Resources, Conservation & Recycling 161 (2020) 104965

Contents lists available at ScienceDirect

Resources, Conservation & Recycling

journal homepage: www.elsevier.com/locate/resconrec

Full length article

Consumer preferences for eco-friendly attributes in disposable dinnerware

MacKenzie B. Gill (Ms., M.S.)[a], Kimberly L. Jensen (Dr., Ph.D.)[b,*], Dayton M Lambert (Dr., Ph.D.)[c], Sreedhar Upendram (Dr., Ph.D.)[d], Burton C English (Dr., Ph.D.)[e], Nicole Labbé (Dr., Ph.D.)[f], Samuel W Jackson (Dr., Ph.D.)[g], Robert J Menard (Mr., M.S.)[h]

[a] Department of Agricultural and Resource Economics, 302 Morgan Hall, 2621 Morgan Circle, The University of Tennessee, Knoxville, TN 37996, United States
[b] Department of Agricultural and Resource Economics, 302 Morgan Hall, 2621 Morgan Circle, The University of Tennessee, Knoxville, TN 37996, United States
[c] Department of Agricultural Economics, 411 Agricultural Hall, Oklahoma State University, Stillwater, OK 74078, United States
[d] Department of Agricultural and Resource Economics, 302 Morgan Hall, 2621 Morgan Circle, The University of Tennessee, Knoxville, TN 37996, United States
[e] Department of Agricultural and Resource Economics, 302 Morgan Hall, 2621 Morgan Circle, The University of Tennessee, Knoxville, TN 37996, United States
[f] Center for Renewable Carbon, CRC - Bioenergy Science & Technology Unit, The University of Tennessee, 2500 Jacob Drive, Knoxville, TN 37996, United States
[g] Genera Energy, Inc, 167 Tellico Port Rd, Vonore, TN 37885
[h] Department of Agricultural and Resource Economics, 302 Morgan Hall, 2621 Morgan Circle, The University of Tennessee, Knoxville, TN 37996, United States

ARTICLE INFO

Keywords:
Disposable
Dinnerware
Consumers
Recyclable
Certified
Biobased

ABSTRACT

The United States (US) uses landfills to dispose paper cups at a rate of 40 percent. Landfill rates on plastic disposable dinnerware are even higher at around 80 percent. This study examines consumer preferences for single-use disposable dinnerware with the attributes: uses no trees; contains no plastic; made from agricultural crop byproduct cellulose; cellulose from dedicated crops, and/or organically sourced cellulose; certified bio-based; and compostable or recyclable. A Multiple Indicator Multiple Causes (MIMIC) model is used to estimate the effects of demographics, expenditures, and consumer perceptions of disposable dinnerware made with 'eco-friendly' materials or processes. The attributes 'no plastic' and 'recyclable' appealed to consumers over the widest range of preferences for eco-friendly attributes in disposable dinnerware. However, 'no trees' and 'certified biobased' appeared to appeal to a narrower segment with the strongest preferences for eco-friendly attributes. Demographic characteristics including gender, residential location, household income, household composition, and environmental attitudes also correlated with preferences for single use products made with the attributes examined.

1. Introduction

1.1. Background

The total amount of municipal solid waste (MSW) generated annually in the United States (US) has increased almost every year since 1960. In 2015, a total of 262.4 million tons of municipal solid waste (MSW) was generated in the US, which amounts to 4.48 pounds per person per day. One contributor to single-use paper and plastic MSW is disposable dinnerware, such as paper or plastic plates and cups. Paper plates and cups represented 1,360,000 tons of MSW in 2015 (EPA, 2018), with about 40 percent eventually landfilled. Of the 1,050,000 tons of MSW generated from plastic plates and cups, 840,000 tons were landfilled in 2015 (EPA, 2018). The food service industry is a substantial contributor to disposable dinnerware use, but shoppers may also purchase disposable dinnerware at retail stores for at-home use. Consumers weigh the convenience of their use of single-use 'throw away' dinnerware against the environmental impacts of this disposable dinnerware post-use when they make purchasing decisions. For example, product attributes such as recyclability or compostability are often considered. Consumers may also contemplate the environmental impacts of the input sourcing for and manufacturing of disposable dinnerware. Examples of pre-use attributes might include 1) whether the product contains plastic; 2) the source of cellulose used in manufacturing paper plates (for example, tree cellulose, agricultural crops, agricultural crop byproducts); 3) whether cellulose for paper products was organically produced; or 4) if the product is certified as bio-based.

Consumer concern about the environment has been growing in recent years. Research indicates that consumers place more value on post-use attributes such as recyclability and compostability as they become

* Corresponding author.
E-mail addresses: mgill5@vols.utk.edu (M.B. Gill), kjensen@utk.edu (K.L. Jensen), dayton.lambert@okstate.edu (D.M. Lambert), supendra@utk.edu (S. Upendram), benglish@utk.edu (B.C. English), nlabbe@utk.edu (N. Labbé), nlabbe@utk.edu (S.W. Jackson), rmenard@utk.edu (R.J. Menard).

https://doi.org/10.1016/j.resconrec.2020.104965
Received 27 June 2019; Received in revised form 20 May 2020; Accepted 20 May 2020

more informed about sustainability issues (Klaiman, et al., 2016). Dilkes-Hoffman et al. (2019) found that plastic in the ocean was considered the most serious among a set of environmental issues and that there was strong support among consumers for reducing use of plastics.

Consumers may also be concerned about the environmental impact of how the disposable dinnerware was manufactured and the cellulose sourced. For example, dinnerware is now being molded from agricultural byproducts such as bagasse cellulose from sugarcane or wheat straw cellulose from wheat grain production. In other cases, cellulose is derived from fast growing plants, such as bamboo, that are grown for making alternative biobased fiber products like disposable dinnerware. In a few cases, the United States Department of Agriculture (USDA) has certified biobased products (USDA Bio-Preferred Program, 2019). The USDA (USDA Bio-Preferred Program, 2019) defines biobased products as those "…derived from plants and other renewable agricultural, marine, and forestry materials. These products provide an alternative to conventional petroleum derived products and include a diverse range of offerings such as lubricants, detergents, inks, fertilizers, and bioplastics."

1.2. Prior research

A few studies have examined factors influencing the retail purchase of bioplastics and other single-use disposable dinnerware substitutes. Some found that consumer attitudes toward the environment influenced use of or willingness to use disposable substitutes (Kainz, 2016; Klein, et al., 2019; Loschelder, et al., 2019). Findings from other studies have suggested that situational factors, such as where the product would be used (for example, food retailers, events, etc.), prior experience with similar substitutes, or convenience inform purchasing decisions (Ertz, 2017; Jahani, et al., 2019).

