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Environmental Concerns and Stewardship Behaviors Among Rural Landowners: What Supports Farmers and Non-farmers in Being Good Stewards?

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Intensive agriculture is a main factor of biodiversity and ecosystem services loss globally. It is therefore of great importance to understand how rural landowners are managing their lands and how environmental stewardship behaviors could be strengthened. Farming and non-farming rural landowners are often considered a homogenous group. In reality, however, they vary by their histories, attitudes, interests, and resources. While many rural landowners manage their lands with environmental values in mind, others may struggle to do so. Ignoring this diversity poses the risk that planning and policy for sustainable agriculture are less effective than they could be. Hence, it is of interest to understand the variety of environmental perceptions and stewardship behaviors across these varied groups. To help addressing this knowledge gap, we conducted a survey of 1,200 farming and non-farming rural landowners, using Ontario as a case study. We specifically investigated whether farming landowners differed from non-farming landowners in expressed environmental concerns and stewardship behaviors, as well as what the roles are of participation in conservation incentive programs, demographic factors, and landholding characteristics. We analyzed survey answers with logistic regression and text analysis. Our results suggest that farming landowners are generally less environmentally concerned than non-farming landowners. However, it appears that this difference may be less driven by farm ownership than by contextual factors, such as landowner age and participation in conservation programs. Participation in conservation programs was more pronounced for non-farming landowners and was associated with higher likelihood of environmental concerns and engaging with stewardship behaviors. In contrast, higher age emerged as predictor of lower environmental concerns. In addition, we found that cost factors and knowledge needs were important barriers for stewardship behaviors across farming and non-farming rural landowners. Based on our results, we are making recommendations for increasing the effectiveness of agricultural sustainability planning and policy in Ontario, focusing on reducing financial and knowledge barriers to pro-environmental land management behaviors.

Keywords: agriculture, environmental concern, farm, land conservation, rural landowner, stewardship, Ontario

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INTRODUCTION

Intensive agriculture has been recognized as one of the main factors in loss of biodiversity (Dudley and Alexander, 2017; Sánchez-Bayo and Wyckhuys, 2019; Raven and Wagner, 2021) and ecosystem services (Gomiero et al., 2011) across the world. The Green Revolution has provided immense benefits for agricultural food production globally (Smil, 2004). However, as the world population continues to grow and globalization of trade expands, agricultural producers are under intensifying pressure to increase production and maximize profits, often at the expense of more conservation-friendly agricultural practices (Gomiero et al., 2011). Consequently, how to balance agricultural production and environmental conservation, and thus increase the sustainability of agricultural operations, remains an enduring problem without easy answers (Mamabolo et al., 2020).

Agriculture is located at the intersection of society and the environment (Fischer et al., 2017). Much past research has focused on the bio-physical and economic aspects of agriculture. However, a better integration of the social sciences is required in this research area to deliver deep understanding of the various actors in the environment-agri-food nexus and enhanced ability to design effective planning and policy in support of sustainable agriculture (de Snoo et al., 2013; Norton, 2016). Next to the rational economic decision-making required to run a successful agricultural business, farmers may also be affected in their land management activities by their perception of being good land stewards (Raymond et al., 2016; Bennett et al., 2018). Many farmers have strong ties to their place of residence, local communities and natural environments, and they care deeply about the lands they manage (Gosling and Williams, 2010; Baldwin et al., 2017). However, it has also been observed that many farmers can perceive environmental issues and stewardship actions differently than other rural landowners or urban dwellers (Berenguer et al., 2005; Huddart-Kennedy et al., 2009; Gottlieb et al., 2015). When designing effective planning and policies for conservation in agricultural landscapes, it is therefore important to differentiate between relevant population groups and understand their specific concerns, needs and opportunities (Raymond et al., 2016; Ujházy et al., 2020).

Several past studies have investigated the environmental impacts of agricultural operations in a variety of regions globally (Tilman et al., 2001) and have provided recommendations for the reduction of environmental impacts (Wezel et al., 2014). Farmers' land management activities can be beneficial to the natural environment, even though they will have to be balanced with agricultural uses (Lewis-Phillips et al., 2019, 2020; Swartz and Miller, 2019). However, various studies also have demonstrated that many farmers apply conservation-friendly management practices less often than they could, often owing to operational, financial and political factors (Lahmar, 2010; Dupraz and Guyomard, 2019). What is less well-researched is whether farming landowners in fact differ in their environmental perspectives and actual stewardship behaviors from non-farming, rural landowners (Greiner and Greg, 2011). Such an understanding is essential for land conservation planning and policies that connect meaningfully with the specific perspectives of farming landowners and the conditions under which they are operating.

Therefore, to help close these existing knowledge gaps, we pursued answers to the following research questions. First, do farming landowners differ in their concerns about environmental issues and in their stewardship behaviors from non-farming, rural landowners? Given farmers' strong ties to their land, we expected that farming landowners show higher levels of environmental concern and higher engagement with stewardship behaviors than non-farming landowners. Second, next to being a farmer, do other factors influence rural landowners' concerns about environmental issues and engagement with stewardship behaviors? We expected that participation in conservation programs, landowner characteristics, and characteristics of the landholding affect environmental concerns and engagement with stewardship behaviors.

MATERIALS AND METHODS

We used data collected with a large-scale survey to investigate rural landowners' environmental concerns and their stewardship behaviors. Using quantitative and qualitative methods, we compared environmental concerns and stewardship behaviors between farming landowners and non-farming landowners. In addition, we investigated the modifying effects of a range of landowner and property characteristics. Below, we first describe the study context, which is then followed by descriptions of the survey, questionnaire, and analyses.

Study Context

With ∼15 million inhabitants, Ontario is Canada's most populous province. The vast majority of this population is concentrated in the province's south-central region, which also is one of Canada's most important agricultural centers. In 2015, Ontario's agriculture and agri-food industries contributed $15 billion to the province's economy (Statistics Canada, 2019). In 2019, agriculture and agri-food industries employed close to 900,000 people, representing close to 12% of total provincial employment [OMAFRA (Ontario Ministry of Agriculture, Food and Rural Affairs), 2020]. In the same year, direct employment in primary agriculture was 74,000 [OMAFRA (Ontario Ministry of Agriculture, Food and Rural Affairs), 2020].

Next to its high population concentration and economic importance, south-central Ontario also is one of Canada's most biodiverse regions, especially for rare plant species (Argus and Pryer, 1990). However, due to species distribution patterns and intense land use pressures, south-central Ontario also is among the Canadian regions with the highest concentration of species-at-risk (Coristine et al., 2018). The most widespread and intense land use in south-central Ontario is agriculture. Of the total land area of south-central Ontario, 4.7 million hectares, or 37%, is classified as farmland [OMAFRA (Ontario Ministry of Agriculture, Food and Rural Affairs), 2020]. Private lands, of which agricultural lands are the largest part, harbor a large proportion of rare and threatened species in Ontario and throughout Canada (Lovett-Doust et al., 2003; McCune

and Morrison, 2020). Land and nutrient management on Ontario farms is correlated with surface water quality over a distance of several kilometers (Houlahan and Findlay, 2004). Consequently, land stewardship practices on Ontario farms can have pronounced biodiversity and other environmental effects across scales from the individual farm to the landscape level throughout south-central Ontario.

Land conservation is a recognized priority in Ontario. Several provincial programs exist that support and encourage private landowners to engage in land stewardship behaviors. These programs include the Conservation Lands Tax Incentive Program (CLTIP), which is focused on the conservation of environmental features of recognized provincial value (Ontario, 2019a), and the Managed Forest Tax Incentive Program (MFTIP), which is focused on the sustainable management of privately owned forests (Ontario, 2019b). Both of these programs are administered by the Ontario Ministry of Natural Resources and Forestry.

Survey

The data used for this study were acquired with a postal mail survey of 1,200 rural landowners. Since we were interested in the stewardship behaviors of rural landowners that owned conservation-relevant properties, the survey was addressed to landowners that owned properties of provincial conservation interest. All addressed landowners participated in one of two provincial conservation programs (CLTIP: $n = 400$; MFTIP: $n = 400$), or were eligible to participate in one of the programs (i.e., CLTIP), but did not participate ($n = 400$). Targeting our study on these landowners ensured that we would be working with participants who own land of importance to land conservation in Ontario.

The survey was designed following the total design method devised by Dillman (2000), including an initial information letter, repeated (three times) mail outs of the full survey package to non-responders, and a final thank you letter to responders. In addition, we offered participants the option of using an online version of the questionnaire and provided each participant a $5 cash token of appreciation. To protect the privacy of all participating landowners, we used a sampling procedure that anonymized landowners and conducted the survey with the help of a third-party mail service.

