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Impacts of changes to Canada's Plant Breeders' Rights Act

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Abstract

On February 27, 2015, as part of the Agricultural Growth Act, amendments to the Canada's Plant Breeders' Rights (PBRs) Act came into force, making Canada compliant with Union for the Protection of the New Varieties of Plants (UPOV) 91. One objective of adopting UPOV 91 was that it would encourage increased investment in plant breeding, giving Canadian farmers greater access to new and innovative plant varieties that enable them to be more globally competitive. To assess whether the adoption of UPOV 91 impacted crop variety investments, a survey of Canadian public and private plant breeders was undertaken in 2021–2022. Results indicate that the length of research grants play a significant role in plant breeders' perspectives. Previous research indicated that the adoption of UPOV 91 provided minimal incentives to increase investments. Results of this survey indicate that 52% of respondents, either agree or strongly agree, that the amendments to the PBR Act have provided an incentive to increase plant breeding investments.

KEYWORDS
incentives, innovation, intellectual property rights, UPOV 91

1 | INTRODUCTION

Incentivizing innovation is a key economic priority for all governments. Increasing demands for greater fiscal resources from many sectors of the economy and all government ministries has encouraged governments to leverage private sector innovation investments through innovative solutions. Governments and international research organizations have been supportive of greater public–private partnerships, enabling more funding for research and development programmes[1] as well as by extending property rights, including patents and plant breeders' rights (PBRs). Property mechanisms have been commonly used in agriculture for decades. Plant patents date back to 1931, when the first patent was granted in the United States for the creation of a new variety of rose.[2] PBRs in Europe date back to 1921.[3] The current international regime was founded in 1961 with creation of the Union Internationale pour la Protection des Obtentions Végétales, known by the French acronym UPOV,[4,5,6] The original Union for the Protection of the New Varieties of Plants (UPOV) Convention was amended in 1972, with additional new Conventions enacted in 1978 and 1991. Canada established its first PBRs Act in 1990, complying to the conditions of UPOV 78. Canada amended its PBRs Act in 2015, bringing it into line with the 1991 Convention, which allows for a greater use of patents and PBRs.

While theory asserts that property rights should incentivize more research, there is only limited evidence of that in the agrifood sector. Research investigating the effects of Canada adopting UPOV 91 was first conducted by surveying public and private plant breeders in 2018. That research found that after 3 years, the transition from UPOV 78 to UPOV 91 had not had a significant effect on increasing investments into plant breeding programmes.[7] Nevertheless, private breeders reported that adoption of UPOV 91 increased their plant breeding programme investments (44%); only 18% of government employed plant breeders and 33% of university employed breeders reported any impacts. The length of funding grants common to plant breeding range from 4 to 7 years, which may have led to lags in response, as plant breeders were still funded in 2018 on the same grants secured before 2015. In short, the period of time between the adoption of UPOV 91 and the survey may not have been long enough to capture the full effect of the changes.

Given that PBRs in Canada have only been in place since 1990, few studies have assessed their economic, legal or technical impacts. When first established Derko[8] argued that PBR legislation aligned with UPOV 78 struck a balance between monopoly rights and public freedoms and that it motivated plant breeders to develop new plant species. Gray et al.[9] analyzed the experiences of the United Kingdom, France and Australia in implementing UPOV 91. Aligning their PBR frameworks with UPOV 91 meant that each country would receive billions of dollars in net benefit over the status quo over a 40-year horizon. The authors posit that Canada could benefit from UPOV 91 aligned PBRs, but if no other institutional arrangements are made besides the adoption of these regulations, plant breeding may be too expensive to fully be pursued by individuals. Groenewegen et al.[10] show that since its establishment, the Crop Development Centre at the University of Saskatchewan has produced more than 450 novel versions of grains and legumes such as wheat, durum, barley, oats, flax, field peas, lentils, chickpeas, canary seed and dry beans. The improved characteristics and productivity of these varieties increase agricultural production and these gains in turn stimulate growth across the prairie economy.

