Adoption of E-Marketing by Direct-Market Farms in the Northeastern United States

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Many farms have begun operating websites in order to promote their businesses. This study uses data from a 2005 survey of farms in the northeastern United States to identify characteristics of farmers, farms, and farm businesses associated with website adoption. Following a technology-adoption framework, a probit model of website use is estimated to identify significant relationships. Sales location, product type, number of advertising methods used, high-speed Internet connection, land tenure arrangement, and gross farm sales is found to be significantly related to website adoption.

Computer technologies have drastically changed society and business in recent years. In the 1980s and 1990s, microcomputers emerged as a new technology that promised to change every aspect of our lives. As computer technology has advanced, the Internet has become a dominant aspect of computer use by individuals and businesses worldwide. Individuals use the Internet for different reasons, including social interaction, obtaining information, and purchasing goods and services. Over 54 percent of United States households now have access to the Internet (Day, Janus, and Davis 2005). This has increased from around 50 percent in 2001, 41 percent in 2000, and 26 percent in 1998 (Day, Janus, and Davis 2005). Currently, 78 percent of Internet users to obtain information on products or services from the Internet and more than 54 percent purchased products or services online in 2003 (Day, Janus, and Davis 2005). As Internet technology has advanced, businesses have adopted it as a sales and marketing medium. The Internet can be used by businesses to reduce transaction costs associated with conducting business, such as providing information about products and services. In addition, companies can use the worldwide web to offer a wider variety of products to a larger audience at lower prices compared to products found in a physical setting (Couclelis 2004).

Specific to the agricultural sector, a majority of farms have reported using computer technologies, including the Internet, for personal use and as a business tool. In 2005, 58 percent of farms in the United States had access to computers and 51 percent had Internet access, an increase of five percent since 2001 (NASS 2005). In the northeastern United States, 55 percent of farms have access to the Internet (NASS 2005). Many farms use the Internet to obtain weather reports, production information, and marketing information such as prices and trends. Nine percent of farms nationwide report using the Internet for gathering information and marketing products (NASS 2005). E-marketing strategies ("the strategic process of creating, distributing, promoting, and pricing goods and services to a target market over the Internet or through digital tools") have become an established presence in the agricultural sector (Hooker, Heilig, and Ernst 2001 p.4). In the Northeast, 11 percent of farms report using the Internet to conduct agricultural marketing activities (NASS 2005); however, very little is known about how farms are using the Internet for direct marketing. Ball and Duval (2001) surveyed farms using the Internet for direct marketing, focusing on the attributes of the farm business and farmers which led to Internet marketing being judged a success. Their study only examined those farms already using some form of e-marketing and provides no details regarding the characteristics of these early adopters relative to those farms which have yet to include e-marketing as part of a market-

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ing strategy. Understanding the characteristics of these innovators provides important information about who is most likely to adopt this technology as well as about who stands to benefit the most from e-marketing.

This study is based on a 2005 survey of direct-market farms in the northeastern United States and uses the presence of a website for the farm business as a proxy for e-marketing adoption. Incorporation of e-marketing into the marketing mix of direct-market farms indicates that the benefits of a website (better serving current customers, attracting new customers, and increasing sales) are greater than the costs (gaining knowledge of computer and Internet applications, time and money spent designing and updating websites, and obtaining Internet access). This study determines the farmer, farm, and farm-business characteristics which lead to website use by direct-marketing farms in the northeastern United States.

Computer, Internet, and E-commerce Adoption in Agriculture

Overall technological changes in the last century have drastically altered agriculture. A large volume of literature exists which examines farmer adoption of agricultural innovations (Sunding and Zilberman 2001). Rogers (1995) categorizes innovations as hardware and software, where hardware innovations provide different levels or forms of material objects and software innovations refer to the informational aspects of the new technology. E-marketing represents a unique form of technology adoption for agriculture. On one hand, e-marketing resembles a software innovation by providing farms with a new means of delivering information, communicating with customers about the farm and its products, and enhancing customer relations. On the other hand, e-marketing could be considered a hardware innovation which provides another advertising and sales medium that expands the scope of the farm operation.