While few studies exist regarding consumer preferences for single-use disposable dinnerware, other studies examined consumer preferences for attributes in food packaging and containers. Findings from these studies hold some relevance to understanding consumer attitudes toward disposable dinnerware. Results from prior research suggest that females are more likely to be interested in environmentally friendly products; hence, it is anticipated that female consumers might be more likely to opt for eco-friendly attributes in single use disposable dinnerware (Casadesus-Masanell et al., 2009; Kainz, 2016; Martinho et al., 2015; Orset, et al., 2017; Yue et al., 2010). Some studies' results suggest that older consumers have stronger preferences for environmentally friendly products; hence, these individuals are more likely to be interested in disposable dinnerware with eco-friendly attributes (Kainz, 2016). Other research suggests that younger consumers more accurately represent target markets for these products (Arboretti and Bordignon, 2016; Martinho et al., 2015; Orset, et al., 2017; Yue et al., 2010). Findings from a study by Casadesus-Masanell et al. (2009) suggest that individuals living in rural milieus may be averse to purchasing products imbued with eco-friendly attributes. Prior research also suggests that decision makers with children are more likely prefer eco-friendly attributes in disposable dinnerware (Kainz, 2016; Yue et al., 2010). The effect of education on probability of preferring eco-friendly attributes in disposable dinnerware is difficult to hypothesize *a priori*. Some studies find that consumers with higher educational attainment are more likely interested in environmentally friendly products (Arboretti and Bordignon, 2016; Yue et al., 2010), while the study by Casadesus-Masanell et al. (2009) suggested the opposite. The effect of household income on preferences for environmentally friendly products is also unclear. Casadesus-Masanell et al. (2009) and Yue et al. (2010) found a positive correlation between preferences for eco-friendly products and income, whereas Kainz (2016) found a negative relationship. Several studies find that consumers who are more concerned with environmental issues are more likely to substitute towards products with ecofriendly attributes and/or packaging (Barnes et al., 2011; Herbes et al., 2018; Kainz, 2016; Klaiman, Ortega, and Garnache, 2016; Klein et al., 2019; Kurka and Menrad, 2009; Martinho et al., 2015; Orset, et al., 2017).

Concerning product attributes, several studies have examined which may be more important in packaging and food containers. Prior research finds that U.S. consumers place the highest value on recyclable packaging, but place less importance on the material composition of packaging and other stages of the production chain of packaging like transport and retail use (Herbes et al., 2018). Other research suggests that being locally produced and competitively priced were important attributes in food containers (Barnes et al., 2011). Sijstema et al. (2016) investigated consumer perceptions of a 'bio-based' label in Europe. The results of Sijstema et al.'s study suggests that a subset of environmentally concerned consumers may be skeptical of company advertising of bio-based products, considering these maneuvers as efforts to capitalize on desires for sustainable products (Sijtstema et al., 2016). However, Kurka and Menrad (2009) found that respondents' top reasons for purchasing bioplastics in order as: to be more ecofriendly, to conserve resources for future generations, for health reasons, to strengthen the regional economy, to buy it for low price, to set an example for others, and to ease one's conscience (Kurka and Menrad, 2009).

Studies have examined factors influencing single-use disposable dinnerware (Ertz et al., 2017; Jahani et al., 2019; Klein, et al., 2019; Kainz, 2016, Loschelder et al., 2019). These studies provide important insight into consumer preferences for single-use disposable items, but they do not examine the importance of multiple pre- and post-use attributes that consumers may perceive as 'eco-friendly' and important to them. The importance of these attributes in single-use disposable dinnerware could ultimately influence consumer purchasing decisions. Furthermore, the previous studies did not examine how demographics, expenditure patterns for disposable dinnerware, or consumers' environmental attitudes influence the importance of attributes in disposable dinnerware.

Markets for disposable dinnerware are emerging with new offerings of attributes that may be perceived as eco-friendly. While several studies examined consumer perceptions of and preferences for eco-friendly packaging attributes, few researched preferences for attributes which consumers may perceive as 'eco-friendly' in single-use disposable dinnerware for at-home use. In this study, we examine importance of eight attributes that consumers may perceive as 'eco-friendly'. Some of the attributes examined are pre-use, while others are post-use. The pre-use attributes considered include 'no trees', 'contains no plastic', 'made from a crop byproduct', 'made from cellulose from a dedicated crop', 'made from organically produced cellulose', 'USDA Certified Biobased', while the post-use attributes include 'compostable, and recyclable'. Furthermore, the effects of demographics, disposable dinnerware expenditure patterns, and attitudes on probability of valuing the attributes as important are measured to develop information about market segments of consumers who may place the most importance on these attributes.

1.3. Objectives

The objectives of this study are to:

a Provide information about the importance consumers place on eight disposable dinnerware attributes that may perceive as eco-friendly. Product attributes include that the dinnerware contains no cellulose from trees (*No Trees*), contains no plastic (*No Plastic*), is made with cellulose from a crop byproduct (*Crop Byproduct*), is made from cellulose from a dedicated energy crop (*Dedicated Crop*), is made from organically produced cellulose (*Organic Cellulose*), is USDA Certified Biobased (*USDA Certified Biobased*), is compostable (*Compostable*), or is recyclable (*Recyclable*);
b Estimate the effects of consumer demographics, expenditures, and attitudes on the probability of selecting these attributes as important

in disposable dinnerware; and

c Determine the effects of consumer demographics, expenditures, and attitudes on the likelihood of selecting multiple disposable dinnerware attributes as important.

2. Data and methods

2.1. Survey and data

This study uses data from an online survey administered through Qualtrics to 218 Tennessee respondents aged 18 or older in late August 2018. Qualtrics randomly recruits from its consumer panels, excluding those under 18 and those who are not residents of Tennessee. The sample size was limited by project budget. However, the margin of error at the 95 percent confidence level with 218 sampled from the population of Tennesseans aged 18 or older is 6.65 percent.[1] The survey was tested on students and staff before pre-testing with a consumer panel. This information was used to modify the survey instrument before survey pre-testing. The final survey was revised based on pre-test responses. The university-level institutional review board for compliance with appropriate human subjects' research protocols reviewed the survey instrument and methods.

The survey contained several sections, including questions about importance of attributes for disposable dinnerware, expenditures, demographics, and attitudes. Table 1 summarizes the variable names and definitions used in the survey instrument. The survey questions used in this analysis are provided in a supplementary document.

For statistical modeling purposes, a dummy variable for each disposable dinnerware attribute (*No Trees, No Plastic, Crop Byproduct, Dedicated Crop, Organic Cellulose, USDA Certified Biobased, Compostable*, and *Recyclable)* was created to indicate whether the consumer perceived the attribute to be important (1 if somewhat to extremely important, 0 if not very important or not important at all). These variables were based on responses to survey questions 4a.-4h. (see supplementary document). An information screen on *USDA Certified Biobased* was provided assuming that respondents may not have been familiar with the term (question 3, supplementary document). An information screen was included in the survey desrcribing the USDA Certified Biobased program for those unfamiliar with this program (Fig. 1).

To build market profiles, information was collected through the survey regarding expenditure patterns on disposable dinnerware and demographics. Demographic variables included: *Female* (question 7); age of respondent, *Age* (question 1); *Rural/Small Town* (dummy variable created from question 9); presence of children under 18, *Children* (dummy variable created from question 10); and college degree status, *College Graduate* (dummy variable created from question 8). Income and expenditure variables included pre-tax household income for 2017, *Household Income*, (created using the mid-points from question 11), and the percent of income spent on disposable dinnerware, *Disp. Expend. Pct of Income* (created from midpoints of question 5 and *Household Income*). Respondents were asked about their knowledge level regarding environmental issues (question 6e). An environmental knowledge dummy variable, *Envir. Knowledge*, was created (1 if strongly or somewhat disagreed with question 6e statement, 0 otherwise). Respondents were also asked about their level of agreement with statements about the environment through Likert scale questions (1 = strongly disagree, 5 = strongly agree). The Likert questions included statements about their personal actions' impact on the environment (*Personal Actions*, question 6b); the ability of science and technology to solve environmental damage and pollution (*Science/Tech,* question 6a); and their perceived responsibility to future generations for the environment (*Future Generations*, question 6c). Respondents were also asked if they agreed or disagreed with a statement that research findings from the survey could encourage disposable dinnerware manufacturers to offer more alternative fiber products (*Consequences,* question 6d).

