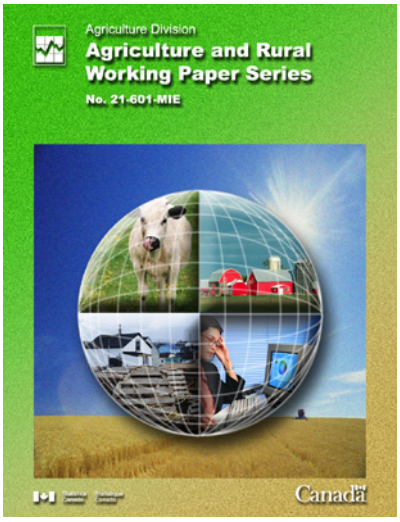
Catalogue no. 21-601-MIE — No. 065
ISSN: 1707-0368
ISBN 0-662-35739-6

Research Paper

Computer technology adoption by Canadian farm businesses: an analysis based on the 2001 Census of Agriculture



by Jean Bosco Sabuhoro and Patti Wunsch

Agriculture Division
Jean Talon Building, 12th floor, Ottawa, K1A 0T6

Telephone: 1 800-465-1991

Statistics Canada Statistique Canada

Canada

Statistics Canada
Agriculture Division

Agriculture and Rural Working Paper Series
Working Paper No. 65

Computer Technology Adoption by Canadian Farm Businesses: An Analysis Based on the 2001 Census of Agriculture

Prepared by

Jean Bosco Sabuhoro, Trade and Economic Analysis Division, Department of Foreign Affairs and International Trade

and

Patti Wunsch, Agriculture Division, Statistics Canada

Statistics Canada, Agriculture Division
Jean Talon Building, 12th floor
Tunney's Pasture
Ottawa, Ontario K1A 0T6

December 2003

Statistics Canada
Agriculture Division

Agriculture and Rural Working Paper Series
Working Paper No. 65

Computer technology adoption by Canadian farm businesses: an analysis based on the 2001 Census of Agriculture

Published by authority of the Minister responsible for Statistics Canada.

December 2003
ISSN: 1707-0368
ISBN 0-662-35739-6

Catalogue No. 21-601-MIE
Frequency: Occasional

Ottawa

La version française est disponible sur demande (n° 21-601-MIF au catalogue)

Note of appreciation: Canada owes the success of its statistical system to a longstanding partnership between Statistics Canada and the citizens, businesses and governments of Canada. Accurate and timely statistical information could not be produced without their continued co-operation and good will.

Abstract

Computer technologies have evolved very rapidly and, compared to other businesses, farm operations have been slow to adopt computer applications. This paper investigates the key characteristics of the farm operators and farm businesses that influence computer use. To that end, data from Statistics Canada's Census of Agriculture are used. The results of the logistic regression point out a trend in the adoption patterns of computer technology use. Farm operations where a computer is used in their management tend to be larger farms, have younger operators who are female, their operators work off the farm, are part-tenant/part owner operators and produce certified organic products. The impact of language spoken on the probability of adopting a computer and types of computer use varies across applications. As for provincial location of the operation, generally the Atlantic Provinces and Manitoba appear less likely to adopt the computer technology than Saskatchewan (= reference province). Finally, all other types of farm have a higher probability of adopting a computer and types of computer use than cattle operations. Although the proportion of farm businesses that have adopted a computer and the various types of computer applications is still far below 50%, further incremental use of computer softwares, mail and internet services increases the potential for better decision making and improved efficiency in farm businesses.

JEL Classification: Q12, Q16.

Key words: Computer technology, probability of adoption, Canadian farm businesses.

This paper was written when Jean Bosco Sabuhoro was working for the Globalisation Research Program, Business and Trade Statistics, Statistics Canada. Agriculture Division, Statistics Canada. We thank Mike Trant from the Statistics Canada's Agriculture Division for helpful comments and the access to data. The views expressed in the paper do not reflect the official position of Statistics Canada. Any remaining errors are the authors' responsibility.

1. Introduction

Recent advances in microcomputers and internet services combined with their affordability have greatly increased the potential for on farm business use of computers. Microcomputers can increase the efficiency, and consequently the profitability, of a farm operation.

A microcomputer has various uses on a farm operation, for example, bookkeeping, payroll and tax preparation, livestock and/or crop record keeping, word processing, internet, e-mail and other activities such as forward contracting, the sale of farm products and auctioning.

The purpose of this paper is to identify and quantify the key characteristics of the farm operators and farm businesses that influence computer use. Key characteristics that influence the different types of computer applications used will also be identified and qualified. Data from Statistics Canada's Census of Agriculture are used to estimate probability models of farm-level computer and computer applications adoption.

2. Factors influencing computer technology adoption and model specification

2.1 Factors

Multivariate techniques are used to investigate the interaction of various farmer and farm business characteristics in determining computer technology adoption. Table 1 presents the list of variables analysed. The dependent variables represent the computer adoption choice (computer = 1 if yes, 0 if no) and the type of computer application used (e.g. internet or accounting = 1 if yes, 0 if no).[1]

Farm size and farm type influence the adoption of computer use as well as the types of computer applications used. Generally speaking, large and/or complex farm businesses are difficult to manage efficiently. Use of a microcomputer can help with both record keeping and management. Therefore, as farms increase in size and complexity, the odds of adopting computer technologies increase. By the same logic, operators of larger farm businesses are believed to have a higher likelihood of using computer technologies as the number of business transactions increases the benefits of computerizing clerical tasks. In this paper, TOTAL FARM AREA and SALES are used as proxies for farm size.

