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## **A Probit Model Analysis of Factors Affecting Consumption of Fresh Sweet Corn in Major U.S. Markets**

by  
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**ABSTRACT:** In an effort to more effectively utilize its resources to promote fresh sweet corn, the Fresh Supersweet Corn Council contracted with the Florida Agricultural Market Research Center (FAMRC) of the University of Florida to conduct a comprehensive consumer survey. The consumer survey was designed to investigate consumer preferences, attitudes, and behavior regarding the purchase and consumption of fresh sweet corn. A total of 1,031 consumer telephone interviews were conducted in Dallas, Atlanta, Chicago, Boston and Philadelphia between September 7 and November 3, 2001. Respondents' revealed very limited consumption in the winter, spring, and fall seasons and consumers' perceptions that sweet corn is not available in these seasons. Probit models are estimated to determine effects of seasonality, demographics, and promotional materials on consumption of fresh sweet corn.

**KEYWORDS:** sweet corn, Florida, market development, consumer survey

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## **INTRODUCTION**

Canned, frozen and fresh markets represent available marketing channels for sweet corn producers in the United States. The fresh market represents two-thirds of the total crop value for sweet corn. According to the Economic Research Service of the U.S. Department of Agriculture, 246,900 acres of fresh market sweet corn were harvested in the U.S. in 2000 (Lucier and Lin). Figures from the Florida Agricultural Statistics Service reveal that Florida production leads the nation, with sweet corn receipts totaling over \$121 million in 2000 (FASS). Florida accounted for 22 percent of U.S. production of fresh sweet corn during 1998-2000. The value of sweet corn produced in Georgia in 1999 reached almost \$53 million, and its 1998-99 production represented 13 percent of U.S. fresh sweet corn (Lucier and Lin).

Members of the Fresh Supersweet Corn Council (FSCC) [formerly the Southern Supersweet Corn Council], an organization of sweet corn growers and shippers from Florida, Georgia, and Alabama, are the primary suppliers of fresh sweet corn in the United States from late fall through early July, and are virtually the sole suppliers of fresh sweet corn shipped east of the Mississippi River during this same marketing period. The majority of Florida's sweet corn production (over 30,000 acres) takes place in South Florida (IFAS). Production then moves to areas of northern Florida, into South Georgia and parts of Alabama to supply fresh market sweet corn from late May until early July.

Sixty percent of fresh market sweet corn grown in the U.S. is marketed from May to August with the highest volume in July. Only about ten percent of volume is marketed during the winter months (January to March) (Lucier and Lin). Peak shipments take place to meet demand for the Memorial Day and the 4<sup>th</sup> of July holiday periods. During

these holiday times fresh sweet corn is in high demand and retailers promote it heavily. However, Florida growers faced a marketing challenge in convincing consumers to increase their year-round purchases of fresh sweet corn.

Although the sweet corn industry had increased consumption of its product through innovations like the introduction of supersweet varieties and convenient tray-packed corn, there remained several factors limiting growth of the industry. The continuing trend of increased food purchases taking place outside the home may have had a significant adverse effect on future purchases of fresh sweet corn. According to a 1994-1996 USDA survey, 87 percent of fresh sweet corn purchases were made at the retail level for home consumption (Lucier and Lin). However, as of 1998, 38 percent of the consumer's food dollar was spent away from home (ERS). Further, between 1990 and 1998, real spending on food away from home increased almost 25 percent, whereas real spending on food at home increased less than five percent (Clausen). Other factors, such as product proliferation and convenient ready-to-eat items in supermarket produce sections, combined with the sweet corn industry's inability to gain a substantial share in the foodservice market, have adversely affected sweet corn producers' marketing opportunities and resulted in a shrinking share of the consumer food dollar.

In addition to these issues, Florida growers faced a unique concern - significant seasonality in the demand for fresh sweet corn during the Florida marketing period. Understanding the forces influencing consumer demand during their time of production will aid them in designing an effective marketing strategy to expand sales of fresh Supersweet corn.

