America & Oceania.

	Agricultural production	Postharvest handling and storage	Processing and packaging	Distribution: Supermarket Retail	Consumption
Cereals	2%	2%	0.5%, 10%	2%	27%
Roots & Tubers	20%	10%	15%	7%	30%
Oilseeds & Pulses	12%	0%	5%	1%	4%
Fruit & Vegetables	20%	4%	2%	12%	28%
Meat	3.5%	1.0%	5%	4%	11%
Fish & Seafood	12%	0.5%	6%	9%	33%
Milk	3.5%	0.5%	1.2%	0.5%	15%

Estimated/assumed waste percentages for each commodity group in each step of the FSC for Industrialized Asia.

	Agricultural production	Postharvest handling and storage	Processing and packaging	Distribution	Consumption
Cereals	2%	10%	0.5%, 10%	2%	20%
Roots & Tubers	20%	7%	15%	9%	10%
Oilseeds & Pulses	6%	3%	5%	1%	4%
Fruit & Vegetables	10%	8%	2%	8%	15%
Meat	2.9%	0.6%	5%	6%	8%
Fish & Seafood	15%	2%	6%	11%	8%
Milk	3.5%	1%	1.2%	0.5%	5%

Estimated/assumed waste percentages for each commodity group in each step of the FSC for sub-Saharan Africa.

	Agricultural Production	Postharvest handling and storage	Processing and packaging	Distribution	Consumption
Cereals	6%	8%	3.5%	2%	1%
Roots & Tubers	14%	18%	15%	5%	2%
Oilseeds & Pulses	12%	8%	8%	2%	1%
Fruits & Vegetables	10%	9%	25%	17%	5%
Meat	15%	0.7%	5%	7%	2%
Fish & Seafood	5.7%	6%	9%	15%	2%
Milk	6%	11%	0.1%	10%	0.1%

Estimated/assumed waste percentages for each commodity group in each step of the FSC for North Africa, West&Central Asia.

	Agricultural production	Postharvest handling and storage	Processing and packaging	Distribution	Consumption
Cereals	6%	8%	2%, 7%	4%	12%
Roots & Tubers	6%	10%	12%	4%	6%
Oilseeds & Pulses	15%	6%	8%	2%	2%
Fruits & Vegetables	17%	10%	20%	15%	12%
Meat	6.6%	0.2%	5%	5%	8%
Fish & Seafood	6.6%	5%	9%	10%	4%
Milk	3.5%	6%	2%	8%	2%

Estimated/assumed waste percentages for each commodity group in each step of the FSC for South & Southeast Asia.

	Agricultural production	Postharvest handling and storage	Processing and packaging	Distribution	Consumption
Cereals	6%	7%	3.5%	2%	3%
Roots & Tubers	6%	19%	10%	11%	3%
Oilseeds & Pulses	7%	12%	8%	2%	1%
Fruits & Vegetables	15%	9%	25%	10%	7%
Meat	5.1%	0.3%	5%	7%	4%
Fish & Seafood	8.2%	6%	9%	15%	2%
Milk	3.5%	6%	2%	10%	1%

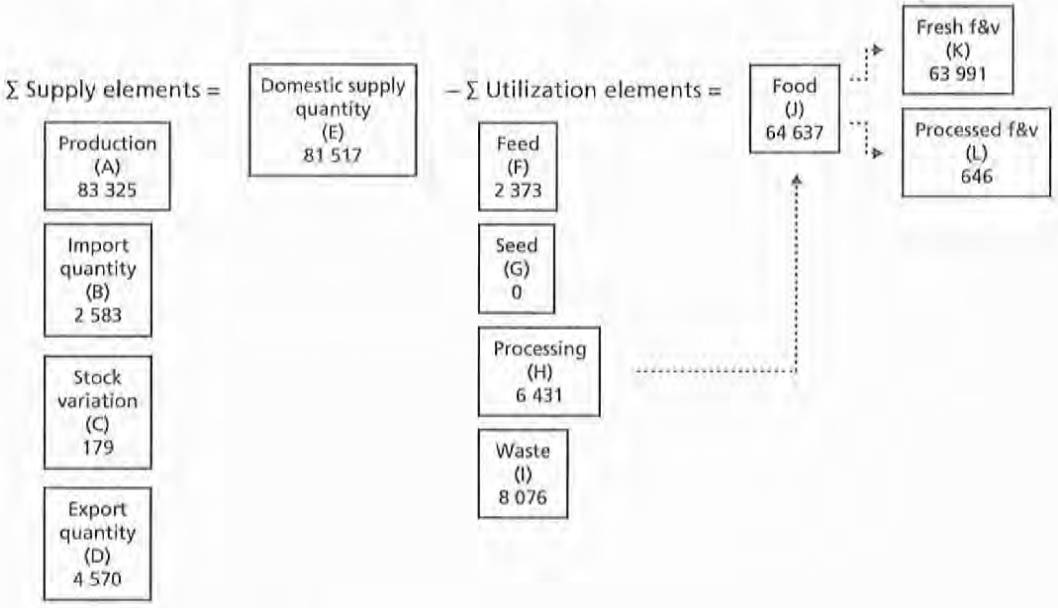
Estimated/assumed waste percentages for each commodity group in each step of the FSC for Latin America.

	Agricultural production	Postharvest handling and storage	Processing and packaging	Distribution	Consumption at household level
Cereals	6%	4%	2%, 7%	4%	10%
Roots & Tubers	14%	14%	12%	3%	4%
Oilseeds & Pulses	6%	3%	8%	2%	2%
Fruits & Vegetables	20%	10%	20%	12%	10%
Meat	5.3%	1.1%	5%	5%	6%
Fish & Seafood	5.7%	5%	9%	10%	4%
Milk	3.5%	6%	2%	8%	4%

Annex 5. Example of calculations of food losses and waste

Example: Calculations on losses and waste of fruit and vegetables (F&V) in SSA. The figure below shows the mass flow of total F&V (1000 tons), as presented in the 2007 FBSs for SSA.

Figure 10. Mass flow of total F&V (1000 tons) as presented in the 2007 FBSs for SSA



A+B+C-D=E-(F+G+H+I) = J=K+L

Waste percentage in each step of the FSC:
Agricultural production = 10%
Postharvest handling and storage = 9%
Processing and packaging = 25%
Distribution (fresh F&V) = 17%
Distribution (processed F&V) = 10%
Consumption (fresh F&V) = 5%
Consumption (processed F&V) = 1%

Calculations on primary equivalent F&V losses and waste in each step of the FSC:
Agricultural production: (0.1/(1-0.1))*83 325 = 9 258 = 9.3 mn tonnes
Postharvest handling and storage: 0.09*83 325 = 7 817 = 7.8 mn tonnes
Processing and packaging = 0.25*(646+6 431) = 1 769 = 1.8 mn tonnes
Distribution (fresh F&V): 0.17*63 991 = 10 878 = 11 mn tonnes
Distribution (processed F&V): 0.1*(646+6 431-1 769) = 531 = 0.5 mn tonnes
Consumption (fresh F&V): 0.05*(63 991-10 878) = 2 656 = 2.7 mn tonnes
Consumption (processed F&V): 0.01*(646+6 431-1 769-531) = 48 = 0.05 mn tonnes
Conversion factors: peeling by hand = 0.8; industrial peeling = 0.75; mean = 0.77

Calculations on edible F&V losses and waste in each step of the FSC:
Agricultural production: 9 258*0.77 = 7 129 = 7.1 mn tonnes
Postharvest handling and storage: 7 817*0.77 = 6 019 = 6.0 mn tonnes
Processing and packaging: 1 769*0.75 = 1 327 = 1.3 mn tonnes
Distribution: (10 878*0.8)+(531*0.75) = 9 101 = 9.1 mn tonnes
Consumption: (2 656*0.8)+(48*0.75) = 2 161 = 2.1 mn tonnes

SAVE FOOD
An initiative of Messe Düsseldorf in collaboration with FAO
www.save-food.org

Rural Infrastructure and Agro-Industries Division (AGS)
Food and Agriculture Organization of the United Nations
Viale delle Terme di Caracalla, 00153 Rome - Italy
www.fao.org/ag/ags
e-mail: AG-Registry@fao.org

Estimating and Addressing America's Food Losses

Linda Scott Kantor, Kathryn Lipton, Alden Manchester, and Victor Oliveira
(202) 219-1264 (202) 219-1106 (202) 219-0832 (202) 219-4133

The U.S. food supply is the most varied and abundant in the world. Americans spend a smaller share of their disposable income on food than citizens of any other country and choose from an average of 50,000 different food products on a typical outing to the supermarket. In 1994, the food supply provided an estimated 3,800 calories per person per day, enough to supply every American with more than one and a half times their average daily energy needs. Given this abundance, few of the Nation's resources have traditionally been devoted to measuring or reducing food waste.

In recent years, growing concern about hunger, resource conservation, and the environmental and economic costs associated with food waste have raised public awareness of food loss. This in turn has accelerated public and private efforts to make better use of available food supplies by recovering safe and nutritious food that would otherwise be wasted.

Of course, not all food that is lost is suitable for consumption (fig. 1). Some losses—like the condemnation

The authors are agricultural economists with the Economic Research Service, USDA. Kantor and Oliveira are with the Food and Consumer Economics Division, Lipton is with the Office of the Administrator, and Manchester is with the Commercial Agriculture Division.

Food Losses Occur Throughout the Food System

Some food losses occur at the farm and farm-to-retail level...

Farm and post-harvest

- Preharvest losses due to severe weather, disease, and predation.
- Harvest losses attributed to mechnization, production practices, and decisions.
- Storage losses due to insects, mold, deterioration, shrinkage, and spoilage.

Processing and wholesaling

- Removal of inedible portions—bones, blood, peels, pits, etc.
- Discard of substandard products (bruised fruit, etc.)
- Shrinkage in storage
- Poor handling or package failure
- Transportation losses

ERS estimates only losses by retailers, consumers, and foodservice[1]...

Retail

- 5.4 billion pounds of food were lost at the retail level in 1995.
- Retail losses were less than 2 percent of edible food supplies.
- Dairy products and fresh fruits and vegetables accounted for half of retail losses.

Consumer and foodservice

- 91 billion pounds of food were lost by consumers and foodservice in 1995.
- Foodservice and consumer losses accounted for 26 percent of edible food supplies.
- Fresh fruits and vegetables accounted for nearly 20 percent of consumer and foodservice losses.

Note: [1]Foodservice and consumer losses include storage, preparation, and plate waste at the household and foodservice levels. Source: Economic Research Service, U.S. Department of Agriculture.

of diseased animals at the slaughtering house, or the discard of moldy fruit from the produce shelf at the supermarket—are necessary to ensure the safety and wholesomeness of the U.S. food supply. Such foods are not recoverable for human use.

Likewise, plate scraps are appropriately discarded at eating establishments out of health considerations. In addition, not all food that is lost is economically recoverable. Food recovery efforts are often limited by financial and logistical constraints that make it difficult to match recovered food with potential recipients.

Nevertheless, large quantities of wholesome, edible food, are lost at every stage of the marketing system. Examples of such losses include meats, bread, and other foods prepared by a restaurant or caterer but never served and the discard of blemished or over-ripe produce, which may be unmarketable for cosmetic reasons, but are otherwise nutritious and safe.

Even a modest increase in the recovery of such wholesome foods could reduce hunger by supplementing existing food-assistance efforts; provide tax savings to farmers, supermarkets, and foodservice establishments that donate food; and lessen the environmental impacts of waste disposal. Understanding where and how much food is lost is an important step in reducing waste and increasing the efficiency of food recovery efforts.

USDA's Economic Research Service (ERS) recently undertook a review of the current data on food waste and built on this knowledge to generate new estimates of food loss by food retailers (supermarkets, convenience stores, and other retail outlets), and consumers and foodservice establishments (storage, preparation, and plate waste in households and foodservice establishments). These losses were estimated by applying known waste factors, gathered from published studies and discussions with commodity experts, to the amount of edible food available for human consumption in the United States. However, losses of nonedible food parts such as bones, pits, seeds, and peels, were excluded (see box about measuring food loss).

Figure 1
While Some Food Is Recoverable, Some Is Not

Not recoverable for human consumption

- Livestock condemned at slaughter because of disease.
- Diseased or otherwise unsafe produce.
- Spoiled perishable food, including meat, dairy, and prepared items.
- Plate waste from foodservice establishments.
- Losses of edible portions associated with processing, such as skin and fat from meat and poultry, and peels from produce.

Recoverable for human consumption

- Edible crops remaining in farmers' fields after harvest.
- Produce rejected because of market "cosmetics" (blemishes, misshapen, etc.)
- Unsold fresh produce from wholesalers and farmers' markets.
- Surplus perishable food from restaurants, cafeterias, caterers, grocery stores, and other foodservice establishments.
- Packaged foods from grocery stores, including overstocked items, dented cans, and seasonal items.

According to the new ERS estimates, about 96 billion pounds of food, or 27 percent of the 356 billion pounds of the edible food available for human consumption in the United States, were lost to human use at these three marketing stages in 1995 (fig. 2). Fresh fruits and vegetables, fluid milk, grain products, and sweeteners (mostly sugar and high-fructose corn syrup) accounted for two-thirds of these losses (fig. 3).

ERS does not know the share of these losses that are recoverable. However, we can get an idea of the significance of loss by calculating the potential benefit of recovery. On average, each American consumes about 3 pounds of food each day. If even 5 percent of the 96 billion pounds were recovered, that quantity would represent the equivalent of a day's food for each of 4 million people. Recovery rates of 10 percent and 25 percent would provide enough food for the equivalent of 8 million and 20 million people, respectively.

The loss estimates presented here are tentative and are intended to serve as a starting point for additional research. Many of the studies on which these estimates are based date from the mid-1970's or before. Dramatic changes have occurred in the food marketing system since then, including innovations in food processing technology and unprecedented growth in the foodservice sector. While we made crude adjustments for these changes in our analysis, additional research—especially updated data on foodservice, processing, and household food losses—is needed to add precision to these estimates and to provide a more complete picture of food loss across the entire marketing system.

Food Losses Begin on the Farm...

Food losses begin on the farm even before a commodity moves into the marketing system. Although ERS was not able to quantify food losses that occur on the farm or between the farm and retail levels, anecdotal evidence suggests that such losses can be significant for some commodities.

Periodic preharvest losses occur, for example, because of severe weather, such as droughts and floods, or pest infestations. For example, each year an average 7 percent of U.S. planted acreage was not harvested during 1994-96. Freezes that periodically damage Florida's citrus crop and natural disasters like Hurricane Fran, which destroyed agricultural crops in North Carolina in the fall of 1996, are examples of causes of such losses. Most of these commodities are not recoverable for human use.

On the other hand, many harvesting losses, especially losses of commodities like fruits and vegetables, are often well-suited for recovery efforts. Economic factors, which affect producers' willingness to bring their product to market, are the most common source of such losses.

For example, minimum quality standards for fresh produce set by State and Federal marketing orders, bumper crops that reduce commodity prices, and consumer demand for blemish-free produce often result in the removal of safe and edible produce from the food marketing system. With such requirements in mind, fruit and vegetable producers often harvest selectively, leaving small, misshapen, or otherwise blemished produce in the field, since these commodities would likely be discarded in the packing shed or processing plant.

Harvesting losses can also be attributed to technological factors, such as increased mechanization, equipment malfunction, and new management practices. Commodities can be lost because mechanized harvesters cannot retrieve the entire item or because the machines are unable to discriminate between immature and ripe products. However, these losses are often viewed as an acceptable tradeoff between field efficiency (lower production costs and faster operation) and increased yields.

Many farmers mitigate harvesting losses by using leftover crops as fertilizer or animal feed. Harvesting losses are also reduced through gleaning efforts, in which volunteers collect leftover crops from farmers' fields where it is not economically profitable to harvest a crop or after a field has been mechanically harvested.

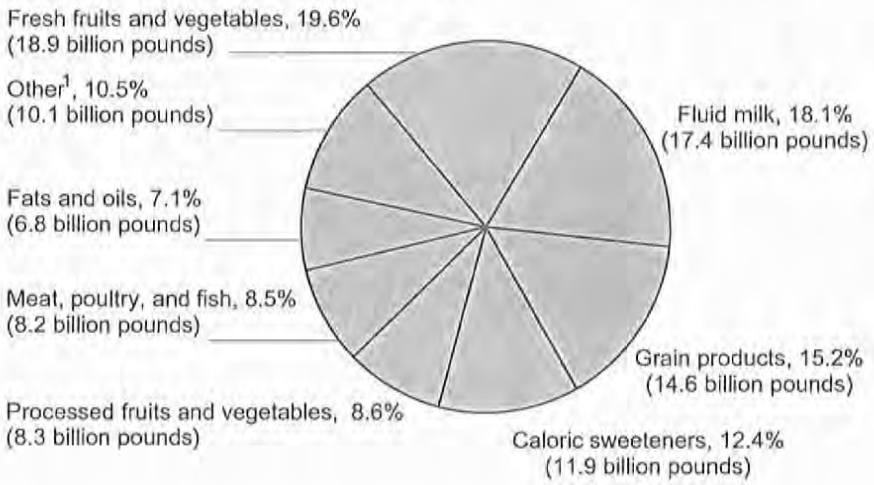
...And Continue Into Processing and Marketing

Food is subject to additional loss as it leaves the farm and enters the food marketing system.

Some loss occurs in storage, due to insect infestations or mold, deterioration, or improper transportation and handling. Produce, dairy, meat, and other fresh items are subject to shrinkage (loss in weight or volume) due to inadequate packaging or simply the passage of time. Also, fresh foods stored or transported at improper temperatures can deteriorate, wilt, or suffer bacterial degradation or microbial growth. Frequent handling by food processors, brokers, and wholesalers can lead to additional losses. According to published studies, a typical food product is handled an average of 33 times before it is ever touched by a consumer in the supermarket.

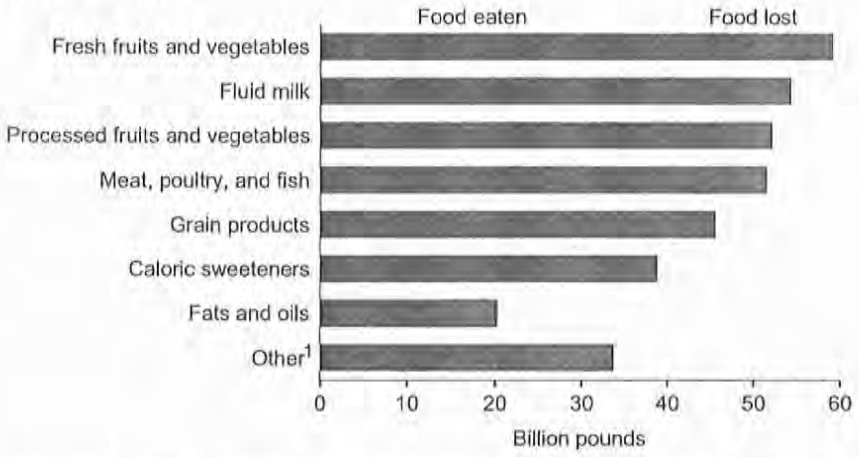
Food-safety regulations also divert some product from the human food chain. According to USDA's Food Safety and Inspection Service (FSIS), 0.2 percent of hogs, 1.7 percent of calves, and 0.4 percent of chickens and turkeys were "condemned" or otherwise rejected at slaughter in 1993 and could not be used for human food. After

Figure 2
More Than 96 Billion Pounds of Edible Food Was Lost by Retailers, Foodservice, and Consumers in 1995



Note: [1] Includes eggs, peanuts, tree nuts, dry beans, peas, and lentils, and dairy products other than fluid milk. Source: Economic Research Service, U.S. Department of Agriculture.

Figure 3
Food Losses Vary by Commodity—Largest Losses Were in the Fresh Fruits and Vegetables, Fluid Milk, and Grain Products Sectors in 1995



Note: [1]Other includes eggs, peanuts, tree nuts, dry beans, peas, and lentils, and dairy products other than fluid milk. Source: Economic Research Service, U.S. Department of Agriculture.

slaughter, some meat is trimmed away because of bruises and other defects. In addition, some viscera, especially livers, are condemned due to safety concerns. Although some of these losses may be preventable through improved farm management and marketing practices, once food becomes spoiled, it is no longer available for human use.

Food losses also occur when raw agricultural commodities are made into final food products. Some of these losses, like removing edible skins from fresh produce, are a normal and necessary part of food processing. For example, about 20 percent of the weight of a fresh apple is lost when it is processed into applesauce. Other processing losses, such as the removal of skin and trimming of fat from meat and poultry, are due to consumer demand for more healthful food choices. Still others, like the increased trimming associated with precut produce, are the result of increased demand for convenience foods from consumers and the foodservice industry.

Although such losses are usually not suitable for direct human consumption, they are often diverted for use in animal feed or as ingredients in other food products. For instance, fresh potatoes lose about half of their weight when they are processed into frozen french fries. Although this appears to represent a "loss" of edible fresh potatoes, most of the "loss" is actually recovered and used by processors for other potato products, such as dehydrated potato flakes and potato starch; and potato skins are often sold to renderers for animal feed.

Dairy Products and Fresh Produce Account for Largest Share of Retail Food Losses

An estimated 5.4 billion pounds of food, less than 2 percent of edible food supplies, was discarded at the retail level in 1995 (table 1). Nearly half of these retail losses came from fluid milk and other dairy products and fresh fruits and vegetables. These findings are consistent with published studies on supermarket discard, which show that fresh produce, dairy products, and other perishable items make up the largest share of retail food losses. Overstocking, overtrimming, improper stock rotation, and post-holiday discard of seasonal items like Halloween cookies are the main reasons that retailers discard food.

Another important component of food loss is stock removed from retail shelves because it has reached its "sell-by" date. Such losses chiefly apply to fresh perishable items such as dairy and bakery products. A rise in the number of instore bakeries and freshly prepared specialty and deli items may mean that supermarkets are managing larger quantities of highly perishable food products with shelf lives as short as a few days. Some of these items, such as day-old bread and expired dairy products, are safe to eat for a short time and are potentially recoverable.

Canned fruits and vegetables, breakfast cereals, pasta, and other nonperishable food products get discarded because of crushed, dented, or otherwise damaged packaging, and expired shelf dates. For example, losses of processed fruit and vegetables, including fruit juices (on a fresh-fruit equivalent basis), were estimated at 521 million pounds, or almost 10 percent of total retail food losses in 1995. Most of these losses occur in inventory control, storage, and handling.

High failure rates for new food products may have increased retail food losses in recent years as the number of new product introductions has risen. More than 16,000 new food products—including new sizes, packaging, flavors, and brands of existing products—were placed on U.S. grocery store shelves in 1995, more than double the fewer than 8,000 introduced in 1988. Although ERS does not know the

success rate for such products, industry experts estimate that more than 90 percent of new food products are removed from the market.

Food recovery programs, which collect such damaged or unmarketable products from food retailers and distribute them to charitable food organizations, can convert these safe but otherwise "unsaleable" items into consumable food and provide a tax benefit to food retailers who donate their products.

Plate Waste Contributes to Large Losses

From foods forgotten and spoiled in the refrigerator to the uneaten vegetables tossed in the garbage, consumer and foodservice food waste is the single largest source of food loss in the marketing chain. Estimated at 91 billion pounds, this food loss accounted for 26 percent of the edible food available for human consumption in 1995. Fresh fruits and vegetables accounted for 19 percent of consumer and foodservice food losses, with an estimated 18 billion pounds discarded annually. An additional 16 billion pounds of fluid milk—the equivalent of one-

Measuring Food Loss: About the Estimates and the Data

Food is lost at every stage of the U.S. marketing system. However, due to the enormous size and diversity of the American food industry, few studies estimate aggregate marketing losses across the entire food sector. Typically, researchers report food losses as a percentage of food servings, household food stocks, or retail inventories at specific points in the marketing system, such as fresh fruit and vegetable losses in supermarket produce departments, household plate waste, or preparation and storage losses in foodservice operations.

In this study, food loss was estimated by applying these loss factors, gleaned from published studies and discussions with commodity experts, to the amount of food available for human consumption in the United States in 1995. Losses at the retail, foodservice, and consumer level were estimated for 260 individual foods, which were aggregated into the food groups listed in table 1. However, preharvest, on-the-farm, and farm-to-retail losses were not measured.

The amount of food available for human consumption was obtained from national food supply and utilization data, collected and published annually by USDA's Economic Research Service (ERS). These data measure flows from production to end uses of several hundred commodities. ERS commodity specialists construct supply and utilization data sets from a wide variety of sources within the Government and food industry. Food available for consumption is calculated as the difference between available commodity supplies (the sum of production, beginning stocks, and imports) and other uses (seed, feed, and industrial consumption, and exports). These components are either directly measurable or estimated by Government agencies using sampling and statistical techniques.

In this study, the amount of food available for consumption was estimated by adjusting these food supply estimates for the removal of nonedible food parts—peels, skins, bones, pits, and seeds. These adjustments were based on ERS conversion factors that account for processing, trimming, and other weight reductions that occur as raw agricultural commodities are made into semiprocessed and final food products available for consumption at the retail, household, and foodservice levels. These reductions ranged from 5 percent for fresh fruit to more than 30 percent for meat, poultry, and processed vegetables.

Limitations inherent in the food supply data suggest that the loss estimates for the consumer, retail, and foodservice sectors presented in table 1 understate total losses for most agricultural commodities. For example, the food supply data for dairy products measure the consumption of manufactured foods, such as ice cream, skim milk, and mozzarella cheese. As a result, the loss estimate for this group includes only the share of processed dairy foods lost to human use. It does not include the loss of raw milk that occurs earlier in the marketing system as the milk is shipped from the farm to the processing plant and used in manufacturing.

Also, estimates of retail, foodservice, and consumer food losses are likely understated due to limitations in the published studies on which these estimates were based. Food loss, particularly at the consumer level, is by nature difficult to measure accurately. Participants in household surveys on food waste, for example, tend to be highly "reactive"—changing their behavior during the survey period out of reluctance to acknowledge how much food they typically discard. Also, archeological examinations of household garbage may underestimate losses due to some food being fed to pets or being discarded in drains and garbage disposals. In addition, only a very limited number of studies, most of them conducted in school and university cafeterias, have successfully measured plate waste at the institutional and foodservice levels.

third of an 8-ounce glass per person per day—and 14 billion pounds of grain products were also lost. Together these foods accounted for more than half of total estimated consumer and foodservice food losses in 1995, partially reflecting their relative importance in the diet when consumption is measured by the weight of food.

Common sources of foodservice food losses include overpreparation of menu items, expanded menu choices (which can make management of food inventories more difficult), and unexpected fluctuations in food sales due to sudden changes in the weather or other factors beyond the control of foodservice operators. In addition, consumer plate loss may be on the rise at restaurants and other eating places due to a growing trend toward the "upsizing" of food portions.

Unless consumers take home uneaten portions for later consumption, restaurants must discard such plate leftovers for health considerations, meaning that increasing amounts of food may be going to waste.

Household food losses occur because of overpreparation, preparation discard, plate waste, cooking losses, spoiled leftovers, and breakage, spillage, and package failure,

Table 1
Large Food Losses Occurred at the Retail, Foodservice, and Consumer Levels in 1995

Commodity	Edible food supply[1]	Losses from edible food supply					
		Retail food loss		Foodservice and consumer food loss		Total retail, foodservice, and consumer food loss	
	Million pounds	*Million pounds*	*Percent*	*Million pounds*	*Percent*	*Million pounds*	*Percent*
Grain products	45,606	912	2	13,682	30	14,594	32
Fruit	48,338	707	2	10,609	23	11,316	23
Fresh	22,389	448	2	6,717	30	7,165	32
Processed	25,949	259	1	3,892	15	4,152	16
Vegetables	63,077	999	2	14,947	24	15,946	25
Fresh	36,830	737	2	11,049	30	11,786	32
Processed	26,247	262	1	3,898	15	4,160	16
Dairy products	76,276	1,525	2	22,883	30	24,408	32
Fluid milk	54,474	1,089	2	16,342	30	17,431	32
Other dairy products	21,802	436	2	6,541	30	6,977	32
Meat, poultry, and fish	51,466	515	1	7,720	15	8,235	16
Red meat	30,350	303	1	4,552	15	4,856	16
Poultry	17,108	171	1	2,566	15	2,737	16
Fish and seafood	4,008	40	1	601	15	641	16
Eggs	7,918	158	2	2,328	29	2,486	31
Dry beans, peas, and lentils	2,263	23	1	336	15	359	16
Tree nuts and peanuts	1,861	19	1	276	15	295	16
Caloric sweeteners	38,827	388	1	11,473	30	11,861	31
Fats and oils	20,250	203	1	6,564	32	6,767	33
Total[2]	355,883	5,449	2	90,818	26	96,266	27

Notes: [1]Excludes nonedible food parts such as bones, hides, peels, skins, pits, cores, and seeds. [2]Totals may not add due to rounding.
Source: Economic Research Service, U.S. Department of Agriculture.

either in the home or en route from the point of purchase. A variety of factors, including household size, income, and food-safety concerns, influence the type and quantity of foods lost at this level.

Archeological examinations of household garbage by researchers at the University of Arizona's Garbage Project revealed that household waste is generally lower for frequently purchased staple items like bread, milk, and cereal than for less frequently used specialty products such as sour cream, hot dog buns, or items bought on impulse. They also concluded that large quantities of single food items, entire heads of lettuce, half-eaten boxes of crackers, and sprouted potatoes—rather than plate scraps—account for the largest share of household food loss.

A 1987 study by the University of Oregon, which examined the reasons that households discard food, suggests that consumer education may play an important role in reducing consumer food loss. In the case of perishable food, knowledge of, or misconceptions about, food safety were the single most important determinants of household food discard. The study indicated that many main meal planners confused quality defects with edibility and were unable to accurately assess whether a food was safe to eat. Such assessments were particularly difficult for consumers under the age of 35. All households had difficulty interpreting package dating information, such as "sell-by" dates or expiration codes.

Looking for Solutions: Food Recovery, Recycling, and Education

Many public and private assistance groups, food retailers, food manufacturers, policymakers, and consumers have looked for ways to prevent food losses, recover lost food, and reduce solid waste. These efforts reach into every corner of the food marketing system. They include food recovery projects to feed the hungry, recycling projects to conserve resources and reduce waste disposal costs, and educational campaigns and economic incentives to prevent food loss.

Food Recovery Efforts Feed the Hungry

Despite the abundance of food in the United States, hunger is a reality for some Americans with limited financial resources. In 1995, 36.4 million people in this country were living in poverty (annual income of less than $15,569 for a family of four). According to USDA food consumption data for the early 1990's, almost 12 percent of U.S. households with annual incomes below the poverty line reported that they sometimes or often did not get enough to eat. USDA spent almost $38 billion providing food assistance to an estimated 45 million people—about 1 in every 6 Americans—at some time during 1996. In addition, an estimated 150,000 nonprofit organizations, including food banks and neighborhood charity outlets, provided more than 10 percent of the U.S. population with a portion of their nutritional needs. However, even with the extensive network of Federal and private food-assistance programs, almost 20 percent of requests for emergency food assistance went unmet in 1995, according to the U.S. Conference of Mayors.

Thus, other sources of food must be utilized.

The term food "recovery" refers to the collection, or recovery, of wholesome food from farmers' fields, retail stores, or foodservice establishments for distribution to the poor and hungry. Food recovery programs operate across the United States and target many different levels of the food marketing system (see box on food recovery efforts). A few are large operations with offices in many States, but most are small local programs that depend largely on the efforts of volunteers from the surrounding community.

A Citizen's Guide to Food Recovery, recently published by USDA, classifies these efforts into four major types:

- ***Field gleaning***—the collection of crops from farmers' fields that have already been mechanically harvested or on fields where it is not economically profitable to harvest;
- ***Perishable food rescue or salvage***—the collection of perishable produce from wholesale and retail sources such as supermarkets;
- ***Food rescue***—the collection of prepared foods from the foodservice industry, including restaurants, hotels, and caterers; and
- ***Nonperishable food collection***—the collection of processed foods with longer shelf lives.

Once surplus food has been "recovered" or prevented from going to waste, volunteers pick up and deliver the food to groups that serve the needy, either directly through neighborhood charitable organizations, such as food pantries and soup kitchens, or indirectly through food banks. In addition to providing additional quantities of food to hungry people, food recovery efforts can also provide food banks with the ability to offer clients more variety and nutrients in their diets by adding fiber-rich fresh fruits and vegetables and grain products to the typical offerings of nonperishable canned and boxed goods.

Food recovery also has benefits that extend beyond providing food to the needy. For example, the additional food supplied by recovery programs allows agencies that serve the disadvantaged to reallocate money to other needed services, money that they would have otherwise spent on food.

These efforts also provide clean fields and tax savings for farmers who donate unharvested crops and reduce waste-removal fees for supermarkets and foodservice establishments. For example, if 5 percent of retail, foodservice, and consumer food losses in 1995 were recovered rather than discarded as solid waste, about $50 million dollars annually could be saved in solid waste disposal costs for landfills alone. If 10 percent of food losses were recovered, savings for landfill disposal costs would be about $90 million. These savings would increase to $200 million with a 25-percent recovery rate.

In addition, large amounts of labor, energy, and other inputs are dedicated to producing food. For example, ERS estimated total U.S. farm production expenses—including seed, fertilizer, and other inputs, and labor, machinery, and other operating expenditures—to be $180 billion in 1995. Food recovery and other loss reduction programs can make more efficient use of these resources by reducing the amount of food that goes to waste.

Food recovery, however, is not without cost. Recovery operations face a number of logistical and financial obstacles in the course of turning "lost" food into food suitable for consumption. At times, these obstacles are quite formidable. They include locating food donors and making them aware of organizations that channel donated food to the needy; obtaining financial resources for transporting, storing, and packaging donated foods; securing labor, whether paid or volunteer; and training those workers in safe food handling and preparation methods. Second Harvest, the Nation's largest domestic charitable hunger relief organization, spends more than $5 million annually transporting food from fields, restaurants, and supermarkets to local food banks that serve the needy.

Until recently, many potential food donors were reluctant to participate in food recovery efforts because they feared legal liability if someone were to become ill from eating their donated foods. The Bill Emerson Good Samaritan Food Donation Act, passed by Congress and signed into law by President Clinton in 1996, promotes food recovery by limiting the liability of food donors to instances of gross negligence or intentional misconduct. It also establishes basic nationwide uniform definitions pertaining to the donation and distribution of nutritious foods, which will ensure that donated foods meet all quality and labeling standards of Federal, State, and local laws and regulations.

Food Waste Recycling and Byproduct Use

Technological advances in food processing and food byproduct development can reduce food loss. For example, many food parts that would have been discarded by food processors 10 years ago are finding new value in industrial raw materials or in other food products. These products include livestock feeds, biodiesel (a fuel made from vegetable oils and animal fats), adhesives and solvents derived from citrus oils, pharmaceutical products made from cow's and goat's milk, and juice products and vinegar made from apple peels.

The large volume of shells from raw eggs processed into liquid egg products, for instance, can be used as a source of calcium in poultry feed or as fertilizer. Eggs taken out of their shells by processing machines may also mean lower rates of processing loss, since up to 30 percent of the egg white can stay with the shell when shells from raw eggs are removed manually. Similarly, the introduction of frozen concentrated orange juice has reduced marketing losses for fresh fruit by enabling processors to use bruised or blemished fruit for juice and the nonjuice portions for cattle feed.

Current research on alternative uses for recycled food waste is focusing on animal feed and compost. For example, research is being conducted on the efficient extraction of food waste materials, known as wash water solids, from dairy processing plants. Extraction of these solids reduces waste disposal fees and results in additional income for dairy processors who sell the recovered material for animal feed.

Food waste can also be blended with other organic compounds, such as newspaper, and composted. The resulting organic material could be developed into a soil-conditioning product. Research is also being conducted on converting food waste into a biodegradable film similar to that used for plastic trash bags. The goal is to develop an organic film that would decompose rapidly and could be used in lawn waste composting operations.

Consumer Education and Economic Incentives

While food recovery and recycling technologies may help to utilize food that would otherwise be discarded, programs designed to prevent food loss in the first place may be particularly useful in reducing consumer and foodservice food losses. A number of programs are currently being implemented.

According to *The Wall Street Journal*, economic incentives are largely behind the Boston Market restaurant chain's recent adoption of a computer program that monitors food inventories. As menu items are sold and entered into the cash register, the program converts these items, such as cole slaw or mashed potatoes, into raw ingredients. At the end of each day, food inventories that remain in the kitchen are

weighed and entered into the computer where they are compared with estimated food uses based on product sales. The difference between used and remaining inventories provides an instant estimate of preparation and storage losses. Since initiating the program, the chain's self-reported food loss has declined from 5 percent to 1 percent of food inventories.

