Consumer Acceptance of Irradiated Produce

by

Danny E. Terry
Assistant Professor
Department of Agriculture
Central Missouri State University
Warrensburg, Missouri

Richard L. Tabor
Professor
Department of Agriculture
Central Missouri State University
Warrensburg, Missouri

Introduction

Food irradiation is a process that uses ionizing radiation to affect physically and interact with the atoms and molecules that make up foods and food contaminants, causing chemical and biological consequences which can be used in beneficial ways (Urbain, 1986). On April 18, 1986, ionizing radiation applications were expanded to include treatment of fresh fruits and vegetables at doses up to 1kGy, or 100 krad (Kader, 1986). At this time, the Food and Drug Administration also required that all irradiated food products sold in retail packages be labeled with a symbol (Figure 1) and the statement, "treated by irradiation" (or "irradiated"). The statement also may describe the type of radiation used, as well as its purpose, e.g. "treated with gamma radiation to extend shelf life." Additional information, such as "this treatment does not induce radioactivity," may be included for educational purposes. Current legislation allows for the removal of the wording "treated by irradiation" (or "irradiated") after April 18, 1988.

Irradiation technology will not solve all the problems of postharvest deterioration of fresh produce. However, it should be considered a possible supplement to refrigeration and other postharvest technology procedures aimed at reducing postharvest losses. Postharvest treatments of fresh fruits and vegetables, which are living tissue, are designed to slow down respiration rates without killing completely. Fresh fruits and vegetables which are relatively tolerant to ionizing-radiation stress at doses less than 1kGy include: apples, cherries, nectarines, peaches, raspberries, strawberries, and tomatoes (Kader, 1986).

Objectives

This report presents results from the first phase of an ongoing project to examine quantitatively consumers' attitudes toward and preferences for irradiated produce. The objectives of the project are to:

1. investigate consumer ability to identify correctly the international irradiation symbol,
2. obtain consumer responses to the concept of food irradiation,
3. determine the impact and effectiveness of additional information on consumers'

Figure 1

INTERNATIONAL SYMBOL FOR IRRADIATED FOODS

perceptions of food irradiation as a value-adding process, and

4. analyze the differences between consumer groups with respect to their willingness to purchase irradiated produce.

Source of Data

Using personal surveys, three contrasting samples were obtained to analyze consumer opinions of irradiated food products. An urban (Kansas City, MO), a suburban (Blue Springs, MO), and a rural (Warrensburg, MO) area were surveyed on three consecutive Saturdays, beginning March 28, 1987. A total of 436 households were interviewed. The person in each household identified as most responsible for food purchasing was questioned. A statistical cluster sampling procedure was used to determine which households were interviewed. The interviewer began by asking the respondent to identify the irradiation symbol. The word "irradiation" was then associated with the logo, and consumer response was again noted. Finally, irradiation itself was briefly described, and additional questions were asked.

Identifying the Irradiation Symbol

After associating certain food products with the irradiation logo, the symbol without the wording "irradiated" was shown, and the respondent was asked to explain its significance. Consumer responses are listed in Table 1. Only 2.8 percent knew what the symbol truly represented; 13.5 percent of the food purchasers identified the symbol as a trademark or brand emblem, while 17.7 percent thought that it was associated with freshness and higher quality. A total of 44 percent made no attempt to identify the logo.

In the second stage of questioning, the situation was repeated with the wording "irradiated" identified with the symbol. Respondents were again asked to explain the emblem's significance. Table 2 documents substantial changes in consumer responses. Responses to the identified irradiation symbol were much more varied than responses to the unidentified symbol. Of particular interest is the fact that most of the responses did not associate the identified symbol with the process of irradiation. However, the ratio of positive to negative responses was much lower when the logo was identified with the word "irradiated."

Consumer Preferences

Inquiries were made to determine consumer preferences for irradiated produce. The questions were constructed so that consumers would compare different prices of irradiated produce with a fixed price for non-irradiated produce. After showing the respondent the irradiation symbol without the word "irradiated," the researcher read the following statement:

> Assume you are in your preferred grocery store. You plan to buy a certain produce item, but there are two groups of the product. One group of produce has stickers on it, while the other does not. Other than the sticker, all the particular fresh produce items appear to be the same and have the same price per pound. From which group of fresh produce would you buy?

Only the irradiation logo, without the word "irradiation" was shown. The same situation was again presented, except the price of the produce with the irradiated symbol was $.03 more per pound than the non-irradiated produce. The same situation was presented for a third time with the only difference being that the price of the produce with the logo was $.03 lower.

At equal prices, results indicated that 33 percent of the food buyers preferred produce with the irradiation symbol, 12 percent preferred the produce without the sticker, and 55 percent were indifferent (Figure 2). At a $.03 higher price per pound, 17 percent of the buyers were willing to purchase produce with the irradiated symbol, while 75 percent preferred to purchase the produce at a $.03 lower price.

In the second stage of questioning, the food buyers were shown the symbol with the wording "irradiated" around it. The buying

Table 1. Initial Consumer Responses to the Unidentified Irradiation Symbol

Consumer Response	Number of Respondents	Percent of Respondents
No idea/don't know/nothing	192	44.0
Fresh/freshness/better quality	77	17.7
Trademark/logo/brand name	59	13.5
Seal of approval/inspection sticker	16	3.7
Irradiation of food/irradiated	12	2.8
Monitored/inspected/graded product	9	2.1
Natural preservatives/without preservatives	8	1.8
USDA quality assurance/government inspected	8	1.8
Agricultural product	6	1.4
Sun ripened/sun grown	6	1.4
Growers association sticker	6	1.4
Growing technique	5	1.1
Treated with something	5	1.1
All natural food/home grown	4	0.9
Area grown/growing area	4	0.9
Safe to eat	4	0.9
Processed/processing of some kind	3	0.7
Growers union/labor union	3	0.7
Healthy/healthier food	2	0.5
Attention getter/marketing ploy	2	0.5
Locally grown	2	0.5
Not safe/problems with product	2	0.5
Nutritional label	1	0.2
TOTAL:	436	100.1*

* Does not equal 100.0 because of rounding error.