2.2. Econometric modeling of attribute preferences

The statistical analysis uses a Multiple Indicator Multiple Causes (MIMIC) model to discern consumer preferences for eco-friendly, single-use dinnerware products. The MIMIC model extends binary choice models by allowing discrete variables to serve as indicators of an underlying unobserved latent variable. The MIMIC model facilitates simultaneous modeling of discrete variables in a general linear model framework (Skrondal and Rabe-Heskath, 2004). The MIMIC model consists of: a) a structural equation specifying the effects of causal variables upon the latent variable, and b) measurement equations defining the relationship between the latent variable and each of the indicators (Fig. 2). The structural equation defines the relationship between the latent variable and the exogenous causal variables, for example, age, education, other consumer demographics, expenditures, and consumer attitudes (top portion of Fig. 2). The measurement equations define the relationship between the probabilities of selecting the indicator variables; in this study, the disposable dinnerware attributes and the latent variable (bottom portion of Fig. 2). The latent variable *ENVIR* is hypothesized to proxy consumer propensity to prefer eco-friendly attributes in disposable dinnerware. The relationship between *ENVIR* and causal variables (i.e., demographic characteristics) is parameterized as a linear regression:

$$ENVIR^{*}=\gamma_1 \cdot Age + \gamma_{12} \cdot Consequences + \varsigma \quad (1)$$

where $\gamma = (\gamma_1, \gamma_{12})$ is a vector of parameters to be estimated and ς a random error term. See Table 1 for the listing of all of the covariate names and definitions.

The second set of equations are the measurement equations which are estimated using logistic regression. The measurement equations specify the relationship between the indicator variables, the importance of the specific disposable dinnerware attributes, and the latent variable, *ENVIR*. The measurement equations are:

$$NoTrees^{*}=\lambda_1^0 + \lambda_1^{NVIR} \cdot ENVIR + \varepsilon_1 \quad (2a)$$

$$NoPlastic^{*}=\lambda_2^0 + \lambda_2^{NVIR} \cdot ENVIR + \varepsilon_2 \quad (2b)$$

$$CropByproduct^{*}=\lambda_3^0 + \lambda_3^{NVIR} \cdot ENVIR + \varepsilon_3 \quad (2c)$$

$$DedicatedCrop^{*}=\lambda_4^0 + \lambda_4^{NVIR} \cdot ENVIR + \varepsilon_4 \quad (2d)$$

$$OrganicCellulose^{*}=\lambda_5^0 + \lambda_5^{NVIR} \cdot ENVIR + \varepsilon_5 \quad (2e)$$

$$USDACertifiedBiobased^{*}=\lambda_6^0 + \lambda_6^{NVIR} \cdot ENVIR + \varepsilon_6 \quad (2f)$$

$$Compostable^{*}=\lambda_7^0 + \lambda_7^{NVIR} \cdot ENVIR + \varepsilon_7 \quad (2g)$$

$$Recyclable^{*}=\lambda_8^0 + \lambda_8^{NVIR} \cdot ENVIR + \varepsilon_8 \quad (2h)$$

where the asterisks denote latency; the λ_j are parameters to be estimated; and ε_j are error terms (Bollen, 1989). The disturbance terms ς and errors ε are assumed to be independent and identically distributed random variables with an expected value of zero and a constant variance $\theta_j = \pi^2/3$ (Dell'Anno and Schneider, 2004; Lambert, et al., 2015). For the purposes of identification, the variance of *ENVIR* (ς) is restricted to one (Maddala, 1983). The reduced-form equations relating the indicators with causal variables are[2]:

$$NoTrees^{*}=\lambda_1^0 + \lambda_1^{ENVIR}(\gamma_1 \cdot Age + \gamma_{12} \cdot Consequences + \varsigma) + \varepsilon_2 \quad (3a)$$

[1] Tennessee had a population aged 18 and older in 2018 of 5,257,068 (US Department of Commerce, 2019). At a 95 percent confidence level with a sample size of 218, the margin of error is 6.65 percent. The sample size (n) is calculated as: $n = [z^2 \cdot p \cdot (1 - p)/e^2]/[1 + (z^2 \cdot p \cdot (1 - p)/(e^2 \cdot N))]$, where $z = 1.96$ for a confidence level (α) of 95%, p = proportion (expressed as a decimal), N = population size, and e = margin of error. Setting $p = 0.5$, $N = 5{,}257{,}068$, and $n = 218$ and solving for the margin of error, $e \approx 0.0665$.

Table 1
Variable Names, Definitions, and Means

Variable Name	Definition	Mean(N = 206)
MIMIC Model:		
Indicator Variables		
No Trees	Contains no cellulose sourced from trees, 1 if important, 0 otherwise	0.437
No Plastic	Contains no plastic, 1 if important, 0 otherwise	0.675
Crop Byproduct	Made from cellulose that is a byproduct of grain production, 1 if important, 0 otherwise	0.568
Dedicated Crop	Made from cellulose sourced from a dedicated crop, 1 if important, 0 otherwise	0.563
Organic Cellulose	Made for organically produced cellulose, 1 if important, 0 otherwise	0.544
USDA Certified Biobased	USDA Certified Biobased product, 1 if important, 0 otherwise	0.529
Compostable	Product is compostable, 1 if important, 0 otherwise	0.587
Recyclable	Product is recyclable, 1 if important, 0 otherwise	0.675
Latent Variable		
ENVIR	Latent variable for preferences for eco-friendly attributes in disposable dinnerware	3.42
Structural Variables		
Female	1 if respondent is female, 0 otherwise	0.771
Age	Age of respondent	43.2
Rural/Small Town	1 if respondent resides in a rural area or small town, 0 otherwise	0.558
Children	1 if children under age 18 reside in respondent's household, 0 otherwise	0.447
College Graduate	1 if respondent college graduate, 0 otherwise	0.306
Household Income	2017 pre-tax household income in $1,000	52.3
Disp. Expend. Pct of Income	Percent of household income spend on disposable dinnerware	0.314
Envir. Knowledge	1 if have enough knowledge to make well-informed decisions on environmental issues, 0 otherwise	0.383
Personal Actions	Personal actions have a significant impact on the environment (1 = strongly disagree, …, 5 = strongly agree)	3.57
Science/Tech	Science and technology will come up with ways to solve environmental damage and pollution(1 = strongly disagree, …, 5 = strongly agree)	3.53
Future Generations	We have a responsibility to future generations to protect the environment (1 = strongly disagree, …, 5 = strongly agree)	4.34
Consequences	Responses to this survey could cause disposable dinnerware manufacturers to offer more alternative fiber products that don't use trees (1 = strongly disagree, …, 5 = strongly agree)	3.84
Logit Model:		
5 or Greater Attributes	1 if number of disposable dinnerware attributes chosen as important is 5 or greater, 0 otherwise	0.534