Dummy variables for types of farm are created to take into account that computer adoption and types of computer application use vary across different industries in the farming sector. For example, record keeping is important to efficient dairy production. Therefore, as a group, dairy farms are expected to have higher odds of using a microcomputer. The dummy variables included are DAIRY, GRAIN, FIELD CROP, and OTHER FARM TYPE while CATTLE is the omitted category in the model.

We posit a negative effect of AGE on the likelihood of computer adoption because younger farmers are more likely than older ones to have been exposed to computers and computer information in school, and have a longer time period over which to use a computer application and to recapture the learning costs or pay for their investment.

[1] This refers to step 4 in the questionnaire of the Census of Agriculture. Is a computer used in the management of this farm business (no, yes)? Indicate the type of computer application used (bookkeeping, payroll or tax preparation; livestock and/or crop record keeping; word processing; internet; e-mail and other).

Farm operators who have an off-farm job or run another business (PART TIME) have smaller farms on average and may have a higher opportunity cost of their time. However, the impact on the existence and use of a computer for this type of farm business most likely depends on the nature of the off-farm activity. If the off-farm work is a non-farming business that greatly benefits from computer technology, then it would probably increase the likelihood of computer adoption for the farming business as well. Otherwise, the adoption and types of computer applications used are less likely due to the increased opportunity cost of the operator's time.

Although the national and provincial rates of internet users from the General Social Survey (Statistics Canada, 2001) are higher for males than females, the effect of GENDER on computer adoption and type of computer applications used in farm businesses remains an empirical question. The same can be said about the effect of LANGUAGE.

Dummy variables are included in the model to capture the influence of land ownership on computer adoption and type of computer applications used. These are TENURE2 and TENURE3. The reference category is TENURE1.

As computer technology adoption varies across provinces, dummy variables for Canadian provinces are included in the model. The Atlantic Provinces are grouped under the label MARITIME and Saskatchewan is the reference province.

The 2001 Census of Agriculture had a question on organic certification: "does this operation produce any certified organic products for sale?" As high standards for land management, environment sustainability and food quality are required to be a certified organic producer, we hypothesize that certified organic producers (CERTIFIED) are more likely to adopt the use of a computer.

The use of microcomputers is also believed to be positively associated with education. Therefore, additional schooling is expected to increase the odds of adopting a computer as a management tool.[2]

2.2. Model specification

Because the dependent variables are categorical, the logit model is appropriate. Consider a model of computer technology adoption. During the period in which the Census of Agriculture is taken, the farm operator either uses a computer in the management of the farm operation (y=1) or does not (y = 0). Theory states that the farm operator makes a marginal benefit-marginal cost calculation based on the satisfaction achieved by either making the adoption, or not making the adoption and using the money for something else. Since marginal benefit is not observable, the net benefit of the adoption (difference between benefit and cost) is modeled as an unobserved variable, y^* related to the abovementioned factors gathered in a vector x as follows: $y^* = \beta' x + \varepsilon.$ β are parameters to be estimated and ε is an error term that has a logistic distribution. When the decision to adopt or not adopt a computer technology is made, our observation is:

$$y = 1 \; if \;\; y^* \succ 0,$$
$$y = 0 \; if \;\; y^* \leq 0.$$

[2] The education variable is currently absent from the Census of Agriculture but will be derived from the Census of the Population when the two files are linked together in late 2003.

(1)
The probability that y = 1 is:
$$P(y^* \succ 0) = P(\beta' x + \varepsilon \succ 0) = P(\varepsilon \succ -\beta' x).$$

(2)
If the distribution is symmetric, as is the logistic, then:
$$P(y = 1) = P(y^* \succ 0) = P(\varepsilon \prec \beta' x) = \Lambda(\beta' x),$$
(3)
where $\Lambda = \dfrac{e^{\beta' x}}{1 + e^{\beta' x}}$ is the logistic cumulative distribution function. Some analysts report the odds ratio or the probability of adoption relative to non-adoption that is given as:
$$\frac{P}{1-P} = e^{\beta' x} \ or \ \ln\left(\frac{P}{1-P}\right) = \beta' x.$$
(4)
The results of using the logit model to analyse the factors associated with adoption of computer technology in Canadian farm businesses are presented in Section 4.

3. The data

Statistics Canada's Census of Agriculture is conducted on the same day as its Census of Population. The Agricultural Census collects a wide range of data on the agriculture industry, such as number and type of agricultural operations, farm operator characteristics, business operating arrangements, land management practices, crop areas, numbers of livestock and poultry, farm business capital, operating expenses and receipts, and farm machinery and equipment. These data provide a comprehensive picture of the agriculture industry across Canada every five years, at the national and provincial levels, as well as at lower levels of geography. In addition, the unique Agriculture-Population Linkage Database, which links data from both the Census of Population and Census of Agriculture, paints a socio-economic portrait not only of farm operators but also of their families and households.

Three questions new to the 2001 Census of Agriculture, asked about the type of computer applications used for farm business, whether the farm produced certified organic products for sale and what category the certified organic products for sale fell into. Although the Agricultural Census has provided data on the number of farms where a computer is used as a management tool for a number of cycles, asking which application category, accounting, inventory control, word processing, Internet, e-mail or some other application, the computer was used for was new. By asking how many farms produced certified organic products for sale and categorizing them into one of four types, fruit, vegetables and greenhouse products, field crops, animals or animal products, and "other", the number of farms with certified organic products for sale was measured for the first time.