Table 2. Initial Consumer Responses to the Identified Irradiation Symbol

Consumer Response	Number of Respondents	Percent of Respondents
Don't know/no idea/nothing	163	37.4
Treated by irradiation/radiation method	48	11.0
Better quality/freshness	25	5.7
Trademark/brand name/logo	14	3.2
Processed/processing of some kind	13	3.0
Warning--not safe/not healthy/dangerous	11	2.5
Treated to preserve freshness	11	2.5
Something to do with the water/irrigation process	11	2.5
Treated with irradiation to preserve freshness	10	2.3
Radioactive/contains radiation in it or on it	9	2.1
Artificial ripening/artificially grown	9	2.1
Sprayed with chemicals/treated with chemical preservatives	9	2.1
Growing method	9	2.1
Something bad/something scary	9	2.1
Treated to kill insects/bacteria/germs	8	1.8
No radiation or radioactivity	8	1.8
Something added/artificial substances added	7	1.6
Inferior product/lower quality	6	1.4
A treatment process/treated	6	1.4
Method of preserving	5	1.1
All natural food	5	1.1
Grown in greenhouse	5	1.1
Exposed to radiation	5	1.1
USDA quality assurance/government inspection sticker	4	1.0
Grown and/or treated in radiation free environment	4	1.0
Contaminated	4	1.0
Pesticide free/chemical free food	3	0.7
No Preservatives	3	0.7
Food subject to X-ray treatment	2	0.5
Naturally ripened	2	0.5
Experimentally grown food	2	0.5
Chemical fertilizer used	1	0.2
Inspected	1	0.2
Area grower's association	1	0.2
Something special	1	0.2
Nutrients removed	1	0.2
Seal of approval	1	0.2
TOTAL:	436	100.1*

* Does not equal 100.0 because of rounding error.

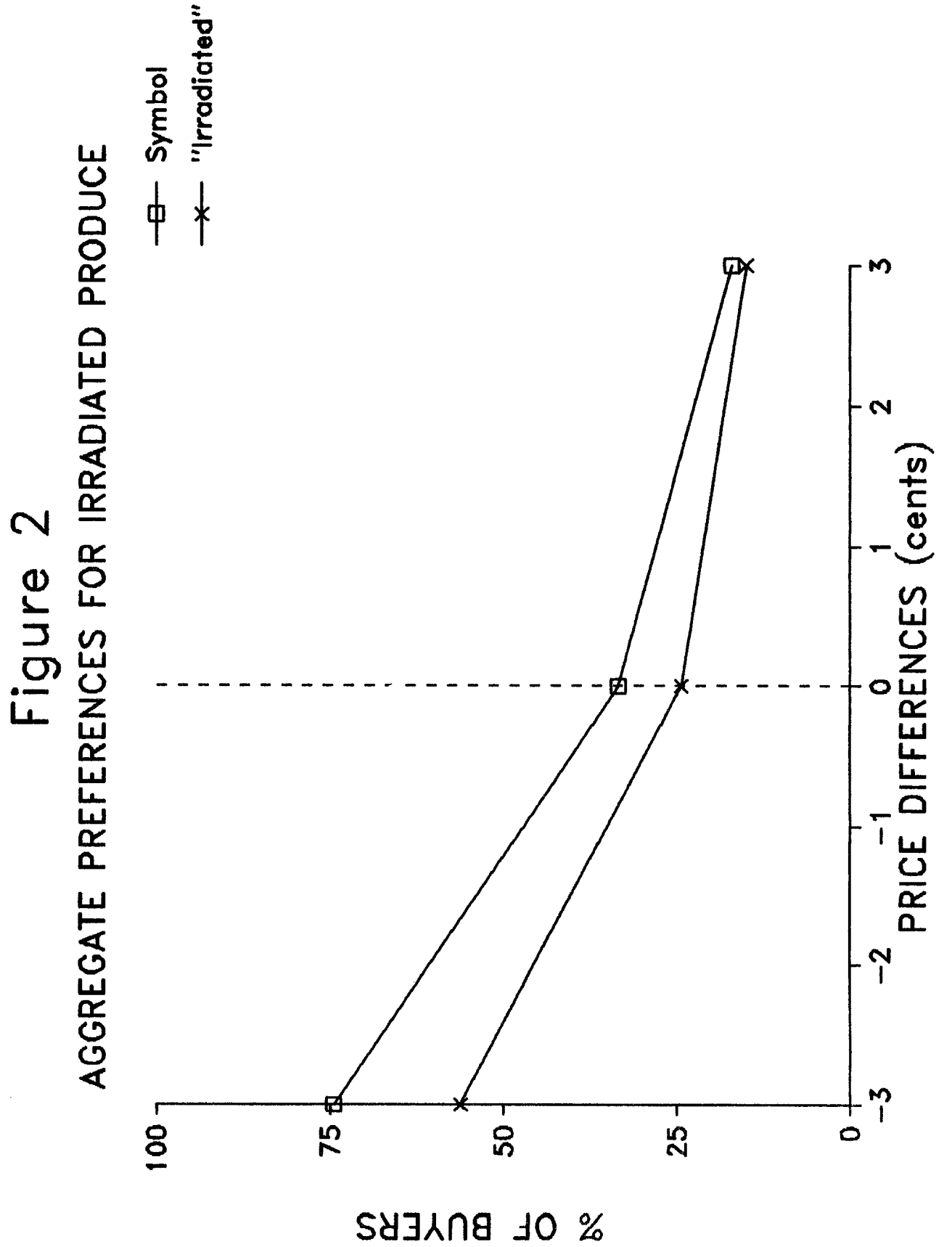
Figure 2
AGGREGATE PREFERENCES FOR IRRADIATED PRODUCE
Symbol
"Irradiated"
% OF BUYERS
100
75
50
25
0
-3
-2
-1
0
1
2
3
PRICE DIFFERENCES (cents)

situation was then repeated using the ±$.03 price range. As Figure 2 shows, use of the term "irradiated" causes a substantial decrease in consumer preference for irradiated produce.

In the next stage of questioning, respondents were again presented with the symbol and the wording "irradiated." In addition, a statement of the purpose of the irradiation was included under the logo (e.g. to control insect infestation, to preserve freshness, and to extend shelf life). Results in Figure 3 indicte that 10 percent of the consumers perceived the additional wording, together with lower prices for irradiated produce, as indicating inferior quality. At equal and higher prices approximately 11 percent of food shoppers associate the additional phrases with a value-adding process. However, a breakdown of three purposes of irradiation showed no substantial differences among them, at equal and higher prices (Figure 4).

