

Learning Not to Waste Food

Lessons from Research & Campus Collaborations

Brian E. Roe, Van Buren Professor

College & University Recycling Coalition Workshop

San Antonio
October 15, 2017



This work was supported by NIH grant R21 AG032231 and partially supported by a NORC Center Grant # P30DK072476 sponsored by NIDDK and partially supported by USDA grant 20176702326268. Roe acknowledges support from the Van Buren program and the Earl B. Poling Fund at Ohio State University and the Ohio Agricultural Research and Development Center. Louisiana State University and Pennington Biomedical Research Center have an interest in the intellectual property surrounding the RFPM and the SmartIntake® app and C. Martin is an inventor of the technology. No other authors have any conflicts to report.



THE OHIO STATE UNIVERSITY

Why focus on food loss and waste?

2

The amounts are staggering

- The FAO estimates that globally, approximately one-third or 1.3 billion tons of food is wasted annually
- USDA estimates that in the United States, food loss and waste at the retail and consumer levels was 31% of the food supply in 2010
 - 66 million tons of food
 - 162 billion dollars



Why focus on food loss and waste?

It's a great waste of the resources used to produce the food

- ❖ **Water:** **70%** of global freshwater withdrawals are used for irrigation (Postel et al., 1996).
- ❖ **Land use:** **37%** of the earth's land surface is occupied by agricultural lands, and 70% of the grassland, 50% of savanna, 45% of the temperate deciduous forest, and 27% of the tropical forest biome **is cleared or converted by agricultural** (Pretty, 2008).
- ❖ **Labor, agricultural investment, fertilizer,...**



Why focus on food loss and waste?

People need the wasted food - now

- Feeding America, a hunger-relief charity, estimates that billions of pounds of potentially usable food loss in the U.S. food supply chain
 - 48 billion pounds pre-distribution
 - 22 billion pounds in local markets



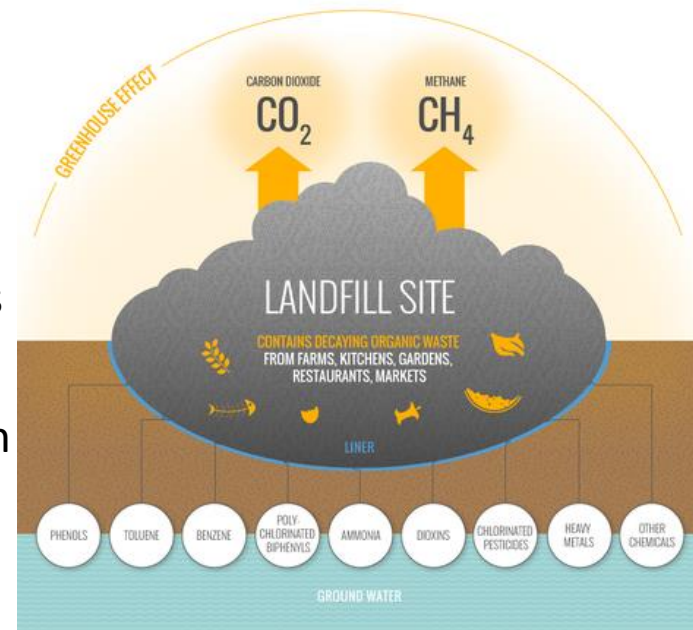
Roe - CURC



Why focus on food loss and waste?

Climate change

- EPA estimates that in the United States:
 - Food is the single largest component of municipal solid waste going to landfills (~21%)
 - Food waste generates methane, a greenhouse gas 20-30 times more potent than carbon dioxide
 - Landfills are the third largest source of methane in the U.S.





The Roe of Consumers and Awareness

In developed countries, ~ 40% of waste occurs at the retail & consumer level

- Food waste at the consumer level in industrialized countries (222 million ton) is almost as high as the total net food production in sub-Saharan Africa

Awareness is moderate, and perhaps increasing

- “In the last 12 months, have you read, seen or heard anything about the amount of food that is wasted or about ways to reduce the amount of food that is wasted?”
 - July 2015 sample of U.S. Consumers – 53% said ‘yes’ [2]
- “In the past year, have you seen or heard anything in the news, social media, or elsewhere about the issue of food that is thrown out or otherwise not eaten by humans? (Sometimes referred to as ‘wasted food’).”
 - April 2014 sample of U.S. Consumers - 42% said ‘yes’ [3]

Scope for Awareness & Promotion Programs?

Can we reduce food waste through awareness formation and messaging?

- Awareness is above 50% but far from universal
- What information levers can be altered?
- Or should we rely on other subtle changes in the consumer setting?
- What is the evidence such programs prompt behavioral change?

Review Several Types of Studies

- Messages encouraging food waste reduction in all you care to eat food service settings and other interventions – published studies
- Self monitoring of food intake patterns
- Elimination of date labels on milk packages



Direct Appeals to Consumers



Kansas State - Messages to Reduce Waste [4]

- 6 weeks collection during spring 2011 of solid food waste during lunch + dinner at a single all you care to eat facility (trays used)
 - Ave lunch patrons: 412
 - Ave dinner patrons: 381
 - 19,046 meals served during study
- 296 students had waste tracked for the entire study
 - Baseline collection: 2 weeks
 - Message #1: next 2 weeks
 - Message #2: following 2 weeks

KSU Messages



Figure 1. The prompt-type message intervention poster used to encourage food waste behavior change in a university dining facility.

On average each resident wastes 2.25 oz. of food each meal. This amounts to more than 22 pounds per person per semester.

This complex disposes of more than 45 pounds of edible food each meal on trays. That is enough food to prepare more than 30 meals



Figure 2. The feedback-based message intervention poster used to encourage food waste behavior change in a university dining facility.



Kansas State - Messages to Reduce Waste

- 6 weeks collection during spring 2011 of food waste during lunch and dinner at a single all you care to eat facility that uses trays
 - Ave lunch patrons: 412
 - Ave dinner patrons: 381
 - 19,046 meals served during study
- 296 students allowed waste to be tracked across the entire study
 - Baseline collection: 2 weeks
 - Message #1: next 2 weeks
 - Message #2: following 2 weeks

Study Period	Edible Plate Waste (lbs)	% Reduction
Baseline	0.138	--
Message #1	0.117	15.4*
Message #2	0.120	13.6*
*statistically significant reduction from baseline		

KSU Messages

- 1st message decreased waste significantly
- 2nd more detailed message had no additional effect
- No way to know if the pattern of waste reduction due to
 - The quality or content of the messages
 - Anyone open to change responded to the 1st message
 - Merely a seasonal effect as there was no 'control' location



Figure 1. The prompt-type message intervention poster used to encourage food waste behavior change in a university dining facility.

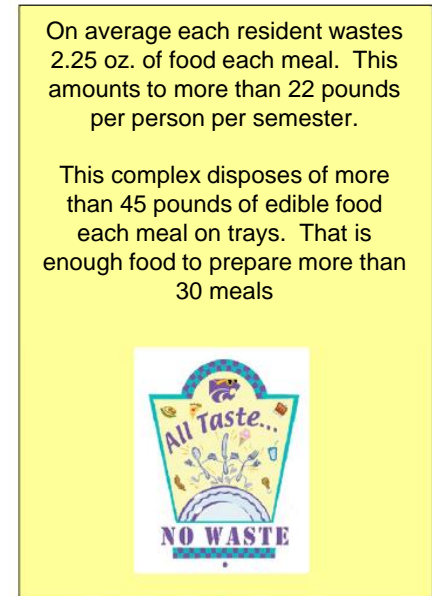


Figure 2. The feedback-based message intervention poster used to encourage food waste behavior change in a university dining facility.



