Waste Not Want Not: Examining the Economic/Financial Dimensions Associated with Plate Waste of Vegetables in Elementary School Lunches

INTRODUCTION

On January 26, 2012, the Food and Nutrition Service (FNS), United States Department of Agriculture (USDA) issued final regulations to implement the alignment of the School Breakfast Program (SBP) and National School Lunch Program (NSLP) with the most recent Dietary Guidelines for Americans (*Federal Register*, 2012). The proposed school meal regulations originally included a limitation on starchy vegetables, but this limitation was later removed. Nevertheless, the proposal to limit starchy vegetables in school meals raised questions concerning vegetable intake or plate waste as well as costs and nutritional values of school meals.

The topic is important from several perspectives. Evidence shows that diets emphasizing vegetables, fruits, whole grains, and low-fat dairy products are not only beneficial for health but also help prevent obesity (USDA and U.S. Department of Health and Human Services, 2010). According to the School Nutrition Dietary Assessment Study-III, a nationally representative survey of students and schools conducted in 2005, starchy vegetables, including French fries, other white potatoes, and corn, were the most regularly offered vegetables in elementary, middle, and high schools (on 56 percent of menus French fries and similar potato products were among the top 10 food sources and contributed to carbohydrate, vitamin E, vitamin B_6, magnesium, potassium and dietary fiber intake (USDA, FNS, 2007). Intakes of potassium and perhaps dietary fiber are likely to be negatively impacted by limiting the inclusion of starchy vegetables in child nutrition programs. Limiting starchy vegetables in school meals also will likely have economic ramifications as the prices of alternative vegetables relative to the prices of potatoes may have increased. Thus, potentially the substitution away from potatoes to alternative vegetables may pose significant economic stress on families, community-based service agencies and school districts.

Monsivais, Aggarwai, and Drewnowski (2011) examined the economic impact of meeting the 2010 Federal Dietary Guidelines for adults. They found that increasing consumption of potassium, the most expensive of the four nutrients of concern (potassium, dietary fiber, vitamin D, and calcium), would add $380 per year to the average food costs of consumers. Hence, changes in diets will require additional guidance for consumers, especially those with little budget flexibility. Nutrition policies at the federal and state levels need to consider the availability and the cost of more healthful foods, in addition to consumers' abilities to act upon the guidance provided by government.

In a report to Congress, Buzby and Guthrie (2002) estimated that food waste costs might approach $600 million. However, the authors had access to only aggregate school meal costs and were unable to examine costs of waste specific to vegetables and entrees. Cohen et al (2013) examined nutrient losses and economic costs associated with school meal waste among middle school students (grades 6-8) in Boston public schools. Analyses were conducted in 2010-2011. For vegetables, Cohen et al (2013) estimated the average cost per vegetable item to be $0.21, the average percentage waste for vegetables to be 73% and for entrees to be 18%, and the average waste cost per student to be $0.09 for vegetables and $0.10 for entrees. Our research permits this examination indigenous to specific types of vegetables for elementary schools in two distinct independent school districts in Texas.

In this light, a study was conducted to investigate the FNS proposal to limit starchy vegetables in school meals, particularly white potatoes. –Our study centered attention on selected schools located in two school districts in Texas, hereafter known as Independent School District 1(ISD 1) located in a medium-sized urban area in southeastern Texas and Independent School District 2 (ISD 2) located in a large urban area of central Texas.. Neither the school districts nor the selected schools is reported to protect confidentiality. The principal objectives are twofold: (1) to measure plate waste for vegetables from school lunches over the period April 2012 to January 2013; and (2) to document the cost associated with plate waste of various types of vegetables in school lunches.

MATERIALS AND METHODS

With the assistance and approval of food and nutrition service administrators from both districts, three schools in ISD 1 were matched to three schools in ISD 2 based on the percentage of students receiving free or reduced-price school meals and comparable numbers of student enrollment (Table 1). The school in ISD 2 with the largest percentage of students eligible for free- and reduced-price lunches had the largest population of non-Hispanic black (NHB) students; the school in ISD 1 with the largest percentage of students eligible for free- and reduced-price lunches had a predominantly Hispanic (HIS) population. Schools with the largest percentage of students eligible for free-and reduced-price lunches had the highest percentages of NHB and HIS students. Children of Asian and Native American descent or other races represented a very small percentage of the school populations in both school districts.

[Place Table 1 Approximately Here]

All school principals, teachers, and food service and custodial staff were notified of the study objectives, the dates of collection, and the plate waste study protocol. Teachers explained the protocol to their students before lunch on days of collection and instructed students that they were not obligated to participate. No child refused to participate at any school. Various undergraduate and graduate field workers (research assistants), various community volunteers, and project coordinators were involved in the data collection.

Study participants were kindergarten through fifth grade students who selected at least one vegetable as part of the NSLP. Lunch periods were scheduled by grade (K-5), and the amount of time allocated for lunch was thirty minutes. Menu items and serving sizes were consistent throughout all lunch periods.

Student lunch trays were included in the study if the student: (1) participated in the NSLP on the day of the data collection; (2) chose at least one vegetable serving and one entrée serving that was sampled on the day of collection; and (3) returned their tray with the data collection tag to a field worker after the lunch period. Student lunch trays were excluded from the study if at least one of the following criteria was met: (1) the student participated in the NSLP, but a sampled entrée or vegetable was not chosen; (2) the student selected an extra serving of the sampled entree, regardless of vegetable selection; (3) the student had special dietary needs and he/she was unable to consume at least one of the sampled entrée choices for the daily meal; (4) the student lost the data collection tag placed on the tray before exiting the lunch line; or (5) field workers were unable to separate one or more sampled food items for plate waste collection. No connection or identification between the student and their individual lunch tray or plate waste was made by the researchers. No other school-wide nutrition intervention program was implemented during the study.