To the best of the authors' knowledge, no study has directly asked plant breeders or funding organizations about their incentives to invest in their breeding programmes since Canada became compliant with UPOV 91. This article presents the results of a survey in 2022 of Canadian plant breeders and research funding organizations about the effects of UPOV 91 as an incentive for increased investment. The survey occurred 7 years after UPOV 91 was adopted, allowing for a period of impact assessment more consistent with the underlying research system.

2 | BACKGROUND

A 2011 study estimated that only about 5% of industrial investments (US$69 billion) are targeted at agriculture,[11] while about 1.2 billion people or one-quarter of the world's labour force were employed in the world's agrifood systems in 2019 and almost half the world's population live in households linked to agrifood systems.[12] Rosegrant et al.[13] assert global investment in agrifood research and development (R&D) needs to rise by at least US$10.5

billion to reduce hunger to 5% globally by 2030 (sustainable development goal SDG2) and to achieve 2030 greenhouse gas emission reductions consistent with the Paris Agreement 2°C and 1.5°C pathways to 2030. At COP 28 in December 2023 the CGIAR[14] released a comprehensive new case for US$4 billion in investments toward the organization's 2025–2027 research portfolio and announced contributions of US$890 million from donors. While substantial, this is only a modest start in filling the more than US$10 billion gap.

Pardey et al.[15] note that private sector R&D investments in 1960 accounted for 43% of total agricultural investments, rising to 53% by 2011, partly in response to more expansive intellectual property rules and a slowdown in public sector investment. Overall, investments in agrifood R&D on average provide large and long-term returns. Alston et al.[16] reviewed the results of 289 studies of returns to agri-food R&D, which provided 1821 estimates of rates of return, finding that the average return was 65% for the overall investments, signalling a significant underinvestment in research. Others suggest the story is more nuanced. A more recent scan of a range of sector level studies in Heisey and Fuglie[17] showed that the social internal rate of return ranged from 4% to 83%, with almost all studies showing double digit returns. Alston et al.[18] further showed that targeting research analysis to specific jurisdictions (in his case US states) effectively ignored spillovers, with the result that led to underestimates of the internal rates of return by on average about 3.8%, with a range of 1.5%–7.9%. While this average suggests massive under investment in agri-food R&D, there may be a few pockets of over-investment.

Meanwhile, a number of studies focused on the net effect of expanded intellectual property rights (IPRs) on research, with mixed results. Alston and Venner[19] modelled the effect on wheat breeding of the US Plant Variety Protection Act (PVPA), which strengthened intellectual property (IP) protection for plant breeders. They found that PVPA may have stimulated public investment in wheat varietal improvement but did not stimulate private sector investment nor did it lead to any increase in experimental or commercial wheat yields. Nhemachena et al.[20] concluded that strengthening IPRs systems in South Africa contributed to improving the number of commercialized wheat varieties as well as their respective yields. Gray and Bolek[21] documented that the use of producer check-offs, facilitated by the new property rights granted through UPOV 91, provided strong incentives for increased R&D investment in the Australian wheat sector. But striking the right balance between optimal protection and investment incentive in plant breeding is a challenge. Malla et al.[22] undertook a longitudinal empirical analysis of the canola research sector globally. They concluded that total competitive research significantly rose after 1990 due to increased research subsidies, new IPR rules, and the advent of genetic modification. However, the total gains to research moderated to below the cost of capital, and the net marginal returns to research turned negative for a period.

These studies lay the groundwork for improving and extending IPRs protection in plant breeding. The UPOV treaties have been in operation for over six decades. Currently, 78 countries are party to one of its iterations and have incorporated their provisions into their respective domestic law.[23] UPOV enables new plant varieties to be registered and thereby protected so that when a farmer buys the seed of a new variety, a small percentage of the price is returned as a royalty to the variety developer. This allows the PBR holder to receive a return on their investment for their role in creating the new variety. The protection granted extends for 20 years and for newly created tree and vine varieties, it lasts for 25 years.