Computer-technology-adoption studies in agriculture have generally described the demographic and structural characteristics of adopting farms compared to non-adopters, following a threshold model of adoption. Innovations such as computer use, Internet use, and e-commerce use have been analyzed using this framework. Characteristics such as farmer age, education, off-farm employment, farm size, and type of products sold have all been investigated in relation to agricultural adoption of these technological innovations over several different populations in North America.

Computer and Internet adoption studies have analyzed certain regions of the United States and Canada since the mid-1980s. Sabuhoro and Wunsch (2003) examined the use of computers and the Internet in Canadian farm businesses with 2001 Canadian Census of Agriculture data. They found that the type of farm operation was most important in explaining the adoption of computer and Internet use. Smith et al. (2004) used data collected in 2001 to examine use of computers, general use of the Internet, and use of the Internet for farm businesses in the Great Plains region of the United States. They discovered that specific education related to computers and employment off the farm had the greatest impact on computer and Internet usage. Hoag, Ascough, and Frasier (1999) also examined Great Plains farmers in 1995 in terms of computer adoption. They found that most of the conventional measures for technology adoption (farm size, farmer experience, and farm type) were significant. Batte (2003) and Batte, Jones, and Schnitkey (1990) looked at commercial Ohio farms using data from 2003 and 1987, respectively. Batte (2003) identified off-farm full-time employment and having more than a high school education as most important in determining computer adoption. Batte, Jones, and Schnitkey (1990) explained that farmers who used farm records for management and who had higher education levels were more likely to use computers, and farmers who produced grain crops were less likely to use computers than were farmers producing livestock. Gloy and Akridge (2000) examined large farms in the United States using 1998 data. Their results showed that higher education was the most important indicator in computer adoption and that younger and more-educated farmers were more likely to use the Internet. North Carolina commercial farms were the subject of a study by Amponsah (1995), who used 1991 data and determined that farm size and education were the most important indicators of computer adoption. Jarvis (1990) found that Texas rice producers had several characteristics that explain computer adoption, such as high income, growing cotton, stable farm size, and exposure to others who use computers

in business. Lastly, Putler and Zilberman (1988) examined computer adoption in Tulare County, California using 1986 data that showed that bachelors and graduate degrees had the greatest impact on computer adoption.

Studies of e-commerce adoption have looked at farmers in the Midwest, Great Plains, and southern United States, and most considered improvements in supply-chain management and purchases of farm inputs. McFarlane, Chembezi, and Befecadu (2003) examined agribusiness firms in Alabama with data collected in 2002. They found that the scope of the business was the largest indicator of Internet and e-commerce adoption. Using 2000 data, Ernst and Tucker (2001, 2002) examined fruit and vegetable producers in Ohio. Their 2001 study showed that a measure of economic optimism about IT (information technologies) was higher for farms that adopted IT. Their 2002 study also found that attitudinal measures of optimism in the role of IT were more important in determining e-commerce activity compared to their measure of age. Henderson, Dooley, and Akridge (2000) studied agribusiness manufacturers, dealers, and distributors, and found that size and scope of the business were the most important determinants of the use of e-commerce strategies.