Plate waste collections were conducted in three phases. The analysis for phase 1 of the study rested on 10 combined visits to the elementary schools in ISD 1 in the months of April and May 2012, before implementation of the Nutrition Standards for School Meals Newman, 2013; Cohen et al (2014), and USDA, 2015)The analysis for phase 2 of the study consisted of a combined 20 visits to the same schools as in phase 1 in ISD 1 in the months of October and November 2012. Altogether for ISD 1, the sample for analysis consisted of the 449 viable observations. Finally, the analysis for phase 3 of the study centered on a combined 30 visits to the elementary schools in ISD 2 in the months of November and December, 2012 and January 2013. This sample for analysis consisted of 434 viable observations for ISD 2. Combined across school districts, a total of 60 days of plate waste collection of lunchtime meals were sampled. All lunch periods for both districts were scheduled by grade (K-5) and the amount of time allocation for lunch was 30 minutes among all schools. Importantly, plate waste measurements were made for various entrée/vegetable combinations. As such, recognition of the possibility that plate waste of entrees may affect plate waste of vegetable was taken into account. With six lunch periods then, we have multiple observations of plate waste for each elementary school per visit.

The respective vegetables in school lunches fell into three categories: (1) white potatoes; (2) other starchy vegetables; and (3) non-starchy vegetables. The list of vegetables during the three respective phases of the project is given in Table 2. Although data also were collected for entrees, attention is centered only on vegetables due to space limitations. The information concerning entrees is available from the authors upon request. Further disaggregation of this set of vegetables was as follows: (1) dark green vegetables; (2) red/orange vegetables; (3) beans; (4) starchy vegetables excluding white potatoes; (5) white potatoes; (6) “other” vegetables; and (7) “additional” vegetables. This disaggregation is consistent with the extant literature (Newman, 2013). Dark green vegetables were composed of steamed broccoli; garden salad; broccoli florets; spinach salad; broccoli salad; turnip greens; and spinach (cooked). Beans included baked beans; pinto beans; ranch-style beans; and pork and beans. Red/orange vegetables consisted of sweet potato fries; glazed carrots; sweet potatoes; baby carrots (cooked); veggie dippers; raw sweet potato sticks; and raw baby carrots and celery. White potatoes comprised potato wedges; mashed potatoes; French fries; and tater tots. Other starchy vegetables referred to green peas; corn on the cob; and whole kernel corn. “Other” vegetables were green beans and whole dill pickles. Finally “additional” vegetables included tomato and cucumber salad; Italian vegetables; Asian vegetables; mixed Normandy vegetables; and Sonoma vegetables. The “additional” vegetable subgroup identified vegetables that fell into two or more subgroups.

[Place Table 2 Approximately Here]

A registered dietitian selected the sampled vegetables to ensure variety among the subgroups. However, the list of vegetables was restricted to the school lunch calendar and menu cycle. Both school district food and nutrition services administrators approved the selected lunchtime meals and notified the participating schools that the research team would be collecting plate waste Each school had complete control over when and what was served to students; researchers had no control over menus or any competitive foods offered before or during the lunch periods.

Plate waste was defined as the quantity of edible portions of food served that students discarded. Plate waste has been assessed by a variety of methods and expressed in terms of proportion of food served that is uneaten, amount of calories, uneaten, or amount of nutrients uneaten. Plate waste in school lunches traditionally has been measured using several methods, including physical measurements such as weighing discarded food (Comstock et al, 1981; Chu et al, 2011, and Glueson, 1994) ; visual estimates made by trained observers (Martin et al, 2007; Parent et al, 2012; and Williamson et al, 2003); recalls made by children (Buzby and Guthrie, 2002), and combinations of methods that include weighing discarded food, photographing and analyzing contents of full and discarded plates (Adams et al, 2005; Marlette, Templeton, and Panemangalore, 2005).

Accurate measurement of school children's food consumption is challenging. Whereas direct observations are considered preferable to self-reporting, the most precise method for dietary assessment is measuring pre- and post-weights of participant food plate waste. This method has been used recently to assess school lunch waste among middle school students in Massachusetts (Cohen et al, 2013). For this reason, our research approach utilized a comparison of pre- and post-consumption plate weights as a basis for plate waste estimation. Though labor intensive and time-consuming, this approach was selected as the method of choice to yield results that minimizes inter-individual error in sample handling and data recording, including the recording of food pre-weights. Simply put, the study design was modeled after the aggregate plate waste method of Chu *et al* (2011) and Cohen et al, 2013).

For each data collection day, five to ten servings of each sampled entrée and vegetable on "test trays" were obtained. The "test trays" were used to gather pre-weights for each food item in which plate waste was collected in order to obtain an average weight in grams (g). The key measure was the percentage of plate waste of the respective entrée and vegetable items. To arrive at this measure, the total amount of plate waste was obtained and this total was divided by the number of children who chose the entrée or vegetable in question. The ratio provided the plate waste per child. Finally the percentage of plate waste was calculated by dividing this ratio by the pre-weight of the entrée or vegetable item, also measured in grams. Hence, plate waste was measured on a standardized basis (percentage). It is recognized that with the use of this method of calculating plate waste measurement some level of error may be introduced. Possible sources of measurement error included: (1) recording errors of plate waste; (2) variability in pre-weight measurements; and (3) recording error of the number of students selecting various entrée/vegetable school lunch combinations. In preparation for data collection days, research assistants were trained to minimize inter-individual error in sample handling and recording of vegetable pre-weights and plate waste.