Before the final set of questions, the following information was presented to the consumer:

> Food irradiation is a process that utilizes gamma radiation to assist in preservation of food. This form of energy does not make food radioactive or leave radiation in the food. Pallet loads of bulk or packaged food products are automatically transported into radiation fields for controlled time periods, and then brought back into adjacent warehouses, where the products are reloaded on trucks and shipped to their destination. Scientific studies have determined that food irradiation can safely lead to the reduction of spoilage and increased shelf life of fresh produce and to the elimination of chemical additives and fumigants necessary to protect and preserve fresh foods. Food irradiation is currently used in 35 countries, with Japan, USSR, Belgium, and Denmark at the top of the list. Organizations, including the United States Department of Agriculture, the United States Food and Drug Administration, and the World Health Organization, say that foods exposed to relatively low doses are safe for human consumption. The U.S. Food and Drug Administration issued a final regulation, effective April 18, 1986, permitting the irradiation of fresh foods, including fruits and vegetables, for the inhibition of growth and maturation, and for insect disinfestation. Treating foods with irradiation also leads to a reduction of bacteria and pathogens, such as trichinosis in pork. These irradiated products are currently marketed in limited quantities at various food stores in the United States.

This presentation of additional information to the respondents resulted in a dramatic increase in both the acceptance of irradiation and the willingness to pay for what was now perceived to be a value-added process. One should note that at the $.03 higher price per pound for irradiated produce, consumer willingness to buy was now at 48 percent (Figure 5), as compared to only 46 percent for the lower priced non-irradiated produce. Even at a $.10 higher price per pound, 27 percent of the interviewed households stated their preference for the irradiated produce.

At lower prices, female food shoppers (Figure 6) were as willing to buy irradiated produce as their male counterparts. However, male shoppers displayed a greater tendency to purchase irradiated produce at equal or higher prices. After supplementary details about irradiation were presented to household food shoppers, substantial increases in acceptance were noted (Figure 7), especially among males. Interestingly, female acceptance, at low prices, was not influenced by this additional information. Even at a $.10 lower price per pound, only 62 percent of the females would purchse irradiated produce as compared to 76 percent of their male counterparts. There is a larger portion of females who, at least initially, will not purchase irradiated produce at any price. Thus, males appear more inclined to accept this controversial food processing technology.

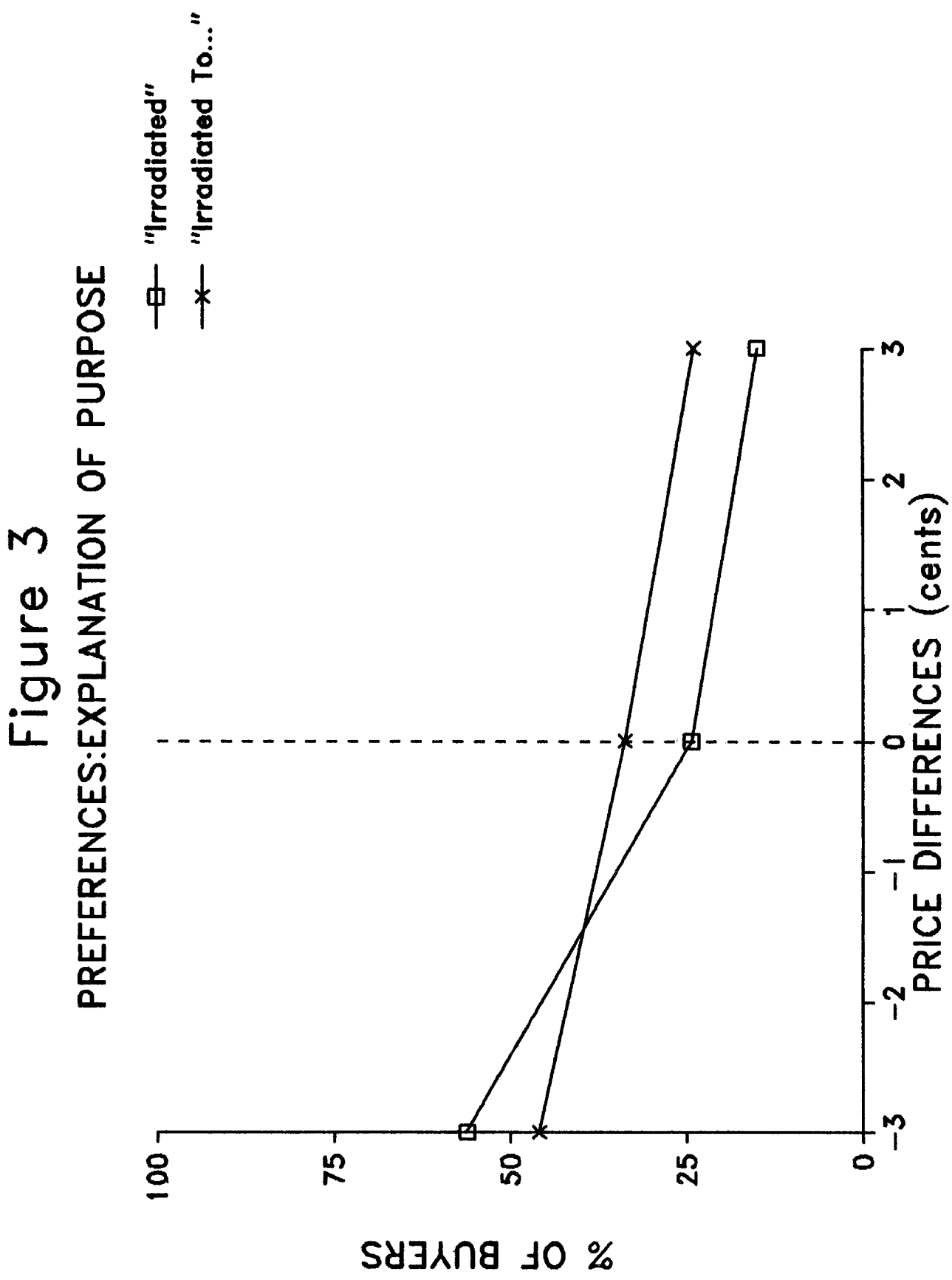
Figure 3
PREFERENCES:EXPLANATION OF PURPOSE
"Irradiated"
"Irradiated To..."
% OF BUYERS
100
75
50
25
0
-3
-2
-1
0
1
2
3
PRICE DIFFERENCES (cents)