Questionnaire

The questionnaire design followed best practices including a full color front cover, use of high-quality paper, consistent visual appearance, and proper ordering of questions (e.g., important questions at the beginning, sensitive questions toward the end). The full questionnaire contained ∼250 questions relating to several topics such as conservation program participation, landowner and landholding characteristics, environmental conservation activities, conservation activity history, condition of natural heritage features on the land, opinions regarding environmental issues, and consumer behaviors. For the purposes of the current study, only a small fraction of questions was utilized (see **Supplementary Material** for short forms of questions included in the current study).

We piloted the questionnaire with eight rural landowners. These landowners provided feedback regarding their understanding and relevance of the questions and we incorporated their feedback to improve the questionnaire.

Analyses

We investigated the effect of being a farming landowner, as opposed to being a non-farming landowner, on landowners' environmental concerns and stewardship behaviors using logistic regression analyses. We defined farming landowners as those who self-identified through the survey as owning a commercial farm that is operated by themselves (47%), or those owning a commercial farm that they leased or rented out to another operator (53%). We defined non-farming landowners as those who self-identified through the survey as owning a residential lot with surrounding lands (i.e., a property not used as a commercial farm).

We used information from CLTIP (Ontario, 2019a) and MFTIP (Ontario, 2019b) guide documents to identify eight potential environmental concerns and eight potential stewardship actions that landowners could reasonably undertake. We used this information because it provides a common basis for possible environmental concerns and stewardship behaviors that can be expected to be relevant to all participating landowners.

Environmental concerns and stewardship behaviors are treated as dependent variables in the logistic regression. Being a farming landowner (or non-farming) is the independent variable of main interest. We also included conservation program participation and several landowner and property characteristics as independent variables that could modify analyses results (see descriptions of the independent variables in the **Supplementary Material**). All regression analyses were conducted with the glm function in RStudio (Version 1.3.1093).

To add richness and depth to the statistical results, we conducted a text analysis of responses to open-ended questions inquiring about (i) suggestions for additional supports for promoting environmental protection and biodiversity conservation on private lands, (ii) possible improvements to the two provincial conservation programs, and (iii) general comments. Text coding was conducted with an iterative process drawing on several coding approaches: hypothesis coding was used to infer respondents' mention of key concepts (e.g., incentives, cost, and taxes); descriptive coding was used to understand respondents' emerging main areas of concern; magnitude coding was used to infer the frequency of topics mentioned (Saldaña, 2009). Coded text fragments were sorted by independent variables (farming identity and conservation program participation) to deduce differences in focus between landowner groups. All coding and text analysis was conducted in MAXQDA Analytics Pro 2020 (Release 20.4.1).

We applied the continuum of resistance model (Lin and Schaeffer, 1995) to investigate whether our data were affected by a non-response bias. For this purpose, we compared the survey responses of early (first half) to late (second half) responders and investigated these groups for differences in gender, age, education, household income, membership in an environmental group, and property size.

TABLE 1 | Summaries of participant and property characteristics for landowners owning a commercial farming property or a rural residential (non-farming) property.

	Farming		Non-farming	
	ha	%	ha	%
Conservation program participation				
CLTIP (participating)		48.6		47.0
MFTIP (participating)		21.5		51.1
Neither		34.6		11.0
Property characteristics				
Property size (median)	40.5		14.0	
Woodlands (present)		87.9		94.0
Grasslands (present)		53.3		51.1
Wetlands (present)		72.9		70.7
Participant characteristics				
Gender (male/female)		71.0/22.4		63.1/33.4
Age (younger/older)		48.6/41.1		58.4/34.1
Education (lower/higher)		49.5/40.2		46.1/49.2
Employment (working/not working)		40.2/54.2		40.7/56.2
Income (lower/higher)		43.0/38.3		43.8/42.3
Environmental group (member/not member)		21.5/71.0		24.6/70.3

RESULTS

Study Participants

We received 598 completed questionnaires from the entire survey. After excluding 110 landowners as they were unreachable, these completions resulted into a response rate of 55%. For the purposes of the current study, we removed from the sample all landowners that identified their property as primarily used as hobby farm, non-farm rural business, and for conservation purposes by a charitable organization or conservation authority. The remaining sample of 421 landowners consisted only of those who identified their property as primarily used for commercial farming by themselves, or by a lessee or renter (henceforth: farming landowners, $n = 107$), and those who identified their property as primarily used for residential purposes (henceforth: non-farming landowners, $n = 317$; **Table 1**).

The largest group of farming landowners participated in the CLTIP (48.6%), their median property size was 40.5 ha and the vast majority of them had woodlands (87.9%) and wetlands (72.9%) on their property. The majority of farming landowners identified as male (71.0%), were younger (<65 years −48.6%), had lower education (no university −49.5%), were not working (54.2%, including landowners owning a farm but not operating the farm themselves), had lower household income (<$100,000 annually −43.0%), and have never been a member of an environmental organization (71.0%).

The majority of non-farming landowners participated in the MFTIP (51.1%), their median property size was 14.0 ha and the vast majority of them had woodlands (94.0%) and wetlands (70.7%) on their property. The majority of non-farming landowners identified as male (63.1%), were younger (<65 years −58.4%), had higher education (at least some university −49.2%), were not working (56.2%), had lower household income (<$100,000 annually −43.8%), and have never been a member of an environmental organization (70.3%).

Early and late responders did not differ by property size ($t = -1.287$, df = 306.68, and $p = 0.199$), gender ($X^2 = 0.229$, df = 1, and $p = 0.632$), age ($X^2 = 1.218$, df = 1, and $p = 0.270$), education ($X^2 = 0.001$, df = 1, and $p = 0.978$), employment ($X^2 = 1.306$, df = 1, and $p = 0.253$), household income ($X^2 = 0.347$, df = 1, and $p = 0.556$), or membership in an environmental group ($X^2 = 2.080$, df = 1, and $p = 0.149$). These results suggest that a non-response bias may not be expected.

Environmental Concerns and Stewardship Behaviors

The survey results demonstrate generally widespread concerns about environmental issues among both farming and non-farming landowners. However, somewhat lower levels of environmental concerns were found among farming landowners than among non-farming landowners, except for threats to water quality and climate change (**Table 2**). For farming landowners, the highest level of concern was for threats to water quality with 84.1% stating this was a serious or slight problem. Farming landowners' lowest levels of concern were for damage to species and loss of species, with 72.0% stating this was a serious or slight problem for both issues. For non-farming landowners, the highest level of concern was for loss of woodlands (90.9%), closely followed by spread of invasive species (90.5%). Non-farming landowners' lowest levels of concern were found for climate change (80.8%).

The survey results for stewardship behaviors were more mixed than for environmental concerns (**Table 2**). Non-farming landowners tended to engage more in planting native species, removing unhealthy trees, improving wildlife habitat and allowing natural succession. However, farming landowners engaged more in controlling erosion. Farming landowners, engaged in or planned most often removing unhealthy trees (55.1%) and least often protecting groundwater and controlling erosion (both 29.0%). Non-farming landowners engaged in or planned most often allowing natural succession (70.0%) and least often controlling erosion (17.0%).

Predictors of Environmental Concerns

The model fit statistics show that most models of environmental concern were highly significant (**Table 3**). The Count R^2 results, which report the proportion of correctly assigned observations, were at least 82% for all models, with 90% as the highest Count R^2 value for loss of woodlands, spread of invasive species and threats to water quality.

The logistic regression analysis results suggest that being a farming landowner does not affect any of the eight environmental concerns (**Table 3**). However, participating in the MFTIP was

TABLE 2 | Summaries of environmental concerns and stewardship behaviors for landowners owning a commercial farming property or a rural residential (non-farming) property.

	Farming (%)	Non-farming (%)	*p*
Environmental concerns (serious or slight problem)			
Damage to species	72.0	85.8	<0.01
Loss of species	72.0	82.0	0.04
Threats to endangered species	72.9	82.0	0.05
Loss of woodlands	82.2	90.9	0.02
Loss of greenspaces	76.6	88.6	<0.01
Spread of invasive species	79.4	90.5	<0.01
Threats to water quality	84.1	89.6	0.16
Climate change	74.8	80.8	0.21
Stewardship behaviors (completed, underway or planned)			
Removing invasive species	29.9	28.1	0.71
Planting native species	30.8	45.7	0.01
Removing unhealthy trees	55.1	67.2	0.03
Leaving dead trees	37.4	34.1	0.56
Improving wildlife habitat	29.0	43.5	<0.01
Protecting groundwater	29.0	24.6	0.37
Controlling erosion	29.0	17.0	0.01
Allowing natural succession	48.6	70.0	<0.01

Shown are counts of landowners who consider the environmental concerns as problems instead of not problems, and who engage in stewardship behaviors instead of those who do not engage. Shown also is the probability of difference between farming and residential landowners using Fisher's Exact Test.

a positive predictor of five environmental concerns (loss of species, threats to endangered species, loss of woodlands, loss of greenspaces, and spread of invasive species: $B \geq 0.887$, odds ratio ≥ 2.428, and $p \leq 0.04$). Participation in the CLTIP was a positive predictor of just two environmental concerns (loss of greenspaces and climate change: $B \geq 0.821$, odds ratio ≥ 2.274, and $p \leq 0.03$).