In order to better utilize marketing dollars, the Fresh Supersweet Corn Council contracted with the Florida Agricultural Market Research Center (FAMRC) to obtain quantitative and qualitative information on consumer preferences and purchasing habits. The FAMRC designed comprehensive consumer surveys to investigate consumer preferences, attitudes, and behavior regarding the purchase and consumption of fresh sweet corn. The goal of this research was to assist the sweet corn industry in defining their market position, and to design a competitive market strategy that will utilize inherent advantages to improve firm performance.

## **OBJECTIVES**

The basic goal of this study was to gain a better understanding of how consumer characteristics, buying habits, usage patterns, and perceptions of quality and availability of sweet corn translate into consumer demand behavior. Using cross-sectional household data obtained from a consumer survey, probit estimates were used to reveal important factors influencing consumers' decisions to buy fresh sweet corn. The probit model analyzed purchasing decisions based upon consumer satisfaction with produce availability and selected demographics. The demographics included city of residence, number of years respondent has resided in the city, household size, the presence of children in the household, education, age, gender, income, and race. The model allowed for comparison and ranking of factors positively or negatively affecting the purchase of fresh sweet corn.

This research provided information about factors influencing the probability of consuming fresh sweet corn and the frequency of purchasing fresh sweet corn. Results

identified marketing strategies designed to improve consumer demand for fresh sweet corn during non-traditional seasons.

## **METHODOLOGY**

After meeting with several major sweet corn growers and shippers in Florida, a consumer questionnaire was designed by the FAMRC in conjunction with the Florida Survey Research Center (FSRC) and a representative of the Fresh Supersweet Corn Council. The questionnaire was pre-tested by FSRC and was reviewed and approved by the University of Florida's Institutional Review Board's Committee for the Protection of Human Subjects.

This survey sampled approximately 200 households in each of five major market areas where FSCC-grown corn is shipped: Dallas, Atlanta, Chicago, Boston, and Philadelphia. Trained, professional interviewers interviewed primary food shoppers by telephone in each of 200 households in each city. Clustering the consumer interviews facilitated statistical analyses of differences in consumer purchasing, storing and preparation methods. In addition to geographical dispersion, these areas provided significant racial and ethnic diversity within the total sample. Moreover, samples contained diversity in terms of education, age, income, and household size. A random digit dialing technique was used to generate residential telephone numbers while avoiding difficulties associated with unlisted numbers.

Consumer interviews took place between September 7 and November 3, 2001. Interviewers attempted to contact each household at various times of the day for a minimum of six times prior to selecting an alternative telephone number. Attempts were made seven days a week at various times of the day (including early evenings) to avoid

over representation of non-working consumers. The average interview lasted approximately ten minutes. Computer-assisted telephone interviewing was used to ensure the immediate, computerized recording of responses. In addition, quality control was exercised in the form of random monitoring of real-time interviews and call back verification of ten percent of completed interviews.

The probit model is a statistical probability model with two categories in the dependent variable (Liao). Probit analysis is based on the cumulative normal probability distribution. The binary dependent variable,  $y$ , takes on the values of zero and one. The outcomes of  $y$  are mutually exclusive and exhaustive. The dependent variable,  $y$ , depends on  $k$  observable variables  $x_k$  where  $k=1, \dots, K$  (Aldrich and Nelson). While the values of zero and one were observed for the dependent variable in the probit model, there was a latent, unobserved continuous variable,  $y^*$ .

$$y^* = \sum_{k=1}^K \beta_k x_k + \varepsilon \quad (1)$$

$\varepsilon$  is IN  $(0, \sigma^2)$

The dummy variable,  $y$ , was observed and was determined by  $y^*$  as follows.

$$y = \begin{cases} 1 & \text{if } y^* > 0, \\ 0 & \text{otherwise} \end{cases} \quad (2)$$

The point of interest relates to the probability that  $y$  equals one. From the above equations, we see that:

$$\begin{aligned} \text{Prob}(y=1) &= \text{Prob} \left( \sum_{k=1}^K \beta_k x_k + \varepsilon > 0 \right) \\ &= \text{Prob} \left( \varepsilon > - \sum_{k=1}^K \beta_k x_k \right) \\ &= 1 - \Phi \left( - \sum_{k=1}^K \beta_k x_k \right) \end{aligned} \quad (3)$$

Where  $\Phi$  was the cumulative distribution function of  $\varepsilon$  (Liao).

