



# Use of Good Agricultural Practices and Attitudes toward On-Farm Food Safety among Niche-Market Producers in Ontario, Canada: A Mixed-Methods Study

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## ABSTRACT

Major agri-food commodities in Canada use on-farm food safety (OFFS) programs that include good agricultural practices (GAPs), but niche-market (e.g. organic and small-scale) producers might have limited awareness of these programs or barriers to implementing them. We used a mixed-methods approach to study the reported use of recommended GAPs and factors related to the potential adoption of an OFFS program among niche-market producers in Ontario, Canada. Questionnaires were administered and 23 semi-structured interviews were conducted during 2008–2009. In total, 575 questionnaires were collected. The most commonly-produced commodities among respondents were vegetables (54.4%), fruits (36.7%) and beef cattle (31.1%). Disinfection of food animal drinking water and of post-harvest produce wash water was reported by 19.0% and 39.4% of respondents, respectively. Organic (26.4%) and OFFS program participation status (24.7%) were associated with the use of GAPs. Primary themes identified through interviews included concerns about the food safety of imported products, suggestions that OFFS programs be tailored by farm scale and be user-friendly and cost-recoverable, and the importance of producer education and government support. Future outreach with niche-market producers should focus on water disinfection (where appropriate), and they should be engaged in reviewing OFFS programs directed toward them to ensure their suitability and adoption.

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## INTRODUCTION

Food safety is a global concern that is best addressed by contributions from stakeholders at each point in the farm-to-fork continuum. At the pre-harvest level, the implementation of good agricultural practices (GAPs) is recommended by international agencies such as the Codex Alimentarius Commission, Food and Agriculture Organization and World Organization for Animal Health (9, 18, 26). In Canada, national commodity groups have developed on-farm food safety (OFFS) programs that are based on hazard analysis and critical control point principles (8). These programs typically comprise a manual of GAPs for producers, auditing requirements, auditor training and an administrative management system (8). However, niche-market (e.g., organic and small-scale) producers might not be aware of or participate in these OFFS programs. This could be a concern, given that consumers who purchase locally produced and organic foods often believe them to be healthier and safer than conventional products (3, 30). Current research indicates that the prevalence of indicator or pathogenic food-borne bacteria does not differ between organic produce and foods of animal origin and their conventional counterparts (1, 4, 38, 41).

The Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) has developed a comprehensive GAPs resource manual for livestock and horticulture producers called Advantage GAP (27). It seeks to ensure that GAPs guidelines are available to producers in Ontario that aren't participating in other OFFS programs. However, baseline information on the use of GAPs and attitudes toward OFFS programs among niche-market producers in Ontario is currently not available. This information would be useful in prioritizing areas for future continuing education and improving the uptake of GAPs and potential adoption of an OFFS program such as Advantage GAP among niche-market producers.

We conducted a mixed-methods study to investigate the following: (1) the reported use of GAPs and attitudes toward GAPs and OFFS programs and (2) associations between participation in an OFFS program and organic status and use of GAPs among niche-market producers in Ontario, Canada. Quantitative and qualitative data were collected concurrently through the administration

of questionnaires by mail, in person and via the Internet, and through 23 individual semi-structured interviews of selected producers. Our definition of "niche-market producer" included organic and community supported agriculture (CSA) farms, and producers marketing their products through local food guides and cooperatives.

## MATERIALS AND METHODS

### Questionnaire design and pre-testing

We developed a 10-page booklet questionnaire to assess the reported use of GAPs among niche-market producers in Ontario. It was pre-tested by three producers before use, and ambiguous or confusing questions were revised as needed. It contained 22 questions divided into eight sections: farm and producer demographics, safe water, worker policies, buildings and equipment, cleaning and sanitizing, traceability and record keeping, crop production and livestock production. The demographics section included two checklist questions about commodities produced and affiliations with speciality farm groups, three multiple-choice questions about respondent age, gender and participation in an OFFS program, and an open-ended question on farm size. The safe water section contained two multiple-choice questions about water sources and the frequency of water testing for bacteria and a yes/no question about the use of disinfection. For each of the other sections, producers indicated their use of three to four GAPs (23 total) on a five-point scale (from 'never' to 'always') and primary reasons for rarely or never using practices. These sections and GAPs were selected and adapted from the OMAFRA Advantage GAP manual (27). A copy of the questionnaire is available from the corresponding author upon request. This study received ethical approval from the University of Guelph Research Ethics Board (protocol #08OC009).

