Plant Variety Rights

Economic and public good benefits

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Executive Summary

Business and Economic Research Limited (BERL) was commissioned by the Ministry of Business, Innovation and Employment (MBIE) to estimate the economic and non-economic public good benefits of the Plant Variety Rights (PVR) scheme in New Zealand. The purpose of this report is to inform future options for funding, and fees charged by the Intellectual Property Office of New Zealand (IPONZ) as the regulator, which sits within MBIE.

New Zealand's PVR scheme enables breeders to regulate the production, sale, and distribution of propagating material of a new plant cultivar for a specified period. During this period, no one else can propagate or sell propagating material of the cultivar without the breeder's authorisation. PVRs are a form of intellectual property right that serve as an incentive for breeders to invest their time, effort, and resources into developing new plant cultivars as it allows them to recoup their investment into the research and development process.

In 2022, the New Zealand Parliament passed the Plant Variety Rights Act 2022 (PVR Act 2022). The three purposes of the Act are:

a. to provide an efficient and effective plant variety rights system that revises and consolidates the law on plant variety rights in the light of New Zealand's obligations under the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP) in relation to the International Union for the Protection of New Varieties of Plants (UPOV) Convention

b. to protect kaitiaki relationships with taonga species and mātauranga Māori in the plant variety rights system

c. to promote innovation and economic growth in New Zealand by providing incentives for the development and use of new plant varieties while maintaining an appropriate balance between the interests of plant breeders, growers, and others so there is a net benefit to society as a whole.

Economic value of the PVR scheme to New Zealand

The primary sector is one of the main pillars of the New Zealand economy. The PVR scheme underpins the performance of New Zealand's primary sector by incentivising plant breeders to invest in technological improvements to cultivars that lead to better performance, higher productivity, and lower costs, resulting in higher returns for the sector. PVR protected cultivars bring significant economic gains to New Zealand.

- Of the $2.9 billion worth of export revenue generated by kiwifruit exports in the year to March 2023, a total of $2 billion was attributable to PVR protected cultivars
- PVR protected apple cultivars generated an estimated total of over $216 million in export revenue during the year ending June 2022
- PVR protected vegetable cultivars contributed approximately $635 million to domestic GDP in 2022

- The sales of PVR protected arable seeds contributed a total $346.4 million to domestic GDP, and accounted for at least $162 million of total arable exports in 2022.

Public good benefits of the PVR scheme

The benefits of the PVR scheme are realised by enabling a system that incentivises plant breeders to invest in the research and development of new varieties by offering a robust mechanism for protection. The range of benefits associated with the scheme span a number of stakeholder groups. Some of the key benefits that the scheme promotes and enhances include:

- The development of higher yielding cultivars. The yield improvements that plant breeders have been able to achieve over the past few decades are considerable. For perennial ryegrass the genetic gain in yield has been over 19 percent since 1990, averaging 0.76 percent per annum. Higher yielding varieties offer significant benefits to society including increased food production and food security, reduced land pressure, efficient use of resources, and enhanced profitability and efficiency of farms
- Resistance to diseases. For example, 70 percent of the new apple cultivars currently bred in New Zealand have some level of resistance to diseases. Disease resistant cultivars help with yield preservation, reduce wasted produce, and result in cost savings for growers
- Supporting sustainable agriculture and horticulture practices. Cultivars that are resistant to pests, diseases, and adverse environmental conditions are less reliant on chemical inputs such as pesticides and fertilisers, which reduces the ecological impact and preserves biodiversity. In New Zealand, research is being undertaken to understand whether fungal endophytes in pasture might be a potential way to influence the amount of methane produced during digestion of the pasture. Plant breeders are also looking at ways to change nitrogen requirements for grass in order to reduce nitrate runoff
- Import of cultivars and genetic material from these cultivars that have been bred overseas. For example, 95 percent of the plant material used to grow potatoes is imported from overseas breeders. Without PVR, not only would the domestic breeding of plants of economic significance to New Zealand reduce significantly, imports of the latest cultivars would also slow. There would also be a reduction in consumer choice and farmers' and growers' access to new and improved cultivars
- The development of new cultivars for high-value export markets, supporting New Zealand's efforts to be competitive in the global market. For example, the PVR scheme has been one of the biggest enablers of success in the case of New Zealand's high-value apple exports, which successfully compete against lower-priced products internationally
- Increased choice and access to a wider variety of plant types throughout the year. For example, consumers have access to over 7,000 cultivars of apples grown worldwide, with different ones available all year round. This number continues to grow as breeders are incentivised to keep investing in the breeding process.

Meeting Te Tiriti obligations

One purpose of the PVR Act 2022 is "to protect kaitiaki relationships with taonga species and mātauranga Māori in the plant variety rights system". Part 5 of the Act was enacted to provide protection for kaitiaki (guardian / custodian) relationships with taonga species consistent with the Crown's obligations under Te Tiriti o Waitangi. Part 5 recognises and respects the Crown's obligations under the principles of Te Tiriti o Waitangi through protecting kaitiaki relationships with taonga species and mātauranga Māori in the PVR system, by:

- Providing additional procedures that will recognise and protect kaitiaki relationships
- Providing for a Māori Plant Varieties Committee (the Committee) to administer those procedures, to make determinations about kaitiaki relationships, and to have advisory functions
- Enabling the nullification or cancellation of PVRs that have adverse effects on kaitiaki relationships.

Cost recovery and PVR

The PVR scheme was set up on the basis of full cost recovery, meaning users of the scheme are expected to cover the full cost of operating the Plant Variety Rights Office (PVRO). This is consistent with New Zealand's other intellectual property schemes, and Treasury's 'Guidelines for Setting Charges in the Public Sector'. The argument is that full cost recovery can improve the efficiency of resource use, and is more equitable.

The Guidelines note that there are some circumstances where charging less than full cost may be appropriate. Despite the intention to fully recover costs, the PVRO is currently operating at a deficit due to a decrease in the volume of applications, and rising fixed costs. In 2022 IPONZ conducted a review of the costs associated with providing an efficient PVR scheme and found that a full cost recovery model would result in significant increases for all fee payers and present a cost prohibitive barrier for some companies. The PVRO estimated that such a significant increase would likely reduce applications by roughly half.

Following the review and the passing of the PVR Act 2022 a new fee structure was introduced. Noting the importance of innovation in plant breeding for the environment, primary industries, and the economy, and the need to ensure the continued integrity, operation, and maintenance of the PVRO, the fee structure does not recover the full cost of the PVR regime. Instead, interim Crown funding was identified to provide a level of funding for 2022/23 to 2024/25. A new regime must be in place for 2025/26 where MBIE will seek to set costs at full cost recovery levels, if appropriate.

PVR applicants rarely consider the costs associated with obtaining and maintaining PVR protection in isolation. What the costs entailed, and how applicants viewed their costs, depended on a number of factors including plant type, whether they were an international or domestic player, the economic viability of their plant type, including the size of the market, and the size of their own operation. Thus, discussions around the potential impact of an increase in fees focussed heavily on how other costs were evolving. Some of the potential impacts of a move to a full cost recovery system include:

- For large breeders, the move to a full cost recovery model is unlikely to have a significant impact on the decision to develop and register new cultivars, or their ability to obtain an economic return. Large breeders have access to bigger markets and a wide range of customers. Thus, they are able to spread the costs of development and PVR protection across these markets reducing the impact of increased PVR costs
- Smaller commercial and recreational breeders (backyard breeders) are likely to be impacted by any move to recover the full costs of the PVR scheme as their ability to recover these costs is limited given that they cater to a smaller market. This is particularly true in the case of breeders of ornamentals and forest trees, where the opportunity to generate significant commercial returns is more limited, and the domestic ornamentals industry is already on a decline
- Any reduction in domestic breeding as a result of full cost recovery would be likely to lead to reduced innovation and competition, with fewer domestically bred plant cultivars available to New Zealand's primary industries and consumers
- For agents and importers, the impact of fee increases was evaluated within the context of how other costs were evolving, most importantly, Customs and quarantine costs. These cost increases in particular were becoming an increasing concern, and higher PVR fees would add to overall costs, having a real impact on profitability. An increase in PVR fees would mean agents and importers are likely to become more selective in what they bring into the country, and reduce the number of cultivars they import. This will lead to a reduction in the range of overseas cultivars available to breeders, growers, and consumers in the domestic market.

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1 Introduction

Plant breeding is one of the earliest forms of technological progress in modern agriculture and horticulture. It is the process of developing new varieties or cultivars of plants by making use of genetic variations in existing plants. Breeders can breed for specific qualities that are considered to be economically, aesthetically, or environmentally desirable. The selective breeding of plants has been around for centuries. All the crops grown for human and/or animal consumption today have been selectively bred from wild plant material, much of which would be unrecognisable to us today.

Today, these improvements in the genetic makeup of plants are being carried out at an unprecedented rate. Every new cultivar that enters the market is an improvement upon older cultivars. Plant breeders invest significant amounts of time and resources to develop and commercialise new cultivars. This can take over two decades in some cases, and is an expensive process.

The process of developing new cultivars of plants is a necessary one. The public good benefits of this process are not always directly visible, but they are invaluable to society. Selective breeding of plants for specific qualities has several benefits, some of which include:

- Improved productivity: New cultivars have significantly higher yields than older ones, which is important to sustain the increasing global population. It also results in higher profitability for farmers and growers. This increase in output efficiency also reduces the need to clear forests and other land to grow crops
- Improved disease and pest resistance: Cultivars that are naturally resistant to pests and diseases are more reliable, and can result in the elimination of the use of harmful pesticides and other chemicals
- Consumer choice and preferences: Plant breeding has led to the development of different cultivars of a plant, each of which suits different uses and/or preferences. For example, the various types of potatoes have different applications, e.g., boiling, frying, or mashing.
- Improved sustainability: Plants are increasingly being bred for qualities such as drought and heat resistance, and storability (which reduces food waste from spoilage).
- Pleasure: Ornamental cultivars, such as roses, are constantly being improved to suit a wide range of consumer preferences.

Given the range of public good benefits that arise from the development of new plant cultivars, it is important to ensure that there are incentives for breeders to continue the process. This includes being able to obtain a return on their investment into the breeding process. Plant Variety Rights (PVR) are a type of intellectual property right. PVRs grant plant breeders exclusive control over the commercial propagation of a new plant cultivar they have created. PVRs enable breeders to regulate the production, sale, and distribution of propagating material of a new plant cultivar for a specified period. During this period, no one else can propagate or sell propagating material of the cultivar without the breeder's authorisation. PVRs serve as an incentive for breeders to invest their time, effort, and resources into developing new plant cultivars, as it allows them to recoup their investment into the research and development process. Like other forms of intellectual property

(IP) protection, PVRs are territorial. This means that a cultivar must be registered in the country or region where protection is sought, and rights are granted and in force under that country's legal system.

Innovation in the plant sector is different from other forms of innovation in a number of key ways:

- Plants take a long time to breed: The entire process from development, to testing, to approval, to commercialisation can take over a decade. For example, it can take 20 years to develop a new peony cultivar
- Unpredictable outcomes: The performance of a cultivar can vary based on external factors including geography, weather conditions, diseases, and pests.
- Specialisation: Most plant breeders specialise in one type of plant. For example, rose breeders will only breed roses. This is because plant breeding requires specialised knowledge and expertise in the genetics and biology of the plant species being worked on
- Plants are physical: Plant cultivars cannot be copied as easily as some other forms of IP. For instance if a trade mark is registered in Australia, nothing prevents the same name from being used in places where the trade mark is not registered. Whereas in the case of plants, physical material is required to reproduce the innovation.

1.1 Aim and methodology

Business and Economic Research (BERL) was commissioned by the Ministry of Business, Innovation and Employment (MBIE) to report on the economic and non-economic public good benefits of the PVR scheme in sufficient detail to inform future options for funding, and fees charged by the Intellectual Property Office of New Zealand (IPONZ) as the regulator.

This report combines desk research, data collection, literature scans, and engagement with a wide range of industry stakeholders. BERL engaged with 33 participants. Thirteen of these represented organisations undertaking breeding activities, six agents and/or importers of international cultivars, three IP managers, three farmers/growers, two manufacturers, two industry body representatives, and four participants from other organisations.

The engagement process enabled the collection of the evidence required to provide an informative and wide ranging assessment of the impact that the New Zealand PVR scheme has on the well-being of New Zealand.

BERL would like to express our gratitude towards the stakeholders who provided their valuable time to participate in this research and share their expert views and experience.

1.2 Background to Plant Variety Rights protection in New Zealand

PVR schemes are in place across the world. New Zealand's international commitments and agreements require the government to have a plant variety rights scheme.

New Zealand has been a member of the International Union for the Protection of New Varieties of Plants (UPOV) since 1981. The UPOV organisation was established in Paris in 1961 with the adoption of the International Convention for the Protection of New Varieties of Plants and is the primary

global agreement governing intellectual property protection for plant cultivars. The convention requires that each member recognise the right of the breeder either by the granting of a special title of protection, or a patent. Additionally, Article 27.3 of the Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS) states that member states, of which New Zealand is one, must provide for the protection of plant cultivars either by patents or by an effective *sui generis* system, or a combination thereof. To meet the UPOV and TRIPS requirements New Zealand uses PVR, also referred to globally as Plant Breeders Rights or PBR.

New Zealand is one of 78 member states or organisations using this common and effective system of plant variety protection. Members follow the 1978 Convention (UPOV 78) or the current 1991 Convention (UPOV 91). Since New Zealand is a member of UPOV, local breeders are entitled to apply for plant variety protection in 78 other member states under the same provisions as breeders in those states. This membership provides opportunities for accessing larger markets, encouraging investment and development in local plant breeding, providing local growers and farmers with access to new cultivars, and facilitating the sharing of information and expertise globally.

1.2.1 PVR legislation in New Zealand

New Zealand passed the Plant Variety Rights Act 1987 (PVR Act 1987) to align its PVR regime with the 1978 version of the UPOV Convention. Under the PVR Act 1987, plant breeders and developers could seek a PVR grant for legal protection for their newly developed plant cultivars.

In 2022, The New Zealand Parliament passed the Plant Variety Rights Act 2022 (PVR Act 2022). The three purposes of the Act are:

a. to provide an efficient and effective plant variety rights system that revises and consolidates the law on plant variety rights in the light of New Zealand's obligations under the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP) in relation to the UPOV Convention

b. to protect kaitiaki relationships with taonga species and mātauranga Māori in the plant variety rights system

c. to promote innovation and economic growth in New Zealand by providing incentives for the development and use of new plant varieties while maintaining an appropriate balance between the interests of plant breeders, growers, and others so there is a net benefit to society as a whole.

The PVR Act 2022 meets the requirements of the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP), which New Zealand ratified in 2018. The CPTPP required New Zealand to either ratify UPOV 91, which strengthens plant breeders' rights in a number of areas, or adopt a *sui generis* plant variety rights system that gives effect to UPOV 91 within three years of the date of entry into force of the CPTPP for New Zealand. The PVR Act 2022 created a standalone regime that gives effect to UPOV 91, while allowing New Zealand to protect indigenous (taonga) plant species in fulfilment of its obligations under Te Tiriti o Waitangi.

The PVR Act 2022 came into force on 24 January 2023, except for subpart 3 of part 5 which deals with PVR applications for taonga species. Part 5 "recognises and respects the Crown's obligations

under the principles of Te Tiriti o Waitangi/the Treaty of Waitangi through protecting kaitiaki relationships with taonga species and mātauranga Māori in the plant variety rights system". This part of the PVR Act 2022 won't be in force until at least 18 November 2023. All applications submitted after 24 January 2023, will be subject to the new law. Any PVR applications made before that date will be subject to the PVR Act 1987, and all existing grants will continue under that 1987 Act.

The 2022 PVR regulations introduce a new fee schedule for all applications under the new law. The fees include the application, examination, and trial fees, which vary based on the testing arrangement and plant species.

The Plant Variety Rights Office (PVRO) is a unit within IPONZ that grants PVR under the delegated powers of the Commissioner of Plant Variety Rights. To obtain protection, a plant cultivar must meet the "DUS" conditions:

- **Distinct** – It must be distinguishable from any other known cultivar by one or more morphological or physiological characteristics. For example, the colour of the fruit or flowers, the time of flowering, or the shape and size of its leaves.
- **Uniform** – All plants of a particular generation must share the same important characteristics, i.e., there should be little difference between them
- **Stable** – Successive generations must be able to retain the characteristics of the original cultivar

The cultivar must also:

- Be **New** – It must not have been sold in New Zealand for more than 12 months, and overseas for more than four or six years, depending on the plant species, to be eligible for protection.
- Have an **acceptable denomination**, also known as a variety or cultivar name.