The probit model assumed that the data were generated from a random sample of size  $N$  with a sample observation denoted by  $i$ ,  $i = 1, \dots, N$ . Thus the observations of  $y$  must be statistically independent of each other to rule out serial correlation. Additionally,

it was assumed that the independent variables (the responses to the consumer survey questions) were random variables.

The Maximum Likelihood Estimation (MLE) technique was used to estimate probit model parameters. MLE focused on choosing parameter estimates that gave the highest probability or likelihood of obtaining the observed sample  $y$ . The main principle of MLE was to choose as an estimate of  $\beta$  the set of  $K$  numbers that would maximize the likelihood of having observed this particular  $y$  (Aldrich and Nelson).

The demographic variables included in the probit model were: the respondent's city of residence, level of education, income, race, gender, the number of years the respondent had resided in the city, household size, the presence of children in the household, and primary food purchaser's age. Additionally, the respondent's level of satisfaction with the availability of fresh fruits and vegetables in the store where he or she shopped most frequently was included as an explanatory variable in the model.

The specification of the probit model was as follows.

$$y^*_{ki} = \beta_{k0} + \beta_{k1} \text{cit1} + \beta_{k2} \text{cit2} + \beta_{k3} \text{cit3} + \beta_{k4} \text{cit4} + \beta_{k5} \text{edu1} + \beta_{k6} \text{edu2} + \beta_{k7} \text{inc1} + \beta_{k8} \text{rac1} + \beta_{k9} \text{rac2} + \beta_{k10} \text{gen1} + \beta_{k11} \text{q24} + \beta_{k12} \text{hwz} + \beta_{k13} \text{chd} + \beta_{k14} \text{age1} + \beta_{k15} \text{age3} + \beta_{k16} \text{sat1} + \beta_{k17} \text{sat2} \quad (7)$$

$$y = \begin{cases} 1 & \text{if respondent's household buys fresh sweet corn} \\ 0 & \text{if respondent's household does not buy fresh sweet corn} \end{cases} \quad (8)$$

The probit model was used both to estimate the impact of the independent variables on consumer behavior regarding the purchase of fresh sweet corn., and to predict probabilities of change in consumer purchasing behavior under several simulated variable levels.



## RESULTS

Because this study was designed to reveal the difference in consumption behavior across various demographic groups, some over-sampling occurred. In order to capture cultural differences, a new variable that combined race and ethnicity was employed to identify Hispanics apart from other racial categories. Under this definition, “Black” refers to non-Hispanic Black, “White” represents only non-Hispanic Whites, and the Hispanic category represents those of Hispanic ancestry regardless of their race. The race/ethnicity variable also had an Asian category, but the five American Indians in the sample and the rest of those in the “Other” racial category (28 respondents) were grouped in the White category. Non-Hispanic Blacks accounted for 27.8 percent of the sample, non-Hispanic Whites were 59 percent, Hispanics, 10.1 percent, and Asians made up 3.1 percent.

Educational attainment was classified into two categories, “high school” and “college”. The high school category contained all those with less than a high school diploma, high school and vocational school graduates. The college category included all respondents that attended or graduated from college. The high school category accounted for 30.5 percent of the sample, compared to 69.5 percent in the college category. Households earning at least \$70,000 made up the largest income group (28 percent of the sample), followed by households earning between \$35,000 and \$49,999 (23 percent) and \$20,000 to \$34,999 (20.9 percent). Households earning less than \$20,000 constituted 12.6 percent of the sample.