U. Illinois Study [5]

Fall 2016 study 2 facilities

- Both all-you-care-to-eat, station-based locations (grill, pizza, pasta, deli, others)
- 1.5 miles apart - furthest apart of their 6 facilities
- One received the messages
- One served as the control location

Intervention implemented mid-semester via signs and napkin holder messages

Baseline Measurement

Treatment	Control	Units
0.195	0.157	Lbs/student/meal
14,875	4,060	Lunches/wk
32	32	wk/acad yr
92,820	20,397	lbs/acad yr
>46	>10	Tons/acad yr

U. III. Intervention Signs



U. III. Intervention Signs



U. Illinois Study - Results

No statistically significant reduction in waste produced:

Treatment*	Control*	Period
0.195	0.157	Pre Education (baseline)
0.187	0.153	Post Education

*Lbs/student/meal

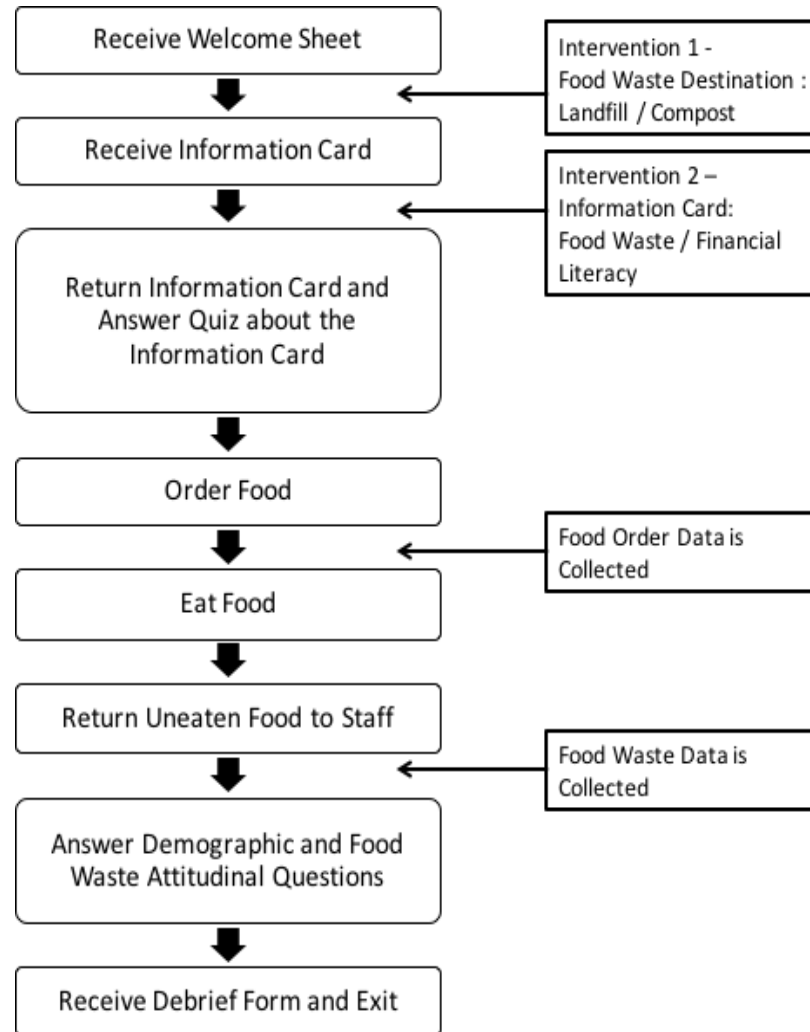
Why no significant improvement? At least 2 possible explanations:

- Messages emphasizing Dining's efforts to reduce impact of food waste (e.g., donations and digester) let students 'off the hook' with respect to their own effort and actions
- More time and broader education effort directed at students required

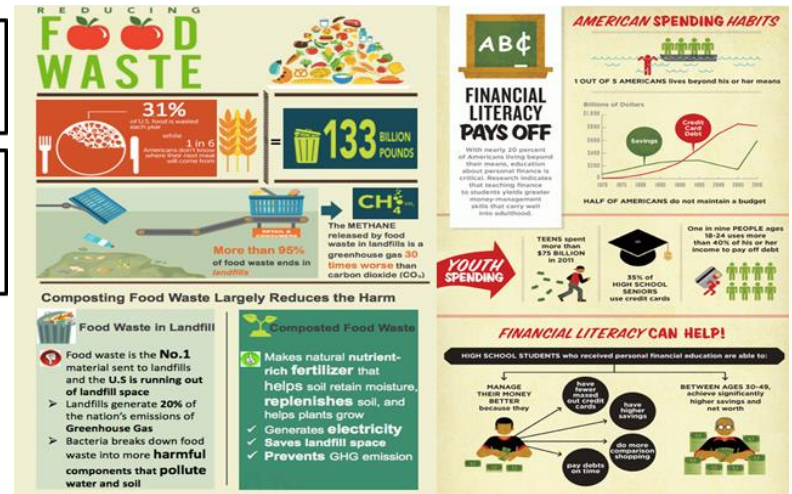
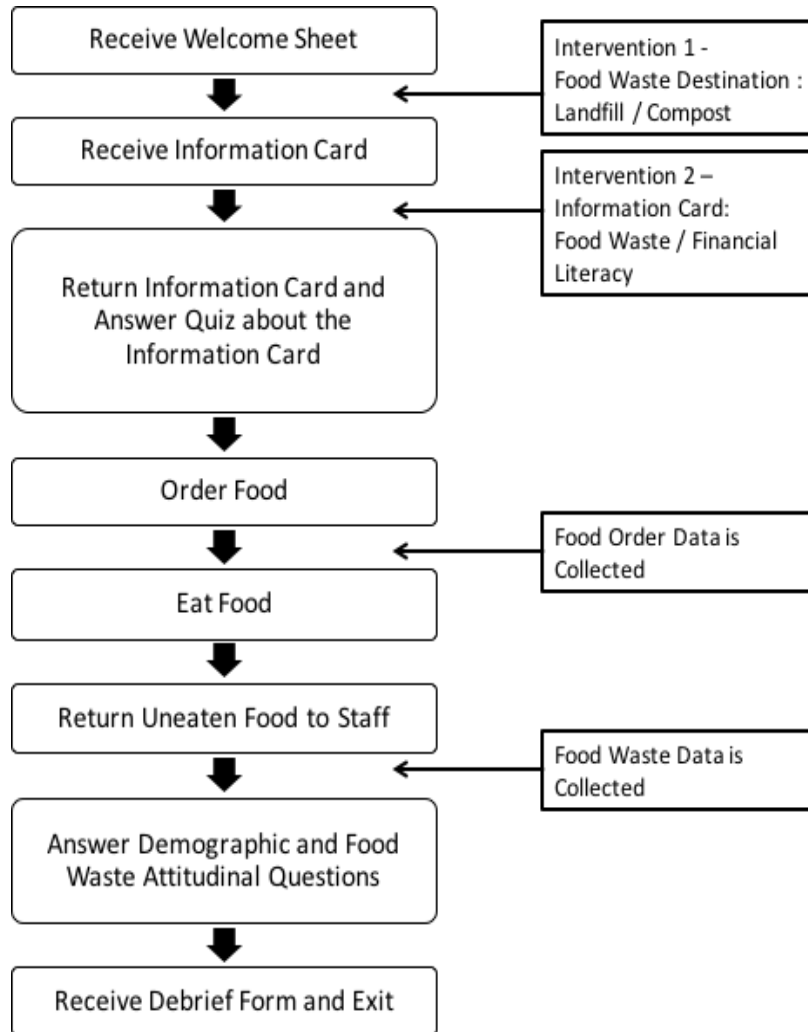
Ohio State Lab Meal Study [6]

- Recruited local residents and student to complete a face-to-face survey
 - 40% of participants were OSU students
- A free meal offered as compensation for participation
 - Sub sandwich segments, apple slices, chips, drinks
- Food selection and plate waste measured surreptitiously
- Between-subjects design
 - Participants in different sessions received different information provided before food selection and consumption