Modeling Website Adoption

Following traditional technology-adoption literature, this paper uses the threshold model of adoption to identify the heterogeneous characteristics leading to website use. The threshold model of adoption focuses on the decision of the individual farmer to adopt a technology, assuming maximizing or satisficing behavior (Sunding and Zilberman 2001). This model assumes individuals experience different levels of benefits and costs from adoption of a particular technology (Dierden et al. 2003; Sunding and Zilberman 2001) depending on the characteristics of the farmer or the farm business. Once the net benefits reach some critical level or threshold, the farmer will adopt the technology. The net benefits, B, for farmer i are a function of (for ease of explanation) one farmer characteristic (such as age), X_i, such that $B_i = \beta_0 + \beta_i X_i$, where the β's are parameters of the model. The probability that the farmer will adopt a website increases as B_i increases, but adoption only occurs after the threshold level of net benefits, B_i^*, is reached, when $B_i \geq B_i^*$. The threshold level of net benefits is not observable, only the final choice of whether or not to adopt. Thus the adoption decision, Y, can only take two values; $Y = 1$ if a website is adopted, and $Y = 0$ if a website is not adopted. Assuming the net benefits are normally distributed, the probability that B_i is greater than or equal to B_i^* can be given as

$$(1)\quad P_i = P(Y=1|X) = P(B_i \geq B_i^*) = P(\beta_0 + \beta_i X_i \geq Z_i) = F(\beta_0 + \beta_i X_i),$$

where $P(Y = 1|X)$ is the probability that a website is adopted given the values of the explanatory variables X, Z_i is the standard normal variable such that $Z_i \sim N(0,\sigma^2)$, and F is the standard normal cumulative distribution function (CDF) (Gujarati 2003). The CDF in this case will be (Gujarati 2003)

$$(2)\quad F(B_i) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{B_i} e^{-z^2/2} dz \text{ or}$$

$$F(B_i) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\beta_0+\beta_1 X_i} e^{-z^2/2} dz .$$

Based on an assumption of a standard normal distribution of the net benefits from website adoption, this study uses a binomial probit model to empirically examine relationships between website (e-marketing) adoption and farmer, farm, and farm-business characteristics.

The marginal effect on website adoption of any explanatory variable is found by taking the derivative of the probit equation with respect to that specific independent variable,

$$(3)\quad \frac{dP_i}{dP_i} = f(\beta_0 + \beta_i X_i),$$

where $f(\beta_0 + \beta_i X_i)$ is the standard normal probability density function (Gujarati 2003). This marginal effect will depend on the value at which it is calculated, which usually involves setting all explanatory variables equal to their means, as is done in this study. Marginal impacts of the explanatory variables are estimated using LIMDEP software, which is also used to estimate the probit model in this study (Greene 2002). In the case of categorical (dummy) explanatory variables, the marginal effect

is calculated by finding the difference between the probability of adopting a website when that category is present and when it is not (Amemiya 1981).

Data

This study used a survey of direct-marketing farms in 12 states in the Northeast[1] to collect data on adoption of e-marketing. In early 2005, 5,392 requests for participation were sent to direct-marketing farms whose names and addresses were gathered from localharvest.com, state departments of agriculture, and specialty/trade association websites. Of the total requests mailed, 987 farmers agreed to participate in the survey, either through the mail or online; 404 surveys were mailed and 583 individuals were e-mailed links and access codes for the Internet survey. Of these, 300 mail surveys (74 percent) were returned, and 346 Internet surveys (59 percent) were completed. A total of 570 complete observations were used in the econometric estimation. Farmers were asked if they had a website for their farm business in 2004 (the dependent variable) and 228 farms (40 percent) answered yes. Table 1 presents descriptive statistics for the variables used in the model.

Based on the computer-technologies-adoption literature as age increases adoption is expected to decline. Age and age-squared are included in the model to capture any non-linear effects of age on e-marketing adoption. Survey respondents (both with and without a website) had a mean and median age of about 53 years; this is slightly younger than the national average farmer age of 55. The 2002 Census of Agriculture also found the average age of farm operators in the Northeast to be slightly younger than the national average in nine of the 12 Northeastern states (Allen and Harris 2005).

Education was measured with an ordinal ranking from one to seven for reported education levels, which ranged from less than ninth grade to a graduate or professional degree. The average education of the sample farms was between some college attendance and a bachelor's degree, which is more education than the national average of a high school education for farmers (Mishra 2006). Education is expected to have a positive influence on the adoption of a website by farmers.