Approximately 40 percent of the sample was between 18 and 34 years of age, while two-thirds of the respondents were younger than 50 years of age. Two-thirds of the households had no children, while slightly less than half the households (46.5 percent)

had exactly two adults. The mean household size was 2.8 people. The sample contained nearly twice as many females (64.5 percent) as males (35.5 percent).

The cities chosen for this study varied significantly across all the demographic variables. Income varied significantly across cities; respondents in Boston and Atlanta had the highest proportion of households with incomes of \$70,000 or higher. Thirty-five percent of households in Boston and 31 percent in Atlanta had incomes above \$70,000 compared to 19 percent in Philadelphia and 26 percent in Dallas. Conversely, 14 percent of households in Philadelphia and 13 percent in Dallas had incomes below \$20,000, compared to 12 percent and 9 percent for Boston and Atlanta. Chicago had the smallest middle-income group with disproportionately large fractions having incomes below \$20,000 and above \$50,000.

In the overall sample, 667 households (67.7 percent) bought sweet corn at least once a year. The pattern of sweet-corn consumption, however, varied significantly across nearly every demographic. In general, the proportion of sweet corn buyers increased with household size, income and education. Middle-aged consumers were more likely to buy sweet corn than young consumers, and women were slightly more likely to buy than men.

The likelihood of a household buying sweet corn varied significantly among the five cities. Residents of Chicago and Philadelphia were most likely to buy sweet corn, with 73.6 percent of respondents and 72.3 percent, respectively, buying sweet corn, compared to lows of 62.2 percent in Dallas and 63.8 percent in Boston. Consumers in Chicago and Philadelphia also tended to buy larger quantities in each purchase. The average number of ears purchased per shopping occasion was 8.0 and 7.3 in Philadelphia

and Chicago, respectively. In contrast, consumers in Dallas typically bought 5.3 ears of corn per shopping trip. Another important component in total sales of sweet corn was the number of times per year that consumers buy sweet corn. Briefly, consumers in Philadelphia bought sweet corn more frequently than did consumers in other cities, but those in Chicago did not.

There were large age differences among those who bought sweet corn. Approximately 80 percent of individuals between 35 and 64 years of age buy sweet corn. Only 56.5 percent of those between 18 and 34 years of age bought sweet corn, while 62.3 percent of those 65 and older bought it. Household size was associated with the decision to buy sweet corn. Households with only one adult and households with no children bought corn 61 percent and 64.5 percent of the time, respectively. On the other hand, more than 71 percent of households with two or more adults bought corn, and over 76 percent of households with children bought sweet corn. Gender was also a significant factor in the decision to buy sweet corn, with 69.8 percent of women buying sweet corn, versus 63.8 percent of men.

When the 333 (or 32.3 percent) non-consumers were queried as to their reasons for not buying fresh sweet corn, only three percent of respondents mentioned a high price as a reason. Thirty percent of all those who did not buy sweet corn gave taste as the reason. Twenty-two percent were concerned with the amount of preparation time or inconvenience, with an additional seven percent bothered by the messiness. Eight percent were concerned by a lack of freshness, while seven percent do not cook, and seven percent preferred canned or frozen corn. Dental concerns were cited by five percent as a reason not to buy sweet corn, with a majority of these in the oldest age group.

Using the consumer survey data and maximum likelihood procedures, the probit model was estimated. The R-squared revealed that just over eleven percent of consumers' decisions to purchase fresh sweet corn are explained by the model. The estimates showed that several demographic factors had a statistically significant impact on the consumption of fresh sweet corn. An income level of less than \$35,000 per year had a negative impact on the consumption of fresh sweet corn. This relationship between income and the demand for fresh sweet corn was consistent with economic theory and the demand for a normal good. Respondents under the age of 30 had a significantly negative effect on the purchase of fresh sweet. Respondents' race also appeared to play a significant role in the purchase of fresh sweet corn. Both black and white consumers were more likely to purchase fresh sweet corn than the average consumer. Household size had a positive statistically significant impact on the decision to buy fresh sweet corn. The presence of children in the household also had a statistically significant positive effect on fresh sweet corn consumption, as expected.