### Questionnaire administration

No single database source was available to obtain a sampling frame of niche-market producers in Ontario. Therefore, a list of 780 mailing addresses was compiled from publicly available directories from nine speciality farm groups and local food guides: Canadian Organic

Growers (COG), Organic Council of Ontario, CSA, Ecological Farming Association of Ontario, Durham Farm Fresh, Kawartha Farm Fresh, Kingston Organic, the Eat Well Guide, and Buy Local Buy Fresh food guides for seven regions in southern Ontario. The following mail-out sequence was used: (1) a pre-notification letter; (2) a questionnaire with a pre-stamped, self-addressed return envelope and cover letter; and (3) a reminder letter. The documents were sent on Feb. 4, Feb. 17 and Mar. 2, 2009, respectively. The questionnaire was also distributed in person at 12 producer conferences and workshops (Table 1) and E-mail (to National Farmers Union members) and electronic newsletter (ON Organic newsletter) notices were used to distribute a link to a web-based version (SurveyMonkey, <http://www.surveymonkey.com>). A \$2 gift certificate to a retail coffee chain was given as an incentive to those who completed (in person or via the Internet) or received (by mail) the questionnaire, except for producers (n = 69) belonging to one speciality farm group that indicated that their members did not wish to receive the incentive.

### Semi-structured interviews

The first author conducted 20 telephone and three in-person interviews from Nov. 2008 to Apr. 2009. Participants were purposively selected to ensure that producers with a range of characteristics (commodities produced, farm size, organic and OFFS program participation status) were included (29). They were recruited at the conferences and workshops where the questionnaire was distributed (Table 1; n = 10), through notices placed in the cover letter of the mail-out questionnaire (n = 10), and via E-mail notices to the COG (n = 2) and Simcoe Country Farm Fresh (n = 1) associations. Because of time constraints and funding deadlines, all interviews were conducted before analysis was initiated.

The interviews, which followed a pre-determined question guide that was updated based on producer responses to early interviews, consisted of six open-ended question topics. Responses to the four most relevant topics are reported here: importance of OFFS programs and GAPs; barriers toward implementing GAPs; recommendations to improve the suitability of OFFS programs; and any other food safety issues of importance to

**TABLE 1. Events used to distribute a questionnaire about GAPs to niche-market producers in Ontario, Canada, 2008–2009**

Event <sup>a</sup>	Date	Location	No. questionnaires distributed	No. (%) questionnaires returned	No. interview participants recruited
OFFMA annual bus tour	Nov. 9, 2008	N/a	30	13 (43.3)	0
Ontario CSA conference	Nov. 21–23, 2008	Orillia	200	6 (3.0)	0
EPAC annual meeting	Dec. 4, 2008	Elmira	77	45 (58.4)	2
Guelph Organic Conference	Jan. 24–25, 2009	Guelph	25	6 (24.0)	2
COG workshop	Feb. 7, 2009	Rockwood	2	2 (100.0)	3
Ontario Fruit and Vegetable Convention	Feb. 18–19, 2009	St. Catherine's	90	15 (16.7)	3
Eco Farm Day	Feb. 28, 2009	Cornwall	7	1 (14.3)	0
OMAFRA Advantage GAP workshops:					
Simcoe County Farm Fresh	Feb. 3, 2009	Midhurst	5	5 (100.0)	0
Multi-commodity producers	Feb. 12, 2009	Durham	5	5 (100.0)	0
Mennonite producers	Mar. 17, 2009	Lucknow	9	9 (100.0)	0
COG Ottawa region	Mar. 28, 2009	Ottawa	11	11 (100.0)	0
Manitoulin Community Food Network and Farmers' Market	Apr. 18, 2009	Manitoulin Island	6	6 (100.0)	0

<sup>a</sup>OFFMA, Ontario Farm Fresh Marketing Association; EPAC, Elmira Produce Auction Cooperative

the participant. Demographic information on producer age and gender, commodities produced, farm size, organic and CSA status, and participation in an OFFS program was also collected. A copy of the question guide is available from the corresponding author upon request.

Producers were offered the choice of a telephone or in-person interview that was audio-recorded, except for two producers who requested not to be recorded and one who was not recorded because of technical complications (comprehensive notes were taken in these situations). The \$2 gift certificate used for the questionnaires was also offered to interview participants.

### Quantitative data analysis

All completed questionnaires were entered into an electronic database (Access 2003, Microsoft Corporation, Redmond, WA), and entry was validated by manually comparing the original and

database versions. Open-ended “other” responses were coded in a spreadsheet (Excel 2003, Microsoft Corporation, Redmond, WA). Frequency tabulations and summary statistics were calculated for each variable, with missing values and “not applicable” responses excluded. Respondents’ average farm size and organic status were compared to the most recent agricultural census (2006), using a one-sample *t*-test and chi-square goodness of fit test, respectively (35);  $P < 0.05$  was considered statistically significant. Mann-Whitney tests (ordinal outcomes) and Fisher’s exact tests (dichotomous outcomes) were used to identify significant differences in the use of each GAP depending on respondents’ (1) organic status and (2) OFFS program participation status. We used respondents’ reported affiliation with organic groups as a surrogate for their organic status. The Bonferroni correction ( $\alpha$  level/number of comparisons) was used to adjust the 0.05 significance level for multiple com-

parisons. Fifty-eight comparisons were conducted (29 GAPs  $\times$  two demographic variables), so the significance level was set at  $P < 0.001$ . Analysis was conducted in Stata 10.0 (Stata Corporation, College Station, TX).