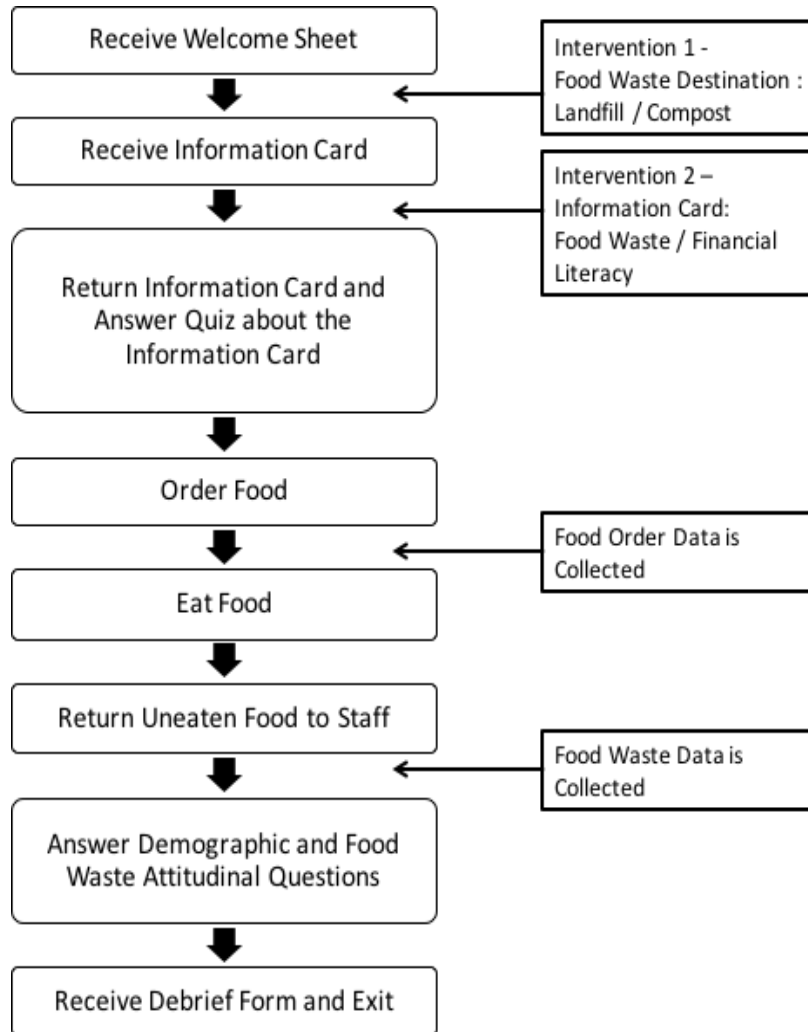
Research Method-Experiment Design



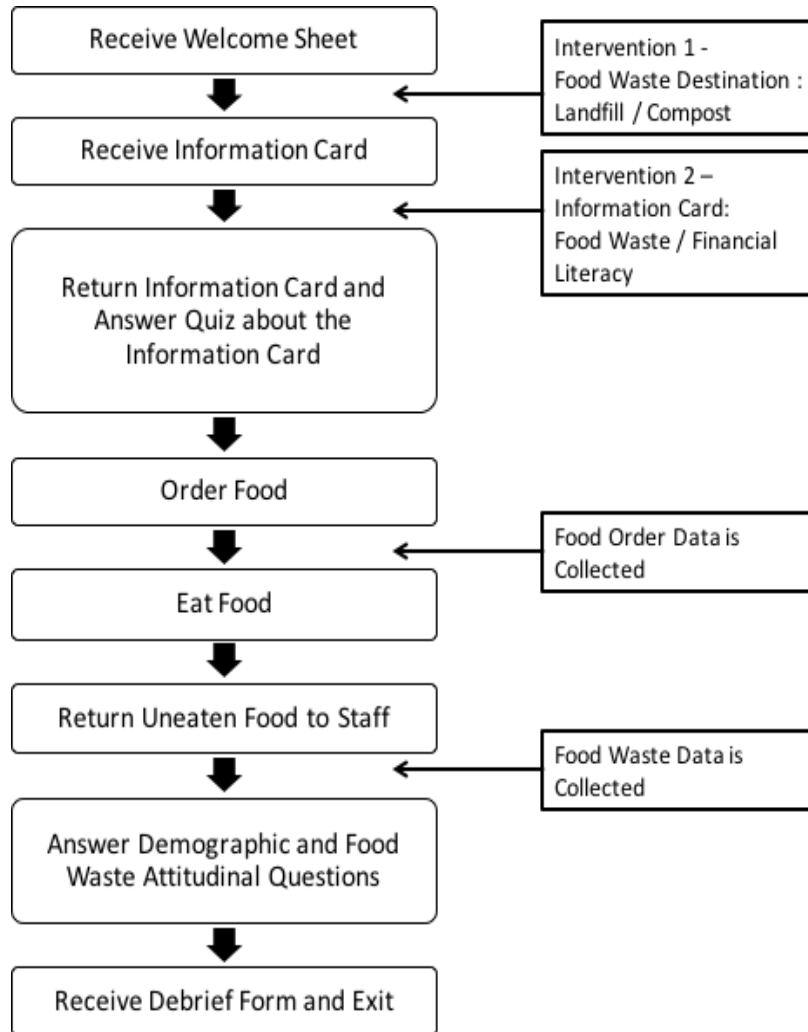
Research Method-Experiment Design



Research Method-Experiment Design



Research Method-Experiment Design





Experiment Design

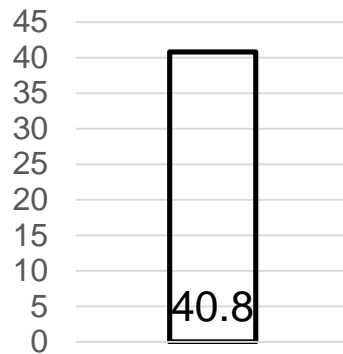
		Information Card Content	
		Food Waste Impacts	Financial Literacy
Where Uneaten Food Goes	Landfill	N=57 4 sessions	N=71 3 sessions
	Compost	N=85 4 sessions	N=38 2 sessions

2x2 Experimental Design

Roe - CURC

Policy Implication

Grams of Solid Food Discarded



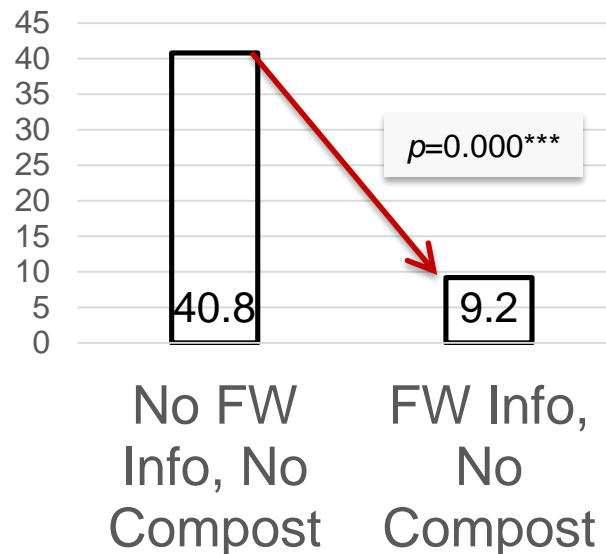
No FW
Info, No
Compost

Baseline

Roe - CURC

Policy Implication

Grams of Solid Food Discarded



Roe – CURC

Added Policy
Promote
Reduction of Food
Waste to
Consumers

Result
Large, significant
decrease in
wasted food



Policy Implication

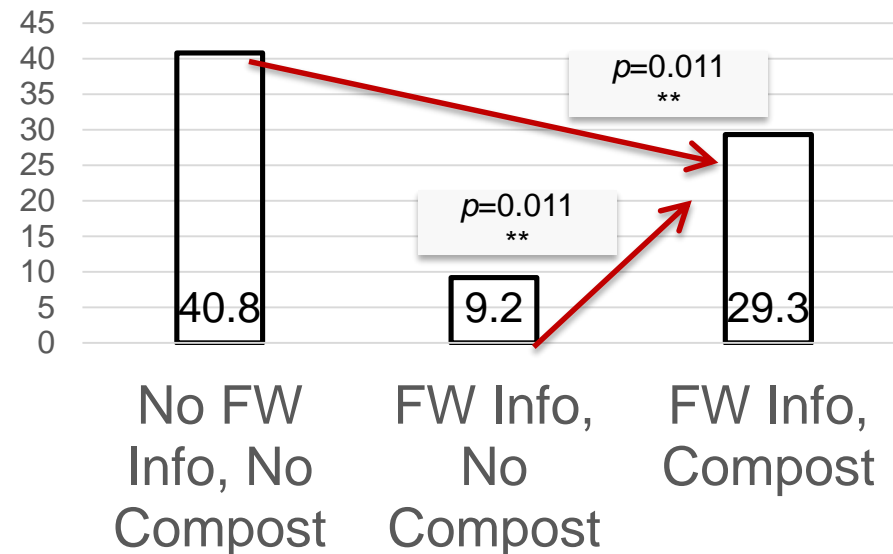
Added 2 Policies

1. Promote Reduction of Food Waste to Consumers
2. Tell consumers about your composting efforts

Result

1. Some improvement over baseline
2. Backsliding compared to only encouraging reduction

Grams of Solid Waste Discarded





Our Thoughts in Food Service Messaging

Avoid mixed messages to maximize reduction of food waste:

- Emphasize potential consumer actions
- Silence about food service ongoing efforts



Other University Cafeteria Interventions



Indiana U. Tray Removal Study

Thiagarajah & Getty, 2013

1 week with trays (per usual, M-F lunches, M-R dinners), 3rd week of Sep.