In Canada, the PBR Act and PRBs are administered by the Canadian Food Inspection Agency. Canada's PBR programme is voluntary, in that a plant breeder may choose to protect a new variety or not. The granting of PBRs does not override other mandatory regulatory requirements. PBRs that are granted in Canada only apply in Canada. To protect a variety in another country, the breeder must make a separate application in that jurisdiction. In 2015, Canada amended and updated its PBR Act, becoming compliant with UPOV 91. The new rules apply to all new varieties granted rights after 2015. Varieties that were already in the market at that time continue to be dealt with under UPOV 78 rules. Canada's current PBR law includes a 'farmers' privilege' clause (Section 5.3 (2)) that allows farmers to condition and use harvested seed from a UPOV 91 variety to plant a future crop on their own holdings. Furthermore, breeders are required to deposit varieties protected by PBRs into a germbank and other breeders can use those materials in their breeding programmes. Provided a breeder develops a new variety that is distinct, uniform and stable, they are not required to seek permission from the owner of the deposit under PBR.

Revisions to the Act came by way of The Agricultural Growth Act, which amended certain aspects of PBRs and came into force on 27 February 2015. The main aim of the changes was to align the Act with the 1991 UPOV Convention. Adjustments were done to the duration and scope of PBRs, as well as the conditions for the protection of those rights. Exceptions to the application of those rights were also included. Adoption of UPOV 91 does not prevent breeders from using other forms of IP to protect new plant varieties, enabling the potential for patents to also be secured.[24] The implementation of Agricultural Growth Act is part of a broader effort on the part of the Canadian government to stimulate plant breeding in Canada, to provide Canadian producers with better access to foreign varieties and to facilitate the protection of Canadian varieties in other countries.

3 | METHODOLOGY

Two surveys were developed, both in English and French, and tested on selected members of our target population. The first survey was targeted at public and private plant breeders, while the second was designed for and directed to organizations that provide financial support in the development of new crop varieties. The surveys were developed in Qualtrix and were estimated to take approximately 20 min to complete.

Between December 2021 and March 2022 electronic survey invitations were sent to a total of 732 individual plant variety breeders with a presence in the Canadian market and the research funder survey was sent to an estimated 60–100 R&D funding organizations. A series of reminders were sent over the 3 months to the potential respondents. The PBR Office within the CFIA also sent notices to all their registered individual plant variety breeders and personalized notes to each of the known R&D funding organizations.

A total of 121 responses were received from individual plant variety breeders. Of these, 12 submissions were received in French and 109 in English. The survey gauged: (1) Canadian plant breeder/title holders' perspectives on PBR; (2) licensee and retailer perspectives on PBR; (3) any changes they made in the use of PBRs following the adoption of UPOV 91; (4) any changes they made in investment in plant breeding; and (5) whether any took advantage of the new opportunities for importing or exporting plant varieties. A total of 46 organizations submitted responses to the second survey. Respondents were not forced to respond to each question, so the number of responses for each survey question varies.

Quantifying a confidence level for the reported data is challenging as no database exists that contains 100% of potential recipients. Every effort was made to ensure as many potential recipients as possible were identified and invited to participate, but undoubtedly, some were missed. With 121 breeder institution responses and 46 R&D funder responses, we are confident the data gathered is representative of the sectors, but are not able to provide a confidence interval. It is estimated there are probably no more than 500 plant breeders in Canada and approximately 100 potential R&D funding organizations, resulting in response rates of about 25% and 46%, respectively, responses that exceed many other industry surveys. No respondent demographics were collected.

We acknowledge that surveys are an imperfect mechanism for soliciting insights into behaviours. Sellers of plant varieties themselves may not know the full value of any specific mechanisms and thus might promote plant breeders' rights regardless of their actual effect on incentivizing their investments. When compared with Sutherland et al.,[25] the two surveys offer somewhat different takes on the question of the impact of changes in the PBR regime in Canada.