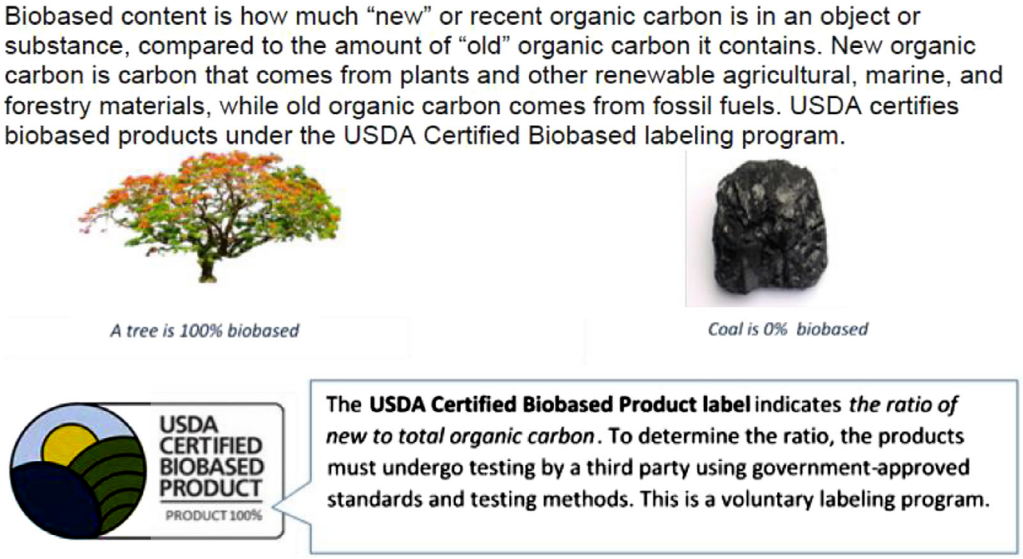

Figure 1. USDA Certified Biobased Product Label Information Screen

$$NoPlastic^{*}=\lambda_2^0+\lambda_2^{ENVIR}(\gamma_1\cdot Age+\gamma_{12}\cdot Consequences+\varsigma)+\varepsilon_2 \quad (3b)$$

$$CropByproduct^{*}=\lambda_3^0+\lambda_3^{ENVIR}(\gamma_1\cdot Age+\gamma_{12}\cdot Consequences+\varsigma)+\varepsilon_3 \quad (3c)$$

$$DedicatedCrop^{*}=\lambda_4^0+\lambda_4^{ENVIR}(\gamma_1\cdot Age+\gamma_{12}\cdot Consequences+\varsigma)+\varepsilon_4 \quad (3d)$$

$$OrganicCellulose^{*}=\lambda_5^0+\lambda_5^{ENVIR}(\gamma_1\cdot Age+\gamma_{12}\cdot Consequences+\varsigma)+\varepsilon_5 \quad (3e)$$

$$USDACertifiedBiobased^{*}=\lambda_6^0+\lambda_6^{ENVIR}(\gamma_1\cdot Age+\gamma_{12}\cdot Consequences+\varsigma)+\varepsilon_6 \quad (3f)$$

$$Compostable^{*}=\lambda_7^0+\lambda_7^{ENVIR}(\gamma_1\cdot Age+\gamma_{12}\cdot Consequences+\varsigma)+\varepsilon_7 \quad (3g)$$

$$Recyclable^{*}=\lambda_8^0+\lambda_8^{ENVIR}(\gamma_1\cdot Age+\gamma_{12}\cdot Consequences+\varsigma)+\varepsilon_8 \quad (3h)$$

The predicted probability of the *i*th respondent choosing attribute *j* as important is then:

$$\Pr(Attribute_j=1)=F_\Lambda\left(\hat{\lambda}_j^0+\hat{\lambda}_j^{ENVIR}(\hat{\gamma}_1\cdot Age_i+\hat{\gamma}_{12}\cdot Consequences_i)\right) \quad (4)$$

[2] The *gsem* procedure in STATA/SE (Version 14.0) was used to estimate the MIMIC model (STATACorp, 2015).

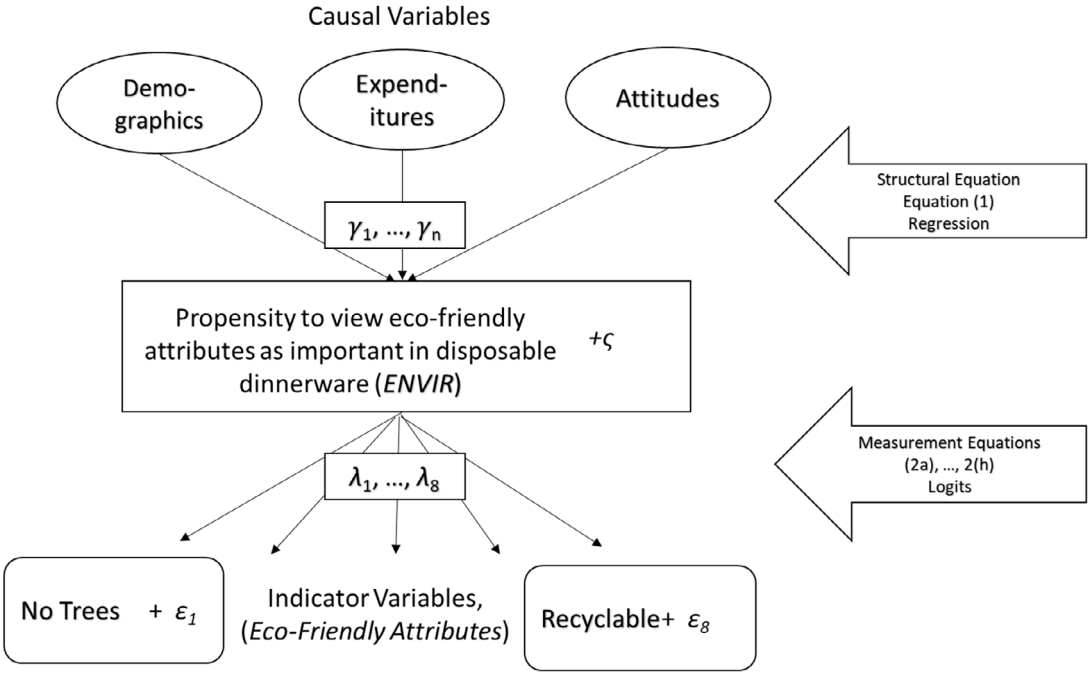

Figure 2. MIMIC Model of Propensity to Choose Eco-Friendly Attributes As Important in Disposable Dinnerware

where F_Λ is the logistic cumulative distribution function and the circumflexes indicate estimated parameters.

The marginal effects (*ME*) are calculated to determine the average change in probability of a respondent selecting a particular attribute as important with a unit change in a given causal variable. The marginal effect of the *n*th causal variable on the probability of selecting the *j*th product attribute as important for the *i*th individual is:

$$ME_i = \frac{\partial \Pr(Attribute_j = 1)}{\partial x_{in}} = \hat{\gamma}_n \cdot \hat{\lambda}_j^{ENVIR} \cdot f_\Lambda\left(\hat{\lambda}_j^0 + \hat{\lambda}_j^{ENVIR}(\hat{\gamma}_1 \cdot Age_i + \hat{\gamma}_{12} \cdot Consequences_i)\right) \quad (5)$$

where f_Λ is the logistic probability density function. The ME_i are averaged over respondents to obtain an average marginal effect.

2.2. Measuring preference intensity

The average number of disposable dinnerware attributes the respondents believed were important was 4.58. In order to measure the intensity of preferences for attributes of disposable dinnerware, a logit model is also estimated with the dependent dummy variable indicating whether respondents believed greater than the average number of attributes (4.58) would be important in disposable dinnerware. Based on this number, a (0,1) dependent dummy variable was created to indicate a respondent believed that five or more attributes were important (1 if 5 or more attributes were important, 0 otherwise). This dummy variable was used as a proxy measure of intensity of preferences for the attributes in disposable dinnerware. Whether the respondents' indicated five or greater attributes as important is hypothesized to be influenced by their demographics, expenditures, and attitudes. The probability of selecting five or more attributes for the *i*th respondent as being important is:

$$\Pr(5 \text{ or more attributes}_i = 1) = F_\Lambda(\beta_0 + \beta_1 \cdot Age_i + \cdot\cdot + \beta_{12} \cdot Consequences_i) \quad (6)$$

where the $\beta_0, \ldots, \beta_n$ are estimated parameters and F_Λ is the logistic cumulative distribution function. For this model, the marginal effects for the n^{th} explanatory variable are calculated as:

$$\frac{\partial \Pr(5 \text{ or more attributes} = 1)}{\partial x_n} = \beta_n \cdot f_\Lambda(\beta_0 + \beta_1 \cdot Age_i + \cdot\cdot + \beta_{12} \cdot Consequences_i) \quad (7)$$

where f_Λ is the logistic distribution function. The average of the individual marginal effects is then calculated. The software STATA/SE (Version 14.0) was used to estimate the logit regressions (STATACorp, 2015).