Among landowner characteristics, age stood out as being most often a predictor of environmental concerns (**Table 3**). Age negatively predicted five environmental concerns (damage to species, loss of species, loss of woodlands, spread of invasive species, and climate change: $B \leq -0.773$, odds ratio ≥ 0.353, and $p \leq 0.05$), and was a marginally significant, negative predictor of another two environmental concerns (threats to endangered species and loss of greenspaces: $B \leq -0.689$, odds ratio ≥ 0.445, and $p \leq 0.08$).

Among property characteristics (**Table 3**), presence of woodlands was most often a predictor of environmental concerns. Presence of woodlands positively predicted three environmental concerns (damage to species, loss of species, and threats to endangered species: $B \geq 1.430$, odds ratio ≥ 4.896, and $p \leq 0.01$).

Predictors of Stewardship Behaviors

The model fit statistics show that most models of stewardship behaviors were highly significant, with one other model being marginally significant (**Table 4**). The Count R^2 results were at least 68% for all models, with 79% as highest Count R^2 value for controlling erosion.

In contrast to environmental concerns, being a farming landowner is a predictor of four stewardship behaviors (**Table 4**). Being a farming landowner positively predicts two stewardship behaviors (removing invasive species and controlling erosion: $B \geq 0.825$, odds ratio ≥ 2.390, and $p \leq 0.02$) and negatively predicts two other stewardship behaviors (planting native species and allowing natural succession: $B \leq -0.678$, odds ratio ≥ 0.461, and $p \leq 0.05$). Participation in the MFTIP was a positive predictor of four stewardship behaviors (removing invasive species, planting native species, removing unhealthy trees and improving wildlife habitat: $B \geq 0.822$, odds ratio ≥ 2.275, and $p \leq 0.02$). Participation in the CLTIP was a negative predictor of one environmental concern (controlling erosion: $B = -0.828$, odds ratio $= 0.437$, and $p = 0.03$).

Most participant characteristics did not stand out as particularly influential on stewardship behaviors (**Table 4**). But among property characteristics, presence of grasslands was a positive predictor of four stewardship behaviors (removing invasive species, planting native species, improving wildlife habitat and allowing natural succession: $B \geq 0.586$, odds ratio ≥ 1.796, and $p \leq 0.04$).

Main Land Conservation Concerns

The text analysis revealed topics of specific interest to farming and non-farming landowners as emerging from the open-ended survey answers. The text analysis results demonstrate that the five most frequently mentioned topics of interests were incentives (8.3% of coded segments), information needs (7.7%), taxes (7.1%), costs (5.7%), and conservation (5.0%).

Farming and non-farming landowners mentioned incentives with similar relative frequency. However, incentives were mentioned somewhat more often by CLTIP participants than by MFTIP participants (CLTIP: 8.9%, MFTIP: 7.8% of all coded segments). While participants generally appreciated the existing incentives, the general tenor of the comments was that financial incentives for land stewardship should be higher, including for specific stewardship behaviors, such as voiced by ID 2030, "*Incentives to promote removal of invasive species.*" An important element was that landowners often felt unable to engage in active stewardship behaviors instead of a general hands-off approach, such as expressed by ID 19003, "*If some authority decided something needed to be done to preserve the environmental features, then we would require compensation.*"

Expressed information needs related both to stewardship behaviors and to conservation programs. Participants in either conservation program mentioned information needs with similar relative frequency. However, information needs were mentioned more frequently by non-farming landowners than by farming landowners (farming: 4.8%, non-farming: 8.7% of all coded segments). Many participants felt not very knowledgeable about land conservation and expressed a need for more information

TABLE 3 | Logistic regressions of eight environmental concerns on owning a commercial farm property, conservation incentive program participation, landowner, and property characteristics.

Independent variable	Damage to species			Loss of species			Threats to endangered species			Loss of woodlands		
	B	**Odds ratio**	***p***	***B***	**Odds ratio**	***p***	***B***	**Odds ratio**	***p***	***B***	**Odds ratio**	***p***
Farming	−0.206	0.814	0.64	0.082	1.086	0.84	0.160	1.173	0.70	0.266	1.305	0.62
CLTIP	0.446	1.561	0.29	0.700	2.014	0.08	0.595	1.814	0.12	0.938	2.554	0.06
MFTIP	0.901	2.461	0.06	**0.932**	**2.540**	**0.03**	**0.887**	**2.428**	**0.04**	**1.874**	**6.511**	**<0.01**
Gender	0.370	1.447	0.33	0.154	1.167	0.66	−0.281	0.755	0.44	−0.214	0.807	0.67
Age	**−0.929**	**0.395**	**0.03**	**−0.992**	**0.371**	**0.01**	−0.689	0.502	0.07	**−1.002**	**0.367**	**0.05**
Education	0.305	1.356	0.40	0.515	1.673	0.12	0.391	1.478	0.23	−0.380	0.684	0.39
Employment	−0.362	0.696	0.39	−0.087	0.917	0.82	0.029	1.029	0.94	−0.271	0.762	0.59
Income	−0.250	0.779	0.51	−0.398	0.672	0.25	0.057	1.058	0.87	0.013	1.014	0.98
Environmental group	**1.029**	**2.799**	**0.05**	0.410	1.507	0.33	**0.886**	**2.424**	**0.05**	1.130	3.095	0.09
Property size	−0.206	0.814	0.18	−0.127	0.880	0.36	−0.172	0.842	0.21	**−0.360**	**0.698**	**0.05**
Woodlands	**1.430**	**4.180**	**<0.01**	**1.589**	**4.896**	**<0.01**	**1.439**	**4.218**	**<0.01**	0.848	2.336	0.15
Grasslands	0.531	1.700	0.14	**0.758**	**2.135**	**0.02**	0.413	1.511	0.19	0.630	1.877	0.14
Wetlands	0.703	2.019	0.06	0.558	1.747	0.11	0.607	1.835	**0.08**	**0.958**	**2.606**	**0.03**
Constant	−0.034	0.966	0.96	−0.874	0.417	0.18	−0.589	0.555	0.37	1.166	3.209	0.18
Log-likelihood	−122.904			−142.452			−144.895			−90.476		
Chi-squared	43.408			53.120			48.234			39.043		
p	<0.001			<0.001			<0.001			<0.001		
Count R^2	0.85			0.82			0.82			0.90		
Mean VIF	1.404											
Max VIF	1.972											

(Continued)

TABLE 3 | Continued

Independent variable	Loss of greenspaces			Spread of invasive species			Threats to water quality			Climate change		
	B	**Odds ratio**	***p***	***B***	**Odds ratio**	***p***	***B***	**Odds ratio**	***p***	***B***	**Odds ratio**	***p***
Farming	−0.258	0.772	0.59	−0.706	0.494	0.16	0.021	1.021	0.97	0.090	1.094	0.82
CLTIP	**1.014**	**2.757**	**0.03**	0.702	2.018	0.13	0.682	1.978	0.17	**0.821**	**2.274**	**0.03**
MFTIP	**1.570**	**4.806**	**<0.01**	**1.218**	**3.381**	**0.03**	0.402	1.494	0.46	0.718	2.050	0.08
Gender	−0.629	0.533	0.20	0.521	1.683	0.24	0.157	1.170	0.73	−0.289	0.749	0.41
Age	−0.809	0.445	0.08	**−1.041**	**0.353**	**0.04**	−0.572	0.564	0.25	**−0.773**	**0.461**	**0.04**
Education	−0.248	0.780	0.54	0.072	1.075	0.86	−0.005	0.995	0.99	0.257	1.293	0.41
Employment	0.550	1.733	0.23	0.111	1.117	0.82	0.348	1.417	0.47	0.145	1.156	0.68
Income	−0.079	0.924	0.85	0.347	1.415	0.44	0.237	1.267	0.60	−0.070	0.933	0.83
Environmental group	1.119	3.061	0.06	1.212	3.361	0.07	0.747	2.111	0.20	0.548	1.730	0.17
Property size	−0.198	0.821	0.24	−0.024	0.976	0.89	−0.096	0.909	0.59	−0.028	0.973	0.84
Woodlands	0.790	2.204	0.15	0.270	1.310	0.64	0.671	1.957	0.26	0.138	1.148	0.79
Grasslands	**1.083**	**2.954**	**0.01**	0.363	1.438	0.38	0.777	2.174	0.07	0.444	1.559	0.14
Wetlands	0.591	1.805	0.16	−0.145	0.865	0.75	−0.064	0.938	0.89	0.065	1.067	0.85
Constant	0.502	1.652	0.53	1.048	2.853	0.20	0.902	2.464	0.28	0.672	1.958	0.32
Log-likelihood	−102.425			−97.007			−96.110			−152.960		
Chi-squared	55.734			34.575			18.918			26.559		
p	<0.001			<0.001			0.126			0.014		
Count R^2	0.88			0.90			0.90			0.82		
Mean VIF	1.404											
Max VIF	1.972											

Significant independent variables ($\alpha \leq 0.05$) are bolded.