Some local communities are successfully reducing food and other waste by requiring households and businesses to pay for solid waste disposal based on the amount of trash that they generate, usually by charging higher fees for each additional trash container used. According to the U.S. Environmental Protection Agency (EPA), there are currently more than 2,000 such programs in place nationwide, with average reductions in household solid waste of 25 to 45 percent. A 1994 study conducted for the EPA reported that food accounted for about 8.5 percent of municipal solid waste collected from households and businesses.

Education programs that help consumers change their food discard behavior may also be effective in

Food Recovery Efforts Reach Across Marketing System

A Citizen's Guide to Food Recovery—USDA has recently published *A Citizen's Guide to Food Recovery*, a resource guide on food recovery programs for businesses, community-based organizations, private citizens, and local governments. The Guide is designed to support food recovery by showing communities, individuals, and businesses how to support existing food recovery efforts or to begin new programs in their communities. The *Citizen's Guide* and other sources of information about gleaning and food rescue efforts, including most of those listed below, are available free of charge by calling toll-free 1-800-GLEAN-IT or through the Internet at http://www.usda.gov/fcs/glean.htm.

In addition to creating the *Citizen's Guide*, USDA has taken a wide variety of steps to promote citizen service related to food recovery and gleaning:

Food Recovery Roundtables—Secretary of Agriculture Dan Glickman has convened "round tables" around the country to bring together interested nonprofit groups, corporate leaders, social service agencies, and Government officials for collaborative action on food recovery.

AmeriCorps Summer of Gleaning—In the Summer of 1996, as one part of its AmeriCorps program, USDA sponsored a special AmeriCorps "Summer of Gleaning" program that implemented 22 food recovery projects in 20 States. The program was based on the so-called "volunteer generator" model, in which a handful of compensated AmeriCorps members recruit volunteers to help implement large-scale tasks. The 88 AmeriCorps members in the summer program recruited over 1,600 volunteers who helped pick, sort, deliver, and prepare recovered foods.

USDA National Hunger Clearinghouse—USDA has contracted with World Hunger Year, a national nonprofit organization, to develop the USDA National Hunger Clearinghouse. The Clearinghouse established a communications network and comprehensive database identifying all known organizations providing hunger- and poverty-related services, particularly organizations supporting food recovery efforts.

Food Safety Training for Food Recovery—USDA's Cooperative State Research, Education and Extension Service (CSREES), in conjunction with the Cooperative Extension System, is helping local hunger groups recover food safely. Nationwide outreach programs like Purdue University's Safe Food for the Hungry and S.T.R.E.T.C.H. (Safety, Training, Resources, and Education to Combat Hunger) teach food-assistance workers how to transport, store, and prepare food safely. They also show groups dedicated to feeding the hungry how to create nutritious meals from the most commonly donated foodstuffs and bulk supplies.

USDA's Food Safety and Inspection Service (FSIS) is working with the Chef and Child Foundation, the philanthropic arm of the American Culinary Federation, to expand food-safety training for people serving food to the needy at nonprofit feeding program sites, including soup kitchens and shelters.

National Collaboration of Youth (NCY)—USDA signed a Memorandum of Understanding with NCY, an umbrella group for such youth organizations as the Boy and Girl Scouts, Big Brothers/Big Sisters, YMCA of America, and the Boys and Girls Clubs. The agreement specifies how the over 40 million members of NCY organizations will be encouraged to volunteer to recover food.

Federal Cafeterias, Schools, and Farmers' Markets—In conjunction with USDA efforts, the Washington cafeterias of the Department of Justice, the Department of Energy, and the Office of Personnel

preventing food loss. For instance, educational programs that help meal planners determine appropriate portion sizes and distinguish between spoiled and safe food can help consumers reduce plate waste and better utilize leftovers. Improved meal planning and purchasing skills—including information that helps consumers understand the meaning of manufacturers' expiration codes, and "use-by" and "sell-by" dates—can reduce the discard of food items.

Government-sponsored initiatives, such as USDA's publication of *A Citizen's Guide to Food Recovery*, along with local efforts to train food recovery volunteers in the safe handling and preparation of rescued food, can increase the safety and efficiency of food recovery efforts. Recent legislation that reduces the liability of food donors has increased the amount of food recovered to feed the needy. Educational programs that increase the awareness of food loss by manufacturers, retailers, and consumers may reduce the amount of food loss and in turn the environmental and economic costs of waste disposal.

Over the long run, the reduction and recovery of uneaten food in the

Management are donating excess food to the DC Central Kitchen in Washington, DC. The DC Central Kitchen plans and distributes 3,000 meals per day, 7 days a week, to 95 charity outlets across the Washington metropolitan area. The Kitchen is in part staffed by homeless workers—48 per year—who receive 3 months of on-the-job training in food preparation and management from professional chefs who volunteer their skills.

USDA is also helping school districts in both the Washington, DC, and Wichita, KS, areas to involve students in community service activities related to fighting hunger and recovering food. USDA is also working with the nonprofit groups Rock & Wrap It Up! and FoodChain to help students recover food from the School Lunch Program, restaurants, and concerts.

In addition, USDA is helping to promote food recovery from farmers' markets nationwide, including markets held at Federal agencies.

Public Service Announcements—USDA worked with the Fox Television Network to air a plot-related public service announcement on the television show *Party of Five* that promoted food recovery and provided viewers with the 1-800-GLEAN-IT telephone number to obtain the *Citizen's Guide* and other information about gleaning and food rescue.

National Summit on Food Recovery—USDA, the Congressional Hunger Center, and the nonprofit groups Second Harvest and FoodChain will co-sponsor a National Summit on Food Recovery, which will be modeled on President Clinton's Summit on America's Future. The Summit will bring together leaders from State, county, and city governments, Indian tribes, nonprofit organizations, religious groups, large corporations, and small businesses. All attendees will be asked to make specific commitments to increase food recovery prior to the event.

National Week of Food Recovery—President Clinton will declare a National Week of Food Recovery, during which food recovery volunteer projects will occur nationally.

The Federal Government is not alone in its food recovery efforts. Foodservice operators, retailers, nonprofit organizations, and individual citizens are also involved.

FoodChain—FoodChain is the Nation's largest network of prepared and perishable food rescue programs. It opened its doors in 1992 with a staff of one. Today, 116 member programs and 22 associate programs participate in FoodChain, distributing nearly 100 million pounds of food to some 7,000 social service agencies each year.

Foodservice—Hundreds of nationwide and regional restaurant chains of various sizes, along with individual foodservice outlets, are channeling unsold food to local food recovery programs.

Second Harvest—Second Harvest, the largest domestic hunger relief organization, rescued 811.3 million pounds of food in 1995 from going to waste by soliciting donations of food and grocery products from the Nation's food industry.

Society of Saint Andrew (SoSA)—The SoSA Gleaning Network has recovered more than 200 million pounds of fresh fruits and vegetables since its founding in 1979, and distributed them to food pantries and soup kitchens across the United States.

"Unsaleable" Food Products—The food industry has developed a Joint Industry Task Force on Unsaleables to develop new strategies and incentives to improve the condition of dented, bruised, or otherwise damaged food products for food banks. These "unsaleables" are channeled through Product Reclamation Centers, which help retailers recover the food for organizations that assist the needy.

United States is a complex undertaking requiring the involvement of public and private institutions, as well as consumers. Efforts to reduce or prevent food loss must be balanced against the cost of conserving and recovering food. However, successful food recovery programs can provide many benefits to society which can offset a portion of these costs. Among other things, food recovery programs can help to reduce hunger; provide tax savings to farmers, food manufacturers, retailers, foodservice operators, and others that donate food; conserve landfill space; and lessen the costs and environmental impact of solid waste disposal. While our estimates of food loss lack precision, they identify an important issue in the food system that deserves closer attention.

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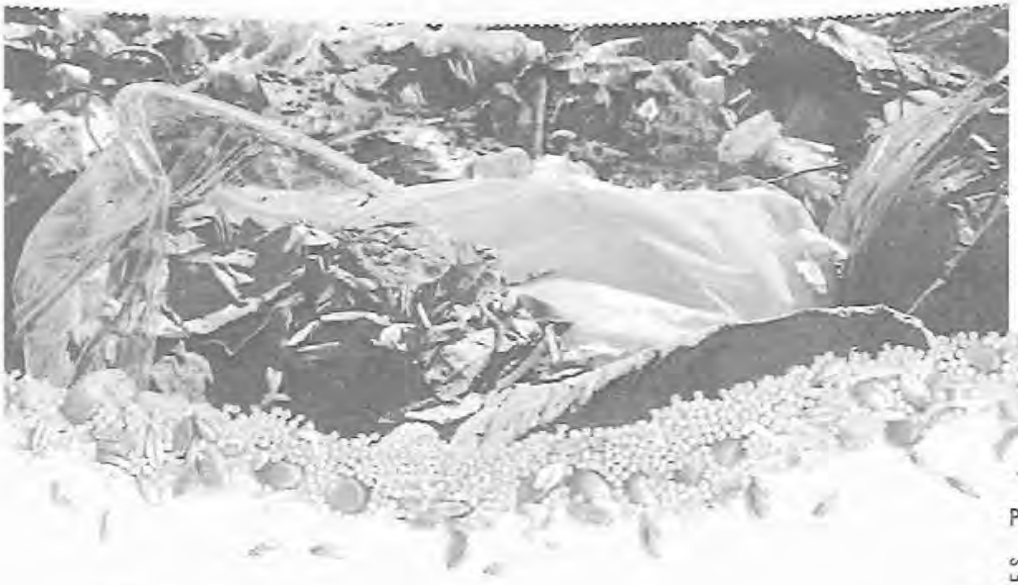


FOOD WASTAGE FOOTPRINTS

DID YOU KNOW?

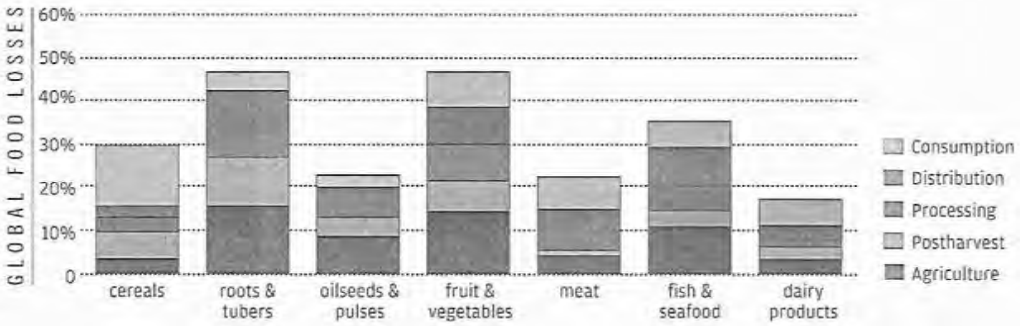
SOCIAL Today, there are 900 million hungry people worldwide and one billion people overfed. Under the current production and consumption trends, global food production will need to increase by 60 percent by 2050.

ECONOMY Post-harvest grain losses in Sub-Saharan Africa alone are estimated at around USD 4 billion a year. This lost grain production could meet the minimum annual food requirement of 48 million people.

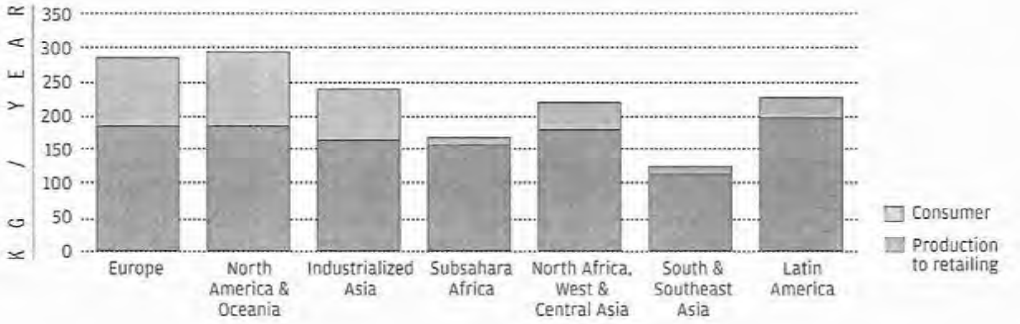
ENVIRONMENT Lost and wasted food represents a missed opportunity to feed the growing world population. It also comes at a steep environmental price, as land quality, water quantity, biodiversity are adversely affected. Wasted food also has a strong impact on global climate change.

GOVERNANCE Food lost after harvest and food wasted along the distribution and consumption chain, or food wastage, has a dual negative environmental impact: undue pressure on natural resources and ecosystem services and pollution through food discards. Within the global context of increasingly scarce natural resources, more than 1/3 of the food produced today is not eaten, which is about 1.3 billion tonnes per year.

PART OF THE INITIAL GLOBAL PRODUCTION LOST OR WASTED



PER CAPITA FOOD LOSSES AND WASTE, AT CONSUMPTION AND PRE-CONSUMPTION STAGES



WHY DOES FOOD WASTAGE MATTER FOR SUSTAINABILITY?

LAND

Intensive farming, without allowing fields to lie fallow and replenish, diminishes soil fertility. Not using roughly one third of world food produced means that soil is unnecessarily pressured. Decreased soil quality leads to further use of synthetic inputs that cause pollution and eventually, loss of arable land.

- In 2005, more than 500 million hectares of arable land were used to produce food not consumed. That amounts to more land than the entire South Asian peninsula.
- Agricultural land use is projected to increase by 10 percent from 2005 to 2050. At current food waste levels, that will mean an estimated 71 million more hectares used in vain.

WATER

Agriculture already uses 70 percent of the global freshwater withdrawal and any increased production will likely mean more water use. Water will be a key constraint to global security and when food is wasted, the water is squandered.

- Globally, water lost when food is not consumed equals about half the water withdrawn for irrigation use; this water waste is equivalent to half the water volume of Lake Victoria (half lake volume is 1350 cubic Km).
- Globally, the loss of water through food wastage would easily meet the household water needs of the 9 billion people expected in 2050.

CLIMATE CHANGE

Food and agriculture systems heavily depend on fossil-fuel energy. Petroleum is used in almost every aspect of food production, from creating fertilizers, to mechanized planting and harvesting, irrigation, cooling and transportation. Furthermore, when food is discarded in a landfill and decomposes anaerobically, it yields methane emissions, a gas more than 25 times as potent as carbon dioxide at trapping heat.

- The total UK greenhouse gas emissions from "avoidable" food waste are equivalent to emissions from 20 percent of cars on UK roads.
- USA food wastage represents 300 million barrels of oil per year, or 4 percent of total national oil use.
- Food is the primary source of landfill gas and the largest component of materials sent to landfills. In USA, landfill gas is responsible for 34 percent of USA methane emissions.

BIODIVERSITY

The food not eaten is one of several factors that contributes to biodiversity loss through habitat change, overexploitation, pollution and climate change.

- Prompted in part by global food production inefficiency, 9.7 million hectares are deforested annually to grow food; this represent 74 percent of total annual deforestation.
- Meat and dairy products wasted in USA and the UK households and food service requires 8.3 million hectares of agricultural land to be produced; this is seven times the amount of land deforested in 2008.
- Up to 70 percent of all fish caught by trawling are discarded.

HIGHLIGHT

SAINSBURY'S ZERO FOOD-WASTE-TO-LANDFILL POLICY

In 2011, Sainsbury's became the first British supermarket to send no food waste to the landfill. The majority of the retailer's excess food is now used to create energy via anaerobic digestion. As of 2011, Sainsbury's was the largest British retail anaerobic digestion user after signing a three-year agreement with Biffa waste management. The grocer made its zero-food-waste-to-landfill pledge in 2009. With this policy, Sainsbury's helps Britain fulfill the EU Landfill Directive mandating reduction of biodegradable waste to landfill to 50 percent of 1995 levels by 2013.

Sainsbury's has also made efforts to reduce its food waste through better inventory control and sales forecasting and by donating edible but unsellable food to the hungry through charities like FareShare. The grocer has been working with the charity for more than 17 years and provided millions of meals.

In addition to reducing their in-store waste, Sainsbury's also helps customers trim their home waste. The chain provides advice on how to properly store produce and launched a Love Your Leftovers campaign, which includes a page on their web site providing recipes and ideas on how to utilize leftover food.

Sainsbury's also unveiled new labeling on its food items advising shoppers on how to use their freezers to extend the life of their food.

HOW CAN YOU HELP?

PRODUCERS

- Harvest all that is grown, at the optimal time.
- Invest in better storage technology.
- Compost/mulch unavoidable organic waste.

CONSUMERS

- Don't buy more food than what is necessary, by planning meals, creating a detailed shopping list and shopping more frequently, buying less each time.
- Store foods properly, whether in air-tight containers or in refrigerators.
- Understand expiration dates and treat them as a suggestion, not the law.

FOOD INDUSTRY

- Allow consumers to customize the amount of food they buy.
- Donate unsellable, edible food.
- Expand definition of acceptable food and sell imperfect items at a discount.

POLICY MAKERS

- Set binding food wastage reduction goal.
- Discourage sending food waste to landfill and enable growers to harvest all they grow.
- Fund or create an awareness campaign to reduce food waste.

RESEARCH REQUIREMENTS

- Quantify the global economic cost of food wastage.
- Calculate how much of current wastage would be required to end hunger and strategize on redistribution.
- Determine whether reducing food loss and waste would enable global agricultural output to feed the estimated 2050 population of 9 billion.

Building on FAO's long experience on post-harvest food losses and the more recent assessment of global food loss and waste, efforts are on-going to model the Food Wastage Footprint along the value chain at global level. FAO is also collecting best practices on reducing food wastage in a public database that would ultimately allow the production of Guidelines of Good Practices.

For more details: www.fao.org/nr/sustainability/food-loss-and-waste

Note: This paper has been submitted to a journal for publication and is available here in the interim as a working paper for informational purposes only.

The Climate Change and Economic Impacts of Food Waste in the United States

Kumar Venkat[1], CleanMetrics Corp.

ABSTRACT

This study presents, for the first time, a comprehensive analysis of both the climate change and economic impacts of food waste in the United States. Using the most recent loss-adjusted national food availability data for 134 distinct food commodities – accounting for most of the food consumption in the US – this study applies a rigorous life cycle assessment methodology to calculate the annual life-cycle greenhouse gas emissions due to wasted food. In addition, the study calculates the annual economic impact of the waste using recent retail prices for food commodities. The analysis shows that the avoidable food waste in the US amounts to over 55 million metric tonnes per year, representing nearly 29% of annual production. This results in greenhouse gas emissions of at least 113 million metric tonnes of CO2e annually, equivalent to 2% of US national emissions. Over two-thirds of these emissions occur in production and processing. The annual economic cost of this waste to US businesses and consumers is $198 billion. Consumers are responsible for 60% of the waste and bear a proportionate fraction of the cost – about $1600 per year for a family of four – while retailers are responsible for one-third of the waste. There is a promising opportunity here to show both consumers and businesses that they can simultaneously mitigate emissions and save money through waste reduction.

Keywords: food waste, climate change, greenhouse gas emissions, life cycle assessment (LCA)

INTRODUCTION

A recent study by the Food and Agriculture Organization (Gustavsson, et al., 2011) reports that one-third of all food produced for human consumption is lost or wasted globally, amounting to as much as 1.2 billion metric tonnes annually. A report from the Waste & Resources Action Programme (Chapagain and James, 2011) states that households in the United Kingdom (UK) waste 8.3 million metric tonnes of food and drink each year, with a value of at least $18.6 billion and responsible for about 3% of UK's domestic greenhouse gas (GHG) emissions.

[1] Address correspondence to Kumar Venkat, CleanMetrics Corp., 4804 NW Bethany Blvd., Suite I-2 #191, Portland, OR 97229, USA. E-mail: kvenkat@cleanmetrics.com

Food waste is now receiving increasing attention in the United States (US). While cities such as Portland are focusing on food waste recycling through composting (Walker, 2011), the food industry has launched an initiative to help reduce food waste at the source (EL, 2011). However, a comprehensive evaluation of the environmental and economic impacts at the national level has been lacking. Two recent studies have taken a first look at the larger environmental impacts of food waste in the US beyond just the disposal stage.

Hall, et al. (2009) used energy balance to calculate that nearly 40% of the food was wasted in the US as of 2003, accounting for more than one quarter of the total freshwater use and 4% of petroleum oil consumption. The water and energy estimates were based on the overall freshwater consumption by agriculture and the fossil energy used by the average farm to produce food containing 1 kcal of energy.

Cuellar and Webber (2010) used food loss data from the US Department of Agriculture for 1995 – which show that 27% of edible food was wasted – and estimated that the energy embedded in wasted food represents about 2% of annual energy consumption in the US. The total energy required for food production (agriculture, processing, transportation and handling) at the national level was compiled from various literature sources. Agricultural energy use for 10 broad food categories was derived from the total energy used by agriculture using relative intensity factors and production mass.

Both of these studies used top-down methods (i.e., starting from an economy-wide estimate of energy used in agriculture and deriving from it a national average for the farm level or food category level) to estimate the energy needed to produce food that is ultimately wasted. While Hall, et al. (2009) discuss GHG emissions from the decomposition of wasted food, neither of these studies directly addresses climate change, arguably the most pressing environmental problem of our times.

It should also be noted that the climate change impact of food waste – as quantified by life-cycle GHG emissions – is a more complete measure of environmental impact than embedded energy or barrels of oil: It includes not only the emissions from the burning of fossil fuels but also significant other GHG emissions that are not energy-related such as methane (in agriculture and waste disposal) and nitrous oxide (in agriculture).

Besides environmental impacts, food waste also imposes an economic cost on consumers and retailers. If quantified correctly, this could provide a unique incentive to simultaneously mitigate emissions and save money through waste reduction.

The motivation for the present study is to quantify in a comprehensive manner, for the first time, the annual climate change and economic impacts of the food wasted in the US using the most recent data available. In conjunction, a secondary goal is to develop a robust food waste

model and methodology – based on the principles of life cycle assessment (LCA) – that can be used to monitor the future impacts of food waste not only in the US but also in other parts of the world.

The approach adopted in this study is both bottom-up and life-cycle based: It analyzes 134 distinct food commodities accounting for most of the food consumed in the US, and then groups them into 16 food categories. Each of the 134 commodities is modeled using one or more representative production systems, based on detailed North American production data in most cases. Foods such as beef, chicken, pork and cheese are placed in their own separate categories because of their unique production characteristics and significant climate change impacts. Such an approach can provide a degree of precision and rigor that may not be possible with top-down methods.

The rest of the paper is organized as follows. We will first describe the methods used in our analysis including: the life-cycle food waste model; LCA standards, software and database used in the calculation of GHG emissions; the system boundary; important assumptions; and the how the economic impact is calculated. Following this, we will describe the food waste data used in this study, including a detailed summary of annual food production, consumption and waste in the US. We will then present detailed results for the climate change and economic impacts of US food waste, including a sensitivity analysis to test a critical subset of the assumptions used in this study. We will then close with concluding remarks and recommendations for further work on quantifying the full impacts of food waste.

METHODS

Life-Cycle Food Waste Model

Figure 1 illustrates the life-cycle model of material flow from production to disposal for each of the food commodities. This model has been developed specifically to fit the loss-adjusted food availability data series from the US Department of Agriculture (USDA ERS, 2009).

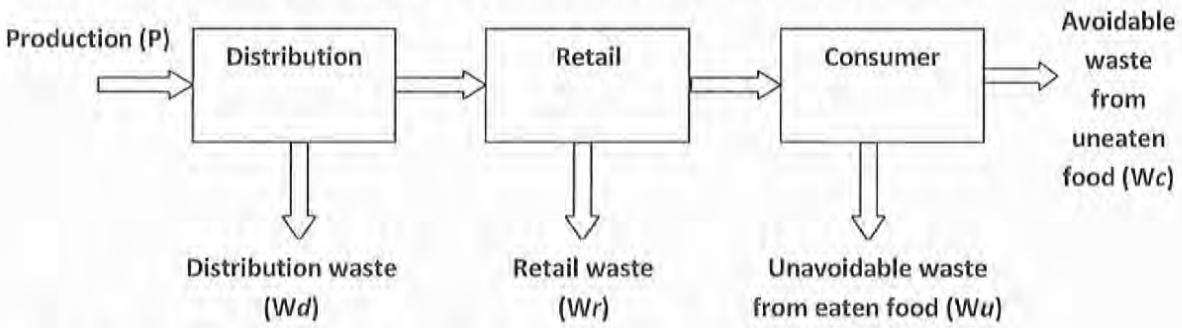


Figure 1 Life-cycle model of material flow from production to disposal

Equation 1 below defines the basic mass balance in the life cycle of a food commodity. The difference between production (P) and consumption (C) is the total gross waste made up of waste at the distribution (Wd), retail (Wr) and consumer (Wcg) levels. All quantities are product weights.

$$P - C = Wd + Wr + Wcg \qquad (1)$$

The food availability data series provides values for each of the terms in Equation 1 for all commodities on an annual basis from 1970 through 2009. Wcg is the gross consumer waste, the sum of avoidable and unavoidable consumer waste:

$$Wcg = Wc + Wu \qquad (2)$$

The avoidable consumer waste (Wc) – also referred to as "consumer waste" in this paper – represents uneaten food that is wasted at the consumer level and is defined in Equation 3. Wc excludes the unavoidable waste in consumed foods due to non-edible parts (such as skins and shells) as well as fat or moisture losses in cooking. N is the fraction of a food commodity that is non-edible, and L is the fraction that is lost as fat or moisture during cooking.

$$Wc = Wcg - \left(\frac{1}{(1-N)(1-L)} - 1\right) C \qquad (3)$$

The non-edible fraction N for each commodity is obtained directly from the food availability data. The fat or moisture lost in typical cooking is estimated from USDA ERS (1998) based on certain cooking assumptions as shown below. These estimates apply only to meats, fish, eggs and oils, all of which lose fat and possibly moisture during cooking. Vegetables may lose moisture in cooking, but we assume that this is compensated on average by added moisture during cooking. Since cooking methods and cooking losses can vary considerably, these typical loss estimates are subjected to a sensitivity analysis as described in the Results and Discussion section.

TABLE 1 Estimated fat and moisture losses in typical cooking

Category	Cooking assumption	Fat/moisture loss fraction
Beef	Steaks	0.25
Pork	Chops	0.25
Chicken	All cooking	0.26
Turkey	All cooking	0.27
Lamb	Chops/Steaks	0.25
Shellfish	Boiled	0.24

Fish	Baked	0.19
Fats & Oils	All cooking	0.10
Eggs	Scrambled	0.08

The total avoidable waste Wa, then, is the sum of distribution waste, retail waste and avoidable consumer waste.

$$Wa = Wd + Wr + Wc \quad (4)$$

The avoidable consumer waste is further adjusted for moisture and fat losses in cooking as follows in order to estimate the remaining solid waste that is actually landfilled. Although cooking is not explicitly included in this study, we assume that half of the consumer waste occurs after cooking. This assumption is necessary for calculating Wl, the quantity of waste sent to landfills after accounting for fat and moisture losses in the cooking of certain foods.

$$Wl = Wa - \frac{Wc}{2}L \quad (5)$$

LCA Standards

Life-cycle GHG emissions for the food commodities have been modeled and analyzed based on the PAS 2050:2008 standard (BSI Group, 2008), which in turn builds on ISO standards (ISO, 2006) by specifying additional requirements for the assessment of GHG emissions in the life cycle of products and services. Within this framework, GHG emissions from agricultural processes and waste disposal are modeled based on the IPCC tier 1 guidelines (IPCC, 2006).

LCA Software and LCI Database

FoodCarbonScope™ (CleanMetrics, 2011b), a web-based LCA software tool for food and beverage products, was used to perform the detailed cradle-to-farm gate GHG emissions modeling and analysis of all the farming systems. FoodCarbonScope supports all of the standards on which this study is based (BSI Group, 2008; ISO, 2006; IPCC, 2006).

FoodCarbonScope includes CarbonScopeData™ (CleanMetrics, 2011a), which is a life cycle inventory (LCI) database. CarbonScopeData includes cradle-to-gate and unit process data for over 1100 products and processes in the food and agriculture sectors, covering a full range of crop and animal production systems, commercial food processing, commercial cooking appliances, packaging, and waste disposal. The majority of this data is for US and Canadian production and processing drawn from over a dozen major agricultural states and provinces. In addition, the database includes: food production data for Europe and other parts of the world;

data for all energy sources including electricity by grid regions; all common freight transport modes used for food products, including refrigerated transport; and refrigerators/freezers used for food storage in distribution and retail locations. FoodCarbonScope and CarbonScopeData have been used previously in major LCA studies of North American food systems (Hamerschlag and Venkat, 2011; Venkat, 2011).

Each of the 134 food commodities is mapped to one or more food production systems in the LCI database for the purposes of this study. Most of the high-volume commodities – including beef, pork, chicken, fish, some dairy, common nuts and legumes, and several fruits and vegetables – are modeled as the average of two or more representative production systems in North America. Most of the other commodities are modeled using the closest available North American production system in the database, with the exception of tropical fruits and tuna which are modeled using overseas production systems.

Functional Unit and System Boundary

The functional unit for the LCA of each food commodity is the actual annual quantity consumed in the United States as calculated from USDA ERS (2009). This in turn requires a higher quantity of production, and the difference between the two quantities determines the wasted food.

The spatial boundary for the LCAs of the food commodities is cradle to grave. This starts with extraction of raw resources from the ground and ends with the disposal of uneaten food. The system boundary includes the production, processing and packaging of food products, transport and storage through typical distribution networks, storage at retail locations, and landfilling of waste. Food production and processing are generally assumed to occur within the United States, except for specialty items such as tropical fruits and tuna which are imported. Food waste is considered at the distribution, retail and consumer levels for which data exist, but not at the farm or processing level (USDA ERS, 2009). Certain food processing steps are excluded where the data are in terms of the primary ingredients only, as explained further under Other Assumptions. All energy used at the consumer level – including shopping trips, refrigeration and cooking – is excluded from this analysis because of uncertainties and lack of adequate data. Therefore, the total climate change and economic impacts of food waste as calculated in this study represent conservative lower bounds on the actual impacts.

The temporal boundary consists of one year of production and consumption based on 2009 data. The assessment period for the LCAs is 100 years, meaning that the climate change impact of one year's food waste is evaluated over the standard 100-year time horizon in this study. This is particularly important for the calculation of long-term emissions from landfills due to food waste deposited in any one year.

Other Assumptions

The food waste analysis undertaken in this study considers the entire US food system, which necessitates a number of reasonable assumptions. These assumptions are listed below, and a critical subset of the assumptions is subjected to a sensitivity analysis as described in the Results and Discussion section.

- The vast majority of the food consumed in the US is assumed to be produced in North America, except as indicated below. This is justified by the fact that nearly 99% of GHG emissions from the provision of food in the US are due to domestic production and value chain activities (Stolaroff, 2009).
- All meat product weights are boneless-equivalent (edible) weights as specified in the food availability data (USDA ERS, 2009).
- All fish and shellfish are assumed to be produced in North America through aquaculture. Tuna is wild caught in Europe and imported to the US.
- Typical food processing is included for all commodities that are listed in their processed forms in the food availability data (USDA ERS, 2009). Examples include fruit juices, canned and frozen vegetables and fruits, canned tuna, various meats and fish, milled flour, etc. On the other hand, some commodities are listed in the data only in terms of the primary ingredients – additional processing steps are excluded from our analysis in such cases. Examples include processed grain products such as breakfast cereals, pasta and bread, which are listed in terms of the primary grains and flour.
- All fresh foods are stored (in refrigerators, freezers or otherwise) in distribution centers and retail stores for an average of 7 days before purchase.
- All food commodities are assumed to be transported an average of 2400 km within North America from production or processing locations to typical retail locations. Out of this, 2240 km are through semi-trailer trucks and 160 km through single-unit trucks. Tropical fruits are transported an additional 5000 km by ocean, and canned tuna is transported an additional 10,000 km by ocean. All transport modes include refrigerator or freezer compartments as needed.
- Two-thirds of all meat and fish is distributed frozen and the rest is distributed fresh.
- Fresh meat, fresh fish, dairy, fruits and vegetables are assumed to require refrigeration throughout the distribution and retail stages. (While some fruits and vegetables may not be refrigerated for certain periods at the retail stage, almost all are refrigerated during distribution.)
- Food packaging materials and configurations for meat and fish products are based on commercial packaging information from Sealed Air (2011). All other commodities – including dairy, vegetables, fruits, nuts, grains, oils, and juices – are assumed to be packaged in typical materials and configurations as found in retail stores. In the case of

grains, the food availability data (USDA ERS, 2009) are in terms of the primary grains and flour produced and consumed, but not in terms of final processed products such as breakfast cereals or pasta. In such cases, the packaging assumptions apply to the forms of the food commodities found in the data.

- All solid waste from wasted food is landfilled under typical US conditions in anaerobic landfills, with 21% of the landfill methane flared and 23.25% of the methane recovered for electricity (EPA, 2006). The landfills are assumed to be distributed equally in Boreal temperate wet and dry climate zones as defined by the IPCC (2006). Long-term carbon storage in the waste matter present in landfills offsets a small portion of the final emissions.
- Fluid milk and juice products are assumed to be disposed through waste water which is then treated in an anaerobic reactor. Energy used in waste water processing comes from US average grid electricity.

Calculating the Economic Impact of Wasted Food

The economic impact of avoidable food waste is calculated in this study using current US retail prices for all the food commodities. The retail price of a commodity reflects all the value added throughout the value chain – including agriculture, processing, packaging, distribution and retail – and provides a very good measure of the total economic value embedded in the commodity as delivered to consumers. Therefore, retail prices are used to uniformly calculate the economic impact of all avoidable food waste occurring after the production/processing stages – specifically waste at the distribution, retail and consumer levels.

The US Department of Agriculture provides current national retail prices for most meats, eggs, vegetables and fruits (USDA AMS, 2011; USDA ERS, 2011). Prices for the other commodities are based on current advertised prices at a major online food retailer (Safeway, 2011). While the food waste data is for the year 2009, all retail prices used in this study are as of December 2011 because a complete set of 2009 prices is not readily available.

Most of the food waste is generally landfilled, as assumed in this study. The typical cost structure for municipal solid waste collection and disposal in North America is a flat rate for a fixed volume of waste (Rosenberg, 1996), which makes it difficult to quantify the real disposal cost of a marginal increase or decrease in the quantity disposed. Therefore, disposal cost is excluded from our calculation of the economic impact of food waste. It should also be noted that disposal costs are likely to be negligible compared to the retail prices of the wasted quantities.

FOOD WASTE DATA

The loss-adjusted food availability data series from the US Department of Agriculture (USDA ERS, 2009) is the basis for the food waste analysis in this study. This data series provides annual per-capita food production, waste and availability data for a full spectrum of food commodities in the United States, adjusted for food spoilage and other losses to closely approximate per-capita intake. Food waste is further broken down into waste at the distribution, retail and consumer levels. The US population estimate for 2009 (US Census Bureau, 2011) is used convert the annual per-capita data for all commodities into national aggregate data.

This study uses the most recent year in the food availability data series, which is 2009, and analyzes a total of 134 commonly consumed food commodities accounting for most of the food consumed in the US. These commodities include common meats, fish, shellfish, dairy products, oils and fats, eggs, sweeteners, nuts, legumes, grains, vegetables, fruits, and fruit juices.

Table 1 summarizes the annual aggregate food production, consumption and avoidable waste data for the major food commodity categories as derived from the food availability data (USDA ERS, 2009). Waste at the consumer level has been adjusted to remove the unavoidable waste in consumed foods as per the food waste model defined in the Methods section. The result is the *avoidable* consumer waste (defined by Equation 3) and includes both the edible and non-edible portions of foods available at the retail level that are not consumed.

All quantities in Table 2 are in millions of metric tonnes (MMT) per year. Using this data, our total estimate of avoidable food waste in the US is 55.41 MMT/year for 2009, which amounts to 28.7% of total annual production by weight. Consumer waste dominates the total waste, accounting for just over 60% of the total avoidable waste. Retail waste – including waste in institutional food service – amounts to 34% of the total. Figure 2 illustrates this in terms of absolute quantities (MMT), and Figure 3 depicts the same data as percentage of food wasted in each category. Appendix A provides the same information in detail for all 134 commodities.