4 | RESULTS

4.1 | Plant breeders

Respondents were asked to best identify their organization, with 45% indicating they are a breeding organization, 25% are a variety licenser and/or retailer, 17% are agents and 14% indicated 'other'. Breeding organizations

included both public and private breeders that conducted research either within Canada and internationally. The top three sources of funding for breeding programmes is revenues from sales, licenses or royalties, producer check-off funding and research grants. Licensees and retailers are organizations that license crop varieties from the developing organizations and retail them to their customers. The majority of these organizations (63%) reported they operate solely in Canada, 22% indicated they operate both in Canada and internationally and 15% operating solely internationally. Agents were virtually all private sector organizations mainly located in Ontario, which included joint stock firms, privately owned firms, sole proprietorships and self-employed individuals. Agents also included law firms specializing in intellectual property.

While 121 responses were received, respondents were able to indicate multiple crop type breeding programmes, resulting in 170 responses when asked about what crop type breeding programmes their organization was involved with. Cereal breeding (wheat, barley, oat, and corn) was the category with the largest rate of response at 18%. This was followed by fruit at 16%, which included soft fruits like strawberries and blueberries, as well as hard core fruits like cherries and orchard fruits like apples. Oilseed (canola, flax, and soybean) and potato were both listed by 14% of respondents. Vegetables (all garden varieties) and ornamentals (predominantly flowers and shrubs) were both identified by 9%. Forages were identified by 6% and the remaining 5% identified as 'other', which included cannabis, basil and hops.

Breeders have a suite of strategies for protecting their IP, including: PBRs; patents; trademarks; trade secrets; nondisclosure agreements; private contracts/licensing agreements; and hybridization. PBRs are the most frequently used form of IP in Canada to protect plant varieties and are employed across all crop variety development programmes (Table 1). Of the 11 possible crop types provided in the survey, respondents reported they protect cereal, pulse, vegetable and root crop plant varieties with the entire spectrum of IP options. The remaining seven crop types are protected with partial protection options. Most oilseed variety development is led by the private sector, yet PBRs are still used by the majority of organizations as the preferred form of protection. Nevertheless, 46% of respondents indicated they have commercialized at least one variety without seeking or securing PBRs.

Patents are utilized to protect new varieties in all categories except tree and ornamental breeding programmes, whereas trade secrets are used in all categories with the exception of fruits. nondisclosure agreements are common

TABLE 1 Forms of IP used to protect new plant varieties (n = 167).

Crop type	PBRs	Patents	Trademarks	Trade secrets	Nondisclosure agreements	Private contracts/ licensing agreements	Hybridization (biological protection)	None
Cereal	102	37	18	4	3	2	1	
Oilseed	40	28	11	2	3	1		
Tree	4		3		1			
Pulse	37	17	17	3	3	2	1	
Forage/grass	17	12	11	11	5	2		
Fruit	49	17		12	4	3	1	1
Vegetables	71	29	23	5	4	3	2	1
Root crops	24	14	4	1	1	2	2	
Spice	3	1	2					
Cannabis	4	4	1	1			1	
Ornamental	8		2	1		1		1

throughout plant breeding, yet are not utilized in spice, cannabis and ornamental development. The use of private contracts between organizations is also a common practice, while hybridization has limited use. The lack of any form of IP protection is very uncommon in Canadian variety development.

Respondents were asked about Canada's adoption of UPOV 91. When queried about whether the current level of protection provided by UPOV 91 was sufficient, 10% of respondents strongly agreed, 52% agreed, 16% neither agreed nor disagreed, 17% disagreed, with 3% strongly disagreed. At a ratio of just over 3:1, respondents agreed that UPOV provided sufficient levels of variety protection.

UPOV 91 allows for the sale of plant varieties within Canada for 1 year before having to file an application for PBR protection. When asked if their organization had taken advantage of this change, 59% indicated they had and 41% stated they had not. PBRs protect crops for a period of 20 years (25 for trees and vines), an increase from 18 years previously. When asked about the appropriateness of the new protection lengths, 51% of respondents indicated this was appropriate, while 31% said the length of protection should be longer than currently provided. There was no significant clustering of those wanting longer protection by plant type in our survey, but in follow up interviews with breeders we found that people working on trees and other perennial crops indicated they would prefer longer periods of protection.