1 week with exact same menu 4 weeks later (menu cycle repeats every 4 weeks)

Switched to trayless 2 weeks prior to 2nd round of data collection, so some acclimation/habit change was possible

Caution: no way to control for possible seasonal changes as there was no hold out group that kept trays during 2nd week of measurement

	Solid Waste (lbs/patron)	Liquid Waste (mL/patron)
With Trays	0.274	49.77
Trayless	0.224	46.36
Reduction	18.4%	6.8%
Statistical Significance	Yes $P = 0.001$	No $P = 0.18$
# patrons	4901	4279



Cornell Trayless Study

Single cafeteria, two Tuesday evenings 2 weeks apart, identical menus

- 1st evening featured trays (per usual)
- 2nd evening trays were removed
 - No acclimation period
- 417 plates were measured for waste
- 338 people interviewed about # of trips through line

Unclear

- If waste measured for final trip or all trips
- How results change as students acclimate to trayless

Indiana study was more robust

- More data
- Allowed time for students to change eating patterns in response to trayless dining

Result	Trayless	W/ Tray	
# trips to line	1.48	1.01	**
finished entrée (%)	38.8	85.7	**
finished dessert (%)	52.9	90.7	**
finished salad (%)	53.6	91.7	**
took any salad (%)	18.4	36.2	**
took any dessert (%)	22.4	28.7	
Waste on unfinished plates (lbs.)			
entrée	0.18	0.13	*
dessert	0.17	0.10	*
salad	0.10	0.12	

** Statistically different at the 5% level

* Statistically different at the 10% level

San Jose State French Fries Study

- Subjects mostly freshmen 'regulars'
- Self-service French fries (FF) in individual paper bags
- Portion size (PS) originally at 88 g, and decreased ~15 g/week for 3 weeks

Table 1 Effect of portion size on total production, consumption, and plate waste of french fries

Portion size ^a (g)	Census count ^b	Number of diners choosing french fries	Total produced (g)	Total consumed (g)	Consumption per diner (g)	Total wasted (g)
88	668 ± 101	315 ± 88	44,727 ± 6,328	23,282 ± 4,227	74.3 ± 2.2	6,168 ± 265
73	680 ± 106	348 ± 62	42,299 ± 3,299	24,158 ± 2,698	71.4 ± 2.4	5,098 ± 250
58	725 ± 110	359 ± 144	37,033 ± 3,767	18,295 ± 4,794	53.0 ± 2.5	4,983 ± 283
44	728 ± 30	377 ± 74	35,150 ± 3,350	17,846 ± 1,318	52.2 ± 6.0	4,242 ± 90

Data are presented as mean ± s.d.

^aPortion size was positively correlated with consumption per diner and plate waste ($P = 0.001$) and total produced was positively correlated with PW ($P = 0.011$). ^bRefers to number of diners who ate in the dining facility during that week.



San Jose State French Fries Study

- # bags taken increased as PS decreased
 - 87% took 1 bag @ 88g down to 51% took 1 bag @ 44g
 - Waste ~ 19% regardless of PS or # bags
- FF production declined 21%
- FF plate waste declined 31% by reducing PS by 50%
- 70% of students surveyed didn't notice change in portion size

Table 1 Effect of portion size on total production, consumption, and plate waste of french fries

Portion size ^a (g)	Census count ^b	Number of diners choosing french fries	Total produced (g)	Total consumed (g)	Consumption per diner (g)	Total wasted (g)
88	668 ± 101	315 ± 88	44,727 ± 6,328	23,282 ± 4,227	74.3 ± 2.2	6,168 ± 265
73	680 ± 106	348 ± 62	42,299 ± 3,299	24,158 ± 2,698	71.4 ± 2.4	5,098 ± 250
58	725 ± 110	359 ± 144	37,033 ± 3,767	18,295 ± 4,794	53.0 ± 2.5	4,983 ± 283
44	728 ± 30	377 ± 74	35,150 ± 3,350	17,846 ± 1,318	52.2 ± 6.0	4,242 ± 90

Data are presented as mean ± s.d.

^aPortion size was positively correlated with consumption per diner and plate waste ($P = 0.001$) and total produced was positively correlated with PW ($P = 0.011$). ^bRefers to number of diners who ate in the dining facility during that week.



Our Thoughts on Other University All You Care to Eat Interventions

- Removing trays will reduce waste though it may require some acclimation
- Portion control for less nutritious items could yield benefits for waste reduction, production costs, and nutrition



Self-monitoring & Plate Waste



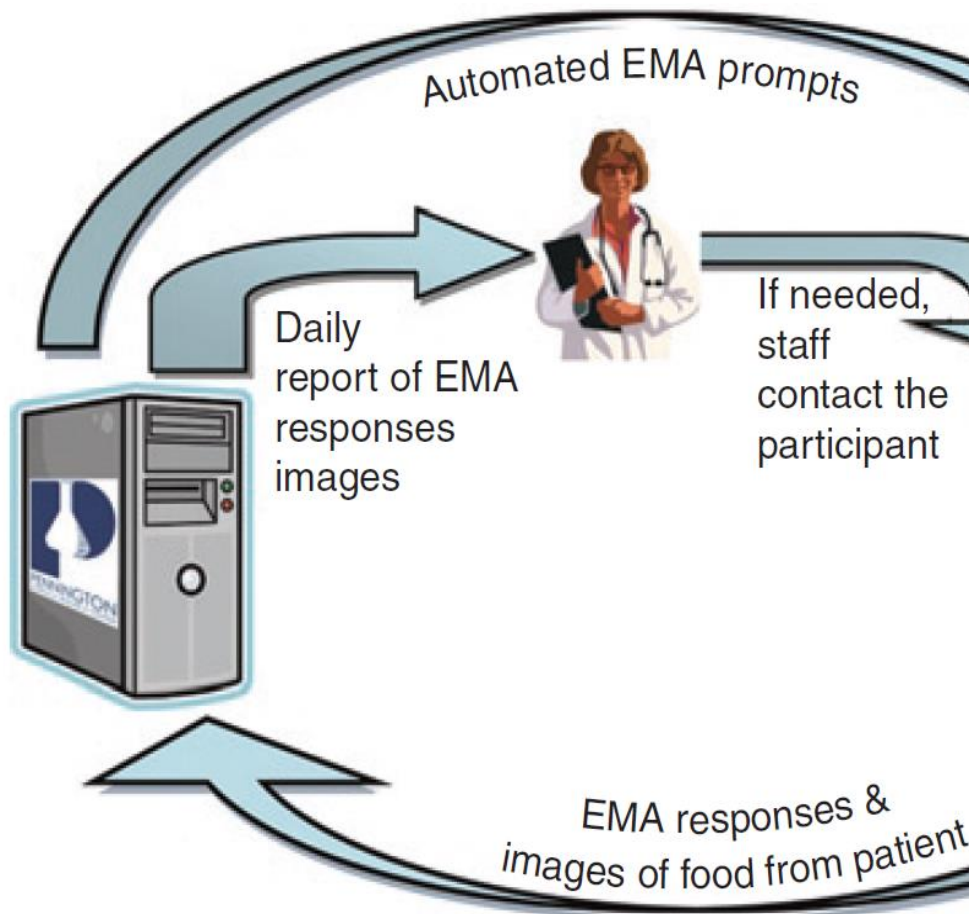
Pennington Biomedical Food Intake Monitoring Study [10]