TABLE 2 US annual food production, consumption and avoidable waste in 2009 (MMT/year)

Category	Production P	Consumption C	Distribution Waste Wd	Retail Waste Wr	Consumer Waste Wc	Total Avoidable Waste Wa
Beef	8.09	5.26	0.00	0.35	0.72	1.07
Pork	6.48	3.78	0.00	0.28	1.16	1.44
Chicken	7.80	4.50	0.00	0.31	1.42	1.73
Other Meats	1.95	1.27	0.00	0.08	0.14	0.21

Fish & Shellfish	1.98	1.29	0.00	0.17	0.25	0.42
Cheese	4.90	3.93	0.00	0.33	0.64	0.97
Milk & Yogurt	26.47	18.63	0.00	3.18	4.66	7.84
Other Dairy	5.70	4.18	0.00	0.62	0.90	1.52
Butter, Fats & Oils	10.88	7.23	0.00	2.08	0.87	2.95
Eggs	4.48	2.93	0.07	0.40	0.40	0.86
Sweeteners	18.00	12.82	0.00	1.98	3.20	5.18
Nuts	1.28	1.08	0.00	0.08	0.12	0.20
Legumes	0.96	0.81	0.00	0.06	0.09	0.15
Grains	27.02	18.89	0.00	3.24	4.89	8.13
Vegetables	37.60	21.91	1.95	2.96	8.72	13.63
Fruits & Juices	29.48	17.59	0.90	2.65	5.56	9.11
Total	193.10	126.13	2.92	18.76	33.73	55.41

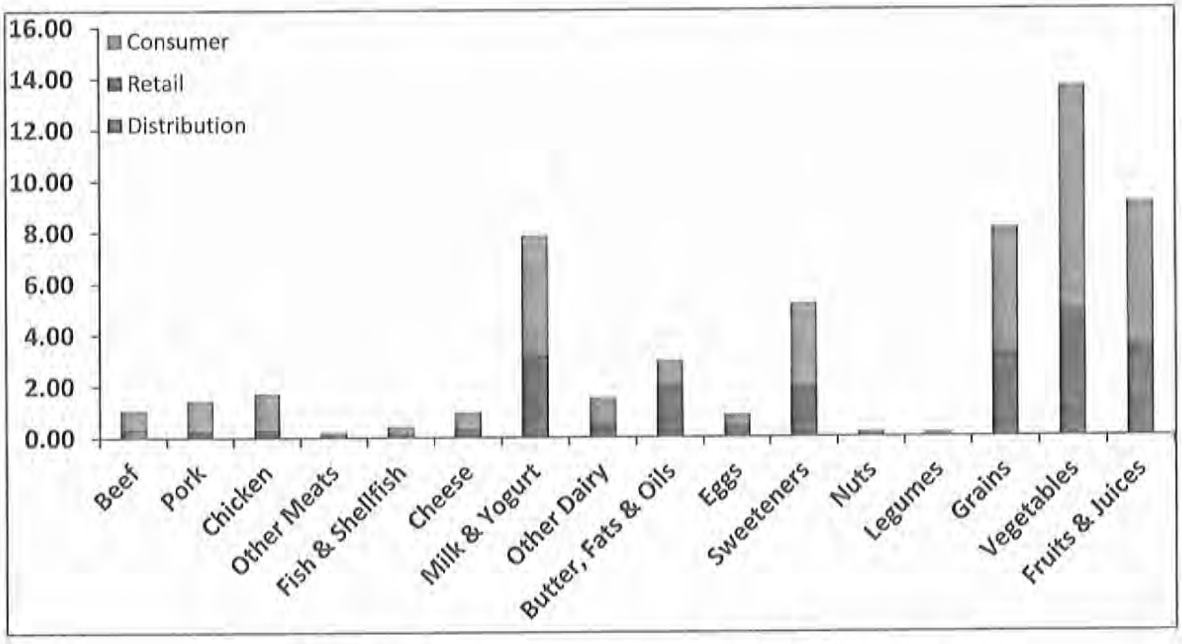


Figure 2 US annual avoidable food waste in 2009 (MMT/year)

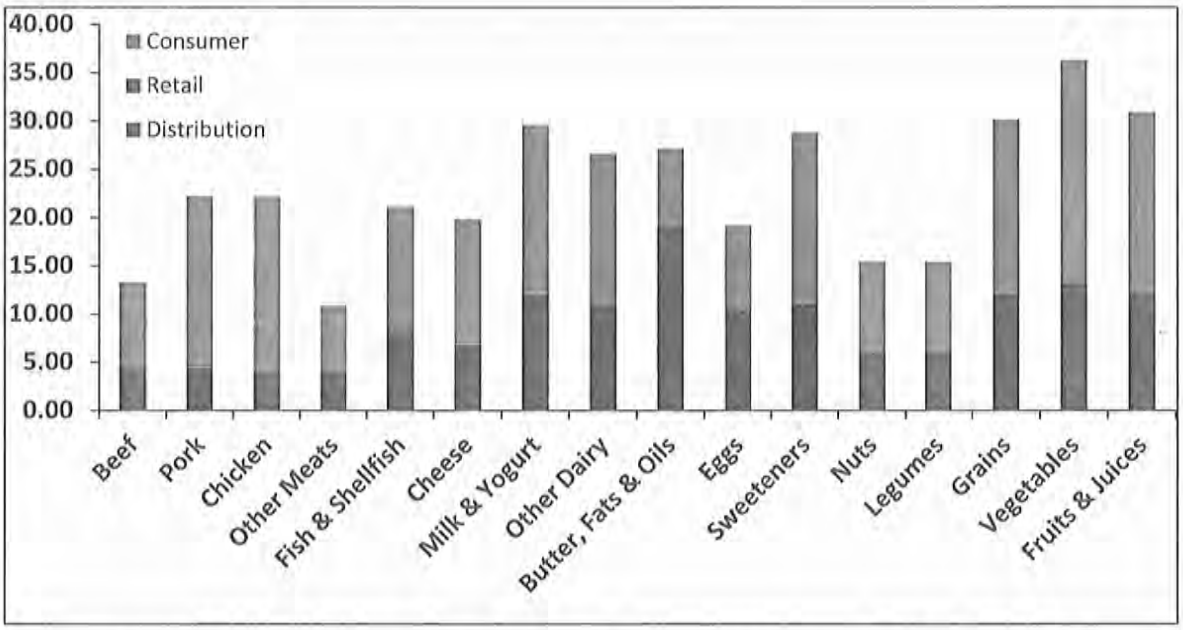


Figure 3 US annual avoidable food waste in 2009 as percentage of production

RESULTS AND DISCUSSION

Climate Change Impact of US Food Waste

Table 3 summarizes the GHG emissions due to avoidable waste throughout the life cycles of food commodities. Figure 4 illustrates these results graphically. Appendix B provides further details for all 134 commodities.

Beef – accounting for 16% of the total emissions – is the single largest contributor to the emissions from wasted food, even though the quantity of beef wasted amounts to less than 2% of the total waste by weight. This is because of the high emissions intensity of beef (Hamerschlag and Venkat, 2011). Animal products have a disproportionate climate change impact because of their relatively high emission footprints. They make up about 30% of all wasted food by weight, but account for nearly 57% of the emissions. On the other hand, grains, vegetables and fruits make up 56% of the waste, but contribute just 31% of the emissions due to their relatively low emission footprints.

TABLE 3 GHG emissions from avoidable US food waste in 2009 (MMT CO2e/year)

Category	Production + Processing Emissions	Packaging Emissions	Distribution + Retail Emissions	Disposal Emissions	Total Emissions due to Avoidable Waste
Beef	17.27	0.10	0.32	0.34	18.03
Pork	7.12	0.13	0.43	0.45	8.13
Chicken	6.17	0.16	0.52	0.54	7.38
Other Meats	1.33	0.02	0.06	0.07	1.48
Fish & Shellfish	2.37	0.05	0.12	0.14	2.68
Cheese	8.60	0.23	0.24	0.34	9.40
Milk & Yogurt	6.89	1.72	1.89	0.20	10.70
Other Dairy	2.04	0.35	0.45	0.53	3.37
Butter, Fats & Oils	5.11	0.49	0.65	1.02	7.26
Eggs	1.82	0.14	0.21	0.29	2.47
Sweeteners	2.15	1.04	1.13	1.81	6.12
Nuts	0.20	0.01	0.04	0.07	0.33
Legumes	0.11	0.01	0.03	0.05	0.20
Grains	5.82	0.57	1.68	2.83	10.91
Vegetables	5.67	0.72	3.23	4.75	14.37
Fruits & Juices	4.79	0.50	2.11	2.68	10.08
Total	**77.46**	**6.23**	**13.12**	**16.11**	**112.92**

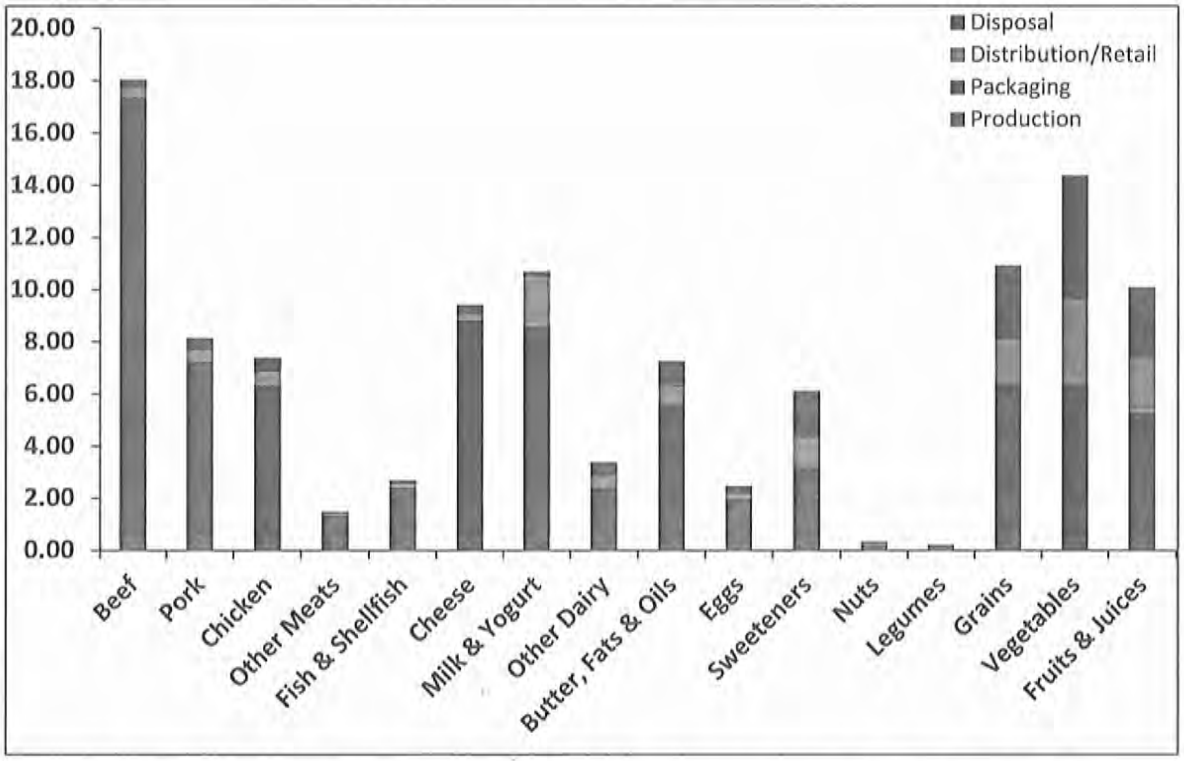


Figure 4 GHG emissions from avoidable US food waste in 2009 (MMT CO2e/year)

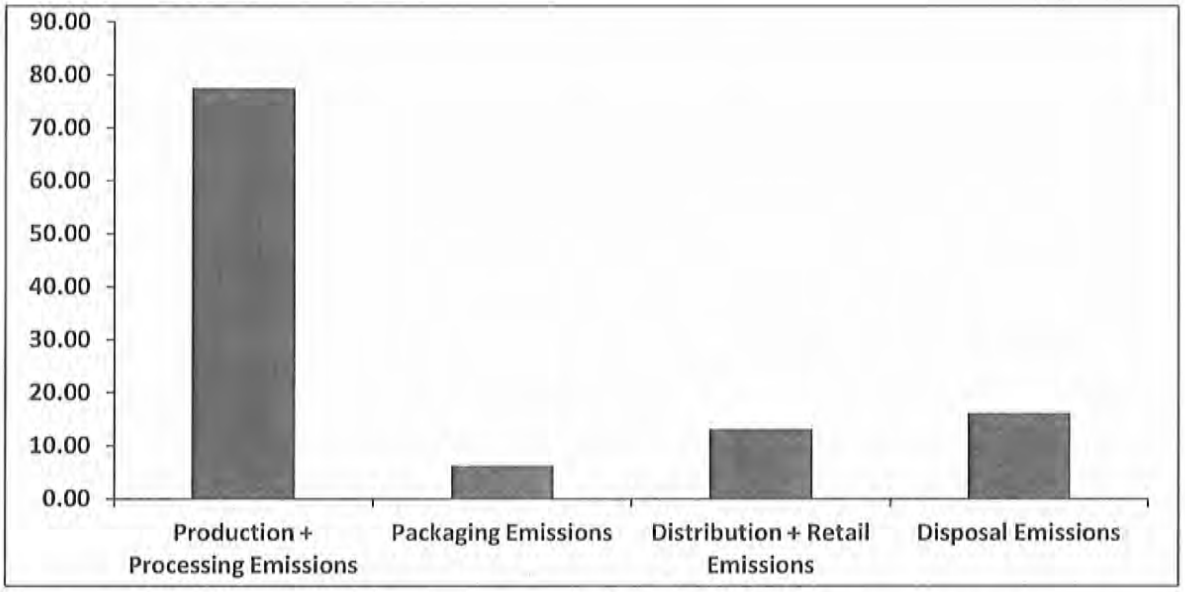


Figure 5 Total GHG emissions from avoidable US food waste in 2009 (MMT CO2e/year)

Figure 5 shows that the wasted GHG emissions are dominated by the production and processing emissions which account for 68.6% of the wasted emissions. The total emissions from the production, processing, packaging, distribution, retail and disposal of the avoidable food waste in the US amounts to 112.9 MMT CO2e per year. These emissions are equivalent to 2% of net US GHG emissions for 2009 based on the national emissions inventory published by the US Environmental Protection Agency (EPA, 2011). Note that these emissions represent a conservative lower bound on the actual emissions attributable to food waste, since all energy used at the consumer level – for example, in shopping trips, refrigeration and cooking – has been excluded from this analysis.

Economic Impact of US Food Waste

The economic impact of the wasted food is considerable. Using 2011 retail prices, the avoidable food waste (for the year 2009) has a total retail value of $197.7 billion, as shown in Table 4 and Figure 6. Out of this, the consumer waste alone amounts to $124.1 billion (nearly 63% of the total retail value of wasted food), which works out to about $1600 per year for a family of four in the US. This suggests a promising opportunity to motivate consumers to reduce waste, which would yield additional dividends by way of lower emissions. Retail waste – including waste in institutional food service – costs $64.6 billion, which shows that businesses and organizations also have much to gain by reducing waste. The economic value reported here is a conservative lower bound because the cost of consumer-level energy use and the cost of waste disposal are not included. Appendix B provides further details for all 134 commodities.

TABLE 4 Retail values of US avoidable food waste in 2009 using 2011 prices (billions of dollars)

Category	Retail Value of Distribution Waste	Retail Value of Retail Waste	Retail Value of Consumer Waste	Total Retail Value of Avoidable Waste
Beef	0.00	3.45	7.09	10.54
Pork	0.00	2.57	10.53	13.10
Chicken	0.00	1.86	8.52	10.38
Other Meats	0.00	0.94	1.60	2.54
Fish & Shellfish	0.00	2.94	4.42	7.37
Cheese	0.00	3.44	6.64	10.08

Milk & Yogurt	0.00	3.46	5.07	8.54
Other Dairy	0.00	3.26	4.76	8.02
Butter, Fats & Oils	0.00	9.26	3.93	13.19
Eggs	0.06	0.36	0.36	0.78
Sweeteners	0.00	6.75	10.92	17.67
Nuts	0.00	1.07	1.68	2.76
Legumes	0.00	0.28	0.45	0.73
Grains	0.00	6.78	10.46	17.24
Vegetables	5.67	10.76	32.56	48.99
Fruits & Juices	3.24	7.42	15.12	25.78
Total	**8.97**	**64.62**	**124.11**	**197.70**

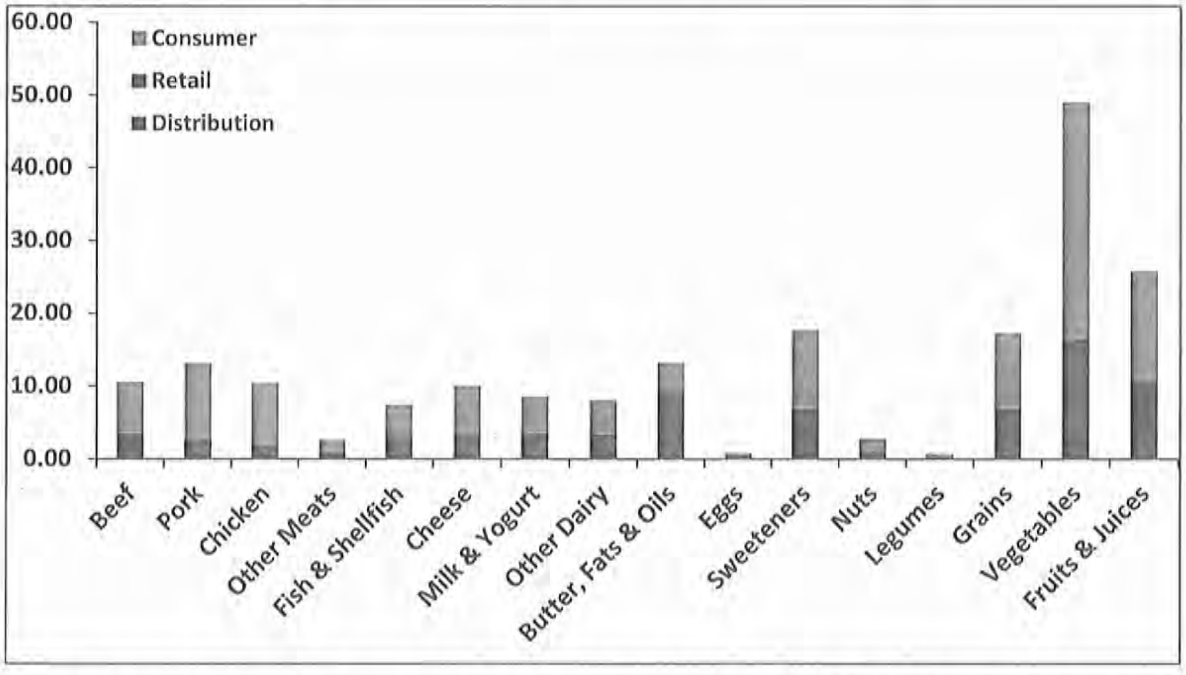


Figure 6 Retail values of US avoidable food waste in 2009 using 2011 prices (billions of dollars)

Animal products have a more moderate influence on economic impact (in contrast to the climate change impact). They account for about 37% of the economic impact, only about seven percentage points above their contribution to the total waste. Grains, vegetables and fruits account for 47% of the economic impact, about nine percentage points below their contribution to the waste.

Sensitivity analysis

Sensitivity analysis is a necessary part of any modeling endeavor. It is used to test the robustness of conclusions to uncertainties in assumptions (Sterman, 2000). Of the different types of sensitivities that models exhibit, numerical sensitivity to parametric assumptions and estimates is important for LCA models and is routinely tested in LCA studies (Dalgaard et al., 2008; Pelletier et al., 2010).

The results presented in the previous subsections have been tested for sensitivity to parameters in four major areas: transport distances, storage time in distribution and retail, portion of consumer waste occurring after cooking, and the fat/moisture losses in cooking. Baseline values for these parameters have been defined in the Methods section. The sensitivity analysis varies these four parameters uniformly one at a time (univariate testing) for all commodities as follows:

- Transport distance from production to retail: +50% and -50% relative to baseline values
- Storage time in distribution and retail: +50% and -50% relative to baseline values
- Post-cooking consumer waste fraction: +50% and -50% relative to baseline values
- Fat/moisture loss fractions: +25% and -25% relative to baseline values

Figure 7 summarizes the sensitivities of the results (total GHG emissions from avoidable waste and total retail value of avoidable waste) to parametric variations. As the transport distances are varied between +50% and -50% relative to baseline values, the total GHG emissions vary by +/-5.2%, indicating that the results exhibit only mild sensitivity to this parameter. For storage times and post-cooking consumer waste, as the parameters are varied in the +/-50% range, the GHG emissions vary by less than 1%, indicating virtually no sensitivity to these parameters.

As fat/moisture losses are varied in the +/-25% range, the total GHG emissions from avoidable waste vary between -16.1% and +13.7%. The total retail value of the waste varies between -9.4% and +8%. This suggests that sensitivity to the fat/moisture loss estimates is significant. As fat/moisture losses increase, correspondingly more of the consumer level waste must be attributed to the unavoidable waste from the cooking of consumed foods. The reverse is true as fat/moisture losses decrease. Since cooking methods for foods such as meats, fish and eggs – and the corresponding fat/moisture losses – can vary considerably, it is reasonable to expect

that the GHG emissions attributable to avoidable waste might have an uncertainty of up to +/-20% and the retail value might have an uncertainty of up to +/-15%.

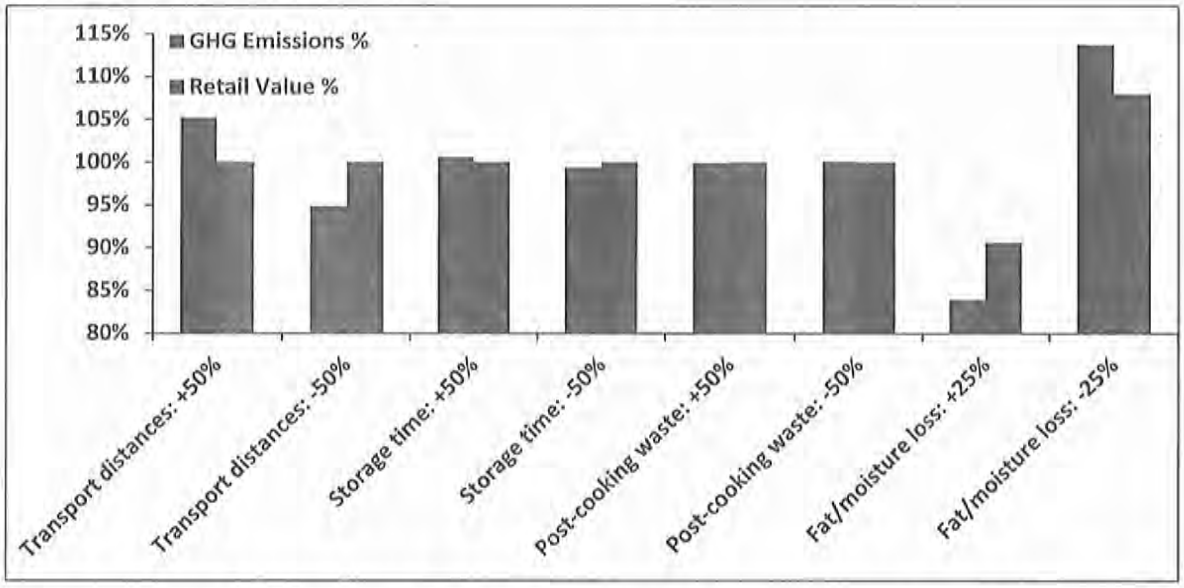


Figure 7 Sensitivities of results to parametric assumptions and estimates

CONCLUSIONS

This study has presented, for the first time, a comprehensive analysis of both the climate change and economic impacts of food waste in the US. Using the most recent loss-adjusted food availability data from the US Department of Agriculture (USDA ERS, 2009), this study has applied a rigorous life cycle assessment methodology to calculate the annual life-cycle GHG emissions, which quantify the climate change impact of food waste. The annual economic impact of the waste has been calculated using recent retail prices for food commodities. The analysis is based on life-cycle modeling and analysis of 134 distinct food commodities accounting for most of the food consumption in the US, most of which are produced in North America (except for tropical fruits and tuna). The food waste model – developed specifically to fit the USDA ERS (2009) food availability data – uses a mass balance method to account for all material flows and adjusts the waste at the consumer level so that only the avoidable waste due to uneaten food is considered in the final analysis.

The total avoidable food waste at the distribution, retail and consumer levels amounts to over 55 MMT/year, representing nearly 29% of annual production by weight. Over 60% of this waste occurs at the consumer level. The production, processing, packaging, distribution, retail and disposal of this wasted food results in GHG emissions of at least 113 MMT CO2e/year, which is equivalent to 2% of US national emissions. Beef is the single largest contributor to this,

producing 16% of all wasted emissions, because of its high emissions intensity. All animal products together contribute 57% of the wasted emissions, even though they make up only 30% of the waste by weight. Over two-thirds of the emissions occur in the production and processing of food commodities.

There is a considerable economic cost to this waste. US businesses and consumers lose as much as $198 billion per year because of wasted food. Consumer waste alone amounts to $124 billion, or nearly 63% of the total value, which works out to about $1600 per year for a family of four. The annual cost to businesses and organizations at the retail level is nearly $65 billion. There is a promising opportunity here to show both consumers and businesses that they have much to gain by reducing waste. Waste reduction can save money as well as reduce emissions.

The total GHG emissions and economic value of food waste reported in this study represent conservative lower bounds, since the analysis ignores all energy used at the consumer level as well as the cost of waste disposal. These emissions are also subject to an uncertainty of up to +/-20% due to cooking assumptions. The economic value of the waste reported here is subject to an uncertainty of up to +/-15%.

The modeling and analysis presented here can be extended in the future in several areas using the analytical framework established in this study. By modeling cooking processes in more detail, the uncertainty bands can be tightened significantly. By including the consumer-level energy use attributable to food waste – due to shopping trips, refrigeration and cooking, using real-world data – the climate change and economic impacts can be made more realistic. Consideration of the water footprint of the wasted food would add further value to the analysis and results. Finally, the methodology developed in this study can be used to monitor the environmental and economic impacts of food waste on an ongoing basis, not only within the US but also for other regions of the world.

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APPENDIX A: US annual production, consumption and waste of 134 commodities (2009 data)

Category	Commodity	Production P (MMT/year)	Consumption C (MMT/year)	Distribution Waste Wd (MMT/year)	Retail Waste Wr (MMT/year)	Non-edible Fraction N	Fat & Moisture Loss Fraction L	Consumer Waste Wc (MMT/year)	Total Avoidable Food Waste Wa (MMT/year)
Beef	Beef	8.09	5.26	0.00	0.35	0.00	0.25	0.72	1.07
Other Meats	Lamb	0.10	0.06	0.00	0.01	0.00	0.25	0.01	0.03
Pork	Pork	6.48	3.78	0.00	0.28	0.00	0.25	1.16	1.44
Chicken	Chicken	7.80	4.50	0.00	0.31	0.00	0.26	1.42	1.73
Other Meats	Turkey	1.85	1.22	0.00	0.06	0.00	0.27	0.12	0.19
Fish & Shellfish	Fish	0.86	0.53	0.00	0.08	0.00	0.19	0.14	0.21
Fish & Shellfish	Shellfish	0.77	0.47	0.00	0.07	0.00	0.24	0.08	0.15
Fish & Shellfish	Canned tuna	0.35	0.29	0.00	0.02	0.00	0.00	0.03	0.05
Eggs	Eggs	4.48	2.93	0.07	0.40	0.12	0.08	0.40	0.86
Milk & Yogurt	Whole milk	7.12	5.01	0.00	0.85	0.00	0.00	1.25	2.11
Milk & Yogurt	Reduced-fat & other milk	17.61	12.39	0.00	2.12	0.00	0.00	3.10	5.21
Milk & Yogurt	Yogurt	1.74	1.22	0.00	0.21	0.00	0.00	0.31	0.51
Cheese	Cheese	4.22	3.45	0.00	0.25	0.00	0.00	0.52	0.77
Cheese	Cottage cheese	0.33	0.23	0.00	0.04	0.00	0.00	0.06	0.10
Other Dairy	Ice cream & frozen dairy	3.40	2.39	0.00	0.41	0.00	0.00	0.60	1.01
Other Dairy	Dry milk products	0.61	0.60	0.00	0.01	0.00	0.00	0.01	0.01
Butter, Fats & Oils	Butter	0.69	0.54	0.00	0.05	0.00	0.00	0.10	0.14
Butter, Fats & Oils	Margarine	0.51	0.40	0.00	0.04	0.00	0.00	0.07	0.11
Butter, Fats & Oils	Shortening	2.22	1.49	0.00	0.47	0.00	0.10	0.10	0.56
Butter, Fats & Oils	Salad & cooking oils	7.47	4.79	0.00	1.53	0.00	0.10	0.61	2.14
Other Dairy	Sour cream	0.58	0.41	0.00	0.07	0.00	0.00	0.10	0.17
Other Dairy	Light cream	1.11	0.78	0.00	0.13	0.00	0.00	0.20	0.33

Cheese	Cream cheese	0.35	0.24	0.00	0.04	0.00	0.00	0.06	0.10
Sweeteners	Sugar	8.85	6.30	0.00	0.97	0.00	0.00	1.58	2.55
Sweeteners	Corn sweeteners	9.15	6.52	0.00	1.01	0.00	0.00	1.63	2.64
Nuts	Peanuts	0.92	0.78	0.00	0.06	0.00	0.00	0.09	0.14
Nuts	Almonds	0.19	0.16	0.00	0.01	0.00	0.00	0.02	0.03
Nuts	Pecans	0.06	0.05	0.00	0.00	0.00	0.00	0.01	0.01
Nuts	Walnuts	0.08	0.06	0.00	0.00	0.00	0.00	0.01	0.01
Nuts	Pistachios	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00
Grain	Rice	2.95	2.08	0.00	0.35	0.00	0.00	0.52	0.87
Grain	Wheat flour	18.74	13.19	0.00	2.25	0.00	0.00	3.30	5.55
Grain	Corn products	4.60	3.24	0.00	0.55	0.00	0.00	0.81	1.36
Grain	Oat products	0.64	0.34	0.00	0.08	0.00	0.00	0.23	0.30
Grain	Barley products	0.09	0.05	0.00	0.01	0.00	0.00	0.03	0.04
Legumes	Dry peas & lentils	0.11	0.09	0.00	0.01	0.00	0.00	0.01	0.02
Legumes	Dry edible beans	0.85	0.72	0.00	0.05	0.00	0.00	0.08	0.13
Vegetables	Fresh artichokes	0.21	0.03	0.01	0.04	0.60	0.00	0.08	0.13
Vegetables	Fresh asparagus	0.18	0.05	0.02	0.02	0.47	0.00	0.06	0.09
Vegetables	Fresh bell peppers	1.31	0.69	0.10	0.09	0.18	0.00	0.27	0.47
Vegetables	Fresh broccoli	0.85	0.28	0.07	0.09	0.39	0.00	0.23	0.39
Vegetables	Fresh Brussels sprouts	0.04	0.02	0.00	0.01	0.10	0.00	0.01	0.02
Vegetables	Fresh cabbage	1.02	0.49	0.07	0.13	0.20	0.00	0.20	0.41
Vegetables	Fresh carrots	1.03	0.65	0.03	0.05	0.11	0.00	0.21	0.29
Vegetables	Fresh cauliflower	0.21	0.03	0.02	0.03	0.61	0.00	0.09	0.13
Vegetables	Fresh celery	0.84	0.51	0.06	0.04	0.11	0.00	0.17	0.27
Vegetables	Fresh collard greens	0.05	0.01	0.01	0.02	0.43	0.00	0.01	0.03
Vegetables	Fresh sweet corn	1.26	0.05	0.10	0.01	0.64	0.00	1.02	1.13
Vegetables	Fresh cucumbers	0.92	0.42	0.07	0.05	0.27	0.00	0.22	0.34
Vegetables	Fresh eggplant	0.12	0.05	0.01	0.02	0.19	0.00	0.03	0.06

Vegetables	Fresh garlic	0.34	0.17	0.07	0.02	0.13	0.00	0.06	0.15
Vegetables	Fresh kale	0.03	0.01	0.00	0.01	0.39	0.00	0.01	0.02
Vegetables	Fresh head lettuce	2.38	1.29	0.17	0.19	0.16	0.00	0.48	0.84
Vegetables	Fresh leaf lettuce	1.53	0.73	0.11	0.20	0.21	0.00	0.31	0.61
Vegetables	Fresh mushrooms	0.33	0.21	0.02	0.04	0.03	0.00	0.06	0.12
Vegetables	Fresh okra	0.06	0.03	0.01	0.01	0.14	0.00	0.01	0.03
Vegetables	Fresh onions	2.68	1.25	0.16	0.25	0.10	0.00	0.88	1.29
Vegetables	Fresh potatoes	5.07	3.19	0.20	0.32	0.00	0.00	1.37	1.89
Vegetables	Fresh pumpkin	0.57	0.23	0.06	0.06	0.30	0.00	0.13	0.24
Vegetables	Fresh radishes	0.07	0.04	0.00	0.01	0.10	0.00	0.01	0.03
Vegetables	Fresh snap beans	0.23	0.11	0.01	0.04	0.12	0.00	0.04	0.10
Vegetables	Fresh spinach	0.26	0.10	0.03	0.03	0.28	0.00	0.05	0.12
Vegetables	Fresh squash	0.61	0.31	0.06	0.07	0.17	0.00	0.12	0.25
Vegetables	Fresh sweetpotatoes	0.73	0.23	0.07	0.09	0.28	0.00	0.24	0.41
Vegetables	Fresh tomatoes	2.69	1.41	0.40	0.30	0.09	0.00	0.44	1.14
Vegetables	Canned asparagus	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00
Vegetables	Canned snap beans	0.30	0.25	0.00	0.02	0.00	0.00	0.03	0.05
Vegetables	Canned cabbage	0.05	0.04	0.00	0.00	0.00	0.00	0.00	0.01
Vegetables	Canned carrots	0.08	0.07	0.00	0.01	0.00	0.00	0.01	0.01
Vegetables	Canned sweet corn	0.77	0.65	0.00	0.05	0.00	0.00	0.07	0.12
Vegetables	Canned cucumbers	0.28	0.24	0.00	0.02	0.00	0.00	0.03	0.04
Vegetables	Canned green peas	0.11	0.10	0.00	0.01	0.00	0.00	0.01	0.02
Vegetables	Canned mushrooms	0.10	0.09	0.00	0.01	0.00	0.00	0.01	0.02
Vegetables	Canned chile peppers	0.67	0.57	0.00	0.04	0.00	0.00	0.06	0.10
Vegetables	Canned potatoes	0.08	0.07	0.00	0.00	0.00	0.00	0.01	0.01

Vegetables	Canned tomatoes	4.01	3.39	0.00	0.24	0.00	0.00	0.38	0.62
Vegetables	Frozen asparagus	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vegetables	Frozen snap beans	0.22	0.17	0.00	0.01	0.00	0.00	0.04	0.06
Vegetables	Frozen broccoli	0.26	0.21	0.00	0.02	0.00	0.00	0.04	0.06
Vegetables	Frozen carrots	0.10	0.09	0.00	0.01	0.00	0.00	0.01	0.02
Vegetables	Frozen cauliflower	0.03	0.03	0.00	0.00	0.00	0.00	0.01	0.01
Vegetables	Frozen sweet corn	0.33	0.27	0.00	0.02	0.00	0.00	0.04	0.06
Vegetables	Frozen green peas	0.22	0.17	0.00	0.01	0.00	0.00	0.03	0.05
Vegetables	Frozen potatoes	3.50	2.24	0.00	0.21	0.00	0.00	1.05	1.26
Vegetables	Frozen spinach	0.07	0.05	0.00	0.00	0.00	0.00	0.01	0.02
Vegetables	Dehydrated onions	0.03	0.02	0.00	0.00	0.00	0.00	0.00	0.00
Vegetables	Dehydrated potatoes	0.23	0.19	0.00	0.01	0.00	0.00	0.02	0.04
Vegetables	Potato chips	0.48	0.40	0.00	0.03	0.00	0.00	0.04	0.07
Fruits & Juices	Fresh oranges	1.26	0.57	0.04	0.14	0.27	0.00	0.30	0.48
Fruits & Juices	Fresh tangerines	0.44	0.18	0.02	0.09	0.26	0.00	0.09	0.20
Fruits & Juices	Fresh grapefruit	0.39	0.10	0.01	0.05	0.50	0.00	0.13	0.19
Fruits & Juices	Fresh lemons	0.44	0.13	0.02	0.03	0.47	0.00	0.15	0.19
Fruits & Juices	Fresh limes	0.35	0.20	0.02	0.03	0.16	0.00	0.07	0.12
Fruits & Juices	Fresh apples	2.29	1.40	0.09	0.19	0.10	0.00	0.45	0.73
Fruits & Juices	Fresh apricots	0.02	0.01	0.00	0.01	0.07	0.00	0.00	0.01
Fruits & Juices	Fresh avacados	0.57	0.26	0.03	0.05	0.26	0.00	0.13	0.22
Fruits & Juices	Fresh bananas	3.44	1.39	0.00	0.27	0.36	0.00	0.99	1.26
Fruits & Juices	Fresh blueberries	0.13	0.09	0.01	0.01	0.05	0.00	0.02	0.04
Fruits & Juices	Fresh cantaloup	1.30	0.32	0.10	0.15	0.49	0.00	0.41	0.66
Fruits & Juices	Fresh cherries	0.21	0.13	0.02	0.01	0.09	0.00	0.04	0.06
Fruits & Juices	Fresh cranberries	0.01	0.01	0.00	0.00	0.02	0.00	0.00	0.00