3.1 Descriptive statistics

Although the Census of Agriculture classifies farms as being operated by either one operator or more than one operator (a maximum of three are allowed), the econometric analysis is restricted to only one operator (operator 1).[3] Using this criteria led to a sample size of 246 923, the total– number of farm operations in Canada. Farms having only an operator 1 represent 70.47% of all operators. This proportion is almost equal to the sum of the proportions of all farms exclusively operated by men (64%) and women (5%).[4] As shown in table 1, 39.44% of Canadian farm businesses used a computer in the management of their farm businesses in 2000. As for computer

[3] The analysis is limited to only operator number one although 30% of the farms had either two or three operators. By eliminating the second and third operator data, data on age may be biased. Also, it is worth mentioning that, while the analysis assumes that operator one is the person who uses the computer and decides which applications to buy/use, this may not be true in all cases.
[4] See Statistics Canada (2001) for more information.

applications, 30.59% of farm businesses used a computer for bookkeeping, 27.76% for internet, 25.46% for word processing, 24.91% for e-mail, 16.14% for record keeping, and 0.22% for other computer-related activities. Traditionally, farmers and others in agribusiness have been seen as rapid adopters of technologies that improved their productivity. This is not the case with computers and the internet. Farm businesses lag behind the rest of businesses in the rate of adoption of computers and the internet (Charles and Leduc, 2002). Part of the reason may lie in the attitudinal issues: operator's optimism and enthusiasm toward information technology (Ernest and Tucker, 2001). The average age of operator 1 was 51.3 years, the average area of land they reported was 675.52 acres while their average gross receipts were $155,579.54. By ownership status, 58.09% were registered as owners, 4.78% as tenants and 37.13% as part-owners/part tenants. Females made up 7.91% of operator 1.[5] Both men and women worked off the farm in 2000. The rate of working off the farm or running another business was 44.58% and 45.89%, respectively for men and women, with a joint rate of 44.68%. French was the mother tongue for only 12.88% of operator 1's. For the first time, farm operators reported whether they produced certified organic products from one of four different categories, organic animals or animal products, organic field crops, organic fruits, vegetables, or greenhouse products, and 'other' organic products. There were 2, 230, or 0.9% of all farms, that produced certified organic products, of which 64.66% produced field crops. By region, 80% of farm businesses were located in four provinces, Quebec, Ontario, Saskatchewan and Alberta. Their shares were 13.01%, 24.20%, 20.37% and 21.83%, respectively. For the type of farm business, 28.37% of farm operations were cattle operations, 7.57% dairy operations, 21.74% grain and oilseed operations, 8.55% field crop operations and 27.45% were other farm types (e.g. hog, poultry and egg, fruit).

4. The results

The logit results for computer adoption in the farm management are displayed in table 2. The various measures of goodness of fit indicate that the estimated model fits the data reasonably well. The R^2 is acceptable for survey data. The three chi-square statistics for the estimated model compared to the model with all coefficients restricted to zero are significant at above the 1% level. The percent of concordance between predicted probabilities and observed responses is high.

All coefficients are significant at the 1% significance level, except for the coefficients on Maritime and Manitoba that are insignificant at the conventional levels. The interpretation of odds ratio is that as the explanatory variables change, the probability of adoption changes by that factor, i.e., variables with an odds ratio greater than unity would increase the probability of computer adoption, while those with a value of less than unity would have a negative effect on adoption. For dummy variables, the comparison refers to the omitted category.

The probability of adopting a computer is found to decrease with the age of operator 1. The adoption of computer and complementary softwares may be judged costly by older farm operators who do not have a longer time horizon to recapture the learning costs. Based on the odds ratio, a one year increase in age lowers the probability of computer adoption by 0.033.

Size matters. Bigger farm businesses, in terms of gross receipts and area of land, are more likely to adopt a computer.

[5] Of all farm operators, females were 26%.

Similarly, the probability of adopting a computer is seen to increase if operator 1 is female, works off the farm or runs another business, speaks French, and if the farm is "certified organic". For example, a certified organic producer's probability of adoption is 1.6 times that of a conventional counterpart.

Compared to owners, farm operators who are tenants are less likely to use computers in the management of the farm, while part-owner/part tenant farmers are more likely to adopt a computer. A mixed regime of ownership may be complex to manage and thus require a computer. Alternatively, compared to cattle (beef) operations, dairy operations, grain and oilseed operations, field crop operations and other farm type operations are more likely to adopt a computer for use in the management of the farm.

Farm operations located in provinces other than Saskatchewan have a higher probability of adopting a computer to be used for farm management. For example, the odds ratio for British Columbia's operations is 1.60 times that of Saskatchewan's operations. Remember, though, that the impacts of Manitoba and Atlantic Provinces are not statistically significant.

The types of computer use considered in this study are internet, e-mail, bookkeeping, payroll and tax preparation (Accounting), livestock and/or crop record keeping (Livestock/crop), word processing, and other activities. Logit results are reported only for the first four types of computer applications.