### Qualitative data analysis

Interview audio recordings were transcribed by a research assistant and validated by the interviewer. Two authors (I.Y. and A.R.) conducted a qualitative content analysis on the transcripts (2). Content analysis is a detailed and systematic examination of a body of material to identify patterns, themes and meaning (2). It involves developing codes, applying them to units of text, sorting the data by categories and interpreting their meaning. We developed our codes inductively (i.e., from the content of the interviews) as opposed to deductively (i.e., from predetermined hypotheses).

We began by independently reviewing five selected interviews, after which we developed summaries of the key

**TABLE 2. Demographics and characteristics of questionnaire respondents and interview participants, Ontario, Canada, 2008–2009**

Characteristic	Categories	Questionnaire respondents (n = 575)		Interview participants (n = 23)	
		No.	%	No.	%
Producer gender <sup>a</sup>	Male	356	73.7	15	68.2
	Female	127	26.3	7	31.8
Producer age <sup>b</sup>	< 30	33	6.0	0	0.0
	30 to 45	145	26.6	7	30.4
	46 to 60	279	51.1	12	52.2
	> 60	89	16.3	4	17.4
OFFS program participation		142	24.7	11	47.8
Organic status <sup>c</sup>		152	26.4	10	43.5
CSA status		46	8.0	2	8.7
Commodities produced	Beef cattle	179	31.1	9	39.1
	Chickens	66	11.5	3	13.0
	Dairy cattle	52	9.0	2	8.7
	Fruit	211	36.7	11	47.8
	Laying hens	101	17.6	5	21.7
	Sheep/lamb	61	10.6	4	17.4
	Swine	70	12.2	3	13.0
Vegetables	313	54.4	16	69.6	

<sup>a</sup>N = 483 for questionnaire because of missing values; n = 22 for interviews because both farm operators were interviewed together for one interview

<sup>b</sup>N = 546 for questionnaire because of missing values

<sup>c</sup>For questionnaire respondents, equal to the percentage of producers who indicated an affiliation with organic groups

quotes and issues identified in each interview and an initial code list. The coding scheme was independently applied to one selected interview and results were reviewed for intercoder reliability. Coding disagreements were discussed and resolved through consensus. The code list was updated and applied to nine additional interviews, and intercoder agreement was again reviewed. The code list was further revised and analysis proceeded with the remaining 13 interviews and open-ended comments from 66 questionnaires. To add additional analytic insight, the results obtained by a third author (A.J.) who coded five selected interviews were compared and merged with those from the other two analysts.

Coding results were integrated into the qualitative data analysis program NVivo 8 (QSR International Pty Ltd., Australia). The software was used to review coded content, search for code co-occurrences and stratify the results by producer characteristics. Themes were developed through combinations of codes that described the same concept. We used a technique called member-checking to ensure the validity of the findings (11). This included sending a summary of the results to the interview participants, along with a pre-stamped return envelope, and asking them to send us comments if they were not in agreement with the findings or if the results did not make sense to them.

## RESULTS

### Questionnaire

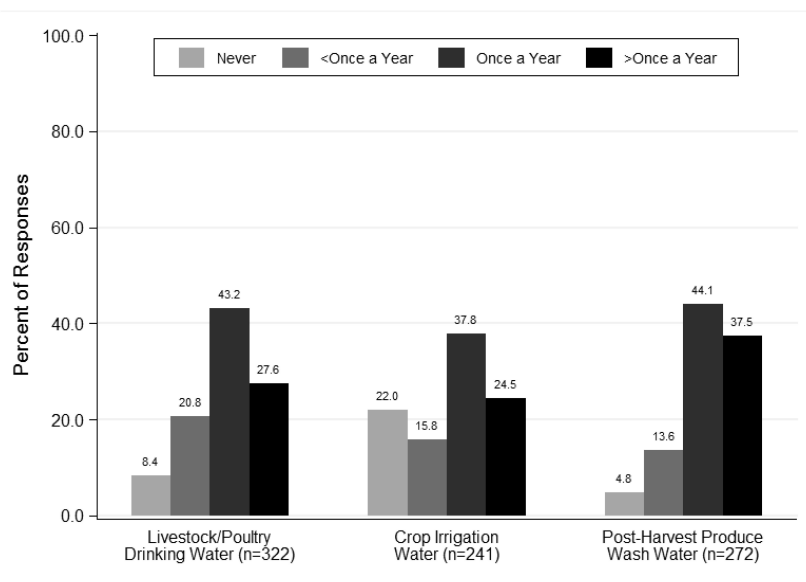
After exclusion of questionnaires sent to incomplete or changed addressees (n = 38) and to producers who had ceased farming (n = 12), the response rate for the postal questionnaire was 61.0% (445/730). In addition, 124 questionnaires were completed at 12 producer conferences and workshops (Table 1), and six were completed online via E-mail and newsletter links, bringing the total to 575. Respondent characteristics are shown in Table 2. The mean farm size among respondents (182.7 acres, standard deviation = 231.4) was signifi-