3. Results and discussion

3.1. Sample demographics

There were 206 observations available for the statistical analysis after removing records with incomplete data. The average age of respondents was just under 44 years, and 77 percent were female (Table 1). About 31 percent were college graduates. The average pretax household income for 2017 was $52,330. These demographics were compared with Tennessee residents using Census Bureau estimates. The average age of respondents was similar to the median age of Tennessee residents. According to the Census Bureau, the median age of Tennessee residents is 37 years (U.S. Department of Commerce, 2019). The median household income for the state in 2017 was $51,340 (U.S. Department of Commerce, 2019), while the sample average was $52,330. The percent of Tennessee residents aged 25 and older who attained a college degree was 27 percent for 2018 (U.S. Department of Commerce, 2019), while 31 percent of the sample were college graduates. While most of the sample demographics were similar to the population demographics, the largest difference was the percentage of females. Sventy-seven percent of the respondents were female, which is higher than the the state's 52 percent (U.S. Department of Commerce, 2019). The survey focused on disposable dinnerware purchases, products which are likely purchased by a primary household food shopper whom prior research has found as more likely to be female (57 percent) (Food Marketing Institute, 2015). This difference should be kept in mind as the findings are discussed.

Table 2
MIMIC Model Estimates of Attribute Importance in Disposable Dinnerware[a]

Indicator Equations						Measurement Equation		
	Estimated Coefficients[b]				Pct. Correctly Classified			Estimated Coefficients γ_n
Indicator Variables	Intercept λ_{0j}		*ENVIR*λ_{ENVIRj}			Structural Variables		
No Trees	-5.63	***	1.49	***	78.6	*Female*	-0.444	**
No Plastic	-5.12	***	1.81	***	83.7	*Age*	0.017	***
Crop Byproduct	-5.59	***	1.72	***	77.2	*Rural/Small Town*	-0.334	*
Dedicated Crop	-6.30	***	1.92	***	81.1	*Children*	0.568	***
Organic Cellulose	-5.87	***	1.75	***	80.1	*College Graduate*	0.192	
USDA Cert. Biobased	-4.83	***	1.42	***	81.7	*Household Income*	0.004	*
Compostable	-8.47	***	2.63	***	88.8	*Disp. Expend. Pct. Inc.*	0.126	
Recyclable	-5.67	***	1.99	***	85.0	*Envir. Knowledge*	0.423	**
						Personal Actions	-0.074	
						Science/Tech	0.218	**
						Future Generations	0.150	
						Consequences	0.375	***
Log likelihood	=-842							
N=206								
Likelihood ratio test against intercept only (LLR), $\chi^2(12df)=72.8$***								

[a] *** indicates significant at $\alpha=0.01$, ** indicates significant at $\alpha=0.05$, and * indicates significant at $\alpha=0.10$.
[b] For purposes of identification, the variance of the latent variable, *ENVIR*, is restricted to 1.

3.2. Preferences for disposable dinnerware attributes

Table 1 reports the proportion of respondents believing that each attribute is important. The attributes *Recyclable* and contains *No Plastic* each were rated as 'important' by more than 67 percent of the respondents. About 57 percent believed the dinnerware made from a *Crop Byproduct* was important, while 56 percent believed dinnerware made from a *Dedicated Crop* was important. This suggests that consumers do not view dinnerware sourced from crop by-products or dedicated crops very differently from each other. Additionally, 54 percent of the respondents believed the cellulose for the dinnerware was organically (*Organic Cellulose*) sourced was important, while 53 percent felt the dinnerware labeled *USDA Certified Biobased* was important. Interestingly, the attribute least commonly cited as important was that that the product contained no cellulose derived from trees (*No Trees*) at under 44 percent of the respondents indicating importance.

The covariates included in the MIMIC model significantly explain preferences for disposable dinnerware as indicated by the log likelihood ratio (LLR) test (Table 2). The second and third columns of Table 2 contain the estimated coefficients for each logit measurement equation in the MIMIC model. The λ_{0j} parameters are the intercepts of the measurement equations for each attribute. The λ_{ENVIRj} parameters are the estimated coefficients for the latent variable *ENVIR*, corresponding with each logistic equation (equations 3(a)-3(h)). The fourth column of Table 2 reports the percent of the observations that each logit equation correctly classified. This information provides an overview on model fit, indicating how well the covariates categorized observed respondent choices. The sixth column of Table 2 contains the regression coefficients (λ_n) relating the causal variables (for example the demographic characteristics of the respondents) to the dependent variable *ENVIR* (from equation 1). For both the estimated coefficients in the logit equations and those in the regression equation portion of the MIMIC model, the asterisks indicate whether the coefficient was statistically different from zero at the 99 percent (***), 95 percent (**) and 90 percent (*) confidence levels, respectively.

For the structural variables, a multicollinearity analysis was conducted. Multicollinearity may inflate the standard errors of estimates and compromise inference. Variance inflation factors (VIF) exceeding 10 indicate multicollinearity may be inflating standard errors (Kutner, et al. 2004). The mean of the variance VIFs was 1.28, suggesting multicollinearity was not serious enough to warrant concern with respect to inference.

As can be seen in the fourth column of Table 2, the logit models correctly classified from 77.2 percent of the observations for *Crop Byproduct* to 88.8 percent for *Compostable*. Both the intercept term λ_{0j} and the estimated coefficient on the latent variable *ENVIR*, λ_{ENVIRj}, are significant for all measurement equations. This suggests that the attributes for disposable dinnerware are reasonable indicators of the underlying latent variable; propensity to value eco-friendly attributes as important (*ENVIR*).

Among the structural variables in the measurement equation (column 6, Table 2), several variables significantly influenced *ENVIR*. These included: *Female, Age, Rural/Small Town, Children, Household Income, Envir. Knowledge, Science/Tech*, and *Consequences*. Variables not exhibiting a significant influence included College Graduate, *Disp. Expend. Pct of Income,* and *Future Generations.*

Being female (*Female*) and located in a rural area or small town (*Rural/Small Town*) were found to have negative associations with *ENVIR*. The result for female gender is contrary to prior research findings of positive effects of female gender on preferences for sustainable packaging (Casadesus-Masanell et al., 2009; Kainz, 2016; Martinho et al., 2015; Orset, et al., 2017; Yue et al., 2010). However, findings by Casadesus-Masanell et al. (2009) regarding negative influence of rural residence on preferences for eco-friendly attributes in packaging is similar to the results in this study for disposable dinnerware. Variables found to have a positive influence include respondent age (*Age*), having children under 18 in the household (*Children*), and household income (*Household Income*). The positive effects of age are similar to findings by Kainz (2016), but dissimilar to those from other research by (Arboretti and Bordignon, 2016; Martinho et al., 2015; Orset, et al., 2017; Yue et al., 2010). The finding of positive effects on *ENVIR* from children in the household is similar to prior research findings for sustainable packaging (Kainz, 2016; Yue et al., 2010). While this study found positive influence of household income on *ENVIR*, the findings from prior research regarding the effects of income are mixed (Casadesus-Masanell et al., 2009; Yue et al., 2010; Kainz, 2016). Other variables with a positive influence on *ENVIR* included being self-described as environmentally knowledgeable (*Envir. Knowledge*), being in greater agreement with the statements that science and technology will come up with ways to solve environmental damage and pollution (*Science/Tech*), and that responses to the survey could cause disposable dinnerware manufacturers to offer more alternative fiber products (*Consequences*). The results regarding the positive influence of environmental attitudes are similar to previous findings from the literature (Klein, et al., 2019; Loschelder, et al., 2019; Kainz, 2016).