The process of growing and testing a cultivar can take several years, depending on the plant type. The duration of the application process varies depending on the plant species and typically takes about two years, but it can take up to five years or longer. From the point of view of a breeder, the process is even longer when the time taken to breed a new cultivar is considered. For example, it can take up to 20 years for a new apple cultivar to go from the breeding stage to being commercialised. Moreover, not every cultivar that is bred will be commercialised. One apple breeder said that they start with 10,000 possible cultivars before getting down to one or two that can be commercialised. The success rate again varies from one plant to another. Other factors such as consumer preferences, growing conditions, and local regulations are all important factors in the decision to commercialise a cultivar.

1.2.2 Obtaining PVR protection

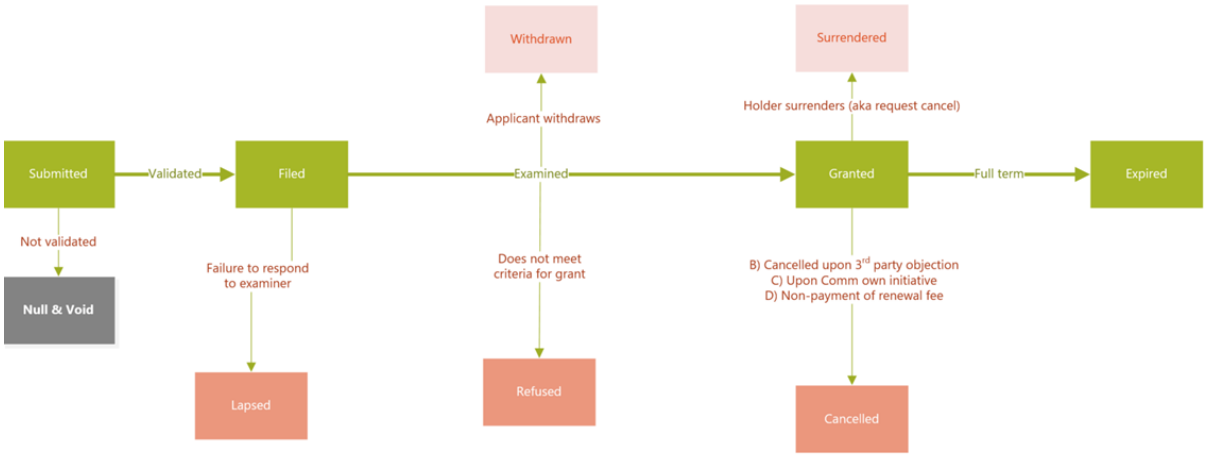
The process for obtaining PVR protection is shown in Figure 1.1. Applications for PVR protection are made by breeders or their representatives. These representatives, also called agents, are usually plant cultivar importers, IP management companies, or law firms specialising in intellectual property. For example, the agent for an overseas crop cultivar could be a local seed company, and the agent

for a fruit or ornamental cultivar could be a local nursery. Applications are completed online through the IPONZ website and require the breeder, or their agent, to submit the technical questionnaire for that species, a digital colour photo for every application for a fruit, ornamental, tree, or vegetable cultivar (including potatoes) as well as other documentation to support the application. For an arable crop, pasture plant, amenity grass or seed propagated vegetable cultivar, a seed sample is required to be supplied to the designated place. A preliminary examination is first carried out, where the cultivar testing requirements and arrangements are determined, similar cultivars are identified, the cultivar denomination is examined, newness is assessed, and formalities such as ownership are checked.

This is then followed by testing and evaluation, the requirements of which will depend on the cultivar being examined. Some cultivars will be tested in a central PVR trial managed by the PVRO, on the applicant's property by the PVRO, by breeder testing, by foreign test report or at specified testing centres, such as the Cultivar Centre in Hawke's Bay which tests apple cultivars. Following the completion of testing an examiner carries out a final examination and to determine whether or not the cultivar is eligible for PVR protection. If the cultivar is determined to meet the criteria for PVR it will be granted protection. For rights granted under the PVR Act 2022, a cultivar from a non-woody plant genus, such as lilies or grasses, can remain protected for up to 20 years, and a cultivar from a woody plant genus, such as apples or roses, can remain protected for up to 25 years. Potatoes can also remain protected for up to 25 years.

If a PVR is granted, a renewal fee becomes payable on each anniversary date of the grant. This fee must be paid in order to renew the grant and allow it to remain in effect. A PVR will be cancelled if it is not renewed in this way, or will expire if it reaches the end of its term of grant.

Figure 1.1 PVR approval process



Source: Plant Variety Rights Office

1.3 A snapshot of PVRs in New Zealand

Protected cultivars have a range of applications and make a significant contribution to a number of our industries beyond the primary sector. The five broad categories of plants are:

- Fruit and nuts: Which includes fruits such as kiwifruit, apples, and cherries

- Crops and vegetables: These consist of plants such as potatoes, lettuce, fodder plants and wheat
- Pasture: These are mainly grasses and clovers
- Ornamentals: These are cultivars of trees, shrubs, perennials and other garden plants that mainly serve a landscape or decorative purpose
- Fungi: The types of fungi protected are mainly endophytes that improve disease resistance in pasture cultivars.

The domestic breeding, protection, and commercialisation landscape varies substantially for each of the five categories, and there can be significant variation even within a category based on plant type.

As of 31 December 2022, there have been nearly 5,450 PVR applications in New Zealand. As Table 1.1 shows 5,038 have been examined and 380 are under examination. The highest number of applications have been submitted for ornamental cultivars (61 percent), followed by fruit and nuts (18 percent), and crops and other vegetables (14 percent). The shares of those cultivars with registered protection by plant type are similar, with ornamentals making up the largest share of approved cultivars. The number of grants show the share of total applications for each plant type that were granted over the period. The overall grant rate for all plant types was 77 percent. Ornamentals had the highest grant rate, with 84 percent of all applications granted a PVR. Fruit and nuts had the lowest rate at 59 percent of applications being approved during this period.

Table 1.1 PVR applications in New Zealand as of 2022

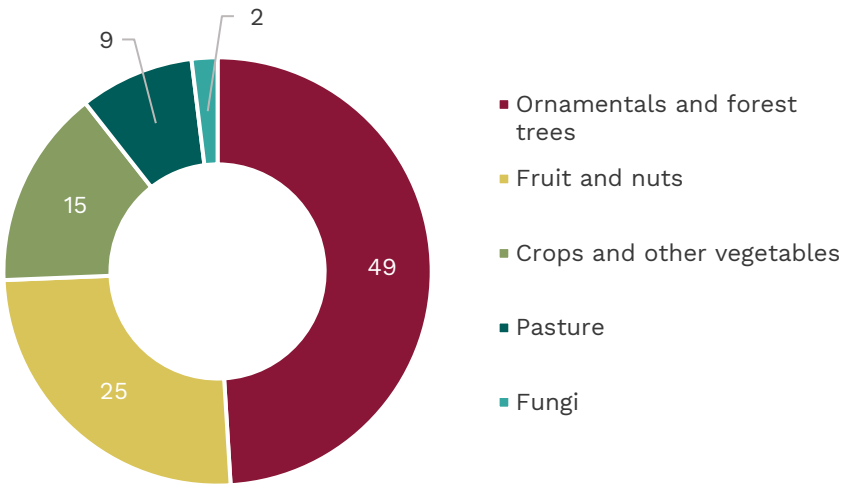
PVR status	Ornamentals and forest trees	Agricultural crops	Vegetables (including potatoes)	Pasture plants and amenity grasses	Fruit and nuts	Fungi (including grass endophytes)	Total
Under examination	**99**	**20**	**67**	**35**	**153**	**6**	**380**
Lapsed	86	6	8	3	43	1	147
Refused	57	1	4	14	36	0	112
Withdrawn	271	30	65	42	170	5	583
Not granted	**415**	**38**	**79**	**61**	**252**	**6**	**851**
Granted	629	86	107	112	325	25	1,284
Surrendered	1,651	127	171	92	158	0	2,199
Cancelled	325	9	20	7	38	0	399
Expired	190	18	27	38	59	3	335
Total granted	**2,795**	**240**	**325**	**249**	**580**	**28**	**4,217**
Total examined	**3,309**	**298**	**471**	**345**	**985**	**40**	**5,068**

Source: Plant Variety Rights Office

As of 31 December 2022, there were approximately 1,300 granted PVRs on the New Zealand register that are in force. As shown in Figure 1.2, the largest share, nearly half, of all PVRs are ornamental cultivars. Roses are the single most protected plant species, with over 180 cultivars protected by PVR. PVR legislation first became operative in 1975 for roses and barley, and the first plant to obtain a PVR grant in New Zealand was a rose cultivar. Legislations for other species were only enacted in

1980. Over the past two decades, the number of valid PVRs for ornamental cultivars has been falling after peaking in the early 2000s. From 2013 to 2022 ornamentals were 41 percent of PVR applications.

Figure 1.2 Granted and in force PVRs by category (%)



Source: Plant Variety Rights Office

The second most protected plant types are fruit and nuts, holding a quarter of all PVRs. Different types of berryfruit make up the largest share of protected fruits, followed by apples. Apricots and kiwifruit cultivars also have relatively high protection numbers. Fifteen percent of all granted and in force PVRs are held by crops and vegetable cultivars. Of these, the biggest share is held by cultivars of potatoes. Potatoes are the second most protected plant species after roses. Other crops with high protection are brassicas, wheat, and other vegetables.

New Zealand's pasture breeding programme is world leading. Different types of pasture cultivars are vital to our primary industries, particularly dairy, sheep, and beef farming. 9 percent of all PVRs are currently held by cultivars of pasture plants such as clover and ryegrass. All of the PVRs held for fungi are for cultivars of endophytes. Endophytes are naturally occurring fungi, found in pasture, that protect the plant from insect attacks. Thus, the breeding of fungal endophytes complements pasture breeding by making pasture cultivars more disease and pest resistant.

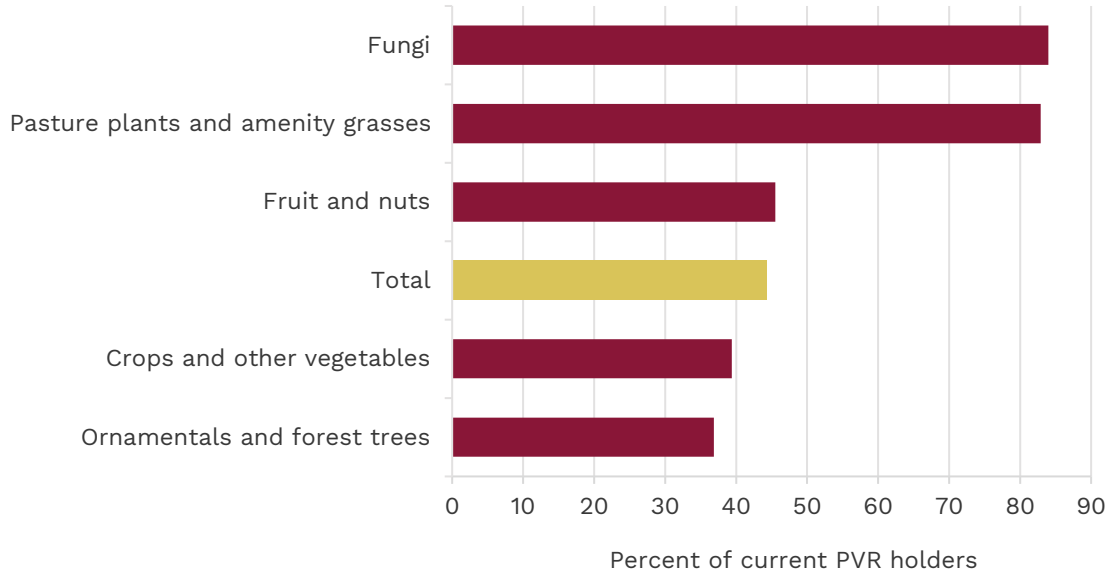
1.3.1 Domestic and international shares

Plant breeding is a global undertaking, and like other forms of innovation, clusters of innovation exist for different plant types in different regions. For instance, the Kiwifruit Breeding Centre based in New Zealand is at the frontier of kiwifruit breeding research globally. New Zealand's membership in the UPOV system allows us to benefit from the development of new cultivars being undertaken overseas through trade. Similarly, New Zealand earns export revenue from exports of domestically developed cultivars.

Overall, 44 percent of applications for granted and in force PVRs were made by domestic applicants, but there is variability in this by plant type, as Figure 1.3 shows. Fungi (84 percent) and pasture

plants (83 percent) had the highest share of domestic applicants. New Zealand has one of the best pasture breeding programmes in the world, and much of the farmlands grow locally bred cultivars that are specially bred to suit the local climate, soil, and animal being farmed. Slightly under half (46 percent) of all PVR applications for fruit and nuts came from domestic applicants. Of the overseas applicants filing for protection in New Zealand, the largest number come from the United States of America (USA), Canada, Australia, the United Kingdom (UK), and France. New Zealand imports plant material for a number of cultivars of apples, various types of berryfruit and summer fruit, and cherries from these countries. The domestic share of applicants for crops and vegetables was just under 40 percent as domestic breeding of these plants is limited. For example, there are no domestically bred cultivars of tomatoes. Ornamentals and forest trees had the lowest share of domestic applicants at 37 percent. These included cultivars of roses, lavender, lilies, tulips, and other flowers and trees.

Figure 1.3 Domestic applicant share of granted and in force PVRs



Source: Plant Variety Rights Office

2 Economic and public good value of PVRs

As with any form of innovation and intellectual property (IP) protection, IP systems should always balance the protection and enforcement of such rights with public interest considerations. IP systems have the power to shape the entire ecosystem of innovation and the markets for these end products. Therefore, it is crucial for public versus private benefits to be balanced and fair. PVRs provide exclusive control over the production, marketing, and distribution of the protected cultivar for a specified period, usually 20 to 25 years. This protection mechanism enables the generation of private benefits (incentives) for those, in this case plant breeders, who generate this potential for public good. The way in which PVRs translate to public good is through an implied 'contract' between the state and the PVR holder, in which the plant breeder is obliged to share the benefits of their innovation with society a whole (Wyatt, Moore & Boyle, 2019). This is clearly stated as one of the purposes of the PVR Act 2022: "to promote innovation and economic growth in New Zealand by providing incentives for the development and use of new plant varieties while *maintaining an appropriate balance between the interests of plant breeders, growers, and others so there is a net benefit to society as a whole*."

2.1 Why is plant breeding undertaken?

The forces that drive innovation of new plant cultivars are complex and vary depending on the type and use of the plants in question. According to Jördens (2010) the raison d'être of plant breeding is to respond to the challenges of a changing world. The needs and preferences of the individual consumer, the primary sector, and those of society as a whole all play a role in determining what innovation looks like. Advances in plant breeding, combined with other technological advancements in agricultural systems, offer new opportunities to further improve the efficiency of agriculture and horticulture while reducing its environmental footprint, and enriching human diets with more nutritious foods.

After the Second World War, there was a huge focus on improving yields to provide enough food for a rapidly growing population. As a result, agricultural policies were geared towards increasing productivity and yield per hectare and unit of labour (Lammerts van Bueren, Struik, Eekeren & Nuijten, 2018). The development and introduction of high-yield cultivars during this time allowed the tripling of cereal yields while the global area of cultivation remained relatively unchanged (Zsögön, Peres, Xiao, Yan & Fernie, 2022). The technology transfer from the developed to the developing world, known as the Green Revolution, contributed to improving food security, reducing poverty, and improving incomes for those who adopted these new technologies. Plant breeding played a crucial role in this revolution by responding to the needs of society during that time.

The challenges of today look quite different to those of the 20th century. The focus on higher productivity and yields placed a high demand on inputs such as freshwater, nutrient rich soil, fertilisers, and pesticides. This turned out to become a huge ecological burden. Water levels were depleted, the contamination of water and soil increased, and fertiliser and pesticide use was associated with a range of environmental and health risks. Today, consumers, growers, breeders, and policymakers are cognisant of the negative externalities associated with agriculture and horticulture. The need to reduce emissions and minimise our impact on the environment is

becoming clearer to us. At the same time, it is important to be able to feed a growing world population. By 2050, the global population is estimated to reach 10 billion people. New Zealand's population is also growing and, by some estimates, will reach six million by 2050.

Given that breeding to commercialisation is a long process, taking up to two decades in the case of some plants, the plants being developed today must meet the needs of the future. The dual, and sometimes opposing, goals of increasing yields while minimising their ecological footprint are some of the key societal outcomes for plant breeding today. The role of the PVR system is to shape the innovation ecosystem, regulations, and incentives for breeders in such a way that innovation efforts are aligned with these societal goals.