Table 3 presents the logit results for internet adoption in the farm management. As for computer adoption, the goodness of fit measures reveals that the estimated model fits the data well. All coefficients are significant at the 1% significance level, except for the coefficient on Maritime that is significant at the 3.66% significance level. Generally speaking, the signing of most coefficients and the size of odds ratios are qualitatively the same as for the computer adoption model, except for the variables "Language", "Maritime" and "Manitoba". The statistical evidence indicates that operators who speak French and who are located in the Atlantic Provinces and in Manitoba are less likely to adopt and use the internet for farm management. The logit results for e-mail adoption shown in table 4 lead to the same interpretation, except for the impacts of Maritime and Quebec that are not statistically significant. It is worth mentioning that these results are, to some extent, consistent with use rates found in the General Social Survey (Statistics Canada, 2001).

The logistic regression was also implemented on the adoption of accounting and livestock/crop applications. Their results are displayed in tables 5 and 6, respectively. The logit results for accounting applications are similar to those found with computer adoption, except that the impact of total farm area is insignificant. This may be because total farm area is a poor proxy for farm size when accounting activities are concerned. As for the livestock/crop adoption, the estimated equation behaves like that of internet and e-mail regarding the variables Language and Maritime, although Maritime is statistically insignificant at conventional levels. Compared to other applications, some peculiarities deserve a mention. First, tenants are more likely to adopt this application than owners. Second, farm operations classified as grain and oilseed farms or field crop farms have lower odds of adoption than cattle.

5. Summary and conclusions

This paper investigates key characteristics of the Canadian farmers and farm businesses that influence computer and types of computer applications use. Data from Statistics Canada's

2001 Census of Agriculture are used to estimate probability models of farm-level computer and computer applications adoption.

Descriptive analysis of data reveals that operators classified as operator 1, make up 70.47% of all operators. 39.44% of Canadian farm operations have a computer used for management of the farm. As for types of computer applications used, 30.59% of farm operations use it for bookkeeping, payroll or tax preparation, 27.76% for internet, 25.46% for word processing and 24.91% for e-mail. The average age of operators 1 is 51.3 years, the average area of their land is 675.52 acres while their average gross receipts are $155,579.54. By ownership status, 58.09% and 37.13% are registered as owners and part-owners/part tenants, respectively. The rate of working off the farm or running another business is similar for both men and women, around 45%. Certified organic producers are a rather tiny proportion of farm businesses, (0.9%) but their numbers are growing rapidly. By type of farm business, cattle and grain and oilseed farms stand out as the largest.

Overall, the results of the logistic regression point out a trend in the adoption patterns of computer technology use. Farm operations where a computer is used in their management tend to be larger farms, have younger operators who are female, their operators work off the farm, are part-tenant/part owner operators and produce certified organic products. The impact of language spoken on the probability of adopting a computer and types of computer use varies across applications. Speaking French exerts a positive effect on computer adoption in general and on the accounting application but a negative effect on the internet, e-mail and livestock/crop adoption. As for provincial location of the operation, generally the Atlantic Provinces and Manitoba appear less likely to adopt the computer technology than Saskatchewan (= reference province). Finally, all other types of farm have a higher probability of adopting a computer and types of computer use than cattle operations; the results for adoption of livestock and/or crop record keeping application constitute an exception.

Although the proportion of farm businesses that have adopted a computer and the various types of computer applications is still far below 50%, further incremental use of computer softwares, mail and internet services increases the potential for better decision making and improved efficiency in farm businesses. This paper identifies and investigates the factors that could be acted on to enhance the probability of adoption.

References

Batte, M.T., Jones, E. and G.D. Schnitkey (1990). Computer use by Ohio commercial farmers. American Journal of Agricultural Economics, pp. 935-945.

Charles, S. and I.A. Leduc (2002). Embracing e-business: does size matter? Statistics Canada, Catalogue no. 56F0004MIE-No. 6.

Ernest, S. and M. Tucker (2002). Agriculture. A new look at adoption and diffusion of information technology.

Huffman, W.E. and S. Mercier (1991). Joint adoption of microcomputer technologies: an analysis of farmers' decisions. The Review of Economics and Statistics, pp. 541-546.

Putler, D.S. and D. Zilberman (1988). Computer use in agriculture: Evidence from Tulare County, California. American Journal of Agricultural Economics, vol. 70, pp. 790-802.

Statistics Canada (2001a). 2001 Census of Agriculture: profile of Canadians farm operators, full release.

Statistics Canada (2001b). Overview: Access to and use of information communication technology. Housing, Family and Social Statistics Division, Catalogue no.56-505-XIE.

Thompson, S. and S.T. Sonka (1997). Potential effects of information technologies on the economic performance of agricultural and food markets. American Journal of Agricultural Economics, 79, pp. 657-662.