TABLE 4 | Logistic regressions of eight stewardship behaviors on owning a commercial farm property, conservation incentive program participation, landowner, and property characteristics.

Independent variable	Removing invasive species			Planting native species			Removing unhealthy trees			Leaving dead trees		
	B	**Odds ratio**	***p***	***B***	**Odds ratio**	***p***	***B***	**Odds ratio**	***p***	***B***	**Odds ratio**	***p***
Farming	**0.871**	**2.390**	**0.02**	**−0.678**	**0.507**	**0.05**	−0.455	0.635	0.18	0.363	1.438	0.26
CLTIP	0.228	1.257	0.52	0.292	1.339	0.38	−0.212	0.809	0.52	0.555	1.742	0.09
MFTIP	**1.537**	**4.652**	**<0.01**	**0.822**	**2.275**	**0.02**	**0.905**	**2.472**	**0.01**	0.191	1.210	0.57
Gender	−0.325	0.723	0.25	0.387	1.473	0.16	−0.216	0.806	0.45	0.501	1.651	0.08
Age	−0.402	0.669	0.24	−0.309	0.734	0.33	−0.366	0.694	0.26	−0.164	0.849	0.60
Education	0.130	1.139	0.63	0.171	1.187	0.50	−0.331	0.718	0.22	0.370	1.448	0.15
Employment	−0.076	0.927	0.82	−0.555	0.574	0.07	0.211	1.235	0.50	−0.387	0.679	0.19
Income	−0.536	0.585	0.06	0.214	1.238	0.42	0.114	1.121	0.68	−0.149	0.862	0.57
Environmental group	0.513	1.670	0.09	**0.783**	**2.187**	**<0.01**	−0.030	0.970	0.92	0.018	1.019	0.95
Property size	**−0.275**	**0.760**	**0.03**	0.055	1.057	0.62	0.066	1.068	0.57	0.030	1.031	0.79
Woodlands	0.001	1.001	1.00	−0.346	0.707	0.50	**1.157**	**3.180**	**0.01**	−0.754	0.470	0.10
Grasslands	**0.756**	**2.130**	**0.01**	**1.152**	**3.164**	**<0.01**	0.207	1.230	0.43	0.011	1.011	0.97
Wetlands	0.138	1.148	0.66	−0.088	0.916	0.77	−0.034	0.967	0.91	−0.359	0.698	0.22
Constant	**−1.261**	**0.283**	**0.05**	**−1.276**	**0.279**	**0.04**	−0.477	0.621	0.43	−0.508	0.602	0.38
Log-likelihood	−181.933			−200.577			−191.665			−203.058		
Chi-squared	39.306			56.062			44.959			16.875		
p	<0.001			<0.001			<0.001			0.205		
Count R^2	0.73			0.68			0.73			0.70		
Mean VIF	1.404											
Max VIF	1.972											

(Continued)

TABLE 4 | Continued

Independent variable	Improving wildlife habitat			Protecting groundwater			Controlling erosion			Allowing natural succession		
	B	**Odds ratio**	***p***	***B***	**Odds ratio**	***p***	***B***	**Odds ratio**	***p***	***B***	**Odds ratio**	***p***
Farming	−0.467	0.627	0.17	0.400	1.492	0.25	**0.825**	**2.282**	**0.02**	**−0.773**	**0.461**	**0.03**
CLTIP	0.289	1.335	0.39	−0.303	0.738	0.37	**−0.828**	**0.437**	**0.03**	0.090	1.094	0.79
MFTIP	**1.523**	**4.584**	**<0.01**	0.380	1.462	0.29	0.025	1.026	0.95	**1.517**	**4.556**	**<0.01**
Gender	−0.166	0.847	0.55	−0.441	0.644	0.12	**−0.666**	**0.514**	**0.04**	0.169	1.184	0.56
Age	−0.422	0.656	0.19	0.476	1.610	0.15	0.693	2.000	0.06	0.554	1.739	0.12
Education	−0.221	0.802	0.40	−0.001	0.999	1.00	0.157	1.170	0.60	0.153	1.166	0.58
Employment	−0.354	0.702	0.25	0.045	1.046	0.89	0.215	1.240	0.55	−0.365	0.694	0.27
Income	−0.294	0.745	0.28	0.464	1.590	0.10	0.350	1.419	0.27	0.006	1.006	0.98
Environmental group	0.270	1.310	0.36	−0.053	0.949	0.86	0.260	1.297	0.43	0.329	1.390	0.32
Property size	0.173	1.189	0.14	−0.039	0.961	0.75	0.152	1.164	0.28	−0.030	0.970	0.80
Woodlands	−0.190	0.827	0.71	0.116	1.123	0.83	0.712	2.038	0.31	0.382	1.465	0.41
Grasslands	**0.698**	**2.010**	**<0.01**	0.226	1.254	0.40	0.488	1.629	0.11	**0.586**	**1.796**	**0.04**
Wetlands	−0.160	0.852	0.60	**0.992**	**2.696**	**<0.01**	0.591	1.806	0.11	0.273	1.314	0.39
Constant	−0.958	0.384	0.12	**−2.162**	**0.115**	**<0.01**	**−3.348**	**0.035**	**<0.01**	−0.675	0.509	0.27
Log-likelihood	−197.763			−183.482			−152.900			−179.817		
Chi-squared	61.088			20.903			37.621			63.038		
p	<0.001			0.075			<0.001			<0.001		
Count R^2	0.68			0.73			0.79			0.73		
Mean VIF	1.404											
Max VIF	1.972											

Significant independent variables ($\alpha \leq 0.05$) are bolded.

on how to protect valuable environmental features, such ID 23213, "*As a new landowner I had zero information as to what is invasive species*." Other landowners suggested that conservation education should be provided by government agencies, such as ID 9797 "*free seminars for landowners on land stewardship*." In addition, several participants mentioned difficulty of obtaining information about conservation programs, such as ID 2146, "*Landowners would benefit from easier access to information and materials pertaining to these programs*."

Dissatisfaction with the tax relief for conservation program participation was commonly expressed. Participants in both conservation programs mentioned taxation with similar relative frequency. However, taxes were mentioned more frequently by non-farming landowners than by farming landowners (farming: 5.3%, non-farming: 7.7% of all coded segments). Many landowners expressed that the height of the tax relief for conservation program participation was too low, such as mentioned by ID 12461, "*More compensation—higher tax relief*." Several participants in the MFTIP specifically suggested providing tax supports to compensate for the cost of the required forest management plan, such as voiced by ID 17483, "*Provide tax rebates [or] subsidies to participants to offset the cost of Managed Forest Tax Incentive Program approved plans*." Other landowners expressed that they did not participate in the conservation programs because the available tax incentive was too low, such as ID 6604 "*We get the farm tax rate, which is the same as the CLTIP or MFTIP, so we are not willing to go to the expense of plans to get the same tax rate*."

Costs were mentioned by many landowners, referring to their own costs but also to the presumed costs of the conservation programs. Participants in MFTIP referred to costs with higher relative frequency than CLTIP participants (CLTIP: 4.3%, MFTIP: 7.0% of all coded segments). As well, non-farming landowners mentioned costs somewhat more often than farming landowners (farming: 4.8%, non-farming: 6.0% of all coded segments). However, many landowners, no matter whether they were participating in the CLTIP or MFTIP, expressed that they were engaging only in passive, hands-off land management because costs of stewardship behaviors were a barrier to more active land conservation, such as ID 27752 "*Free material like bat boxes, cages, etc*.," and ID 7964 "*Provide free [tree] saplings (native species)*." Several landowners suggested that especially the CLTIP was too burdensome administratively and costs could be reduced by streamlining the conservation program delivery, such as ID 2146 "*Offering the program in 3-year increments would reduce the administrative costs, including time, significantly*."