From the perspective of the plant breeders we engaged with, the potential for a return on their investment was almost always cited as a key motivator for investing in the process of breeding new and improved cultivars. This is by design, and is vital for a well-functioning IP protection mechanism. An effective PVR system generally only results in the development of new cultivars where there is the potential for commercial gain. This is because breeders are able to capture some of the economic value that new cultivars create through licensing fees and royalties. Breeders invest a vast amount of money and time into the research and development process that leads to the creation of new cultivars. Returns from this process are not always guaranteed and depend on the successful commercialisation. Thus, breeders are concerned not with the recovery of the costs of breeding individual cultivars, but with the recovery of research and development costs more generally. Building scale and specialised knowledge over time is important to improve efficiency in the breeding process, and this can only be achieved if the gains from commercialisation are large enough to cover breeding, trialling, and cultivar introduction costs.

The incentives for breeders themselves are indirectly determined by the market. Ultimately breeders themselves are responding to multiple needs – those of the consumers, manufacturers, exporters, and growers. In the case of apple breeding in New Zealand, for example, from the growers' perspective, access to land is becoming more difficult and costs of production are going up. For New Zealand's apple industry to be internationally competitive, growers need to be able to produce more fruit on the same amount of land while also keeping costs low. This means that breeders have to continually develop new breeds of apples that have high yield and high productivity. At the same time, they must also be less prone to diseases, so that growers can minimise losses to pests and diseases. Sustainability and resilience are also important traits that growers are starting to prioritise. The immense loss and damage from the flooding in Hawke's Bay in early 2023 highlighted this need. It is becoming more and more important for trees to be able to survive in those environments. Thus, from the grower angle, these evolving genetics must be able to handle changes that are both environmental and economic. For consumers, new cultivars can have improved taste, appearance, size, nutritional content, and other functional benefits. This meets consumers' changing demands and preferences.

2.2 Economic benefits

The success of intellectual property rights such as PVRs, and the level of public good that such rights result in, depends on several contextual factors. Maskus (2000) noted that according to economic theory, intellectual protection standards, such as PVR, could play either a positive or negative role in fostering overall growth. In the European Union (EU), the additional value added (contribution to GDP) generated by PVR-protected crops amounted to nearly €13 billion, of which €7.1 billion was for arable crops, €1.1 billion for fruit, €2.2 billion for vegetables, and €2.5 billion for ornamentals (European Union Intellectual Property Office and the Community Plant Variety Office of the European Union, 2022). Additional production of such crops translated into higher employment in the agriculture sector. The arable crops sector employed 25,000 additional workers as a result, the horticulture sector 19,500, and the ornamentals sector 45,000 additional workers, for a total direct employment gain of almost 90,000 jobs. A study on the economic benefits of Australia's PVR system showed that the collective turnover of Australian PVR-owning firms over five years old was AU$13 billion, with 78,000 full-time people employed.

In New Zealand, most PVR protected cultivars for all plant types are considered to be higher value than non-protected ones. This is because they are able to generate higher premiums in the market because of their recognition and/or because they have a real or perceived superior quality.

This translates into higher returns for growers, IP managers, and breeders. The commercial success of a cultivar allows growers to expand production and employ more people generating employment in the regions. These returns are also shared with industries that provide inputs to these businesses. For example, the building of larger packhouses and storage facilities, higher demand for transport services and utilities, and wider marketing and brand management. Further down the chain, the fresh produce industry is vital for the growth of the food processing sector. For instance, domestic processors such as McCain and Bluebird use domestically grown potatoes to produce their products, generating further employment, export revenue, and income for their other suppliers.

All of this is reinvested back into the New Zealand economy. The participants pointed out that without PVR protection, growers may still be able to survive in good years, but the higher returns from PVR protected cultivars creates another layer of economic benefits for growers that otherwise would not exist. The potential for economic gains from apple and pear breeding continues to increase. Fourteen new apple and pear cultivars have been commercialised through Prevar Limited.

For breeders, the security that PVR protection provides, and the opportunity to earn returns that comes with this protection, forms the basis for further investment and expenditure. Once the decision to commercialise a cultivar has been made, breeders obtain PVR protection. Having this PVR protection means that the cultivar can be confidently progressed through the supply chain and can be marketed.

PVRs may also be used in conjunction with trade marks to maximise the value from commercialisation. Registering a name as a trade mark may afford the owners the exclusive right to sell a cultivar under that name in perpetuity. For example, Jazz, Envy, and Pink Lady are all trade marks used in the commercialisation of protected apple cultivars 'Scifresh', 'Scilate', and 'Cripps Pink' respectively. A trade mark can be a particularly powerful brand building tool in cases where the trade mark is accepted by customers who rely on the name as an indicator of consistent quality.

Taking the example of Rockit apples, a brand has been developed around the cultivar 'PremA96'. Global marketing campaigns have grown the brand and helped build loyalty and increased consumers' willingness to pay. IP owners and managers use the 20-25 years of PVR protection they have to develop their brand. Once PVR expires, the cultivar can continue to generate profits for the IP owners and managers based on brand recognition.

2.2.1 Economic benefits for growers

In a recent study, Di Fonzo, Nardone, Fathinejad and Russo (2019) examined the impact of PVR regulations on agri-food value chains (AFVC) by conducting a survey of kiwifruit producers in Italy. The research revealed that producers of protected kiwifruit enjoyed higher returns on their investments and bore less risk than others. This is because breeders must give growers highly profitable contract terms in order to elicit the production and to promote the adoption of the new cultivar. Thus, growers were found to be capturing a share of the value of innovation. Results from engagement with local industry players indicated that these effects were also observed domestically, particularly in industries where the potential for commercial gain is especially high. A World Intellectual Property Organization (2006) report highlighted the success of PVR-protected rice cultivars developed in the Philippines, which have been licensed to other countries, resulting in the widespread adoption of new cultivars and increased rice productivity. Furthermore, the report discussed how PVR has stimulated the development of fresh fruit and vegetable cultivars, leading to enhanced productivity and profitability for growers.

PVR protected cultivars of all plant types are generally of a higher value than non-protected cultivars. One reason for this is simply that they perform better than older, unprotected cultivars. Breeders are, therefore, able to command a higher price for cultivars that may be resistant to pests and diseases, are able to produce higher yields, and are more visually uniform and appealing. But, having a better performing cultivar is only one part of the entire formula for commercial success. IP managers spend hundreds of thousands of dollars on developing a brand around cultivars with the potential for commercial success. For example, it can cost upwards of $100,000 in just marketing costs to get a new brand of potatoes onto supermarket shelves; this excludes the cost associated with growing, harvesting, packaging, shipping, and distribution. The combination of obtaining trade mark and PVR protection helps create unique and distinctive products that stand out from generic offerings. Once a brand has been established, and customer loyalty around that brand grows, consumers' willingness to pay also increases as a result of perceived value and exclusivity. Thus, retailers are able to extract higher prices from consumers, translating into bigger profit margins. Growers of these cultivars are able to share in these higher returns and earn a premium for higher-value cultivars. For example, in the case of potatoes, a grower can earn between 10 to 15 percent higher returns on protected cultivars, and in the case of flagship brands with high loyalty, the premiums can be as high as 40 percent. For apples, the premium on protected cultivars is generally over 30 percent. In the case of unprotected cultivars, growers compete more strongly on price, which drives down their own returns and margins as a greater share of the market is captured by those who can offer the lowest prices.

2.2.2 Support for other industries

Plant breeding activities play a role in advancing the productivity and performance of sectors other than fresh food. For instance, pasture and forage crops are a key, but often ignored, input that underpins the dairy, wool, meat, and livestock industries. The economic impact of these plants derives significantly from their on-farm usage as an input to the livestock industry, rather than as a traded commodity. Thus, their inherent value lies in improving outcomes for the highly valued primary sector. In Australia, these sectors collectively represented more than $32.4 billion of output in 2019-2020 (Australian Bureau of Statistics, 2021). The Australian Seed Federation (2022) estimated that in 2021, $2.98 billion in farm-gate value from the major livestock industries could be attributed to annual pasture seed.

The $20 billion livestock industries in New Zealand depend on the arable sector as the source of seed for pastures, grain, and silage for complementary animal feed. In New Zealand, ryegrass and clover dominate the forage seed industry. The development of new and improved cultivars is underpinned by intensive investment in plant breeding by the public and private sectors. The goal of these breeding programmes is to embed built in technological advancements into the seed to grow high quality pasture for dairy cows.

New Zealand's international competitiveness and profitability of the livestock industries is closely linked to innovations in pasture seeds and fungal endophytes. The genetic improvements that have taken place in these plant species have been one of the most essential factors in improving the long-term productivity of livestock industries. New Zealand has climatic zones that are distinct from those of Europe, and is also faced with a unique spectrum of pests. Domestic breeding programmes have been extremely successful at developing cultivars of pasture and fungal endophytes that are tailored to suit a particular farm system, climate, soil type, and pests. Farmers are able to select unique combinations of pasture and endophytes that match their particular farm. This improves their productivity and efficiency. Research participants who develop these new cultivars highlight that without PVR protection, there would be no incentive for their research and development activities. As a result, the ongoing breeding activity in this space would come to a virtual halt. Given that new cultivars help farmers remain productive and profitable, and support the wider agricultural sector and rural economy, the performance of these sectors would be significantly impacted in the long-term.

Locally grown potatoes form the pillar of the potato processing industry in New Zealand. Over 72 percent of all harvested potatoes are processed into products such as chips, French fries, and hash browns. According to estimates from some key industry players, over half of the cultivars used as inputs are protected. The food processing sector is exposed to international competition, which means that productivity improvements are highly valued and are crucial to remain competitive. Participants in the potato processing industry said that it is vital for them to get access to the same, or better, cultivars as their overseas competitors to remain in business. The specific characteristics the industry values and seeks to improve on include:

- Crisping potato cultivars have low sugar content, which prevents the overbrowning of bagged chips
- French fry potatoes are bred to be long so they can be easily cut into fries

- Higher yielding cultivars allow processors to produce more output for lower input costs
- More sustainable and resilient cultivars use fewer inputs, also contributing to minimising costs
- Cultivars that store better can be used in the summer season when there is a gap in the availability of fresh harvests.

Without continuous access to the newest and most advanced cultivars, the domestic food processing industry would not be able to remain competitive at a global level. This would also mean that the gap in supply would have to be increasingly filled in by international manufacturers, reducing self-sufficiency. The final price paid by consumers would also be likely to increase as these products would have to be increasingly imported, with the added cost of shipping. Further down the chain, there would be a detrimental impact on other domestic firms that provide supporting services to the local food processing industry. This includes firms that provide services such as marketing and distribution, energy supply, logistics and transportation, and packaging.

2.3 Public good benefits

2.3.1 Higher yields

One of the key focus areas for plant breeding is improving yields, i.e., to be able to maximise output per unit of land. Crop yields are determined by a mix of three key factors:

1. The underlying genes of a plant
2. The environmental conditions under which a plant is grown
3. The growing systems and management practices used during the production/growing process (Voss-Fels, Stahl & Hickey, 2022).

Improvements in yields through breeding are made via the first factor. But the yield of a specific cultivar can vary significantly based on the interaction of the three factors. Growing a cultivar in the right environmental conditions, and with the right supporting management systems is crucial to maximising yields. This is why successful yield improvements in one market do not always translate across regions, even in places with similar climatic conditions. Thus, for growers to be able to realise the incremental benefits offered by new cultivars often requires significant investments in the accompanying support systems.

The yield improvements that plant breeders have been able to achieve over the past few decades are considerable. According to Kolady & Lesser (2009) the implementation of plant variety protection attracted private investment in wheat in the USA and resulted in a higher number of high-yielding crop cultivars from both public and private sectors. Campi's (2017) research examined how strengthening IP protection affected agricultural productivity in various countries from 1961-2011. The study found a positive correlation between strengthened IP protection and cereal productivity in both high- and low-income countries, but not in middle-income countries. These findings suggest that the impact of IP protections is influenced by country-specific factors and there is no one-size-fits-all solution. Many studies have also indicated that the United States' Plant Variety Protection Act of 1970 led to growth in cotton and wheat yields (Kolady & Lesser, 2009; Naseem, Oehmke & Schimmelpfennig, 2005; Perrin, Kunnings & Ihnen, 1983).

A study conducted by Charity, Johann and Bingadzo (2019) examined the impact of strengthening intellectual property protection on wheat productivity and the release of new cultivars. The study used an intellectual property protection index to measure the strength of the IP protection systems, as well as the plant breeders' rights granted for wheat cultivars. The findings revealed that enhancing IP protection systems in South Africa led to an improvement in wheat productivity and the release of more wheat cultivars.

In the case of apples, the cumulative yield efficiency of rootstock has increased by nearly 80 percent since the 1990s.[1] For perennial ryegrass, the genetic gain in yield has been over 19 percent since 1990, averaging 0.76 percent per annum.[2] These improvements have been worth $15 to $20 per hectare every year, on average (Harmer, Stewart & Woodfield, 2016).

Some breeders are also starting to focus on breeding cultivars with extended harvest or flowering periods. Breeders of apples, pears, and kiwifruit are developing cultivars with extended harvest periods and/or shifting the harvest period. There are several flow on benefits of this. First, from the point of view of consumers, the fruit is available to enjoy for a longer period of time than was traditionally possible. From the point of view of the sellers, it provides an opportunity to fill gaps in a market. For example, having a range of apple cultivars with different ripening times allows sellers to capture demand during the “off-seasons”, while also providing a more consistent revenue stream during the year.

Domestic breeders of pastures have focused their efforts on improving performance and yields outside the spring season (Harmer, Stewart & Woodfield, 2016). Currently, the gains have been considerable in the winter (1 percent per annum), dry summer seasons (1.1 percent), and autumn (1.3 percent). These gains have partly been achieved as a result of better insect and pest resistance. According to participants we engaged with, all of these yield gains have been enabled by PVR. Technological improvements are happening at such a fast pace that if New Zealand did not have an internationally aligned PVR system, the domestic industry would be 20 to 25 years behind the curve on these gains since they would only be able to access these cultivars once protection overseas had lapsed.

2.3.2 Disease resistance

Natural resistance to diseases and pests has always been one of the leading areas of research in plant breeding. The role of this characteristic cannot be overstated and is a quality that is highly valued by growers. Smale et al. (2008) found that PVRs have encouraged the development of new wheat cultivars in India, leading to increased genetic diversity in wheat production. The study also found that PVRs have contributed to the development of more disease-resistant plant cultivars, resulting in a reduction in the use of pesticides and fungicides.

PVRs have contributed to the development of healthier and more resilient plants for domestic growers. Newer apple rootstocks are resistant to multiple pests and diseases like phytophthora

[1] Cumulative yield efficiency, expressed as kg cm^{-2}, is a commonly utilised metric that compares plants of different sizes to evaluate the long term yield efficiency effects of rootstocks, planting densities, training systems and growth regulators, over several years.
[2] Rate of genetic gain was defined as a regression over time of the series of best available cultivars, i.e., the first available (the incumbent), the next to be released that had better performance (which becomes the new incumbent) and so on; these were defined as ‘frontier cultivars’.

fungus, fireblight bacteria, and woolly apple aphid insects. These rootstocks are generally developed overseas and imported to New Zealand for use by domestic growers. Prior to the introduction of these rootstocks, farmers would use large amounts of neonicotinoid insecticides to kill the aphids living underground. This was not limited to apples. Neonicotinoid insecticides have been used to spray a variety of crops including kiwifruit, avocados, onions, potatoes, peaches, and nectarines. Neonicotinoids are some of the deadliest pesticides ever created. International research has shown that the use of these pesticides has exterminated, or resulted in severe defects in, populations of bees, butterflies, birds, fisheries, and even deer (Natural Resources Defence Council, 2022). Only about 5 percent of neonicotinoids get absorbed by the plants they are intended for, and the rest is estimated to remain in the soil for years. Rain and irrigation can carry neonicotinoids over large distances contaminating other plant and animal life, and water supplies. The development of plant cultivars that are naturally resistant to these aphids has reduced the need for these deadly insecticides to be used. Similarly, fireblight infestations, that have been known to wipe out significant portions of apple orchards, are no longer a risk thanks to naturally resistant rootstocks.

Domestic importers of rootstock and new plant cultivars were certain that without PVR protection, international breeders would not supply new cultivars to them. Industry participants cited examples of countries, such as China and India, that do not have robust systems for the protection of breeders' rights, where growers are unable to access new cultivars that have improved disease resistance.