**TABLE 3. Reported water sources for different agricultural uses among niche-market producers, Ontario, Canada, 2008–2009**

Agricultural use	Total	% responses <sup>a</sup>		
		Private surface water	Private well water	Municipal water
Livestock/poultry drinking water	355	13.0	93.2	4.2
Crop irrigation water	289	52.9	57.8	2.8
Post-harvest produce wash water	294	5.1	88.4	8.8

<sup>a</sup>Multiple selections were allowed

**FIGURE 1.** Reported frequency of testing private water sources for bacteria among niche-market producers, Ontario, Canada, 2008–2009.



cantly smaller than the provincial average (232.7 acres,  $P < 0.001$ ). Respondents were also more likely to be organic compared to the provincial average (26.4% vs. 6.3%,  $P < 0.001$ ).

Respondents' reported water sources and disinfection and testing practices are shown in Tables 3 and 4 and Fig. 1. Their reported use of GAPs measured on an ordinal scale and reasons for rarely or never using any practices are shown in Table 5. Respondents who reported participation in an OFFS program were more likely to

have written guidelines for worker tasks that can impact food safety ( $P < 0.001$ ) and to apply manure to their crops within three months of harvest ( $P < 0.001$ ). Organic respondents were more likely to test their livestock and poultry drinking water for bacteria more frequently ( $P < 0.001$ ) and to keep records of each product received ( $P < 0.001$ ) and used ( $P < 0.001$ ) on the farm, each crop harvested and shipped ( $P < 0.001$ ), and the transfer of all livestock and food to and from the farm ( $P < 0.001$ ).

### Semi-structured interviews

Interviews lasted an average of 18 min (range, 9–40 min). The interview participant characteristics are shown in Table 2. Only one participant responded with comments during member-checking, which resulted in clarification of the results section. Quotes from interview participants and questionnaire comments are shown below to illustrate the identified themes.

There was near unanimous agreement among interview participants ( $n = 22/23$ ) that OFFS programs and the implementation of GAPs, at least to some degree, are important to maintain a safe food supply in Canada.

"Anybody producing food should have HACCP [hazard analysis critical control point] or some variant of it. I mean, at least be aware of where things can go wrong." (ID 9)

Participants also identified several barriers, concerns and suggested areas for improvement of OFFS in Ontario. These are summarized in Fig. 2 and below as six primary themes (discussed by 9–14 participants) and two secondary themes (discussed by 4 or 5 participants).

### IMPORTED PRODUCTS

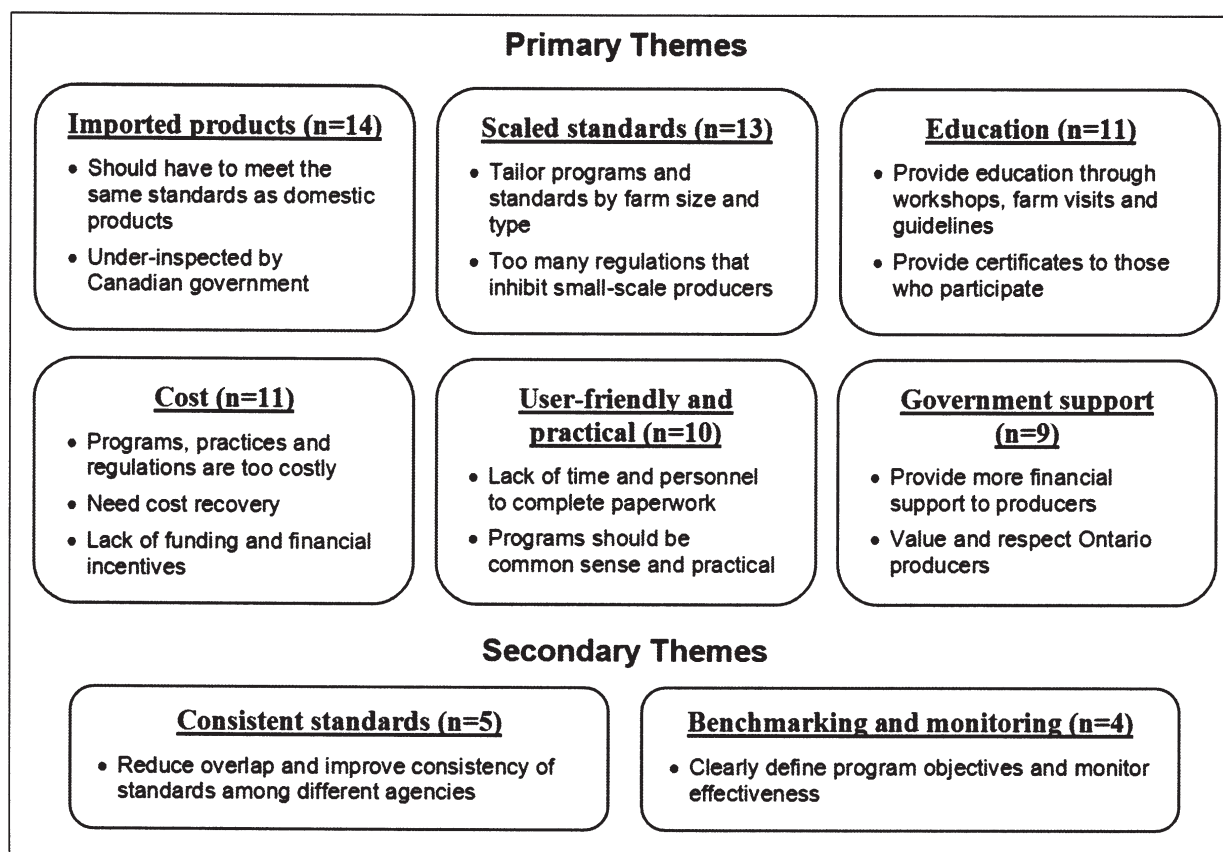
Several participants ( $n = 14$ ) expressed concerns about the uncertainty and inferiority of food safety standards in foreign countries and their belief that imported products should be required to meet the same standards as Canadian products. "They [imported products]