The results did not indicate a significant link between the percent of

Table 3
Marginal Effects of the Causal Variables on the Probability of Eco-Friendly Attributes Being Important in Disposable Dinnerware [a,b]

	No Trees		No Plastic		Crop Byproduct		Dedicated Crop		Organic Cellulose		USDA Cert. Biobased		Compostable		Recyclable	
Female	-0.102	**	-0.101	**	-0.108	**	-0.113	**	-0.110	**	-0.101	**	-0.121	**	-0.105	**
Age	0.004	***	0.004	***	0.004	***	0.004	***	0.004	***	0.004	**	0.005	***	0.004	***
Rural/Small	-0.077	*	-0.076	*	-0.081	*	-0.085	*	-0.083	*	-0.076	*	-0.091	*	-0.079	*
Children	0.131	***	0.130	***	0.139	***	0.144	***	0.141	***	0.130	***	0.154	***	0.134	***
College Graduate	0.044		0.044		0.047		0.049		0.048		0.044		0.052		0.045	
Household Income	0.001	*	0.001	*	0.001	*	0.001	*	0.001	*	0.001	*	0.001	*	0.001	*
Disp. Expend. Pct of Income	0.029		0.029		0.031		0.032		0.031		0.029		0.034		0.030	
Envir. Knowledge	0.097	**	0.096	**	0.103	**	0.107	**	0.105	**	0.096	**	0.115	**	0.100	**
Personal Actions	-0.017		-0.017		-0.018		-0.019		-0.018		-0.017		-0.020		-0.017	
Science/Tech	0.050	**	0.050	**	0.053	**	0.055	**	0.054	**	0.050	**	0.059	**	0.051	**
Future Generations	0.035		0.034		0.037		0.038		0.037		0.034		0.041		0.035	
Consequences	0.086	***	0.086	***	0.091	***	0.095	***	0.093	***	0.086	***	0.102	***	0.088	***

[a] *** indicates significant at $\alpha = 0.01$, ** indicates significant at $\alpha = 0.05$, and * indicates significant at $\alpha = 0.10$.
[b] Standard errors around the estimates to conduct the statistical tests of significance were calculated using the Delta method (Greene, 2018).

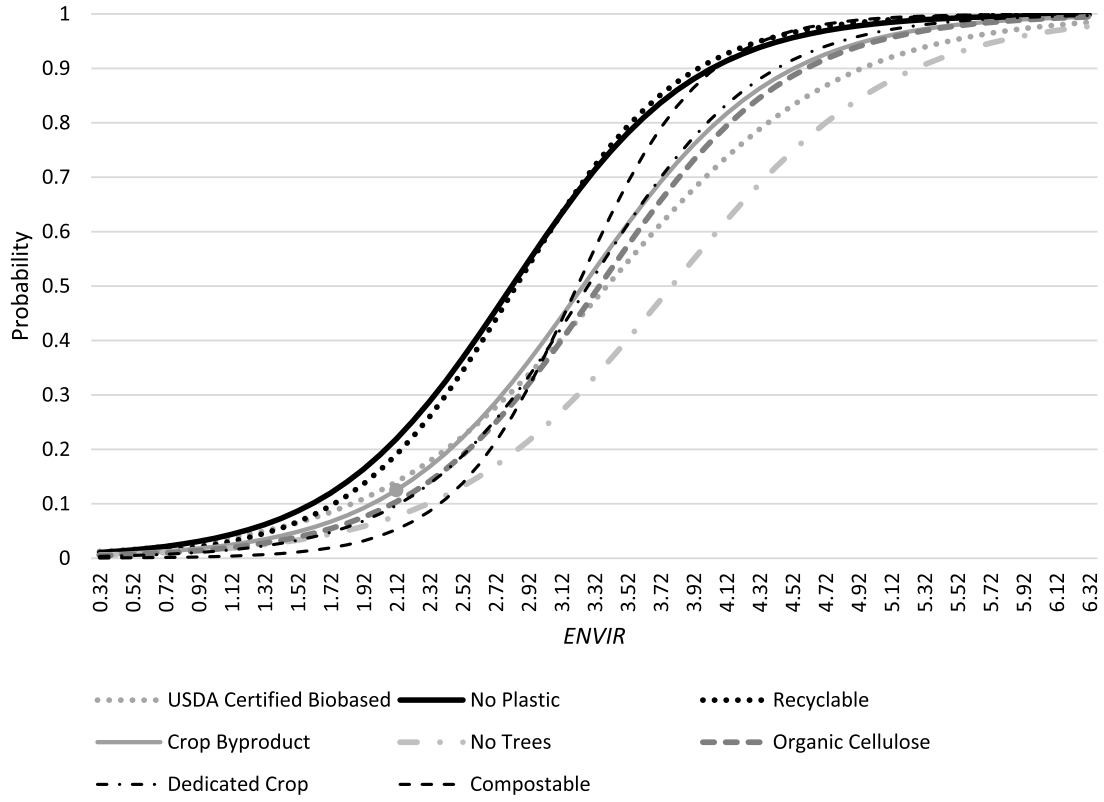

Figure 3. Probability of Eight Eco-Friendly Attributes Chosen as Important in Disposable Dinnerware across *ENVIR*

income spent on disposable dinnerware (*Disp. Expend. Pct of Income*) and *ENVIR*. This suggests that consumers with relatively high expenditures on disposable dinnerware as a percentage of income have about the same propensity to prefer eco-friendly attributes as those with a relatively low percentage of their income spent on these products. Unlike previous studies (Arboretti and Bordignon, 2016; Yue et al., 2010), the results did not reflect a significant influence of education level (*College Graduate*).

The estimated coefficients from Table 2 and the data were used to estimate the marginal effects (equation 5) (Table 3). Each column in Table 3 includes the marginal effect of a covariate on probability of selecting a particular eco-friendly attribute. The marginal effects indicate the effect of a 1-unit change in the covariate on the probability of selecting an eco-friendly attribute. The asterisks associated with each marginal effect indicate at which level the effect was significant. For each attribute, the marginal effects of the variables on *Compostable* are largest, while the smallest are on *No Plastic* and *USDA Certified Biobased*.

Among the dummy variables, the largest positive marginal effects were associated with having children in the household, which increases the probabilities of choosing the attributes by 13.0 percent (*USDA Certified Biobased* or *No Plastics*) to 15.4 percent (*Compostable*). The largest negative marginal effects among the dummy variables were for the respondent being female, which decreases the probabilities of choosing the attributes, ranging from 10.1 percent (*USDA Certified Biobased* or *No Plastics*) to 12.1 percent (*Compostable*).

For the continuous variables, each year of age positively affects the probabilities of selecting the attributes as important by 0.4 percent to 0.5 percent. Therefore, for example, a decade older age would positively influence the probabilities of believing the attributes are important in disposable dinnerware by 4.0 to 5.0 percent. Each $1,000 of household income increased the probabilities by about 0.1 percent. For example, a $10,000 increase in household income would increase probabilities of choosing the attributes by 1 percent.