Research assistants affixed coded data tags to eligible student lunch trays after food and beverage selection in the cafeteria line. Data tags identified the vegetables selected, as well as student gender and grade. Students received a small incentive, such as a sticker, pencil, or eraser if their tray and data tag were returned after the lunch period. Plate waste stations were located in the cafeteria to collect the sampled vegetables. Plate waste was collected from each eligible tray, while all other tray contents were discarded. The method was repeated for each lunch period to determine plate waste differences by grade/lunch period. Three trial runs were conducted to familiarize each research assistant with the movement of students through the cafeteria, the mechanics of labeling trays, obtaining samples, and collecting and weighing plate waste.

All plate waste was separated in a labeled and dedicated trash container lined with a plastic bag for each specific item at each given lunch period. Aggregated plate waste for each item was recorded and divided by the number of children that selected the item. In addition, the waste was segregated according to grade level within each of the participating schools. In sum, aggregate plate waste was measured for each vegetable by elementary school and by grade level using a Denver Instrument food balance with maximum capacity of 5,000 grams (g). Percentage plate waste was calculated as follows:

% plate waste = [(aggregate vegetable plate waste for each vegetable/total number of children selecting the vegetable)/weight of the mean serving size for each vegetable] * 100. The calculation of plate waste as a percentage allows for comparisons among types of vegetables as well as for comparisons by elementary school and by grade.

The respective school districts provided the following public information essential for our analysis: (1) district food costs (excluding labor costs) per menu item and per-serving; (2) school lunch production sheets for the days of plate waste collection that include the number of servings per item served and nutrient information; and (3) meal counts (free, reduced, paid, and "other" meals served on days of plate waste collection. Additionally, information was recorded as to the particular school, grade, the type of entrée, number of students consuming particular entrées, type of vegetable, number of students consuming particular vegetables, the entrée pre-weight, the vegetable pre-weight, the entrée plate waste in terms of percent, the vegetable plate waste in terms of percent, the total number of students (male and female) who bought/received a school lunch, the total number of lunches served, the number of free lunches served, the number of reduced lunches served, and the number of paid lunches.

Plate waste measurements were collected for each entrée/vegetable combination. With six lunch periods then (K-5), multiple observations of plate waste for each elementary school per visit were recorded. With three schools located in ISD 1 and 10 visits per school, and with three schools located in ISD 2 and 10 visits per school, more than a sufficient number of observations for statistical analysis were available.

EMPIRICAL RESULTS

Plate Waste

Two separate analyses were provided: (1) pooling ISD 1 phase 1 (April 2012 and May 2012) and ISD 1 phase 2 (October 2012 and November 2012); and (2) ISD 2 phase 3 (November 2012, December 2012, and January 2013). The menus for the ISD 1 phase 2 period and for the ISD 2 phase 3 period were compliant with the new 2012 nutrition standards for school meals, that is, the new USDA rules. Consequently, we are in position to compare empirical results not only across school districts but across time periods with different nutrition standards for school meals.

A breakdown of the average plate waste for vegetables in ISD 1 and in ISD 2 is reported in Tables 3 and 4. On average, plate waste for vegetables (55.9% in ISD 1 and 48.5% in ISD 2) was greater than plate waste for entrées (29.1% in ISD 1 and 32.9% in ISD 2). Our figures for plate waste for all vegetables were lower than that estimated by Cohen et al (2013) at 73%. However, our figures for plate waste for entrees were higher than that estimated by Cohen et al (2013) at 18%. Plate waste for vegetables varied by type of vegetable, ranging from 20.7% (tater tots) to 91.4% (sweet potato fries) in ISD 1 and from 29.4% (French fries) to 81.5% (Asian vegetables) in ISD 2. Plate waste for white potatoes (35.2% in ISD 1 and 42.6% in ISD 2) was less than the plate waste for other vegetable subgroups. As shown in Tables 3 and 4, plate waste for white potatoes varied by product form. In particular, plate waste for French fries and tater tots were lower in comparison to plate waste for potato wedges and mashed potatoes in ISD 1, and plate waste for French fries was lower in comparison to plate waste for mashed potatoes in ISD 2.

[Place Tables 3 and 4 Approximately Here]

Based on statistical tests of equality of means and medians, statistically significant differences were evident for vegetable plate waste by vegetable type (individually as well as for vegetable subgroups). The Welch F-test was chosen to test the equality of means due to the fact that this statistic takes into account unequal variances. The non-parametric Kruskal-Wallis test was chosen to test the equality of medians. The software package EVIEWS 8.0 was employed to calculate the mean and median measurements and to carry out the respective statistical tests[19]. The level of significance chosen for all statistical tests was 0.05.