50 adults used the SmartIntake® app to track food intake

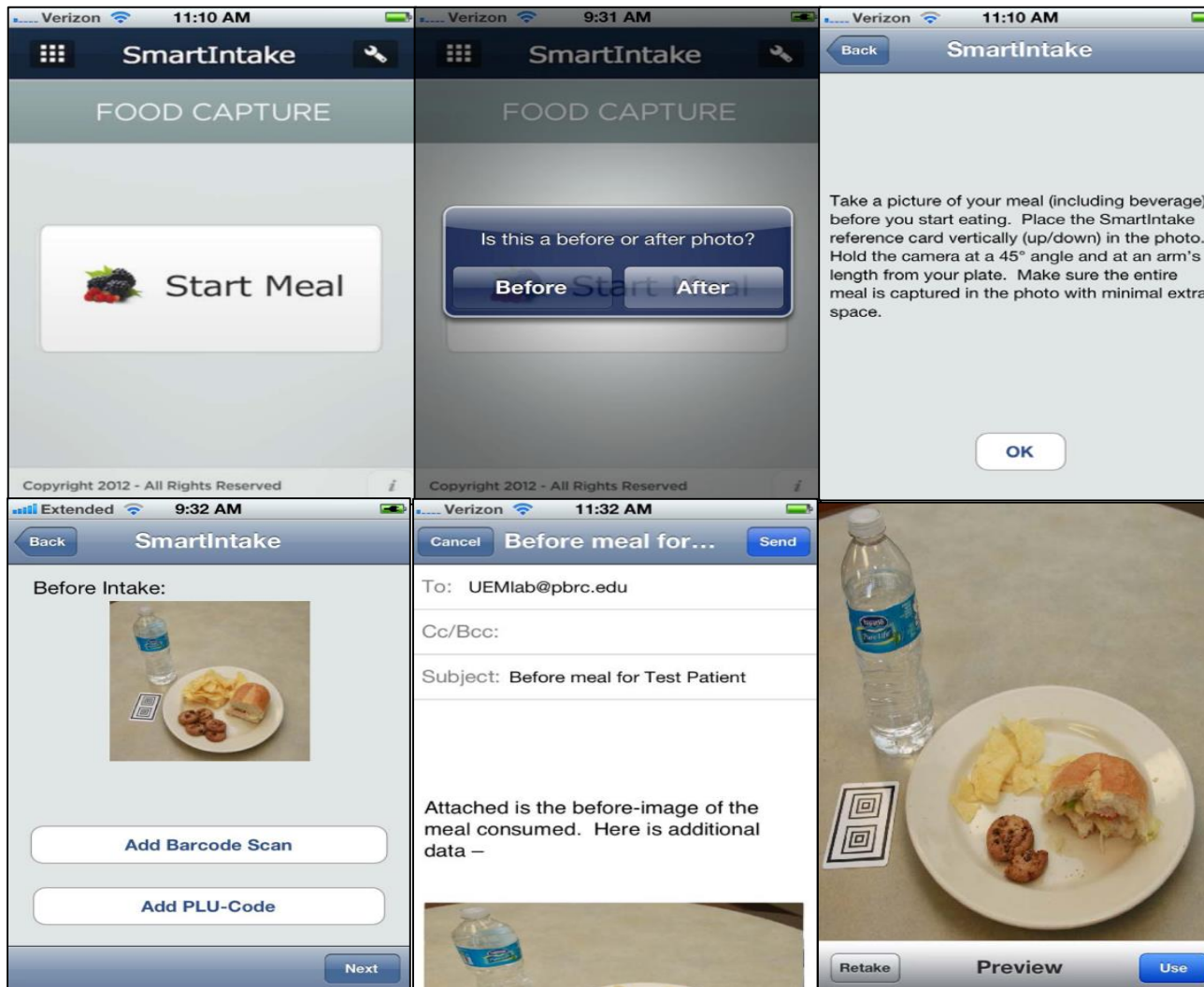
- All caloric intake over 6 days in every day life (free-living conditions)
- The Remote Food Photography Method (RFPM) estimated quantities, calories, macronutrients and micronutrients of
 - Food selection
 - Plate waste
 - Food intake (Food selection – plate waste)
- Validated that energy (calorie) intake as measured by RFPM was within 3.7% of actual intake [10]
 - RFPM doesn't rely upon participants to estimate portion size
 - Error doesn't vary with weight or BMI
 - SmartIntake/RFPM did not induce undereating by participants

Our Method: Remote Food Photography Method (RFPM)

The Remote Food Photography Method (RFPM)® uses ecological momentary assessment (EMA) methods to improve data quality & minimize missing data. The Food Photography Application stores & manages images sent from participants.

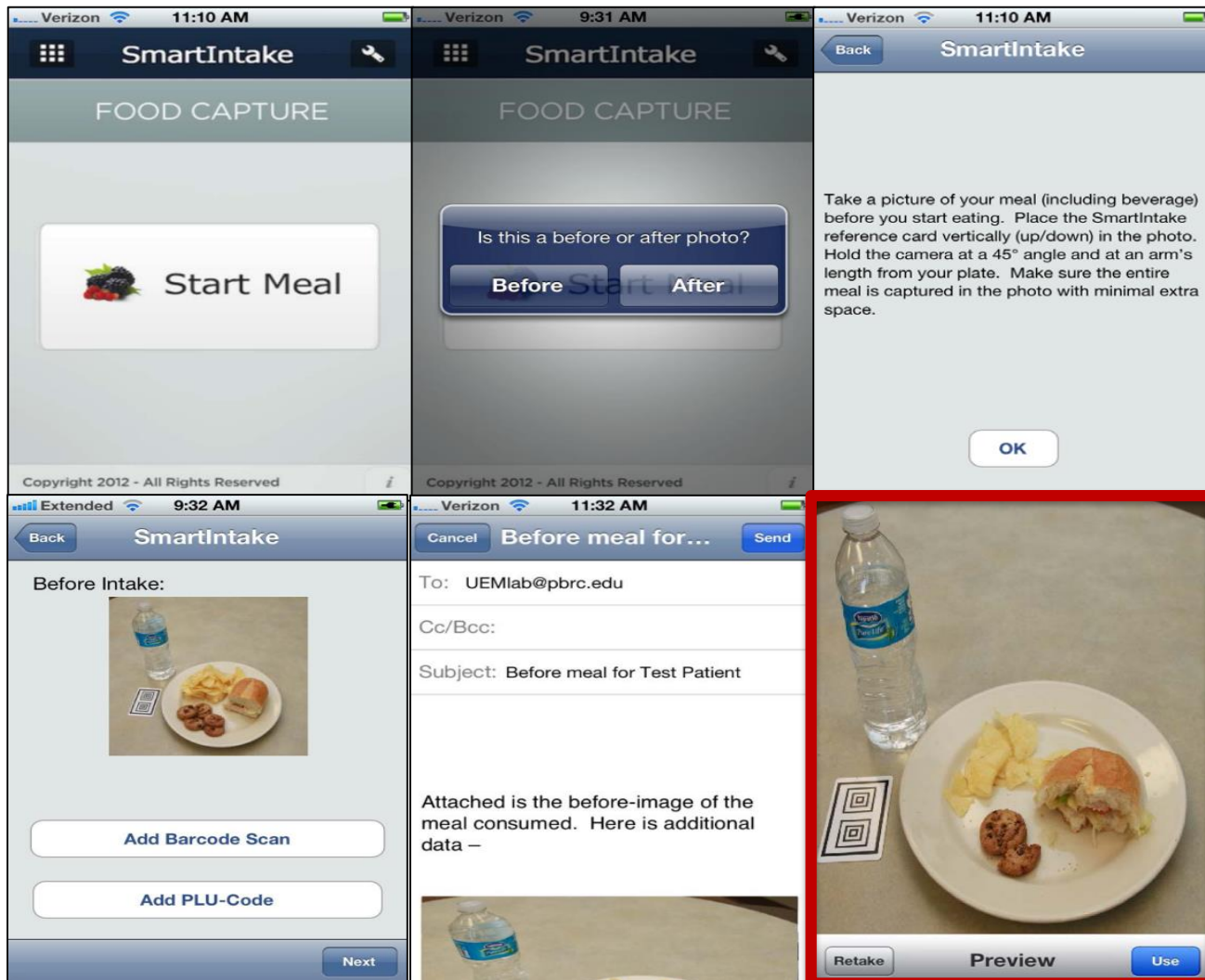


Remote Food Photography Method (RFPM)



Screen shots of the RFPM being used as part of the SmartIntake smart phone app to capture pre-meal (bottom left) and post-meal (bottom right) images

Remote Food Photography Method (RFPM)