Some of the benefits that come with high disease resistance include:

- Yield preservation: Diseases can significantly reduce yields and may even lead to complete crop failure.
- Food security: Disease resistant plants are less likely to be destroyed by such attacks. This contributes to stability in agricultural production, improving food security
- Reduced waste: Since the instances of infection are reduced, fewer crops are wasted as result of infestations
- Cost savings for growers: Since plants that are naturally resistant to diseases do not require as many chemical inputs, the need for frequent cop monitoring and management drops
- Environmental sustainability: Reduced reliance on chemical inputs results in a shift towards more environmentally friendly and sustainable agricultural practices.

Like new plant cultivars, diseases and pathogens can adapt and evolve over time, and are a constant challenge in the case of all plant types. Thus, developing disease resistant cultivars is an ongoing process. Collaboration between plant breeders, researchers, and growers allows research to remain ahead of the curve by identifying and transferring new resistance genes into commercial cultivars. For example, 70 percent of the new apple cultivars currently bred in New Zealand have some level of resistance to diseases.

2.3.3 Environmental sustainability

Environmental sustainability was cited as one of the biggest drivers of innovation in new cultivars by breeders and importers of all plant types. PVRs can support sustainable agriculture and horticulture

practices. Encouraging the development of plant cultivars with increased resistance to pests, diseases, and adverse environmental conditions, reduces the reliance on chemical inputs such as pesticides and fertilisers. This promotes environmentally friendly farming methods, reduces the ecological impact of agriculture and horticulture, and preserves biodiversity.

One of the factors that has pulled innovation in this direction has been policy in the European market. In this market, which is growing in importance for exporters of horticultural produce, there are regulatory requirements around sustainability and the carbon footprint of products being imported. New Zealand breeders recognise that to be able to continue to export to this market in the future, new cultivars must be able to meet the standards set by these authorities.

Environmental sustainability and resistance to fluctuating and adverse weather conditions is a big requirement for potato growers. The key things growers are looking for are cultivars that are resistant to the impact of climate change. Breeders are increasingly focusing their efforts on cultivars that require less water, are more drought tolerant, disease resistant, and require less nitrogen (fertiliser). Again, tougher regulations overseas are driving some of this innovation. For example, in the Netherlands, the government has severely reduced the amount of nitrogen farmers can use. This means that cultivars being planted now must have a stronger root system so they can source more nitrogen from the soil themselves without needing external nitrogen. Since the Netherlands is one of the hubs of potato breeding worldwide, sustainability has become one of the key focus areas in the journey to developing new potato cultivars.

Domestically, the pasture breeding industry is at the forefront of researching and developing new cultivars with traits that can improve sustainability in the agriculture sector. Apart from improvements in disease and pest resistance, which reduce the need for chemical inputs, breeders are exploring other ways to reduce the overall carbon footprint of the sector. For example, scientists are working on developing plants with deeper roots as a means to increase resistance to droughts. Research is also being undertaken to understand whether endophytes might be a potential way to influence the amount of methane produced during digestion of the pasture, and looking at ways to change nitrogen requirements for grass in order to reduce nitrate runoff. The Ecotain environmental plantain brand is used to market a mix of the formerly protected plantain cultivar 'Ceres Tonic' and the protected cultivar 'Agritonic', granted PVR in 2017. These cultivars are not only highly palatable to livestock, but they have also been shown to have significant impact in reducing nitrogen leaching in dairy farms. Lincoln University studies have shown a reduction in nitrogen leaching by 89 percent from the urine patch compared with ryegrass and white clover.

Since the last ice-age, humans have cleared a third of the world's forested land and two-thirds of wild grasslands to grow crops and raise livestock to feed a rapidly growing world population (Ritchie, 2022). Over the past few decades, there has been a decoupling of agricultural land and food production. In other words, food production continues to increase but global agricultural land use is falling. The productivity of growers and farmers has improved significantly, as outputs per hectare continue to grow. This means that the number of people that can be fed using the same amount of agricultural land is also increasing. For example, today, the world can produce almost three times as much cereal from a given area of land than it did in 1961. This has only been possible due to the vast improvements in crop yields. The selective breeding of high yielding cultivars, combined with better growing systems and more advanced farm equipment and technology have all contributed to

this. Continued efforts in breeding better quality and higher yielding crops will further diminish the need to clear protected land for agriculture and horticulture.

2.3.4 Collaboration in breeding

The capacity of the local system and institutions to develop and absorb new technologies is an important factor in determining the nature and size of economic and public benefits. Programmes such as technology demonstration projects, information sharing within industry, and improved linkages between government, academia, and the private sector can enhance benefits to society. This is known as the triple helix model of innovation, where research and development activities are jointly funded by the private and public sector. Carew (2017) examined the application patterns for PVR for horticultural crops in Canada and found that stronger intellectual property rights could promote greater private investment. Internationally, public-private-academic partnerships are common in countries that have a PVR system aligned with UPOV. In Kenya, accession to UPOV facilitated public-private partnerships for plant breeding extended beyond domestic borders. Breeders partnered with international research institutes and seed companies, leading to the emergence of new types of breeders. Similarly, in South Korea the PVR regime stimulated certain sectors of plant breeding, and new types of breeders such as individual rice breeders (farmers) as well as new university researchers.

New Zealand has successfully adopted the triple helix model of innovation in plant breeding. Plant & Food Research, in collaboration with other industry players, has established breeding programmes for kiwifruit and apples. For example, the Kiwifruit Breeding Centre is a joint venture between Plant & Food Research and Zespri. Plant & Food Research has significant capability and capacity for research and development, physical assets, and access to new and existing plant material. Collaborations with industry players allow for financial burdens to be shared, and ensures that breeding activity is aligned with market needs. The commercialisation of these cultivars is then undertaken by private sector players. In the case of apples, Prevar is a private joint venture between New Zealand Apples and Pears, representing growers, packers, and marketers of apples and pears; Plant & Food Research, which brings breeding capability; and Apples and Pears Australia Limited, which is Australia's peak industry body for apple and pear growers.

2.4 Benefits to consumers

2.4.1 Consumer choice and availability

PVRs have improved New Zealand's access to new and improved cultivars in two ways – by enabling trade in protected cultivars and by incentivising domestic breeding programmes. Both these channels have increased in the availability of a number of plants, which would not have otherwise been possible. For example, consumers have access to various types of potatoes, each of which has unique qualities that suit different cooking styles. The same is also true for other fruit and vegetable cultivars. Apart from improved choice in food, PVR has also enabled the breeding of ornamental cultivars tailored to the tastes and preferences of gardeners. Ornamental plants are incredibly diverse and include indoor and outdoor plants, flowering plants, shrubs, and native plants. In fact, the largest numbers of PVRs are granted to ornamentals, highlighting the importance of the

system in improving the choice available to buyers. For ornamental breeders, improving the health and beauty of these plants, for consumers to enjoy, is a key goal of breeding new cultivars. Some of the benefits that come with breeding newer cultivars of flowering plants include better flowers, more evenly shaped leaves, and a higher possibility of fragrance. Moreover, newer cultivars also do not need to be sprayed with pesticides as often and are more disease resistant, minimising spending on such inputs.

Plant breeding has also contributed to the extension of the traditional periods during which a particular plant may have been available for consumers to enjoy. This has been enabled by the PVR system through a number of channels. First, New Zealand imports cultivars from overseas breeders to fill gaps in the domestic harvest season and also as producers of fruit for counter season export markets. Second, breeders have developed cultivars that can be harvested and/or grown out of the traditional growing and harvesting period. For example, roses traditionally flower once a year for around six to eight weeks during spring or early summer. Newer rose cultivars have repeat flowering patterns and can bloom multiple times during the growing season. These cultivars can have up to five flowering cycles a year. This is a highly desirable characteristic since the value of ornamentals is strongly linked to their visual appeal. A rose plant that can flower more times a year amplifies the benefits the plant offers to those who grow it, and those who sell it, as well as those who derive value from viewing it.

Breeders are able to segment consumers and breed cultivars for specific purposes. This has also resulted in health benefits for consumers, or groups of consumers. Apple breeders are working on developing high-energy cultivars that can be successful substitutes to high-sugar foods and snacks such as chocolates and protein bars. Other types of crops are being bred for high nutritional content, such as enhanced levels of antioxidants and beta-glucan. Moreover, improvements in disease resistance play an important role in minimising food safety concerns and can help reduce levels of mycotoxins caused by fungal infections.

The ability to commercialise a cultivar and develop a brand around it has contributed to more consistent products. This means that a greater priority is placed on the quality of outputs. PVRs also help maintain a sustainable supply chain by ensuring growers adhere to minimum standards for the cultivar. This allows for a more consistent experience for consumers.

2.4.2 Food security

PVRs contribute to global food security by facilitating the development of high-yielding, disease-resistant, and climate-resilient plant cultivars. These improved cultivars help farmers produce more food per unit of land, ensuring an adequate food supply for all. Additionally, breeders can focus on enhancing nutritional qualities, addressing specific dietary needs, and developing crops suitable for specific regions, thus improving public health.

Food insecurity encompasses the inability to access adequate food calories and undernutrition, which can be caused by food and non-food reasons. A study conducted jointly by the European Union Intellectual Property Office and the Community Plant Variety Office of the European Union (2022) found that additional production brought about by plant variety innovations were sufficient to feed an additional 57 million people world-wide for arable crops, 38 million people in the case of

fruit, and 28 million people for vegetables. Consumers are able to enjoy a higher level of food security as access to cultivars has improved. Gains in yield improvements and better resistance to diseases and pests have improved resilience and reduced the instances of crop failures. Moreover, there is also a focus on breeding cultivars with better nutritional value.

2.5 PVRs and trade

Internationally aligned and accepted plant protection mechanisms, such as PVR, play an important role in eradicating barriers to trade in plant cultivars, increasing domestic and international market scope. A study by Minyu, Sheldon, and Jihyun (2018) explored the influence of IP rights protection on field crop seed imports from the USA. Through the use of the Heckman selection and Poisson fixed-effects panel econometric methods, the study found that countries that are members of both UPOV and the TRIPS Agreement of the World Trade Organization tend to import more field crop seeds from the USA. A study conducted by Galushko (2012) analysed the impact of IP rights on seed exports from the USA. Using a Heckman selection model, the study found that the influence of these rights differs based on the type of crop being exported. While TRIPS provisions are significant for facilitating the transfer of genetically modified crops, they have a minor effect on open-pollinated and hybrid crops. Additionally, the study revealed that plant breeders' rights aligned with the 1991 UPOV Convention can be essential for promoting seed exchange if proper enforcement mechanisms are in place.

In another study, Awokuse and Yin (2010) examined the effects of IP protection on China's imports, both at an aggregate level and in detail, for various product categories for both developed and developing nations. The empirical results revealed that heightened IP protection encourages China's imports, particularly for knowledge-intensive products.

2.5.1 Export revenue

The government's Food and Beverage Industry Transformation Plan (ITP) identifies three major drivers that are shaping transformation in the global food and beverage industry: climate change, consumer preferences, and technological progress (Ministry for Primary Industries, 2022). The ITP identifies that these drivers can be a source of competitive advantage and that New Zealand can embrace change and deepen its competitive position in the food and beverage sector globally. Consistent with the feedback from stakeholders, the ITP notes that this means utilising the drivers of change, rather than remaining vulnerable to them. The government has put an emphasis on transforming the sector from being seen only as a global provider of dairy and meat commodities, to being recognised as a global leader in environmental excellence, providing both traditional and emerging foods that are high-quality and nutrient-rich.

The vision is for a transformed sector that will deliver more value per output produced that will lift productivity, deliver high wages, and promote a low emissions future. It will also limit our reliance on particular sectors or markets by creating a broader, more evolved export portfolio, with offerings for a wider consumer base capturing value from new markets.

PVR plays an important role in the development of new cultivars for export markets, as well as enabling domestic producers to be part of the network of global trade in plant cultivars. As the

participants mentioned, New Zealand has high costs of production and is not a scale producer, and is unlikely to ever be a scale producer in the horticulture space. Our geographical disadvantage in terms of size and distance from large markets is also a major constraint when it comes to generating potential for the export of perishables. For New Zealand to be competitive in the global market exports have to be able to compete on higher quality, and must be able to draw out a higher price and value, rather than competing on quantity.

Apples are a good example of a plant category with a rapidly growing export market, and an area in which we are building a competitive advantage. 'Royal Gala' and 'Braeburn' are examples of old cultivars that highlighted the export potential of the fruit. These cultivars had unprecedented commercial success for decades. Participants from the apple industry believe that PVR has been the backbone of success for the industry over the past decade. Without PVR, the industry would not have been able to develop sustained competitiveness at a global stage. According to the World Apple Review (Belrose Inc., 2018), much of the innovation in apple cultivars globally over the past two to three decades has been undertaken in New Zealand. New Zealand was placed number one in the world on the international competitiveness rankings for global apple production. The PVR system has undoubtedly been one of the biggest enablers of this innovation. A commercialisation strategy, where vertical integration has been key, has enabled New Zealand apple exports to compete against lower-priced products internationally.

Another channel through which PVR ensures sustainability of export revenue is by enabling specialisation. Our breeding programmes for plants such as kiwifruit, apples, and grasses are recognised as being world class and plant material is exported to growers overseas. New Zealand breeders of pasture plants such as ryegrass and clover are part of an innovation cluster in the Canterbury region, researching and developing some of the best pasture seeds in the world. For instance, New Zealand produces 50 percent of the world's white clover seed (Foundation for Arable Research, 2023).

Being able to breed specific cultivars for specific markets and/or conditions is also another way plant breeding helps maximise export revenue for New Zealand. For example, there are apple cultivars that have been bred specifically to suit the preferences of consumers in Asian markets in terms of their taste and colour profiles. For example, consumers in Asian markets have a strong preference for bright red apple cultivars. A Plant & Food research developed cultivar, 'HOT84A1', was bred specifically for planting in hotter climates, such as in Spain, while also being able to develop a bright red colour as these sell for a premium in Asian markets. According to Plant & Food Research, developments such as these are important for New Zealand to be able to maintain its reputation as leader in the breeding of new apple cultivars that can be grown worldwide and sell for a premium price.

2.5.2 Imports

Being a member state of UPOV also means that New Zealand is better able to import cultivars that have been bred overseas, as well as genetic material required to establish new cultivars in New Zealand. Without PVR, not only would the domestic breeding of plants of economic significance to New Zealand reduce significantly, imports of the latest cultivars would also collapse. This is because overseas rights holder of protected cultivars would not be willing to send their material, or

agree to licensing arrangements with domestic growers, in the absence of the PVR system as the risk of losing control of their IP would be too high.

For growers, being able to import overseas cultivars opens the door to new markets. For example, apple growers propagate overseas cultivars that have been tested and proven to be commercially successful with consumers in markets outside New Zealand. So, if there are cultivars that have established themselves in the USA and Asian markets, growers obtain licenses to grow these domestically to export. This is a particularly successful strategy since growers are able to fill in gaps in these markets, offering counter seasonal supply. For example, the 'Honeycrisp apple, a cultivar developed in the USA, is also the most popular cultivar in that market. It sells for approximately three times the price of any other cultivar the USA. Growers in New Zealand plant and harvest it in orchards domestically and then export it back to the USA. Participants estimated that close to 60 percent of the value of sales is returned to growers in the form of profits. This is a high value model for growers that has been fully enabled by PVR.

2.6 Technological improvements

2.6.1 The development of new cultivars

Investing in the research and development of new cultivars of plants can open the door to new export markets and products. The soybean industry in the USA has particularly benefitted from PVR, with innovative developments in new soybean cultivars that are higher-yielding and exhibit better disease resistance. The International Seed Federation (ISF) conducted a thorough survey on generating value in the soybean chain through royalty collection, which supports the positive impact of PVR in promoting innovation. Soybeans were originally cultivated in Asia, but today, the United States, Brazil, and Argentina collectively produce approximately 80 percent of the world's soybeans. Soybean is the most widely planted biotechnological crop globally. The introduction of glyphosate-tolerant soybeans (RR1) in 1995 paved the way for the breeding of the RR1 gene into numerous soybean cultivars. In Argentina, the United States, Paraguay, and other countries, nearly 100 percent of soybean cultivation involves RR1 soybeans (Bergadá et al., 2016).

In the June 2023 Situation and Outlook for Primary Industries (SOPI) (Ministry for Primary Industries, 2023), strengthening PVR protection was noted as a key strategy to diversify our export base. Plant and Food Research is currently undertaking research and trials to establish the potential for growing dragon fruit as a new crop. A production trial is being undertaken at the Kerikeri research Centre to investigate the level of climatic adaptation, agronomic requirements, and economic feasibility of the idea. If successful, this would open the door to a completely new area where export competitiveness could be developed on a global stage.