In Tables 5 and 6, mean and median vegetable plate waste measurements are reported by grade (K-5) and by school for ISD 1 and for ISD 2. In ISD 1, significant differences were evident in mean and median vegetable plate waste by grade but not by elementary schools. In ISD 1, greater mean and median vegetable plate waster was evident in the Fall (phase 2) relative to the Spring (phase 1). Hence, after USDA issued new, more stringent school meal nutrition standards, vegetable plate was significantly higher relative to the period before these new standards were instituted. In ISD 2, significant differences were evident in mean and median vegetable plate waste by school but not by grade. In ISD 2, plate waste for vegetables was higher for schools receiving higher percentages of free lunches. The same result was evident in ISD 1 albeit the differences in vegetable plate waste were not significant.

[Place Tables 5 and 6 Approximately Here]

Increasing vegetable consumption of children has been a challenge for decades. Twenty years ago, Reger et al (1996) showed vegetable plate waste, excluding potatoes, was 54% among children in a low-socio-economic elementary school in southern Louisiana; potato plate waste was 37%. Our study revealed similar results, so little has changed in acceptance of vegetables by elementary schools students over two decades.

Our study, like others, shows that vegetable waste remains a notable problem for schools, despite new USDA regulations requiring schools to offer a greater variety of vegetables to students. Plate waste of most vegetables was high and similar to that shown in other studies. High vegetable plate waste was observed by Cohen et al. (2013) who examined the effect of the new USDA regulations pre- and post-implementation in eight urban, low-income elementary schools in Massachusetts. There was no change in percentage of students selecting vegetables with about 68% of students choosing a vegetable pre- and post-implementation. Among the children who did choose a vegetable, consumption increased from 0.13 to 0.31 cups/day. On the other hand, significantly more students selected fruit post-implementation rather than a vegetable, but the amount of fruit consumed (0.42 cups/day waste did not change).

Byker et al. (2014) found that preschool and kindergarten students wasted more than half of the vegetables served following implementation of the new school lunch guidelines. Of 140 cups of vegetables served, 93 cups were wasted. In a study of two Vermont elementary schools, vegetable consumption was less than half that of fruit (Taylor, Yon, and Johnson). If we assume that a typical serving of fruit or vegetables weighs about 80 grams (g), these researchers found almost half of the vegetables were wasted by students in third to fifth grade. Ishdorj et al. (2015) noted a relationship between entrées and vegetables suggesting that greater consumption of certain entrées was associated with greater waste of certain vegetables. Further, understanding the dynamics of food pairings and providing desirable entrée and vegetable pairings may help reduce waste from school lunches.

Another study examined whether a salad bar would increase fruit and vegetable consumption over pre-proportioned servings (Adams, et al., 2005). A study of four low-income elementary schools in San Diego county with a predominately Latino/Hispanic population found that a self-serve salad bar did not increase in children's consumption of fruit and vegetables, compared with pre-proportioned servings.

Gase et al (2014) showed substantial waste of fruit and vegetables among middle school-aged children in four schools in the Los Angeles Unified School District. Participating schools had more than three-fourths of the children eligible for free or reduced price lunches. The assessment measured fruit, vegetable and milk wasted. At all schools, vegetables had the highest waste. Salads were prepared least often and were wasted the most. In one school, five salads were prepared and none were eaten. Among Latino and African-American students, 43% and 39%, respectively, did not take a vegetable. Among those who did select a vegetable, 31% wasted all of it.

There is some thinking that as children get older, they will learn to like vegetables. Nicklas et al (2013) examined plate waste at lunch and dinner of pre-school children enrolled in Head Start. Among 3- to 5-year old children enrolled in Head Start, plate waste for vegetables at lunch was 61%. Vegetable consumption was about one-third (36%) of recommended levels. Because studies of older children show similar patterns of vegetable plate waste, it does not appear that acceptance of vegetables improves with age. Our study revealed mixed results. Statistically significant differences in vegetable plate waste between kindergarteners and fifth-graders were evident in ISD 1 but not in ISD 2.

Lost or Wasted Dollars

We turn attention to the financial/economic ramifications associated with plate waste for vegetables. Specifically, in this study, interest centers on lost or wasted dollars per serving of vegetables, the percentage of dollars lost or wasted, and the amount of lost dollars for vegetables. As exhibited in Table 7, the average waste cost per serving on all vegetables was slightly more than 7 cents, and as exhibited in Table 8, the average waste cost per serving was slightly more than 5 cents per serving. In ISD 1 (see Table 7) the average waste cost per serving of vegetables ranged from $0.0262 (tater tots) to $0.2512 (sweet potatoes fries). In ISD 2 (see Table 8), the average waste cost per serving ranged from $0.0246 (mashed potatoes) to $0.2436 (sweet potatoes). The percentage of dollars wasted or lost varied from 22.1% (tater tots) to 90.4% (sweet potato fries) for ISD 1. The percentage of dollars wasted varied from 29.5% (French fries) to 81.2% (broccoli salad) for ISD 2. Bottom line, differences in the lost or wasted dollars were evident across the respective vegetables.

As exhibited in Table 7 and 8, for the respective vegetable subgroups across the two school districts, average waste costs per serving were lower for ISD 2 in comparison to ISD 1, except for red/orange vegetables. Across all vegetable types, average waste cost per serving for ISD 2 was $0.0533, lower in comparison to the corresponding measure for ISD 1 at $0.0739. Perhaps the primary reason for the difference by district may be attributed to the mix of the individual vegetables served. For each school district, white potatoes had the lowest average waste cost per serving among the respective vegetable subgroups. Another major finding relates to the magnitude of the lost dollars on the order of 44% to 56% for the aggregate vegetable category for the respective elementary schools from the two school districts indigenous to the study. Actual dollars lost due to vegetable plate waste amounted to $281.11 in ISD 2 and to

$547.81 in ISD 1 over the 10 visits to each elementary school within the two districts. That said, actual dollars lost due to vegetable plate waste averaged $9.37 per day per school in ISD 2 and $18.26 per day per school in ISD 1. If we assume a 180-day school calendar, then actual dollars lost attribute to vegetable plate waste alone amounted to $1,687 per school in ISD 2 and $3,287 per school in ISD 1. Consequently, economic/financial repercussions were evident from vegetable plate waste per school. Depending on the number of schools per ISD as well as the menus served each day, the costs associated with vegetable plate waste are non-trivial.