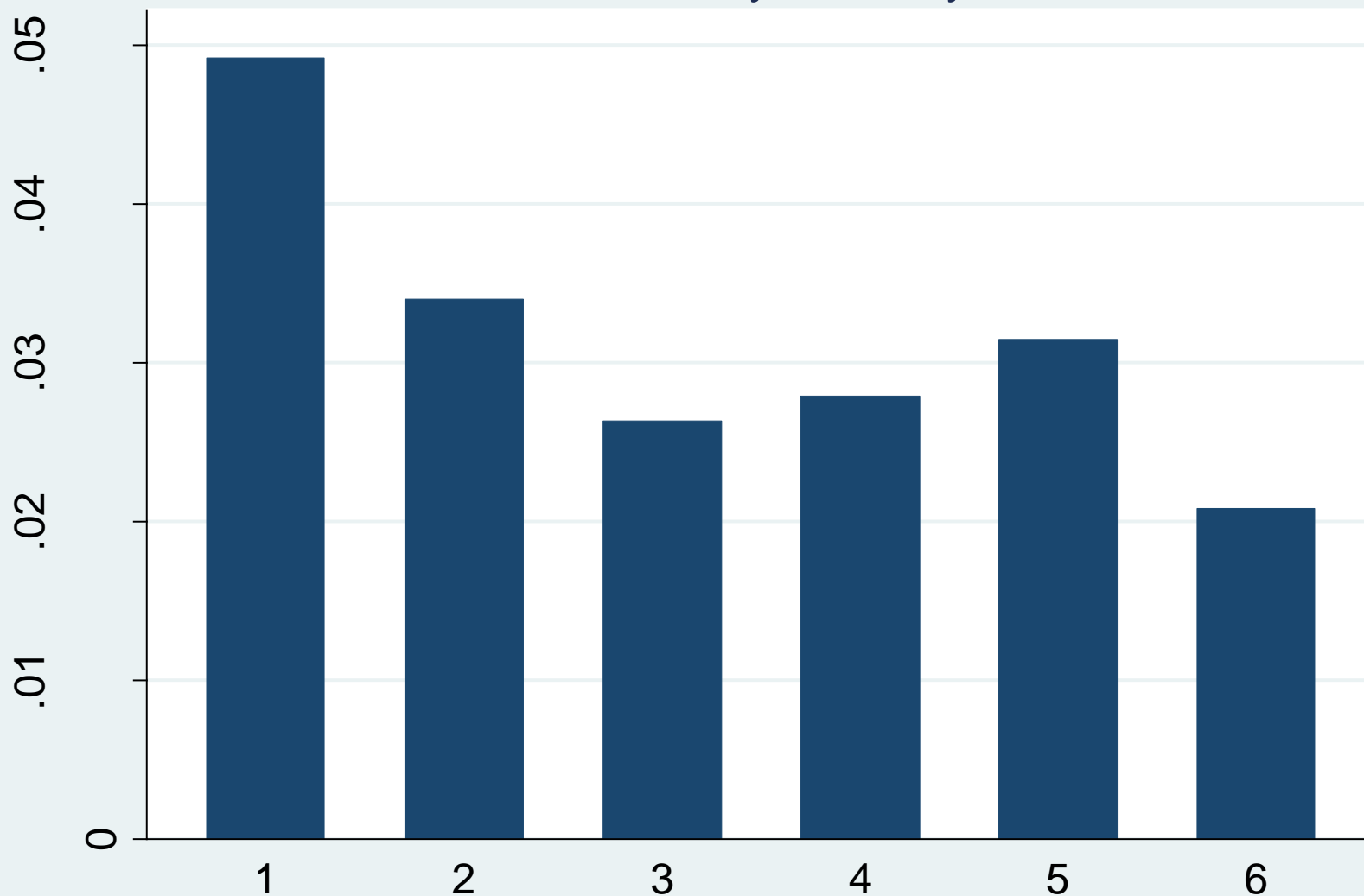


Screen shots of the RFPM being used to capture pre-meal (bottom left) and post-meal (bottom right) images

 **Plate Waste**



Plate Waste Fraction by # of Days in Field Trial





Implications

No instructions focused on food waste

- Yet plate waste declined with app use
- Even indirect efforts that make waste salient to consumers may induce reduction behavior
 - Will this translate to other household food waste sources?
- Currently working with Pennington to develop a more comprehensive app that also measures
 - Prep waste and purges of stored food
 - Amount, nutrient content and destination of waste
 - Food acquisition source and cost

Date Labels



What Do Date Labels Teach Consumers?

Broad-Lieb et al./NRDC [7] discussion of date labels

- “...poorly understood and surprisingly under-regulated... their meanings and timeframes are generally not defined in law...”
- “...dearth of rigorous policy analyses of how these labels affect consumers’ choices surrounding purchasing and discarding food products...”
- “...if milk is “handled properly,” it will still be safe to consume even after the expiration date passes...”

ReFED [8] rates standardizing food date labels as being one of the most promising avenues for reducing food waste

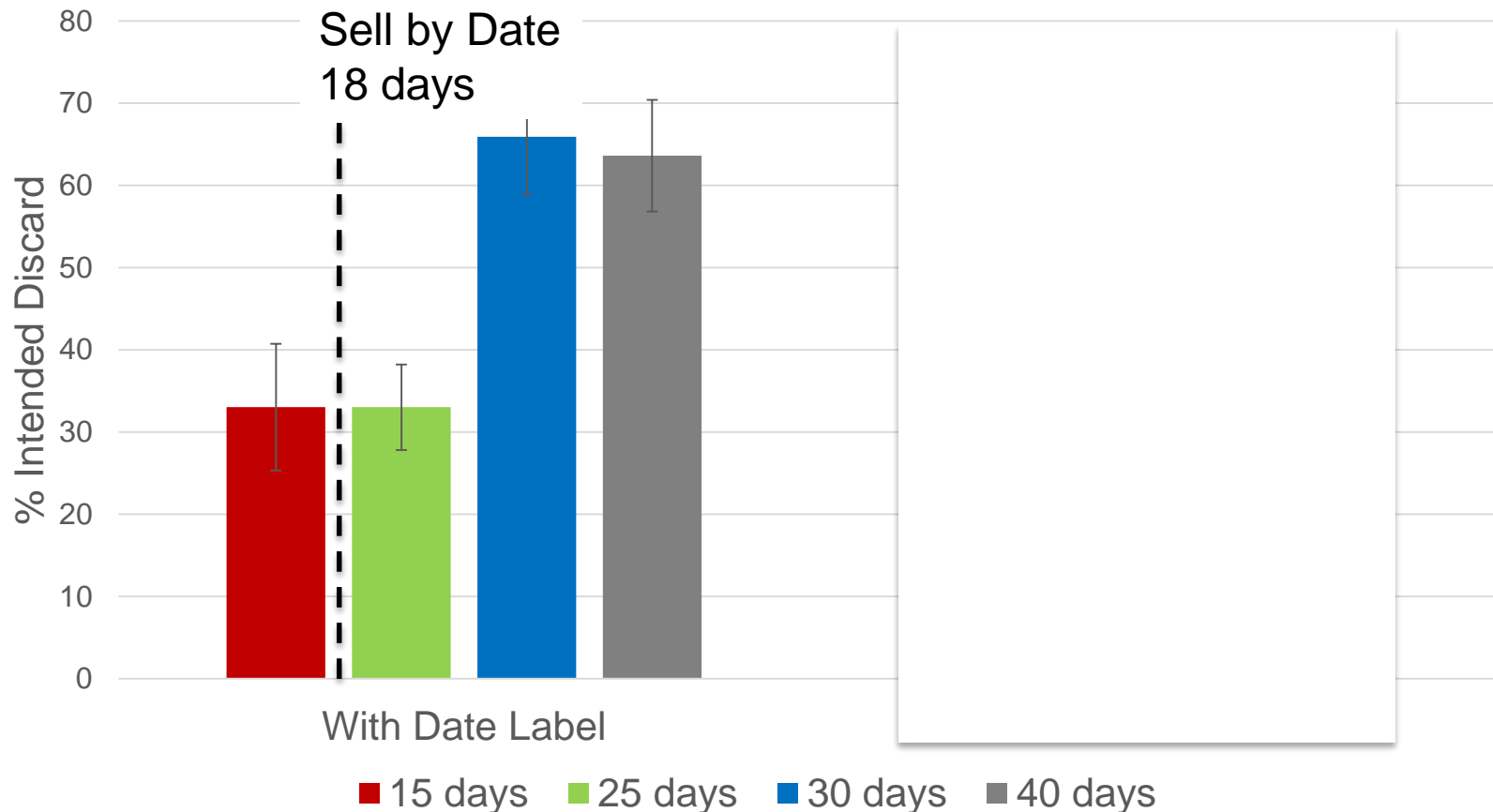


Ohio State Milk Date Labeling Study [9]