Various types of berries are another emerging area with significant export potential. Plant and Food Research and VentureFruit have co-invested in the development and breeding of a range of berries such as raspberries, boysenberries, blackberries, blueberries, and hybrid cultivars. For example, research is being undertaken to breed larger, tastier blueberries that are also disease resistant and have higher yields for growers.

2.6.2 Domestic breeding

The mechanism that PVR provides to protect new cultivars, and the potential to commercialise these cultivars forms the basis for the existence of the domestic breeding industry. This has been observed internationally in several other countries. In Argentina, the number of domestic breeding entities increased with UPOV membership, particularly in the private sector for soybean and wheat (World Intellectual Property Organisation, 2006). Similarly, in Poland, the number of commercial breeding entities increased, as did the number of new and improved cultivars being introduced to the market. In China, commercial breeding activities in public research institutes and seed companies grew.

From engagement with domestic breeders, it is clear that without the PVR scheme, domestic breeding activity would be severely jeopardised. The vast majority of breeders felt that without the PVR system, and therefore the lack of a robust mechanism that enables protection and commercialisation, their breeding activities would no longer be economically feasible. While genetic improvements are important motivators for plant breeders, it is equally important to be able to earn a financial return to enable further investments into research and development activity. While other options like trade marks and patents do exist, they are not designed for the protection of new plant cultivars. Thus, in isolation, they do not provide the same safeguards that PVR does, both domestically and internationally. Therefore, only PVR is able to provide breeders with the level of appropriability needed to consider their investment in plant breeding worthwhile.

2.6.3 Technology transfer

Under the UPOV Convention, all breeders in all member countries of UPOV enjoy the same level of protection, at a minimum. Thus, effective plant variety systems that are aligned with UPOV play an important role in removing barriers to trade in cultivars. This is crucial for the transfer of technology and for trade to take place. PVRs provide breeders with an incentive to disclose information about their new cultivars. This knowledge sharing enables collaboration between breeders, scientists, and farmers, leading to the exchange of valuable agricultural information and the advancement of breeding techniques. Such collaborations can accelerate agricultural progress, improve crop productivity, and benefit the public at large.

Breeders are willing to send their material overseas when they can be assured that their IP will remain protected, and that they will earn a return from any commercial gains. Similarly, having internationally comparable protections allow domestic breeders to gain access to new genetic material being developed overseas.

Some of the key aspects of technology transfer that are enabled through a system of plant variety protection include:

- The incentivising of innovation
- Access to genetic material
- Learning via dissemination of best practices
- The adoption of new and improved cultivars by growers and farmers, enabling productivity growth

- The encouragement of collaboration between researchers domestically and across borders.

Domestic breeders and importers confirmed that being a part of the UPOV system has been hugely beneficial to the local economy through being able to benefit from innovation happening overseas. Breeders are able to get access to the latest plant material being developed overseas to build on previous innovations. Moreover, not every plant type is bred in New Zealand. Thus, for domestic consumers and other users of plant cultivars to have access to the newest and most efficient plants, a PVR system that is aligned UPOV has been vital. The agents and importers responsible for bringing new material into the country highlighted that without PVR overseas breeders would not have the confidence to send their innovations to New Zealand. This is because there would be no mechanism for them to track how and where their IP is being used, and thus, their ability to capture economic gains from the sale and use of this material would be uncertain.

2.7 Would these benefits still exist without PVR protection?

The economic and public good benefits outlined in the preceding sections result directly from investments into plant breeding and research. It is clear that these benefits are realised through the intentional efforts of plant breeders, who develop and test thousands of cultivars to successfully attain the traits valuable to society now and in the future.

Industry participants were of the view that the existence of PVR provided growers with the confidence to try out new cultivars. If there was no protection available on new cultivars being developed, then cultivars with potential for commercial success would be free for every grower to use. This would significantly erode growers' margins, limiting the multiplier effects of additional funding to flow through the rest of the local and national economy.

For breeders, the role of the incentives that PVR protection creates cannot be overstated. As one breeder noted, when control over a plant cultivar is lost it can cripple a business or even an entire industry that depends on the revenue streams that PVR enables. Stakeholders we spoke to were clear that a strong PVR protection regime is essential for New Zealand to continue to support domestic breeders in developing new cultivars, and to provide confidence for international breeders to allow their new cultivars to be imported and grown in New Zealand. Without PVR protections, New Zealand would likely see a reduction in the number of cultivars, domestic and international, available to growers. This would lead to New Zealand failing to gain the benefits that come with improved cultivars, and over time this would have long term impacts on food supply and the export competitiveness of our primary industries.

3 The economic value of the PVR system to New Zealand

The primary sector is one of the main pillars of the New Zealand economy. PVR underpins the performance of New Zealand's primary sector by incentivising technological improvements that lead to better performance, higher productivity, and lower costs, resulting in higher returns for the sector. The food and fibre sector alone contributed 10.7 percent of New Zealand's GDP in 2021 (Ministry for Primary Industries, 2023). This sector also provided employment to around 359,000 people in the year ending March 2021, accounting for approximately 13 percent of the total workforce of the country (Ministry for Primary Industries, 2023). In 2022, the export revenue generated by the primary sector amounted to $53.1 billion, equalling 81.4 percent of New Zealand's total merchandise exports (Table 3.1).[3]

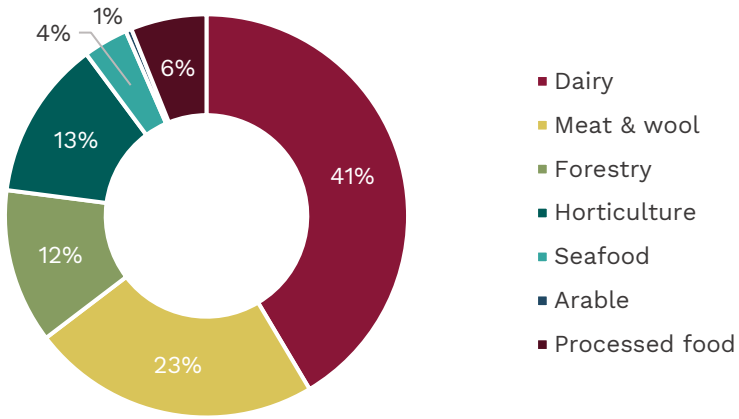
In 2022, dairy exports alone generated a revenue equal to $22 billion, accounting for 41 percent of the value of New Zealand's total primary sector exports, as shown in Figure 3.1. Additionally, meat and wool products also contributed significantly, with export revenue equal to $12.3 billion during the year. The productivity of both these industries depends heavily on the breeding activity in the pasture and arable seed industry, as detailed in the preceding sections.

Horticulture exports grew by 91 percent between 2013 and 2022, making it the fastest growing primary sector export over the period. Horticulture exports were valued at $6.8 billion in 2022 and accounts for 13 percent of primary exports. This has seen horticulture surpass forestry as New Zealand's third largest primary sector export industry.

Despite its export value being surpassed by horticulture forestry remains a significant primary export. In 2022 forestry exports were $6.6 billion. Although the value of forestry exports grew by 45 percent between 2013 and 2022 growth of exports in other industries meant forestry's proportion of primary sector exports fell from 14 percent in 2013 to 12 percent in 2022.

The arable industry remains the smallest primary sector export industry. The $252 million exported in 2022 accounted for 1 percent of New Zealand's primary sector exports.

Figure 3.1 Export structure of the primary industries in 2022, by value



Source: Stats NZ

[3] Export values are all free on board (FOB). That is the value of goods at New Zealand ports before export.

Table 3.1 Food and fibre sector export revenue 2007-22 (Year to 30 June, NZ$ million)

	2007	2013	2016	2018	2020	2021	2022
Dairy	7,848	13,139	13289	16,655	20,135	19093	21,998
Meat & wool	6,774	7,793	9,200	9,542	10,678	10,391	12,310
Horticulture	2,646	3,546	5,000	5,392	6,555	6,622	6,782
Forestry	3,648	4,527	5,140	6,382	5,539	6,531	6,578
Processed food	1,546	2,015	2,714	2,709	3,006	3,112	3,226
Seafood	1,312	1,546	1,768	1,777	1,855	1,772	1,919
Arable	110	229	210	243	290	260	252
Total	23,884	32,795	37,321	42,700	48,058	47,781	53,065

Source: Stats NZ

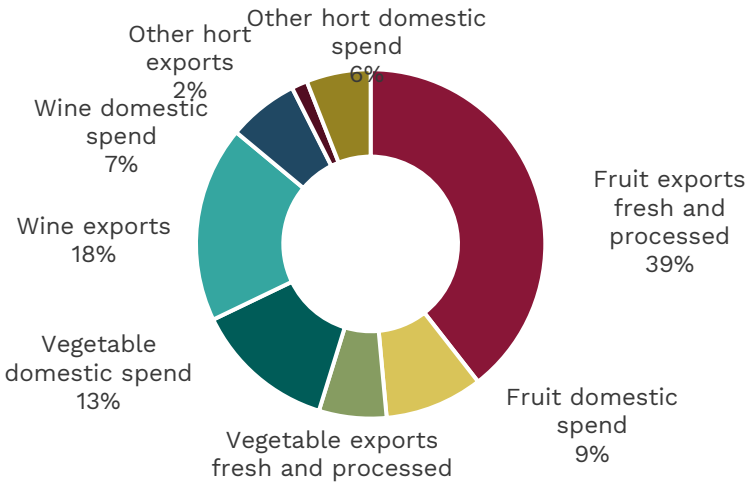
In this section, we highlight the economic value of the PVR regime on New Zealand's kiwifruit, apple, and vegetable industries, the arable sector, and ornamental plants to illustrate the ways in which PVR contributes to improved performance, international competitiveness, and productivity of the primary sector industries.

3.1 Horticulture

The growth of significant parts of New Zealand's horticulture industry has been, and will continue to be, underpinned by PVR. As identified earlier, New Zealand's food and fibre industry transformation plan is focused on growing high value exports while maintaining New Zealand's reputation for quality and environmental performance. This requires increasing yields in conjunction with better quality products that meet the changing needs of consumers, while minimising environmental impacts.

In 2021, the value of production from New Zealand's horticultural industries was estimated to exceed $10 billion. As Figure 3.2 shows, 48 percent of production was fresh and processed fruit (39 percent fresh and processed exports and 9 percent domestic spend), 19 percent was vegetables (6 percent fresh and frozen exports and 13 percent domestic spend), and 8 percent was other horticultural products (2 percent exports and 6 percent domestic spend). Wine made up the remaining 25 percent.

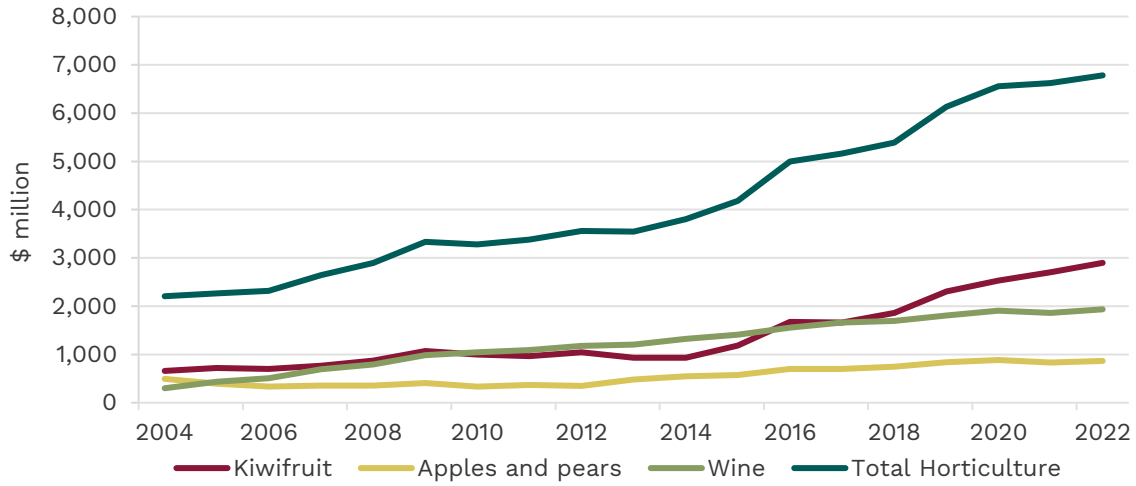
Figure 3.2 New Zealand horticultural production by destination, 2021



Source: Stats NZ

New Zealand's horticulture exports have a global reputation for high quality and high value products. As Figure 3.3 shows, horticulture exports generated $6.8 billion in export revenue in 2022. This was equal to 13 percent of total merchandise export revenue. Our dominant horticulture exports are kiwifruit, wine, and apples. While not as significant as fresh fruit exports, fresh and processed vegetables such as frozen and dried vegetables also generate significant export revenue.

Figure 3.3 New Zealand fresh horticulture exports trend ($million)

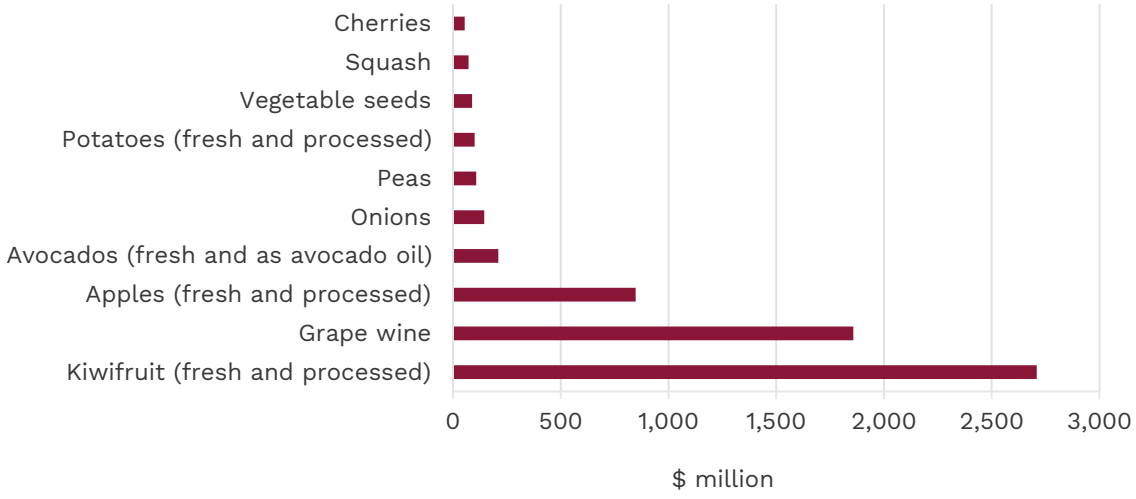


Source: Stats NZ

Kiwifruit and apples are New Zealand's most valuable exports that have PVR protection, accounting for 55 percent of total export value in 2022 (

Figure 3.4). Kiwifruit alone accounted for 43 percent of total export value from the horticulture sector in 2022. The revenue generated by kiwifruit exports was 33 percent greater than that of the second largest export, grape wine, and over three times the size of apple exports.

Figure 3.4 Horticulture exports in 2022 ($ million)



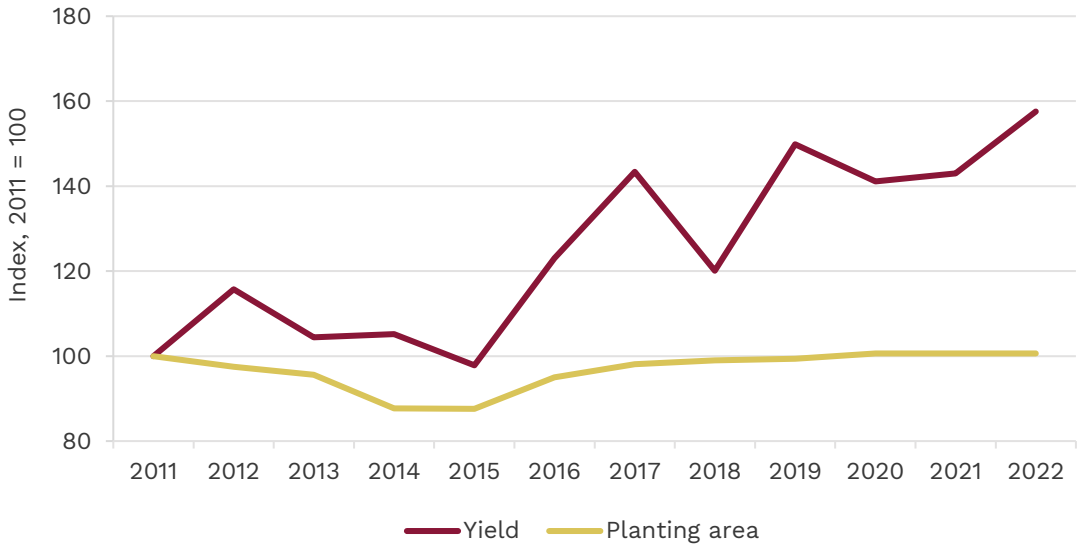
Source: Stats NZ

3.1.1 Kiwifruit production and exports

The kiwifruit industry is the most significant and commercially important sector in New Zealand's horticulture industry. In the year ending June 2022, approximately 2,843 growers grew 12,905 productive hectares and produced around 184 million trays. Kiwifruit growing contributed $723 million to GDP and employed over 6,000 full time equivalent employees (FTEs) during the year.[4] The industry also supported 38 packhouses and 65 cool stores (New Zealand Horticulture Export Authority, n.d.).