[Place Tables 7 and 8 Approximately Here]

DISCUSSION

Unlike any others in the extant literature, this study provides plate waste measurements for various types of vegetables collected from elementary schools from two independent districts of Texas. In each school district, roughly one of every two school lunches served was sampled. As such, our study is representative of the student population. As measured by the median number of students who selected various vegetables, white potatoes in various forms were the most popular vegetables.

Results from our study suggested that there were notable economic/financial consequences to limiting starchy vegetables, particularly white potatoes, as a part of school meals. The variation in plate waste by vegetable type was considerable. Plate waste was lowest for potatoes in comparison with plate waste for other starchy vegetables and with plate waste for non-starchy vegetables. Plate waste ranged from 21% to 91% depending on vegetable type in selected elementary schools from two school districts. The lowest plate waste was observed with white potatoes (especially tater tots, French fries, and mashed potatoes); the highest waste was observed with Asian vegetables, broccoli salad, green peas, corn on the cob, mixed Normandy vegetables, Sonoma vegetables, and sweet potato fries. White potatoes in all forms were a “win-win” for school meals;that is, they were relatively inexpensive in comparison to the cost of other vegetables, and they were wasted the least, resulting in cost savings. When vegetables are wasted, schools are losing money; we found that 44% to 56% of the total cost of vegetable preparation was wasted. On average, the lost dollars per serving of potatoes was less than 4 cents compared to 6 cents to 10 cents for beans, 7 cents to 9 cents for dark green vegetables, and 8 cents to 13 cents for red/orange vegetables. On average, the percentage of lost dollars for white potatoes was 36% to 39%, compared to 31% to 60% for beans, 53% to 55% for dark green vegetables, and 58% to 69% for red/orange vegetables.

LIMITATIONS

Only two Texas schools participated in the study, therefore, the results may not apply to other regions of the state as well as to other regions of the country. The race/ethnicity of the student populations from the middle- and low-income schools between the two school districts differed in the percentage of NHB and HIS students. Researchers did not control food menu decisions, select or otherwise influence the food choices of children participating on collection days. The schools had total control over the menus and foods served as well as any competitive foods served. Purchase of treats, such as ice cream and popsicles, prior to lunch may have reduced hunger leading to decreased consumption of vegetables by older children.

IMPLICATIONS FOR RESEARCH AND PRACTICE

In 2010, Congress passed the Healthy Hunger-Free Kids Act with a goal to ensure that children receive nutritious meals at school. This Act instituted many changes to the NSLP, and in concert with these changes, USDA issued new more stringent school meal nutrition standards. Dietitians, nutritionists, and meal planners from the respective elementary schools know what food items the students are choosing, but they do not necessarily know the specific consumption and waste behaviors. School food providers are concerned that students may not accept healthier foods.[7] Information on consumption and waste of various foods at school meals is central to our research project, and underlines the importance of plate waste data collection. Counter to *a priori* expectations, plate waste for vegetables was higher for elementary schools receiving higher percentages of free lunch. Our research described not only the vegetables that were wasted the most but also the implications associated with economic cost. In any research scenario, where it is found that food items are being wasted, particularly those designated as healthy, strategies must be developed and implemented to increase consumption. These strategies may include conducting taste tests, providing nutrition education, and implementing health promotion interventions. Hanks, Just, and Wansink (2012) introduced the notion of *trigger foods*, defined as, for the purpose of our study, foods that either increase or decrease the selection of various vegetables.

Based on our empirical results, the consequences of limiting white potatoes and other starchy vegetables on school lunch menus, considering economic/financial dimensions were non-trivial. If white potato servings were limited in school lunches, we would expect a rise in vegetable plate waste and concomitantly, a rise in lost dollars associated with the preparation of vegetables. Ultimately, nutritional ramifications associated with this rise in vegetable plate waste attributed to limiting starchy vegetables, particularly white potatoes, also may occur. This information is useful to policy makers, food service professionals, and perhaps other Federal, State, or local program staff. Importantly, our research efforts have the potential not only to be conducted on a larger scale down the road but also to be implemented at relatively low cost. In essence, this work served as an initial undertaking designed to vet the merits of the FNS initiative. Future research should center on replications of this project in other geographical areas in Texas as well as other geographical regions outside the boundaries of Texas. Additionally, research centered on establishing factors linked to vegetable plate waste and the nutritional implications associated with plate waste are in order.

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Table 1. Sampled Elementary School Profile for Percentage Eligible for Free or Reduced-Price School Meals and Student Enrollment[a]

	Total Students	Percent receiving free lunch (%)	Percent receiving reduced-price lunch (%)	Race/Ethnicity		
				NHW[c] (%)	NHB[c] (%)	HIS[c] (%)
ISD 1						
School A[b]	763	91	4	3	20	76
School B[b]	566	65	6	28	35	34
School C[b]	550	28	3	69	10	20
ISD 2						
School D[b]	606	96	2	1	74	23
School E[b]	782	69	7	14	34	51
School C[b]	579	26	3	64	9	26

[a] Data available from www.texas.webschoolpro.com for the 2011-2012 academic school year.