Conservation was broadly supported by participants and many comments were provided on the performance of conservation programs and suggestions made for improved land stewardship. Participants in the CLTIP mentioned conservation with somewhat higher relative frequency than MFTIP participants (CLTIP: 5.8%, MFTIP: 4.3% of all coded segments). In addition, conservation was mentioned more frequently by non-farming landowners than by farming landowners (farming: 3.7%, non-farming: 5.5% of all coded segments). Broad support for land conservation and a desire for increased protection was expressed by several participants, such as stated by ID 10374, "*I would like to see you protect valuable land, example [area name] from pavement and strip malls with the same vengeance you protect poor land*" and by ID 27598, "*The [government agency] needs to raise the bar in terms of active forest management by MFTIP participants as most people enter the program only for tax savings*." Other participants made more specific suggestions for measures to support increased land conservation, including stronger policies, such as ID 19906, "*Pass laws strengthening protection of streams and rivers running through private lands and farmings*."

DISCUSSION

Often rural landowners are dealt with as if they were a homogenous group (Huddart-Kennedy et al., 2009). However, rural landowners are diverse; their histories, attitudes, interests, resources, and abilities differ among geographies and groups, causing a whole range of different motivations and behaviors. Ignoring this diversity poses the risk that conservation policies and programs aimed at these populations are not connected well to the conditions under which they are operating, potentially leaving these policies and programs less effective than they could be otherwise (Raymond et al., 2016). One of the key contributions of the current study is the explicit differentiation between farming and non-farming rural landowners. Our results provide insights into the similarities and differences in environmental concerns and stewardship behaviors between these populations.

We found that farming and non-farming, residential landowners generally share concerns about environmental issues. Supporting our findings that environmental concerns are widespread across rural landowners are the results by Wardropper et al. (2020) regarding effects of "farming identity" on appreciation of natural areas and processes in Wisconsin, USA. They found that appreciation of water quality and supply, or wildlife habitat did not differ between study participants who relied, or did not rely, on agriculture for their livelihood (Wardropper et al., 2020). However, our results suggest that farming landowners do tend to be somewhat less concerned about most environmental issues than non-farming landowners. Our findings also echo the work of Berenguer et al. (2005) who investigated conservation concerns among residents in central Spain. They found that concerns about environmental issues were not affected by residents' economic dependence on the natural environment (Berenguer et al., 2005).

Environmental attitudes and behaviors are linked with people's experiences with nature (Rosa and Collado, 2019). Therefore, differences between farming and non-farming landowners in the degree of environmental concern, as observed in our study, might be driven by differences in past experiences with specific environmental issues. Our results show that the properties of farming landowners harbored natural habitats (woodlands, grasslands, and wetlands) similarly or more often than the properties of non-farming landowners. However, through the very nature of farming lands, one can assume that natural habitats cover smaller areas of farming properties than

of non-farming properties. This could mean that non-farming landowners are more exposed to natural habitats than farming landowners, which might lead to more positive environmental attitudes and higher levels of environmental concerns about habitat and species losses in non-farming than in farming landowners (Rosa and Collado, 2019). Interestingly, this logic might also provide an explanation for the lack of difference in concerns about water quality and climate change between farming and non-farming landowners in our results: Both landowner groups should be equally likely to experience climate change and water quality problems and therefore be similarly concerned about these environmental issues. Such a line of argument is supported by the results of Haden et al. (2012), who found that farmers' concern about climate change was related to their past experience with climate change impacts.

In addition, our results also suggest that differences in environmental concerns between farming and non-farming landowners may not primarily be driven by farming identity *per se*. Instead, it appears they might be influenced more by other landowner characteristics, such as participation in conservation programs and landowner's age. Specifically, we found that increasing age had a negative effect of environmental concerns. This finding parallels results from a study of Austrian farmers by Vogel (1996). His results suggest that the age of farmers was negatively correlated with general attitudes toward the environment (Vogel, 1996). It may be possible that in our study the negative impacts of age on environmental concerns are driven by a cohort-effect. In his review of demographic effects on farmers' environmental perceptions and behaviors, Burton (2014) suggested the existence of such an effect, where a person's attitudes and beliefs become fixed through the particular socio-historical context of their education and socialization. It is quite possible that the environmental attitudes of older farmers in our study were fixed by their past socio-historical context when environmental concerns were of lower prominence than at present. However, our results stand in contrast to the findings by some other studies, which did not find an effect of age on general environmental concerns (Berenguer et al., 2005) or appreciation of natural areas and processes (Wardropper et al., 2020). It is possible that the studies by Berenguer et al. (2005) and Wardropper et al. (2020) covered younger individuals or a smaller age range and therefore did not observe an age effect. Unfortunately, Berenguer et al. (2005) did not report the age of their study participants.

Interestingly, we did not find an effect of educational level on environmental concerns. This result parallels the findings by Vogel (1996) who did not find an effect of farmers' education on environmental concerns either. However, our results stand in contrast to Maas et al. (2021). In a study of farmers' perceptions of biodiversity and ecosystem services in Germany and Austria, they found that lower education level was correlated with lower importance attributed to biodiversity and ecosystem services (Maas et al., 2021). Conflicting results about the role of education in famers' environmental concerns might be explained by a lack of detail pertaining to farmers' education. In a study of Finnish students' attitudes toward environmental issues, Tikka et al. (2000) found that knowledge and attitude regarding environmental issues varied by students' major subject and not terminal degree. It is therefore possible that a farmers' educational orientation (e.g., Ecology vs. Business) would be of greater effect on environmental concerns than educational level itself.

Our results suggest that farming landowners engaged with half of all stewardship behaviors just as often or more often than non-farming landowners; for the remaining stewardship behaviors farming landowners engaged less than farming landowners. Differently from environmental concerns, ownership of a commercial farm property did appear to be a driver of differences between farming and non-farming landowners for several stewardship behaviors. Commercial farm ownership had a positive effect on engaging with removing invasive species and controlling erosion, and it had a negative effect on planting native species and allowing natural succession. Most of these effects might be explicable by farmers' concerns for the agricultural productivity of their land. Reimer et al. (2012) found that farmers in Indiana, USA, who viewed their farm mostly through a business lens, were least likely to adopt conservation practices. In contrast, farmers who were motivated by off-farm environmental benefits were more likely to adopt conservation practices (Reimer et al., 2012). Similarly, in a study of farmers in Illinois, USA, Thompson et al. (2015) did find a positive effect of stewardship views on farmers' willingness to adopt environmental best management practices. Invasive species can invade crops, erosion can reduce availability of high quality soil and natural succession, for example on fallow land, can make subsequent agricultural production more difficult. Therefore, these stewardship behaviors might be driven by a focus on agricultural production as well as by conservation concerns (Raymond et al., 2016). McGuire et al. (2013) found that even farmers who are focused on agricultural productivity can harbor conservationist views. However, these conservation views tend to be overshadowed by production interests and need to be specifically triggered to lead to more frequent stewardship behaviors (McGuire et al., 2013). On the other hand, the work by Marr and Howley (2019) supports the view that some farmers' stewardship behaviors might be driven by non-conservationist motives. In a comparison of farmers in England and Ontario, they found that farmers engaged in pro-environmental behaviors for other reasons, such as the health and well-being of their family (Marr and Howley, 2019).

In the current study, landowner characteristics were less frequently of importance for stewardship behaviors relative to for environmental concerns. Our results suggest an effect of gender, where male landowners were less likely to engage in controlling erosion than female landowners. Our results match several other studies who found that gender can have an effect on environmental perceptions and stewardship behaviors. Liu et al. (2014) found that female ranchers and farmers in Nevada, USA, were better informed about climate change and its impacts than males. In his review of demographic effects on famers' environmental perceptions and behaviors, Burton (2014) found that women farmers were generally more environmentally oriented and preferred more extensive production methods than men.