Figure 3.5 shows how yields have grown compared to planting area since 2011. The values for 2011 have been indexed to 100 to highlight comparative growth rates. Although the planting area has remained roughly the same since 2011, the yields per hectare have grown by almost 60 percent during this period. This highlights the improving efficiency of the industry, partly reflecting technological developments created through new and improved cultivars created through investment in the breeding process.

Figure 3.5 Kiwifruit planting area and yield growth 2011-2022



Source: New Zealand Horticulture Export Authority

In 2022, kiwifruit exports generated $2.9 billion in export revenue, making it the country's most significant single horticulture export in terms of both volume and value (Ministry for Primary Industries, 2023). As Figure 3.6 shows, kiwifruit continues to achieve increased returns per tonne exported. Although the number of growers and planting area has not increased greatly, the yield of kiwifruit has significantly improved, as high-yield and disease resistant cultivars, particularly PVR protected cultivars such as 'Zesy002' (marketed under the trade mark SunGold), have contributed to improved performance for the sector. An estimated 58 percent of exported fruit by volume is produced by protected cultivars. The share of PVR protected exports of kiwifruit by value is approximately 70 percent. This is because the 'Zesy002' cultivar is able to earn a higher price in export markets compared to older cultivars. Of the $2.9 billion worth of export revenue generated

[4] BERL Local Authority Database.

by kiwifruit exports in the year to March 2023, a total of $2 billion is attributable to PVR protected cultivars (Stats NZ, 2023).

New Zealand has 7,771 hectares of productive land dedicated to growing Gold3 (including organic). In Zespri's 2022/23 financial year, these hectares produced 96.4 million trays. The market performance of Gold3 has been very strong, and as a result Zespri released an additional 400 licensed hectares in 2016, 400 hectares in 2017, and 750 hectares in 2018, 2019, and 2020. In 2021, Zespri released licences for 700 hectares of 'Zesy002' and 50 hectares of Organic 'Zesy002'. The growing share of Gold3 of total kiwifruit grown in New Zealand is contributing to the improving yields per hectare.

Figure 3.6: Kiwifruit export value and volumes

Source: Stats NZ

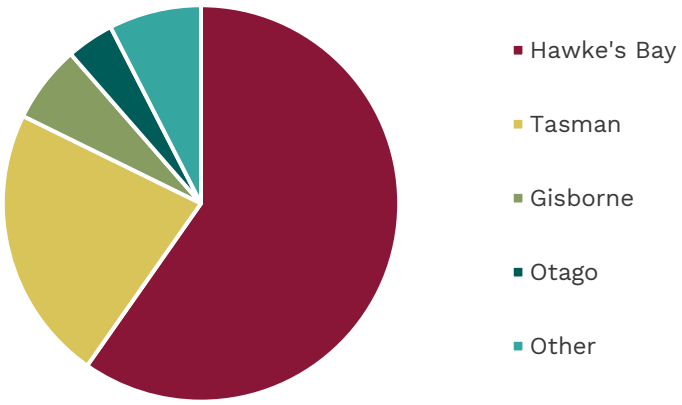
3.1.2 Apple production and exports

New Zealand's apple industry is growing fast and is becoming increasingly more internationally competitive. Apple and pear growing in New Zealand contributed $639 million to New Zealand's GDP in 2022 and employed over 5,300 FTEs.

The most recent World Apple Review from 2018 showed that New Zealand had the highest apple productivity in the world in terms of output by land area (Belrose Inc., 2018). New Zealand's apple production was 61 tonnes per hectare, followed by South Africa at 41 tonnes per hectare. The global average was just 23 tonnes per hectare. Research participants from the apple industry in New Zealand pointed out that older cultivars consistently produce between 30 to 60 tonnes a hectare, but newer cultivars that are protected by PVR are significantly more productive, with many being able to produce over 120 tonnes of fruit per hectare. This increase in efficiency has been aided by investments to improve growing systems. Growers and post-harvest operators are investing in technologies and practices such as new orchard production and training systems (for example narrow, well supported hedge row systems), picking platforms, hail netting, use of reflective mulch, and modern fruit sorting systems.

Figure 3.7 shows the apple growing regions in New Zealand. Sixty percent of the total production area for apples is in Hawke's Bay, followed by Tasman (22.5 percent), and Gisborne (6 percent). Thanks to these efficiency gains, an increasing share of the total production area is being planted in cultivars that have PVR protection. Currently, over 50 percent of the total production area is planted in domestic or international cultivars with PVR protection. This has increased from just 20 percent over the past decade.

Figure 3.7 Apple growing regions

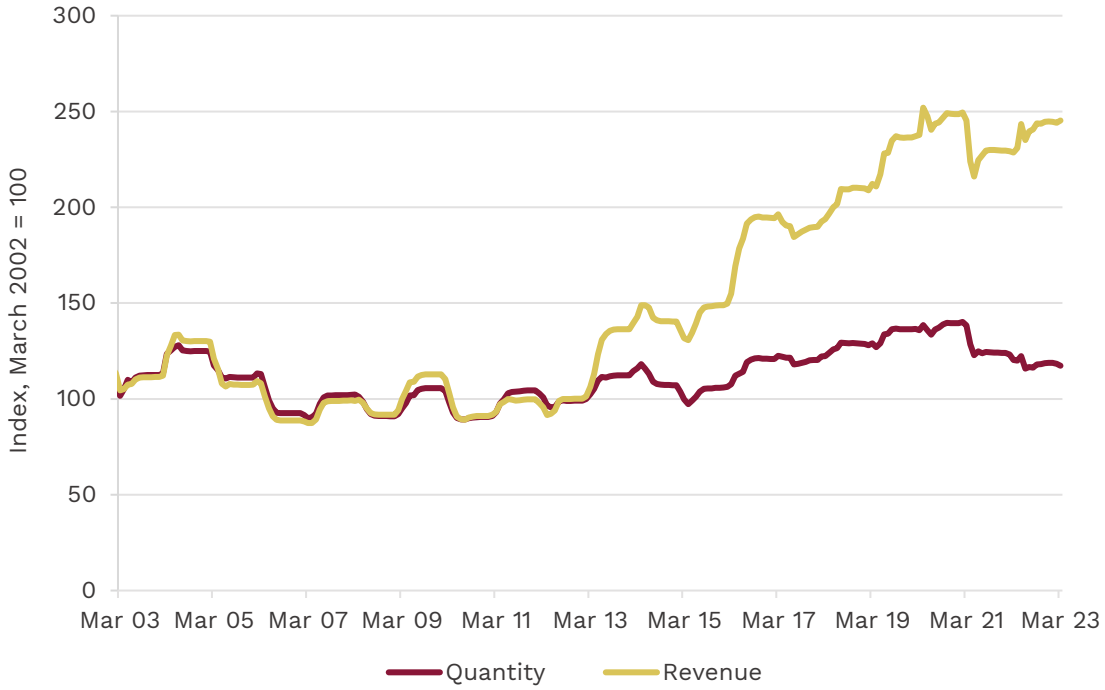


Source: Stats NZ

In recent years, New Zealand has expanded its apple exports by introducing new apple cultivars that better meet the demands of consumers and the market. 65 percent of the New Zealand apple and pear crop is sold to export markets. Another 13 percent is sold fresh domestically and the rest is processed. The export revenue for apples and pears was $865 million for the year to June 2022, accounting for 13 percent of total horticulture export revenue. In 2022, New Zealand ranked fourth in the world in terms of apple exports, by value, accounting for over 9 percent of global apple exports. In terms of production volume, it ranked 23rd in the world. The fact that New Zealand is ranked significantly higher on export values compared to domestic production highlights the high-value nature of New Zealand apples. Moreover, since the domestic market is relatively small, much of the domestic production can be exported to higher value markets to be sold at a premium. New Zealand apples are exported to 66 countries. The top five markets for exports are China, Vietnam, Taiwan, the EU (excluding the UK), and the USA. Free Trade Agreements are expected to continue to improve access to overseas markets. For instance, tariffs on apples have effectively been removed in the UK market since the NZ-UK FTA came into force.

A quarter of all exports are domestic cultivars bred by Plant & Food Research, and six of the top 10 export apple cultivars were bred here in New Zealand. These cultivars generated an estimated total of $216.3 million in export revenue during the June 2022 year. PVR protected cultivars bring higher prices than traditional cultivars like 'Braeburn' and 'Royal Gala', which formed the majority of the industry's production 15 years ago. Although the quantity of apples exported over the past two decades has remained relatively stable, there has been a notable increase in export revenue, particularly since 2013 (Figure 3.8).

Figure 3.8 Apple and pear exports ($ million), year ended June



Source: Statistics New Zealand and MPI

Export revenue from apples and pears is projected to continue to increase once the impacts from the flooding start to recede. This will most likely be driven by a larger focus on growing for Asian markets, and an increase in the uptake of newer, more productive and profitable PVR protected cultivars. Growers are replacing older cultivars such as 'Braeburn', 'Cox', and 'Gala' with newer New Zealand-bred cultivars like 'PremA96', 'Scilate', and 'PremA129'. This is reflected in the average export price for apples and pears, which, as Figure 3.9 shows, has more than doubled since 2010.

Figure 3.9 Average export price for apples, NZ$ per kilogram

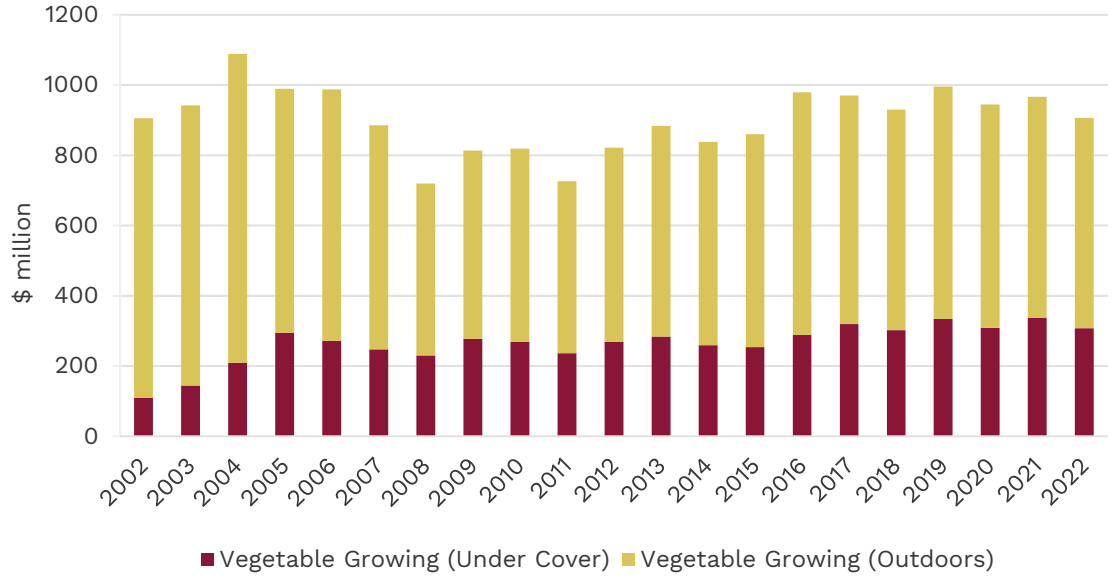
Source: Stats NZ and MPI

3.1.3 Vegetables

The vegetable growing industry (indoors and outdoors) has remained relatively stable over the past two decades. In 2022, these industries generated $907 million in GDP, with $599 million (66 percent) being generated by the outdoor vegetable growing sector. Potato growing uses the largest share of outdoor land for vegetable growing, followed by onions, and then buttercup squash.

Around 70 percent of vegetable seed grown in New Zealand is protected under PVR. Assuming value generated by the sector is proportional to this, PVR protected cultivars contributed approximately $635 million to the domestic economy.

Figure 3.10 GDP generated by vegetable growing



Source: Stats NZ, BERL analysis

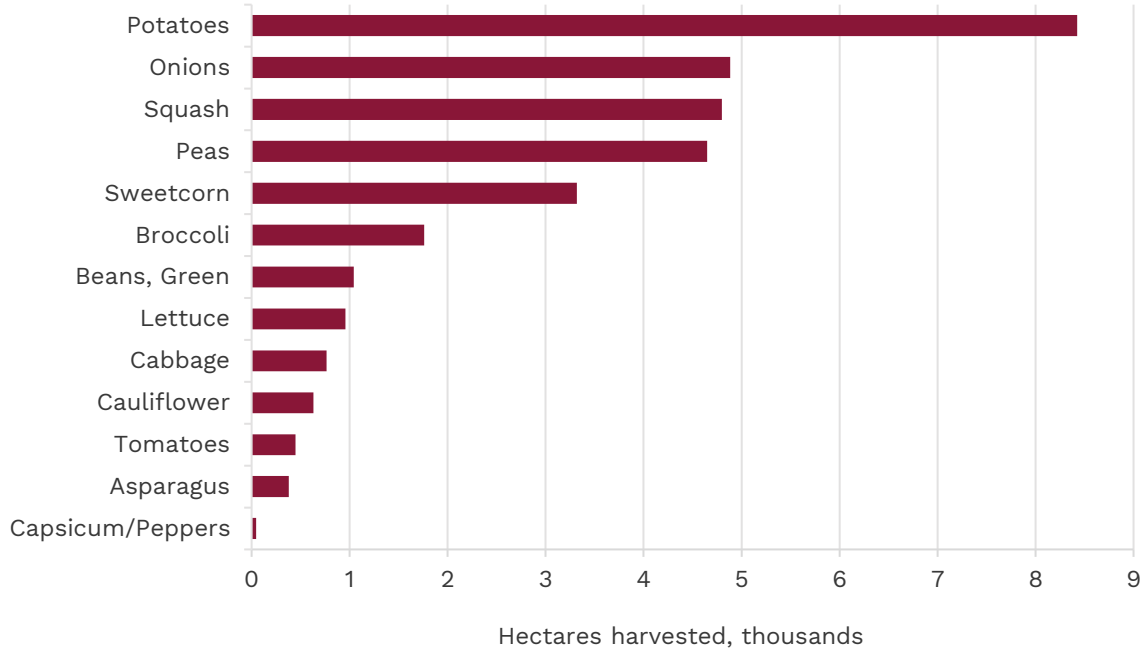
Exports

Much of the production of fresh vegetables is either consumed domestically or processed into frozen vegetables or other vegetable products. Exports of fresh and processed vegetables equalled $622 million in the year to June 2022, making up 9.2 percent of all horticultural exports (Ministry for Primary Industries, 2023). The top markets for these exports were Australia (29 percent), Japan (19 percent), and Fiji (7 percent). Fresh vegetables are not a major export commodity. In the year to June 2022 fresh vegetable export revenue, which includes onions, squash, capsicum, and potatoes was $231 million. Processed vegetable exports, including frozen vegetables (including frozen potatoes, peas, sweetcorn, etc.), dried vegetables, dry legumes, prepared and/or preserved vegetables, and vegetable juices were valued at $391 million in 2022.

Potatoes

Potatoes accounted for the largest area of harvested land of any vegetable in 2022 (Figure 3.11). This was followed by onions, squash, peas, and sweetcorn. Potatoes are grown all over New Zealand. Canterbury (50 percent), Auckland (15 percent), and Waikato (14.6 percent) were the top three growing regions in 2022. The New Zealand-wide production equalled over 450,000 tonnes.