Fruits & Juices	Fresh grapes	1.10	0.71	0.10	0.08	0.04	0.00	0.19	0.37
Fruits & Juices	Fresh honeydew	0.23	0.04	0.02	0.05	0.54	0.00	0.07	0.14
Fruits & Juices	Fresh kiwifruit	0.07	0.04	0.01	0.01	0.14	0.00	0.01	0.03
Fruits & Juices	Fresh mangoes	0.28	0.11	0.01	0.04	0.31	0.00	0.07	0.12
Fruits & Juices	Fresh papaya	0.17	0.03	0.01	0.09	0.33	0.00	0.02	0.12
Fruits & Juices	Fresh peaches	0.61	0.30	0.03	0.07	0.07	0.00	0.19	0.29
Fruits & Juices	Fresh pears	0.44	0.24	0.02	0.07	0.10	0.00	0.08	0.17
Fruits & Juices	Fresh pineapple	0.71	0.18	0.04	0.10	0.49	0.00	0.23	0.36
Fruits & Juices	Fresh plums	0.10	0.06	0.01	0.02	0.06	0.00	0.02	0.04
Fruits & Juices	Fresh strawberries	1.00	0.61	0.08	0.09	0.06	0.00	0.18	0.35
Fruits & Juices	Fresh watermelon	2.13	0.51	0.21	0.32	0.48	0.00	0.61	1.15
Fruits & Juices	Canned apples	0.49	0.41	0.00	0.03	0.00	0.00	0.05	0.07
Fruits & Juices	Canned apricots	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Fruits & Juices	Canned tart cherries	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00
Fruits & Juices	Canned peaches	0.38	0.32	0.00	0.02	0.00	0.00	0.04	0.06
Fruits & Juices	Canned pears	0.34	0.29	0.00	0.02	0.00	0.00	0.03	0.05
Fruits & Juices	Canned pineapple	0.34	0.29	0.00	0.02	0.00	0.00	0.03	0.05
Fruits & Juices	Canned olives	0.10	0.08	0.00	0.01	0.00	0.00	0.01	0.02
Fruits & Juices	Frozen blueberries	0.21	0.18	0.00	0.01	0.00	0.00	0.02	0.03
Fruits & Juices	Frozen tart cherries	0.07	0.06	0.00	0.00	0.00	0.00	0.01	0.01
Fruits & Juices	Frozen raspberries	0.07	0.06	0.00	0.00	0.00	0.00	0.01	0.01
Fruits & Juices	Frozen strawberries	0.05	0.04	0.00	0.00	0.00	0.00	0.00	0.01
Fruits & Juices	Frozen apricots	0.10	0.09	0.00	0.01	0.00	0.00	0.01	0.02
Fruits & Juices	Frozen peaches	0.08	0.07	0.00	0.00	0.00	0.00	0.01	0.01

Fruits & Juices	Dried apples	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Fruits & Juices	Dried apricots	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Fruits & Juices	Dried dates	0.03	0.02	0.00	0.00	0.10	0.00	0.00	0.00
Fruits & Juices	Dried figs	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Fruits & Juices	Dried peaches	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fruits & Juices	Dried plums	0.04	0.04	0.00	0.00	0.00	0.00	0.00	0.01
Fruits & Juices	Raisins	0.18	0.15	0.00	0.01	0.00	0.00	0.02	0.03
Fruits & Juices	Citrus juice	5.53	4.68	0.00	0.33	0.00	0.00	0.52	0.85
Fruits & Juices	Noncitrus juice	3.69	3.12	0.00	0.22	0.00	0.00	0.35	0.57
Total		**193.10**	**126.13**	**2.92**	**18.76**			**33.73**	**55.41**

APPENDIX B: Annual GHG emissions and retail values of avoidable waste for 134 commodities

Category	Commodity	Total GHG Emissions from Avoidable Waste (MMT CO2e/year)	Total Retail Value of Avoidable Waste ($billions/year)
Beef	Beef	18.03	10.54
Other Meats	Lamb	0.52	0.49
Pork	Pork	8.13	13.10
Chicken	Chicken	7.38	10.38
Other Meats	Turkey	0.96	2.05
Fish & Shellfish	Fish	1.22	3.73
Fish & Shellfish	Shellfish	1.20	2.72
Fish & Shellfish	Canned tuna	0.26	0.92
Eggs	Eggs	2.47	0.78
Milk & Yogurt	Whole milk	3.28	1.92
Milk & Yogurt	Reduced-fat & other milk	6.52	4.62
Milk & Yogurt	Yogurt	0.89	2.00
Cheese	Cheese	8.20	8.48
Cheese	Cottage cheese	0.11	0.47
Other Dairy	Ice cream & frozen dairy	2.74	4.96
Other Dairy	Dry milk products	0.13	0.12
Butter, Fats & Oils	Butter	0.29	1.06
Butter, Fats & Oils	Margarine	0.28	0.68
Butter, Fats & Oils	Shortening	1.46	4.37
Butter, Fats & Oils	Salad & cooking oils	5.24	7.08
Other Dairy	Sour cream	0.18	0.72
Other Dairy	Light cream	0.32	2.23
Cheese	Cream cheese	1.10	1.12

Sweeteners	Sugar	3.14	5.39
Sweeteners	Corn sweeteners	2.98	12.28
Nuts	Peanuts	0.20	1.50
Nuts	Almonds	0.08	0.64
Nuts	Pecans	0.02	0.32
Nuts	Walnuts	0.02	0.21
Nuts	Pistachios	0.01	0.09
Grain	Rice	2.54	3.70
Grain	Wheat flour	6.82	9.78
Grain	Corn products	1.22	2.40
Grain	Oat products	0.28	1.29
Grain	Barley products	0.04	0.08
Legumes	Dry peas & lentils	0.02	0.08
Legumes	Dry edible beans	0.19	0.65
Vegetables	Fresh artichokes	0.12	0.59
Vegetables	Fresh asparagus	0.13	0.49
Vegetables	Fresh bell peppers	0.40	1.38
Vegetables	Fresh broccoli	0.37	0.88
Vegetables	Fresh Brussels sprouts	0.01	0.11
Vegetables	Fresh cabbage	0.29	0.43
Vegetables	Fresh carrots	0.21	0.60
Vegetables	Fresh cauliflower	0.12	0.29
Vegetables	Fresh celery	0.19	0.69
Vegetables	Fresh collard greens	0.03	0.09
Vegetables	Fresh sweet corn	0.98	7.35
Vegetables	Fresh cucumbers	0.26	0.48
Vegetables	Fresh eggplant	0.07	0.28
Vegetables	Fresh garlic	0.13	0.16

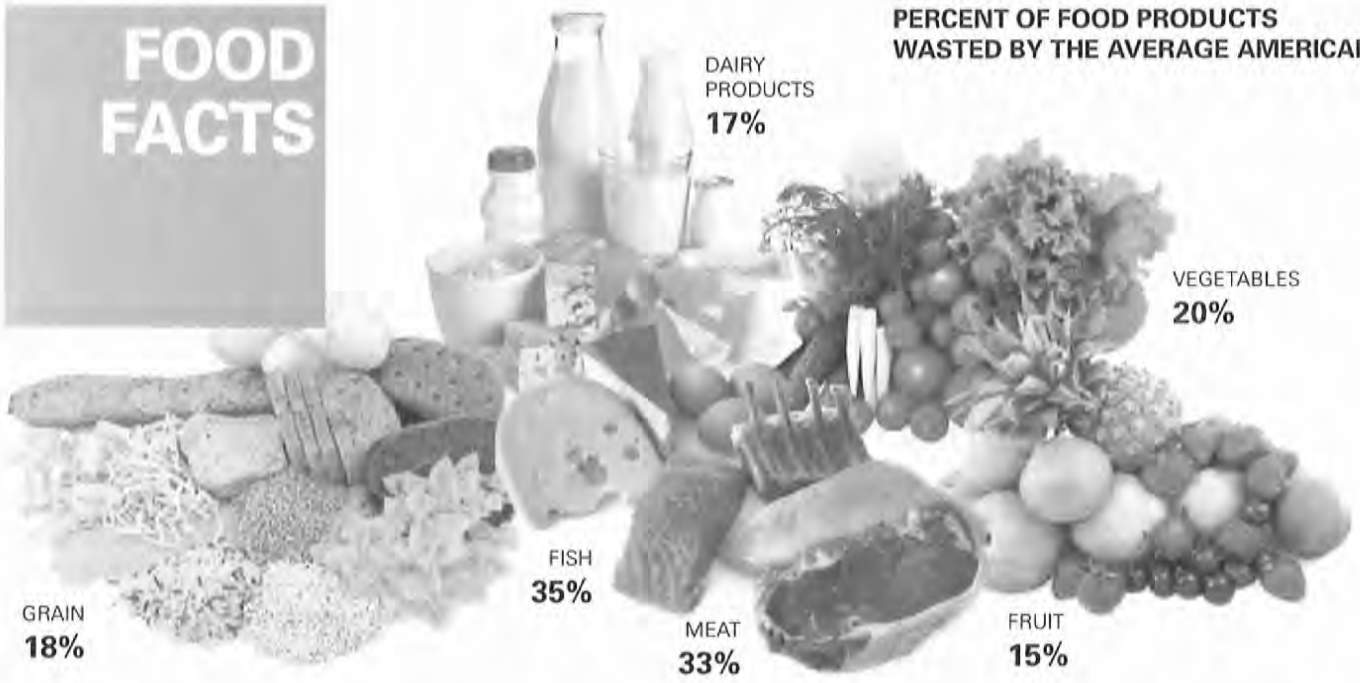
Vegetables	Fresh kale	0.02	0.06
Vegetables	Fresh head lettuce	0.67	2.15
Vegetables	Fresh leaf lettuce	0.42	4.09
Vegetables	Fresh mushrooms	0.07	0.98
Vegetables	Fresh okra	0.03	0.17
Vegetables	Fresh onions	1.15	2.82
Vegetables	Fresh potatoes	1.69	3.33
Vegetables	Fresh pumpkin	0.18	0.06
Vegetables	Fresh radishes	0.02	0.09
Vegetables	Fresh snap beans	0.08	0.42
Vegetables	Fresh spinach	0.12	0.53
Vegetables	Fresh squash	0.23	0.65
Vegetables	Fresh sweetpotatoes	0.42	0.64
Vegetables	Fresh tomatoes	0.89	3.49
Vegetables	Canned asparagus	0.01	0.02
Vegetables	Canned snap beans	0.08	0.13
Vegetables	Canned cabbage	0.01	0.02
Vegetables	Canned carrots	0.02	0.03
Vegetables	Canned sweet corn	0.19	0.80
Vegetables	Canned cucumbers	0.07	0.29
Vegetables	Canned green peas	0.03	0.04
Vegetables	Canned mushrooms	0.02	0.17
Vegetables	Canned chile peppers	0.16	1.09
Vegetables	Canned potatoes	0.02	0.04
Vegetables	Canned tomatoes	1.01	1.31

Vegetables	Frozen asparagus	0.01	0.02
Vegetables	Frozen snap beans	0.09	0.53
Vegetables	Frozen broccoli	0.10	0.41
Vegetables	Frozen carrots	0.03	0.12
Vegetables	Frozen cauliflower	0.01	0.03
Vegetables	Frozen sweet corn	0.18	0.52
Vegetables	Frozen green peas	0.09	0.38
Vegetables	Frozen potatoes	2.48	7.14
Vegetables	Frozen spinach	0.04	0.07
Vegetables	Dehydrated onions	0.01	0.26
Vegetables	Dehydrated potatoes	0.09	0.74
Vegetables	Potato chips	0.30	1.53
Fruits & Juices	Fresh oranges	0.36	0.75
Fruits & Juices	Fresh tangerines	0.15	0.46
Fruits & Juices	Fresh grapefruit	0.15	0.26
Fruits & Juices	Fresh lemons	0.14	0.85
Fruits & Juices	Fresh limes	0.08	0.53
Fruits & Juices	Fresh apples	0.59	2.07
Fruits & Juices	Fresh apricots	0.01	0.07
Fruits & Juices	Fresh avacados	0.18	0.59
Fruits & Juices	Fresh bananas	1.16	1.59
Fruits & Juices	Fresh blueberries	0.06	0.71
Fruits & Juices	Fresh cantaloup	0.49	1.06
Fruits & Juices	Fresh cherries	0.09	0.65
Fruits & Juices	Fresh cranberries	0.00	0.02
Fruits & Juices	Fresh grapes	0.30	1.90

Fruits & Juices	Fresh honeydew	0.10	0.33
Fruits & Juices	Fresh kiwifruit	0.03	0.34
Fruits & Juices	Fresh mangoes	0.08	0.64
Fruits & Juices	Fresh papaya	0.11	0.63
Fruits & Juices	Fresh peaches	0.24	1.94
Fruits & Juices	Fresh pears	0.14	0.50
Fruits & Juices	Fresh pineapple	0.26	0.45
Fruits & Juices	Fresh plums	0.03	0.11
Fruits & Juices	Fresh strawberries	0.32	2.87
Fruits & Juices	Fresh watermelon	0.80	1.75
Fruits & Juices	Canned apples	0.11	0.34
Fruits & Juices	Canned apricots	0.00	0.01
Fruits & Juices	Canned tart cherries	0.01	0.01
Fruits & Juices	Canned peaches	0.09	0.27
Fruits & Juices	Canned pears	0.07	0.24
Fruits & Juices	Canned pineapple	0.07	0.26
Fruits & Juices	Canned olives	0.02	0.27
Fruits & Juices	Frozen blueberries	0.07	0.41
Fruits & Juices	Frozen tart cherries	0.02	0.15
Fruits & Juices	Frozen raspberries	0.02	0.14
Fruits & Juices	Frozen strawberries	0.01	0.05
Fruits & Juices	Frozen apricots	0.03	0.10
Fruits & Juices	Frozen peaches	0.02	0.08
Fruits & Juices	Dried apples	0.01	0.02

Fruits & Juices	Dried apricots	0.01	0.02
Fruits & Juices	Dried dates	0.00	0.05
Fruits & Juices	Dried figs	0.01	0.04
Fruits & Juices	Dried peaches	0.00	0.01
Fruits & Juices	Dried plums	0.01	0.15
Fruits & Juices	Raisins	0.11	0.21
Fruits & Juices	Citrus juice	2.13	1.15
Fruits & Juices	Noncitrus juice	1.42	0.74
Total		**112.92**	**197.70**

FOOD FACTS



Your Scraps Add Up: Reducing food waste can save money and resources

Feeding the U.S. population requires an enormous amount of land and resources. Yet, 40 percent of food in the U.S. goes to waste. When the resources to grow that food are considered, this amounts to approximately 25 percent of all freshwater, 4 percent of the oil we consume, and more than $100 billion dollars all dedicated to producing food that never gets eaten. Reducing your own food waste is an easy way to trim down your bills and your environmental footprint.

HOW MUCH DO WE WASTE?

In the U.S., we waste around 40 percent[2] of all edible food. A large portion of that waste is caused by consumers. The average American throws away between $28-43[3] in the form of about 20 pounds[4] of food each month.If we wasted just 5 percent less food, it would be enough to feed 4 million Americans; 20 percent less waste would feed 25 million people.[5]

Feeding the planet is already a struggle, and will only become more difficult with 9-10 billion people expected on the planet in 2050. This makes food conservation all the more important. The United Nations has predicted that we'll need up to 70 percent more food to feed that projected population.[6] Developing habits to save food now could dramatically reduce the need for increased food production in the future.

WHAT DOES WASTING FOOD COST US?

The cost of wasted food is staggering. In addition to the wasting of water, energy, chemicals, and global warming pollution that goes into producing, packaging, and transporting discarded food, nearly all of the food waste ends up in landfills where it decomposes and releases methane, a heat-trapping greenhouse gas that is 21 times more potent that carbon dioxide. Consider these cost estimates of all the food that never gets eaten in the U.S., and imagine just how much we can save by wasting less food:

- 25 percent of all freshwater used in U.S.[7]
- 4 percent of total U.S. oil consumption[7]
- $100 billion per year (more than $40 billion from households)[8]
- $750 million per year just to dispose of the food[9]
- 33 million tons of landfill waste (leading to greenhouse gas emissions)[10]

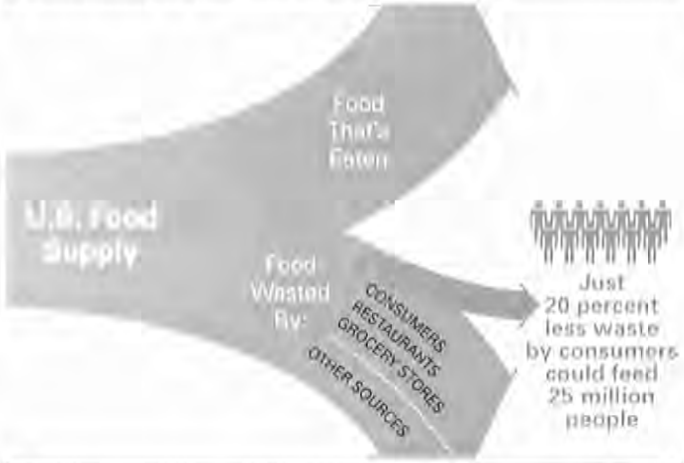
NRDC
THE EARTH'S BEST DEFENSE

For more information, please contact:

Dana Gunders
dgunders@nrdc.org
(415) 875-6100
switchboard.nrdc.org/blogs/dgunders/

www.nrdc.org/policy
www.facebook.com/nrdc.org
www.twitter.com/nrdc

25 million people could be fed if we reduced consumer food waste by 20 percent



WHERE DOES FOOD WASTE COME FROM?

Food waste is a complex problem with losses occurring throughout the supply chain from "farm to fork." Crops are sometimes left unharvested because their appearance does not meet strict quality standards imposed by supermarkets. Food can be mishandled or stored improperly during transport. Large portions, large menus, and poor training for food handlers contribute to food waste in restaurants.

In households, fresh products make up most of the wasted food. The U.S. Department of Agriculture reports that a typical American throws out 40 percent of fresh fish, 23 percent of eggs, and 20 percent of milk. Citrus fruits and cherries top the list for fruits, and sweet potatoes, onions, and greens are commonly wasted vegetables.[11]

Much of household waste is due to overpurchasing, food spoilage, and plate waste. About 2/3 of household waste is due to food spoilage from not being used in time, whereas the other 1/3 is caused by people cooking or serving too much.[12] Single households produce proportionately more waste per person than multiple occupancy situations with more than one adult. Children, however, can add to the waste tally too. In fact, in a study of British households, those with children produced 41 percent more food waste than similarly sized households without children.[13]

The good news is we can reverse this costly food waste trend. Follow these tips and you'll finish your plate feeling satisfied in a whole new way.

EASY STEPS TO REDUCING YOUR FOOD WASTE

Follow these tips to keep your food bill and "food-print" down at the same time:

- **Shop Wisely**—Plan meals, use shopping lists, buy from bulk bins, and avoid impulse buys. Don't succumb to marketing tricks that lead you to buy more food than you need, particularly for perishable items. Though these may be less expensive per ounce, they can be more expensive overall if much of that food is discarded.
- **Buy Funny Fruit**—Many fruits and vegetables are thrown out because their size, shape, or color are not "right". Buying these perfectly good funny fruit, at the farmer's market or elsewhere, utilizes food that might otherwise go to waste.
- **Learn When Food Goes Bad**—"Sell-by" and "use-by" dates are not federally regulated and do not indicate safety, except on certain baby foods. Rather, they are manufacturer suggestions for peak quality. Most foods can be safely consumed well after their use-by dates.[14]
- **Mine Your Fridge**—Websites such as www.lovefoodhatewaste.com can help you get creative with recipes to use up anything that might go bad soon.
- **Use Your Freezer**—Frozen foods remain safe indefinitely. Freeze fresh produce and leftovers if you won't have the chance to eat them before they go bad.
- **Request Smaller Portions**—Restaurants will often provide half-portions upon request at reduced prices.
- **Eat Leftovers**—Ask your restaurant to pack up your extras so you can eat them later. Freeze them if you don't want to eat immediately. Only about half of Americans take leftovers home from restaurants.
- **Compost**—Composting food scraps can reduce their climate impact while also recycling their nutrients. Food makes up almost 13 percent of the U.S. waste stream, but a much higher percent of landfill-caused methane.[15]
- **Donate**—Non-perishable and unspoiled perishable food can be donated to local food banks, soup kitchens, pantries, and shelters. Local and national programs frequently offer free pick-up and provide reusable containers to donors.

1 Buzby, et al. The Value of Retail- and Consumer-Level Fruit and Vegetable Losses in the United States. Journal of Consumer Affairs, Fall 2011: 492-515.
2 Hall KD, Guo J, Dore M, Chow CC (2009) The Progressive Increase of Food Waste in America and Its Environmental Impact. National Institute of Diabetes and Digestive and Kidney Diseases. PLoS ONE 4(11):e7940.
3 Jonathan Bloom, *American Wasteland* (Cambridge: Da Capo Press, 2010).
4 Food and Agriculture Organization of the United Nations, *Global Food Losses and Food Waste*. http://www.fao.org/ag/ags/ags-division/publications/publication/en/?dyna_fef%5Buid%5D=74045.
5 See USDA, endnote 2.
6 Food and Agriculture Organization (FAO) http://www.fao.org/fileadmin/templates/wsfs/docs/expert_paper/How_to_Feed_the_World_in_2050.pdf.
7 See Hall 2009 above.
8 Jones, Timothy. Corner on Food Loss. Biocycle, July 2005. p25.
9 USDA and US EPA. Waste Not, Want Not. Feeding the Hungry and Reducing Solid Waste Through Food Recovery. EPA 530-R-99-040. See vii above.
10 http://www.epa.gov/osw/conserve/materials/organics/food/fd-basic.htm.
11 http://www.ers.usda.gov/Publications/TB1927/TB1927.pdf.
12 http://www.wrap.org.uk/downloads/Household_Food_and_Drink_Waste_in_the_UK_Nov_2011.da3b2381.8048.pdf p27.
13 ibid.
14 http://www.fsis.usda.gov/factsheets/food_product_dating/index.asp.
15 See USDA/EPA above.

NRDC

FOOD WASTE
is a major worldwide problem

1.3 billion tons of all edible food produced worldwide is wasted or lost each year. That is 1/3 of the food produced annually.

Much of that food is wasted by consumers.

While much food is wasted during production in all regions, industrialized nations waste far more food in the homes of consumers.

Food is the largest category of waste

reaching US landfills. In 2010, 34+ million tons of food waste were generated in the US. Only 3% was recycled, resulting in 33 million tons going to landfills & incinerators.

or **254 lbs** per person, per year

Why is this a problem?

25% of all fresh water consumed

is used each year to produce food that is ultimately wasted, while 1.1 billion people in the world do not have access to safe drinking water. 25% is equal to approximately 600 cubic kilometers, or a bit more than the volume of Lake Erie.

1 billion people are malnourished

even though the world produces enough food to feed twice the world's present population. 1 billion people is roughly 3.2x the population of the US.

24 million acres are deforested to grow food

each year, despite the fact that worldwide food production produces more than enough food for all. This accounts for 74% of the total annual deforestation. 24 million acres is approximately the size of the entire state of Indiana.

300 million barrels of oil

are used each year to produce food that is ultimately wasted.

■ = 10m barrels

What can you do about it?

While you may not be able to reduce food lost during production, you can certainly reduce food waste at home. To reduce your personal level of food waste:

- Plan out meals and make shopping lists to determine what you actually need for the week.
- Buy in quantities you can realistically use. Avoid impulse buys.
- Don't throw out fruits and veggies with aesthetic-only blemishes. Use-by dates are for best quality, and are not "safety dates," according to the USDA.
- "Re-use" your leftovers by eating them for lunch the next day. If your food does go bad, compost it to avoid sending it to the landfill.

SOURCES: Food and Agriculture Organization of the UN | United Nations Convention on Climate Change | US Environmental Protection Agency | United Nations Environment Programme | National Institute of Diabetes and Digestive and Kidney Diseases

door to door organics

Eureka Recycling: Preventing Wasted Food Pilot
Interview and Focus Group Methodology

Pre-Pilot Interviews
Initial interviews were conducted with just residents in originally designated area of the Macalester-Groveland neighborhood (the other two communities had not yet been engaged) both via telephone and in person, to understand pre-existing attitudes and behaviors about preventing wasted food.

Sample selection and recruitment
Participants in the Macalester-Groveland neighborhood were recruited by responding to a mailer sent by Eureka Recycling to all residents in the study area. We worked with a well-connected community member from the Rondo neighborhood of Saint Paul to recruit participants from the African American community. The staff of the Lao Family Center worked with us to recruit participants from the Hmong community based mostly on the east side of Saint Paul.

Gathering Feedback
At the end of the 6-week pilot, participants were asked to attend one of two possible focus groups in their neighborhood, and to bring the previously disseminated education materials and tools and be ready to share their feedback or suggestions. The discussions were audio-recorded. There were 25 participants in the focus groups, which occurred on four evenings in the summer of 2011 in Saint Paul, Minnesota:

- Macalester Groveland neighborhood (Primarily Caucasian): Tuesday, June 2 (5 participants)
- Macalester Groveland neighborhood (Primarily Caucasian): Thurs, June 7 (7 participants)
- Hmong community: Wednesday, June 15 (7 participants)
- African American community: Thursday, June 16 (6 participants)

All participants, including those who were unable to attend a focus group discussion, were encouraged to fill out a survey to document their level of use of the program materials. There were 55 surveys returned.

Many of the participants in the Hmong and African American communities were not comfortable attending or could not attend the focus groups, and so follow-up interviews with the focus group questions were conducted through our community partners one-on-one, often in people's homes. These results were analyzed with the results of the focus group discussions to prioritize and make changes to the final tools.

Incentives
Nominal incentives were provided to residents to participate in the study, return surveys, or attend focus groups or interviews, which consisted of discounted or free samples of tools designed to prevent wasted food (such as clear glass storage containers) or gift cards for local businesses.

Pre-Pilot Interview Questions

Thank you for your support of our composting project and for your time to complete this interview - it should take about 30 minutes.

This interview, with the other interviews with your neighbors, is kicking off the next phase of the larger composting project that we began in your neighborhood earlier this spring. With support from the Minnesota Pollution Control Agency, we are turning our attention to looking at ways to reduce the food that is wasted before it even needs to be composted! The responses you provide will help us develop and test tools that can help people plan, shop, cook, preserve and store food in ways that will help reduce wasted food.

To show our appreciation, please choose one of the following gifts:

- ☐ a $10 gift card to Trotters
- ☐ a $10 gift card to
- ☐ a $10 gift card to Izzy's
- ☐ a *Chinook Book* (formerly known as the Blue Sky Guide) to thank you for your time.

Make Dirt Not Waste ...in Macalester-Groveland!

A. Background questions

A1. Are you bothered by the amount of food wasted in your home?

- ☐ Not at all
- ☐ A little
- ☐ A lot

Comments:

A2. How much of the food you purchase or grow do you think ends up being wasted in your home every week?

- ☐ none
- ☐ very little
- ☐ some
- ☐ about half
- ☐ more than half

Comments:

A3. What types of food most often end up wasted in your home? (check all that apply)

- ☐ Fresh fruits
- ☐ Fresh vegetables
- ☐ Bread
- ☐ Meat
- ☐ Eggs
- ☐ Cheese
- ☐ Leftovers (cooked food)

A4. What are the two biggest reasons food ends up going to waste in your home?

1.

2.

Here are some common reasons that other people have named for why food goes to waste in their homes. Do you think that any of these other reasons might also apply to you?

Yes	No	Unsure	
____	____	____	When I buy items in discount bulk (like Sam's Club, Costco), I end up with more than I can use.
____	____	____	I try something new and don't like it, or my family doesn't like it.
____	____	____	I receive things from other people that I/we don't eat.
____	____	____	I bring home restaurant leftovers, even if I probably won't eat them
____	____	____	I receive vegetables from a CSA/other that I/we don't eat.
____	____	____	Grow more vegetables in the garden than I/we can eat.
____	____	____	I buy for other household members who don't eat it.
____	____	____	I prepare more than can be eaten, and don't eat the leftovers.
____	____	____	I don't know how to make another meal out of what I have.
____	____	____	Things get pushed to the back of the fridge and I don't see them.
____	____	____	I don't know if something is safe to eat or not, so I throw it out.
____	____	____	Things go bad earlier than I expect.
____	____	____	I don't use the food I buy fast enough.
____	____	____	Does anything else occur to you?_____

A5. How do you decide when to throw away (or compost) food items?

B. Specific questions about household habits

B1. About how much of the food you eat at home is cooked by you or someone else in your household? (Who?) _____

- ☐ very little
- ☐ some
- ☐ about half
- ☐ more than half
- ☐ almost all

B2. How much time do you (or the person who cooks) spend preparing food?

- ☐ 15 minutes a day
- ☐ 30 minutes a day

- ☐ 1 hour a day
- ☐ More than one hour per day
- ☐ Other _____

B3. Do you do more food preparation on weekends for the upcoming week?

☐ yes ☐ no ☐ sometimes

B4. On a scale of 1 to 5, tell me how confident you are substituting ingredients or inventing recipes.

1 = very confident

5 = not at all confident

Circle one: 1 2 3 4 5

B5. If you store food or leftovers in the freezer, does it usually eventually get eaten?

- ☐ never
- ☐ rarely
- ☐ sometimes
- ☐ almost always
- ☐ always

B6. How much of your frozen food do you think ends up being thrown away (or composted)?

- ☐ none
- ☐ very little
- ☐ some
- ☐ about half
- ☐ more than half

Why?

B7. Do you compost food waste?

☐ yes ☐ no ☐sometimes

Comments:

B8. Do you feel better about food not being eaten if it ends up in the compost? (and not the trash)

☐ yes ☐ no ☐ never thought about it/unsure

Comments:

B9. Do you use a garbage disposal?

☐ yes ☐ no ☐sometimes

Comments:

B10. Do you feel better about food not being eaten if it ends up in the garbage disposal? (and not the trash)

☐ yes ☐ no ☐ never thought about it/unsure

Comments:

B11. Which option below best describes how you plan meals?

- ☐ I plan meals as I get hungry
- ☐ I plan the day before
- ☐ I plan for a few days ahead
- ☐ I make a plan for the whole week
- ☐ other _____

B12. Do you *write down* a meal plan?

- ☐ never
- ☐ rarely
- ☐ sometimes
- ☐ almost always
- ☐ always

If yes, what do you base your plan on?

- ☐ what's about to go bad
- ☐ what's in season
- ☐ cravings
- ☐ picky eaters in my household
- ☐ what's on sale/coupons
- ☐ diet restrictions
- ☐ nutritional reasons
- ☐ other_____

B13. How often do you or other members of your household go grocery shopping?

How often do you usually shop for groceries? (open-ended)

B14. Do you plan a shopping list before you shop for groceries?

- ☐ never
- ☐ rarely
- ☐ sometimes
- ☐ almost always
- ☐ always

Comments: (do people keep different types of lists- updated daily or put together each week?)

B15. Do you check your fridge, freezer, or cupboards before you go grocery shopping?

- ☐ never
- ☐ rarely
- ☐ sometimes
- ☐ almost always
- ☐ always

B16. How do you decide what to buy at the grocery store?

- ☐ follow list carefully
- ☐ what looks good
- ☐ what is on sale
- ☐ memory of what is needed
- ☐ call home while at the store
- ☐ usual items purchased
- ☐ other _____

B17. How much of the food you buy is semi-prepared or packaged?

- ☐ very little
- ☐ some
- ☐ about half
- ☐ more than half
- ☐ almost all

B18. How much of your food is bought as raw materials for a recipe?

- ☐ very little
- ☐ some
- ☐ about half
- ☐ more than half
- ☐ almost all

B19. How often do you look at the dates on the food your buy before you put it in your cart?

- ☐ never
- ☐ rarely
- ☐ sometimes
- ☐ almost always
- ☐ always

B20. How often do you look at the dates on the food in your fridge before you eat it?

- ☐ never
- ☐ rarely
- ☐ sometimes
- ☐ almost always

☐ always

B21. Do you or members of your household eat leftovers?

☐ never
☐ rarely
☐ sometimes
☐ almost always
☐ always

Why or why not?

B22. Do you ever cook extra food just so you can have leftovers or something to freeze for later?

☐ never
☐ rarely
☐ sometimes
☐ almost always
☐ always

B23. Where does most of your food knowledge come from? (check all that apply)

☐ family
☐ friends
☐ TV/media
☐ self-taught (cookbooks, internet, cooking shows)
☐ high school
☐ formal training
☐ the directions on packages
☐ other _____

C. Check-list questions

C1. Which (if any) of the reasons below are motivating for you not to waste food?

- ☐ money
- ☐ environmental impacts of disposal
- ☐ wasting energy and resources used to create and transport food
- ☐ I try to eat everything grown in my/our garden because I/we work hard for it!
- ☐ social concerns (people are hungry)
- ☐ saving time
- ☐ pressure from friends or others in household
- ☐ past experiences (such as living through depression era, etc.)
- ☐ cultural norms
- ☐ Other _____

C2. Please rank the **top four** tools that you think would be **most useful** for your household to prevent food from going to waste.

- ☐ Meal planning tips
- ☐ Shopping tips
- ☐ Information on the shelf-life and nutrition of frozen foods
- ☐ Recipe ideas for the "shrapnel" in the fridge
- ☐ Tips for modifying recipes to use what you have
- ☐ Information on the best way to store various foods
- ☐ Pantry storage tips
- ☐ Portion measuring tools
- ☐ Cold storage bag to bring home refrigerated items from the store
- ☐ Breathable produce storage bags
- ☐ Clear storage containers and labels
- ☐ Freezer storage containers
- ☐ Guide to meal planning
- ☐ Guide for canning food
- ☐ Guide for drying food
- ☐ Guide for freezing different foods
- ☐ Guide for appropriate refrigerator temperature settings
- ☐ Guide for how and when to reference "best-by", "use-buy" and "sell-by" dates
- ☐ Guide for safety – what is it ok to scrape mold off of?
- ☐ Directions to set-up non-refrigerated winter storage for vegetables (something like a root cellar)
- ☐ Other _____

C3. Would you be more likely to use web-based tools or physical/printed tools? (circle one)

Thank you for your participation

Pre-Pilot Wasted Food Interviews in Mac-Groveland households
A final report submitted to Eureka Recycling

Christie Manning, Eva Beal, Owen Daniels, Macalester College

In November 2010, nineteen residents of the Mac-Groveland neighborhood of Saint Paul were interviewed in their homes and asked about their household food waste. Residents of Macalester-Groveland are on average well-educated and have an above-median income. The recycling rate in this area is higher than other areas of the city, and a higher than average number already do some sort of composting in their homes. In the six months prior to the interviews, a neighborhood composting program had been pilot-tested and some of the homes in the interviews took part in this pilot project. This report describes the results of the household food waste interviews.

General Observations

1. The people interviewed for this research are typically competent, capable cooks who make a majority of their meals at home and feel comfortable working with basic ingredients (rather than relying on a lot packaged foods).

2. This group expressed disapproval of food waste and seemed motivated to waste less. This may be a characteristic of this particular demographic and their recent exposure to the Eureka composting program and a generally heightened awareness of waste.

3. The participants did not directly attribute wasted food to their buying habits. Instead, they seemed to feel that food waste happens because of storage issues in both the refrigerator and the freezer such as things getting pushed out of sight, going bad quickly, or simply not getting eaten fast enough.

4. Though a majority of interviewees reported keeping a list for their grocery shopping, they also tended to buy food that wasn't on the list if it looked good or was on sale.

5. Most of the group reported fairly short-term meal planning – and almost half said their meals are planned to use up ingredients that are about to go bad.

6. All participants eat at least some leftovers and many reported making extra food at a meal or on the weekends just to be able to eat some as leftovers.

7. Most participants were aware that wasted food is also wasted energy and that food waste has an environmental impact. However, the biggest motivator that people reported for cutting down on wasted food was because throwing away food is also a waste of money.

8. When it comes to choosing the most useful tools to avoid food waste, the participants had widely divergent answers. It seems that food waste is highly context-dependent and so a variety of tools is needed. The most often mentioned tool was information about proper food storage.

Recommendations:

1. Flexible set of tools. This group needs flexibility and a variety of tools. The reasons that food is wasted are diverse and context dependent and no single tool can address all of them. Eureka has already thought about and listed a number of potentially effective tools. There may also be others that we haven't yet thought of. In this report I've put a * where I think we should talk and brainstorm ideas for new or modified tools.