Chi-square tests found a significant difference for farms with websites, which reported higher levels of advertising expenses and use of more types of advertising methods, compared with farms without websites. A variable was created to measure the number of different advertising methods that farms reported using in 2004. There were 16 possible advertising methods, although no one used all of the methods. The value of the variable ranges from a minimum of 1 (everyone used "word of mouth") to a maximum of 14 methods.[2]

Malecki (2001) stated that broadband (high-speed) access is an important tool in using the Internet for business activities. A dummy variable equal to one if the farm had a high-speed connection and zero if access was by dialup is therefore included in the website-adoption model. Fiber optic, wireless, and satellite connections were combined with DSL and cable connections into one high-speed Internet-access variable (31 percent of farms).

In general, the technology-adoption literature found evidence of a positive relationship between farm size and adoption. For this analysis, farm size is represented by gross farm sales, following the work of Smith et al. (2004), Sabuhoro and Wunsch (2003), Batte (2003), and Gloy and Akridge (2000). According to Rogers (1995), adopters of innovations have a larger scale of units, regardless of the actual form of measurement (acres, gross farm sales, or gross farm income). Chi-square tests showed no significant difference between adoption categories when acreage was considered; there was a significant difference when using gross farm sales for 2004. Level of gross farm sales therefore is used as a measure of farm size in the empirical estimation. Eleven gross-farm-sales categories were used in the survey. The econometric estimation uses the midpoint of nine of these, with $500 used for the "Less than $1,000" category and $1 million used for the "$1 million or more" category.

Land ownership was found to play a positive role

[1] The 12 Northeast states defined as the Northeast SARE Region are Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, and West Virginia.

[2] The 16 possible methods are newspaper, business card, group newsletter ad, farm brochure/newsletter, listing in a farm tour, direct mail, other print, radio, TV, farm directory web listing, web page, email, other electronic, word of mouth, roadside signs, other.

Table 1. Descriptive Statistics of Variables (N=570).

Variable	Mean	Standard deviation	Minimum	Maximum
Dependent variable				
Farm had a website	0.400	0.490	0	1
Explanatory variables				
Farmer's age (years)	53.461	11.375	24	89
Farmer's age squared	2987.296	1255.421	576	7921
Farmer's education level[a]	5.395	1.445	1	7
Number of advertising methods used	4.635	2.563	1	14
High-speed Internet connection	0.311	0.463	0	1
Gross farm sales ($1,000)[b]	118.779	240.679	0.5	1000
Land-tenure categories ("own all land farmed" is base case)				
Own all land farmed	0.651	0.477	0	1
Rent all land farmed	0.051	0.220	0	1
Own some and rent some	0.240	0.428	0	1
Other land arrangement	0.058	0.234	0	1
Product categories (not mutually exclusive)				
Produce	0.596	0.491	0	1
Ornamentals	0.265	0.442	0	1
Meat, dairy, or eggs	0.461	0.499	0	1
Wool or hair products	0.132	0.338	0	1
Honey	0.112	0.314	0	1
Cider	0.061	0.240	0	1
Baked goods	0.112	0.316	0	1
Wine	0.019	0.138	0	1
Maple syrup	0.100	0.300	0	1
Sales-location categories (not mutually exclusive)				
Roadside stand or tailgate	0.165	0.371	0	1
Farmers market	0.326	0.469	0	1
Pick-your-own	0.230	0.421	0	1
CSA (community supported agriculture)	0.116	0.320	0	1
On-farm stand or store	0.511	0.500	0	1
Flea market	0.018	0.131	0	1
Home delivery	0.156	0.363	0	1
Mail order	0.051	0.220	0	1
Restaurants	0.161	0.368	0	1
Grocery stores	0.221	0.415	0	1
Wholesaler or broker	0.223	0.416	0	1

[a]Education categories: <9th grade; 9th to 12th grade, no degree; high school diploma; some college, no degree; associate's degree; bachelor's degree; graduate or professional degree.