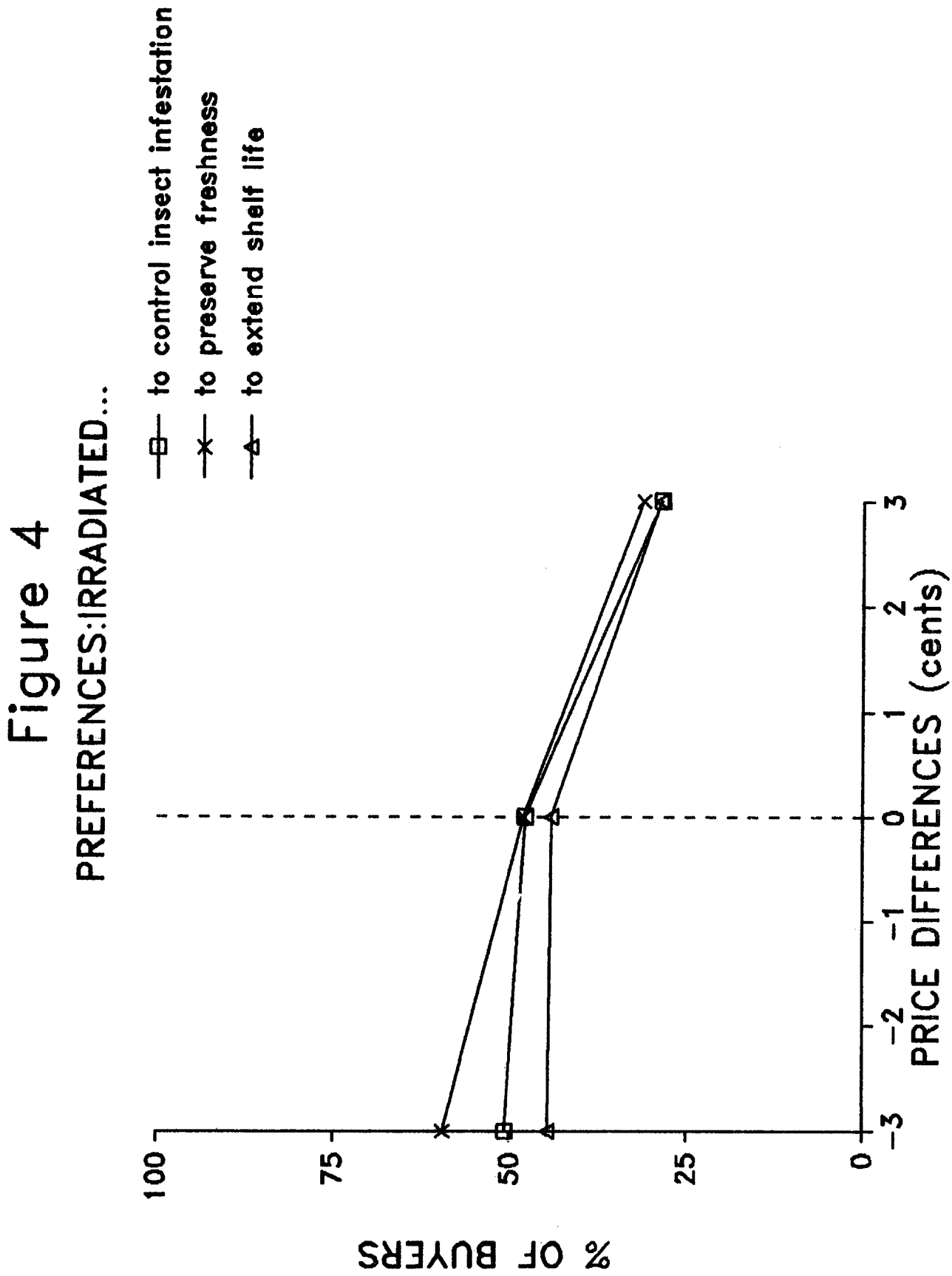
Figure 4
PREFERENCES:IRRADIATED...
to control insect infestation
to preserve freshness
to extend shelf life
% OF BUYERS
100
75
50
25
0
-3
-2
-1
0
1
2
3
PRICE DIFFERENCES (cents)