[b] The actual names of the independent school districts (ISDs) and the names of the schools within each ISD were withheld to ensure confidentiality.

[c] Non-Hispanic white (NHW); non-Hispanic black (NHB) and Hispanic (HIS). Race/ethnicity categories do not add to 100 due to rounding and/or small percentages of children classified identified as Asian or Native American.

Table 2. The List of Vegetables During the Three Phases of the Project

ISD 1 Spring Plate Waste Collection (Phase 1)	ISD 1 Fall Plate Waste Collection (Phase 2)	ISD 2 Plate Waste Collection (Phase 3)
	Potatoes	
French fries Mashed potatoes Potato wedges Tater tots	French fries Mashed potatoes Potato wedges Tater tots	French fries Mashed potatoes
	Other Starchy Vegetables	
Corn on the cob 3" Green peas Ranch style beans	Baked beans Corn on the Cob 3" Green Peas Pork and beans Sweet potato fries Ranch style beans Raw sweet potato sticks Whole kernel corn	Baked beans Pinto beans Sweet potatoes Sweet potato Fries Whole kernel corn
ISD 1 Spring Plate Waste Collection (Phase 1)	ISD 1 Fall Plate Waste Collection (Phase 2)	ISD 2 Plate Waste Collection (Phase 3)
	Non-Starchy Vegetables	
Green beans Steamed broccoli Veggie dippers (raw carrots, celery, and cucumber)	Baby carrots and celery sticks (raw) Broccoli florets (raw) Garden salad (iceberg lettuce, spinach, cabbage and carrots) Green beans Mixed Normandy vegetables (cooked broccoli, cauliflower, carrots) Sonoma vegetables (cooked sugar snap peas, carrots, yellow carrots, broccoli) Steamed broccoli Steamed broccoli w/cheese sauce Veggie dippers (raw carrots, celery, and cucumber) Whole dill pickle	Asian vegetables Baby carrots (raw) Broccoli (cooked) Broccoli salad w/raisins Glazed carrots Green beans Italian vegetables Spinach (cooked) Spinach salad Tomato and cucumber salad Turnip greens

Source: The authors.

Table 3. A Breakdown of Mean and Median Vegetable Plate Waste Measurements by Vegetable Type and Vegetable Subgroups for ISD 1

Vegetable Type[a]	Number of Observations	% Vegetable Plate Waste - Mean	% Vegetable Plate Waste - Median
Potato Wedges	23	50.06	55.88
Mashed Potatoes	45	53.36	52.48
French Fries	33	37.68	33.38
Tater Tots	24	22.11	20.70
Green Beans	38	57.49	58.87
Green Peas	30	71.30	74.87
Steamed Broccoli	11	49.82	55.64
Veggie Dippers	58	59.68	61.99
Corn On The Cob	21	71.30	73.52
Ranch Style Beans	16	52.90	54.00
Whole Dill Pickle	23	47.67	49.02
Garden Salad	17	51.57	51.44
Baked Beans	12	66.57	68.60
Raw Sweet Potato Sticks	8	56.91	60.89
Mixed Normandy Vegetables	16	73.90	76.98
Broccoli Florets	16	55.16	54.66
Whole Kernel Corn	21	71.02	78.38
Sonoma Vegetables	7	77.84	80.68
Sweet Potato Fries	3	89.26	91.39
Raw Baby Carrots And Celery	8	61.21	62.42
Steamed Broccoli W/ Cheese Sauce	7	60.41	60.57
Pork And Beans	12	48.83	49.38
Vegetable Subgroup[b]	**Number of Observations**	**% Vegetable Plate Waste - Mean**	**% Vegetable Plate Waste - Median**
Beans	40	55.78	55.40
Additional Vegetables	23	75.10	78.34
Dark Green Vegetables	51	53.53	53.26
Other Vegetables	61	53.79	56.46
White Potatoes	125	42.61	41.71
Red/Orange Vegetables	77	60.70	62.98
Other Starchy Vegetables	72	71.22	74.87

[a] Test for equality of means - Welch F-statistic 20.70 p-value 0.0000;

Test for equality of medians; Kruskal-Wallis statistic 150.37 p-value 0.0000

[b] Test for equality of means; Welch F-statistic 26.81 p-value 0.0000

Test for equality of medians; Kruskal-Wallis statistic 110.53 p-value 0.0000

Source: Computations by the authors using EVIEWS 8.0

Table 4. A Breakdown of Mean and Median Vegetable Plate Waste Measurements by Vegetable Type and Vegetable Subgroups for ISD 2