[b]The midpoint for nine of 11 gross farm sales categories is used; $500 is used for "less than $1,000" and $1 million is used for "$1 million or more."

in technology adoption in a study of conservation-practice adoption by U.S. corn producers (Soule, Tegene, and Weibe 2000). To examine the impact of land ownership on website adoption, four categories of farmland ownership were considered: owning all of the land used for farming, owning some of the land and renting some of the land, renting all of the land, and other land arrangements.

To account for the effect of product type on website use, three broad categories of products are included in the analysis, as are several specific products that were reported in the survey in a miscellaneous category. Farmers could have produced any or all of these products, which include produce; ornamentals; meat, dairy, or eggs; wool or hair products; honey; cider; baked goods; wine; and maple syrup. Sales location may also influence a farmer's decision to use a website. Farmers were asked where they sold their farm products in 2004, and they may have used any or all of these outlets. Included in the model as dummy variables are roadside stand or tailgate, farmers market, pick-your-own, Community Supported Agriculture (CSA), on-farm stand or store, flea market, home delivery, and mail order, along with sales to restaurants, grocery stores, or wholesalers/brokers.

The empirical model used for econometric estimation is specified as

$$(4)\quad Y_i = \beta_0 + \beta_1 Age + \beta_2 Age^2 + \beta_3 Education + \beta_4 Advertising + \beta_5 High\text{-}Speed\ Internet + \beta_6 Gross\ Farm\ Sales + \beta_{7-9} Land\ Ownership + \beta_{10-18} Products + \beta_{19-29} Sales\ Locations\ ,$$

where Y_i, website adoption, is equal to one if the farmer used a website for the farm business in 2004, and the other variables and variable categories are as defined above and in Table 1.

Results and Discussion

Measures of fit for the probit model of website adoption show that the model generally performs well. The McFadden R^2 statistic of 0.394 is consistent with what the technology-adoption literature has reported (Amponsah 1995; Batte, Jones, and Schnitkey 1990; Gloy and Akridge 2000; Hoag, Ascough, and Frasier 1999; Jarvis 1990; Putler and Zilberman 1988; Sabuhoro and Wunsch 2003). In addition, this model correctly predicted 80.5 percent of the observations. Table 2 reports the results of the probit model of website adoption with significant coefficients (p-value ≤ 0.10) in bold. Marginal effects for the significant variables are also included.

While it was expected that farmer's age would decrease the probability of adopting a website at a decreasing rate, there was no evidence of a significant impact. This is consistent with the early literature on computer adoption and with more recent studies of Internet and e-commerce adoption which found no relationship with age (Amponsah 1995; Jarvis 1990; Putler and Zilberman 1988). The insignificance of age on website adoption could also be the result of farmers hiring professionals to construct and maintain websites. Nearly 74 percent of farms that reported operating a website in 2004 had the website developed by someone else, with 31 percent hiring a professional web developer.

Farmer education level was not found to have a significant effect on adoption of a website, although the coefficient did show the expected sign. The direct-marketing farmers examined in this study had relatively high levels of education; 60 percent had either a bachelor's or graduate/professional degree. This lack of heterogeneity in education may be reflected in the insignificant coefficient. Jarvis (1990) also found that education was not a significant determinant of computer adoption. Contrary to these findings, Batte (2003), Gloy and Akridge (2000), Amponsah (1995), Batte, Jones, and Schnitkey (1990), and Putler and Zilberman (1988) found that education played a positive role in computer adoption. The insignificance of education in this study could indicate that education does not play a role in determining website adoption because farmers do not typically design their own websites. In addition, it may be that specific skills related to web development and maintenance are not related to overall education level. Smith et al. (2004) found that having a college degree had mixed results on computer use but computer-related education increased the probability of owning a computer and using the Internet for business. The insignificance of education in this study might also be attributed to the different role that websites play for a farm compared to general farm computer use. Computer-adoption studies examined the role of computers in record keeping and information processing, while websites play a role in advertising the farm business or marketing products, which may require less

Table 2. Website Adoption Probit Results (N=570).