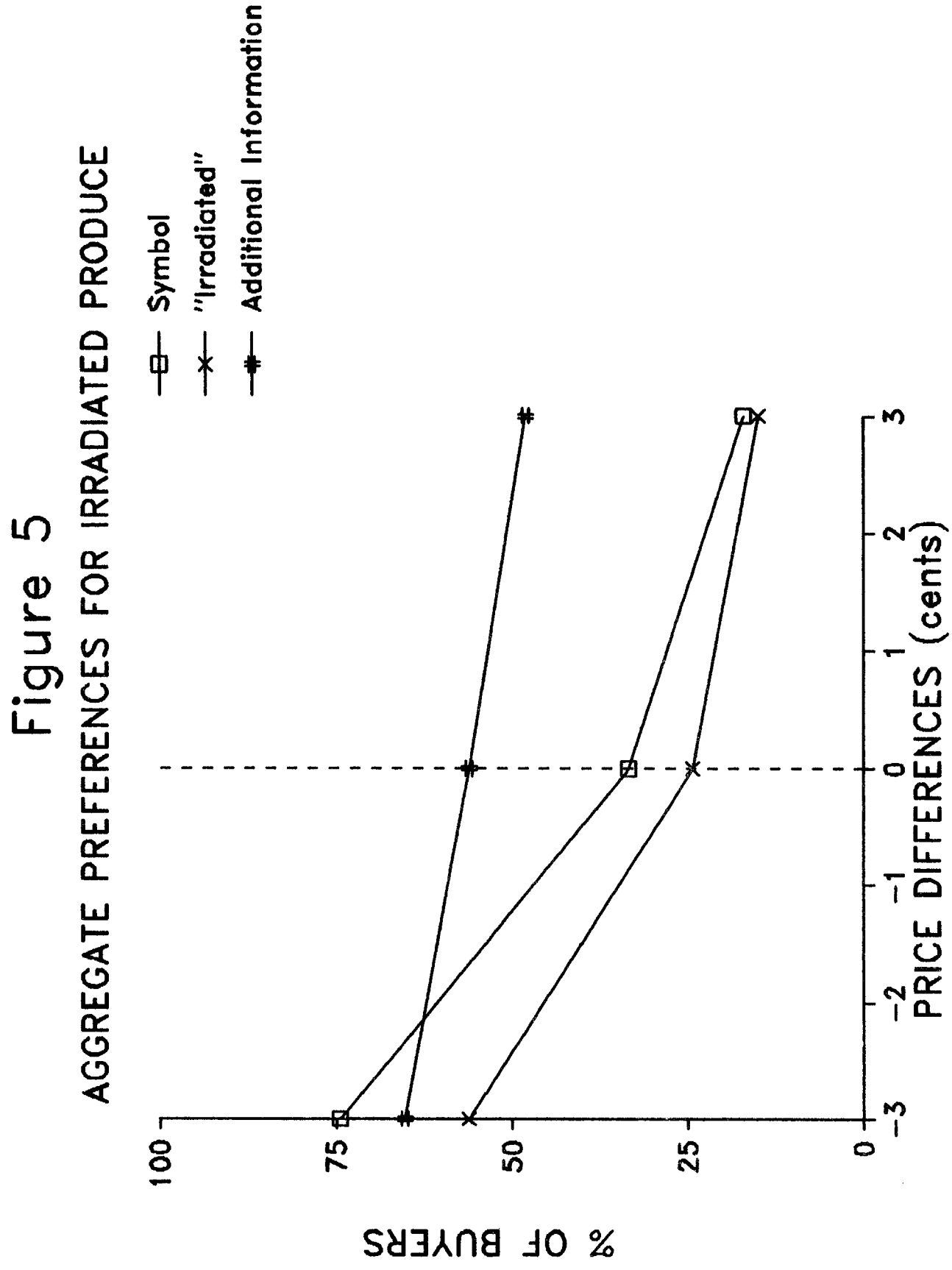
Figure 5
AGGREGATE PREFERENCES FOR IRRADIATED PRODUCE
Symbol
"Irradiated"
Additional Information
% OF BUYERS
100
75
50
25
0
-3
-2
-1
0
1
2
3
PRICE DIFFERENCES (cents)

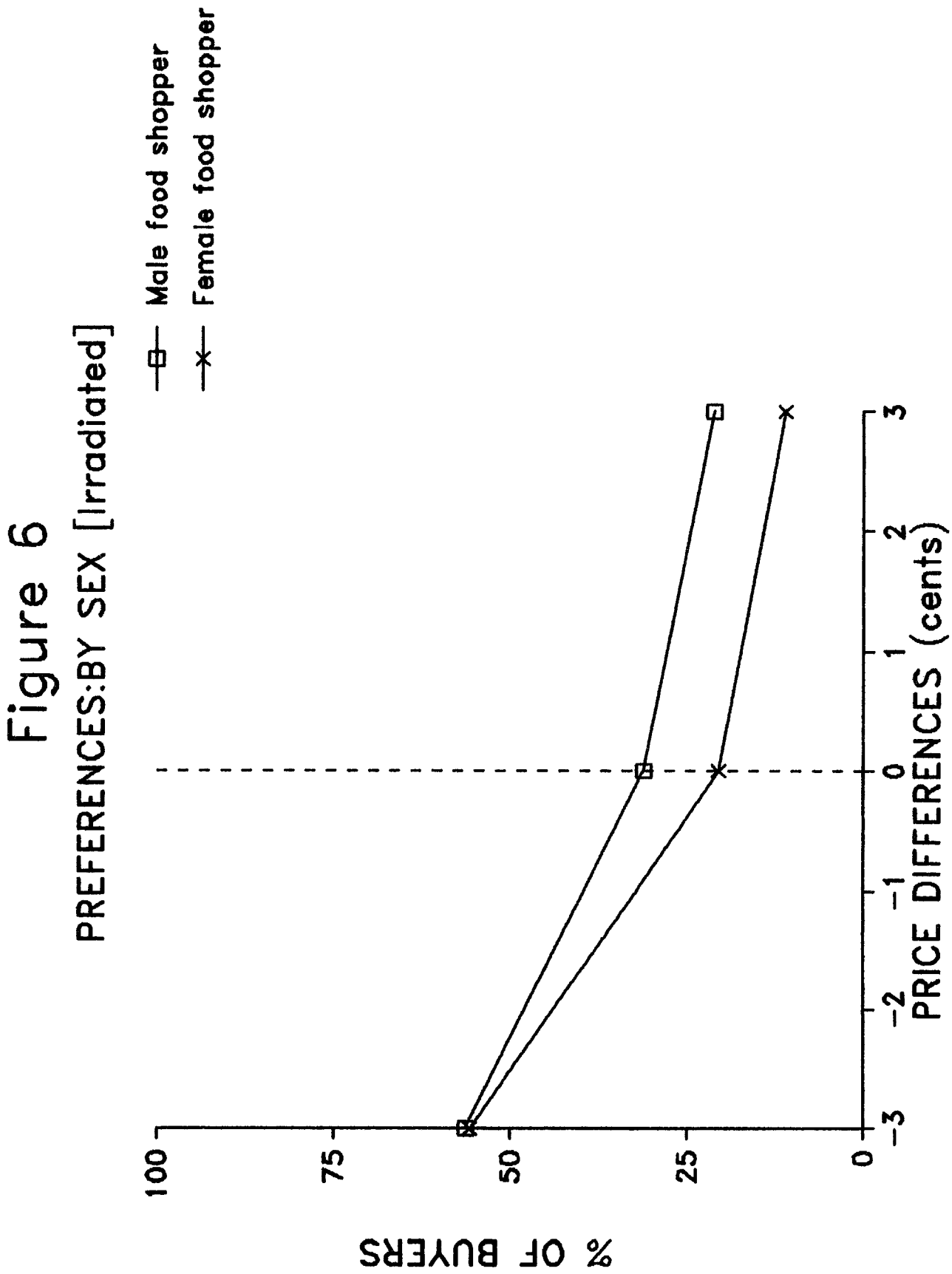
Figure 6
PREFERENCES:BY SEX [Irradiated]
Male food shopper
Female food shopper
% OF BUYERS
100
75
50
25
0
-3
-2
-1
0
1
2
3
PRICE DIFFERENCES (cents)