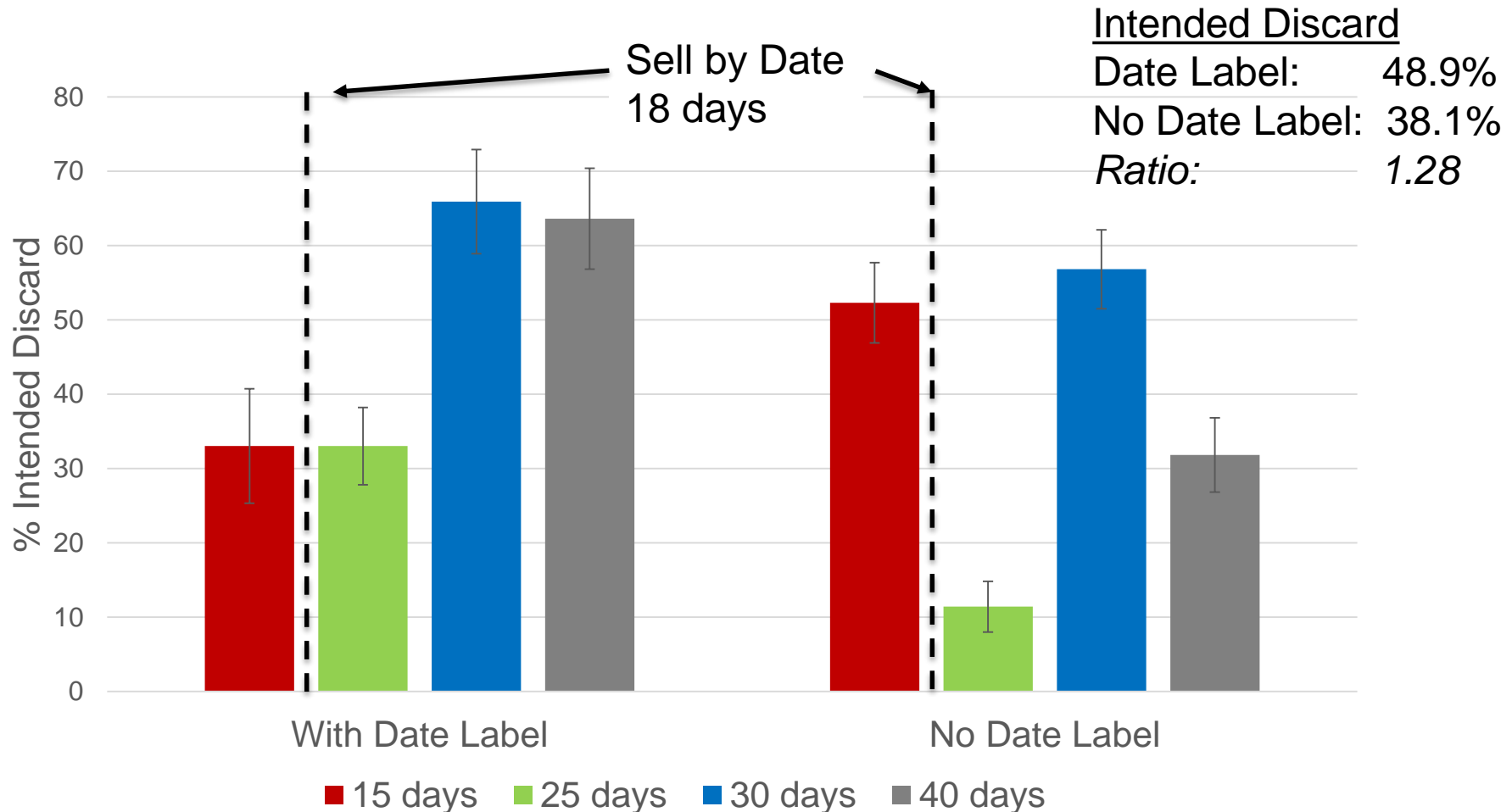
88 regular milk drinkers smelled 2 'flights' of ½ gal. containers

- Each flight featured 4 containers with whole milk
- One container each: 15, 25, 30 and 40 days post bottling
- All containers had been continuously stored at 4° C
- All containers opened 2 days prior & had 1/3 of milk removed
- One flight had a 'sell-by' date printed on each label that was 18 days post bottling
 - → 3 days prior, 7 days past, 12 days past and 22 days past date
- The other flight had no date label
- Order of flights and order of presentation within flights randomized
- Asked if they would keep/discard milk if it was in their own fridge
- Smelled inside of forearm between samples to re-orient smell

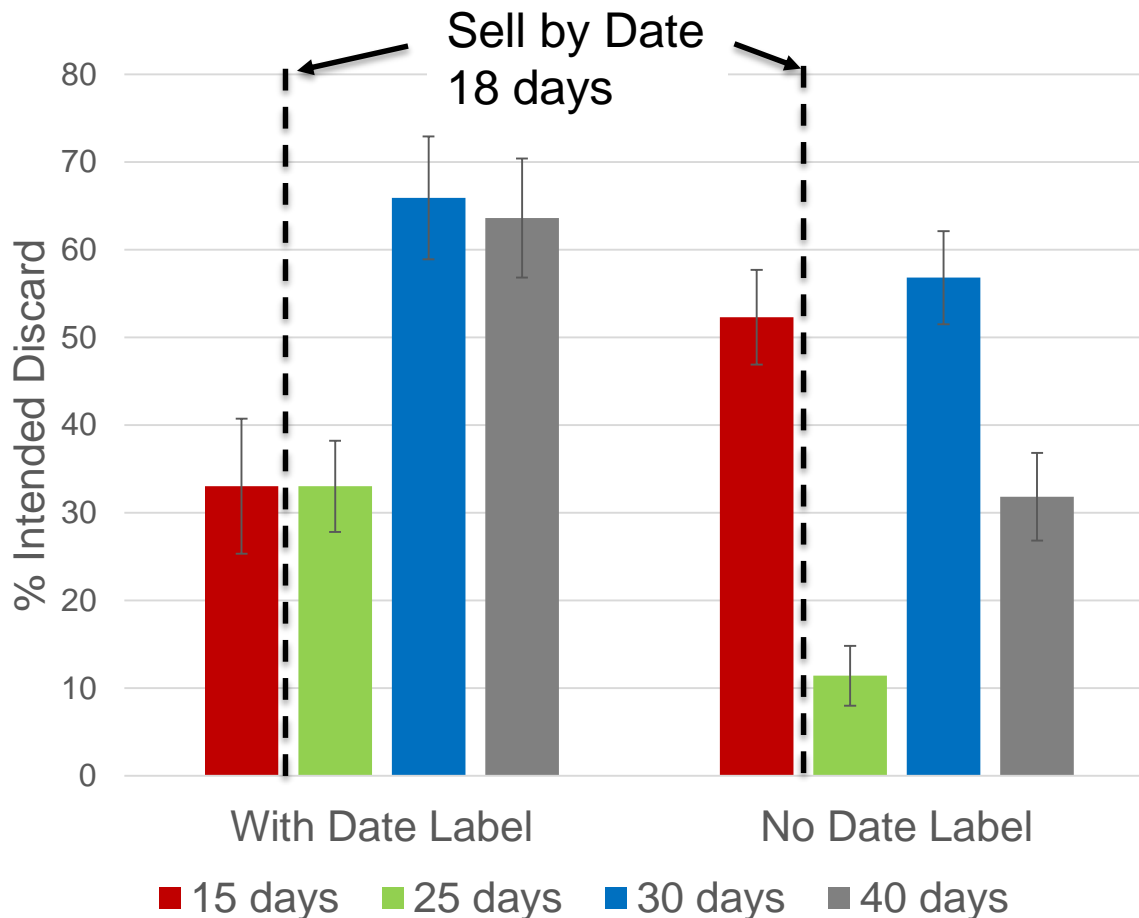
Intention to Discard Milk After Examining Bottle & Sniffing



Intention to Discard Milk After Examining Bottle & Sniffing



Intention to Discard Milk After Examining Bottle & Sniffing



Intended Discard

Post-date samples

With Date: 64.0%

No Date: 45.8%

Ratio: 1.40

In-date samples

With Date: 33.0%

No Date: 52.3%

Ratio: 0.63



Implications & Insights

Remove Date Labels from Milk?

- Intriguing potential, but problematic
 - Yes, could reduce discards of post-date milk
 - But, could also increase discards of in-date milk
- Consumer likely still wants label guidance
 - Need to help consumers trust their senses for items that lack food safety concerns
 - Currently we are testing 'smart' labels that display accumulated temperature abuse



Take Home Messages

Consumers can potentially learn to waste less

- Avoid mixed messages and focus on consumer action to reduce waste
- Changing eating setting (no trays, smaller portions) can alter waste and eating habits
- Apps or other interventions that increase attention to food handling and intake decisions may help draw attention to plate waste and lead to reductions
- Reforming date labels for milk will require additional innovation and educational effort but could help consumers discard less milk



Ohio State Food Waste Collaborative



Genesis & Mission

Genesis

A group of faculty, students, staff and community partners with common interests in addressing food waste joined to develop and submit a seed grant to the Initiative for Food and Agricultural Transformation (InFACT) & the OSU's Sustainability Fund with matching funds from my department (AEDE).