Variable	Coefficient	p-value	Marginal effect
Constant	-1.3033	0.2778	
Farmer's age	-0.0365	0.3839	
Farmer's age squared	0.0003	0.3584	
Farmer's education level	0.0432	0.3895	
Number of advertising methods used	**0.4399**	0.0000	0.1669
High-speed Internet connection	**0.3772**	0.0111	0.1452
Gross farm sales ($1,000)	**0.0015**	0.0000	0.0006
Rent all land farmed	0.5116	0.1149	
Own some and rent some	**-0.3212**	0.0744	-0.1178
Other land arrangement	0.1500	0.6135	
Produce	**-0.3884**	0.0196	-0.1481
Ornamentals	-0.0155	0.9252	
Meat, dairy, or eggs	-0.1433	0.3727	
Wool or hair products	0.3068	0.1491	
Honey	-0.0052	0.9829	
Cider	0.2913	0.3794	
Baked goods	**-0.4688**	0.0735	-0.1481
Wine	0.5430	0.3980	
Maple syrup	0.1001	0.6731	
Roadside stand or tailgate	**-0.5513**	0.0100	-0.1921
Farmers market	-0.0080	0.9610	
Pick-your-own	-0.0061	0.9735	
CSA (community supported agriculture)	-0.2932	0.1973	
On-farm stand or store	**-0.3590**	0.0139	-0.1357
Flea market	**1.0472**	0.0657	0.3931
Home delivery	-0.1675	0.4014	
Mail order	-0.1326	0.6839	
Restaurants	0.0914	0.6442	
Grocery stores	-0.1078	0.5528	
Wholesaler or broker	-0.1130	0.5278	
Percentage of correct predictions	80.5		
McFadden R^2	0.394		

Bold indicates significance for variable at p-value ≤10 percent.

computer use by the farmer.

The variable measuring the number of advertising methods used has a positive and significant impact on website adoption. The marginal effect indicates that use of one additional advertising method leads to an increase of 16.7 percent in the probability of adopting a website at the mean value of advertising diversity (almost five forms of advertising). This suggests that farmers use websites to augment other advertising formats.

As expected, the relationship between high-speed Internet access and website adoption was positive and significant. High-speed Internet access increases the probability of adopting a website by 14.5 percent. This is supported by Malecki (2001), who stated that broadband access is becoming an

essential aspect of Internet access in relation to online business activities.

The gross-farm-sales coefficient is positive and significant, with marginal effects indicating that the probability of adopting a website increases by 0.06 percent when gross farm sales increases by $1000 from the mean of almost $119,000. This reinforces the expectation that the ratio of benefits to costs is greater for larger farms than for smaller ones. The cost of paying a professional web developer may be prohibitive for many small farms. The median cost reported in the survey was $775, with a mean of $2152 (N=67). This result is consistent with the relationship that the computer-technology-adoption literature has found between size of an operation measured by gross farm sales and adoption of that technology (Gloy and Akridge 2000; Hoag, Ascough, and Frasier 1999; Putler and Zilberman 1988). Henderson, Dooley, and Akridge (2000) also established a positive relationship between e-commerce activities of agribusinesses and gross sales.

Of the three land-tenure categories, only "own some and rent some" has a significant (and negative) impact on website adoption when compared with the base category of owning all of the land being farmed. Being in this mixed land-tenure category results in an 11.8 percent decrease in the probability of website adoption relative to a farmer who owns all of the land he/she is farming. Owning the farm is the most secure arrangement, which may lend itself to adoption of new techniques such as using the Internet for e-marketing.