Table 1. Variable names, definitions and means

Name	Definition	Proportion or mean
COMPUTER	= 1 if computer is used in the management of this farm, 0 otherwise	39.44%
ACCOUNTING	= 1 if computer is used for bookkeeping, payroll or tax preparation, 0 otherwise	30.59%
LIVESTOCK/CROP	= 1 if computer is used for livestock and/or crop record keeping , 0 otherwise	16.14%
WORD PROCESSING	= 1 if computer is used for word processing, 0 otherwise	25.46%
INTERNET	= 1 if computer is used for internet, 0 otherwise	27.76%
E-MAIL	= 1 if computer is used for E-mail, 0 otherwise	24.91%
AGE	Age of operator 1 (in years)	51.30
TOTAL FARM AREA	Total area of land of this operation (in acres)	675.52
SALES	Total gross farm receipts (in dollars)	155 579.54
GENDER	= 1 if operator 1 is female, 0 if male	7.91%
PART TIME	= 1 if operator 1 works off farm or runs another business, 0 otherwise	44.68%
TENURE1	= 1 if operator 1 is owner, 0 otherwise	58.09%
TENURE2	= 1 if operator 1 is tenant, 0 otherwise	4.78%
TENURE3	= 1 if operator 1 is part owner/part tenant, 0 otherwise	37.13%
CERTIFIED	= 1 if operator 1 is certified organic, 0 otherwise	0.90%
LANGUAGE	= 1 if operator 1 is francophone, 0 otherwise	12.88%
MARITIME	= 1 if operator 1 is located in the Atlantic provinces, 0 otherwise	3.82%
QUEBEC	= 1 if operator 1 is located in Quebec, 0 otherwise	13.01%
ONTARIO	= 1 if operator 1 is located in Ontario, 0 otherwise	24.20%
MANITOBA	= 1 if operator 1 is located in Manitoba, 0 otherwise	8.54%
SASKATCHEWAN	= 1 if operator 1 is located in Saskatchewan, 0 otherwise	20.37%
ALBERTA	= 1 if operator 1 is located in Alberta, 0 otherwise	21.83%
BRITISH COLUMBIA	= 1 if operator 1 is located in British Columbia, 0 otherwise	8.24%
CATTLE	= 1 if type of farm is cattle (beef) , 0 otherwise	28.37%
DAIRY	= 1 if type of farm is dairy, 0 otherwise	7.57%
GRAIN	= 1 if type of farm is grain and oilseed (except wheat) , 0 otherwise	21.74%
FIELD CROP	= 1 if type of farm is field crop (except grain and oilseed) , 0 otherwise	8.55%
OTHER FARM TYPE	= 1 if farm is of other type, 0 otherwise	27.45%

Table 2. Logit results for adoption of computer in the farm management

Variable	Coefficient	Standard error	Pr > χ^2	Odds ratio
Intercept	-2.9750	0.0469	<0.0001	
Age	-0.0337	0.000391	<0.0001	0.967
Total farm area	0.0112	0.00417	0.0073	1.011
Total sales	0.3166	0.00350	<0.0001	1.372
Gender	0.2659	0.0168	<0.0001	1.305
Part time	0.4039	0.0103	<0.0001	1.498
Tenure 2	-0.0753	0.0211	0.0004	0.927
Tenure 3	0.1577	0.0107	<0.0001	1.171
Certified	0.4441	0.0452	<0.0001	1.559
Language	0.1628	0.0356	<0.0001	1.177
Maritime	0.0244	0.0266	0.3577	1.025
Quebec	0.1548	0.0374	<0.0001	1.167
Ontario	0.2128	0.0152	<0.0001	1.237
Manitoba	-0.00028	0.0185	0.9881	1.000
Alberta	0.3204	0.0141	<0.0001	1.378
British Columbia	0.4712	0.0210	<0.0001	1.602
Dairy	0.5047	0.0193	<0.0001	1.657
Grain and oilseed	0.3285	0.0124	<0.0001	1.389
Field crop	0.3232	0.0181	<0.0001	1.382
Other farm type	0.6919	0.0132	<0.0001	1.998
Association of predicted probabilities and observed responses				
Percent concordant	71.2			
Percent discordant	28.5			
Percent tied	0.3			
Testing global hypothesis: beta =0				
Test	χ^2	Degrees of freedom	Pr > χ^2	
Likelihood Ratio	34364.2150	19	<0.0001	
Score	31623.9769	19	<0.0001	
Wald	27957.6165	19	<0.0001	
R^2	0.1299			
Max-rescaled R^2	0.1759			

Table 3. Logit results for adoption of internet in the farm management

Variable	Coefficient	Standard error	Pr > χ^2	Odds ratio
Intercept	-3.0209	0.0501	<0.0001	
Age	-0.0346	0.000424	<0.0001	0.966
Total farm area	0.0199	0.00446	<0.0001	1.020
Total sales	0.2753	0.00369	<0.0001	1.317
Gender	0.2725	0.0179	<0.0001	1.313
Part time	0.3550	0.0111	<0.0001	1.426
Tenure 2	-0.1303	0.0229	<0.0001	0.878
Tenure 3	0.1613	0.0115	<0.0001	1.175
Certified	0.5467	0.0457	<0.0001	1.728
Language	-0.2037	0.0389	<0.0001	0.816
Maritime	-0.0608	0.0291	0.0366	0.941
Quebec	0.1369	0.0408	0.0008	1.147
Ontario	0.1919	0.0163	<0.0001	1.212
Manitoba	-0.1622	0.0203	<0.0001	0.850
Alberta	0.2527	0.0152	<0.0001	1.287
British Columbia	0.3648	0.0227	<0.0001	1.440
Dairy	0.5458	0.0202	<0.0001	1.726
Grain and oilseed	0.4220	0.0134	<0.0001	1.525
Field crop	0.3133	0.0202	<0.0001	1.368
Other farm type	0.6590	0.0143	<0.0001	1.933
Association of predicted probabilities and observed responses				
Percent concordant	70.1			
Percent discordant	29.5			
Percent tied	0.3			
Testing global hypothesis: beta =0				
Test	χ^2	Degrees of freedom	Pr > χ^2	
Likelihood ratio	25934.6227	19	<0.0001	
Score	23809.3323	19	<0.0001	
Wald	21565.8157	19	<0.0001	
R^2	0.0997			
Max-rescaled R^2	0.1438			