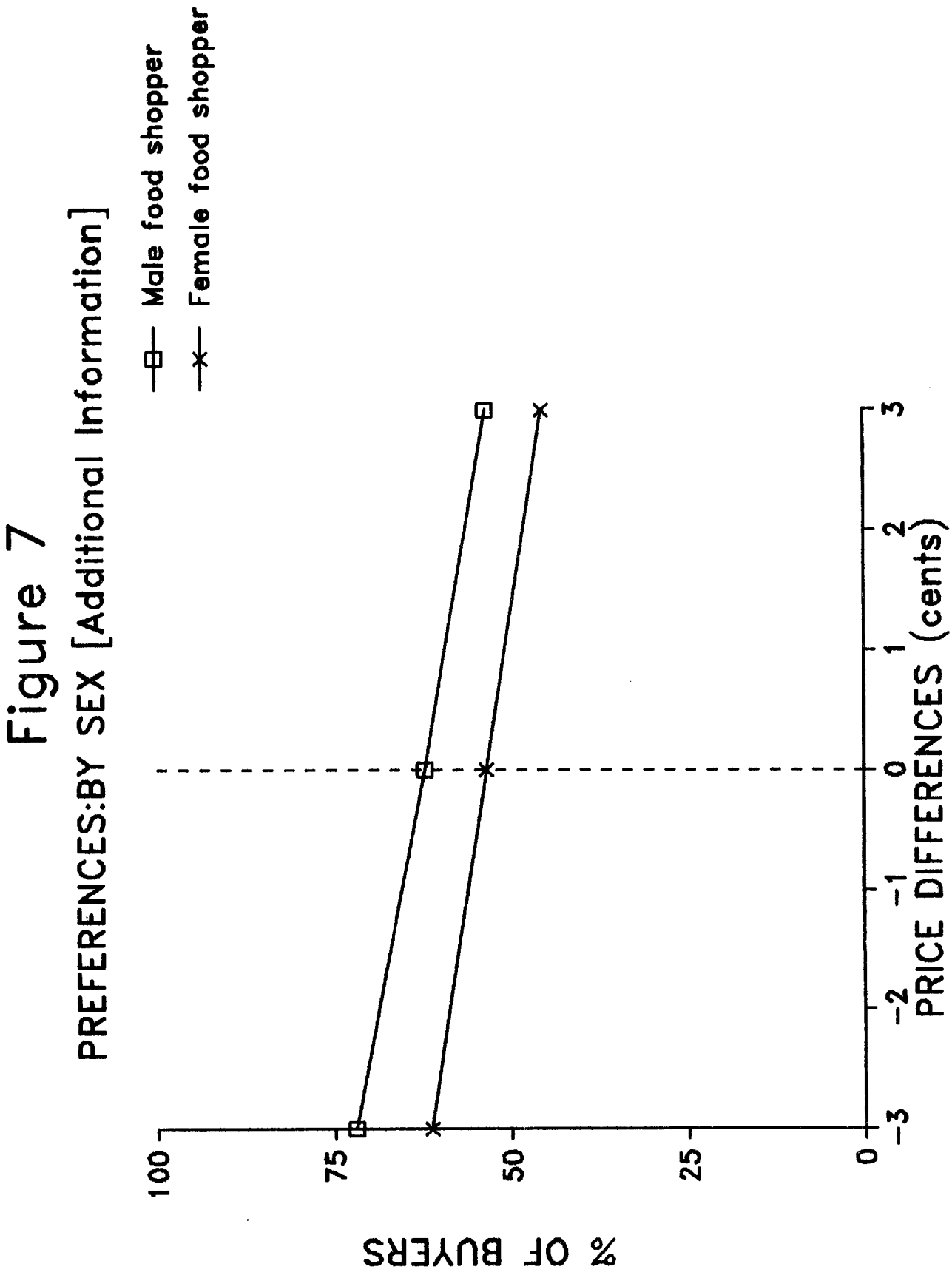
Figure 7
PREFERENCES:BY SEX [Additional Information]
Male food shopper
Female food shopper
% OF BUYERS
100
75
50
25
0
-3
-2
-1
0
1
2
3
PRICE DIFFERENCES (cents)

As seen in Figure 8, no clear trend existed among the various income groups before they acquired additional information about irradiation. Although there was a definite increase in desires to purchase after information was provided (Figure 9), the lowest income group appeared to be strongly influenced by the relative prices of the products. The highest income group was more likely to purchase at all prices. At the $.03 per pound higher price, 66 percent of the highest income earning households stated their preference for irradiated produce.

Discriminant Analysis

The data were divided into two categories--those households willing to buy irradiated produce and those unwilling to purchase. The contributing variables are listed below.

W_0 - W_3 = employment status of the respondent. The zero-one dummy variable technique was used to represent the data as follows:

W_0 = houseperson
W_1 = 1 if high school/college student and unemployed, and = 0 otherwise
W_2 = 1 if employed and = 0 otherwise
W_3 = 1 if retired and = 0 otherwise

The houseperson category (W_0) was omitted to avoid singularity.

M_0 - M_2 = the marital status of the respondent. Marital status was coded using the zero-one dummy variable format:

M_0 = married
M_1 = 1 if single and = 0 otherwise
M_2 = 1 if divorced, separated, or widowed, and = 0 otherwise

N = number of members in the household who depend on a common pool of income for their livelihood.

C = 1 if there are children under 18 years of age residing in the household and = 0 if not.

A = age of the respondent.

R = 1 if race of the household members is other than white and = 0 otherwise.

S = 1 if male and = 0 if female.