**TABLE 4. Reported use of water disinfection for different agricultural uses among niche-market producers, Ontario, Canada, 2008–2009**

Agricultural use	Total	% Yes	Disinfectants used – % <sup>a</sup>			
			UV light	Hydrogen peroxide	Chlorine	Ozone
Livestock/poultry drinking water	327	19.0	41.9	35.5	27.4	0.0
Crop irrigation water	263	6.8	61.1	27.8	16.7	11.1
Post-harvest produce wash water	279	39.4	55.5	47.3	8.2	0.9

<sup>a</sup>Multiple selections were allowed.

**FIGURE 2.** Primary and secondary themes identified by semi-structured interview participants, Ontario, Canada, 2008–2009; n indicates the number of participants who discussed each theme.



don't have the same standards we do, which I have a problem with because why am I being held to standards that mean nothing when we import so much from elsewhere?" (ID 11)

"I think if we're expecting it from ourselves, we need to expect it from any-

thing that's coming into the country." (ID 16)

### SCALED STANDARDS

Another theme discussed by more than half of the participants (n = 13) was that OFFS programs, standards

and regulations should be differentiated based on farm size and type (e.g., organic vs. conventional). "You can't really use a broad-brush. I think you need to have different categories, because what's going to apply for a large factory farm is not necessarily going to apply for someone my size." (ID 5)

**TABLE 5. Reported use of GAPs among niche-market producers, Ontario, Canada, 2008–2009**

Practice	Total	% responses in each category					Reasons for rarely or never using the practice (n) <sup>a</sup>
		Never	Rarely	Sometimes	Often	Always	
<b>Worker policies</b>							
Ensure workers are properly trained in food safety	419	3.3	4.3	13.4	26.7	52.3	Insufficient personnel safety (7); too time-consuming (6); not necessary (5)
Ensure workers wash their hands before handling food or animals	458	4.8	2.2	10.5	31.0	51.5	Insufficient personnel (7); not necessary (6); too time-consuming (5)
Ensure workers wear suitable clothing and footwear	468	2.4	3.0	9.6	29.9	55.1	
Have written guidelines for worker tasks that impact food safety	381	28.9	16.3	13.4	13.9	27.6	Insufficient personnel (59); too time-consuming (39); verbal training instead (18); no other workers (15); not necessary (11); too expensive (6)
<b>Buildings and equipment</b>							
Ensure pests are kept out of farm buildings	515	4.9	3.1	16.3	35.0	40.8	Not necessary (10); not possible (10); too time-consuming (6)
Perform regular equipment maintenance and calibration	505	1.4	1.2	11.5	40.6	45.4	
Provide washroom and hand-washing facilities for visitors and workers	468	6.2	4.1	7.3	9.6	72.9	Too expensive (14); insufficient personnel (10); not necessary (8); no other workers (5)
Use restricted access signs or locked doors/gates to control farm entry <sup>b</sup>	271	38.0	10.7	17.7	10.0	23.6	Not necessary (46); too time-consuming (11); insufficient personnel (10); too expensive (10); open access, sell on farm (7)
<b>Cleaning and sanitizing</b>							
Clean and sanitize equipment that comes into contact with chemicals or food	447	1.8	2.0	10.1	28.9	57.3	Too time-consuming (8)
Clean and sanitize food handling and storage areas	472	1.1	1.3	13.4	34.1	50.2	
Ensure transport vehicles for animals or food are clean	484	0.6	1.0	5.2	29.6	63.6	