Similarly to environmental conerns, our results did not indicate any effect of education on stewardship behaviors. These findings coincide with the results of a study on farmers' environmental awareness and farming practices in Michigan, USA (McCann et al., 1997). McCann et al. (1997) found that level of education did not differ between farmers that practiced more eco-friendly than conventional agriculture. Similarly, in a study of Californian farmers' perceptions and behaviors toward several types of wildlife, Kross et al. (2018) did not find an effect of education. However, in their review of the literature, Ahnström et al. (2008) reported that education can have variable effects on farmers' conservation behaviors. They suggested that higher educated farmers might have higher readiness to apply new practices including conservation actions, but also to use pesticides (Ahnström et al., 2008). As is the case with environmental concerns, the driver of stewardship behaviors might not be educational level itself but rather educational orientation (Tikka et al., 2000). Educational orientation, i.e., the subject of somebody's education such as Ecology or Business, might be better at predicting their stewardship behaviors than their highest level of education, as it may indicate underlying interest and acquired knowledge base (Tikka et al., 2000).

In addition, our results indicate that participation in conservation programs influenced environmental concerns and several stewardship behaviors. We found that participation in the MFTIP frequently was associated with environmental concerns and with engagement in stewardship behaviors. The MFTIP requires landowners to create an approved forest management plan (Ontario, 2019b). Creation of such a plan and discussion of it with the forest management approver requires the landowner to be at least somewhat knowledgeable about environmental and ecological topics, at least as they pertain to forests. For landowners, creation of a forest management plan therefore is an opportunity to inform themselves and become aware of environmental and ecological topics. This learning effect might explain the positive effects of MFTIP participation on environmental concerns and on stewardship behaviors (Drescher et al., 2019). Unfortunately, the rate of MFTIP participation of farming landowners is less than half of non-farming landowners. The reason for this might be that most farming landowners will participate in the Ontario Farm Property Class Tax Rate Program. Participation in this program guarantees that the property class tax rate applied to the farmed land is not more than 25% of residential property tax (Agricorp, 2019). This, however, is the same tax incentive as provided by the MFTIP. Consequently, there is little reason for farming landowners to participate in the MFTIP for financial reasons, which often is a driver of farmers' stewardship behaviors (Mills et al., 2018). Further, the creation of a forest management plan is an additional cost factor and participation barrier for the MFTIP, which has been criticized by many of our study participants. The CLTIP provides tax relief of 100% of the residential property tax for the program eligible lands and may explain why the proportion of CLTIP participating farming and non-farming landowners is almost equal. Consequently, increasing the tax relief for the MFTIP might increase the participation by farming landowners and provide for more widespread land stewardship across the rural landscape.

Our qualitative results highlight the importance of financial factors (incentives, taxes, and costs) for engagement in stewardship behaviors for rural landowners. It might be surprising that conservation incentives were not mentioned more frequently by farmers than by non-farming landowners given that stewardship behaviors might impose a greater opportunity cost on farmers than on non-farmers. We speculate that this lack of a difference in attention to incentives might be due to high perceived conservation costs even among non-farming landowners, who emphasized this issue more frequently than farming landowners. High perceived conservation costs might stem from non-farming landowners not seeing themselves as active land managers. Our results suggest that non-farming landowners more frequently feel that they lack conservation knowledge than farming landowners. Lack of knowledge and lack of access to equipment, may lead to increased perceived and actual costs for stewardship behaviors.

Other studies have found that financial factors clearly are a major component in motivating, enabling, and constraining environmental actions. For example, Mills et al. (2018) found that overall farmers engaged more in subsidized environmental activities than in non-subsidized activities. They also found that farmers' motives for engaging in stewardship activities varied by whether they were subsidized or not. When activities were subsidized, the main motivation was financial, while for non-subsidized activities main motives varied between agronomic, environmental and tradition (Mills et al., 2018). It is possible that we did not find a stronger influence of financial factors on farming landowners' stewardship behaviors because several of these behaviors are in a farmer's self-interest, such as improving soil health and water quality, which were addressed by us through questions about controlling erosion and protecting groundwater. On the other hand, controlling erosion and protecting groundwater were among the stewardship behaviors that farmers least engaged with.

The qualitative results of our study also suggest that while land conservation was largely supported by rural landowners, many landowners wished for more help by government agencies and some landowners called for stronger conservation policies. Knowledge gaps about environmental issues and conservation programs were frequently mentioned by landowners, suggesting they might be a constraint for stewardship behaviors. However, farming landowners much less frequently expressed a need for more information than did non-farming landowners. This difference might be driven by farmers' strong local knowledge of the land they manage and the perception that they do not require access to additional information, especially not from outside experts that do not have the same intimate knowledge of their land. By necessity, farmers certainly should have good knowledge of their land, and many do. For example, farmers in Austria have been found to be knowledgeable about the threats of toxic plant species to grassland management (Winter et al., 2011; Šumane et al., 2018). However, there is also evidence to suggest that farmers' local environmental knowledge may be limited to more obvious phenomena and that at times they could

benefit from additional advice from outside experts, especially regarding more technical applications (Wyckhuys and O'Neil, 2007; Ingram, 2008).

The stewardship behaviors that we assessed should be of general relevance to farming and non-farming rural landowners (e.g., protecting groundwater) and should be broadly accessible to them because they require only limited technical know-how and equipment (e.g., removing invasive species). However, the range of stewardship behaviors that we assessed was necessarily limited and it is possible that rural landowners might engage in stewardship behaviors that we did not cover (e.g., reducing pesticide use, limiting nutrient runoff, and planting windbreaks). The Canada-Ontario Environmental Farm Plan is a voluntary program in support of farmers' environmental education, awareness, and actions [OMAFRA (Ontario Ministry of Agriculture, Food and Rural Affairs), 2016]. This program stresses farmers' self-assessment of the strengths and challenges of their individual agricultural operations and emphasizes that standardized lists of stewardship behaviors might not connect well with all farmers. Had we inquired about a much broader range of possible stewardship behaviors, we might have uncovered more stewardship behaviors that farmers engage in Robinson (2006). However, participation in the Canada-Ontario Environmental Farm Plan is confidential and therefore it is unknown how widespread farmers' participation is and what stewardship behaviors they engage in. Smithers and Furman (2003) conducted a study on participation in the Canada-Ontario Environmental Farm Plan. They found that about a third of farmers participating in the Canada-Ontario Environmental Farm Plan do not proceed to the implementation of any environmental actions (Smithers and Furman, 2003). The extent of farmers' active engagement in stewardship behaviors, whether as part of an environmental program or not, remains poorly understood.

CONCLUSIONS

Intensive agriculture is a main factor in biodiversity and ecosystem services loss globally. Increasing the sustainability of the agricultural sector is paramount to safeguard world food supplies and protect global society against widespread environmental collapse. Achieving this goal requires a multi-sectoral approach that involves all stakeholders from policy-makers to producers and consumers. To be effective, planning and policy for agricultural sustainability must be sensitive to local conditions and the varied needs, interests and opportunities of the various stakeholder groups. The key findings of the current study are its contributions to increasing understanding of the environmental concerns and stewardship behaviors of farming and non-farming rural landowners, as well as of drivers of similarities and differences between these groups. The results of this study from Ontario, Canada, highlight the importance of contextual factors for the expression of environmental concerns and stewardship behaviors in rural landowners. Farmers tended to be less concerned about addressed environmental issues than non-farmers. However, this difference was not primarily driven by being a farming landowner *per se*, but by factors such as participation in conservation programs that provide environmental learning opportunities, and landowner age, which might point toward fixing of environmental attitudes during past socio-historical contexts. Possible drivers of stewardship behaviors may be external to conservation concerns and more often be related to landowners' regard for agricultural productivity; if stewardship behaviors are also positive for agricultural operations, farmers are more likely to engage. Of clear relevance to rural landowners, farmers and non-farmers alike, are finances. Participants expressed a desire for decreased costs of stewardship actions and larger incentives. Knowledge needs were especially expressed by non-farmers, but they may also be present for farmers even though they might be unaware of these needs. Based on our results, we make several recommendations that should be useful for increasing the effectiveness of agricultural conservation planning and policy in Ontario:

1. Decrease the costs of stewardship behaviors. Rural landowners express concerns about the costs of stewardship actions and experience several constraints including time and money. In the context of the CLTIP, the provision of materials and equipment by (semi-)governmental agencies at no or shared cost would help many landowners who currently are confined to being passive stewards. Participation costs for the MFTIP could be reduced by subsidizing the costs for an approved forest management plan.
2. Increase the incentives for conservation program participation. When programs do not offer any financial incentive beyond the status quo, program participation is largely driven by conservation ethics, which are not shared by all. Increasing the incentives, such as through additional property tax relief, also will speak to landowners who are primarily driven by the business factors of agricultural operations. In the context of the MFTIP, this means that tax relief should be increased to a level that is higher than the tax relief provided by the Ontario Farm Property Class Tax Rate Program.
3. Increase knowledge transfer about possible stewardship behaviors. Being motivated to engage in stewardship behaviors is not enough when landowners lack knowledge about realistic and effective stewardship options. When a conservation incentive program lacks knowledge transfer mechanisms, government should re-design the program to include them, such as provision of information pamphlets and workshops. In the Ontario context, this is especially true for the CLTIP, which does not contain an active knowledge transfer mechanism. This stands in contrast to the MFTIP, which provides an active learning opportunity through the requirement for an approved forest management plan.
4. Clarify to landowners the co-benefits of environmental stewardship behaviors for agricultural operations. Some farmers may be unsure about managing their land differently and might worry about potential negative impacts of stewardship actions on the profitability of their agricultural business. However, many stewardship actions do not

only provide off-farm benefits but can also improve the economics of farm operations (e.g., windbreaks can decrease energy consumption). Government should reinvest into agricultural outreach programs that educate farmers about the simultaneous environmental and business benefits of a variety of stewardship behaviors.