E_0 - E_2 = level of education attained by the respondent where:

E_0 = attended and/or graduated from high school
E_1 = 1 if attended no high school and = 0 otherwise
E_2 = 1 if attended college and = 0 otherwise

I = household's total income for 1986.

As shown in Table 3, sex, income, children, and students were the only major contributing variables. The sex of the respondent was a significant variable in all price situations, while income was a significant variable in the equal and higher price situations only. Children and students were significant variables in the lower priced situations.

Canonical correlation values of 0.27, 0.28 and 0.25 for the three function coefficients, respectively, indicte a low degree of relatedness between the groups and the discriminating variables. This relationship indicates that the variables are poor discriminators. The Wilks' lambda values of 0.92, 0.92 and 0.93 for the first, second and third situations also indicate the low discriminant power of the model. However, chi-square significant levels of 0.004, 0.002 and 0.013 demonstrate that the Wilks' lambda measure of group differences is significant.

The ineffectiveness of the model to discriminate among the three situations was further demonstrated. While the procedure correctly classified the situations 63.22 percent, 62.97 percent and 59.45 percent of the times while examining these data, it must be remembered that the only two possible responses were buy or not buy and therefore probability would result in a correct situation classification 50 percent of the time. A grand mean correct situation classification of 61.88 percent

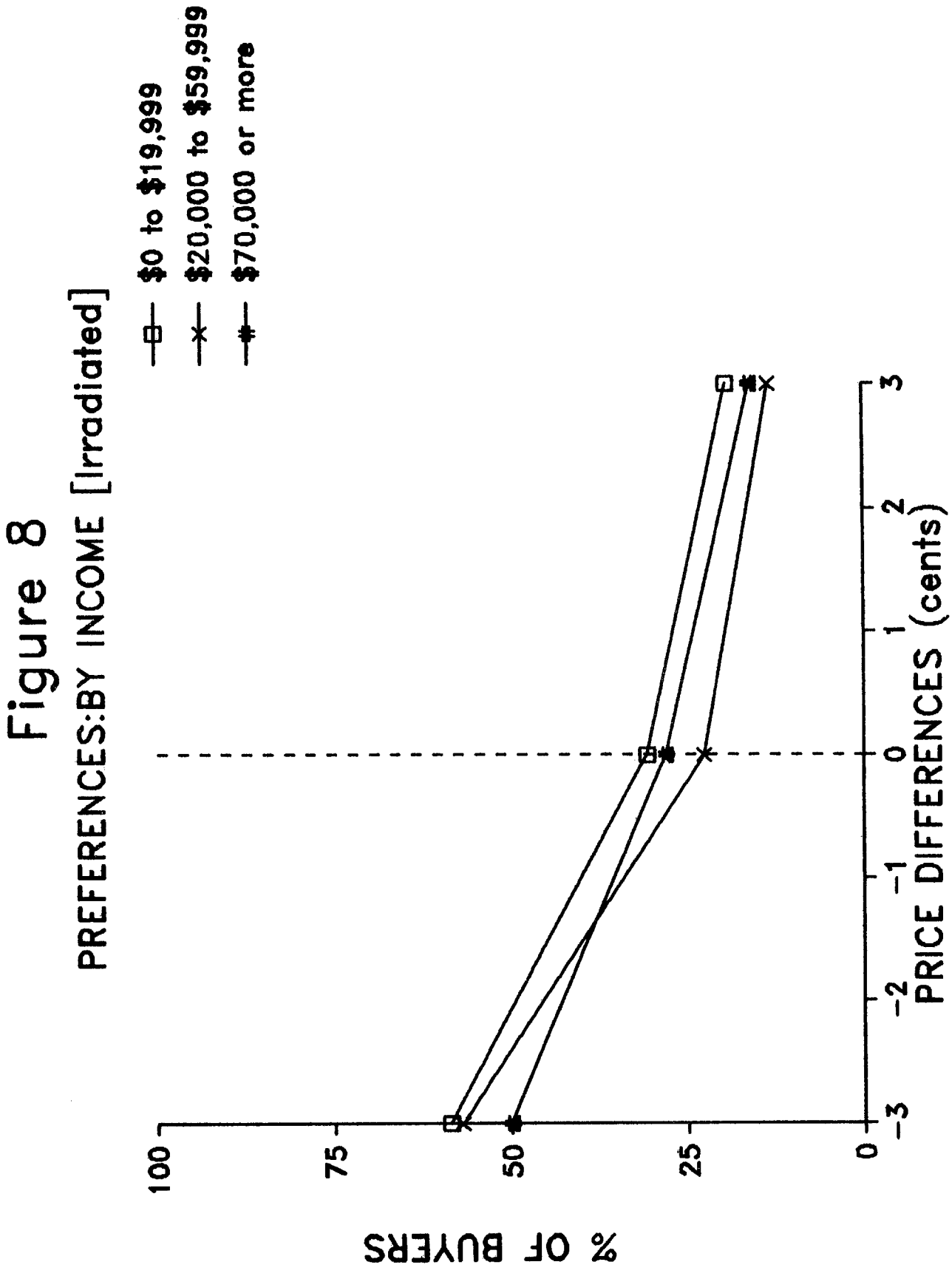
Figure 8
PREFERENCES:BY INCOME [Irradiated]
$0 to $19,999
$20,000 to $59,999
$70,000 or more
% OF BUYERS
100
75
50
25
0
-3
-2
-1
0
1
2
3
PRICE DIFFERENCES (cents)

Table 3. Results of Discriminant Analysis

Variable	Irradiated Produce: Three Cents Lower Price	Irradiated Produce: Equal Price	Irradiated Produce: Three Cents Higher Price
	Standardized Canonical Discriminant Function Coefficients		
STUDENT (W_1)	-0.33*	-0.12	-0.27
WORKER (W_2)	-0.39	-0.33	-0.19
RETIRED (W_3)	-0.17	-0.15	0.10
SINGLE (M_1)	0.14	0.51	0.45
DIVORCE (M_2)	0.28	0.39	0.31
HHSIZE (N)	0.22	0.33	0.25
CHILD (C)	-0.51*	-0.35	-0.33
AGE (A)	-0.07	-0.19	0.08
RACE (R)	-0.06	-0.03	0.08
SEX (S)	0.62*	0.46*	0.50*
NOHSED (E_1)	0.19	-0.22	-0.22
COLLEGE (E_2)	-0.30	-0.46	-0.52
INCOME (I)	0.60	0.86*	0.82*
Function Measurements			
Eigenvalue	0.08	0.09	0.07
Canonical Correlation	0.27	0.28	0.25
Wilks' lambda	0.92	0.92	0.93
Chi-square	30.52	32.83	26.67
Significance	0.004	0.002	0.013