Respondents were asked about whether or not PBR amendments encouraged them, or their clients, to invest more into their plant breeding programme (Table 2). The majority (52%) of respondents reported that the PBR amendments have encouraged investment, 34% neither agree nor disagree, 8% disagreed and 7% reporting they do not know. When asked if the amendments encouraged the release of greater numbers of new varieties, responses were very similar to the investment responses, with 46% agreeing or strongly agreeing. Respondents were asked whether the amendments encouraged a greater diversity of plant variety commercialization. Equal response rates of 36% were found with those that agreed and those that neither agreed nor disagreed, while 16% thought the changes reduced diversity and 13% reported they did not know. When asked whether PBR amendments facilitated greater economic opportunities in the Canadian marketplace for respondents or their clients, 60% either agreed or strongly agreed, with 26% responding they neither agree or disagree.

The adoption of UPOV 91 resulted in five specific amendments (Table 3). The amendment identified as having the greatest value is providing the ability to sell new crop varieties from the date of filing for PBRs, with 86% of respondents indicating this had either significant or some value. This amendment made PBRs consistent with patent protection, where protection is granted from the date of filing for a patent. The amendments that allowed for

TABLE 2 Changes from PBR amendments (%).

Response	Encouraged more investment	Encouraged release of greater number of varieties	Encouraged greater diversity	Facilitated greater economic opportunities
Number of responses	88	88	87	88
Strongly agree	14	14	9	20
Agree	38	32	26	40
Neither agree or disagree	34	38	36	26
Disagree	1	2	6	3
Strongly disagree	7	9	10	7
Don't know	7	6	13	3

TABLE 3 Value from PBR amendments (%) ($n = 85$).

Change	Significant value	Some value	Minimal value	No value	Not sure
Current—Extension of rights to include: sale, production, reproduction, import, export, conditioning (clean, treat) and stocking. *Previously—Under the previous version of the Act, exclusive rights were limited to sale and production.*	48	27	9	6	10
Current—Expanding novelty (newness) to allow for up to one year of sales in the Canadian market before filing for PBR. *Previously—Under the previous version of the Act, no sales were permitted in Canada before filing for PBR.*	51	27	12	8	2
Current—Providing automatic provisional protection for a new plant variety from date of filing, allowing applicants to exercise their rights while applicationsare pending grant of rights. *Previously—Under the previous version of the Act, applicants had to apply for 'provisional protection', andno sales were permitted while the application was pending grant of rights.*	64	22	6	5	4
Current—Providing the breeder of a protected initial variety the opportunity to exercise exclusive rights on any subsequently bred essentially derived variety(ies) (EDV). *Previously—Under the previous version of the Act there was no provision for EDV's.*	42	27	8	8	14
Current—Extending the breeders' right to allow claims for damages for harvested material (e.g., grain, fruit, etc.) when unauthorized use of propagating materialoccurred, such as illegal sales. *Previously—Under the previous version of the Act, opportunity to exercise rights was only limited to propagating material.*	52	26	8	8	6

domestic sales of varieties before applying for PBRs and extending PBRs to allow claims for damages for harvested materials when unauthorized use occurred were both of either significant or some value to 78% of respondents. Respondents identified that not being able to sell new varieties domestically before filing for PBRs was perceived as a barrier and extending the right to sell domestically for up to 1 year before filing was a positive amendment. The ability to allow PBR holders to file for compensation when unauthorized materials are used was additionally viewed as a positive amendment. Three-quarters of respondents gained either significant or some value from extending rights to now include reproduction, import, export, conditioning and stocking. Lastly, the amendment to provide breeders with the opportunity to ensure they retain PBRs from any essentially derived varieties was viewed as being of either significant or some value by 69% or respondents.