Those who considered themselves as environmentally

knowledgeable (*Envir Knowledge*) were around 9.6 percent more likely to choose *No Plastic* or *USDA Certified Biobased* and 11.5 percent more likely to choose *Compostable*. In addition to the demographic variables, attitudes and beliefs variables had significant marginal effects on probabilities of choosing the dinnerware attributes as important. For example, compared with a person who strongly disagrees that science and technology could provide environmental solutions (*Science/Tech*), a person who strongly agrees with this statement is estimated to be 23.6 percent more likely to choose *Compostable*. This increase in agreement with *Science/T*ech is estimated to increase probability of choosing *No Plastic* or *USDA Certified Biobased* by 20 percent. Also, compared with a person who strongly disagrees that the survey results could influence product offerings (*Consequences*), a person who strongly agrees with this statement is estimated to be 40.8 percent more likely to choose *Compostable*. This increase in agreement with *Consequences* is estimated to increase probability of choosing *No Plastic* or *USDA Certified Biobased* by 34.4 percent.

Fig. 3 illustrates how the level of *ENVIR* influences the probabilities of choosing the disposable dinnerware attributes as important. The curves that increase more steeply as *ENVIR* increases reflect attributes that have a wide appeal, even among those with low levels of preferences for environmental attributes (*ENVIR*). Notably, the probabilities of *No Plastic* and *Recyclable* being chosen emerge at relatively low levels of *ENVIR*. This suggests wide appeal of these attributes among consumers, even at low levels of *ENVIR*. The attribute *Compostable* emerges rapidly among consumers with moderate levels of *ENVIR*. The probability curve for *No Trees* increases the most slowly as *ENVIR* increases, suggesting that this attribute may be popular only among those with stronger preferences for perceived eco-friendly attributes.

The estimated logit model of the probability of the respondent indicating five or greater eco-friendly attributes would be important to their disposable dinnerware decision is shown in Table 4. The LLR test indicates the model is significant overall. The pseudo-R^2 is 0.156 and the model correctly classifies 71.4 percent of the observations. The estimated coefficients are in column 2, with asterisks indicating coefficient significance. The estimated marginal effects of each variable on the probability of selecting five or greater eco-friendly attributes are shown in column 3. These were calculated using the data, estimated coefficients, and equation 7. The asterisks indicate the statistical significance of each estimated coefficient and marginal effect.

Table 4
Estimated Logit Model of Probability of Choosing Five or Greater Disposable DinnerwareAttributes as Important and Marginal Effects[a]

	Probability of Choosing Five or Greater Attributes as Important:			
Variables	Estimated Coefficients		Marginal Effects	
Intercept	-3.49	***	—	
Female	-0.793	*	-0.158	*
Age	0.021	*	0.004	*
Rural/Small Town	-0.787	**	-0.157	**
Children	0.724	**	0.144	**
College Graduate	0.191		0.038	
Household Income	0.004		0.001	
Disp. Expend. Pct of Income	-0.047		-0.009	
Envir. Knowledge	0.659	*	0.132	**
Personal Actions	-0.240		-0.048	
Science/Tech	0.078		0.016	
Future Generations	0.214		0.043	
Consequences	0.683	***	0.136	***
Log likelihood = -120			Pseudo R^2 = 0.156	
LLR test against intercept only Chi^2(12df) = 44.5***	Percent Correctly Classified = 71.4%			

a*** indicates significant at α = 0.01, ** indicates significant at α = 0.05, and * indicates significant at α = 0.10.

The marginal effects in the third column of Table 4 show how each variable influences the intensity of preferences for the disposable dinnerware attributes as measured by the respondent choosing at least five of the attributes as important. Being female (*Female*) negatively affects the probability of choosing at least five attributes as important by 15.8 percent compared with males. Residing in a rural area or small town (*Rural/Small Town)* also has a negative impact. Compared with metro or suburban respondents, respondents residing in rural/small town areas are 15.7 percent less to choose at least five attributes as important. However, each additional year of age (*Age*) positively influences the probability of choosing at least five attributes by 0.4 percent. Having children in the household (*Children*) positively influences the probability by 14.4 percent compared with households without children. If the respondent believed they had enough knowledge to make informed environmental decisions (*Envir. Knowledge*), they were 13.2 percent more likely to indicate five or greater attributes. Furthermore, if respondents strongly agree the survey results could influence disposable dinnerware manufacturers (*Consequences*) they are 54.4 percent more likely to choose at least five attributes than those who strongly disagree with survey response consequences. These results suggest that the market segments most likely to believe multiple attributes are important in disposable dinnerware are older males residing in an urban area, who have children living with them in the household. These individuals perceive themselves to be knowledgeable enough to make environmentally responsible purchasing decisions, and more likely to agree that this research will encourage disposable dinnerware manufacturers to offer more disposable dinnerware from alternative fibers.

In examining the results, it is important to note that this study has several limitations. First, the study region was limited to Tennessee. Effective marketing of these emerging products would require a national study of consumers' preferences. Second, female response was disproportionate to males. Additional research should stratify the sample according along gender lines. As the results are examined, these caveats should be kept in mind. Third, additional research might include focus groups to identify which attributes are identified as most eco-friendly and are most valued by shoppers. Fourth, additional research should likely include other dinnerware attributes, such as sturdiness, absorption, and other functionality attributes. Furthermore, the study did not include price effects. Additional research should extend this research by integrating prices along with the attributes in the study using a conjoint analysis to elicit willingness to pay for attributes in a disposable dinnerware product.

4. Conclusions

With a variety of product alternatives and labels being introduced into the market, it is helpful to build an understanding of how different segments of consumers perceive the importance of eco-friendly attributes in disposable dinnerware. Shoppers are more frequently offered the opportunity to purchase disposable dinnerware that is recyclable, compostable, made from organic cellulose, or cellulose from alternative fibers to trees. With paper plates and cups landfilled at rates of 40 percent, and plastic ware at 80 percent, wider acceptance of market-based alternatives could help reduce some of these landfilling rates. Some consumers may prefer to purchase products made from fibers from sources (crop byproducts or fast-growing dedicated crops) that are alternatives to tree harvest. Some single-use disposable dinnerware items are being registered as USDA Certified Biobased. This study aimed to provide information about which attributes (among eight offered), might be most important to consumers. The study also provides a market profile of consumers who might be more likely to believe these attributes are important in disposable dinnerware.

The results have several implications for the associated market. First, consumers appear to prefer strongly products being recyclable and containing no plastic, with nearly 68 percent choosing these attributes as important. An interesting finding is that disposable

dinnerware made from crop byproducts or dedicated crops were about equally acceptable to consumers. One might posit *a priori* that consumers believe that using crop byproducts would be more eco-friendly than producing dedicated crops for their cellulose; however, this did not appear to be the case. This suggests that disposables derived from cellulose from crop byproducts such as wheat straw or bagasse may be about equally acceptable as disposables derived from cellulose from crops produced specifically for their cellulose. Perhaps consumer education about the benefits of using crop byproducts, instead of, for example, burning them for disposal or landfilling might help differentiate these two sources of cellulose. Also, despite the 'no trees' label already being used in the marketplace, this label held the narrowest appeal of all the attributes, appealing to less than half the consumers. The results regarding relative importance of these attributes to consumers could help inform disposable dinnerware manufacturers in prioritizing market provision of dinnerware with the respective attributes.

Furthermore, the results from this study provide information about market segments which may place greater importance on the attributes. This information could be helpful in target marketing disposable dinnerware products with the associated attributes. Male, urban, those with children in the household, and having higher incomes have a greater propensity to view the dinnerware attributes as important. The findings are consistent with those from prior research about consumer preferences for eco-friendly packaging with the exception of gender. In several studies, female gender has been found to positively influence preferences for ecofriendly packaging. One potential reason may be the differences in product, being disposable dinnerware rather than packaging material. However, this result merits further investigation.

Those self-described as environmentally knowledgeable are more likely to select the dinnerware attributes. Those with greater confidence that science and technology would come up with ways to solve environmental problems are also more likely to select the dinnerware attributes as important. This could indicate that consumers who are confident of product innovation and development are more likely to believe the dinnerware attributes are important. This confidence in the ability of the industry to adapt is likely reflected in the positive effect of beliefs in consequentiality of the survey results. In other words, consumers who believe their responses are likely to be used in product development by the industry are more likely to believe the dinnerware attributes are important.