Though the presented research is based on a case study from Ontario, we believe that the general results can be transferred to other regions with similar socio-economic contexts. Useful extensions of our analyses would be experimental, longitudinal studies that investigate the effects of conservation incentive programs designed to provide educational elements on environmental concerns and stewardship behaviors. While many rural landowners are at least partially motivated by conservation ethics to engage in stewardship behaviors, willingness-to-accept studies that explore farmers' engagement in stewardship behaviors at various incentive levels, would be of great interest. Together, these kinds of information would be useful for further strengthening planning and policy for sustainable agricultural operations.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by University of Waterloo Office of Research Ethics. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

MD ideated the study, collected and analyzed the data, and wrote the draft manuscript. MD and GW designed the research. GW critically reviewed the data analysis and provided critical review of the draft. Both authors contributed to the article and approved the submitted version.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fsufs.2022.758426/full#supplementary-material

REFERENCES

Agricorp (2019). *Farm Property Class Tax Rate Program*. Retrieved from: https://www.agricorp.com/SiteCollectionDocuments/FarmTax-FeatureSheet-en.pdf (accessed July 30, 2021).

Ahnström, J., Höckert, J., Bergeå, H. L., Francis, C. A., Skelton, P., and Hallgren, L. (2008). Farmers and nature conservation: what is known about attitudes, context factors and actions affecting conservation? *Renewable Agric. Food Syst.* 24, 38–47. doi: 10.1017/S1742170508002391

Argus, G. W., and Pryer, K. M. (1990). *Rare Vascular Plants in Canada: Our Natural Heritage.* Ottawa, ON: Canadian Museum of Nature.

Baldwin, C., Smith, T., and Jacobson, C. (2017). Love of the land: social-ecological connectivity of rural landholders. *J. R. Stud.* 51, 37–52. doi: 10.1016/j.jrurstud.2017.01.012

Bennett, N. J., Whitty, T. S., Finkbeiner, E., Pittman, J., Bassett, H., Gelcich, S., et al. (2018). Environmental stewardship: a conceptual review and analytical framework. *Environ. Manag.* 61, 597–614. doi: 10.1007/s00267-017-0993-2

Berenguer, J., Corraliza, J. A., and Martin, R. (2005). Rural-Urban differences in environmental concern, attitudes, and actions. *Eur. J. Psychol. Assess.* 21, 128–138. doi: 10.1027/1015-5759.21.2.128

Burton, R. J. F. (2014). The influence of farmer demographic characteristics on environmental behaviour: a review. *J. Environ. Manag.* 135, 19–26. doi: 10.1016/j.jenvman.2013.12.005

Coristine, L. E., Jacob, A. L., Schuster, R., Otto, S. P., Baron, N. E., Bennett, N. J., et al. (2018). Informing Canada's commitment to biodiversity conservation: A science-based framework to help guide protected areas designation through Target 1 and beyond. *FACETS.* 3, 531–562. doi: 10.1139/facets-2017-0102

de Snoo, G. R., Herzon, I., Staats, H., Burton, R. J., Schindler, S., van Dijk, J., et al. (2013). Toward effective nature conservation on farmland: making farmers matter. *Conserv. Lett.* 6, 66–72. doi: 10.1111/j.1755-263X.2012.00296.x

Dillman, D. (2000). *Mail and Internet Surveys: The Tailored Design Method*. New York, NY: Wiley.

Drescher, M., Epstein, G. B., Warriner, G. K., and Rooney, R. C. (2019). An investigation of the effects of conservation incentive programs on management of invasive species by private landowners. *Conserv. Sci. Pract.* 1, e56. doi: 10.1111/csp2.56

Dudley, N., and Alexander, S. (2017). Agriculture and biodiversity: a review. *Biodiversity* 18, 45–49. doi: 10.1080/14888386.2017.1351892

Dupraz, P., and Guyomard, H. (2019). Environment and climate in the common agricultural policy. *EuroChoices* 18, 18–25. doi: 10.1111/1746-692X.12219

Fischer, J., Abson, D. J., Bergsten, A., French Collier, N., Dorresteijn, I., Hanspach, J., et al. (2017). Reframing the food-biodiversity challenge. *Trends Ecol. Evol.* 32, 335–345. doi: 10.1016/j.tree.2017.02.009

Gomiero, T., Pimentel, D., and Paoletti, M. G. (2011). Is there a need for a more sustainable agriculture? *Crit. Rev. Plant Sci.* 30, 6–23. doi: 10.1080/07352689.2011.553515

Gosling, E., and Williams, K. J. H. (2010). Connectedness to nature, place attachment and conservation behaviour: testing connectedness theory among farmers. *J. Environ. Psychol.* 30, 298–304. doi: 10.1016/j.jenvp.2010.01.005

Gottlieb, P. D., Schilling, B. J., Sullivan, K., Esseks, J. D., Lynch, L., and Duke, J. M. (2015). Are preserved farms actively engaged in agriculture and

conservation? *Land Use Policy* 45, 103–116. doi: 10.1016/j.landusepol.2015.01.013

Greiner, R., and Greg, D. (2011). Farmers' intrinsic motivations, barriers to the adoption of conservation practices and effectiveness of policy instruments: empirical evidence from northern Australia. *Land Use Policy* 28, 257–265. doi: 10.1016/j.landusepol.2010.06.006

Haden, V. R., Niles, M. T., Lubell, M., Perlman, J., and Jackson, L. E. (2012). Global and local concerns: what attitudes and beliefs motivate farmers to mitigate and adapt to climate change? *PLoS One* 7, e52882. doi: 10.1371/journal.pone.0052882

Houlahan, J. E., and Findlay, C. S. (2004). Estimating the 'critical' distance at which adjacent land-use degrades wetland water and sediment quality. *Landsc. Ecol.* 19, 677–690. doi: 10.1023/B:LAND.0000042912.87067.35

Huddart-Kennedy, E. H., Beckley, T. M., McFarlane, B. L., and Nadeau, S. (2009). Rural-urban differences in environmental concern in Canada. *Rural Sociol.* 74, 309–329. doi: 10.1526/003601109789037268

Ingram, J. (2008). Are farmers in England equipped to meet the knowledge challenge of sustainable soil management? An analysis of farmer and advisor views. *J. Environ. Manag.* 86, 214–228. doi: 10.1016/j.jenvman.2006.12.036

Kross, S. M., Ingram, K. P., Long, R. F., and Niles, M. T. (2018). Farmer perceptions and behaviors related to wildlife and on-farm conservation actions. *Conserv. Lett.* 11, e12364. doi: 10.1111/conl.12364

Lahmar, R. (2010). Adoption of conservation agriculture in Europe. Lessons of the KASSA project. *Land Use Policy* 27, 4–10. doi: 10.1016/j.landusepol.2008.02.001

Lewis-Phillips, J., Brooks, S., Sayer, C. D., McCrea, R., Siriwardena, G., and Axmacher, J. C. (2019). Pond management enhances the local abundance and species richness of farmland bird communities. *Agric. Ecosyst. Environ.* 273, 130–140. doi: 10.1016/j.agee.2018.12.015

Lewis-Phillips, J., Brooks, S., Sayer, C. D., Patmore, I. R., Hilton, G. M., Harrison, A., et al. (2020). Ponds as insect chimneys: restoring overgrown farmland ponds benefits birds through elevated productivity of emerging aquatic insects. *Biol. Conserv.* 241, 108253. doi: 10.1016/j.biocon.2019.108253

Lin, I.-F., and Schaeffer, N. C. (1995). Using survey participants to esti- mate the impact of nonparticipation. *Public Opin. Q.* 59, 236–258.