Table 4. Logit results for adoption of e-mail in the farm management

Variable	Coefficient	Standard error	Pr > χ^2	Odds ratio
Intercept	-3.1448	0.0513	<0.0001	
Age	-0.0320	0.000435	<0.0001	0.969
Total farm area	0.0162	0.00456	0.0004	1.016
Total sales	0.2646	0.00377	<0.0001	1.303
Gender	0.3084	0.0182	<0.0001	1.361
Part time	0.3316	0.0113	<0.0001	1.393
Tenure 2	-0.1293	0.0236	<0.0001	0.879
Tenure 3	0.1343	0.0118	<0.0001	1.144
Certified	0.6553	0.0457	<0.0001	1.926
Language	-0.3061	0.0408	<0.0001	0.736
Maritime	-0.0241	0.0297	0.4178	0.976
Quebec	0.0420	0.0427	0.3246	1.043
Ontario	0.1725	0.0167	<0.0001	1.188
Manitoba	-0.1367	0.0209	<0.0001	0.872
Alberta	0.2813	0.0155	<0.0001	1.325
British Columbia	0.4022	0.0231	<0.0001	1.495
Dairy	0.5147	0.0209	<0.0001	1.673
Grain and oilseed	0.4177	0.0139	<0.0001	1.518
Field crop	0.3212	0.0208	<0.0001	1.379
Other farm type	0.6994	0.0147	<0.0001	2.013
Association of predicted probabilities and observed responses				
Percent concordant	69.3			
Percent discordant	30.3			
Percent tied	0.4			
Testing global hypothesis: beta =0				
Test	χ^2	Degrees of freedom	Pr > χ^2	
Likelihood ratio	22270.3662	19	<0.0001	
Score	20598.4810	19	<0.0001	
Wald	18855.1730	19	<0.0001	
R^2	0.0862			
Max-rescaled R^2	0.1278			

Table 5. Logit results for adoption of accounting application

Variable	Coefficient	Standard error	Pr > χ^2	Odds ratio
Intercept	-3.8872	0.0500	<0.0001	
Age	-0.0300	0.000413	<0.0001	0.970
Total farm area	0.00672	0.00439	0.1254	1.007
Total sales	0.3483	0.00372	<0.0001	1.417
Gender	0.1889	0.0179	<0.0001	1.208
Part time	0.4049	0.0109	<0.0001	1.499
Tenure 2	-0.0500	0.0224	0.0253	0.951
Tenure 3	0.1291	0.0113	<0.0001	1.138
Certified	0.3417	0.0463	<0.0001	1.407
Language	0.2910	0.0370	<0.0001	1.338
Maritime	0.0786	0.0284	0.0056	1.082
Quebec	0.2034	0.0391	<0.0001	1.226
Ontario	0.1977	0.0162	<0.0001	1.219
Manitoba	0.0161	0.0197	0.4134	1.016
Alberta	0.3400	0.0150	<0.0001	1.405
British Columbia	0.4222	0.0225	<0.0001	1.525
Dairy	0.3890	0.0197	<0.0001	1.476
Grain and oilseed	0.3222	0.0132	<0.0001	1.380
Field crop	0.3613	0.0195	<0.0001	1.435
Other farm type	0.5772	0.0140	<0.0001	1.781
Association of predicted probabilities and observed responses				
Percent concordant	71.0			
Percent discordant	28.7			
Percent tied	0.3			
Testing global hypothesis: beta =0				
Test	χ^2	Degrees of freedom	Pr > χ^2	
Likelihood ratio	29982.2925	19	<0.0001	
Score	27506.1921	19	<0.0001	
Wald	24609.3488	19	<0.0001	
R^2	0.1143			
Max-rescaled R^2	0.1615			

Table 6. Logit results for adoption of livestock and/or crop record keeping application

Variable	Coefficient	Standard error	Pr > χ^2	Odds ratio
Intercept	-4.0218	0.0599	<0.0001	
Age	-0.0299	0.000509	<0.0001	0.971
Total farm area	0.0494	0.00521	<0.0001	1.051
Total sales	0.2814	0.00436	<0.0001	1.325
Gender	0.3132	0.0211	<0.0001	1.368
Part time	0.2899	0.0132	<0.0001	1.336
Tenure 2	0.0673	0.0266	0.0113	1.070
Tenure 3	0.1279	0.0137	<0.0001	1.136
Certified	0.2842	0.0545	<0.0001	1.329
Language	-0.1890	0.0477	<0.0001	0.828
Maritime	-0.0424	0.0354	0.2314	0.959
Quebec	0.0803	0.0499	0.1075	1.084
Ontario	0.0893	0.0201	<0.0001	1.093
Manitoba	0.1613	0.0234	<0.0001	1.175
Alberta	0.3485	0.0181	<0.0001	1.417
British Columbia	0.4895	0.0267	<0.0001	1.632
Dairy	0.2893	0.0236	<0.0001	1.335
Grain and oilseed	-0.0968	0.0165	<0.0001	0.908
Field crop	-0.2013	0.0270	<0.0001	0.818
Other farm type	0.5561	0.0167	<0.0001	1.744
Association of predicted probabilities and observed responses				
Percent concordant	69.0			
Percent discordant	30.5			
Percent tied	0.5			
Testing global hypothesis: beta =0				
Test	χ^2	Degrees of freedom	Pr > χ^2	
Likelihood ratio	16210.8762	19	<0.0001	
Score	14950.1656	19	<0.0001	
Wald	13863.7651	19	<0.0001	
R^2	0.0635			
Max-rescaled R^2	0.1083			

Agriculture and Rural Working Paper Series

(* The *Agriculture and Rural Working Paper Series* is now available on Statistics Canada's Web Site (www.statcan.ca). From the *Our products and services* page, under *Browse our Internet publications (PDF or HTML)*, choose *Free*, then *Agriculture*.)