**TABLE 5. (Continued) Reported use of GAPs among niche-market producers, Ontario, Canada, 2008–2009**

Practice	Total	% responses in each category					Reasons for rarely or never using the practice (n) <sup>a</sup>
		Never	Rarely	Sometimes	Often	Always	
<b>Traceability and record-keeping</b>							
Keep records of all products received on the farm	518	3.9	6.6	11.6	20.5	57.5	Too time-consuming (25); insufficient personnel (16); too expensive (8)
Keep records of all products used on the farm	501	2.0	4.8	8.4	20.2	64.7	Too time-consuming (17); insufficient personnel (8)
Keep records for each crop that is harvested and shipped <sup>c</sup>	341	4.1	6.2	12.9	21.4	55.4	Too time-consuming (20); not necessary (5)
Keep records for the transfer of all livestock and food to and from the farm	448	4.2	4.5	11.2	18.3	61.8	Too time-consuming (20); too expensive (6); not necessary (5)
<b>Crop production</b>							
Restrict animal access to fruit and vegetable production areas <sup>c</sup>	327	5.2	3.1	7.3	19.0	65.4	Too expensive (11); not possible with wild animals (6)
Use pesticides according to label instructions <sup>c</sup>	255	0.0	0.0	0.4	8.6	91.0	
Schedule nutrient applications to avoid rain <sup>c</sup>	278	1.4	2.2	9.4	24.1	63.0	
Apply manure to crops at least 3 months before harvest <sup>c</sup>	264	2.3	0.4	3.8	12.1	81.4	
<b>Livestock production</b>							
Use animal health products according to label instructions <sup>b</sup>	277	0.0	1.1	2.9	13.4	82.7	
Carry out proper sanitation before, during and after milking <sup>d</sup>	54	0.0	0.0	1.9	3.7	94.4	
Wash and clean egg trays before reuse <sup>e</sup>	80	11.3	6.3	13.8	20.0	48.8	
Refrigerate eggs as soon as possible after collecting <sup>e</sup>	96	5.2	5.2	8.3	17.7	63.5	

<sup>a</sup>Producers only answered this question if they indicated that the practice was rarely or never used. The options “too time-consuming”, “too expensive” and “insufficient personnel” were provided as check-boxes, all other categories were created through open-ended answers. Multiple selections were allowed. Only responses with a frequency of  $\geq 5$  are shown in the interest of saving space

<sup>b</sup>Tabulated for livestock and poultry producers only

<sup>c</sup>Tabulated for horticulture producers only

<sup>d</sup>Tabulated for dairy and goat producers only

<sup>e</sup>Tabulated for laying hen producers only



“Best possible practices for chemical handling doesn’t really have much relevance to an organic farmer.” (ID 21)

## EDUCATION

Participants (n = 11) recommended that OFFS programs should include education and training for producers. Suggestions included workshops, educational farm visits, written guidelines, and certificates for producers who participate in educational activities. However, there was a difference in opinion about whether education should be mandatory or voluntary. “I’m always looking for the expertise, the knowledge. I don’t always know, and that’s why it’s great if there’s some source of information that can help me do a better job.” (ID 12)

“We should have some level of certification for farmers where they can display their new knowledge. It should be right up there on the walls just like anybody else that wants to deal with the public. They can give them some assurance that they’ve got some education.” (ID 7)

## Cost

Participants (n = 11) noted that certain practices and regulations are too expensive to implement (e.g., installing new equipment), that OFFS programs must be cost-recoverable (i.e., they shouldn’t unduly affect producers’ profits), and that there should be increased financial support for producers to implement these programs.

“The biggest barrier with some of the programs is the cost that we have to bear in order to meet and follow, in particular, the ones that are legislated, regulated.” (ID 23)

“We do our best at quality assurance for food safety but commodity prices do not reward for the time and paperwork involved or cost.” (Questionnaire comment)

## User-friendly and practical

Several participants (n = 10) indicated that they don’t have sufficient time or personnel to complete paperwork requirements (i.e., record keeping), which they identified as being excessive and too complicated. They also noted that OFFS programs and GAPs should be “common sense” and practical.

“I think labour and time are of the biggest factors on the farm and will con-

tinue to be a factor as more paperwork just gets pushed on.” (ID 13)

“Things have to be user-friendly... meaning, a farmer buys into it and they’ll put whatever it takes, a little time into it, because they’re buying into the premise of it.” (ID 22)

## Government support

Several participants (n = 9) noted that the government needs to provide more financial support to producers to implement OFFS programs, as well as show that they value and respect Ontario producers.

“The government will say, ‘Oh yeah, we’re giving this out to this’, but by the time they implement the program there’s no money left. So the money isn’t dwindling down where it’s supposed to go, it’s staying with everybody’s buddy up there, just to make him a living.” (ID 15)

“I don’t feel that I’m working as a team with the government, I feel that I’m working as if the government is a policeman that’s always causing me troubles and not really working with me and helping me, and charging me an awful lot to do it.” (ID 17)

## Consistent standards

Some participants (n = 5) discussed the need to improve consistency and reduce overlap in food safety standards among different levels of government and among retailers.