The core group has been meeting since Dec. 2015

Mission

To promote the reduction and redirection of food waste as an integral part of a healthy and sustainable food system.



Leadership Team

Faculty (3)

Administrative Staff (1 - Tony Gillund)

Students (2 plus an undergraduate club)

External

- Ohio EPA

- Private Sector

- Pennington Biomedical/LSU

Staffing (1 admin, 2 special projects, all part time)



Activities

Research

- Consumer Behavior, Economic Analyses, Supply Chain
- Articles, Presentations, Grants, App Development

Outreach, Education & Network Facilitation

- Annual Conference and Webinar
- FAQ Project
- Newsletter and Informational Presentations
- Media Engagement

Project Consultations & Evaluations

- Campus
- Community

Roe - CURC

Campus Projects & Consults

Residence Hall Composting Pilot – Spring '17

Scott, Blackburn & Haverfield Halls

Student led & organized

Student life + Housekeeping buy-in

Collaborative paid for student hours & materials

Facilities provided vehicle to transport to farm

Pilot yielded 392 lbs. total FW + compostables

If results replicated in all residence halls:

- Could yield ~ 13 tons/AY
- Or about 4% of current FW diversion total

Roe - CURC





Campus Projects & Consults

Student Business Start Up Support

- OSU student duo (1 @ Newark, 1 @ Columbus)
- Sought Collaborative advice for developing business concept
 - Online platform for matching residents seeking curbside FW pick up and FW recyclers
- FWC members provided general advice, facilitated networking
- Hired students to develop background research related to the food recycling sector and related business opportunities
- Students have developed a platform prototype
- Verbal commitment from a Cincinnati-area municipality to use service next summer

Roe - CURC



Community Projects & Consults

FWC members have consulted with more than 30 individuals and organizations from around Ohio and the Country to provide

- Information
- Feedback
- Expertise
- Presentations

Central Ohio

- Franklin Park Conservatory, Land Grant Brewery, Region Planning Commission, Hunger Relief Agencies, K-12 Schools

National

- USDA Expert Panel on National Food Waste Estimates, USDA's Further with Food website, National Geographic, FoodTank, EPA, Nestle Foods



Campus Food Waste Inventory to Support Planning

Will document

- Current entry points and disposition channels (consumed vs. landfill vs. compost vs. other) for food and related organic and compostable materials on campus
- Current projects and technologies involving redirection of food waste and related materials from landfill

With this information in hand, bring key parties together to develop a strategic plan to

- Reduce campus food waste
- Divert remaining food waste and related organic and compostable materials from landfills
- Address related/overlapping campus sustainability goals

Discussions begun:

- Dining Services (monitoring, learning from and engaging staff)
- Facilities, Operations & Development
- Medical Center
- Need to include Athletics and other food handling entities

Research Partners

Pennington Biomedical Research Center

Corby K. Martin, John W. Apolzan,
H. Raymond Allen



Ohio State University

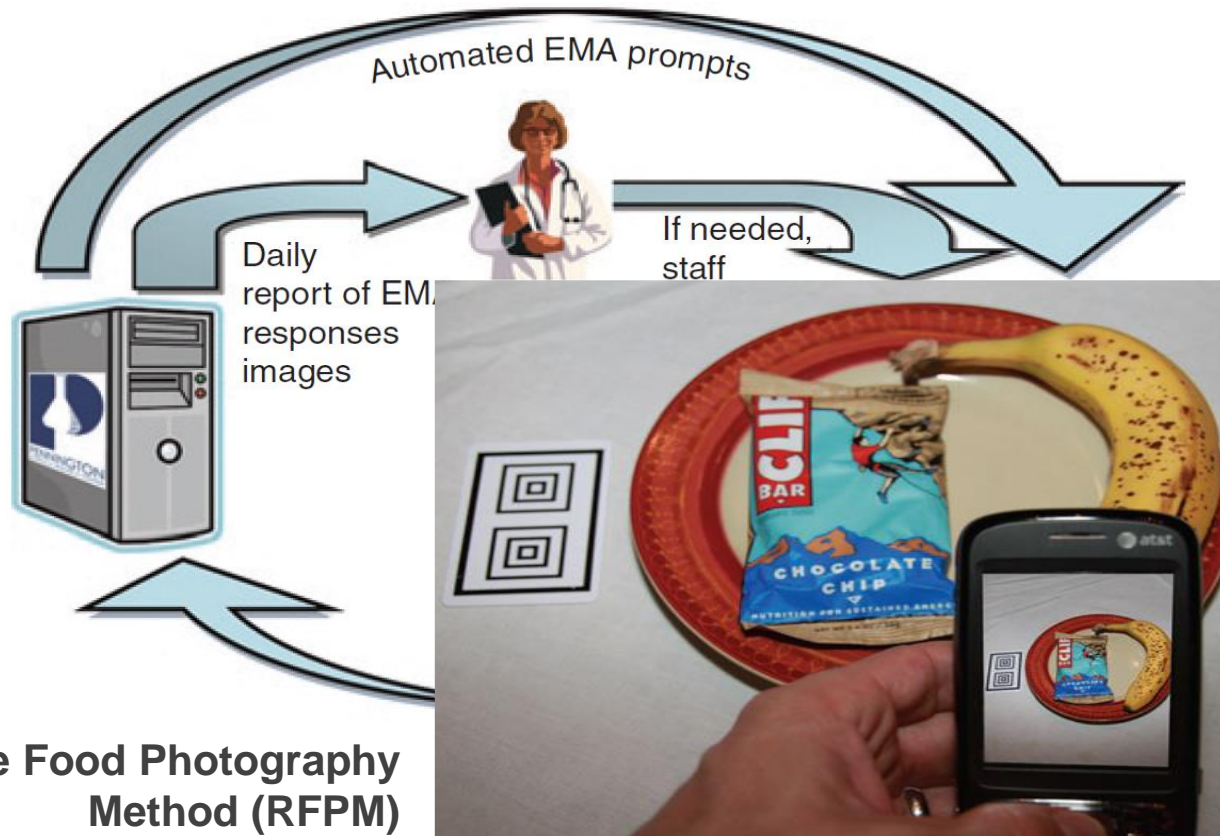
Danyi Qi, Dennis Heldman
David Phinney, Chris Simons

References

- [1] Gustavsson J, Cederberg C, Sonesson U, Van Otterdijk R, Meybeck A. Food losses and food waste: extent, causes and prevention. FAO, Rome. 2011.
- [2] Qi, D., and B.E. Roe. 2016. "Household Food Waste: Multivariate Regression and Principal Components Analyses of Awareness and Attitudes among US Consumers." PLOS ONE 11:e0159250
- [3] Neff, R.A., M.L. Spiker, and P.L. Truant. 2015. "Wasted Food: US Consumers' Reported Awareness, Attitudes, and Behaviors." PLOS ONE 10:e0127881
- [4] Whitehair KJ, Shanklin CW, Brannon LA. Written messages improve edible food waste behaviors in a university dining facility. Journal of the Academy of Nutrition and Dietetics. 2013 Jan 31;113(1):63-9
- [5] Ellison, B., Nehrling, E. W., Nikolaus, C. J., & Duff, B. R. (2017). Evaluation of a Food Waste Reduction Campaign in a University Dining Hall. Journal of Nutrition Education and Behavior, 49(7), S9-S10.
- [6] Qi D, Roe BE. Foodservice composting crowds out consumer food waste reduction behavior in a dining experiment, American Journal of Agricultural Economics forthcoming 2017.
- [7] Leib, E. B., Gunders, D., Ferro, J., Nielsen, A., Nosek, G., & Qu, J. (2013). The dating game: How confusing food date labels lead to food waste in America. National Resources Defense Council.
- [8] Rethink Food Waste Through Economics and Data, 2016. A Roadmap to Reduce U.S. Food Waste by 20 Percent. Available online at http://www.refed.com/downloads/ReFED_Report_2016.pdf (accessed November 4, 2016)
- [9] Roe, BE, JW Apolzan, D Qi, HR Allen, CK Martin. 2017. Plate waste of adults in the United States measured in free-living conditions, unpublished manuscript.
- [10] Qi et al. 2017, unpublished
- [11] Martin CK, Correa JB, Han H, et al. Validity of the Remote Food Photography Method (RFPM) for estimating energy and nutrient intake in near real-time. Obesity. 2012;20(4):891-899



Questions?



Remote Food Photography
Method (RFPM)