No.1	(21-601-MPE1980001)	**A Description of Theil's RMPSE Method in Agricultural Statistical Forecasts (1980)**, Stuart Pursey
No.3	(21-601-MPE1981003)	**A Review of the Livestock Estimating Project with Recommendations for the Future (1981)**, Bernard Rosien and Elizabeth Leckie
No.4	(21-601-MPE1984004)	**An Overview of the Canadian Oilseed Industry (1984)**, Glenn Lennox
No.5	(21-601-MPE1984005)	**Preliminary Analysis of the Contribution of Direct Government Payments to Realized Net Farm Income (1984)**, Lambert Gauthier
No.6	(21-601-MPE1984006)	**Characteristics of Farm Entrants and their Enterprises in Southern Ontario for the Years 1966 to 1976 (1984)**, Jean B. Down
No.7	(21-601-MPE1984007)	**A Summary of Commodity Programs in the United States (1984)**, Allister Hickson
No.8	(21-601-MPE1984008)	**Prairie Summerfallow Intensity: An Analysis of 1981 Census Data (1984)**, Les Macartney
No.9	(21-601-MPE1985009)	**The Changing Profile of the Canadian Pig Sector (1985)**, Mike Shumsky
No.10	(21-601-MPE1986010)	**Revisions to the Treatment of Imputed House Rents in the Canadian Farm Accounts, 1926-1979 (1986)**, Mike Trant
No.11	(21-601-MPE1992011)	**The Ratio Estimator: an Intuitive Explanation and Its Use in Estimating Agriculture Variables (1992)**, François maranda and Stuart Pursey
No.12	(21-601-MPE1991012)	**The Impact of Geographic Distortion Due to the Headquarters Rule (1991)**, Rick Burroughs
No.13	(21-601-MPE1991013)	**The Quality of Agriculture Data - Strengths and Weaknesses (1991)**, Stuart Pursey
No.14	(21-601-MPE1992014)	**Alternative Frameworks for Rural Data (1992)**, A.M. Fuller, Derek Cook and Dr. John Fitzsimons
No.15	(21-601-MPE1993015)	**Trends and Characteristics of Rural and Small Town Canada (1993)**, Brian Bigs, Ray Bollman and Michael McNames
No.16	(21-601-MPE1992016)	**The Microdynamics and Farm Family Economics of Structural Change in Agriculture (1992)**, Phil Ehrensaft and Ray Bollman
No.17	(21-601-MPE1993017)	**Grains and Oilseeds Consumption by Livestock and Poultry, Canada and Provinces 1992**, Livestock and Animal Products Section
No.18	(21-601-MPE1994018)	**Trends and Patterns of Agricultural Structural Change: Canada / US Comparison**, Ray Bollman, Leslie A. Whitener and Fu Lai Tung
No.19	(21-601-MPE1994019)	**Farm Family Total Income by Farm Type, Region and Size for 1990 (1994)**, Saiyed Rizvi, David Culver, Lina Di Piétro and Kim O'Connor
No.20	(21-601-MPE1991020)	**Adjustment in Canadian Agriculture (1994)**, George McLaughlin
No.21	(21-601-MPE1993021)	**Microdynamics of Farm Size Growth and Decline: A Canada-United States Comparison**, Fred Gale and Stuart Pursey
No.22	(21-601-MPE1992022)	**The Structures of Agricultural Household Earnings in North America: Positioning for Trade Liberalization**, Leonard Apedaile, Charles Barnard, Ray Bollman and Blaine Calkins
No.23	(21-601-MPE1992023)	**Potatoes: A Comparison of Canada/USA Structure**, Glenn Zepp, Charles Plummer and Barbara McLaughlin
No.24	(21-601-MPE1994024)	**Farm Structure Data: A US-Canadian Comparative Review**, Victor J. Oliveira, Leslie A. Whitener and Ray Bollman
No.25	(21-601-MPE1994025)	**Grain Marketing Statistics Statistical Methods Working Paper Version 2**, Karen Gray

Agriculture and Rural Working Paper Series (continued)

(* The *Agriculture and Rural Working Paper Series* is now available on Statistics Canada's Web Site (www.statcan.ca). From the *Our products and services* page, under *Browse our Internet publications (PDF or HTML)*, choose *Free*, then *Agriculture*.)