Respondents were asked about the sources of additional investments into their breeding programmes. Most investments come from the revenue stream generated from licensing, sales and royalties from their collections, with the second leading source being their own organization's investment. Respondents were asked to rank what component of their plant breeding programme they had directed their investments towards (Table 4). Most respondents invested in the marketing of their varieties, followed closely by permanent workers for their breeding programmes.

A final survey topic involves increased collaborations. One-quarter of respondents indicated they have changed their international research partnerships due to the 2015 amendments.

4.2 | Research funders

As part of the effort to fully assess the impacts of the UPOV 91 amendments to the plant variety R&D sector, a separate survey was created and distributed to Canadian organizations involved in funding plant variety R&D. A total of 46 organization responses were received, representing farmers (21%), farmer funding organizations (21%), private breeders (18%), seed growers (12%), seed retailers (12%), public breeders (8%) and other (8%). When asked to identify how important the protection of new plant varieties is to their organization, 61% indicated it was very important, with 33% saying somewhat important and 6% saying neither important nor unimportant. No respondents indicated PBRs were not important to their organization.

R&D funding organizations were asked to rank the various forms of IP protection from most to least favourable (Table 5). Some respondents used the 'Other' opportunity to provide comments. One respondent reported that in addition to the forms of IP listed in Table 5, they used consent forms, but provided no further details on what that

TABLE 4 Targeting of new programme investments.

Rank	Plant breeding investment component	No. of responses
1	Marketing for variety(ies)	46
2	Permanent workers	39
3	Instruments/equipment necessary for breeding programme	38
4	Computers, software or other business equipment	34
5	Physical infrastructure/greenhouse improvement/expansion	33
6	Land area for breeding programme	32
7	Temporary workers	32
8	Workshops to improve skills	15
9	Other	9

TABLE 5 Research funding organization IP protection ranking.

Rank	Forms of IP protection	Number of respondents
1	Plant breeders rights	16
2	Private contracts/licensing agreements	14
3	Patents	13
4	Trademarks	12
5	Hybridization	12
6	Nondisclosure agreements	11
7	Trade secrets	10
8	Other	7
9	None	7

TABLE 6 R&D funder perspectives on PBR amendments (%).

	Provide investment incentives	Additional incentives required	Amendments increased R %D investments	Increased access to new plant varieties
Strongly agree	6	22	0	11
Agree	44	22	33	33
Neither agree or disagree	33	33	50	50
Somewhat disagree	11	11	11	6
Strongly disagree	0	0	0	0
Don't know	6	11	6	0

involved. One respondent engaged in ornamental plant variety development reported their IP strategy consists of applying PBRs on foreign genetics, using patents in the United States, trademarking or private contracts on most new varieties in Canada and when appropriate, licensing agreements as well.

Most respondents either strongly agreed (32%) or agreed (42%) that the current Canadian PBR system provides a sufficient level of protection for plant varieties. Only one respondent (5%) somewhat disagreed that the current system provides sufficient protection. Two-thirds of respondents think that the current period for which PBRs are granted is appropriate (25 years for trees and vines and 20 years for all other crops) while 14% ($n = 3$) of respondents would like to see these time periods extended. About two-thirds of respondents agree or strongly agree that current Canadian PBRs makes Canada internationally competitive, 17% neither agreed or disagreed, with 6% somewhat disagreeing and 11% of respondents reporting they do not know.

When asked whether the 2015 PBRs amendments provide sufficient IP protection to incentivize investment in plant breeding and the release of new varieties into the Canadian marketplace, respondents were positive (Table 6). Half of respondents agree or strongly agree, while one-third neither agreed nor disagreed. Respondents were asked whether they believed additional IP incentives beyond the 2015 amendments would be required to generate additional R&D investments, with 44% agreeing or strongly agreeing additional incentives were required, with 33% neither agreeing nor disagreeing. Those who responded in the affirmative were asked to comment. Two respondents called for clearer

communication of the public breeding strategy in Canada, as well as increased return on crops with a high percentage of farm-saved seed usage. Another respondent called for more proactive communication from all stakeholders (public administration, public research and farmers' organizations) about the benefits of new varieties and the role of PBR protection to ensure a fair level of investment for the breeding sector to drive further innovation.