2. Improper food storage seems to be one of the big reasons that food goes to waste.

A. **Information about proper storage**: Many people said that food was wasted because "it spoiled", and people also indicated that they want information about how to store different types of food, although they did not mention lack of knowledge of proper storage as one of the things that causes them to throw away food. This may be because "lack of knowledge" was not a listed response option. However, it is also possible that people don't at first think about improper storage causing things to go bad more quickly. It isn't until people are offered information about "proper storage" that they realize they might be able to keep food fresh longer. This "surprise" element could add a bit of mystery and excitement to the toolkit.* You could create a "quiz" or kid's activity that has people match the different vegetable types to their proper storage; answers are given on the back. With an online tool, it could be a daily "how do you store THIS food" contest/quiz.

B. **Refrigerator rotation to bring food to the front of the fridge/freezer:** People also said that food often was forgotten in the back of the refrigerator or bottom of the freezer. The "lazy susan" tool is one way to solve that problem, though there may be other less technical solutions. I suggest that we brainstorm a bit about ways to prevent food from being forgotten*. There may be clever stickers or other zany things that we can suggest/offer people to keep those food items from disappearing, for example animal head caps that fit onto lids of condiments. Other, less exciting, ideas include a rotation chart for the freezer or the fridge.

3. Prompts. Many people report that food went to waste because it was forgotten- either it went out of sight in the refrigerator, or it was overlooked when meals were planned. A useful tool would be some sort of prompt that reminded people to (1) look around in the refrigerator before shopping, planning a meal, or cooking, and/or (2) rotate the refrigerator contents regularly. When designing prompts, it is

important to consider that people often "habituate" to things they see every day, like stickers on the refrigerator. A sticker prompt might work for a few weeks but after that it blends into the background and is no longer effective as a reminder. There may be ways to overcome this*. A second kind of prompt is an electronic/email/text prompt that sends people a message at specified time intervals, "Hey- it's your ketchup- Have you seen me lately? It's time to rotate your refrigerator!"

4. Recipes. Because so many people reported planning a meal based on "what's about to go bad", it is clear that a recipe index for random single ingredients would be a useful thing to have. The interesting problem with this recipe index is its format. On the one hand, a searchable online index would be the most flexible and likely to yield exactly the right recipe for the person and the ingredient. However, people do not usually have computers in their kitchens. We therefore need to offer people something that can be used in both formats. One idea is to create a binder in which people can store recipes and other useful materials from the Eureka food-waste-reducing web site. There are many other things that could go in this binder.*

5. Social norms. Though the largest number of people mentioned avoiding wasted money as a big motivator to cut down on food waste, it has been consistently shown in psychological studies that perceived social norms can have an even bigger influence on behavior. Thus it is important that this program include some sort of a social norm builder. Some ideas for this include: an online forum where people share their ideas, online or printed material with many individual pictures and possibly testimonials from people who don't like food waste and/or who have done creative things to avoid wasting food, a sticker or pin that people can wear to proclaim their participation in a food-waste-reduction effort, a sticker for the outdoor garbage bin that says "no wasted food in here!", etc.*

6. Tools for goal setting and feedback. Because people expressed concern about their food waste and are motivated to do something about it, another useful tool might be to give them a way to create goals around reducing it. People are generally more successful at making an intentional change if they set a goal for themselves and can check their progress toward that goal. In this case, it might involve setting either a waste-reduction goal or a goal to increase some sort of positive behavior such as trying new "shrapnel" recipes. Either way, we must create a way to make this a fun endeavor rather than it being a guilt-inducing chore. For example, people could have a chart in their binder where they keep track of the number of times they do something new (e.g., make veggie stock) to avoid food waste. *

Focus Group & Interview Questions

Introduction

Good evening and welcome! Thank you for your time to join this discussion. My name is Laura Angvall and with me to take notes is Caitlin Schwartz. We are both with Eureka Recycling. We are working with a group of organizations that are interested in your perceptions of the program materials you tested to reduce wasted food.

You were invited here tonight because you have tested some materials in your home over the past six weeks, like these we have set out on the table. We want to know how you used these materials and what you feel may be most helpful in reducing wasted food. We are having discussions like this with several groups around the City of Saint Paul.

The results of this discussion will help us focus on sharing materials that are the most useful, and improve this program for others in the future. The final materials and significant findings will be made available on our website, provided to the Minnesota Pollution Control Agency for distribution, and shared with other organizations and cities who may be interested in implementing an education program of their own. We will also contact you with the results of this work.

Your individual opinion is important to us. Please feel free to share both positive and negative feedback with us about the materials you tested at home. Throughout our discussion today, there are no wrong answers. Feel free to share your point of view even if it differs from what others have said. Also, we ask that you turn off or silence your cell phones. If you must respond to a call, please step out of the room as quietly as possible and rejoin us as quickly as you can. Please help yourself to the refreshments on the table.

We are recording this session today so we don't miss any of your comments. Although we are on a first name basis in our discussion, I assure you that we won't use any names in our reports, your comments will be anonymous.

So, let's begin. We're going to start our discussion all together, then break into two smaller groups so we are sure to have enough time to get feedback from everyone. We have these name cards here, but let's also take a minute to go around the table and introduce ourselves. Please tell us your name and what you enjoy doing in your free time.

Questions

[5 minutes] **1.** What caught your interest to participate in testing this program?

[5 minutes] **2.** Think about when the information binder and supplies were delivered to your home. What were your first impressions?

* At this point, participants were asked by name to break into groups pre-identified by their participation level.

[10 minutes] **3.** List the top five things you liked <u>best</u> about the information and tools you tested in your home to help prevent food waste. (Then go around the circle and have each participant share what they wrote down).

[10 minutes] **4.** List the five things you liked <u>least</u> about the information and tools you tested in your

home to help prevent food waste. (Then go around the circle and have each participant share what they wrote down).

[10 minutes] **5.** We're interested in how we can make this material more accessible on a website. Think about some websites that you go to (they don't have to be about food waste). What are the aspects of those websites that you appreciate? How could we incorporate some of those into our website or what do you think is critical about those websites that you think we should consider?

[5 minutes] **6.** Think about some of the materials that you didn't use. Please list what you didn't use and what prevented you from using them.

[5 minutes] **7.** Thank you all for bringing in the materials you were testing in your homes. What are some tips or recipes that you added yourself?

At this point, the groups were brought back together.

[5 minutes] **8.** Is your household food waste any different now since you started participating in this program? If so, how?

[5 minutes] **9.** Are your household food costs any different? If so, how?

[5 minutes] **10.** Considering the feedback we covered today, please list the two most important things you think we need to focus on as we further develop these materials. (Then go around the circle and have each participant share what they wrote down).

[5 minutes] **11.** *Ask note taker to provide a brief summary of the discussion and end by asking the group:* Is this an adequate summary, or have we missed anything you would like to add?

[5 minutes] **12.** We were here tonight to discuss your experience in testing these materials at home and to hear your suggestions about how we could improve these materials. Is there anything we should have talked about but didn't?

Thank you all very much for your valuable feedback. In the interest of not wasting food...feel free to help yourself to the refreshments and bring some home with you!

Survey Template

Thank you for your time and participation in Eureka Recycling's "Keeping it in the Kitchen: Preventing Wasted Food" program over the last six weeks. We are excited to hear about and learn from your experience so we can help others waste less food as we work toward zero-waste!

Please take a few minutes now to fill out this eight-question survey. Whatever your level of participation in the program, we value all of your feedback!

The information you provide in the survey will be kept confidential. We will only associate responses with your address when it is necessary for analysis, and will not use your address in any reports. After analysis, data will no longer be identified by address to ensure confidentiality. Participation in this survey is voluntary. If you do not wish to answer any of the questions included in the survey, you may skip them and move on to the next question.

1. What is your address?

2. Before you participated in this program, did you have any habits as part of your kitchen and/or shopping routines to help prevent wasted food?

3. Did you talk to any friends/neighbors/family members about the project?
   If yes, what did you say?

4. We know that many people were able to use the binder of materials frequently, but we also recognize that some didn't have a chance to use the materials much, if at all. Please let us know if you were able to use any of the following materials, and if so, how frequently.

   a. I tried a recipe to use up leftovers, either finding a recipe on my own or one from the binder (please circle one):
      never once 2-3 times 4-5 times more than 5 times

   b. I referenced the food storage tips (A-Z guide) in the binder (please circle one):
      never once 2-3 times 4-5 times more than 5 times

   c. I used kitchen utensils/storage containers that I ordered through the program (please circle one):
      never once 2-3 times 4-5 times more than 5 times

   d. I referenced the online resources (www.eurekarecycling.org/NoMoreWastedFood.cfm) (please circle one):
      never once 2-3 times 4-5 times more than 5 times

   e. I used a meal planner (please circle one):
      never once 2-3 times 4-5 times more than 5 times

   f. I read and referenced information in the binder about shopping tips, refrigerator storage or other information (please circle one):
      never once 2-3 times 4-5 times more than 5 times

5. Which of the types of materials listed below (a-e) was the most challenging to fit into your daily routine? (please circle one)
    a. recipes to use up leftovers
    b. food storage tips (A-Z guide) in the binder
    c. kitchen utensils/storage containers that I ordered through the program
    d. online resources (www.eurekarecycling.org/NoMoreWastedFood.cfm)
    e. meal planner

6. What do you think it would it take to make this item you selected in Question #5 easier to use or more useful?

7. What did you enjoy most about participating in this program?

8. Is there anything else you would like to share with us?

Gathering Community Input on Preventing Wasted Food

Eureka Recycling, June 2012

As a nonprofit community-based organization, Eureka Recycling strongly believes that the most successful waste-reduction programs (that result in the most effective behavior change) address the specific values, interests, and needs of the community for which the program is being designed. We believe the best way to get that information is to listen to community members!

Social marketing principles suggest that for most people, just increasing knowledge is not enough to change behavior. Instead, we need to appeal to personal values and understand the barriers that prevent behavior change, so we can design programs and messages that target our specific community's values and encourage them to act on the behavior we are promoting; in this case, preventing wasted food. Using this approach doesn't have to cost a lot of money, but because food habits can be personal and cultural, getting input and feedback from the specific audience and community you are targeting is critical.

These recommendations were formed through Eureka Recycling's recent experience engaging three groups in the City of Saint Paul to help create our first set of wasted food prevention tools. This work is also deeply informed by more than a decade of community engagement on our variety of zero-waste programs and services.

Asking Fruitful Questions

When designing a wasted food prevention program specifically for your community, it is important to know the motivating factors and barriers that are specific to your community members. The most information-rich dialogue came from our focus group participants when we asked the following types of questions. This list also includes some recommended questions that we did not ask but have since learned the value of including.

- **Attitudes and motivations to reduce food waste**
  Knowing the motivations of your target audience can help you encourage participation in the program; for example if their primary motivation is to save money, messaging about the environmental benefits won't be very effective.
  - How do your participants feel about the food they waste?
  - Do they see it as a problem? Why?
  - Do people think others waste food?
  - Is it acceptable, or do people aspire to waste less?
  - Do they think they saved/would save money by participating in the program?
  - Where do they rank it among other issues they would like to address?
  - What are the benefits they can see from wasting less food?

- **Cultural relationships to food**
  Find out what works and doesn't work for them to prevent wasted food. For example, in our conversations with some participants in our pilot, we heard about their cultural expectations to have enough food on hand to prepare meals for large groups of people at any time (which can result in large amounts of unused wasted food). This group found food storage tips particularly useful.

- **Barriers to change (real and perceived)**
  If you are pilot testing, we recommend you discuss barriers with participants both before and after the program is tested. Identifying barriers can help you design a program and massaging targeted to your audience. Barriers can be attributed to the individual (such as a lack of knowledge to carry out the behavior) or they can be attributed to the external world (such as the grocery store being located far away, so larger and less frequent shopping trips are required).

- **Current food habits**
  What kinds of conscious actions are people already taking to prevent food waste? What are the specific challenges they feel they face in using up all the food they bring home? Are there specific foods they have more problems with? Do they already use meal planning tools? This can help you focus your resources on developing tools that are most needed.

Finding the Right Methods

To get quality responses and greater participation in providing feedback, we recommend being ready to use a variety of methods to collect responses. This allows you to be flexible to the comfort and needs of your participants.

We used some typical methods to gather feedback with some success, such as focus groups and emailed surveys. However, through conversations with our community representatives who helped us to recruit program participants, we learned better ways to contact program participants.

Community representatives who serve as your point person to participants are critical in gathering feedback. These representatives not only helped us recruit program participants, they guided us in connecting with participants to get meaningful feedback at the end. For one community, we first sent postal mail invitations and began communications via email after participants opted in to the program. In another group, community representatives suggested contacting participants via postal mail and through telephone calls conducted by the staff of a familiar and popular community center.

We learned that some participants were more comfortable with one-on-one interviews, so we followed up with our first group in the pilot using individual interviews instead of focus groups, which were conducted by members of that community who were trained by Eureka Recycling. When some participants had a strong connection with our community representative, we had our representative conduct one-on-one follow up interviews rather than conducting focus groups.

Overall, if you are interested in developing education about preventing wasted food or connecting people in your community to existing tools, you will get more of the useful information and feedback you need by catering your methods to the needs of your participants.

Significant Findings: Feedback from Participants via Interviews and Focus Groups

- **Food storage tips and menu planning were cited as the two most useful tools across all three groups.** Of all the tools tested in the pilot, these two were reported as being used most often by all three groups, and identified as "most useful" by all three groups in conversation. Making them available in a variety of formats – especially web-based – was a common suggestion.

- **There are a variety of barriers to preventing food waste.**
  We heard from our focus group participants that it takes a long time to change deeply ingrained habits and it is often challenging to evaluate the benefits of preventing food waste when you can't see direct benefits or rapid progress.
  - "I found I was pretty set in my ways, I've got my habits established."
    (6/2 Macalester Groveland)

  In focus group discussions, participants cited having children was a barrier to reducing food waste due to food preferences or "picky eaters" who don't finish their meals or don't like what is served for them.

  - "To invest energy into trying something that my kids might not like or that might take some time instead of just doing the usual...there are a number of barriers."
    (6/2 Macalester Groveland)
  - "Time is worth putting into it if I think its something the kids are going to like but my kids can be pretty picky eaters sometimes."
    (6/2 Macalester Groveland)
  - "I eat the leftovers, but my daughter, she doesn't want.
    (6/16 African American community)

  Also, it was more difficult to track and manage in households that that had more than one person in the family doing the cooking.

  - "This would work if there is one person in the family that does the cooking. And that person has tightness and control over the food. My family, and for my personality, it didn't work."
    (6/2 Macalester Groveland)

- **Messaging about food waste may be effective if they are connected to people's social values and their existing attitudes about saving money, the environment or improving their health.**
  Understanding what beliefs, attitudes and behaviors people participate in can help us best communicate with our audience and motivate behavior change. When participants could make a connection from their values to preventing food waste, they were more likely to participate. For some, they saw that preventing food waste was an extension of other waste reduction behaviors like recycling and composting and saw it as an opportunity to do more for the environment.
  - "I have sort of been rabid about recycling and composting and this just seemed like the next piece for me"
    (6/2 Macalester Groveland)

  For others, they valued programs that their friends participated in so when they were recruited to join by our community organizer they signed up because they knew if the community organizer valued the program then it was something they should check out.

- "I just thought I'd try it because you know what's important to her is important to me so if she was that curious abut what it was, I figured I'd go ahead and give it a try."
  (6/16 African American community)
- "Some people I couldn't convince, but some- a lot of people- were like, okay, Sheronda, if you're doing it I guess it's okay."
  (6/16 African American community)

Some also stated that they saw the program as an opportunity for them to eat healthier and plan meals so that they could lose weight.

- "I thought it might be healthy for me to come."
  (6/16 African American community)

Others, too, saw the program as an opportunity to save money.

- "It saved me money too....I could save money on groceries by planning."
  (6/7 Macalester Groveland)
- "I wanted to save more money and more food so that's why I was interested."
  (6/16 African American community)

Since there is a wide variety of reasons why people may find the program valuable, and many ways to reduce food waste, it is key to learn about the values of your community so you can tailor communication about your program to explain how it will help your community members meet their personal goals.

- **Behaviors regarding food waste prevention were varied across participants.**
  - Of participants that responded to our survey, 80% (45/56) responded "YES", when asked, "Before you participated in this program, did you have any habits as part of your kitchen and/or shopping routines to help prevent wasted food?"
  - Within neighborhoods, there is more variation; 15% of participants in the Hmong Community; 0% of participants in Macalester Groveland; and 50% of participants in the African American community did not have any habits prior to the program to help prevent wasted food.

- **Food habits are cultural and personal.**

The Hmong Community didn't use some of the tools or information provided in the program such as recipes to use up leftovers because they weren't culturally relevant. The recipes didn't reflect typical meals that the participants would regularly eat.

- "I wish there were some more Asian recipes in there just because I cook Hmong food more than I cook even American food, so I guess the recipes could have been more Asian."
  (6/15 Hmong Community)

Participants also explained that they often buy their food and cook their food in bulk quantities and have weekly gatherings where serving an over abundance of food is expected and considered hospitable, and because of this cultural expectations, meal planning and portion sizing is difficult.

- "Our culture is very hospitality driven, so you always want to overcook everything, you know, just in case...it's better to have more then not have enough."
  (6/15 Hmong Community)
- "...that's how we're kind of engrained in this culture, like I brought home two rotisseries because another family was coming over, and I got yelled at because I didn't bring home a third one to

show respect for the family."
(6/15 Hmong Community)

We also heard from our participants that food habits are greatly determined by how you are raised, and several participants referenced having parents that grew up during the Depression as the reason why they value behaviors that prevent waste.

- "I was raised by parents who grew up in the Depression so I know how to not waste food, that's just how we did it in our house."
  (6/2 Macalester Groveland)
- "I think it's maybe how you've been raised, how you've been educated, what you've been exposed to."
  (6/7 Macalester Groveland)
- "I didn't grow up throwing away food. I come from a family of eleven and so I just have a real appreciation for not wasting."
  (6/16 African American community)

- **Having a goal-setting structure or specific program targets would make the program more achievable.** Changing any behavior that has been well established, takes time and commitment. Food behaviors are generally behaviors we have grown used to over time and require great motivation to change. People are generally more successful at making an intentional change if they set a goal for themselves and can check their progress toward that goal. So, providing a program with small, flexible goals that allow participants to adapt the program to fit their motivations and their level of readiness would help make the program more applicable and achievable to a broader audience.

  Participants could list personal goals or the program could provide people with program targets to work toward. In this case, it might involve setting either a waste-reduction goal or a goal to increase some sort of positive behavior. It is important for the program to provide a way to make this a fun activity rather an a guilt-inducing chore by focusing on the positive aspects of their behavior, such as tracking every time participants do something new to avoid food waste.

  Some suggestions we received from participants included:
  - "...if we could create an account and keep track of our meal plans and see how things, how we have been planning- have we gotten any better? We could keep track of our journals and grade ourselves or if there's a grading system, then we could see our progress."
    (6/15 Hmong Community)
  - "I think it would have been easier for me if it was more structured. Not like my whole list of things that I could do but just some, like one thing...Just one thing laid out and you just practice that one thing and see how that worked for you. That probably would have worked for me."
    (6/16 African American community)

- **People need to access information in multiple formats.**
  Participants suggested providing information in audio and video formats in addition to the printed or web-based text, and to attend community events to present information in an interactive face-to-face demonstration. Due to different learning styles, literacy levels, preferences for interactivity and reminders, technology options, and reaching different generations, information needs to be provided in multiple formats. Participants also suggested to make sure that the website would be cellular phone/mobile-friendly.

- "We've got to realize too that still we're kind of even at a time and space where a lot of folks are still not literate so even if you're putting it into multiple languages, they're not literate, even in their own language."
  (6/16 African American community)
- "Make it interactive so people can video-blog, people can regular blog or listen to some audio if they want to because people learn and take in information different....Some people just want to look at a video."
  (6/16 African American community)

- **Branding our program as a credible information source was critical.** Our program participants were interested in being involved because they were familiar with our work and trusted our programs.
  - "I like what Eureka does and I was curious to see what kinds of things Eureka was exploring with this food waste project"
    (6/2 Macalester Groveland)
  - "I thought it was going to be a lot of fun because it's Eureka and I love Eureka."
    (6/7 Macalester Groveland)
  - "We're pretty regular recyclers so it just, being familiar with the brand name. We just figured why not, and so that was pretty much it for us.
    (6/15 Hmong Community)
  - "By the brand name being, like you know, Eureka – we're familiar with it."
    (6/15 Hmong Community)

How to use this toolkit:

This binder is yours to use and abuse! Spill food on it, write in the margins, fill out the journals, add your favorite recipes and tips…

Did you *hate* a particular recipe? Do you *love* a bit of info? Is something missing? Please take notes! **We want to know!**

Join us for a discussion about your experience using these tools in your kitchen!

Thursday, June 2 or Tuesday, June 7
6:30-8:15 p.m.

Turn page for more info…

<u>Join us for a discussion</u> about your experience using these tools in your kitchen and receive a thank-you gift.

Mark your calendar!

Edgcumbe
Recreation Center
Thursday, June 2 or
Tuesday, June 7
6:30-8:15 p.m.

At the discussions, we will collect the binders for a brief time so that we can document all your comments, additional resources, journal entries, etc., and then give the binder back for you to keep!

Welcome!

We're excited to learn with you about how we can all waste less food and save money! We look forward to getting your feedback at the discussions in June!

Keeping it in the Kitchen!

1. Journals:

- **Weekly Journal Entries:** Please take a few minutes to answer the questions on one of these pages each week, to record your observations, questions, and suggestions.
- **Major Clean-Out Journal:** If you do a major clean-out of your fridge, pantry, or freezer over the next six weeks, please take a little time to document it here.
- **Fridge inventory:** Taking stock and keeping track of everything in your fridge can help you plan meals and make grocery lists.

2. Menu Planning:

Planning meals ahead of time saves time and money by making it easier to only buy what you need and what you will have time to prepare and eat.

3. Recipes:

This collection of 24 recipes was pulled together to provide ideas for using up extra or left-over food. Give a few a try and let us know what you think!

4. Food Storage:

- **A-Z Food Storage Guide:** Herbs getting wilted? Bananas going brown? Check out this guide for tips on storing and using up your favorite foods.
- **Fridge and Freezer tips:** Info and ideas for getting the most out of your fridge and freezer, like optimal temperature settings and organizing tips.
- **Dates on Food Packaging:** A guide to understanding the "best-by" "use-by" and "sell-by" dates printed on packaged food.
- **Web Resources:** Check out **www.eurekarecycling.org/NoMoreWastedFood.cfm** for links to helpful resources for canning, freezing, root cellars, and more!
- **Freezer labels:** (in back folder) Keep track of when that delicious dish went in the freezer!

EUREKA! RECYCLING

Questions? Call Eureka Recycling's Hotline at (651) 222-7678
or email info@eurekarecyclling.org

Why worry about preventing wasted food?

Trash in the Twin Cities goes to an incinerator or landfill, creating greenhouse gases, harmful pollutants, and toxins that make their way into our air, water, and bodies.

Sending food scraps down the drain in a garbage disposal is basically the same thing as throwing them in the trash, it's just a longer, more energy-intensive journey to the landfill or incinerator!

Try as we might, we can't always avoid having some food waste. (Anybody have a good recipe for eating up banana peels?) But through **composting** we can avoid the pollution and harmful effects that come with throwing some of our food scraps in the trash!

With just a little set-up, you can quickly start composting kitchen scraps (except for meat and dairy) right in your own backyard or worm bin. For more information, check out our composting website: www.MakeDirtNotWaste.org

Although composting is a great way to deal with inevitable food scraps, **preventing as much wasted food as we can in the first place** is the best for the environment and our wallets!

Eureka Recycling is the only organization in Minnesota that specializes in zero waste. A 501(c)(3) nonprofit organization, based in the Twin Cities of Saint Paul and Minneapolis, Eureka Recycling's mission is to demonstrate that waste is preventable, not inevitable.

www.eurekarecycling.org /(651) 222-7678 / info@eurekarecycling.org

Please take a few minutes to answer the questions below each week.

Week 1 – Dates: _____

Weekly Journal Entries

1. Tools, information, or tips that were useful this week, and why:

_____

_____

2. Things I tried that were **not** helpful, and why:

_____

_____

3. Information that I wish was available or that would have come in handy:

_____

_____

4a. I am still having to compost or throw away these foods:

_____

_____

4b. I think that this is because:

_____

_____

5. Wasting less food often means saving money! Does it seem like any of these tools or information helped you save money on your grocery bills this week?

_____

_____

6. Did you notice any changes in your habits this week? If so, which ones?

_____

_____

7. Additional thoughts, questions, or complaints for this week:

_____

_____

Please take a few minutes to answer the questions below each week.

Week 2 – Dates: _____

Weekly Journal Entries

1. Tools, information, or tips that were useful this week, and why:

_____

_____

2. Things I tried that were **not** helpful, and why:

_____

_____

3. Information that I wish was available or that would have come in handy:

_____

_____

4a. I am still having to compost or throw away these foods:

_____

_____

4b. I think that this is because:

_____

_____

5. Wasting less food often means saving money! Does it seem like any of these tools or information helped you save money on your grocery bills this week?

_____

_____

6. Did you notice any changes in your habits this week? If so, which ones?

_____

_____

7. Additional thoughts, questions, or complaints for this week:

_____

_____

Please take a few minutes to answer the questions below each week.

Week 3 – Dates: _____

Weekly Journal Entries

1. Tools, information, or tips that were useful this week, and why:

_____

_____

2. Things I tried that were **not** helpful, and why:

_____

_____

3. Information that I wish was available or that would have come in handy:

_____

_____

4a. I am still having to compost or throw away these foods:

_____

_____

4b. I think that this is because:

_____

_____

5. Wasting less food often means saving money! Does it seem like any of these tools or information helped you save money on your grocery bills this week?

_____

_____

6. Did you notice any changes in your habits this week? If so, which ones?

_____

_____

7. Additional thoughts, questions, or complaints for this week:

_____

_____

Please take a few minutes to answer the questions below each week.

Week 4 – Dates: _____

Weekly Journal Entries

1. Tools, information, or tips that were useful this week, and why:

_____

_____

2. Things I tried that were **not** helpful, and why:

_____

_____

3. Information that I wish was available or that would have come in handy:

_____

_____

4a. I am still having to compost or throw away these foods:

_____

_____

4b. I think that this is because:

_____

_____

5. Wasting less food often means saving money! Does it seem like any of these tools or information helped you save money on your grocery bills this week?

_____

_____

6. Did you notice any changes in your habits this week? If so, which ones?

_____

_____

7. Additional thoughts, questions, or complaints for this week:

_____

_____

Please take a few minutes to answer the questions below each week.

Week 5 – Dates: _____

Weekly Journal Entries

1. Tools, information, or tips that were useful this week, and why:

_____

_____

2. Things I tried that were **not** helpful, and why:

_____

_____

3. Information that I wish was available or that would have come in handy:

_____

_____

4a. I am still having to compost or throw away these foods:

_____

_____

4b. I think that this is because:

_____

_____

5. Wasting less food often means saving money! Does it seem like any of these tools or information helped you save money on your grocery bills this week?

_____

_____

6. Did you notice any changes in your habits this week? If so, which ones?

_____

_____

7. Additional thoughts, questions, or complaints for this week:

_____

_____

Please take a few minutes to answer the questions below each week.

Week 6 – Dates: _____

Weekly Journal Entries

1. Tools, information, or tips that were useful this week, and why:

_____

_____

2. Things I tried that were **not** helpful, and why:

_____

_____

3. Information that I wish was available or that would have come in handy:

_____

_____

4a. I am still having to compost or throw away these foods:

_____

_____

4b. I think that this is because:

_____

_____

5. Wasting less food often means saving money! Does it seem like any of these tools or information helped you save money on your grocery bills this week?

_____

_____

6. Did you notice any changes in your habits this week? If so, which ones?

_____

_____

7. Additional thoughts, questions, or complaints for this week:

_____

_____

Major Clean-Out Journal

If you do a major clean-out of the fridge, freezer, or pantry, please record some notes about what you got rid of (if you could identify it!) You may even want to do this right at the beginning to get a fresh start!

Don't be shy about sharing the worst—remember we're all learning! Check out this photo from the fridge in Eureka Recycling's office a few weeks ago!

Areas that were cleaned out:

- ☐ Fridge
- ☐ Pantry
- ☐ Freezer

Types of foods that were thrown out:	Reason food was thrown out (gone bad, unidentifiable, sick of eating it, etc.):

Refrigerator Inventory

Taking stock and keeping track of everything in your fridge can help you plan meals and make grocery lists.

Meal Planner

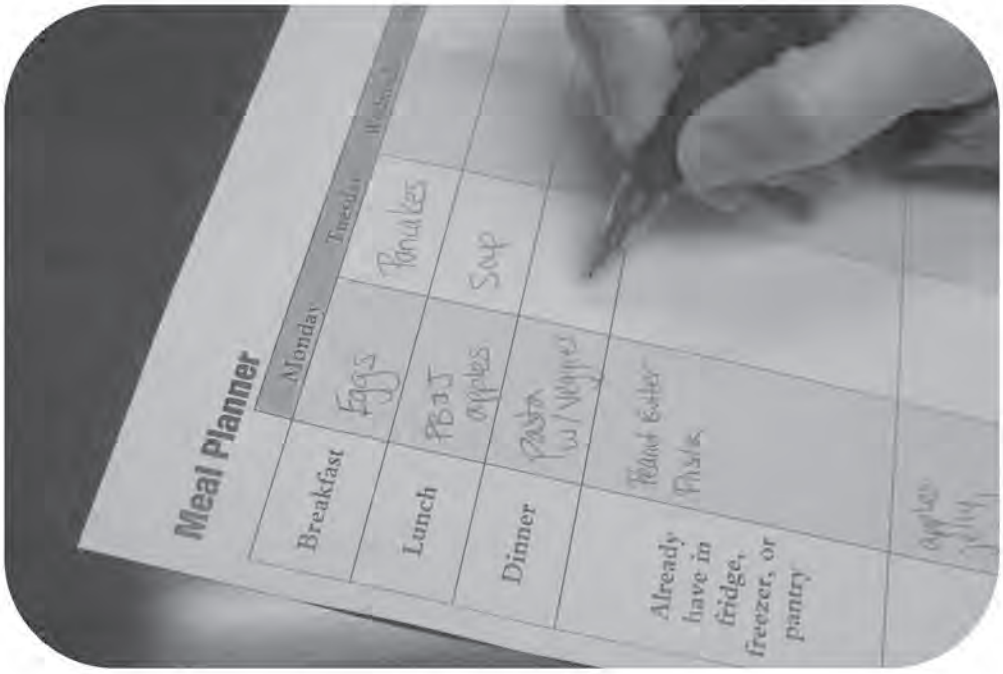
Use this guide to help you plan your meals for the week. Planning ahead not only saves time and money, but can also reduce the amount of food you throw out at the end of each week.

1. **Before you go shopping**, look at your week and plan accordingly. For instance, if you have commitments that won't let you make dinner for the whole family, plan something like burritos from leftover veggies, scraps of cheese, and a can of beans that everyone can put together themselves.

2. **Take a little time to plan** at the beginning of each week, and write down what you will have for breakfast, lunch, and dinner each day on the following pages.

3. **Think about portion sizes** as well when you are planning. Is everyone going to be home for dinner? Do you need to make the whole package of spaghetti or can you just make two servings?

4. Think about what you will need to make each meal and do a pantry, fridge, and freezer check to **see what you already have** before making your grocery list.



Shopping Tips

1. **Think carefully before buying in large quantities.** It doesn't save you money if you end up throwing out half of the item because you couldn't eat it in time. Only buy what you know you can either eat or preserve before it goes bad.

2. **Be realistic;** if you know you're too tired to cook anything elaborate on weeknights, don't buy the ingredients for a multi-course dinner.

3. **Keeping your pantry stocked** with non-perishables ensures you always have what you need on hand. For some lists of pantry essentials, check out the "Web Resources" in the "Food Storage" section of this toolkit.

4. **Try to stick to your list.** When we buy things (just because they are on sale or look really good) without a plan for eating or using them, that often leads to wasted food.

5. **Produce lasts longer when it's kept consistently cool.** Try to reduce the time it spends outside of the fridge by shopping for produce last when you're at the grocery store. This also helps it not get bruised and banged up—so you don't put the milk on top of the lettuce!

Meal Planner

Week: _____

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Breakfast	Cereal	eggs	oatmeal	toast	cereal	Pancakes + bacon	Eggbake
Lunch	Peanut Butter + jelly + apples	Salads	Quesadilla	Ham + cheese Sandwiches	Leftover soup	Mac + cheese	Salads
Dinner	Roast chicken + veggies	Burgers	chicken noodle soup	Baked potatoes + Broccoli + cheese	Pizza	out for Dad's Birthday!	Pork Sandwiches
Already have in fridge, freezer, or pantry	cereal bread Peanut butter frozen peas	eggs tomato ground beef (freeze) cheese	oatmeal	Bread cheese Broccoli	cereal pepperoni	flour Syrup pasta cheese	eggs peppers cheese
Grocery list	milk Jelly chicken	lettuce buns	tortillas Salsa	Ham lunchmeat potatoes.	pizza crust mozz. cheese	bacon	pork roast (buns) (lettuce)

Meal Planner

Week: _____

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Breakfast							
Lunch							
Dinner							
Already have in fridge, freezer, or pantry							
Grocery list							

Meal Planner

Week: _____

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Breakfast							
Lunch							
Dinner							
Already have in fridge, freezer, or pantry							
Grocery list							

Meal Planner

Week: _____

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Breakfast							
Lunch							
Dinner							
Already have in fridge, freezer, or pantry							
Grocery list							

Meal Planner

Week: _____

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Breakfast							
Lunch							
Dinner							
Already have in fridge, freezer, or pantry							
Grocery list							

Meal Planner

Week: _____

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Breakfast							
Lunch							
Dinner							
Already have in fridge, freezer, or pantry							
Grocery list							

Meal Planner

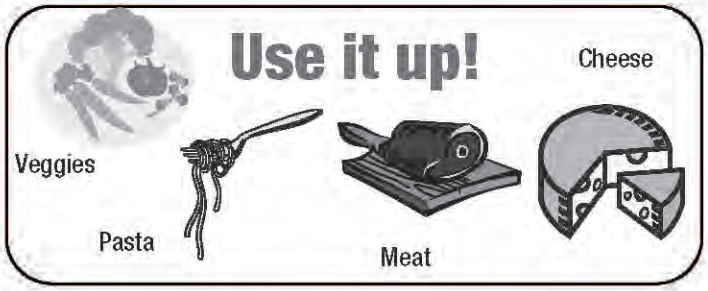
Week: _____

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Breakfast							
Lunch							
Dinner							
Already have in fridge, freezer, or pantry							
Grocery list							

Recipes

Creatively reusing leftovers is a great way to reduce your food waste. We've included some recipes to get you started, but remember that you can often add and substitute ingredients to your favorite dishes based on what you have on hand.

Easy Marinated Salads



Marinated salads make it easy to turn last night's noodles into today's lunch. Beans, grains, and potatoes are also champion marinaters and can be combined with whatever meats, cheeses, and veggies you have lying around to create tasty and healthful salads. Here are some example ingredients. Pick and choose what you like and what you have on hand!

- **Starches:**
  - Leftover cooked pasta (if it's a long noodle like spaghetti, chop it into bite sized pieces before using)
  - Canned or cooked beans
  - Rice, wheat berries, barley, or other grains
  - Boiled, chopped potatoes
- **Cheese:**
  - Cubed, grated, or crumbled; any type will do
- **Meat:**
  - Chopped chicken or turkey
  - Canned tuna or salmon
  - Sliced deli meats
- **Vegetables:**
  - Frozen peas or corn
  - Chopped fresh peapods, cherry tomatoes, mushrooms, or spinach
  - Roasted or steamed broccoli, eggplant, squash, peppers, or onion
- **Extra ingredients:**
  - Nuts, avocados, and olives all make great additions!

Once you've selected your ingredients, it's time to create a marinade. Marinades combine a fat with something acidic like lemon juice or vinegar along with spices and herbs to tenderize and bring out the flavor of your ingredients. Even items you normally might not like raw such as zucchini or green beans become tasty and crisp after a few hours in a marinade, and it will do equal wonders for veggies that are beginning to wilt or go soft. A good rule of thumb is 3 parts oil to 1 part acid, but this will vary depending on your tastes and the ingredients you use. If you don't want to make your own, any salad dressing with the word "vinegar" or "vinaigrette" in the name will do. Have fun experimenting and don't forget to taste along the way!

- **Fats:**
  - Olive, sesame, vegetable, or walnut oil
  - Mayonnaise, yogurt, or sour cream
- **Acids:**
  - Vinegar, such as red or white wine, rice, or balsamic
  - Lemon or lime juice

Continues on next page

- **Herbs, spices and flavors:**
  - Crushed garlic
  - Fresh or dried herbs such as rosemary, sage, or oregano
  - Spices like cumin, coriander, or chili
  - Mustard
  - A sweetener like honey, maple syrup, or sugar

Instructions:

All you have to do to create a great salad is to combine your ingredients and let them sit in the fridge for a few hours, tossing occasionally to coat. If you find you have extra marinade after you finish your salad, save it in a jar and reuse it for a future meal.