Vegetable Type[a]	Number of Observations	% Vegetable Plate Waste - Mean	% Vegetable Plate Waste - Median
Whole Kernel Corn	38	50.04	53.16
Sweet Potato Fries	36	53.94	48.52
Glazed Carrots	27	56.23	60.46
Spinach Salad	7	59.72	65.33
Tomato And Cucumber Salad	10	45.88	46.47
Green Beans	52	41.87	35.65
Sweet Potatoes	10	61.86	67.49
Baked Beans	25	34.98	33.23
Baby Carrots	48	67.01	69.24
Italian Vegetables	11	55.15	62.50
Asian Vegetables	5	64.93	81.53
Broccoli Salad	4	79.69	79.07
French Fries	31	32.43	29.42
Pinto Beans	22	41.87	33.69
Turnip Greens	18	61.52	65.80
Mashed Potatoes	65	36.58	38.65
Steamed Broccoli	16	45.22	45.23
Spinach	6	62.42	60.61
Vegetable Subgroup[b]	**Number of Observations**	**% Vegetable Plate Waste - Mean**	**% Vegetable Plate Waste - Median**
Beans	47	38.21	33.23
Additional Vegetables	26	53.47	54.71
Dark Green Vegetables	51	57.69	60.00
Other Vegetables	52	41.87	35.65
White Potatoes	96	35.24	35.81
Red Orange Vegetables	121	60.29	64.10
Other Starchy Vegetables	38	50.04	53.16

[a] Test for equality of means; Welch F-statistic 10.09 p-value 0.0000

Test for equality of medians; Kruskal-Wallis statistic 102.39 p-value 0.0000

[b] Test for equality of means; Welch F-statistic 20.56 p-value 0.0000

Test for equality of medians; Kruskal-Wallis statistic8 2.70 p-value 0.0000

Source: Computations by the authors using EVIEWS 8.0

Table 5. A Breakdown of Vegetable Plate Waste by Grade, School, and Phase for ISD 1

	Number of Observations	% Vegetable Plate Waste: Mean	% Vegetable Plate Waste: Median
Category by Grade[a]			
ALL VEGETABLES	449	55.90	58.07
ALL ENTREES	449	29.10	25.62
All Vegetables--Kindergarten	69	61.76	65.83
All Vegetables--First Grade	72	53.98	53.79
All Vegetables--Second Grade	78	56.88	56.59
All Vegetables--Third Grade	78	52.80	56.50
All Vegetables--Fourth Grade	76	51.46	51.05
All Vegetables--Fifth Grade	76	59.01	65.87
Category by School[b]			
All Vegetables – School A	127	57.72	61.40
All Vegetables – School B	196	55.40	58.13
All Vegetables – School C	126	54.84	54.47
Category by Phase[c]			
All Vegetables – Phase 1	144	52.11	53.86
All Vegetables – Phase 2	305	57.68	59.03

[a] Test for equality of means; Welch F-statistic 2.65 p-value 0.0239

Test for equality of medians; Kruskal-Wallis statistic 12.23 p-value 0.0317

[b] Test for equality of means; Welch F-statistic 0.62 p-value 0.5391

Test for equality of medians; Kruskal-Wallis statistic 1.67 p-value 0.4346

[c] Test for equality of means; Welch F-statistic 6.20 p-value 0.0134

Test for equality of medians; Kruskal-Wallis statistic 5.39 p-value 0.0202

Source: Computations by the authors using EVIEWS 8.0

Table 6. A Breakdown of Vegetable Plate Waste by Grade and School for ISD 2

	Number of Observations	% Vegetable Plate Waste: Mean	% Vegetable Plate Waste: Median
Category by Grade[a]			
ALL VEGETABLES	431	48.46	47.18
ALL ENTREES	432	32.92	29.37
All Vegetables--Kindergarten	73	49.93	48.25
All Vegetables--First Grade	67	47.23	44.21
All Vegetables--Second Grade	66	49.36	45.90
All Vegetables--Third Grade	81	50.94	51.08
All Vegetables--Fourth Grade	75	48.25	45.68
All Vegetables--Fifth Grade	69	44.55	39.94
Category by School[b]			
All Vegetables – School D	160	57.80	63.09
All Vegetables – School E	120	49.12	48.17
All Vegetables – School F	151	38.03	36.39

[a] Test for equality of means; Welch F-statistic 0.66 p-value 0.6517

Test for equality of medians; Kruskal-Wallis statistic 4.16 p-value 0.5270

[b] Test for equality of means; Welch F-statistic 32.64 p-value 0.0000

Test for equality of medians; Kruskal-Wallis statistic 55.98 p-value 0.0000

Source: Computations by the authors using EVIEWS 8.0

Table 7. Lost Dollars for Vegetables by Vegetable Type and Vegetable Subgroup for ISD 1