“I would like there to be some similarities and follow-through across provincial and federal, because the criteria even between those two groups are quite different and it’s very frustrating.” (ID 16)

## Benchmarking and monitoring

Some participants (n = 4) noted that the objectives of OFFS programs must be clearly outlined and must include ongoing monitoring to evaluate their effectiveness.

“No benchmarking has been done with on farm production safety to see if more stringent regulations and record-keeping will have any significant improvements in the future. Producers need to be presented with factual/statistical information not perceived ‘motherhood’ benefits before they will become encouraged to change [their] ways.” (ID 13)

## DISCUSSION

Most respondents reported that they test their private irrigation, post-harvest

produce wash water and livestock and poultry drinking water sources for bacteria at the recommended frequency of at least once per year (27). This is higher than the frequency reported in previous surveys of horticulture producers in New York State and New England, United States (US), where 85% and 73% of respondents, respectively, didn’t test their irrigation water for bacteria (10, 32). In contrast, disinfection of livestock and poultry drinking water and post-harvest produce wash water was reported by only a minority of respondents (Table 4), corresponding to the low percentages found in previous surveys of horticulture and livestock producers in the US and Canada (10, 32, 36, 40). Water disinfection should be improved among niche-market horticulture and poultry producers in Ontario, because it is an important pathogen reduction practice for produce wash water (23), and it can protect poultry against colonization with *Campylobacter* (17).

Roughly 45% of respondents reported that they do not have written guidelines for worker tasks that impact food safety, indicating that it would be useful to provide niche-market producers in Ontario with a manual of GAPs, such as Advantage GAP. Particular effort should be made to reach producers that are not currently using an OFFS program, as they were less likely to have written guidelines. It is not surprising that organic producers were more likely to use traceability practices, given the stringent record-keeping requirements of organic certification (7). For example, organic producers in Canada must maintain records of all inputs and details regarding the use, production, preparation and handling of all crops, livestock and products, and these must be kept for at least 5 years (7). Organic producers were also more likely to test their livestock or poultry drinking water for bacteria more frequently, which corresponds with results of previous research that found that organic horticulture producers in New York State were more likely to test their irrigation water for bacteria than conventional producers (32).

It was surprising that respondents who reported participation in an OFFS program were more likely to report that they apply manure to their crops within three months of harvest. It is possible that these producers were referring to composted manure, as the question didn’t distinguish between composted

and non-composted. The importance of not spreading non-composted manure on crops and of ensuring proper composting techniques should be communicated with niche-market producers that apply manure to their crops within three months of harvest, because the application of non- and improperly-composted manure as fertilizer can increase the risk of contamination of produce with generic *E. coli* (25).

Nearly 50% of livestock and poultry producers reported that they rarely or never restrict visitor entry to the farm by using signs, gates or barriers, mostly reporting that this practice is not necessary. This practice might not be practical for producers on certain farms, such as CSA, where consumers might visit regularly to obtain foods or pick their own produce. However, these producers should at least ensure that protective precautions (e.g., use of boots and coveralls and hand-washing) are taken by farm visitors, because contact with farm animals is a known risk factor for enteric illness in humans (14, 19). In addition, farms that are open to the public have been the source of outbreaks of foodborne and waterborne disease among farm visitors (22, 31).

The response percentage for the mail-out portion of this study (61%) was high compared to those of similar surveys of broiler chicken (33%) and dairy (21%) producers in Canada and horticulture producers in the US (35%–49%) (10, 32, 39, 40). This might be attributed to the \$2 gift card, which was not used in the previously mentioned surveys. Financial incentives are known to increase response percentages of mailed questionnaires (15). However, it is also possible that this study population had less survey fatigue than the larger commodity sectors. We cannot rule out the possibility that some respondents over-reported their true use of GAPs in order to give a socially desirable response. Farm visits to verify producers' reported use of GAPs against practices actually observed on the farm could not be conducted in this study because of limited resources, but, if feasible, should be carried out in future studies that measure the reported use of GAPs by producers in order to determine the extent of any potential biases. The lack of a formal sampling frame for this unique population limits our ability to assess whether the respondents were representative of the target population. However, comparisons showed that respondents had smaller farms and were

more likely to be organic than the provincial average, which are characteristics of our target population. We believe that in the absence of a centralized database of niche-market producers, our approach was the most suitable alternative, and the resulting information can be used as a baseline for future surveys targeting the same types of producers in Ontario.

The most discussed issue among interview participants was their belief that imported products should be required to meet the same standards as domestic products. Similar concerns were noted among livestock farmers in the United Kingdom (UK) (16). In Canada, imported food products are regulated by the Canadian Food Inspection Agency (CFIA), and they must meet the same health and safety legislative requirements that apply to foods of domestic origin (6). The CFIA has a code of practice called "Good Importing Practices" for importers to ensure that they meet these requirements (6). In addition, the CFIA conducts national monitoring of chemical and veterinary drug residues and pathogens in both domestic and imported food products (5). Governments should provide more transparency to Ontario niche-market producers about the specific processes and requirements for imported food products. However, unless producers can be assured that similar GAPs and OFFS programs are being implemented in importing countries, they will likely continue to have these concerns.