Although slightly over two-thirds of all households bought sweet corn at some time during the year, examination of purchases on a seasonal basis reveals drastic intra-seasonal differences. For example, during the summer months, nearly all of the sweet corn purchasing households purchased it (97.5 percent). However, during the winter, only 36.5 percent of the households reported buying sweet corn. In the spring months, the percentage of households buying it increased to just over 70 percent, and in the fall, about half of the fresh sweet corn purchasing households bought the product.

Respondents in sweet corn consuming households were queried as to why they bought sweet corn in the winter, spring and fall seasons, and the reasons given were quite

similar over all three seasons. “Good taste” was by far the most common reason, cited by just over half all purchasers in the winter and spring seasons, and just fewer than 60 percent in the fall. “Habit” was the second-most mentioned reason, given by 8 to 13 percent, depending on the season. “Freshness” was the third most frequent response, given by approximately 7 to 10 percent of all respondents. “Adds variety” and “Health/nutrition” reasons were cited by similar numbers of respondents, approximately 3 to 6 percent of the sweet corn buying households in the various seasons. About 3 or 4 percent of respondents indicated that they bought fresh sweet corn because they needed it for specific recipes. “Low price” was the reason listed by about 2 percent of respondents in the winter, spring and fall seasons, and “Availability” was mentioned by a few, about one percent. Very small numbers cited specific physical attributes such as appealing color, good smell, and tenderness, and only two respondents mentioned advertising as a reason for buying fresh sweet corn.

While it is important to understand why people buy sweet corn during FSCC’s prime marketing seasons, it is even more important to identify those reasons why some consumers do not. Respondents from all households that said they did not buy fresh sweet corn during the winter, spring and fall seasons were asked for the “Main reason” why they did not buy. The overwhelming majority said that it was not available where they usually shop for produce. Nearly 70 percent of the winter “non-buyers” cited lack of availability, as compared to about 57 percent of the spring “non-buyers” and 63 percent of the fall “non-buyers”.

“Lack of freshness” was the second most frequent reason given, mentioned by about 12 to 14 percent of all non-buyers. “High prices” were the third most frequent

reason, given by about 5 percent of the non-buyers. “Not locally grown” and “Do not like taste” were the next most important reasons cited for not buying winter, spring, and fall sweet corn, mentioned by 4 to 8 percent of the respondents. Other reasons, given by extremely small numbers of respondents, included “preparation time”, “diet/health concerns”, “short shelf life”, “too messy”, “packages too large”, and “damaged product”.

Probit model examinations of seasonal purchase behavior by race and ethnicity revealed statistically significant and consistent differences. In the winter, approximately half of the black non-Hispanics and half of the Hispanic respondents said they purchased sweet corn, compared with only 28 percent of the white non-Hispanics and one-third of the Asian respondents. In the spring, about 85 percent of the blacks and 83 percent of the Hispanics purchased sweet corn, compared with only 63 percent of the whites and about 53 percent of the Asians. The fall showed the same general pattern, with 60 percent of the blacks, 55 percent of the Hispanics, 45 percent of the whites, and 40 percent of the Asians buying fresh sweet corn. Summer was the only season when whites had a higher purchase rate than blacks or Hispanics.

Probit models provided a means to examine the probability of certain events occurring given a particular set of conditions or range of explanatory variables. The estimated probit model can be used to predict the probabilities of change in consumer behavior over a range of independent variable values. (Verbeke, Ward, and Viaene) The impact individual explanatory variables had on the decision to purchase fresh sweet corn can be evaluated through probit model simulations.