It would be expected that farmers selling products with different characteristics would make different choices in using a website. Products that are branded and/or processed were expected to have a positive influence on the adoption of a website since these products may possess characteristics that are easily differentiated by visual inspection, such as a picture on a website. Product choices were not limited to a single selection; many operations reported selling products from several categories. The model found a negative relationship between farms growing produce and website adoption, with the probability of adopting a website 14.8 percent lower for farms selling produce compared with farms that do not sell produce. This negative relationship could be due to an inability to differentiate produce over an extended period of time due to its seasonality and perishability. Because produce may be difficult to sell over the Internet, produce growers may believe that a website would not be useful for their business. Baked goods also had a significant and negative coefficient. Those selling baked goods have a 14.8 percent lower probability of adopting a website compared with direct-market producers who do not sell baked goods. This result is surprising as baked goods could easily be a branded product that not only could be advertised on a website but also sold online and shipped to customers, although perishability could be a problem. None of the other specialty products, including ornamentals, were significant predictors of website adoption. The insignificance of meat, dairy, or eggs regarding website adoption (compared to farmers who did not produce meat, dairy or eggs) was similar to results found in the literature, even though those studies did not consider direct market sales of these products. In their studies of computer adoption by farms, Gloy and Akridge (2000) and Putler and Zilberman (1988) found cattle and dairy production had an insignificant impact on adoption. Gloy and Akridge (2000) also discovered a similar result in their analysis of Internet use.

Selling at a roadside stand or tailgate and selling at an on-farm stand or store both had a negative and significant relationship with website adoption. When a roadside stand or tailgate is used by a farm business, there is a 19.2 percent lower probability of website adoption compared with farmers who do not use these outlets. This could be due to the informal nature of roadside stands, which are generally at locations that are conducive to spontaneous purchases by consumers. Contrary to prior expectations, selling via an on-farm stand or store results in a 13.6 percent lower probability of website adoption compared with producers who do not have an on-farm stand or store. This result may be due to a majority of the farmers operating on-farm stands or stores being small operations; 59 percent of these farmers had gross sales of less than $50,000 in 2004 (85 percent less than $250,000). These small operations may lack specific hours and may also cater mostly to drive-by consumers, compared with bigger, more professional operations which would be expected to have a website. Farmers who sell at flea markets had a 39.3 percent greater probability of having a website than did farmers who do not. Further investigation into the ten farmers in the sample who sold at flea markets is needed

to understand this result. None of the other sales locations/methods had a significant relationship with website adoption.

Summary and Conclusions

Following the advances in computer technology in the last few decades and increased use of direct sales to improve farm income, there has been a need to research the characteristics of direct-marketing farms that use the Internet for marketing. This study examined which factors significantly influenced website adoption by direct-marketing farmers in the northeastern United States in 2004 using a probit model for estimation. Marginal impacts of the significant variables were also examined. The analysis included variables previously identified in computer, Internet, and e-commerce adoption studies and variables specifically related to direct-marketing farms.

The significance of gross farm sales shows that the size of a farm business has an effect on website adoption, indicating that the costs of a website may cause larger farms to use websites more often than smaller farms. Having high-speed Internet access increased the probability of website adoption. Both produce and baked goods appear to have a negative impact on website adoption. The negative impact of roadside stand or tailgate and on-farm stand or store shows that farmers who sold at these venues were less likely to adopt a website than were farmers who did not use these outlets. This result, along with the small size of the farms selling at these locations, suggests that less-organized and time-constrained locations are less likely to perceive a need for a website. Farmers selling at flea markets were more likely to have a website than were farmers who do not use these markets. The results also indicate that farmers who advertise in a variety of ways are more likely to use a website. Farmers who own some of the land they farm and also rent some of the land they farm are less likely to adopt a website compared with farmers who own all of the land they farm. The data does not suggest that a farmer's education level or age is important in determining website adoption.