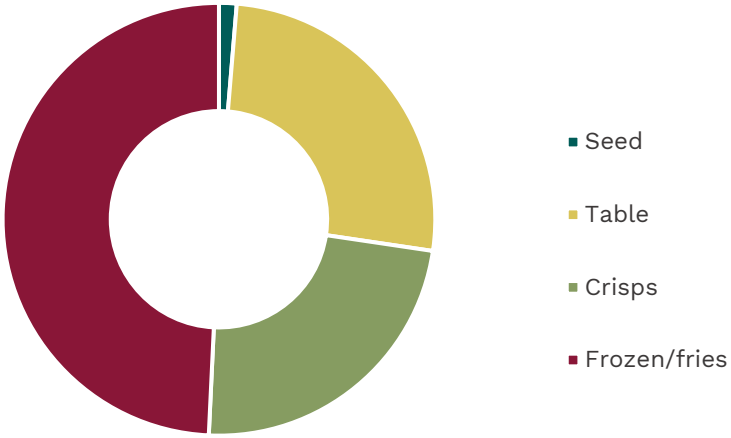
Figure 3.11 Area of vegetables harvested in New Zealand



Source: Stats NZ

According to the latest available data from Potatoes NZ, the potato industry generated a revenue of $1.1 billion in 2021. This value is generated by four main segments within the potato industry: seed, table, crisps, and frozen/fries. Table potatoes are intended for use by households in the preparation of food at home. This segment accounts for just over a quarter (26 percent) of the value of the industry (Figure 3.12). The sale of seed potatoes account for just 1.3 percent of the total value of the sector. According to industry estimates, around 80 percent of potatoes grown by large growers is protected under PVR. Going by these estimates, the sales of PVR protected cultivars in the seed and table potato segments was equal to $240 million.

Figure 3.12 Potato segment share of industry value, 2021



Source: Potatoes New Zealand

The crisps and frozen/fries segments process potatoes grown in New Zealand into other products for domestic and international customers. These segments generate the most value. Nearly half of the entire value of $1.1 billion was generated by the frozen/fries segment, while the crisps segment generated just over 23 percent of the value. It is estimated that over 50 percent of the output of the processing segment is created using PVR protected cultivars. Thus, over $398 million of the revenue generated by the processing sector can be attributed to PVR protected cultivars.

Consequently, of the $1.1 billion of revenue generated by the potato sector, a conservative value of $637.3 million can be attributed to cultivars currently protected under PVR.

3.2 Arable crops

The arable industry is a vital part of New Zealand's primary sector. Traditionally, the arable industry focused on production of cereal crops (wheat, barley and maize) and rye grass seed but in recent years, to optimise profitability and productivity, the industry has diversified to include production of other cereal grain crops, specialist small seed and vegetable crops, forage brassicas, and seed for multiplication. New Zealand's weed, pest, and disease free status means that our arable farmers are world leaders in seed production for multiplication onto the international market.

Arable production, by definition, is anything that is grown and harvested as a crop. This includes all grains, all seeds, and certain other plants which are grown as crops. In 2021 the arable industry had sales of just over $1 billion, directly contributed $399 to national GDP, and directly supported the employment of 3,548 FTEs (BERL, 2021).

The grains produced by the arable sector are used to produce beer, bread, cakes and biscuits, along with many other goods we enjoy. Maize silage produced by the arable sector, and grains sold to livestock farmers, contribute to the production of other primary products including milk, meat, and eggs as the source of seed for animal pastures, and grain and silage for supplementary animal feed. New Zealand's arable farmers grow more than 40 different grain and seed crops, with some farmers having up to 20 crops on their farm in a single year.

The arable sector can be split into two distinct parts: grains and pulses, and seeds for sowing. Grains and pulses include crops such as maize, wheat, and barley. Seeds for sowing include grasses, legumes, brassicas, and other crops. Vegetable seeds are included in seeds for sowing.

Over 2.2 million tonnes of grains and pulses were sold in 2021. Maize, wheat, and barley accounted for the highest shares of sales. The vast majority of these crops are used as feed for animals. However, a small proportion is also milled or processed for human consumption.

The total value of these sales equaled $740 million, with a GDP contribution of $293 million (BERL, 2021). The industry also employed a total of 2,600 FTEs in the 2021 year. Stakeholders estimated that 90 percent of the grains and pulses seed sold are protected by PVR. This means that the estimated value of PVR protected sales equalled $666 million in 2021, and the GDP generated by these sales directly added approximately $264 million to the New Zealand economy in 2021.

The second part of the arable industry comprises seeds for sowing. The total sales value of these seeds was $267 million in 2021. Close to half (47 percent) of this was earned from the sales of grasses such as ryegrass and clover. The second largest share was generated from the sales of brassicas (22.5 percent), followed by non-brassicas (18.4 percent). These sales generated GDP of $106 million for the New Zealand economy in 2021, and created employment for 942 FTEs.

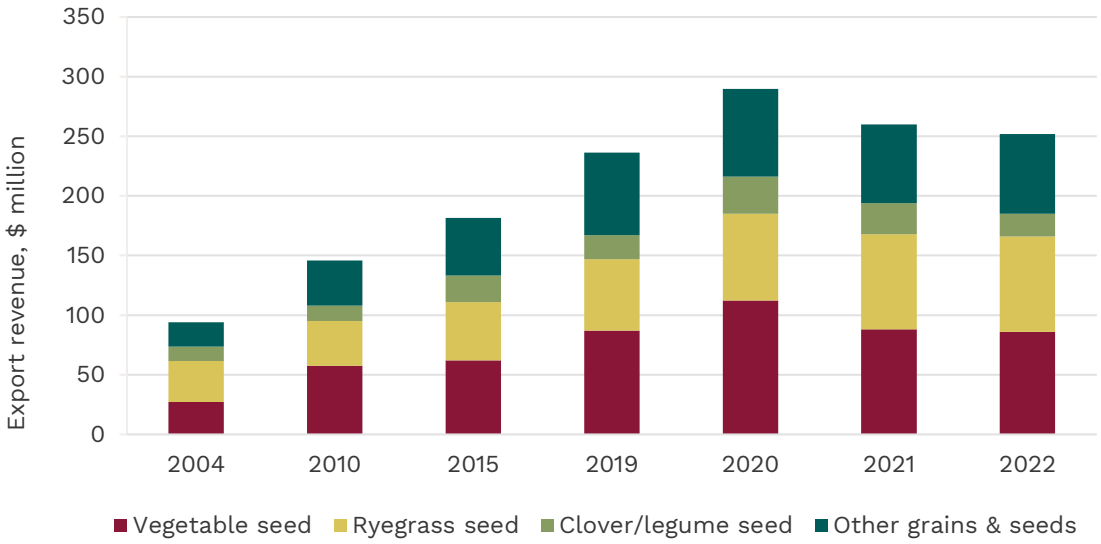
According to industry estimates, approximately 95 percent of pasture seed and 10 percent of vegetable seed sold is protected by PVR. Thus, the value of sales from the sale of PVR protected cultivars was $134.5 million in 2021. These sales directly contributed $53.4 million to the economy in the same year.

In total, the arable sector is estimated to have earned a total revenue of $874.5 million from the sale of PVR protected seeds. These sales contributed a total $346.4 million in GDP to the New Zealand economy.

Exports

In 2022, total arable exports equalled $252 million. Vegetable seeds accounted for the largest share (34 percent) followed by ryegrass seed (32 percent). Assuming the same PVR coverage as above, we estimate that PVR protected cultivars would account for at least $162 million, or 64.3 percent, of total arable exports.

Figure 3.13 Exports of arable seeds

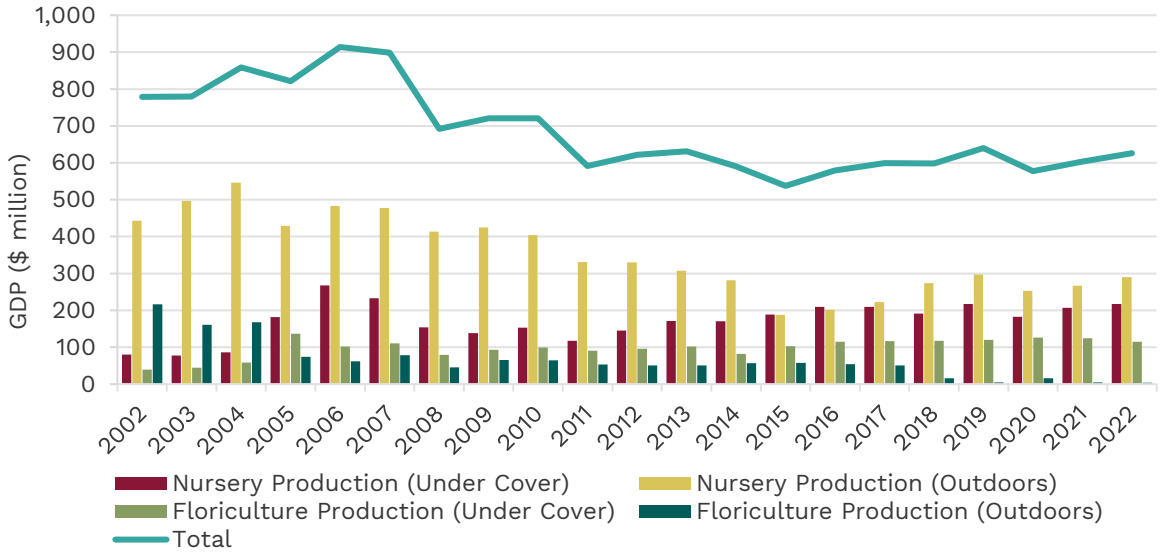


Source: Stats NZ and MPI

3.3 Ornamentals

The ornamentals industry is declining in New Zealand. In 2022, the nursey production and floriculture production industries generated a total of $626 million in GDP. In 2002, these industries generated a GDP of $779 million, a 20 percent drop. The outdoor floriculture production industry experienced the biggest decline over this period, shrinking by 98 percent. The primary activities in this industry include outdoor flower growing and display foliage growing. The indoor and outdoor nursery production industries have remained relatively stagnant over the past few years. Nursery production includes propagating and/or growing plants such as bulbs, seedlings, and vine stocks. This category also includes fruit tree nursery operations.

Figure 3.14 GDP generated by ornamental production



Source: Stats NZ and BERL analysis

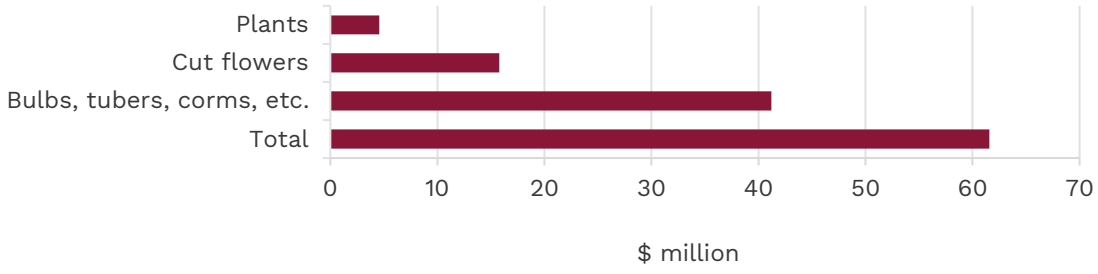
Ornamental breeders, rose breeders in particular, were the first to start using PVR in New Zealand. Ornamental plants are still the most protected plant type – In 2022, 66 percent of all PVRs granted in New Zealand were for ornamental cultivars. However, the number of granted and in force PVRs in this category is on a decline, having peaked in the early 2000s. For example, the rose industry has diminished significantly over the past few decades. Only a handful of professional breeders in New Zealand still use PVR to earn commercial returns. It is estimated that the number of rose plants grown today are just a tenth of what was grown 20 years ago. Approximately 300,000 rose plants are grown every year, with about half being protected by PVR. Breeders earn royalties per plant sold, regardless of how successful propagation is. The royalties are generally around 8 to 10 percent of the value of the plant. A gradual drop in demand from consumers is partly to blame. Factors such as urban densification and a saturated market have contributed to this. This means that the commercial viability, and thus the need to protect new cultivars, is falling.

Exports

In 2021, New Zealand's exports of cut flowers, plants, and bulbs, tubers, and corms equalled just over $60 million. The bulk of exports were *Lilium* and tulip bulbs. There are currently 41 protected cultivars of tulips, all of which are held by breeders based in the Netherlands. In 2022, the global exports of ornamentals[5] were valued at $37.8 billion. The export market for ornamentals is dominated by a handful of countries, including the Netherlands (50.6 percent of global exports), Italy (5.7 percent), Germany (4.4 percent), and Ecuador (4.4 percent).

New Zealand's share in exports equalled just 0.1 percent. Growers in these top export markets operate on a much larger scale than New Zealand growers. New Zealand breeders are unable to compete with the large scale breeding that happens overseas, and they cannot create the economies of scale that would make them globally competitive. For example, Wyatt, Moore, and Boyle (2019) noted that rose-breeding nurseries in New Zealand range between one and five hectares in size, compared to hundreds of hectares in the case of overseas rose farms. The report also noted that New Zealand tends to be a second mover in the international ornamentals market, with the sector being driven by international trends and tastes. New Zealand's distance from key markets, such as the USA and Europe, is also a barrier for exporters of cut flowers. These need to be transported in a temperature controlled environment, in cold chain storage, and cut flowers lose approximately 15 percent in value per extra day in the supply chain (Mamias, 2018).

Figure 3.15 Ornamental exports by type, 2021



Source: Stats NZ and Fresh Facts

[5] Live trees and other plants; bulbs, roots and the like; cut flowers and ornamental foliage.

Ratnayake (2016) summarises the key factors that have led to a gradual decline of the industry in New Zealand, which has resulted in the decline in the number of PVR applications. First, in the early 2000s, competition from low cost international growers in Asian markets started to grow, which led to intense price competition and deteriorated the ability of New Zealand exporters to command high prices for their products. Thus, returns to exporters fell drastically. As year-round products such as roses, lilies, and chrysanthemums lost their competitiveness internationally, growers either downsized to supply the domestic market, or exited the market altogether. The domestic market for ornamentals is relatively small, and did not have the capacity to absorb supply, resulting in further exits. Moreover, these days, domestic market supply is dominated by big box retailers that operate on low profit margins, driving out smaller players who cannot operate at such low costs. Cut flower exports in particular have dropped drastically over the past two decades. These exports generated $46.2 million in revenue in 2000. By 2010, this had dropped to $35 million, and by 2021 exports were only worth $15.8 million.

3.4 PVR case studies

3.4.1 Kiwifruit and innovation

Kiwifruit seeds were first brought into New Zealand from China by Isabel Fraser, in 1904. In 1927, Hayward Wright bred a cultivar of kiwifruit known as 'Hayward'. By the 1960s, Hayward became the standard cultivar of exported kiwifruit around the world and now makes up 90 percent of the world production of kiwifruit (New Zealand Kiwifruit Growers, 2022).

Since 1975, 62 applications have been made to register kiwifruit cultivars, making it the 15th most common plant species. There are currently 14 granted cultivars, of which nine are held by Zespri or Plant & Food Research. Three are owned by other New Zealand based breeders, two are owned by Chinese breeders, and one by a breeder from Greece. An additional 12 applications have been filed, with three cultivars from a New Zealand based breeder, Baker PVR Ltd, and nine from overseas applicants.[6]

New Zealand's first gold kiwifruit cultivar, 'Hort16A', was developed by the New Zealand Kiwifruit Marketing Board (later renamed Zespri) in partnership with Plant & Food Research and was released to growers in 1995. 'Hort16A's' gold flesh and sweet taste provided a significant change from 'Hayward'. It was exported for the first time in 1998, quickly becoming popular thanks to its sweet taste, and nutritional benefits.

In November 2010 the vine bacterial disease Psa-V was found in New Zealand and had a devastating impact on 'Hort16A'. Coincidentally, at that time Zespri and Plant & Food had been exploring potential new cultivars for more than a decade and a new gold cultivar, 'Zesy002' was licensed with a small number of our New Zealand growers. Highly resistant to Psa-V and with greater nutritional benefits, greater yield, longer storage, and greater consumer preference than 'Hort16A', 'Zesy002' played an important role in the recovery of New Zealand's kiwifruit industry. Today, 'Zesy002' has become a multi-billion-dollar product. Zespri owns the rights to 'Zesy002' and authorises growers via a hectare licensing mechanism. Zespri's PVR protection for 'Zesy002' expires in 2039.

[6] New Zealand PVR register.

After more than 10 years of development, in 2019 Zespri commercialised its first red kiwifruit cultivar. 'Zes008' (marketed under the trademark RubyRed) offers vibrant red flesh, temptingly sweet berry-like flavour, and nutritional benefits that set it apart from its red and green counterparts and provides an alternative for consumers.