While this study represents a case study for a state-level geographic region, because so few studies have examined consumer preferences for disposable dinnerware, future research is needed on a national scale to fully measure the consumer preferences for eco-friendly attributes in disposable dinnerware. Future research should likely also include environmental impact information about the attributes, such as Life Cycle Analysis, to quantify more fully potential environmental impacts of attributes. In addition, future research should investigate the influence of the attributes considered on consumers' willingness to purchase a disposable dinnerware product. Additional research should also consider consumer willingness to pay premiums for disposable dinnerware with eco-friendly attributes compared with conventional disposable dinnerware.

Credit Author Statement

Mackenzie Gill: Data curation, Estimation, Writing-Original draft preparation; Kimberly L. Jensen: Conceptualization, Methodology, Data collection; Data curation; Dayton Lambert: Writing- Methodology, Original draft preparation; Sreedhar Upendram: Conceptualization, Survey Development; Burton C. English: Conceptualization, Survey Development; Nicole Labbé: Conceptualization, Survey Development; Samuel W. Jackson: Conceptualization, Survey Development and R. Jamey Menard-Survey Development, Original draft preparation;.

Funding

This research was funded in part by the US Federal Aviation Administration (FAA) Office of Environment and Energy as a part of ASCENT Project 1 under FAA Award Number: 13-C-AJFEUTENN-Amd 5. Funding also was provided by the United States Department of Agriculture through Hatch Projects TN000444 and OKL03125, and the Sparks Endowed Chair for Agricultural Sciences & Natural Resources. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the FAA or other ASCENT sponsor organizations

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.resconrec.2020.104965.

References

Arboretti, R., Bordignon, P., 2016. Consumer preferences in food packaging: CUB models and conjoint analysis. Fabio Verneau and Professor Christopher J., ed. British Food J 118 (3), 527–540. https://doi.org/10.1108/BFJ-04-2015-0146.

Barnes, M., Chan-Halbrendt, C., Zhang, Q, Abejon, N., 2011. Consumer preference and willingness to pay for non-plastic food containers in Honolulu, USA. J Envir. Protect. 2 (9), 1264–1273. https://doi.org/10.4236/jep.2011.29146.

Bollen, K.A, 1989. Structural Equations with Latent Variables. New York: Wiley.

Casadesus-Masanell, R., Crooke, M., Reinhardt, F., Vasishth, V., 2009. Households' willingness to pay for 'green' goods: evidence from Patagonia's introduction of organic sportswear. J. Econ. Mgmt. Strat. 18 (1), 203–233. https://doi.org/10.1111/j.1530-9134.2009.00212.x.

Dell'Anno, R., Schneider, F., 2004. The Shadow economy of Italy and other OECD countries: qhat do we know? University of Linz, Department of Economics.

Dilkes-Hoffman, L., Pratt, S., Laycock, B., Ashworth, P., Lant, P., 2019. Public attitudes towards plastics. Resour. Conserv. Recycl. 147, 227–235. https://doi.org/10.1016/j.resconrec.2019.05.005.

Ertz, N., Huang, R., Jo, M., Karakas, F., Sarigollu., E, 2017. From single-use to multi-use: study of consumers' behavior toward consumption of reusable containers. J. Environ. Mgmt 193 (15), 334–344. https://doi.org/10.1016/j.jenvman.2017.01.060.

Food Marketing Institute. 2015. US grocery shopper trends 2015 executive summary. https://www.fmi.org/docs/default-source/document-share/fmitrends15-exec-summ-06-02-15.pdf. (accessed June 13, 2019).

Greene, W., 2018. *Econometric Analysis* (8th Edition). New York: Pearson.

Herbes, C., Beuthner, C., Ramme, I., 2018. Consumer attitudes towards biobased packaging – A cross-cultural comparative study. J. Cleaner Prod. 194, 203–218. https://doi.org/10.1016/j.jclepro.2018.05.106.

Jahani, A., Dehdari, T., Farzadkia, M., Mansourian, M., 2019. Iranian experiences in terms of consumption of disposable single- use plastics: introduction to theoretical variables for developing environmental health promotion efforts. Environ. Toxicol. Pharmac. 65, 18–22. https://doi.org/10.1016/j.etap.2018.11.004.

Kainz, U.W., 2016. Consumers' willingness to pay for durable biobased plastic products: findings from an experimental auction. Unpublished, Technical Paper. University of Munich.

Klaiman, K., Ortega, D.L., Garnache, C., 2016. Consumer preferences and demand for packaging material and recyclability. Resour. Conserv. Recycl 115, 1–8. https://doi.org/10.1016/j.resconrec.2016.08.021.

Klein, F., Emberger-Klein, A., Menrad, K., Möhring, W., Blesin, J.M., 2019. Influencing factors for the purchase intention of consumers choosing bioplastic products in Germany. Sustain. Prod. Consump 19, 33–43. https://doi.org/10.1016/j.spc.2019.01.004. July.

Kurka, S., Menrad, K., 2009. Bio-refineries and bio-based products from the consumer's point of view. Paper presented at 13th ICABR Int'l. Conf. on Agric. Biotech., Italy, June.

Kutner, M., Nachstsheim, Neter, J., 2004. Applied Linear Regression Models, 4 ed. McGraw-Hill Irwin.

Lambert, D., Paudel, K, Larson, J., 2015. Bundled adoption of precision agriculture technologies by cotton producers. J. Agr. Appl. Econ 40 (2), 325–345.

Loschelder, D., Siepelmeyer, H.Fischer, D., Rubel, J., A., 2019. Dynamic norms drive sustainable consumption: norm-based nudging helps café customers to avoid disposable to-go-cups. J. Econ. Psych. https://doi.org/10.1016/j.joep.2019.02.002. February.

Maddala, G.S., 1983. Limited-Dependent and Qualitative Variables in Econometrics. Cambridge University Press, Cambridge, UK.

Martinho, G., Pires, A., Portela, G, Fonseca, M., 2015. Factors affecting consumers' choices concerning sustainable packaging during product purchase and recycling. Resources, Conserv. Recycl. 103, 58–68. https://doi.org/10.1016/j.resconrec.2015.07.012.

Orset, C., Barret, N., Lemaire, A., 2017. How consumers of plastic water bottles are responding to environmental policies? Waste Mgmt 61, 13–27. https://doi.org/10.1016/j.wasman.2016.12.034.

Sijtsema, S.J., Onwezen, M.C., Reinders, M.J., Dagevos, H., Partanen, A., Meeusen, M., 2016. Consumer perception of bio-based products—An exploratory study in 5 European countries. NJAS - Wageningen J. Life Sci. 77, 61–69.

Skrondal, A., Rabe-Hesketh, S., 2004. Generalized Latent Variable Modeling: Multilevel, Longitudinal, and Structural Equation Models. Boca Raton, FL: Chapman & Hall/CRC.

StataCorp, 2015. Stata Statistical Software: Release 14, *Version SE*. College Station, TX: StataCorp LP.

Yue, C., Hall, C., Behe, B., Campbell, B., Dennis, J., Lopez, R., 2010. Are consumers willing to pay more for biodegradable containers than for plastic ones? Evidence from hypothetical conjoint analysis and nonhypothetical experimental auctions. J. Agr. Appl. Econ 42 (4), 757–772.

U.S. Department of Commerce, Bureau of the Census. 2019. United States Population Census. Washington D.C. https://data.census.gov/cedsci/. (accessed May 31, 2019).