Liu, Z., Smith, W. J. Jr., and Safi, A. S. (2014). Rancher and farmer perceptions of climate change in Nevada, USA. *Clim. Change* 122, 313–327. doi: 10.1007/s10584-013-0979-x

Lovett-Doust, J., Biernacki, M., Page, R., Chan, M., Natgunarajah, R., and Timis, G. (2003). Effects of land ownership and landscape-level factors on rare-species richness in natural areas of southern Ontario, Canada. *Landsc. Ecol.* 18, 621–633. doi: 10.1023/A:1026028017696

Maas, B., Fabian, Y., Kross, S. M., and Richter, A. (2021). Divergent farmer and scientist perceptions of agricultural biodiversity, ecosystem services and decision-making. *Biol. Conserv.* 256, 109065. doi: 10.1016/j.biocon.2021.109065

Mamabolo, E., Makwela, M. M., and Tsilo, T. J. (2020). Achieving sustainability and biodiversity conservation in agriculture: importance, challenges and prospects. *Eur. J. Sustain. Dev.* 9, 616–625. doi: 10.14207/ejsd.2020.v9n3p616

Marr, E. J., and Howley, P. (2019). The accidental environmentalists: Factors affecting farmers' adoption of pro- environmental activities in England and Ontario. *J. Rural Stud.* 68, 100–111. doi: 10.1016/j.jrurstud.2019.01.013

McCann, E., Sullivan, S., Erickson, D., and De Young, R. (1997). Environmental awareness, economic orientation, and farming practices: a comparison of organic and conventional farmers. *Environ. Manag.* 21, 747–758. doi: 10.1007/s002679900064

McCune, J. L., and Morrison, P. D. S. (2020). Conserving plant species at risk in Canada- land tenure, threats, and representation in federal programs. *Facets* 5, 538–550. doi: 10.1139/facets-2019-0014

McGuire, J., Wright Morton, L., and Cast, A. D. (2013). Reconstructing the good farmer identity: shifts in farmer identities and farm management practices to improve water quality. *Agric. Hum. Values* 30, 57–69. doi: 10.1007/s10460-012-9381-y

Mills, J., Gaskell, P., Ingram, J., and Chaplin, S. (2018). Understanding farmers' motivations for providing unsubsidised environmental benefits. *Land Use Policy* 76, 697–707. doi: 10.1016/j.landusepol.2018.02.053

Norton, L. R. (2016). Is it time for a socio-ecological revolution in agriculture? *Agric. Ecosyst. Environ.* 235, 13–16. doi: 10.1016/j.agee.2016.10.007

OMAFRA (Ontario Ministry of Agriculture, Food and Rural Affairs) (2016). *Canada-Ontario Environmental Farm Plan*. Retrieved from: http://www.omafra.gov.on.ca/english/environment/efp/efp.htm (accessed August 11, 2021).

OMAFRA (Ontario Ministry of Agriculture, Food and Rural Affairs) (2020). *Economic Indicators*. Retrieved from: http://www.omafra.gov.on.ca/english/stats/economy/index.html (accessed July 30, 2021).

Ontario (2019a). *Conservation Land Tax Incentive Program*. Retrieved from: https://www.ontario.ca/page/conservation-land-tax-incentive-program (accessed July 30, 2021).

Ontario (2019b). *Ontario Managed Forest Tax Incentive Program (MFTIP) Guide*. Retrieved from: https://dr6j45jk9xcmk.cloudfront.net/documents/2720/mnr-e000245.pdf (accessed July 30, 2021).

Raven, P. H., and Wagner, D. L. (2021). Agricultural intensification and climate change are rapidly decreasing insect biodiversity. *Proc. Natural Acad. Sci.* 118, e2002548117. doi: 10.1073/pnas.2002548117

Raymond, C. M., Bieling, C., Fagerholm, N., Martin-Lopez, B., and Plieninger, T. (2016). The farmer as a landscape steward: comparing local understandings of landscape stewardship, landscape values, and land management actions. *Ambio* 45, 173–184. doi: 10.1007/s13280-015-0694-0

Reimer, A. P., Thompson, A. W., and Prokopy, L. S. (2012). The multi-dimensional nature of environmental attitudes among farmers in Indiana: implications for conservation adoption. *Agric. Hum. Values* 29, 29–40. doi: 10.1007/s10460-011-9308-z

Robinson, G. M. (2006). Canada's environmental farm plans: transatlantic perspectives on agri-environmental schemes. *Geogr. J.* 172, 206–218. doi: 10.1111/j.1475-4959.2006.00207.x

Rosa, C. D., and Collado, S. (2019). Experiences in nature and environmental attitudes and behaviors: setting the ground for future research. *Front. Psychol.* 10, 763. doi: 10.3389/fpsyg.2019.00763

Saldaña, J. (2009). *The Coding Manual for Qualitative Researchers*. London: Sage Publications Ltd.

Sánchez-Bayo, F., and Wyckhuys, K. A. G. (2019). Worldwide decline of the entomofauna: a review of its drivers. *Biol. Conserv.* 232, 8–27. doi: 10.1016/j.biocon.2019.01.020

Smil, V. (2004). *Enriching the Earth. Fritz Haber, Carl Bosch, and the Transformation of World Food Production*. Cambridge, MA: MIT Press.

Smithers, J., and Furman, M. (2003). Environmental farm planning in Ontario: Exploring participation and the endurance of change. *Land Use Policy* 20, 343–356. doi: 10.1016/S0264-8377(03)00055-3

Statistics Canada (2019). *Agriculture and Agri-Food Economic Account, 2015: Component of Statistics Canada catalogue no. 11-001-X*. Retrieved from: https://www150.statcan.gc.ca/n1/en/daily-quotidien/190730/dq190730a-eng.pdf?st=16xd5N1Q (accessed July 30, 2021).

Šumane, S., Kunda, I., Knickel, K., Strauss, A., Chebach, T., and Ashkenazy, A. (2018). Local and farmers' knowledge matters! How integrating informal and formal knowledge enhances sustainable and resilient agriculture. *J. R. Stud.* 59, 232–241. doi: 10.1016/j.jrurstud.2017.01.020

Swartz, T. M., and Miller, J. R. (2019). Managing farm ponds as breeding sites for amphibians: key trade-offs in agricultural function and habitat conservation. *Ecol. Appl.* 29, e01964. doi: 10.1002/eap.1964

Thompson, A. W., Reimer, A., and Prokopy, L. S. (2015). Farmers' views of the environment: the influence of competing attitude frames on landscape conservation efforts. *Agric. Hum. Values* 32, 385–399. doi: 10.1007/s10460-014-9555-x

Tikka, P. M., Kuitunen, M. T., and Tynys, S. M. (2000). Effects of educational background on students' attitudes, activity levels, and knowledge concerning the environment. *J. Environ. Educ.* 31, 12–19. doi: 10.1080/00958960009598640

Tilman, D., Fargione, J., Wolff, B., D'Antonio, C., Dobson, A., Howarth, R., et al. (2001). Forecasting agriculturally driven global environmental change. *Science* 292, 281–284. doi: 10.1126/science.1057544

Ujházy, N., Molnár, Z., Bede-Fazekas, Á., Szabó, M. O., and Biró, M. (2020). Do farmers and conservationists perceive landscape changes differently? *Ecol. Soc.* 25, 12. doi: 10.5751/ES-11742-250312

Vogel, S. (1996). Farmers' environmental attitudes and behavior - a case study for Austria. *Environ. Behav.* 28, 591–613. doi: 10.1177/001391659602800502

Wardropper, C. B., Mase, A. S., Qiu, J., Kohl, P., Booth, E. G., and Rissman, A. R. (2020). Ecological worldview, agricultural or natural resource-based activities, and geography affect perceived importance of ecosystem services. *Landsc. Urban Plann.* 197, 103768. doi: 10.1016/j.landurbplan.2020.103768

Wezel, A., Casagrande, M., Celette, F., Vian, J.-F., Ferrer, A., and Peigné, J. (2014). Agroecological practices for sustainable agriculture. A review. *Agron. Sustain. Dev.* 34, 1–20. doi: 10.1007/s13593-013-0180-7

Winter, S., Penker, M., and Kriechbaum, M. (2011). Integrating farmers' knowledge on toxic plants and grassland management: a case study on Colchicum autumnale in Austria. *Biodivers. Conserv.* 20, 1763–1787. doi: 10.1007/s10531-011-0060-x

Wyckhuys, K. A. G., and O'Neil, R. J. (2007). Local agro-ecological knowledge and its relationship to farmers' pest management decision making in rural Honduras. *Agric. Hum. Values* 24, 307–321. doi: 10.1007/s10460-007-9068-y

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