A base with a clearly defined set of explanatory variables was established and applied to the estimated model. Changes in the probability of consuming fresh sweet

corn reveal factors affecting the demand for the product. The base fixed almost all the explanatory variables at their average value. City of residence, level of education, income, race, gender, satisfaction with produce availability, the number of years the respondent has lived in the city, and household size, and presence of children were set at their average. The base value set for the age variable was 30 to 55 years of age, which allowed for comparison of those under 30 and those over 55 years old. Using this base, the impact from changing each discrete variable value from zero to one and adjusting each continuous variable, while holding all other variables constant at their base value is illustrated.

Income level did have a substantial impact on the consumption of fresh sweet corn. Survey respondents with a total annual household income before taxes of less than \$35,000 had an almost 12 percent lower probability of purchasing fresh sweet corn. Those with income levels greater than \$35,000 per year increased their probability of consuming by over 10 percent. Black respondents as well as white respondents have an increased probability of consuming fresh sweet corn. Also of note is that respondents of other races had a much lower probability of purchasing fresh sweet corn, over 25 percent below the base probability of consumption.

As household size increased, so did the probability of purchasing fresh sweet corn. The presence of children in the household was an important component of the decision to purchase fresh sweet corn. This probability was almost 14 percent higher than the base. Households without children had a 15 percent lower probability of buying fresh sweet corn. Respondents over 55 years of age exhibited a probability of consumption that was very close to the base value age level of 30 to 55 years of age.

However, those respondents 18 to 30 years of age had a probability of purchasing almost 28 percent below the base value.

Numerous other explanatory variables had a statistically significant impact on the frequency of consumption of fresh sweet corn. Habit was the most important reason consumers purchase fresh sweet corn in any given season. Good taste, freshness, or tenderness were found to be statistically significant traits determining whether sweet corn was purchased during the winter months. Magazines were an important source of information about fresh sweet corn for consumers during the winter months.

Several factors had a statistically significant impact on the frequency of purchase during the spring. Significant demographic factors included household size and an age of over 55 years. Consumers that were “Somewhat satisfied” with overall produce availability purchased fresh sweet corn relatively fewer times per month. This effect was significant at the 99 percent confidence level. A significant positive effect resulted from respondents being not at all satisfied with produce availability. These results revealed the presence of the substitution effect. When consumers were not satisfied with general produce availability, fresh sweet corn consumption became more frequent.

## **SUMMARY AND CONCLUSIONS**

The purpose of this study is to evaluate about factors influencing consumer purchases of fresh sweet corn and the factors positively or negatively affecting consumers’ frequency of purchase in each season. Results are intended to assist the sweet corn industry in developing market strategies to increase consumer demand for its product. In order to achieve these objectives, a probit model for each of the four calendar



seasons was estimated. Simulations were then used to predict probabilities of change in consumer behavior over a range of explanatory variable values.

Using maximum likelihood procedures, probit model parameter estimates revealed several important factors significantly affected consumers' decisions to purchase fresh sweet corn. An income level of below \$35,000 per year and an age of less than thirty have highly significant negative effects on purchasing fresh sweet corn. Therefore, increased marketing efforts targeting young consumers have the potential to attract many new consumers less than thirty years of age. Increasing the proportion of young shoppers buying sweet corn is an essential component of building demand for fresh sweet corn and sustaining future sales.

Probit model simulations also revealed that races other than black and white and the absence of children in the household had substantial negative effects on the probability of buying fresh sweet corn. These simulations also showed that households with children present, the black and white races, and household with an income level above \$35,000 per year exhibited the highest probabilities of being consumers of fresh sweet corn.

Consumer survey results revealed significant seasonality in the purchase of fresh sweet corn. Sweet corn consumers were more likely to purchase the product in the summer than in other seasons and had a higher probability of purchasing more frequently during the summer months. Between 57 and 70 percent of respondents who purchased fresh sweet corn sometime during the year did not buy during the winter, spring, or fall because they believed fresh sweet corn was not available during these times. In order to take advantage of the potential increase in off-season fresh sweet corn consumption,

promotional efforts must focus on informing consumers of the availability of fresh sweet corn. The findings of this research provide motivation and direction for the sweet corn industry to target marketing resources for fresh supersweet corn grown in the Southeast.

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