No.26	(21-601-MPE1994026)	**Farm Business Performance: Estimates from the Whole Farm Database**, W. Steven Danford
No.27	(21-601-MPE1994027)	**An Attempt to Measure Rural Tourism Employment**, Brian Biggs
No.28*	(21-601-MIE1995028)	**Delineation of the Canadian Agricultural Ecumene for 1991**, Timothy J. Werschler
No.29	(21-601-MPE1995029)	**Mapping the Diversity of Rural Economies: A preliminary Typology of Rural Canada**, Liz Hawkins
No.30*	(21-601-MIE1996030)	**Structure and Trends of Rural Employment: Canada in the Context of OECD Countries**, Ron Cunningham and Ray D. Bollman
No.31*	(21-601-MIE1996031)	**A New Approach to Non-CMA/CA Areas**, Linda Howatson-Leo and Louise Earl
No.32	(21-601-MPE1996032)	**Employment in Agriculture and Closely Related Industries in Rural Areas: Structure and Change 1981-1991**, Sylvain Cloutier
No.33*	(21-601-MIE1998033)	**Hobby Farming - For Pleasure or Profit?**, Stephen Boyd
No.34*	(21-601-MIE1998034)	**Utilization of Document Imaging Technology by the 1996 Canadian Census of Agriculture**, Mel Jones and Ivan Green
No.35*	(21-601-MIE1998035)	**Employment Patterns in the Non-Metro Workforce**, Robert Mendelson
No.36*	(21-601-MIE1998036)	**Rural and Small Town Population is Growing in the 1990s**, Robert Mendelson and Ray D. Bollman
No.37*	(21-601-MIE1998037)	**The Composition of Business Establishments in Smaller and Larger Communities in Canada**, Robert Mendelson
No.38*	(21-601-MIE1998038)	**Off-farm Work by Census-farm Operators: An Overview of Structure and Mobility Patterns**, Michael Swidinsky, Wayne Howard and Alfons Weersink
No.39*	(21-601-MIE1999039)	**Human Capital and Rural Development: What Are the Linkages?**, Ray D. Bollman
No.40*	(21-601-MIE1999040)	**Computer Use and Internet Use by Members of Rural Households**, Margaret Thompson-James
No.41*	(21-601-MIE1999041)	**RRSP Contributions by Canadian Farm Producers in 1994**, Marco Morin
No.42*	(21-601-MIE1999042)	**Integration of Administrative Data with Survey and Census Data**, Michael Trant and Patricia Whitridge
No.43*	(21-601-MIE2001043)	**The Dynamics of Income and Employment in Rural Canada: The Risk of Poverty and Exclusion**, Esperanza Vera-Toscano, Euan Phimister and Alfons Weersink
No.44*	(21-601-MIE2001044)	**Rural Youth Migration Between 1971 and 1996**, Juno Tremblay
No.45*	(21-601-MIE2001045)	**Measuring Economic Well-Being of Rural Canadians Using Income Indicators**, Carlo Rupnik, Margaret Thompson-James and Ray D. Bollman
No.46*	(21-601-MIE2001046)	**The Geographical Patterns of Socio-Economic Well-Being of First Nations Communities in Canada**, Robin P. Armstrong
No.47*	(21-601-MIE2001047)	**Distribution and Concentration of Canadian Livestock**, Martin S. Beaulieu
No.48*	(21-601-MIE2001048)	**Intensive Livestock Farming: Does Farm Size Matter?**, Martin S. Beaulieu
No.49*	(21-601-MIE2001049)	**Agriculture Statistics for Rural Development**, Ray D. Bollman
No.50*	(21-601-MIE2001050)	**Rural and Small Town Employment: Structure by Industry**, Roland Beshiri and Ray D. Bollman

Agriculture and Rural Working Paper Series **(continued)**

(* The *Agriculture and Rural Working Paper Series* is now available on Statistics Canada's Web Site (www.statcan.ca). From the *Our products and services* page, under *Browse our Internet publications (PDF or HTML)*, choose *Free*, then *Agriculture*.)

No.51*	(21-601-MIE2001051)	**Working Time: How do Farmers Juggle with it and How has it Impacted Their Family Total Income**, Sylvain Cloutier
No.52*	(21-601-MIE2001052)	**Growers of Genetically Modified Grain Corn and Soybeans in Quebec and Ontario: A Profile**, Bernard Hategekimana
No.53*	(21-601-MIE2002053)	**Integration of Canadian and U.S. Cattle Markets**, Rita Athwal
No.54*	(21-601-MIE2002054)	**Genetically Modified Grain Corn and Soybeans in Quebec and Ontario in 2000 and 2001,** Bernard Hategekimana
No.55*	(21-601-MIE2002055)	**Recent Migration Patterns in Rural and Small Town Canada,** Neil Rothwell et al
No.56*	(21-601-MIE2002056)	**Performance in the Food Retailing Segment of the Agri-Food Chain**, David Smith and Michael Trant
No.57*	(21-601-MIE2002057)	**Financial Characteristics of Acquired Firms in the Canadian Food Industry**, Martin S. Beaulieu
No.58*	(21-601-MIE2002058)	**Provincial Trade Patterns**, Marjorie Page
No.59*	(21-601-MIE2002059)	**An Analysis of Profits within the Canadian Food Processing Sector**, Rick Burroughs and Deborah Harper
No.60*	(21-601-MIE2002060)	**Rural Diversification**, Marjorie L. Page
No.61*	(21-601-MIE2002061)	**Definitions of « Rural »**, Valerie du Plessie et al
No.62*	(21-601-MIE2003062)	**A Geographic Profile of Canadian Livestock**, Martin S. Beaulieu et Frédéric Bédard
No.63*	(21-601-MIE2003063)	**Sub-provincial Income Disparity in Canada: Evidence from 1992 to 1999**, Alessandro Alasia
No.64*	(21-601-MIE2003064)	**Canada – Mexico Agricultural Economies and Trade Under Closer North American Relations**, Verna Mitura et al