Interview participants also noted that OFFS programs and GAPs should be differentiated by farm size and type. In general, these participants shared views that other authors have previously argued, that food from smaller farms has more of a local market distribution and less potential to cause national or international outbreaks than food produced on a larger scale, and that it might not be justifiable or necessary to apply the same food safety standards to both types of farms (13, 37). Participants also felt that OFFS programs and GAPs directed at larger farms might be too burdensome for smaller producers. OFFS programs that target niche-market producers should be reviewed to ensure that they are applicable and suitable for this population while still protecting the safety of the food supply. Niche-market producer groups should be invited and encouraged to participate in this process.

The importance of education and training was noted by several (n = 11) interview participants. This result corres-

ponds with findings of a previous survey of farmers' market vendors in Florida, US, in which most producers (> 80%) indicated that it was very important for them to learn more about food safety (34). Lack of knowledge was also seen as a barrier towards implementing zoonotic disease control programs among livestock producers in the UK (16). Producers indicated interest in a certificate for participating in training or educational courses, which they could display on their farm or at farmers' markets. Government and industry stakeholders should ensure the provision of educational opportunities for niche-market producers in Ontario and offer certificates of completion to those who participate. Ideally, courses that offer certificates to producers should be proven to enhance their food safety knowledge and awareness.

Increased production costs are a known constraint to implementing OFFS programs and GAPs among producers in different sectors (16, 20, 24), and this factor was discussed by several (n = 11) interview participants. Funding opportunities for producers to implement GAPs exist in Canada, although not all producers may be aware of them or successful in receiving them. For example, in Ontario there is a Food Safety and Traceability Initiative, where producers can apply for a partial reimbursement of eligible expenses to implement written food safety programs or a traceability system, purchase and install equipment or train staff to improve food safety and traceability (28). Governments in Canada should focus on promoting the availability of such initiatives to niche-market producers.

Participants also discussed the need to ensure that OFFS programs are user-friendly and practical, noting a lack of time and labor to complete paperwork requirements. Paperwork was also seen as a constraint to farming among cattle and sheep farmers in the UK (21). Future research should investigate whether making record-keeping requirements less burdensome for niche-market producers would help to improve their participation in an OFFS program or use of GAPs.

The notion that governments undervalue and fail to support producers was noted by several interview participants (n = 9). Similar attitudes were expressed by livestock producers in the UK (16, 21). In order to achieve acceptability of an OFFS program among niche-market producers in Ontario, governments need to strengthen their relationship and develop trust with these producers

through collaborations, partnerships and education.

As some interview participants identified ( $n = 5$ ), the development of OFFS programs and guidelines that producers do not always deem to be consistent across multiple agencies and organizations has resulted in confusion among producers, and there is a need for these groups to work together to ensure that their messages are not in conflict. The lack of clearly defined objectives and measurable outcomes was also identified as a constraint to food safety policy development and implementation among various stakeholders in the food chain in the US and Canada (33). OFFS programs for niche-market producers should outline targeted outcomes for the reduction of microbial and chemical hazards and include regular monitoring on participating farms to demonstrate program effectiveness against these targets over time.

Validity in qualitative research refers to how well the research findings represent the realities of the participants (11). To ensure validity in the qualitative component of this study, we used triangulation of multiple data sources (i.e., interviews and questionnaire comments) and analysts, as well as member-checking. One limitation of the interview results is that they cannot be generalized to a larger population because of the non-probabilistic and small sample of participants. However, our purposive sample provided information-rich cases, which allowed a more in-depth analysis of producers with defined characteristics. Another potential limitation of the interviews is that they were mostly conducted by telephone rather than in person. It is possible that in-person interviews could have helped to develop trust and rapport, leading participants to feel more comfortable disclosing more information. However, we believe that this topic, food safety, would be less susceptible to this type of bias than those of a more sensitive nature. Furthermore, conducting interviews by telephone allowed us to reach a broader geographic region and to accommodate the busy schedules of producers.

The use of both quantitative and qualitative methods in this study allowed us to answer complementary research questions on producers' use of GAPs and attitudes toward GAPs and OFFS programs, respectively. Mixed-method studies are useful because they provide more comprehensive evidence on complex and multi-faceted topics, such as food safety

(12). However, there are also drawbacks to this approach, including the requirements for additional time, resources and researcher expertise to collect, analyze and integrate both types of data (12).

## CONCLUSIONS

This survey showed that niche-market producers in Ontario have a high reported use of most recommended GAPs. However, some areas for improvement were identified (e.g., disinfection of livestock and poultry drinking water and post-harvest produce wash water). The semi-structured interview participants identified key issues that should be addressed through future research and producer outreach to improve the suitability and adoption of OFFS programs and GAPs among niche-market producers in Ontario. A similar study should be conducted in this population in three to five years to measure potential changes in the use of GAPs and attitudes towards GAPs and OFFS programs over time.

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