Sample Recipe: Pasta Salad with Feta and Snow Peas

Serves 6

Ingredients:

- **coarse salt and ground pepper**
- **1 pound fusilli, or other short pasta, cooked**
- **4 ounces snow peas, strings removed, sliced diagonally into 1/2-inch-wide strips**
- **1 yellow bell pepper, ribs and seeds removed, chopped into 1/2-inch pieces**
- **2 scallions, thinly sliced**
- **1/2 cup chopped fresh cilantro**
- **1 cup (4 ounces) crumbled feta cheese**
- **2 tablespoons olive oil**
- **2 tablespoons white wine vinegar**
- **1 teaspoon balsamic vinegar**

Directions:

In a large bowl, combine pasta and peas, bell pepper, scallions, cilantro, feta, oil, vinegars, 1 teaspoon salt, and 1/4 teaspoon pepper; toss to combine. Serve chilled or at room temperature.

Adapted from: Martha Stewart

http://www.marthastewart.com/317985/pasta-salad-with-feta-and-snow-peas

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Please use this space to write down your feedback on this recipe.

Chimichurri Sauce

Use it up!

Parsley and Cilantro

It's common to buy cilantro or parsley for a recipe and find that you only need a small portion of the bunch it was sold in. Chimichurri is a delicious uncooked sauce from Argentina that will ensure nothing goes to waste. It's fantastic on bread, pasta, meat, and seafood, and it's super easy to make.

Ingredients:

- **1 cup (packed) fresh Italian parsley**
- **1/2 cup olive oil**
- **1/3 cup red wine vinegar**
- **1/4 cup (packed) fresh cilantro**
- **2 garlic cloves, peeled**
- **3/4 teaspoon dried crushed red pepper**
- **1/2 teaspoon ground cumin**
- **1/2 teaspoon salt**

Instructions:

Puree all ingredients in a food processor, or chop by hand and combine. Transfer to a bowl, cover and let stand for 2 hours at room temperature before using.

Adapted from: Epicurious

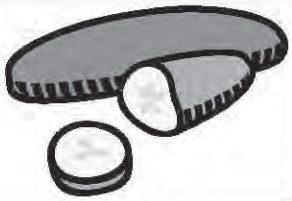
http://www.epicurious.com/recipes/food/views/Chimichurri-Sauce-107159

Please use this space to write down your feedback on this recipe.

Refrigerator Pickles

Use it up!

Cucumbers



If you've ever grown cucumbers in a garden, you know how much of a bounty you get throughout the summer! So if you need to find a use for those extra cukes (or if you just love pickles on hamburgers) try these easy and quick refrigerator pickles.

Ingredients:

- **3 large cucumbers**
- **1 bell pepper (green or red)**
- **1 onion**
- **1 tablespoon salt**
- **2 teaspoons celery seed**
- **1/4 cup granulated sugar**
- **1/2 cup white vinegar**

Instructions:

Slice the cucumbers into a medium sized bowl, leaving the peel on, about 1/8" thick. Wash and remove seeds from the pepper and skin the onion.

Finely chop the onion and pepper; add to cucumbers. Sprinkle with salt and celery seed. Cover loosely and set aside for 1 hour.

In a small saucepan, bring vinegar to a boil then remove immediately from heat. Stir in sugar, stirring until dissolved. Allow to cool, and then pour over cucumbers.

Mix well; cover and refrigerate for at least 24 hours before serving.

Adapted from: Cooks

http://www.cooks.com/rec/view/0,1736,134184-255199,00.html

Please use this space to write down your feedback on this recipe.

Roasted Pumpkin Seeds

Use it up!

Pumpkin Seeds or Squash

No need to throw out the pumpkin seeds from your Halloween jack-o-lantern or your pie pumpkin. The roast seeds make a quick and satisfying snack that both kids and grownups will love.

Serves 6

Ingredients:

- **1 teaspoon olive oil**
- **seeds from a pumpkin or winter squash**
- **pinch of cumin**
- **pinch of garlic salt**
- **pinch of paprika**
- **pinch of coarse sea salt**
- **freshly ground black pepper**

Instructions:

Heat a frying pan, add the olive oil and then add the pumpkin seeds.

Once seeds become brown, tip them into a bowl and season with the remaining ingredients.

Adapted from: Love Food Hate Waste

http://www.lovefoodhatewaste.com/recipes/show/76-roast-pumpkin-seeds

Please use this space to write down your feedback on this recipe.

Potato Peel Crisps

Use it up!

Potato Peels

Potato peels, despite being packed with fiber and vitamins, are one of the most frequently discarded usable foods. Next time you make a dish that calls for potatoes, save the skins to make this irresistible snack. Make sure to scrub the potatoes before using the peel.

Ingredients:

- **assorted potato peels, baked, boiled, or raw, cut into 3 by 1 inch strips**
- **butter**
- **salt and pepper**

Instructions:

Preheat oven to 450° F.

Arrange the strips in one layer in a buttered baking dish, dot them with unsalted butter, using 1 tablespoon for each cup of peels, and sprinkle them with salt and pepper.

Bake the peels for 5 to 25 minutes, according to the type of peel, or until they are very crisp. (Baked peels cook in 5 to 7 minutes, raw peels cook in 15 to 20 minutes, and boiled peels cook in 20 to 25 minutes.)

Transfer the peels to a plate or bowl, sprinkle with salt and pepper if desired, and serve as an hors d'oeuvre.

Adapted from: Astray Recipes

http://www.astray.com/recipes/?show=Potato%20peel%20crisps

Please use this space to write down your feedback on this recipe.

Vegetable Stock

Use it up!

Vegetable Scraps

Stocks are a great base for soups and stews and help you close the gap on veggie waste in your home food system. Start by keeping a stock box in your freezer. Every time you find yourself with vegetable scraps, wash them and toss them into your container.

Try saving onions and onion peels, garlic, carrots, celery, mushroom stems, the green parts of onions, zucchini ends, potato skins, carrot tops and peels, or any other mild vegetable. Try to avoid cabbage, Brussels sprouts, broccoli, beets, and tomatoes, because they can make your stock have a harsh or bitter flavor.

You can start making stock once you've got about **4 cups of vegetables.**

Makes about 8 cups

Instructions:

Make sure you have a balanced mix of vegetables before you start. Onions, carrots, and garlic are the usual basis for a tasty stock. If you don't have any garlic in your scrap box, peel 2-3 cloves and add.

Spread the scraps in a glass baking dish. Drizzle with a little olive oil. Roast at 350° F until the scraps begin to caramelize. Stir periodically.

In a large pot, add vegetables to 8 cups water. Add about 1-1/2 tsp. salt, a few whole peppercorns, one bay leaf, and a sprig of thyme. Simmer for about an hour.

Strain the stock into a bowl or glass container to cool.

When it is cool, store in quart-size bags. Seal the bags and lay them flat in the freezer.

Adapted from: Sound Food

http://www.soundfood.org/sfcommunity/sfrecipeblog/240takingstock.html

Please use this space to write down your feedback on this recipe.

Chicken Stock

Making stock from the leftover bones from a roast will ensure you always have a good base for soups, risottos, and gravies. Making stocks at home really helps us get the most from the meat that we buy and are a great alternative to stock cubes and powders. If you don't have time to make stock right after dinner, freeze the bones from the roast bird and make the stock later.

Makes about 6 cups

Ingredients:

- **chicken or turkey carcass**
- **1 onion, cut into quarters (including skin)**
- **a couple of carrots (skin scrubbed)**
- **1 garlic clove**
- **1 celery rib, chopped in half**
- **1 teaspoon of black peppercorns**
- **a few sprigs of thyme**
- **some parsley and a small bay leaf**

Instructions:

Put the carcass into a large saucepan and cover with water. Add onion, chopped carrots, garlic clove, and celery. Sprinkle in black peppercorns, thyme, parsley, and bay leaf.

Bring up to boil and remove the film from the surface with a large spoon, turn down the heat, and simmer for 1-1/2 – 2 hours.

Cool a little, strain, and leave to cool. The vegetables can be kept to use in a soup. The fat can be removed from the surface by drawing absorbent paper towels over it.

Adapted from: Love Food Hate Waste

http://www.lovefoodhatewaste.com/recipes/show/61-basic-chicken-or-turkey-stock

Please use this space to write down your feedback on this recipe.

"Garbage" Soup

Use it up!

Leftover meals

Vegetable peelings and scraps

This simple dish is a basic stock made from the food waste made while making dinner. The following process takes almost no time at all and can easily become part of routine meal preparation. You'll never get bored with garbage soup since it's never the same twice!

Serves 4

Ingredients:

- **bones and pan scrapings**
- **vegetable peelings & seeds**
- **wilted or limp vegetables**
- **cores, stems, ends**
- **any leftover vegetables and meat scraps**
- **potato & beans**
- **herbs to add flavor**
- **any leftover sauces or soups to add flavor**

Instructions:

Place a pot full of cold water over the stove when you start making dinner. Keep the water simmering through dinner, adding unusable leftovers as you cook. After dinner, turn off the burner, let the soup cool, and put it into the refrigerator until the next day.

The next evening, put the pot back on the stove and repeat the process, adding water as needed. Continue adding, heating, and refrigerating each night.

At the end of the week, you can strain the soup through a sieve and taste the results!

A recipe from: Tim Brownell's mother. Tim is CEO of Eureka Recycling.

Please use this space to write down your feedback on this recipe.

Garlic and Bread Soup

Use it up!

Stale Bread

This is a good way of using up a special loaf, such as rye, focaccia, or sourdough, that's gone a bit stale. Keep stale dry bread in a metal tin, taking care to ensure that it is moisture free. This can be done by putting the tin on a plate and leaving it overnight on a radiator.

Serves 4

Ingredients:

- **6-1/2 cups chicken or vegetable stock**
- **1-1/2 cups stale uncut bread, cut into cubes or sticks**
- **1/2 teaspoon salt**
- **8 garlic cloves, peeled and finely sliced**
- **a handful of chopped parsley**
- **black pepper**
- **1 oz. grated parmesan cheese**

Instructions:

In a large 3-quart saucepan, heat up the stock and add the stale bread, salt, and garlic.

Bring to a boil, turn down the heat and simmer for 15 minutes. Remove from the heat and add the parsley and black pepper.

Ladle the soup into warmed bowls and top with a generous sprinkling of cheese.

Adapted from: Love Food Hate Waste

http://www.lovefoodhatewaste.com/recipes/show/67-garlic-and-bread-soup

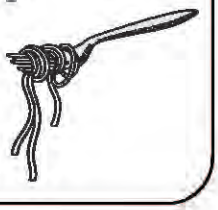
Please use this space to write down your feedback on this recipe.

Chicken Noodle Soup

Use it up!

Cooked Meats

Pasta



This is a really quick and easy soup, great for a night when you need to relax. Turkey can be used instead of chicken and other leftover vegetables can be added if you like. It's the perfect place to use up those odds and ends that crop up in your kitchen.

Ingredients:

- **1 onion, chopped finely**
- **4-1/2 cups chicken stock**
- **1-3/4 oz. pasta (use whatever you have!)**
- **1 cup cooked chicken, turkey, or ham**
- **a pinch of salt**
- **ground black pepper**
- **spring onions and cilantro to garnish**

Instructions:

In a large pan, cook the onion in a little of the stock until tender, about 5 minutes.

Add the remaining stock and the noodles. Cook following the instructions on the back of the pasta box.

Add the chopped chicken, turkey, or ham and heat through. Adjust the seasoning.

Ladle the soup into bowls and garnish.

Adapted from Love Food Hate Waste and Women's Institute

http://www.lovefoodhatewaste.com/recipes/show/130-turkey-noodle-soup

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Please use this space to write down your feedback on this recipe.

Broccoli Stalk Soup

Use it up!

Broccoli stalks

Broccoli stalks are great for throwing in salads, stir-fries, and this delicious, healthy soup. Simply peel the rough outer layer off of the stalks before using. You can try substituting other vegetables, such as Brussels sprouts, cauliflower, or spinach in place of the broccoli stalks depending on what you have on hand.

Serves 4

Ingredients:

- **4 potatoes, peeled and cut into chunks**
- **1 onion, peeled and roughly chopped**
- **2 carrots, peeled and chopped into chunks**
- **a handful of pearl barley or red lentils**
- **leftover broccoli stalks, about 7 oz.**
- **1/2 tablespoon fennel seeds (optional)**
- **salt and black pepper**
- **sour cream or crème fraiche**
- **a few tarragon leaves (optional)**

Instructions:

Put the potatoes, onion, carrots, and pearl barley or lentils in a large pan and cover with water. Bring to boil, reduce the heat and simmer for about 10 minutes.

Add the broccoli stalks and fennel and continue to cook until all the vegetables are just tender. Take off the heat and allow to cool a little before pouring into a blender and pureeing until smooth. Taste and season.

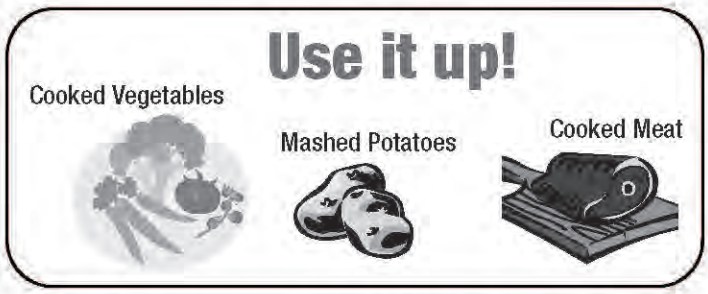
Pour into warm bowls and add little sour cream or crème fraiche, swirl into the soup and add a few sprigs of herb such as tarragon.

Adapted from: Love Food Hate Waste

http://www.lovefoodhatewaste.com/recipes/show/259-broccoli-stalk-soup?units=imperial

Please use this space to write down your feedback on this recipe.

Leftover Shepherd's Pie



Here's a delicious way to transform the leftovers from a roast beef dinner into a new dish for the next night. You can add in any stray vegetables you have to increase the fiber in this comforting dish.

Serves 4-6

Ingredients:

- **1 large onion, quartered and sliced**
- **2 tablespoons butter or margarine**
- **2 cups diced leftover roast beef**
- **2 cups brown or beef gravy, leftover or prepared from mix**
- **1/2 cup sliced or diced cooked carrots**
- **1 cup cooked vegetables such as peas, broccoli, or spinach**
- **salt and pepper, to taste**
- **1 egg yolk***
- **2 cups leftover mashed potatoes**

***Save the egg white in a closed jar in the refrigerator to use later.**

Instructions:

Preheat the oven to 400° F.

Melt butter in a heavy skillet over medium heat; add onions. Sauté onions until tender; add diced beef, gravy, carrots, and peas. Heat through; season with salt and pepper, to taste.

Transfer to baking dish. Beat the egg yolk into the potatoes and spoon potatoes over the shepherd's pie meat and vegetables (press potatoes through a pastry tube, if desired).

Bake shepherd's pie for about 30 minutes, or until mashed potatoes are browned and gravy is bubbling.

Adapted from: Southern Food

http://southernfood.about.com/od/beefcasserolesandpies/r/bl30131k.htm

Please use this space to write down your feedback on this recipe.

Burritos

Use it up!

Cooked Meat

Cooked Rice

Burritos are a great way to sneak leftovers by even the pickiest of eaters. Experiment with using a variety of meats, beans, veggies and condiments-whatever you have in the fridge that needs to be used up. For a vegetarian version, use beans or vegetarian soy crumbles instead of meat.

Makes 6-8 Burritos

Ingredients:

- **2 tablespoons olive oil**
- **1 lb. cooked leftover meat (turkey, chicken, beef etc.)**
- **1/2 cup chopped or grated fresh onion**
- **1/4 tablespoon chili powder (for mild seasoning - increase if you like it hotter)**
- **1 teaspoon garlic salt**
- **1/2 teaspoon kosher salt**
- **1/4 teaspoon onion powder**
- **1/4 teaspoon crushed red pepper**
- **1/4 teaspoon dried oregano**
- **1/2 teaspoon paprika**
- **1-1/2 teaspoon ground cumin**
- **1/4 teaspoon ground black pepper**
- **1 - 2 cups cooked (or canned) beans**
- **1 cup cooked rice, barley, or other grain**
- **6-8 flour, corn, or whole wheat tortillas**
- **tomatoes, peppers, avocados and any other veggies you like**
- **1 cup grated cheese of choice**

Instructions:

Heat skillet over medium heat and add olive oil. Add meat and heat until warmed through, then stir in spices.

Add 1/2 cup of water and bring to a boil, stirring to evenly coat the meat. Remove from skillet. Add onion to pan until it begins to turn golden. Add beans and cook until warm.

Chop the tomato, avocado and any other vegetables you want to add, and grate the cheese.

Fill burritos with prepared ingredients, then lay in dry warm pan to seal.

Adapted from: The Kitchn:
http://www.thekitchn.com/thekitchn/quick-weeknight-meals-2009/
jessicas-planned-leftover-burritos-quick-weeknight-meals-recipe-contest-2009-096389

Please use this space to write down your feedback on this recipe.

Fried Rice

Fried rice is an easy and delicious meal that can be made from leftover rice and vegetable odds and ends in your refrigerator. This recipe is a basic outline of how to make a really easy version of fried rice, and can be easily improvised on. Have fun thinking of different variations to this dish to suit your tastes!

Ingredients:

- **vegetable oil**
- **leftover rice**
- **eggs, whisked**
- **frozen or leftover cooked vegetables**
- **salt**
- **pepper**
- **soy sauce**
- **sesame oil**

Instructions:

Put a frying pan on the stove, turn on the burner, and add just enough vegetable oil to coat the bottom of the pan.

Add the leftover rice from the fridge to the frying pan.

Stir for about two minutes, being careful not to turn the burner on too high, so rice does not burn.

Use the spatula to push the rice to one half of the pan, and then put the pan to the side of the burner so that the empty side of the pan is in the middle of the burner.

Turn up the burner high and add whisked eggs, stirring them quickly and choppily until the egg is cooked and in small pieces.

Add vegetables to the pan, move it back to the center of the burner, and turn the heat down slightly. Mix all the ingredients together until everything is cooked and hot.

Add soy sauce and sesame oil to taste, stir it all up, and serve!

Adapted from: Wiki How

http://www.wikihow.com/Make-Easy-Fried-Rice-Using Leftover-Rice

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Please use this space to write down your feedback on this recipe.

Anything Goes Quesadilla

Use it up!

Cooked Veggies

Cheese

Keep a pack of flour tortillas handy to use with leftover veggies like sweet potato, butternut squash, or carrots. Then hunt through the fridge and pull out all those scraps of leftover cheese—the brick of cheddar, that cube of Monterrey Jack, or just slices of American, and put it all together in minutes.

Serves 8

Ingredients:

- **8 flour tortillas**
- **1-1/2 cups cooked sweet potato or butternut squash (or substitute any tasty leftover veggies you have), chopped**
- **sea salt**
- **ground black pepper**
- **1/2 cup creamy blue cheese**
- **1 cup fresh mozzarella (or substitute scraps of other leftover cheeses)**

Instructions:

Place a flour tortilla in a dry nonstick frying pan and spread with the chopped vegetables right to the edges.

Season the vegetables with salt and pepper and sprinkle them with the cheese. Top with another tortilla and cook over a medium heat until lightly browned, about 3 minutes.

Turn once, and cook the other side until lightly browned and the cheese has melted.

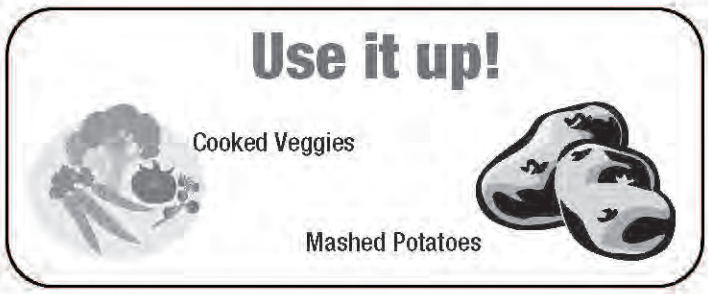
Transfer to a cutting board, and keep them warm while you make the others.
Cut into quarters to serve.

Adapted from: Love Food hate Waste

www.lovefoodhatewaste.com/recipes/show/38-anything-goes-quesadilla

Please use this space to write down your feedback on this recipe.

Mashed Potato Patties



This is a great leftover recipe that can be made with any vegetable leftovers from Sunday dinner. Serve with a poached, fried or scrambled egg and crispy bacon for breakfast, or with fish, like smoked haddock or grilled trout, for dinner.

Serves 6

Ingredients:

- **1 red onion, finely chopped**
- **4 slices of bacon, cut into small pieces**
- **2 cups leftover mashed potatoes**
- **1-1/2 cups leftover mixed cooked vegetables: roast parsnips, green beans, Brussels sprouts, cabbage, carrots, cauliflower, broccoli, or peas, chopped into small pieces**
- **pepper**
- **salt**
- **1 oz. hard cheese**
- **2 tablespoons butter**
- **all-purpose flour**

Instructions

Heat the oil in a frying pan and cook the onion for 4-5 minutes until soft. Add the bacon and cook for a further 3-4 minutes or until it begins to turn a golden color.

Remove the pan from the heat and transfer the bacon and onions into a large bowl. Add the mashed potatoes and cooked vegetables, season well. Add the cheese, mix well and divide the mixture into six portions.

Using your hands, shape each portion into a cake. Put a little flour on a plate and coat each cake in flour on both sides.

Put onto a greased baking tray and brush with a little melted butter. Bake in a preheated oven at 400° F for 25 minutes or fry on both sides until golden brown.

Adapted from: Love Food Hate Waste

http://www.lovefoodhatewaste.com/recipes/show/23-bubble-and-squeak

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Please use this space to write down your feedback on this recipe.

Turkey Pot Pie

A traditional turkey or chicken pie contains lots of vegetables and is the perfect 'use-up' dish. You can add almost anything to your pie, such as mushrooms, potatoes, sweet corn, peas, spinach, parsnips, and carrots. This recipe makes use of the turkey stock, but you can make it richer if you prefer by adding cream to the sauce.

Serves 4 to 6

Ingredients:

- **6-1/2 tablespoons butter**
- **2 tablespoons flour**
- **1 quart turkey or chicken stock**
- **a pinch of salt**
- **black pepper**
- **1 tablespoon Dijon mustard**
- **1 cup cooked turkey or chicken, cut into chunks or strips**
- **1/2 cup cooked ham, cut into chunks**
- **6 leeks, thoroughly cleaned and chopped**
- **2 tablespoons chopped parsley**
- **1 egg lightly beaten**
- **1 prepared pie crust**

Instructions:

Preheat the oven to 425° F.

Melt the butter in a heavy saucepan and add the flour with the pan off of the heat. Whisk in the turkey stock and cook over medium heat, stirring constantly until the sauce is smooth. Season well and add the mustard.

Place the turkey pieces, ham, and leeks into the bottom of a pie dish. Sprinkle with the fresh parsley, and add the turkey stock mixture.

Roll out the pie crust on a lightly floured surface and place the crust on top of the pie dish.

Brush the top of the crust with a little beaten egg and bake in the oven for 20-25 minutes. Reduce the heat to 350° F and bake for another 15 minutes.

Adapted from: Love Food Hate Waste

http://www.lovefoodhatewaste.com/recipes/show/128-turkey-ham-and-leek-pie

Please use this space to write down your feedback on this recipe.

Spanish Potato Tortilla

Use it up!

Cooked Meat

This dish is great for breakfast or dinner. You can exclude the meat to make it vegetarian, and add in any vegetables you have lying around in the fridge to add color and flavor.

Serves 6

Ingredients:

- **1 tablespoon olive oil**
- **about 3/4 lb. potatoes, sliced thinly**
- **1 large onion, sliced thinly**
- **6 large eggs**
- **salt**
- **leftover sausage or cooked meat**
- **a handful of grated cheese**
- **cilantro sprigs or parsley sprigs, for garnish**

Instructions:

Heat the olive oil in a large pan, add the potatoes and onion and cook gently for 20-30 minutes until softened, without browning the onion.

Beat the eggs in large bowl, season well and add the potatoes and onion mixture. Combine well and tip into a oven-safe frying pan.

Cook over a gentle heat for 10-12 minutes until set and then sprinkle the top with the sausage slices and grated cheese and place under a broiler until golden brown. Garnish with parsley or cilantro leaves.

Adapted from: Love Food Hate Waste

http://www.lovefoodhatewaste.com/recipes/show/258-spanish-potato-tortilla

Please use this space to write down your feedback on this recipe.

Soured Milk Scones

Use it up!

Sour milk or buttermilk

If milk turns sour, it is excellent for adding to this scone recipe. If you don't have sour milk, use fresh milk or buttermilk instead. Since the milk is cooked in this recipe, it is ok to use milk that smells or tastes sour. However, do not use if it has separated or curdled. Scones should be eaten within a day of being baked, but with a little jam and butter, that shouldn't be a problem!

Serves 4

Ingredients:

- **1 1/3 cups all-purpose flour**
- **2 tablespoons baking powder**
- **1/2 cup chilled and diced butter**
- **1/2 pint of soured milk**
- **1/2 cup sugar**
- **1 beaten egg**

Instructions:

Preheat the oven to 400° F. Combine the flour and baking powder together into a large bowl. Add the butter and cut it into the flour using a fork or pastry cutter until the mixture resembles breadcrumbs.

Pour the soured milk into a saucepan and warm it over low heat. Remove the pan from the stove. Whisk in the egg and sugar and pour the milk into the flour, mixing until the dough forms a smooth ball.

Roll out the dough and cut out 12 scones. Place them on a floured baking sheet, and let the scones rest for 10 minutes.

Bake the scones until they are golden brown, about 12 minutes.

Adapted from: Love Food Hate Waste

http://www.lovefoodhatewaste.com/recipes/show/50-soured-milk-scones?units=imperial

Please use this space to write down your feedback on this recipe.

Fruit Compote

Use it up!

Overripe Fruit and Berries

Fruit Compote is a healthy way to use up fruit that is starting to go bad in your fridge. It's a great topping over yogurt, ice cream, cake, or toast and you can use almost any kind of fruit to make it! Some common fruits used for compote include plums, strawberries, raspberries, rhubarb, blackberries, cherries and apples. Go wild trying out new fruit combinations and ways to use this tasty condiment!

Ingredients:

- **enough fruit of your choosing to cover the bottom of a 3 quart saucepan**
- **granulated sugar**
- **1/2 tsp. vanilla extract**
- **3 tsp. lemon juice**

Instructions:

Place fruit in a saucepan and cook on low heat until the fruit starts to soften. You may need to add water if the fruit is dry so that it does not burn.

Pour enough granulated sugar into the saucepan to taste. You can choose to add as much or as little sugar as you like. Slowly add the sugar and taste test periodically to make sure you have just enough.

Add the lemon juice and vanilla extract to the saucepan and stir.

Cook until the fruit is soft but not soupy or mushy.

Adapted from: Hub Pages

http://hubpages.com/hub/Easy-Recipe-for-FruitCompote

Please use this space to write down your feedback on this recipe.

Bread Pudding

Use it up!

Stale Bread

This simple recipe provides a great base for tasty desserts with ingredients that you probably already have! Try spooning on some Berry Compote (p. 21) and whipped cream for a delicious dessert that is sure to impress.

Ingredients:

- **3 medium eggs, beaten**
- **3-1/2 cups milk**
- **2 teaspoons vanilla extract**
- **1 teaspoon ground cinnamon**
- **1/2 teaspoon salt**
- **3 cups bread cubes**
- **3/4 cup packed brown sugar**
- **1/2 cup raisins**

Instructions:

Combine all ingredients, making sure bread is thoroughly wet.

Spray inside of crockpot with cooking spray; pour bread mixture in crockpot.

Cover; cook on High for 3 to 4 hours or until knife inserted into the middle comes out clean.

Adapted from: Big oven

http://www.bigoven.com/recipe/157672/slow-cooker-bread-pudding

Please use this space to write down your feedback on this recipe.

Pear Butter

Pear butter, like compote, is fruit cooked with sugar to make a sweet and tasty spread for toast or English muffins. Pear butter, however, is softer and smoother than compote, and has great spices added to the mix. Apple and pumpkin butter are other popular variations of this recipe, and are two other tasty ways to help you use up some of your leftover fruit.

Ingredients:

- **1 or 2 pounds of pears**
- **1/2 or 1 cup of sugar**
- **1 tsp. grated orange peel**
- **1/2 tsp. nutmeg**
- **1/4 cup orange juice**

Instructions:

Core, peel, and slice pears. Cook in a large pot with 1/4 cup water until soft. Mash the pears until they are very smooth or use a food processor.

Add sugar, grated orange peel, nutmeg, and orange juice. You should use about 1/2 cup of sugar for each cup of pear puree.

Simmer slowly until mixture thickens, stirring frequently. This may take up to an hour. Ladle hot butter into a Mason jar to store in the refrigerator.

Adapted from: Chickens in the Road

http://chickensintheroad.com/cooking/making-pear-butter-at-the-old-farmhouse/

Please use this space to write down your feedback on this recipe.

Fruit Cobbler

Use it up!

Overripe Fruit and Berries

Heading for the vanilla ice cream for dessert again tonight? Try this recipe for fruit cobbler instead! It never gets old because you get to make it with whichever fruit you like. Depending on what you have on hand, you can have cobbler with berries, peaches, apples, or something entirely unique!

Serves 8

Ingredients:

- **1 stick butter, melted**
- **1 cup all-purpose flour**
- **1 cup granulated sugar**
- **1 cup milk**
- **2 teaspoons baking powder**
- **2 cups berries (blackberries, raspberries, or strawberries) sweetened with 1 tsp. lemon extract OR**
- **4 cups peaches sweetened and with 1 tsp. almond extract OR**
- **4 medium apples, peeled, sliced, chopped, with brown sugar and cinnamon**

Instructions:

Melt the butter in an 8 x 8" glass dish. Mix the flour, sugar, baking powder, milk together and pour on top of the butter. Do not stir.

Then, add the fruit of your choice, but again don't stir. Bake at 350° F for 40 minutes or until golden brown.

Adapted from: Big Oven
http://www.bigoven.com/recipe/160113/cobbler-berry-peach-or-apple

Please use this space to write down your feedback on this recipe.

Banana Ice Cream

Soft Bananas

Use it up!

Tired of having to use old bananas to make banana bread? Try this recipe for banana ice cream instead. This simple ice cream contains no cream or sugar so it's both tasty and good for you.

Serves 4

Ingredients:

- **8 ripe bananas**

Instructions:

Peel 8 ripe bananas, wrap in plastic wrap or waxed paper, place in a Ziploc bag or reusable container, and freeze overnight.

Allow to soften for 20 minutes then put into a food processor and blend until thick and creamy. Serve immediately or refreeze.

Adapted from: Love Food Hate Waste

http://www.lovefoodhatewaste.com/recipes/show/33-good-for-you-banana-ice-cream

Please use this space to write down your feedback on this recipe.

EUREKA! RECYCLING

A-Z Food Storage Guide

Tips for storing food so that it lasts longer and gets wasted less

- ➔ Read up on the items you buy most often for tips to help extend their life.
- ➔ Look for ideas when you have food that is in danger of going bad.
- ➔ Learn more about pantry and fridge stocking, canning, freezing, and other preservation tips.

Apples

- Store apples in the **fridge** to extend shelf life.
- One bad apple can ruin the whole bunch, so eat up the bruised ones first!

My Tips/ Comments/Questions _____

Asparagus

- Store asparagus in the **fridge** for up to 2 weeks.
  - o Trim the base of the stalks and place in an upright jar filled with an inch of water.
  - o Or, wrap the cut ends of the stalks in a moist paper towel or rag.

My Tips/ Comments/ Questions _____

Avocados

- Once ripe, store avocados in the **fridge**.
  - o Mix avocados or guacamole with a little lemon or lime juice or leave the pit in to stop browning.

My Tips/ Comments/ Questions _____

Bacon

- Store unused bacon in the **freezer** between sheets of waxed paper in an **airtight container**.

My Tips/ Comments/ Questions

Bananas

- Store bananas **on the counter away from other fruit**. They give off ethylene gas which speeds ripening in other produce.
- Bananas can be **frozen** with or without their peel and used later in baked goods or smoothies.

My Tips/ Comments/ Questions

Beef

- Be sure to keep all cooked meat in the **fridge**, using within 3-4 days, and keep uncooked meat **frozen** until a day or two before you will cook it.

My Tips/ Comments/ Questions

Beans, Green

- Store unwashed in plastic bags in the **fridge**. Wet beans will develop black spots and decay quickly.
- Beans can be **frozen**, either raw or blanched (see the Website Resources later in this section for information on blanching and freezing).

My Tips/ Comments/Questions

Beets

- Store beets in the **fridge**, greens removed, unwashed, and in a closed plastic bag with a dry paper towel inside to absorb moisture.
- If you plan to eat the beet greens, store them separately in the **fridge** in a plastic bag with a paper towel to absorb the moisture, or in a special refrigerator storage bag.

My Tips/ Comments/Questions

Blueberries

- Before storing berries, remove any spoiled or crushed fruits, and store unwashed in an **airtight container**.
- Store excess blueberries in the **freezer** by laying on a cookie sheet, freezing, and then transferring to an airtight container (see the Website Resources later in this section for information on freezing).

My Tips/ Comments/ Questions

Bread & Breadcrumbs

- Store sliced bread in an **airtight container** in the **freezer**.
    - Thaw in the microwave or toaster.
- To freshen up a day-old loaf, hold it very briefly under a running cold tap. Give it a good shake and pop in a hot oven for about 10 minutes; it will be as soft and crusty as freshly baked bread.
- Use stale bread, crusts, and crumbs to make breadcrumbs. Gather these and store in the freezer until ready to make breadcrumbs. Store breadcrumbs in an airtight container in the freezer.

My Tips/ Comments/ Questions

Broccoli

- Store broccoli in the **fridge** in a loosely tied plastic bag that allows the broccoli room to breathe.

My Tips/ Comments/Questions

Butter

- When storing butter in the **fridge**, don't keep butter in the door of the fridge (often where the "Butter" compartment is) because it is often warmer than other parts of the fridge and could spoil more quickly.
- Butter can be stored in the **freezer** for up to a year.
    - o Cut it into tablespoon-sized chunks and store in an **airtight container.**

My Tips/ Comments/ Questions

Carrots

- Store carrots in the **fridge** either in a container of water or unwashed in a sealed bag in the crisper.
- If you have a lot of carrots at the end of the season, store them in buckets of sand in a **cool, dry place.**

My Tips/ Comments/Questions

Celery

- Store celery in the **fridge** either in a container of water, or in a sealed plastic bag.
- Celery leaves can be washed, dried, and **frozen**, then crumbled into soups and stews for extra flavor.

My Tips/ Comments/ Questions

Cereal

- Store cereal in a dry place.
  - o If cereals have gone a little soft or stale, lay them out on a cookie sheet and pop them in the oven for a bit to remove some of the excess moisture.
  - o If you have several boxes of cereal but not enough in any one box to be worthwhile, mix them all together, blend them in a food processor, and use like breadcrumbs, as toppings for muffins or baked goods, or on ice cream!

My Tips/ Comments/ Questions

Cheese

- Cheese can be grated or cubed and kept in the **freezer**, for up to 2 months.
  - o Mascarpone, Brie, and Camembert don't freeze well.
  - o Semi soft cheese like Monterey jack, Muenster, Havarti, and Gorgonzola get crumbly after thawing.

My Tips/ Comments/Questions

Cherries

- Pitted cherries can be stored in the **freezer** in an **airtight container**.
  - o First freeze them on a cookie sheet before transferring to a container to prevent them from sticking into one solid lump.

My Tips/ Comments/ Questions

Chicken

- Keep raw chicken in the **freezer** (for up to a year) and thaw it out in the fridge a day or two before you will cook it. Cooked chicken can keep up to 4-5 days in the **fridge**.

My Tips/ Comments/ Questions

Coconut Milk

- Coconut milk can be kept for up to 3 months in the **freezer**.
  - Freeze it in ice cube trays then transfer cubes to an **airtight container.**

My Tips/ Comments/Questions

Corn

- Buy corn when it's in season and store it in the **freezer** by blanching, cutting from the cob, and transferring to an **airtight container** (see the Website Resources later in this section for information on blanching and freezing).

My Tips/ Comments/ Questions

Cream

- When storing cream in the **fridge**, don't store it in the door, because that is often warmer than other parts of the fridge, and could make it spoil more quickly.
- Cream can be **frozen**.
  - o Freeze in ice cube trays then transfer cubes to an **airtight container**.
  - o Lightly whip the cream before freezing to prevent it from getting grainy.

My Tips/ Comments/ Questions

Cucumbers

- Store cucumbers in the **fridge** by standing them upright in a container of water with the stalk down.
  - o Store away from tomatoes, apples, and citrus, which all give off ethylene gas that causes cucumbers to deteriorate.