One-third agreed the 2015 PBR amendments had led to increased investment into plant variety development, with 50% neither agreeing nor disagreeing. If respondents agreed, they were asked to elaborate on what had changed as a result of the amendments. One respondent stated that because the Canadian market is very small, if there have been increased investments into the development of new horticultural varieties, it was a result of need rather than changes in the PBR Act. According to the same respondent, financial gain for new horticultural plants developed in Canada is low; they assert foreign companies have developed a great number of new varieties, but few are specifically for the small Canadian market. Another respondent stated that while a renewed interest has arisen from private breeders, public investment is declining.

Respondents were asked whether they believed access to new plant varieties in the Canadian marketplace had increased. While 44% responded positively, 50% neither agreed nor disagreed. Those who agreed provided comments. One respondent asserted, '[m]ore varieties are being brought in from other countries. While options are helpful, preserving the integrity of the quality assurance system that supports the Canada brand is essential'. A sentiment of allowing foreign varieties into Canada while simultaneously protecting Canadian varieties was echoed in many comments on this question.

5 | DISCUSSION

The survey undertaken in 2018 and this survey are somewhat different and, while targeted at the same general source population, may have different respondents, we found a number of useful differences. Acknowledging that, we note that there were similar questions about whether the respondents thought the amendments incentivized them to increase investments into R&D. We found that a change in the proportion of. responding both positively and negatively. Sutherland et al.[26] found in 2018 that only 36% supported and 62% rejected the benefits of adopting UPOV 91, while this current survey found support rose to 52% and only 8% disagreed. This raises the question as to what changed in this 4-year period?

In the first instance, we found the number of PBRs granted rose to almost 1900 in the almost 9 years since the change, up about 30% over the equivalent period before the change. But the underlying effort was not overly different. The number of plant breeders making application was steady at about 110, about 18 multinational seed companies sought PBRs in both periods and the number of direct imports of foreign varieties rose was only somewhat over 80 for each period. So one might infer that familiarity is a more likely factor in changing attitudes than the composition of the industry.

The change in plant breeder perspectives may be connected to funding cycles and the length of grants. Private breeders rely heavily on internal funding sources for much of their needs, but they also use public funding to supplement investments. In contrast, public breeders rely almost exclusively on public funding sources to sustain breeding programmes. While more recent funding competitions have provided funding for 3-year periods, previous competitions provided funds for longer time periods, commonly 4–7 years. Undertaking a survey in 2018, just 3 years after the UPOV 91 amendments came into effect may not have allowed for a sufficient period of time to have passed to be able to fully assess impacts. Undertaking the 2022 survey found a significant shift in perspectives, as breeders have had an opportunity to apply for additional funding and test the impact of new IPR rules on their applications. Given the length of time required to develop new crop varieties and the length of funding grants, it would be highly appropriate to undertake this survey again in 2025, to be able to assess the impacts a full decade after the initial amendments were implemented.

The results of this current survey show that a majority (52%) of breeders report PBRs offer an important incentive for investment. Without these incentives for investments in new crop and plant varieties would be likely be less and, all other things being equal, there would be fewer new varieties commercialized. With fewer new varieties entering the market, farmers would be forced to rely for longer on older crop varieties that lack higher yielding capabilities. Those lower yields

would then translate into lower production and generally higher food costs for consumers. As climates change in the coming years, ensuring that farmers have continued access to new varieties that respond to new stressors will be of fundamental importance. However, it must also be recognized that PBRs alone may not be sufficient to entice individual breeders to optimally invest into their breeding programmes. That is because setting up contracts and implementing collection enforcement mechanisms under the existing legal guidelines may still be too costly for individual breeders interested in financing private breeding operations in Canada. In other words, PBRs are only a component in a portfolio of policies that need to be enacted to stimulate investment in Canadian plant breeding programmes.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available upon request.

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ENDNOTES

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