* Major contributing variables

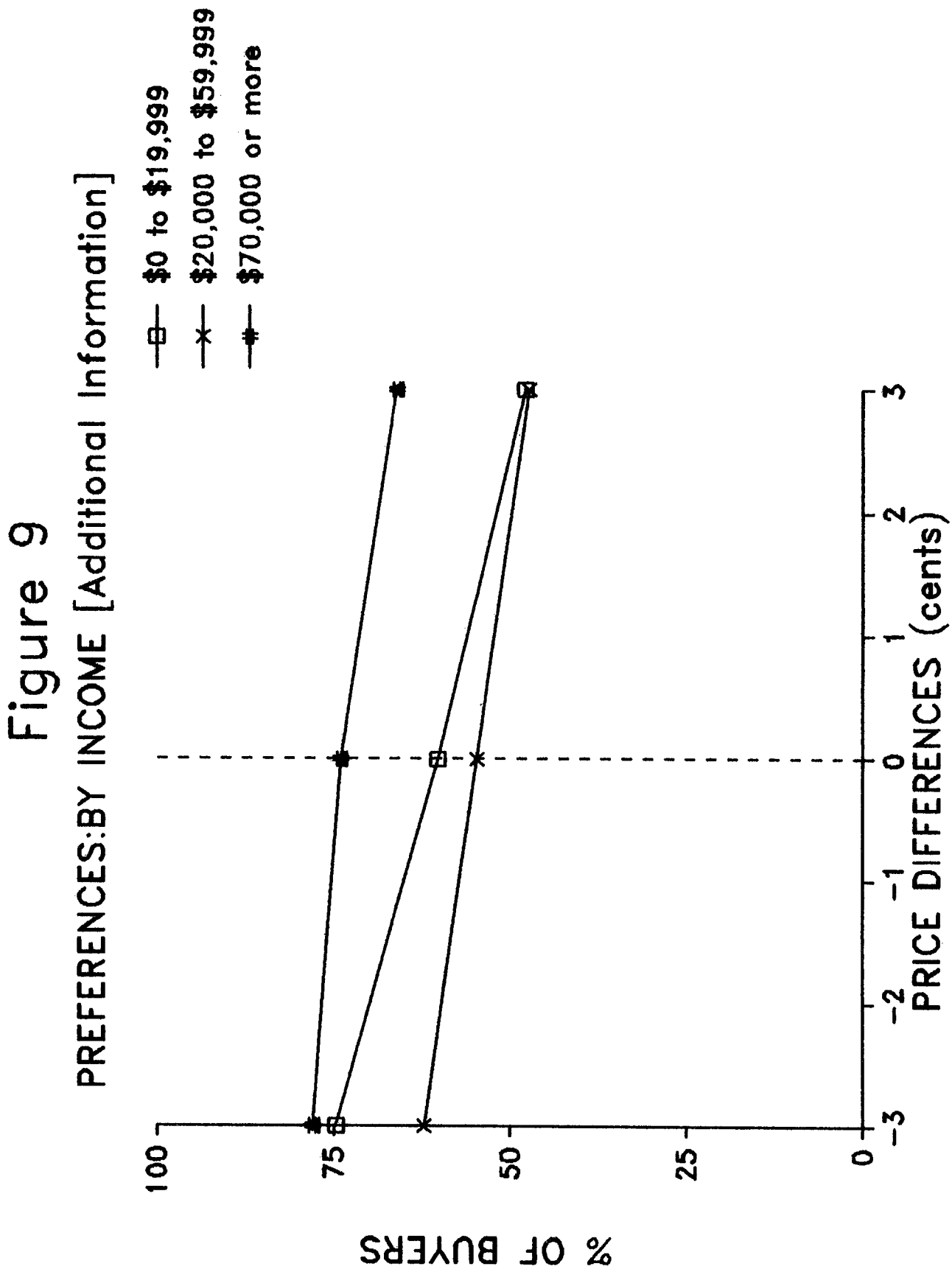
Figure 9
PREFERENCES:BY INCOME [Additional Information]
$0 to $19,999
$20,000 to $59,999
$70,000 or more
% OF BUYERS
100
75
50
25
0
-3
-2
-1
0
1
2
3
PRICE DIFFERENCES (cents)

is only 11.88 percent above results expected by probability.

Conclusions

Results of this study indicate that consumers are initially wary of irradiated produce but respond favorably after additional information is provided. Many of the respondents viewed the irradiation treatment as a value-adding process. The most promising population sample for market development seems to be higher income households. This situation appears to be particularly true for those households where the male influences food purchase decisions.

After providing additional information on the irradiation process, attempts were made to identify respondent characteristics which might predict willingness to purchase irradiated products. Results of the discriminate analysis indicated that predicting group membership with traditional socio-economic characteristics resulted in substantial inadequacies. During the course of this study, interviewees often expressed apprehension concerning food preservatives and fumigants now in their produce. Therefore, a relevant major contributing variable could possibly be attitudes toward chemical preservatives and the use of fungicides and insecticides. Other important variables may be political ideologies and attitudes toward nuclear power generation. An effective campaign strategy, therefore, might involve targeting groups with similar attitudes and concerns. Considerable time and effort were necessary to win consumer acceptance for other food processing techniques, such as canning and pasteurization. Provided the proper information can be presented in a timely and convincing manner, a substantial market could exist for irradiated produce in the future.

References

Food and Drug Administration, 1984. "Irradiation in the Production, Processing, and Handling of Food." Federal Register. 49(31):5714.

Kader, Adel A., 1986. "Potential Application of Ionizing Radiation in Postharvest Handling of Fresh Fruits and Vegetables." Food Technology. June, pp. 117-121.

Urbain, Walter M., 1986. Food Irradiation. Academic Press, Inc. Harcourt Brace Jovanovich, Publishers.