My Tips/ Comments/Questions

Eggs

- When storing eggs in the **fridge**, write the date you bought them on the shells or cartons to make sure to use the older ones first.
- To test if an egg is still good, try dropping one in a glass of water. If the egg....
  - o stays at the bottom, flat or at an angle - it is fresh.
  - o stands on its pointed end at the bottom - it is still safe to eat but best used for baking and making hard-boiled eggs.
  - o floats – it's stale and best discarded.

My Tips/ Comments/ Questions

Fish

- Store raw fish in the coldest part of the **fridge**—the bottom shelf.
- Fish can be stored in the **freezer**, and thawed in a bowl of cold water on the counter before cooking.

My Tips/ Comments/ Questions

Grapes

- Remove spoiled or soft grapes and do not wash them before storing in the **fridge**.
- Grapes can be **frozen** to use in smoothies or as a frozen treat.

My Tips/ Comments/ Questions

Ham

- Hams with higher salt content, like cured ham, can be **frozen** and kept for up to a month. Other hams can be frozen, sliced or whole, for up to 3 months.

My Tips/ Comments/ Questions

Herbs

- Store herbs in the **fridge** upright in jars filled with 1-2 inches of water, covered loosely with plastic wrap or a baggie, or dry in a plastic bag in the crisper.
    - o Basil is a warm weather crop and turns black quickly in the fridge. Store **on the counter** in a glass of water, or wrapped in a dry paper towel in an **airtight container**.
- Herbs can be **frozen** by chopping and freezing in ice cube trays full of oil. You can also freeze pesto in ice cube trays.

My Tips/ Comments/ Questions

Lemons

- Lemon juice and peel can be stored in the **freezer**. Freeze juice in ice cube trays, wrap peels in plastic wrap.
    - o Juice from lemons can be used to keep apples, pears, and avocados from going brown.
    - o One tablespoon of lemon juice plus enough milk to make 1 cup is an easy substitute for buttermilk in any recipe!

My Tips/ Comments/ Questions

Lettuce

- Store lettuce in the **fridge** in a plastic bag with a paper towel to absorb moisture, or in a special refrigerator storage bag.
    - o Soak leaves that have gone limp for 30 minutes in water to revive crispness.

My Tips/ Comments/ Questions

Limes

- Lime juice and peel can be stored in the **freezer**. Freeze juice in ice cube trays, wrap peels in plastic wrap.
    - o Frozen cubes of juice can be added to recipes or drinks later.

My Tips/ Comments/Questions _____

Melons

- Once ripe, store melons in the **fridge**.
- Cubed melon can be **frozen** on trays before transferring to an **airtight container**. It will keep for up to 6 months and is best in smoothies.

My Tips/ Comments/ Questions _____

Milk

- When storing milk in the **fridge**, don't store milk in the door because that is often warmer than other parts of the fridge, and could make it spoil more quickly.
- Skim or low fat milk can be **frozen** in glass jars to use later in baking. Be sure to leave room in the jar for the milk to expand.

My Tips/ Comments/ Questions _____

Mushrooms

- Keep mushrooms in a paper bag in the **fridge** to avoid getting "slimy."
- Mushrooms can be sautéed and then **frozen**.

My Tips/ Comments/Questions

Nuts

- Nuts can be stored in the **freezer** for up to a year, in the fridge up to 6 months, and up to 4 months in a cool, dry place.
    - o Nuts take on other flavors easily, so store away from high-odor foods.
- Nut butters should be stored in the **fridge** to extend shelf life.

My Tips/ Comments/ Questions

Onions

- Store partially used onions in the **fridge**, leaving the papery outer layer on.
- Store whole onions in a **cool, dark place** or in buckets of sand somewhere slightly warmer than the refrigerator.
    - o Onions cause potatoes to sprout, so keep them separate.

My Tips/ Comments/ Questions

Oranges

- Store oranges in the **fridge** to extend shelf life.
- Orange juice and peel can be stored in the **freezer**. Freeze juice in ice cube trays, wrap peels in plastic wrap.

My Tips/ Comments/Questions _____

Pasta

- Store dry pasta in an **airtight container**.
- Cooked pasta can be **frozen** in individual- or meal-sized portions.

My Tips/ Comments/ Questions _____

Pears

- Store pears in the **fridge** to extend shelf life.
- Bruised pears can be used in a variety of baked goods, or they can be cooked with some apple cider, cinnamon, and vanilla for delicious pear butter (See the Recipes section of this toolkit).

My Tips/ Comments/Questions _____

Peas

- Fresh peas can be blanched and **frozen** in an **airtight container** (see the Website Resources later in this section for sources of information on blanching).
    - o Store with as little air as possible.
    - o First freeze them on a cookie sheet before transferring to a container to avoid sticking.

My Tips/ Comments/ Questions

Peppers: red, green, or hot

- Peppers can be stored in the **fridge** with the seeds and stems attached to extend shelf life.
- Peppers can be **frozen**, either raw or blanched (see the Website Resources later in this section information on blanching and freezing).

My Tips/ Comments/ Questions

Pork

- If not being thawed for a recipe, pork should be **frozen** immediately after coming from the grocery store; it can be kept in the **refrigerator** for up to 4 or 5 days after cooking.
- Store frozen pork in the freezer for as long as you like, but after a year, freezer burn can become a problem.

My Tips/ Comments/Questions

Potatoes

- Store potatoes in a **cool, dark place** or in buckets of sand somewhere slightly warmer than the refrigerator.
  - o Moisture and exposure to light causes spoilage.
  - o Onions cause potatoes to sprout. They're still good to eat—just cut off the sprouts and eyes.
- Mashed potatoes can be **frozen** to eat later.

My Tips/ Comments/ Questions _____

Rice

- Store dry rice in a **dry plastic or glass container**.
- Cooked rice can be **frozen** for up to a year.

My Tips/ Comments/ Questions _____

Spinach

- Cooked or blanched spinach can be **frozen** (see the Website Resources later in this section for information on blanching and freezing).
- Keep fresh spinach in the **fridge** in an **airtight bag** with a paper towel to wick moisture.

My Tips/ Comments/ Questions _____

Strawberries

- Remove any spoiled or crushed fruits, and store unwashed in plastic bags or containers in the **fridge**.
    - o Do not remove green tops before storing in the fridge.
- Strawberries can be **frozen**.

My Tips/ Comments/ Questions

Tomatoes

- Tomatoes can be **frozen** either raw or cooked.
- Tomatoes should be stored **on the counter** unless very ripe, at which point transfer them to the fridge.
    - o Tomatoes give off ethylene gas that causes other produce to deteriorate, so store them separately.

My Tips/ Comments/ Questions

Turkey

- Cooked turkey can be **frozen** in individual servings to be used later.
- After a Thanksgiving meal, or whenever you serve turkey, save the carcass in the **freezer** to be used in turkey stock.

My Tips/ Comments/ Questions

Fridge Tips

- **Visibility is key**! Keeping the fridge organized and not overflowing allows you to easily see what you have and what you need.

- **Labeling items** like leftovers, eggs, and dairy products with the date they were made or purchased allows you to keep track of how long items have been in the fridge, and when you need to use them by.

- **Store produce in the crisper**. If you have a humidity control, keep it high for leafy vegetables like lettuce and low for sturdier vegetables like zucchini or eggplant.

- **Organize the fridge** so that it's easy to grab items you use frequently. This will help food last longer by reducing the amount of time you spend keeping the door open while searching around for an item.

- The door of the refrigerator tends to be the warmest area. Store easily perishable items like milk elsewhere.

- Refrigerators should be kept **between 37° F and 40° F** to optimally store food.

Freezer Tips

- **The freezer is great for extending the life of food** you might otherwise throw out. Almost any food can be frozen, from butter and cheese to casseroles and berries. Check out our A-Z guide for tips on how to freeze specific foods.

- Store anything you put in the freezer in an **airtight container** to help prevent freezer burn or to keep things from getting too frosty. An airtight container can be anything from a jar or plastic storage container to a plastic freezer bag. Make sure to get as much air out of the container as possible.
  - When using plastic freezer bags, get as much air as possible out of the bag. A great way to do this is to close the bag except for room for a straw. Suck out all the air through the straw and pinch the opening closed. Remove the straw and seal the bag!

- It's easy for things to get lost in the freezer. **Label everything** you freeze so that you know what it is and when it was frozen.

- Freeze items in **portion sizes** that you'll use. For example, freezing tomato sauce in ice cube trays rather than a jar means you can select exactly the amount you need, rather than having to de-thaw the whole jar.

- Freezers should be **between 0° F and 2°F** to optimally store food.

Dates on Food Packaging: What do they *really* mean?

It's easy to get confused by the dates printed on packaged foods. By understanding some general rules, you can be sure that you are buying food wisely, and consuming it while it's still fresh and full of nutrients.

Sell by: This is simply a guide for retailers telling them how long to display an item. It is not an indication of food safety, and not an estimate of how long the food will remain good to eat.

Best if Used Before *or* Best By: This is an estimate made by the manufacturer as to how long the food will last before the taste or the quality begins to decline. It is not an indication of food safety, and it's good to remember that this is just an estimate. Many foods are still perfectly good long past the "best by" date. Your eyes and nose are often the best tools to gauge for whether or not something is still edible.

Use By: This date indicates the last day when the manufacturer estimates the product will be at peak quality. It can be a good goal for when to use up easily spoiled food like meat and eggs, but if food is properly handled and stored, it can remain perfectly edible past its "use by" date. Use your best judgment.

Still hungry for more food storage tips and resources?

Visit our website www.eurekarecycling.org/NoMoreWastedFood.cfm to find links to these additional in-depth tools.

Blanching

Freezing food is a great way to store fruits and vegetables while retaining all of great nutrients. However, most vegetables require blanching (briefly boiling or steaming vegetables to inactivate the enzymes that break down food) to keep them looking and tasting great when they come out of the freezer.

- http://www.extension.umn.edu/distribution/nutrition/dj0555.html
- http://www.uga.edu/nchfp/how/freeze/blanching.html

Canning

Get the benefits of the past summer's garden or the abundant farmer's market all winter long. By canning, you are able to preserve fruits, vegetables, and meats, and you can also make pickles, jellies, and salsas.

- http://www.wikihow.com/Can-Food
- http://www.freshpreserving.com/pages/preserve__fresh_preserving__home_canning_/33.php
- http://www.uga.edu/nchfp/how/can_home.html

Drying/Dehydrating

Drying foods is an excellent way to preserve food for a long time. It is a simple process that doesn't require you to own a bunch of appliances, either!

- http://www.aces.uiuc.edu/vista/html_pubs/DRYING/dryfood.html
- http://www.preservefood.com/drying.shtml
- http://www.uga.edu/nchfp/how/dry.html

Freezing

The freezer is one of the most important tools to help prevent wasted food. Visit the helpful links below for tips on loading the freezer, keeping an inventory, foods that do not freeze well, suggested storage time, etc. (Be sure to visit our links about blanching to make sure that you get the most out of your frozen vegetables.)

- http://www.ag.ndsu.edu/pubs/yf/foods/fn403.pdf
- http://www.uga.edu/nchfp/how/freeze.html

Root Cellar

One of the benefits of living on the northern edge of the United States is that we can use the cold outside to help extend the life of our cool season produce without any electricity by using a root cellar. Cool basements and storage areas, or even a root cellar built from a buried garbage can, are great spaces to store root vegetables such as onions and carrots, as well as apples to eat over the winter.

- http://www.thefoodguys.com/rootcellar1.htm
- http://www.maryjanesfarm.org/About/farmlife/home/root-cellars.asp
- http://other90.cooperhewitt.org/Design/pot-in-pot-cooler

Stocking Your Pantry, Fridge, and Freezer

From savory soups and stews to last-minute meals, a well-stocked pantry ensures that you always have the ingredients on hand to create tasty and nutritious meals at home. Keeping your space organized allows you to easily find what you need and know what you have. Here are some great resources to help develop a list of pantry staples of your own.

- http://www.realsimple.com/food-recipes/shopping-storing/food/pantry-staples-checklist-00000000000197/index.html
- http://familyfun.go.com/recipes/helpful-checklist-of-pantry-staples-714146/
- http://www.cookinglight.com/cooking-101/essential-ingredients/stock-the-essentials-00400000005809/

More Recipes for Leftovers

There are lots more resources with many recipes on the web! You can find links to more sites on Eureka Recycling's website. The following provide recipes to use up leftover foods.

- http://teriskitchen.com/leftovers.html#soups
- http://www.leftoverchef.com/
- www.notbeansagain.com
- www.kitchenhintsandtips.com/leftovers.shtml

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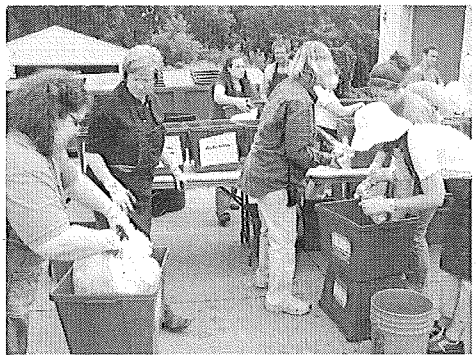
Using Waste Sorts to Learn About Preventing Wasted Food



As part of our mission to demonstrate that waste is completely preventable, Eureka Recycling has literally sorted through tons of waste from neighborhoods, colleges, government institutions, offices, public parks, and more. Waste sorts help us shed light on what is currently being thrown away, and have provided insight into the development of our recycling, composting, and waste prevention programs and services for many years.

When we began developing tools to help people in our community prevent wasting food, we knew waste sorts would provide us with critical information about what food is actually being wasted here. This information could not only provide insight into what tools and education will be more effective, but could provide baseline data to help us track our progress toward zero waste. Currently, unlike categories such as *recyclables* or *all food waste*, no baseline data exists for *preventable wasted food* at the regional, state, or city level. There are a few recent reports that calculate estimates around the quantities of preventable food waste in residential waste at the national level. However, these numbers are broad and based on food consumption and distribution patterns along with other types of data, not by actually examining residential waste. Food habits are personal, regional, and cultural, so specific information about wasted food is extremely valuable when creating education and tools that are relevant and effective for the people in your community.

Recommendations

For a waste sort to help us learn about preventable wasted food, a different level of detail is needed than in a typical waste sort that examines composting or recycling. Knowing what types of food are wasted helps connect people to the wide variety of solutions they can use to prevent it. For example, some types of wasted food are best addressed through meal planning, while others can be prevented through better food storage methods. We can get a better sense of the most effective and needed tools by determining the types and amounts of wasted food in the trash. How much of it is leftovers? Packaged food? Fresh fruits and vegetables? How often are these types of food getting wasted?

The following recommendations were generated from the lessons learned through successes and shortcomings of our own initial waste sorts looking for information about preventable wasted food in the trash in three communities in Saint Paul, Minnesota. For more information on waste sorts in general, see Eureka Recycling's report on Best Practices in Public Space Recycling (pages 26 & 27), located on our website.

1. Setting the Scope

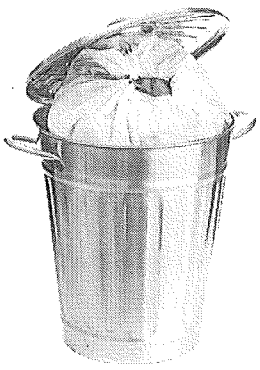
Before an ounce of trash is collected from the curb, waste sorts need to be carefully designed to ensure they meet the goals of the project.

Statistically Significant Data: Using waste sorts to generate statistically significant data that can be extrapolated to a more general population requires a large number of data points (in this case households) that cover a broad range of demographics (unless the project is focusing on a specific demographic) a number of times throughout the year(s) to account for seasonal and other variables. If you are seeking to measure the impacts of an applied education program, reliable baseline data needs to be established first.

Anecdotal Information: If generating statistically significant data is outside of the scope of your project, waste sorts can still provide very valuable insights. Waste sorts of any size can produce information that tests assumptions or insights that challenge or strengthen other data collected (e.g., focus groups or interviews), and can even be an event or activity that rallies support and calls attention to your project.

2. Tracking Waste by Household

Because of the detailed information required to assess wasted food trends, we recommend tracking each household's waste separately. This provides more data points than sorting the combined waste of multiple households, and gives greater insight into what challenges are facing people when it comes to preventing wasted food. This is critical because there is such a wide range of wasted food trends in different households.



If you sort all of the material you collect together, you get one aggregate number rather than useful information about individual or groups of households, and lose the ability to discount an extreme outlier or anomaly. For example, because we tracked data by household, we had some level of detail about households: we know that 15% of the households we collected trash from had no wasted food at all, and more than half of them had less than 10% food waste in their trash. We can also calculate the average amount of wasted food per household, which is 14%. We were also able to collect more specific anecdotal data, such as noticing that households with small children (identified by the presence of diapers in the trash) had higher levels of wasted food than similar households without children. This is important to note because the challenges of these households may require different tools. If we had sorted all the waste together, we would only know one aggregate number: that wasted food made up 17% of all the trash, which does not tell as complete a story.

We recommend collecting trash from each household tagged with the address, and then sorting each household's trash separately, tallying all weights and emptying all sorting containers between each household.

3. Tracking Categories

In addition to sorting by household, we recommend tracking data from detailed categories to maximize the usefulness of information gathered in the sort.

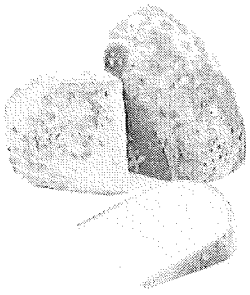
A. Preventable wasted food vs. food trimmings

Sort preventable wasted food from food trimmings. Preventable wasted food is food that could have been eaten at one time, like soggy whole carrots or a large portion of leftover lasagna. Food trimmings are parts of food that are not typically eaten, like bones and banana peels. There are decisions to make about where to draw the line between these two categories. Some will be clear, such as differentiating between trimmings that could not be eaten (avocado pits, meat bones) and those that obviously could have (a whole head of soggy lettuce). However, there can be grey areas, such as trimmings that potentially *could have* been eaten (beet greens, broccoli stems) but that not many people do eat. Thoughtful categorization ahead of time will prevent confusion and inconsistency during the waste sorts, but make sure to document the questions that come up and the decisions that are made during the sort.

B. Preventable wasted food categories

We recommend sorting the preventable wasted food into a minimum of three categories to help target education towards shopping habits, meal planning, and food storage.

- Wasted fruits, veggies, breads, meat, and cheese
- Wasted leftovers
- Wasted packaged food



As with any waste sort, the more detailed your categories, the more specific data you'll have to answer unanticipated questions. You can separate the above categories even further and take the time to make additional notes about what foods appear in each category. However, consider how you may likely use the data before going to a lot of extra time and effort to track just for the sake of it.

C. Tracking "frequency" in addition to weights

Depending on the goals of your waste sort, consider taking the additional step of tracking the number of specific times particular items are wasted. Typical waste sorts track categories only by weight. Understanding the percentage of trash by weight that is preventable wasted food helps to calculate environmental benefits and overall success rates of applied education. However, it doesn't necessarily tell a clear story about behavior. For

example, weight results could show that there was an equal amount of wasted watermelon and bread. Because bread weighs much less than watermelon, if they are also tracked by frequency, the sort results might show that bread gets wasted many more times that watermelon. This can help focus tools of an education campaign on the food groups that are most problematic for people.

D. Other categories

Consider sorting the remaining material in the trash into the following, broader categories. These categories will help you identify overall trends that could be useful (like the relationship between throwing recyclables in the trash and wasting food), but do not necessarily require the same level of detailed notes as the wasted food categories.

- Food trimmings: food waste that would not normally be eaten, such as fruit peels, carrot tops, and meat bones.
- Non-recyclable paper: paper that can be composted, such as napkins, tissues, egg cartons, and freezer boxes.
- Recyclable bottles and cans
- Recyclable paper
- Pet waste and diapers
- Other trash

E. Training Sorters

Whatever data you set out to collect, it is critical to give sorters clear instructions and be thoughtful about the number of categories you ask them to sort into to prevent confusion and ensure that the sorting is consistent.

Recommendations for Programs to Reduce Food Waste
Submitted to Eureka Recycling
By Christie Manning, Ph.D.
August 25, 2011
Updated June 26, 2012

1. **Feedback.** People need feedback about wasted food. When are they wasting? How much? This is invisible information and individuals cannot respond to a problem that they cannot detect.
    a. Why feedback? Feedback is critical because it makes otherwise hidden information visible. People have no idea how much food they throw away over the course of a week or month- the food simply goes into the compost or trash and then disappears. People not only don't know how much food they have wasted, they have no idea of the environmental, social, and financial impact of their waste. We must make this information visible by giving people feedback about the food that they waste, how it affects the environment, how it affects larger systems (e.g., agriculture), and how it affects their own pocketbooks.

    b. Important features of successful feedback
        i. **Make feedback immediate and in close proximity to where the behavior occurs.** Feedback should happen at the moment that the behavior occurs, or as close in time to that moment as possible. This principle is highlighted in Community Based Social Marketing materials (e.g., McKenzie-Mohr, 2011). However, the premise comes from basic Learning Theory in Psychology. Giving feedback is akin to giving people a reward or a punishment in response to a particular behavior – similar to B.F. Skinner and his rats – he put them in a "Skinner box" and trained them to hit a lever by immediately rewarding them with a food pellet. Positive feedback makes a person more likely to continue to engage in the behavior whereas negative feedback makes a person less likely to continue (negative feedback acts like a punishment). According to Learning Theory, we are strengthening the link between the behavior and the reward (or punishment) by making that reward/punishment (= feedback) happen as close as possible in space and time to the behavior. The stronger the link between the behavior and the feedback response, the more effective it will be in shaping behavior. An example from energy conservation: monthly bills are a form of feedback that is very removed in time and space from the behavior of using energy – people don't have an easy time responding with behavior change because no specific behavior is linked to the feedback on the bill. However, if you give people immediately feedback when they turn on an appliance (e.g., a glowing orb turns orange) then the light-switching behavior becomes linked with the feedback and people are able to respond by changing that behavior (for a review of research on energy feedback, see Darby, 2008.)

        ii. **Make feedback concrete, tangible, meaningful.** The more concrete, tangible, meaningful and personally relevant that you can make the feedback you give people, the more likely they are to respond to it. This recommendation is based in part on McKenzie-Mohr (2011) and Community-Based Social Marketing principles. There is also growing evidence that people are more likely to take action in response to a problem

or crisis if they can link the information they receive about the issue to some sort of personal experience they have had (see, for example, Spence, Poortinga, Butler and Pidgeon, 2011; and Marx, et al., 2007).

iii. **Combine feedback with goal-setting.** According to many years of research on motivation, people perform better when they have set a goal, and the most motivating goals are those that are challenging but attainable (Latham and Locke, 2002). Without a goal, please lack a focus for their efforts and they will quickly lose steam. And to monitor progress toward their goal, people need feedback to tell them how they are doing. Feedback allows people to adjust their behavior/performance and get closer to the goal they have set – if the feedback tells them that they are falling behind, they can increase their effort.

2. **Movement building.** To build a social movement around reducing food waste, the best place to start is with the early adopters. This group is willing and motivated – they are more likely to overcome barriers to reducing their food waste and they are also more likely to stay engaged because they are already interested and personally invested.
    a. Early adopters are the essential first step in building a movement. They are enthusiastic and willing, eager to embrace change. Once you have a strong critical mass of early adopters, they can begin to change the social norm of the behavior (see point 3: Social Norms) and people beyond the early adopters will begin to embrace the new normal.
    b. What other key features are there in the movement?
        i. Make it visible. Make sure that people see the early adopters who are out there embracing a no-wasted-food lifestyle. Take every opportunity to highlight these people in whatever community communication channels there are- community paper, radio, TV, community festivals.
        ii. Make it personal- one to one connections. Have the early adopters act as ambassadors. Give them every opportunity to talk to other people, one-on-one, to tell them about what they are doing (wasting very little food), why, and how. Highlight their enthusiasm and the rewards they find in what they are doing.
        iii. Help the early adopters welcome the people who come after them
            1. No shaming! Early adopters should talk about their own journey- why they are doing what they are doing and why it might be personally important. They should avoid implying that other people are doing it wrong. Instead, they should focus on the rewards that they have gotten from the efforts they have made.
            2. Early adopters should enthusiastically talk about what they are doing. Make it invitational rather than combative. Again, they should focus on the rewards (personal, financial, ethical, etc.) they have gotten from the change they have made. They should not challenge anyone else's lifestyle or come across as accusing toward others ("YOU are polluting the environment with your wasted food!")

3. **Social Norms.** Social norms are probably the most powerful behavior motivator. Social norms are more powerful than values in shaping behavior, though values have a role, too. People are more likely

to reduce their food waste if they believe that people around them are already doing it (and/or at least think it is the right thing to do). For example, most people today share the value that we shouldn't waste energy. Yet nearly all have home wireless systems and they leave them on all day, every day while at work or even when away for several weeks on vacation. The value is not strong enough to overcome the many barriers to turning off the wireless router (inconvenience of going into room to turn switch, forgetfulness, lack of awareness that it uses energy, desire for immediate no-wait wireless connectivity).

There is strong reason to believe that the perception of a new social norm around food wasting is probably a strong motivator. In a 2008 study, Nolan, Schultz, Cialdini, Goldstein, and Griskevicius asked participants to rate how important it was that using less energy protected the environment, saved money, benefited society, and mirrored many other people trying to conserve on a scale from 1 (not at all important) to 4 (extremely important). Participants rated environmental protection highest among the four reasons to conserve energy followed by benefitting society and saving money. However, when Nolan et al actually looked at people's energy conservation behavior, it turned out that those individual households that received a social norm message (e.g., "Your neighbors are turning off their air conditioning during the day to save energy!") were significantly more likely to reduce their energy use than people who received any other message (ethical, financial, environmental), including the environmental message. Recently, a student of mine, Bridgette Kelly, has replicated the first Nolan et al study, looking at people's responses to messages about food waste rather than about energy. She finds similar results to Nolan et al, that is, people when asked directly claim that they are more motivated by the environmental message than by the social norm message. Bridgette will soon replicate the second Nolan et al, study to see if, similar to energy conservation behavior, people actually change their behavior more readily in response to the social norm message despite claiming that the environmental message is more compelling.

There are different types of social norms. Most relevant here are:

a. **Descriptive social norm:** what we see others doing is what we think of as "normal" and acceptable. People are more likely to engage in a behavior if we see others doing it and thus perceive it as the norm. Basic psychology research shows that individuals are particularly influenced by descriptive social norms when they are uncertain about the right thing to do. For example, imagine eating dinner with a new group of people or in a new restaurant and you receive unusually large portions. Because you are in a new situation, you are more likely to look around and you notice that nobody is asking for a take-home box. Instead, people are letting uneaten food on the plate get bussed away, in this new and uncertain situation you feel uncomfortable asking for a take-home box for yourself because it seems that "this is not the way it is done here".

b. **Injunctive social norm:** what we believe others approve of. Similar to the descriptive norm, the injunctive norm shapes behavior. If people believe that their community approves of a particular behavior (e.g., buying lots of food in bulk even if it doesn't all get eaten before it goes bad), then they are more likely to engage in that behavior. And conversely, if they think that others disapprove, then they are less likely.

4. **Addressing the social dilemma aspect of food waste.** A social dilemma is a problem in which an individual's self-interest conflicts with the greater good. Food waste is a social dilemma because individual people's self-interest probably encourages them to have wasteful food habits- having lots of food choices is individually rewarding, and the personal cost of wasted food is relatively low. But the cost to the environment and to society is quite high when aggregated across all individuals. How can the social dilemma aspect of food waste be addressed? Myers (2005: Social Psychology) makes four relevant suggestions.

    a. **Make the group size small.** When people are in a small group or community where there are personal connections, they are more likely to recognize the impact of their behavior on the larger group and thus be more motivated to behave differently. This is a strong argument for work with small communities, where information and stories can be shared in a more personal way. The more personal connections there are within a community, the more likely people will act in the interest of the community rather than solely self-interestedly. Most people hold a personal standard of social responsibility, reciprocity (with community members), equity, and keeping commitments to others. It seems that it is easier to behave in alignment with this personal standard (or value) when the social group is smaller (Kerr, 1992, as reference by Myers, 2005).

    In addition to feeling more responsible to the community when the group is small, people also feel more effective (Myers, 2005). They are more likely to see that their small action has had some sort of an effect, and thus they feel empowered and motivated.

    Finally, in a smaller community or group, people are more likely to feel a sense of personal identity that is tied to the community. They are probably more likely to feel like a "Frogtowner", or even a member of their block, for example, than a "St. Paulite". Appealing to this identity, and the social norm of this group as people who don't waste food, can help overcome the tendency for self-interest to push people toward food-wasting behavior.

    b. **Communicate.** "Open, clear, forthright communication reduces mistrust." (Myers, 2005, pg. 327) When you are faced with a social dilemma, it is essential to give people clear information about the problem and why they should help despite it feeling like they are acting against their self-interest. Of course, in-person communication is the most powerful, but not always feasible. The important point here is not to forget that people can be persuaded by facts and reasonable arguments, and accurate information provides the bedrock for any successful behavior change campaign. But information alone is never enough to shift behavior substantially.

    It also seems that the simple fact of communicating what a social dilemma is might inspire people to new, less self-interested and more community-minded behavior. (Mio et al., 1993, as referenced in Myers, 2005).

    c. **Change the incentives.** Look for ways to change the incentives/rewards that people feel (implicitly or explicitly) they receive for maintaining their current behavior with respect to food waste. This probably requires an observation and analysis of barriers to the goal behavior (explained in McKenzie-Mohr, 2011). If possible, make food-wasting behavior "more

expensive" in some way- perhaps by giving people the social norm message that "we do not waste food here". This makes wasting food "expensive" in the sense that individuals will feel socially awkward if other people see them wasting food.

d. **Appeal to altruism**. Is it possible to encourage lower food waste by appealing to people's sense of doing the right thing for others? The answer is a tentative yet. According to Myer, there are mixed results when it comes to appealing to altruism as a way to motivate a new behavior. Myers reviews studies showing that that people's attitudes may respond to an altruistic appeal, but they don't necessarily then change their behavior.

   However, recent research shows that altruistic appeals only work when they are completely separate from economic appeals. Apparently, once economic (or any other sort of incentive/reward) factors are included, a different region of the brain takes over processing the information and this brain process essentially eclipses the part of the brain that wants to respond to the altruistic appeal. This interesting finding is discussed in two recent books: Sway: The Irresistable Pull of Irrational Behavior (2008) by Brafman and Brafman, and Drive: The Surprising Truth about What Motivates Us (2009) by Daniel Pink.

5. **Context change.** A great evolutionary adaptation of the human brain is also a huge barrier to individual change: habit. To save ourselves the strenuous necessity of cognitively processing every detailed action we take, our brains save us mental resources by forming sets of reflexive-like behaviors that we perform automatically. Most people are familiar with "autopilot" behaviors: things we find ourselves doing the same old way we usually do when we actually had intended to do something differently.

   Habits are notoriously difficult to overcome. This is in part because the brain has created a neural network/pathway that results in the habit, and that network must be dismantled or avoided to overcome the habit. Breaking a habit through dismantling the neural pathway involves slowly weakening the connection between the features in the environment and situation that prompt the behavior and the behavior itself. For example, when a person goes to cook a meal, a probable habit is to open the fridge and start with the things in front that are most salient, rather than to look at the things in the back of the fridge first for the things that are more likely to be close to their expiration date. To break this habit, the features of the environment and the situation must slowly be linked to a new, different behavior (look at the food in the back of the fridge first). There are many ways to go about this sort of intentional change program- any behavior change program teaches techniques for this kind of behavior modification (e.g., diet centers, fitness programs, some addiction programs.)

   A complementary approach to habit-breaking is to change the context of the behavior. That is, to make some change to the situation, a big change or a small, so that the features of the environment that usually support the habitual behavior are not there. Several researchers are conducting work on habits and context change, most notably Neal, Wood and Quinn (2006). For the example of looking in the front of the fridge, a context change could be done in many ways. One could put up **reminders** or **prompts** that get the individual's attention as they open the fridge door, so that they consciously and intentionally look in the back. Or, one could change the position of the refrigerator – move it a few feet away from its

usual position, or rehang the door so that it opens on the other side. Though this sounds perhaps simplistic, it in some cases can be enough of a change that the individual notices "something is different!" and this breaks them out of autopilot mode and enables them to think more intentionally about what they were about to do. Macalester students have noted, when engaged in class projects on personal behavior change, that small changes to context do indeed help them break a habit. One student was trying to avoid producing any trash for 10 days and she had the habitual behavior of taking a napkin each time she sat down in Café Mac for a meal. One day as she sat down and reached for a napkin, she noticed that the napkin holder was new- the old metal had been replaced by something brightly colored. This small change disrupted her habit of napkin-taking in that moment.

It is important to note that small context changes tend to be a temporary disrupter of habits. The brain is powerfully motivated to develop and maintain habitual behaviors, and it will adjust quickly to small changes. This is called habituation. Thus, prompts, reminders, and minor changes lose their effectiveness rather quickly- they become part of the background that people no longer perceive (think about all of the "turn the lights off" stickers on light switches that nobody pays attention to anymore.)

A more permanent context change is something major- a kitchen remodel, for example, or a move to a new house. In fact, Neal, Wood, Quinn (2006) and others find that habits are most successfully broken when there major life context changes occurring, such as a move, a job-change, change in marital status, or becoming a parent. In these situations, people's habits are forcibly being changed. They thus need **support in times of other life changes** to form new and more sustainable habits. It is a great idea to give people resources and ideas of how to avoid food waste when they, for example, move to a new neighborhood. In addition, people in a new situation are also looking (subconsciously) for information about the social norms of this new and different place. It is good time to communicate the community injunctive norm "people here think it is important to not waste food" or social norm "in this neighborhood, there are a lot of people who work hard to avoid food waste".

Finally, one last suggestion for context change and food waste. A context change could be coupled with goal-setting (briefly described above). Encourage people to set a goal that addresses food waste but also contributes to a change in the situation/context in which the habitual behavior occurs. For example, to support changing the habit of looking at the front of the fridge first, people could be encouraged to set the goal of rotating the food in their fridge weekly. This context change (different food is in the front of the fridge) supports a different kind of behavior (people will no longer let things linger in the back of the fridge until they go bad).

6. **An overarching societal barrier**. It is important to note that food waste in America occurs in a broader societal context that supports and promotes (over)consumption. Buying more food than one can eat is a common practice, encouraged, for example, by the prevalence of buying-club style stores where the savings is larger if one buys in quantity or by the relatively small jump in price for extra-large sizes of soft-drinks or fast food. In restaurants, plentiful portions are the norm. At home, it is also the norm for people have extra-large refrigerators, often more than one, for their food storage. The availability of more fridge space also invites buying (and storing) extra food.

The work that Eureka is doing on the individual level will always be constrained by this social context and infrastructure in which buying too much food is easy, encouraged, and perceived as "what everyone does". Wherever possible we should bring attention to these structural barriers and look for opportunities to change them (lobbying, legislating, organizing within a community).

7. **Being given the opportunity to be right vs. being told you are wrong**. Why do people change their behavior? They change because they recognize that the old way is not working and/or that there is a new opportunity available that has advantages over the old. What motivates people to take the new opportunity? According to Self Determination Theory (SDT, Ryan and Deci, 2000), internal motivation is highest when people feel like they have *autonomy* – they can make the choice, no one is forcing them. In addition, internal motivation is hight when people feel *competent* and a sense of *relatedness* (e.g., to a social circle, to a higher power, to an important value or idea or goal).

   Autonomy underscores how critical it is that people do not feel forced into taking an action. Competence underscores the importance of people being able to maintain a sense of themselves as capable actors in the world. When someone confronts a person to say "you're doing this wrong", the person receiving the message is likely to feel that both their autonomy and their competence has been threatened. This will erode their internal motivation to take any sort of action.

   Instead of in any way implying to people that they're doing something wrong, I recommend bolstering their sense of competence by finding something they are doing right, noting it, and building on it. Give them the opportunity to move further into the program, invite them to continue their good habits and take them to the next level.

8. **The importance of a multi-pronged approach.**
   Each recommendation listed here, once implemented, can make a small difference in how people engage with the issue of food waste. However, there are no magic bullet solutions: none of these recommendations on its own is likely to fully address the behavior of food waste. To gain the most power from these suggestions, one should always take a multi-pronged approach. The more of the recommendations that are implemented, the higher the likelihood of noticeable progress on changing food waste behavior.

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Preventing Wasted Food through Education & Community Engagement

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Americans are wasting more food than ever before. According to a recent study, we throw away 50% more food than 40 years ago. The majority of this wasted food occurs at the consumer level. Several recent reports are quantifying the avoidable wasted food, including its economic cost and environmental impacts. For example, 20% of vegetables produced are never eaten and wasted by consumers.