The fact that higher sales increase the probability of website adoption indicates that websites are likely more feasible for larger operations. Thus programs encouraging small farms to use a website as part of their marketing strategy may need to consider subsidizing the cost of web development. This could mean providing free, expense-paid workshops to teach web-development skills to farmers and family members or subsidizing payments to professional web developers. Evidence that cost is a concern for farmers comes from survey respondents who did not have websites, 32 percent of whom reported it was due to lack of skills or money, with an additional 31 percent saying they do not have the time.

It may be necessary to educate farmers on how to use and evaluate advertising in general before they will move on to electronic advertising and customer communication via a website. All survey respondents used word-of-mouth advertising and a majority (53 percent) used business cards, but only 41 percent had placed an advertisement in the newspaper, 39 percent had a farm brochure, 27 percent sent email to customers, and 23 percent had roadside signage. It also appears that farmers who use a website may also perceive the importance of evaluating advertising methods. Overall, 48 percent of survey respondents do not evaluate their advertising campaigns; however, this lack of evaluation increases to 60 percent for farms without a website and drops to 31 percent for farms with a website. When examining methods of evaluating advertising, 60 percent of farms with websites asked customers where they had heard about the business, compared with 36 percent of farms without a website; 12 percent of farms with a website used coupons indicating the ad source, whereas only two percent without a website have used such coupons; and 30 percent of farms with a website looked at whether an ad campaign increased sales, compared with 13 percent without a website. Advertising-savvy farmers likely take advantage of as many feasible methods and opportunities as possible to promote their businesses, as indicated by the positive impact of number of advertising methods on website adoption. This may indicate that development of farmers' familiarity with and skills regarding advertising as a business tool are the first steps to website adoption.

This study adds to the discussion regarding a need for high-speed Internet access in rural areas, the problem of the "digital divide." Although farmers may be able to outsource their website development and hosting to organizations with high-speed access, this will increase the cost of development and maintenance. This study found that farmers

are more likely to use a website if they have high-speed Internet access, indicating that farmers may consider the cost of outsourcing too high, prefer to do this work in house, or be unaware of the option of outsourcing their website. Another issue is whether the customers of these direct-market farmers have high-speed access to the Internet. This study does not have information on access capabilities of customers; however, one could assume that if the customers live in rural areas, they, too, may be limited to dialup. This could result in urban customers having easier access to a farmer's website than his/her neighbors. This has implications for a farmer's willingness to use a website if the farmer is attempting to build his/her business on a base of local customers.

The results of this study suggest that not all direct-market farmers are interested in using the Internet as a marketing tool. The benefits of developing a website need to outweigh the costs, and both will vary across farm size, product produced, and sales outlet. The interaction of each of these, along with other characteristics unique to each farm, its goals, and its customers, add to the complexities of the website adoption decision. Of the farmers surveyed for this study, 11 percent had decided that a website was not appropriate for their business. Anecdotal evidence from written survey comments and discussions with local farmers suggests that some farmers do not want to expand their operations to increase production to meet the increase in demand that may be generated by having a website. Yet other comments indicate that some farmers would like to have a website but have not been able to afford the costs (in time or money) to make this a part of their marketing strategy. This study adds to the discussion of e-marketing use by direct-market farms, but there is much work to still be done on this topic.

Limitations and Future Research

This research was limited to the Northeast region of the United States for the year 2004. The farms used in this study were direct-marketing farms, which may be different from farms that do not directly market products to consumers. While the location of the farms was available by zip code, tests for spatial dependence or heterogeneity were not conducted, so spatial variability was assumed to have no impact in the model.

Several avenues could be followed to expand this research. Identifying the impact of a farm-business website on gross farm sales and on the percentage of household income from the farm is planned for future research. Additional research could identify the characteristics of farms that sell products online compared wth farms that use websites only as a form of advertising to determine if there are important differences between these two groups. Spatial analysis could identify any geographic patterns of diffusion of website use. Lastly, studying the demographics of consumers using farm websites would provide essential information to farms designing and using a website as part of their marketing plan.

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