	Number of Observations	Average Cost per Serving	Total Number of Servings	Total Cost of Preparation	Total Lost Dollars	% Lost Dollars	Average Waste Cost Per Serving
Vegetable Type							
Potato Wedges	23	$0.1146	536	$61.44	$29.79	48.48	$0.0556
Mashed Potatoes	45	$0.0615	1,563	$96.08	$48.62	50.60	$0.0311
French Fries	33	$0.1022	994	$101.60	$35.21	34.66	$0.0354
Tater Tots	24	$0.1188	718	$85.31	$18.84	22.08	$0.0262
Green Beans	38	$0.1729	541	$93.52	$54.49	58.27	$0.1007
Green Peas	30	$0.2128	512	$113.18	$81.14	71.69	$0.1585
Steamed Broccoli	11	$0.1411	40	$5.64	$3.18	56.40	$0.0796
Veggie Dippers	58	$0.1070	399	$42.68	$26.86	62.94	$0.0673
Corn On The Cob	21	$0.1759	495	$84.87	$61.01	71.89	$0.1233
Ranch Style Beans	16	$0.1621	137	$22.39	$13.58	60.64	$0.0991
Whole Dill Pickle	23	$0.1559	198	$30.86	$14.24	46.13	$0.0719
Garden Salad	17	$0.1443	82	$11.83	$5.63	47.57	$0.0686
Baked Beans	12	$0.1881	120	$22.57	$15.75	69.79	$0.1312
Raw Sweet Potato Sticks	8	$0.0582	28	$1.63	$0.91	55.92	$0.0325
Mixed Normandy Vegetables	16	$0.2915	188	$54.80	$39.87	72.76	$0.2121
Broccoli Florets	16	$0.1431	61	$8.73	$5.07	58.13	$0.0832
Whole Kernel Corn	21	$0.1652	386	$63.77	$45.68	71.63	$0.1183
Sonoma Vegetables	7	$0.2698	42	$11.33	$9.02	79.57	$0.2147
Sweet Potato Fries	3	$0.2779	49	$13.62	$12.31	90.39	$0.2512
Raw Baby Carrots and Celery	8	$0.1119	49	$5.48	$3.40	62.02	$0.0694
Steamed Broccoli w/ Cheese Sauce	7	$0.1879	99	$18.61	$10.55	56.69	$0.1065
Pork And Beans	12	$0.1456	173	$25.18	$12.66	50.29	$0.0732
ALL VEGETABLES	449	$0.1436	7,410	$975.10	$547.81	56.18	$0.0739
Vegetable Subgroup							
Beans	40	$0.1649	430	$70.14	$41.99	59.87	$0.0976
Additional Vegetables	23	$0.2849	230	$66.13	$48.89	73.93	$0.2126
Dark Green Vegetables	51	$0.1492	282	$44.81	$24.43	54.53	$0.0866
Other Vegetables	61	$0.1665	739	$124.38	$68.73	55.26	$0.0930
White Potatoes	125	$0.0930	3,811	$344.42	$132.45	38.46	$0.0348
Red/Orange Vegetables	77	$0.1091	525	$63.41	$43.48	68.57	$0.0828
Other Starchy Vegetables	72	$0.1882	1,393	$261.82	$187.83	71.74	$0.1348
ALL VEGETABLES	449	$0.1436	7,410	$975.10	$547.81	56.18	$0.0739

Source: Calculations by the authors

Table 8. Lost Dollars for Vegetables by Vegetable Type and Vegetable Subgroup for ISD 2

	Number of Observations	Average Cost Per Serving	Total Number of Servings	Total Cost of Preparation	Average % Plate Waste	Total Lost Dollars	% Lost Dollars	Average Waste Cost Per Serving
Vegetable Type								
Whole Kernel Corn	38	$0.1898	562	$106.65	50.04	$53.89	50.53	$0.0959
Sweet Potato Fries	36	$0.2368	208	$49.23	53.94	$23.28	47.30	$0.1119
Glazed Carrots	27	$0.2822	157	$42.75	56.23	$27.51	64.35	$0.1752
Spinach Salad	7	$0.2439	22	$5.43	59.72	$3.31	60.90	$0.1503
Tomato And Cucumber Salad	10	$0.1277	25	$3.25	45.88	$1.52	46.65	$0.0607
Green Beans	52	$0.1474	344	$50.74	41.87	$21.45	42.28	$0.0624
Sweet Potatoes	10	$0.3807	23	$8.76	61.86	$5.60	64.00	$0.2436
Baked Beans	25	$0.1534	160	$24.42	34.98	$8.05	32.98	$0.0503
Baby Carrots	48	$0.1369	249	$33.86	67.01	$22.37	66.07	$0.0898
Italian Vegetables	11	$0.0838	23	$1.87	55.15	$1.06	56.84	$0.0462
Asian Vegetables	5	$0.1054	28	$2.96	64.93	$2.06	69.71	$0.0736
Broccoli Salad	4	$0.0975	14	$1.37	79.69	$1.11	81.18	$0.0792
French Fries	31	$0.0932	838	$78.06	32.43	$22.99	29.45	$0.0274
Pinto Beans	22	$0.2020	439	$88.50	41.87	$26.55	30.00	$0.0605
Turnip Greens	18	$0.1172	35	$4.11	61.52	$2.65	64.44	$0.0756
Mashed Potatoes	65	$0.0606	1,989	$120.50	36.58	$48.95	40.62	$0.0246
Steamed Broccoli	16	$0.1115	142	$15.80	45.22	$6.99	44.28	$0.0493
Spinach	6	$0.2050	15	$3.08	62.42	$1.76	57.33	$0.1175
ALL VEGETABLES	431	$0.1542	5,273	$641.31	48.46	$281.11	43.83	$0.0533
Vegetable Subgroup								
Beans	47	$0.1761	599	$112.91	38.21	$34.60	30.65	$0.0578
Additional Vegetables	26	$0.1048	76	$8.08	53.47	$4.64	57.45	$0.0611
Dark Green Vegetables	51	$0.1416	228	$29.77	57.69	$15.82	53.13	$0.0694
Other Vegetables	52	$0.1474	344	$50.74	41.87	$21.45	42.28	$0.0624
White Potatoes	96	$0.0711	2,827	$198.56	35.24	$71.94	36.23	$0.0254
Red/Orange Vegetables	121	$0.2192	637	$134.59	60.29	$78.77	58.52	$0.1237
Other Starchy Vegetables	38	$0.1898	562	$106.65	50.04	$53.89	50.53	$0.0959
ALL VEGETABLES	431	$0.1542	5,273	$641.31	48.46	$281.11	43.83	$0.0533

Source: Calculations by the authors