Based on recent estimates, **the average Saint Paul household wastes up to $96 per month in preventable food waste.** And that is just a measure of the cost of purchasing that food—not including the extraordinary amount of resources it takes to grow, harvest, process, and transport food from the field to the store—which often includes a trip half way around the world that represents a significantly larger cost, both financially and environmentally.

Through a partnership with the University of Minnesota's Institute on the Environment (NorthStar Initiative for Sustainable Enterprise) and with support from the Minnesota Pollution Control Agency, Eureka Recycling has dug deep into questions about preventing wasted food in our local context:

- What kind of foods do we most often waste?
- What type of information, education, and messaging is motivating for people to change their habits and waste less food?
- Are there tools that are especially helpful?
- How much of an impact can we have on reducing the amount of discards that needs to be composted using those tools and information?

Using this data, social marketing tools, and the psychology of sustainable behavior, this project generated and tested tools, messages, and strategies to engage the community in wasting less food.

The tools below consolidate some of these resources and link to two new interactive web-based tools to help people waste less food.

1. **Sources for Information on Wasted Food** (Created June 2012)
   More information about the issue of wasted food in all parts of the food chain is now emerging frequently. The links are some of the sources that Eureka Recycling has found most interesting or useful as we explore the impacts and opportunities of preventing wasted food at the household "consumer" level. We have also added our newly developed program materials and resources to this list.
2. ***Recommendations for Programs to Reduce Food Waste***, submitted to Eureka Recycling by psychologist Christie Manning, Ph.D., Visiting Assistant Professor of Environmental Psychology at Macalester College
3. **Gathering Community Input on Preventing Wasted Food**
   As a nonprofit community-based organization, Eureka Recycling strongly believes that the most successful waste-reduction programs (that result in the most effective behavior change) address the specific values, interests, and needs of the community for which the program is being designed. We believe the best way to get that information is to listen to community members, and this report details some of our experiences and recommendations.
4. **Using Waste Sorts to Learn About Preventing Wasted Food**
   For a waste sort to help us learn about preventable wasted food, a different level of detail is needed than in a typical waste sort that examines composting or recycling. These recommendations were generated from the lessons learned through successes and shortcomings of our own initial waste sorts looking for information about preventable wasted food in the trash in three communities in Saint Paul, Minnesota. For more information on waste sorts in general, see Eureka Recycling's report on **Best Practices in Public Space Recycling** (pages 26 & 27).
5. **Creating tools**
   In our initial pilot, we tested a wide variety of tools all aimed at helping residents of Saint Paul reduce the amount of food they waste at home. As a result of direct feedback from participants, we focused on further developing two of these tools in multiple formats: **A-Z Food Storage Tips**, and an **interactive Meal Planner**, both available on our composting website, www.makedirtnotwaste.org. These were clearly the most widely used tools, and participants felt they were the most effective.

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COMPOST Make dirt, not waste.

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Prevent Wasted Food

Why worry about preventing wasted food? Although composting is a great way to deal with inevitable food scraps like banana peels, it is much better to eat the food we can than to compost it.

Prevention helps the environment as well as our budgets. After all, it takes a lot of resources to get food from the fields to our homes.

While no one buys food with the intention of throwing it away, based on recent estimates, the average household in Saint Paul wastes **up to $96** worth of once edible food **every month!**

Eureka Recycling has assembled tips and tools to help!

- Find food storage tips and add your own
- Download our A-Z Food Storage Tips (PDF, 632 KB)
- Download our Food Storage Tips--Quick Reference (PDF, 307 KB) to post on your fridge
- Start meal planning
- Print a meal planner (PDF, 133KB)

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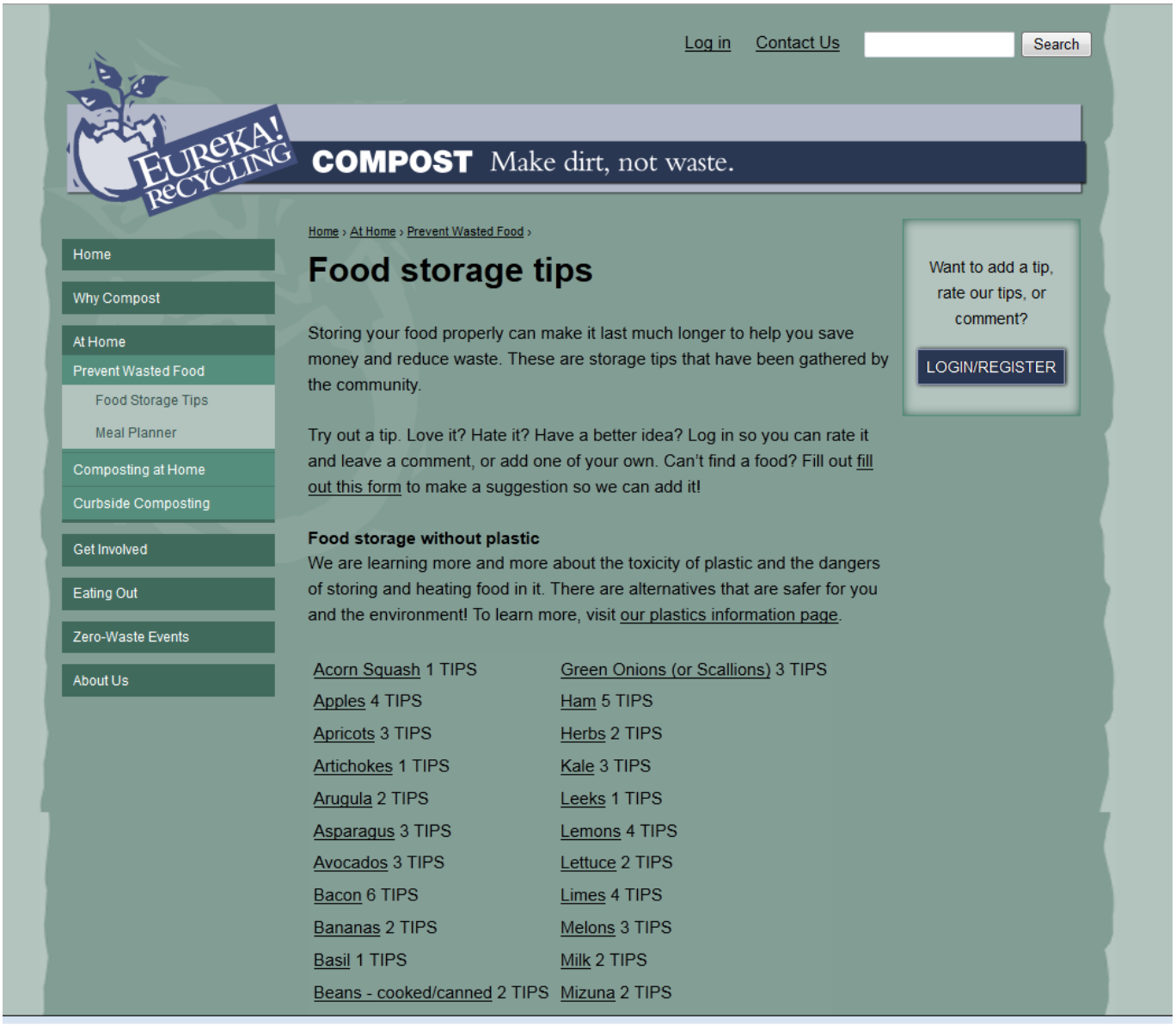
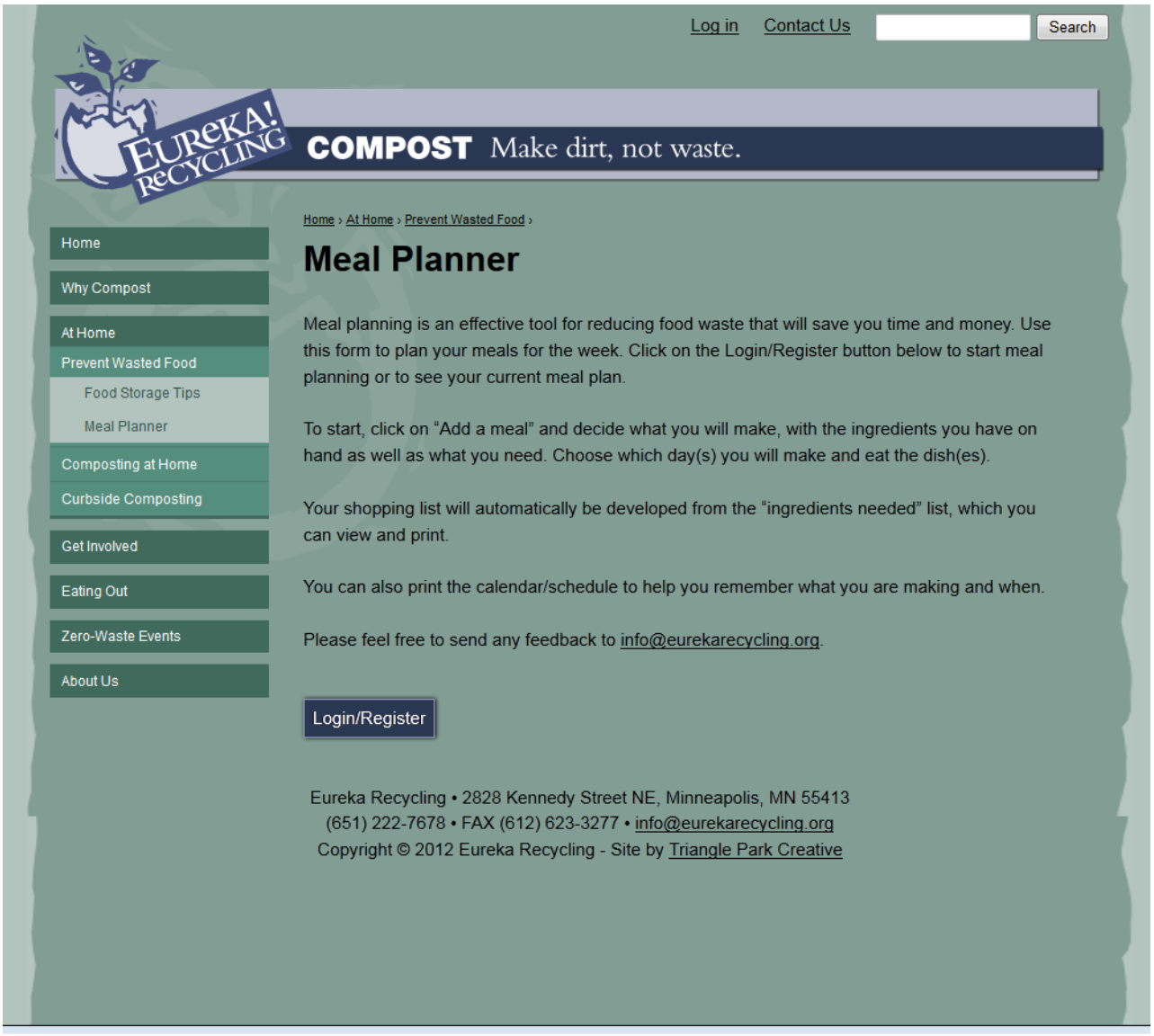
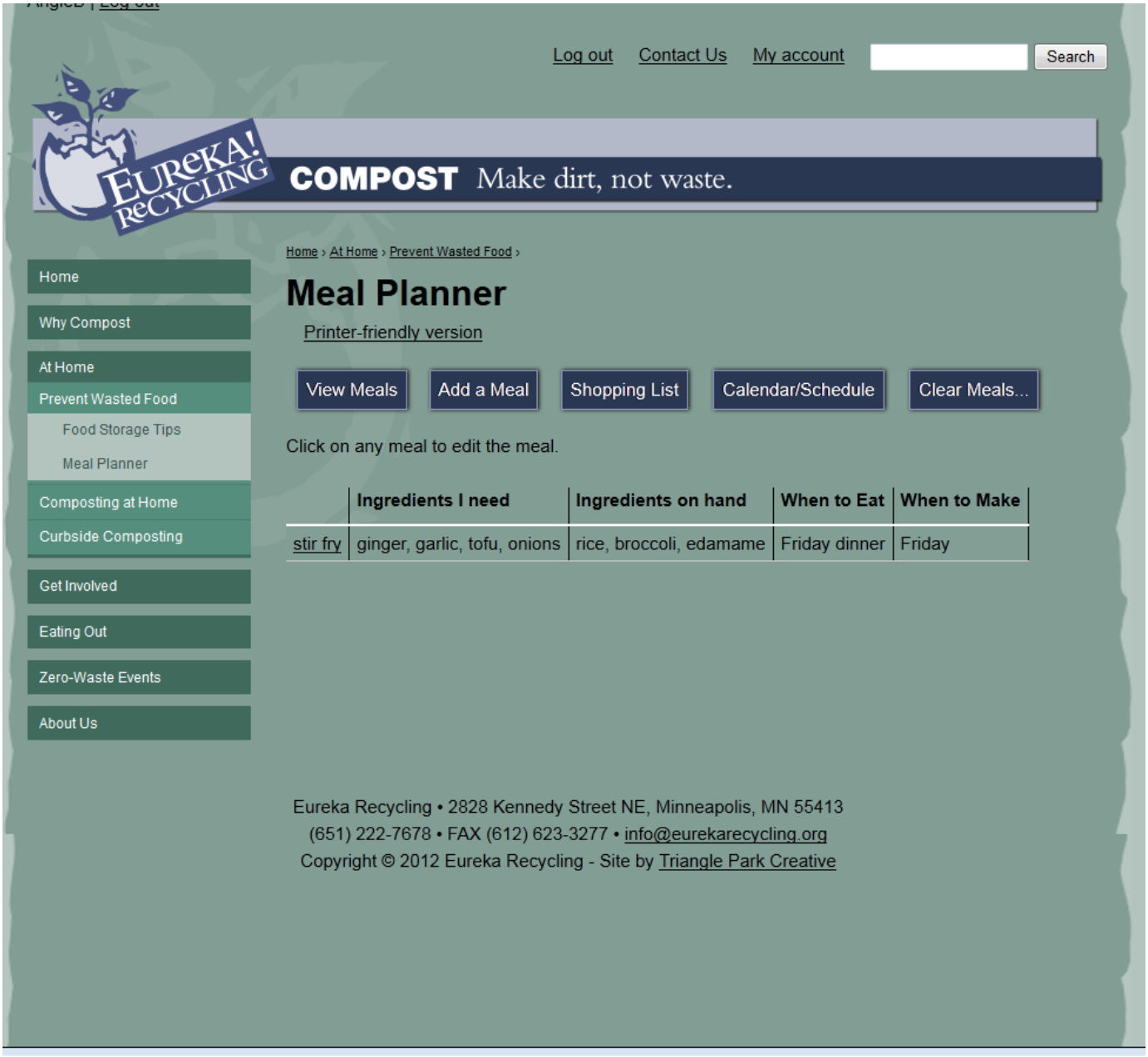
Online preventing wasted food landing page
http://www.makedirtnotwaste.org/prevent-wasted-food



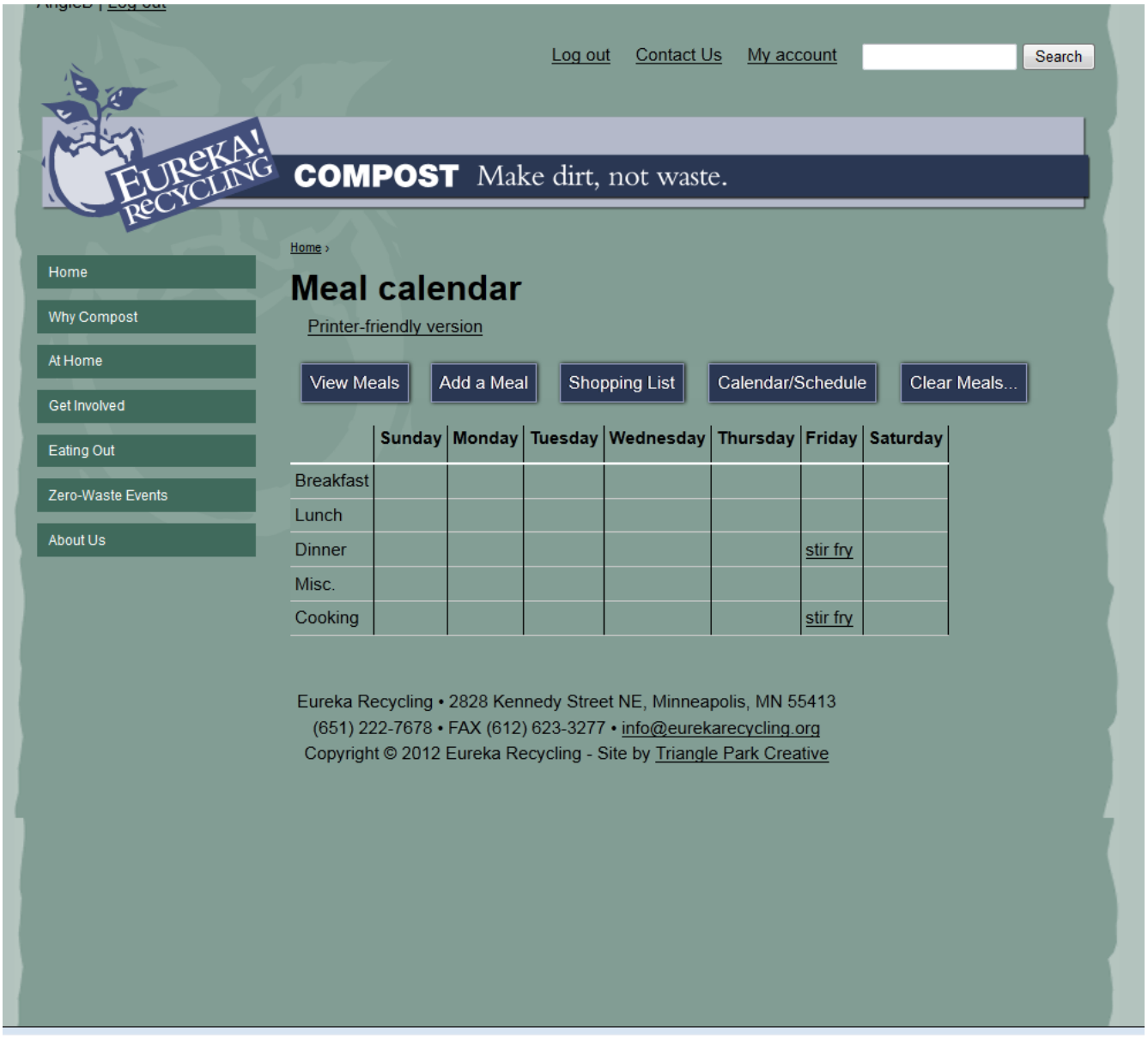
Online food storage tips
http://makedirtnotwaste.org/food-storage-tips



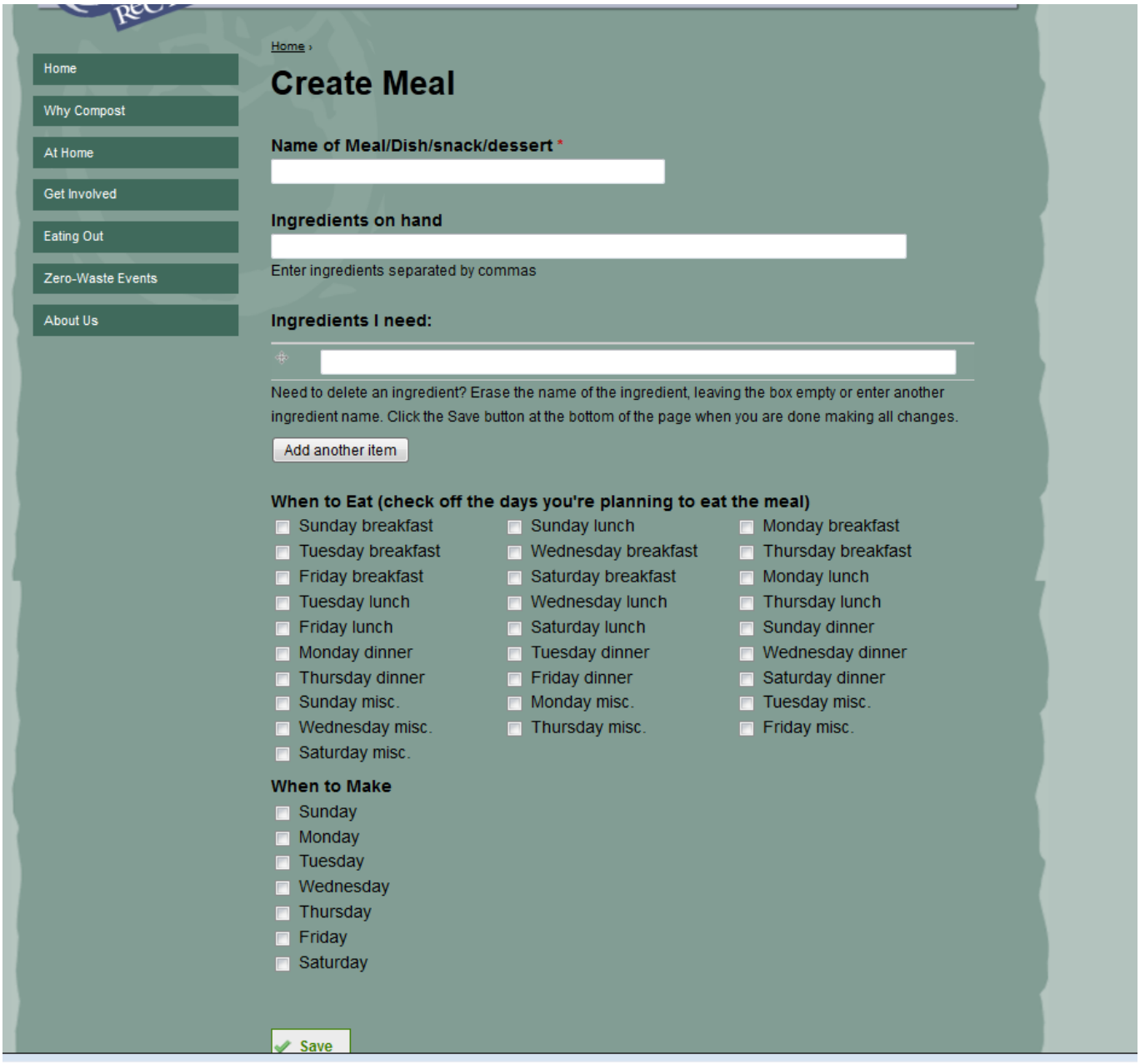
Online meal planner
http://makedirtnotwaste.org/prevent-wasted-food/meal-planner



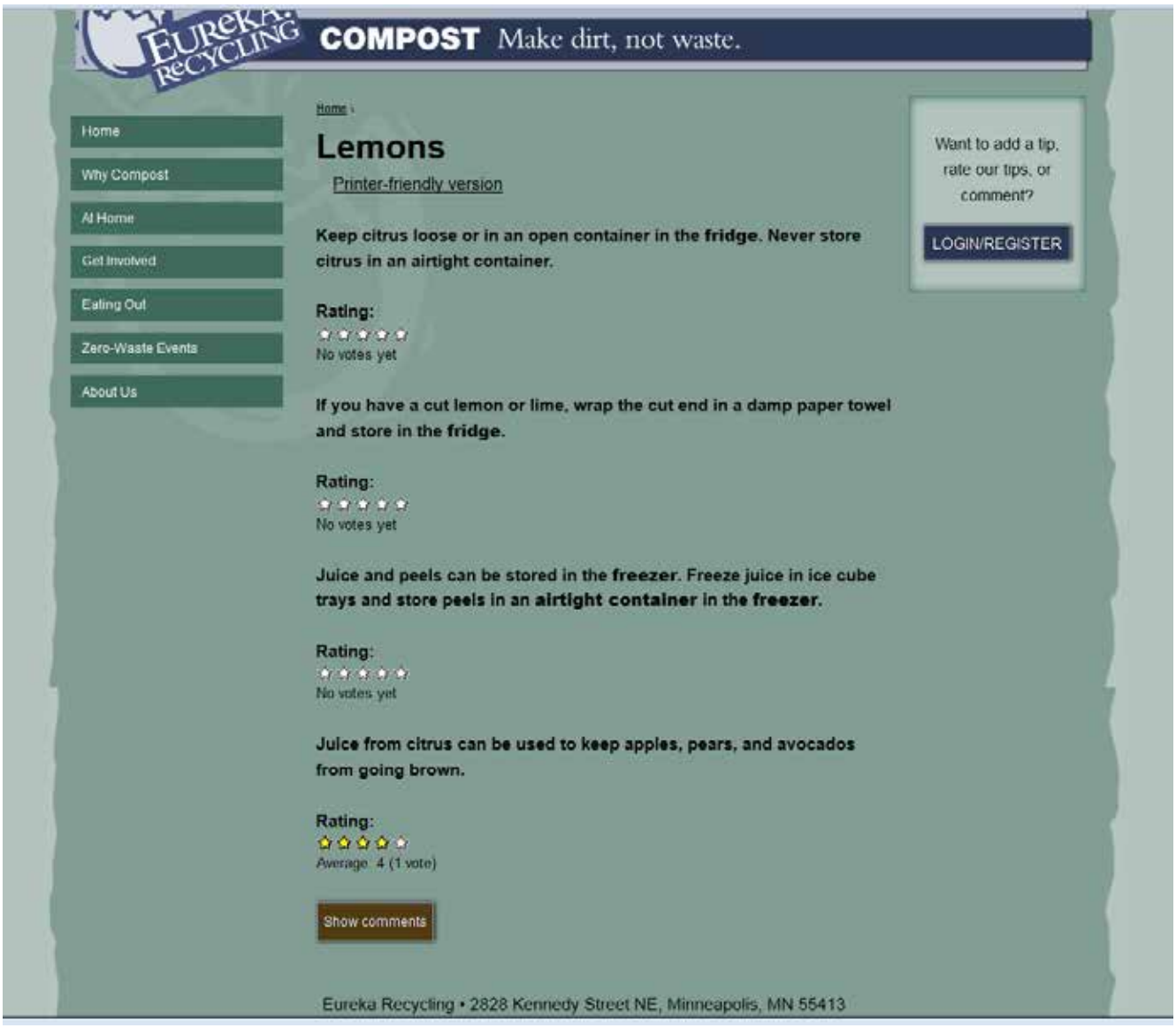
Online meal planner (summary view)
http://makedirtnotwaste.org/prevent-wasted-food/meal-planner



Online meal planner (schedule view)
http://makedirtnotwaste.org/prevent-wasted-food/meal-planner



Online meal planner (add a meal view)
http://makedirtnotwaste.org/prevent-wasted-food/meal-planner



Online food storage tips
http://makedirtnotwaste.org/food-storage-tips

Food Storage Tips—Quick Reference

Tips for storing food so that it lasts longer and gets wasted less

Why worry about preventing wasted food? Although composting is a great way to deal with inevitable food scraps like banana peels, it is much better to eat the food we can than to compost it. Prevention helps the environment as well as our budgets. After all, it takes a lot of resources to get food from the fields to our homes.

While no one buys food with the intention of throwing it away, based on recent estimates, the average household in Saint Paul **wastes up to $96** worth of once edible food **every month**!

Storing your food properly can make it last much longer to help you save money and reduce waste. Post this on your fridge as a quick reference for how to store some common groups of foods.

You can also check our more detailed list of food storage tips on our website at www.makedirtnotwaste.org. Try out a tip. Love it? Hate it? Have a better idea? Log in so you can rate it and leave a comment, or add a tip of your own.

Food storage without plastic

We are learning more and more about the toxicity of plastic and the dangers of storing or heating food in it. There are alternatives that are safer for you and the environment! To learn more, visit www.eurekarecycling.org/plastics.cfm.

Some general storage tips to keep in mind:

- Keep apples, bananas, citrus, and tomatoes away from other produce—they give off ethylene gas that makes other produce ripen/deteriorate faster.
- Untie all bunches (herbs, greens, etc.) to allow the produce to breathe.
- The length of time that the food will last depends on how fresh it was when you bought it. Local, in-season produce will last much longer than something that has been shipped a long way. For all perishable food, use your nose and eyes to determine if it has gone bad. Sometimes, it may just be past its prime for raw eating but can be cooked—pears, apples, berries, or other fruit can be made into sauces, crisps, or cobblers. Stale bread can be kept for breadcrumbs, French toast, or bread pudding.
- All frozen things should be in an airtight container with as much air removed as possible. Air contains moisture that creates ice crystals that "burn" the food or make it deteriorate faster. Freezing in a flat, rectangular, clear, glass container works lets you see your food and stack containers. Don't forget to label when it went in the freezer, and what it is!
- Many of these foods can be dried in a food dehydrator or canned with a hot water bath canner or a pressure canner. Check out a dehydrating or a canning guide to find the best recipes for preserving large quantities of produce.
- For best results, keep your fridge between 37° F and 40° F, and your freezer between 0° F and 2°F.
- Use your fridge's crisper drawer. The higher humidity environment benefits many vegetables by helping them last longer. If you can adjust the humidity setting on your crisper drawer, set it on high humidity for leafy greens or on low for non-leafy vegetables like carrots and cucumbers.

Food Storage Tips—Quick Reference

		Counter/Room Temp	Fridge	Freezer	Exceptions
Fruits	**Apples, pears**	Ripen **pears** on counter.	Keep in the fridge; remove bad apples/pears.		For longer storage: keep in cool place in a cardboard box with damp towel over them.
	Berries, cherries, grapes	Last longer in fridge.	Store single layer, unwashed, airtight container.	Freeze in single layer on cookie sheet. Store airtight.	If you need to wash ahead, put a little vinegar in water.
	Citrus	Last longer in fridge.	Keep in open container in fridge.	Freeze juice in ice cube trays. Store peels and cubes airtight.	
	Melons	Ripen on counter.	Store ripe and cut melons in the fridge.	Freeze cut up melon and store airtight for smoothies.	
	Stone fruits *(peaches, plums, apricots, etc.)*	Ripen on counter.	Once ripe, store in open container in fridge.	Peel and freeze, then store airtight.	**Cherries** should be kept in the fridge—follow berry guidelines.
	Tropical fruits *(bananas, avocados, etc.)*	Ripen on counter. Keep **bananas** on counter.	Store ripe in the fridge. Keep pit in avocado to keep it from going brown.	Store peeled or unpeeled bananas in freezer to use for baking or smoothies.	Don't put **bananas** in fridge, even when ripe.
Vegetables	**Cucumber, squash**	Last longer in fridge. **Winter squash** can be stored in a cool, dark place.	Wrap whole or cut in damp towel in fridge.	Blanch and freeze **zucchini**. Store airtight.	
	Greens *(salad and cooking)*	**Kale or collards** can keep on counter in cup of cold water changed daily. Better to keep in fridge.	Store airtight in fridge with damp towel.	Blanch and freeze cooking greens. Store airtight.	Store **broccoli** in open/loose container in crisper.
	Mushrooms	Last longer in fridge.	Store in a paper bag in fridge.	Sauté and then freeze in airtight container.	
	Root Vegetables *(potatoes, onions, carrots, etc.)*	Store in cool, dark place with original dirt on them or in wet sand. No potatoes with onions.	Keep in airtight container with a damp towel. Store **partial onions** in fridge with paper skin on in airtight container.	Better stored in root cellar, but can blanch, freeze, and store airtight.	**Potatoes** and **whole onions**—no fridge. Potatoes can be kept near apples to help keep them from sprouting.
	Stalk vegetables *(celery, asparagus, etc.)*	Lasts longer in fridge.	Keep standing up in jar of water.	Blanch and freeze. Store airtight.	
	Tomatoes, peppers, eggplant	**Tomatoes** on counter, unless really ripe. Keep away from other produce.	Keep in crisper drawer. Keep seeds and stem attached to **partial peppers**.	Freeze raw or blanched. Store airtight.	Keep **eggplant** away from moisture.
	Herbs	Keep **basil** on counter in damp towel or cup of water.	Put in jars with a little water, covered loosely with a damp towel or airtight in crisper.	Chop and freeze in ice cube trays; add olive oil to fill. Store airtight.	Don't put **basil** in fridge.
	Meat, poultry, fish	NO 	Keep on bottom shelf of fridge.	Freeze individual portions between wax paper and store airtight.	Storage length: Fridge, uncooked: 1-2 days; cooked: 4-5 days. Freeze: several months.
	Dairy	NO	Don't keep in door, keep in colder parts of fridge like bottom shelf. Wrap **cheese** in wax paper to breathe.	Freeze liquid in ice cube trays or jars. Freeze **firm cheese** cubed or grated. Store airtight.	Slightly whip **cream** before freezing so it doesn't get grainy.
	Grains *(rice, pasta, flours, bread, etc.)*	Wrap **bread** in wax paper and put in tin. Store other grains airtight.	Cooked grains.	Freeze flours, sliced bread, breadcrumbs, stale bread, and cooked rice and other grains in airtight containers.	Don't keep bread in fridge unless using for toast—it will dry out.
	Nuts	Keep airtight. Lasts longer in fridge.	Keep away from high odor foods —nuts will take on other odors.	Freeze in airtight containers.	

Meal Planner

Plan your meals to help prevent wasting food

Why worry about preventing wasted food? Although composting is a great way to deal with inevitable food scraps like banana peels, it is much better to eat the food we can than to compost it. Prevention helps the environment as well as our budgets. After all, it takes a lot of resources to get food from the fields to our homes.

While no one buys food with the intention of throwing it away, based on recent estimates, the average household in Saint Paul **wastes up to $96** worth of once edible food **every month**!

Eureka Recycling has assembled cooking, shopping, and food storage tips and tools to help. Learn more at www.MakeDirtNotWaste.org.

This meal planning tool saves time and money by making it easier to buy only what you will have time to prepare and eat, and reduce the amount of food you throw out.

Use the planner on the back to help you schedule your meals and create your grocery list for the week.

Some tips for planning:

1. **Before you go shopping**, look at your week and plan accordingly. For instance, if you have commitments that won't let you make dinner for the whole family, plan something that everyone can put together themselves, like burritos that use up leftover veggies, scraps of cheese, and a can of beans. Or decide that you will make that delicious meal on Sunday to eat before the big event on Monday.

2. **Think about portion sizes**. Is everyone going to be home for dinner? Do you want leftovers for lunch? Do you need to make the whole package of spaghetti or can you just make two servings?

3. Think about what you will need to make each meal and do a pantry, fridge, and freezer check to **see what you already have** before making your grocery list.

4. Some foods do well stored longer than others. Plan your meals using the hardier foods later in the week. Shop more than once in a week if you know something will not last until the end of the week. Consult our **Food Storage Tips** at www.makedirtnotwaste.org to see how foods should be stored so they last longer and get wasted less.

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Meal Planner (Week: _____)

Meal planning is an effective tool for reducing food waste that will save you time and money. Use this chart to help plan your meals for the week. Decide what you will make and when and fill in the dish(es) for that meal. Then you can make your grocery list from the "ingredients needed" column.

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Breakfast							
Lunch							
Dinner							
Snack							
To Cook							

Meals To Make

EX. Stirfry
(Dish or Food Item)

Ingredients on hand	Ingredients needed
pea pods, rice, cumin, ginger	soy sauce, scallions, mushrooms

Dissemination Plan for Project Results

Eureka Recycling will actively continue to share and distribute the project results and on-going work seeded by this grant project through the following avenues:

- Eureka Recycling's websites, www.eurekarecycling.org, is a national resource for environmental advocates looking for the latest information, studies, and reports published by Eureka Recycling, along with our composting website, www.makedirtnotwaste.org. Both websites will prominently feature announcements on the homepages about the Wasted Food Prevention toolkit and tools.

- Our e–newsletter, sent to 1,200 supporters a few times a year, will include an announcement and links to the toolkit and tools in the next issue, likely in July, 2012.

- An electronic announcement will be sent to other organizations and groups with overlapping interests, including Homegrown Minneapolis, Institute for Agriculture and Trade Policy, Land Stewardship Project, ComGar (Twin Cities' Community Gardens e-forum) via Gardening Matters, Twin Cities Farmer's Markets, Minnesota Environmental Fund, and the League of Women Voters.

- Members of Eureka Recycling's staff are frequently invited to speak at conferences and address a wide corporate, nonprofit, and government audience. As an active participant in industry groups including the Association of Recycling Managers, the Recycling Association of Minnesota, the Solid Waste Association of North America, and many other national and grassroots community groups, Eureka Recycling will look for appropriate opportunities to present findings and facilitate discussions about this project and the additional work needed in our industry about preventing wasted food.

- Eureka Recycling is in the process of launching a social media strategy that will provide other platforms through which to share the results and on-going work related to this project.

- If the plan for city-wide composting in Saint Paul is included in the city's budget this year, Eureka Recycling will begin rolling out prevention education in every neighborhood of Saint, building an education platform off of the foundations and tool established through this grant. This composting program will be a national model, and the unique education about preventing wasted food will be a highlight.