As of June 2023, Zespri exports the following four cultivars of kiwifruit, three of which have PVR protection:

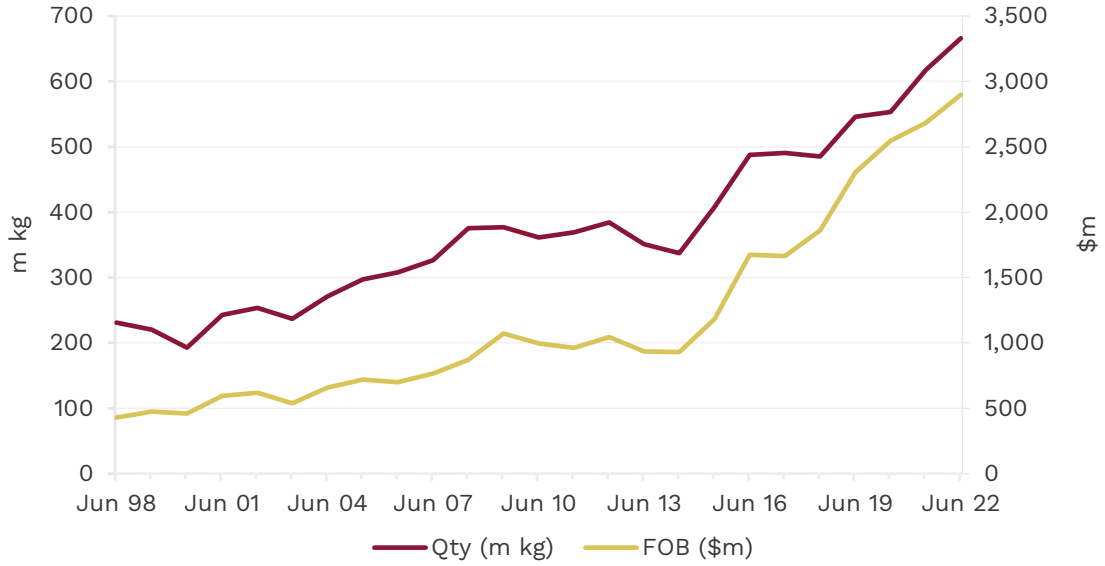
- Zespri Green ('Hayward')
- Zespri SunGold ('Zesy002')
- Zespri SweetGreen ('Zesh004')
- Zespri RubyRed ('Zes008')

With the protection of overseas PVR schemes, Zespri has close to 5,000 hectares of planted 'Zesy002' kiwifruit in the northern hemisphere. The partnerships it has with growers and suppliers in Europe support Zespri's 12-month supply strategy which aims to ensure kiwifruit remains in stock all year round, retaining its shelf space in export markets, and supporting efforts to build the brand.

With the introduction of Zespri's gold cultivars, New Zealand's kiwifruit exports have soared and returns to growers have increased. In 2022/23 New Zealand exported 158.7 million trays to countries other than Australia. Of these almost 61 percent by volume were protected cultivars. Because of the demand for 'Zesy002'. and Zespri's ability to manage global supply due to its PVR protections, alongside initiatives including investment in the brand, sales and marketing, and a commitment to and quality and, it provides the greatest returns to growers. Orchard gate returns for 'Zesy002' were $137,524 per hectare compared to $57,636 for green kiwifruit in the 2022/23 season (Zespri Kiwifruit, 2023). This was a down year for the industry because of fruit quality issues driven by labour shortages resulting from pandemic border restrictions.

As Figure 3.16 shows, since 'Hort16A' was introduced in 1998, the annual volumes of New Zealand's kiwifruit exports have increased by 205 percent, and the value has increased from $439 million in the 12 months to June 2018 to $2,898 million in the 12 months to June 2022. The impact of the introduction of 'Zesy002' is also visible. After a period to establish the new cultivar there was a spike in the value of kiwifruit exports which grew by 42 percent from 2015 to 2016. This growth then continued with export values increasing by an average 12 percent per annum from 2016 to 2022.

Figure 3.16 New Zealand kiwifruit exports 1998-2022 (June years)



Source: Stats NZ

As a global leader it is vital that New Zealand's kiwifruit industry continues to innovate to remain ahead of competition. The Kiwifruit Breeding Centre (KBC) was formed in 2021 as a joint venture between Plant & Food Research and Zespri. The establishment of the KBC builds on a 30-year shared history in kiwifruit breeding, and will focus on new cultivars with high quality taste, nutrition, and sustainability characteristics that deliver new cultivars to meet the demands of consumers, improve outcomes for growers, and enhance efficiencies in the supply chain. Given the 20-to-25-year lead time to develop new cultivars, this includes growing trials in Northland to replicate climates expected in current kiwifruit growing regions by 2060.

3.4.2 Wheat and food security

Wheat is a cereal widely cultivated for its seed, a cereal grain which is a staple food around the world and was first cultivated around 9600 BC. A wheat grain consists of 83 percent white flour, 14.5 percent bran, and 2.5 percent wheat germ. Globally, it is the leading source of vegetable protein in human food (NZ Flour Millers Association, n.d.).

There are currently 21 granted and in force cultivars of common wheat in the PVR register, of which 10 are from New Zealand applicants. There are also two new applications filed from New Zealand breeders. A further 48 cultivars have been surrendered, with 22 from New Zealand breeders. Cereal cultivars have a four-to-five-year longevity, meaning that the surrendered cultivars were likely surpassed by superior cultivars before the full PVR period had passed but are still being grown in New Zealand.

The importance of wheat in New Zealand's food security was highlighted during the COVID-19 pandemic when up and down the country flour shelves emptied. This was consistent with other disruptive events in human history - war, drought, pandemic – which have all included food limitations and shortages.

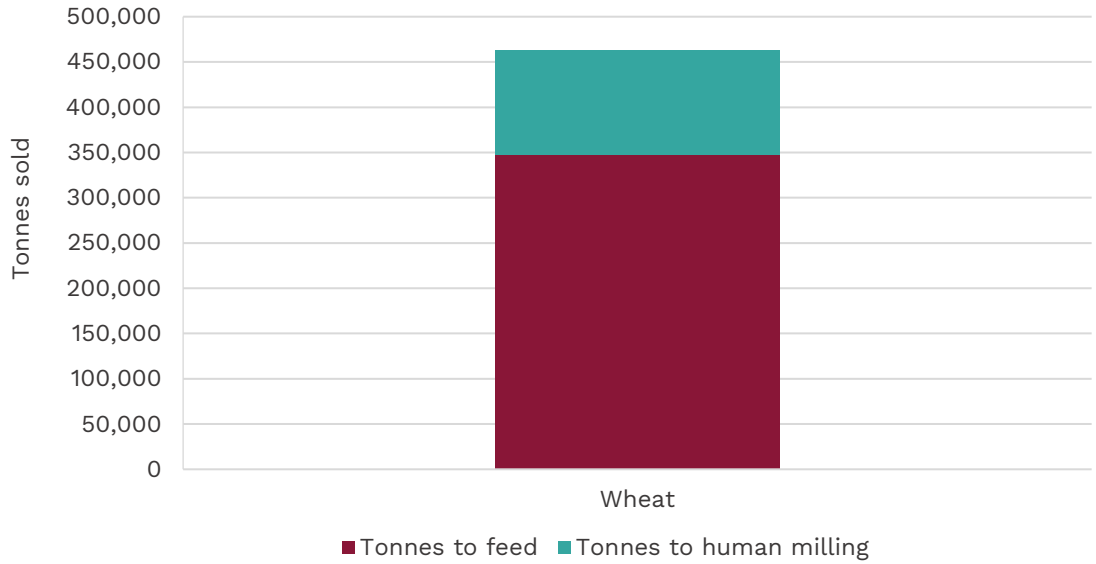
Domestic wheat breeding provides a stable source of flour for making bread, pasta, biscuits, breakfast cereals, beer, and many other foods. PVR supports development of new varieties that enable farmers to maximise yields across New Zealand's diverse growing environments.

Despite New Zealand's average yield for milling wheat of 10 tonnes a hectare, most of the wheat eaten in New Zealand comes from Australia, with 75 percent of bread sold in supermarkets made from Australia wheat. Despite yields of just two-to-three tonnes a hectare land is cheaper in Australia and greater total volumes can be grown. This makes it cheaper to transport grain from Australia to Auckland, rather than getting grain up from the South Island where most of New Zealand's wheat is grown.

The reliance on foreign supply puts New Zealand at risk if there is a global shortage. Not only will prices likely increase, but New Zealand does not have the storage capacity to stockpile wheat for long term shortages. As a small isolated market at the bottom of the world, it can be difficult to attract international supply and get ships to call at our ports during times of international crisis.

In the past, New Zealand was fully self-sufficient in grain. However, over the past two decades, low wheat prices from overseas and high demand and prices for grains as stock feed have caused a major shift (Macdonald, 2020). As Figure 3.17 shows, in 2021 New Zealand produced approximately 463,000 tonnes of wheat. Of this production, 348,000 tonnes went to feed for animals, and 115,000 tonnes went to human milling (BERL, 2021). It is estimated that approximately 80 percent of New Zealand's wheat production is of protected cultivars, including most of the wheat used in milling.

Figure 3.17 New Zealand domestic wheat sales, 2021



Source: BERL, AFIC

New PVR protected cultivars provide farmers with choices tailored to specific requirements to deliver better quality wheat, provide a stable supply, and produce yields that are world leading (Index Mundi, 2023).

Knowing that PVR protections are available has encouraged domestic innovation in wheat breeding. The Plant & Food Research milling wheat breeding programme has produced several successful

cultivars that have been shown to perform just as well, or better, in terms of baking and environmental footprint, as imported products (Plant & Food Research, 2022).

It is not just quality and yield that benefit from domestic wheat breeding. These ongoing programmes, backed by PVR protection, enable (relatively) rapid response to challenges like changes in local disease pressure, or climate change, or new market opportunities, such as breeding a low-gluten epitope cultivar. New cultivars have also been developed to meet the needs of niche export products that are attracting high prices in export markets.

The high quality and high yields that have resulted from domestic breeding programmes have ensured that wheat remains a viable part of crop rotation. However, if New Zealand fails to incentivise (through the ability to obtain royalties) the development of its wheat cultivars to remain competitive with imports, arable farmers will be likely to move away from wheat for milling and grow wheat for animal feed, which is likely to drive down the price.

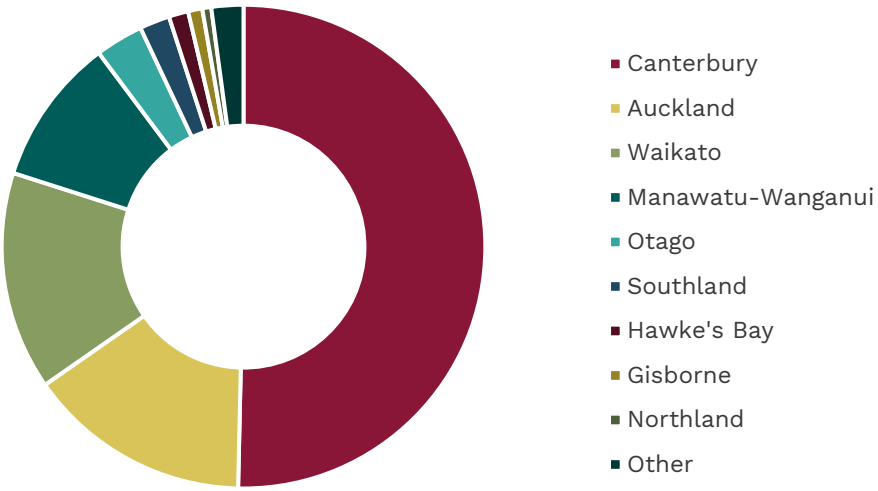
Without competitive wheat cultivars there may be flow on impacts for other arable crops. Wheat utilises the excess nitrogen left behind from legume crops, manages soil nutrients, manages herbicide resistance, and spreads the farm workload. If wheat is no longer profitable for farmers, it will probably be replaced in the rotation. Without wheat as part of the rotation it is likely that some farmers would choose to convert to livestock farming (sheep and beef or dairy). Fewer hectares of land dedicated to arable production will reduce the market for domestic arable seed sales, creating negative flow on effects for New Zealand's world leading breeding activities across all arable crops. This could potentially threaten food security beyond wheat.

3.4.3 Potatoes and food security

Food security exists when "all people at all times have access to sufficient, safe, and nutritious food to maintain a healthy and active life". It is built on four pillars: food availability, food access, food use, and food stability. The role of the humble potato in ensuring food security for the entire population is undeniable. They are a good source of complex carbohydrates, fibre, and vitamins and minerals such as vitamin C, potassium, and vitamin B6. They are one of the most efficient and high-yielding plants cultivated in New Zealand – approximately 85 percent of what is grown can be eaten. As a comparison, only around half of the rice, wheat, and maize crops are edible. Potatoes are also relatively less water intensive than other staple crops.

This is an important characteristic in the face of increasing pressure on freshwater resources. Moreover, they are one of the few crops that can be grown all over New Zealand (Figure 3.18), making them accessible to all New Zealanders, without the added cost and climate impacts of freight and shipping. This also reduces the risk of widespread crop failure from regional extreme weather events. Compared to other perishables, potatoes have an excellent capability to be kept in cool storage, meaning their supply is relatively stable throughout the year. 97 percent of New Zealanders consume potatoes in some form, with 53 percent consuming fresh potatoes four times a week. A fifth of the population eats potatoes daily (5+ A Day, n.d.). In 2020, the average new Zealander consumed close to 50 kgs of potatoes during the year.

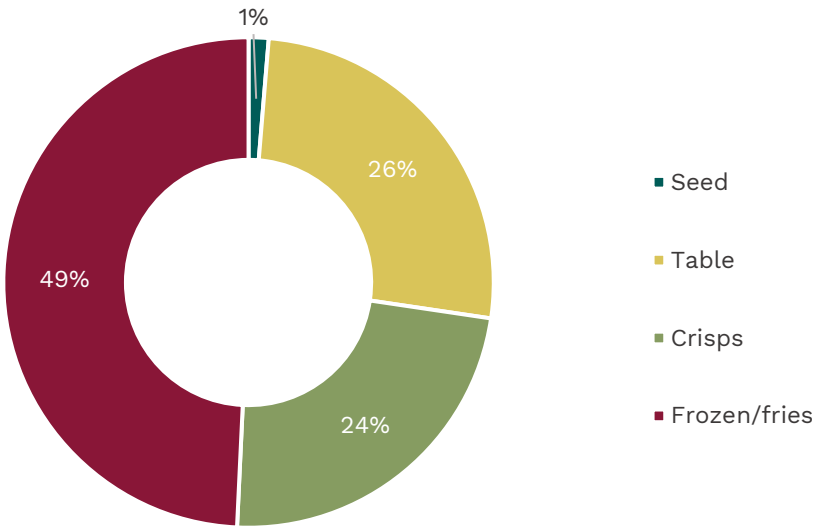
Figure 3.18 Potato growing by region



Source: Stats NZ

All potatoes sold and processed in New Zealand are grown locally. There are more than 50 cultivars of potato grown commercially. Nearly all (95 percent) of plant material is imported from overseas, with just 5 percent being domestically bred. The potato industry was worth $1.1 billion to the New Zealand economy in 2021. Over 90 percent of this value is generated domestically, largely from the frozen and fries segment which accounts for nearly half of the total value of the sector (Figure 3.19).

Figure 3.19 Value of potato sales by type, 2021



Source: Potatoes New Zealand

Growers in New Zealand produce enough potatoes to feed 20,000 people per day per hectare. In 2021, the total yield from a planted area of 8,951 hectares was 456,072 tonnes. Not all potato cultivars are created equal. Each cultivar has qualities that make it best suited for specific purposes. Some cultivars are best suited to be processed into fries and other potato products. Others are bred for specific cooking styles such as boiling, mashing, roasting, etc. Breeders are also

consistently working to develop new cultivars that cater to different fragments of consumer groups. For example, a cultivars of potato marketed as “Lotatoes” have a 40 percent lower carbohydrate content than other common cultivars. There are also cultivars have a higher vitamin C content, higher antioxidants, and so on.

PVR is crucial to the domestic potato industry, and to ensure continued access to the newest cultivars as virtually all improvements are imported. Currently, the domestic breeding programme is not competitive with overseas programmes. Of the 72 granted PVRs for potatoes, just 14 are held by New Zealand breeders, 13 of which are held by Plant & Food Research. According to estimates from potato growers, under 5 percent of potatoes grown are domestically bred.

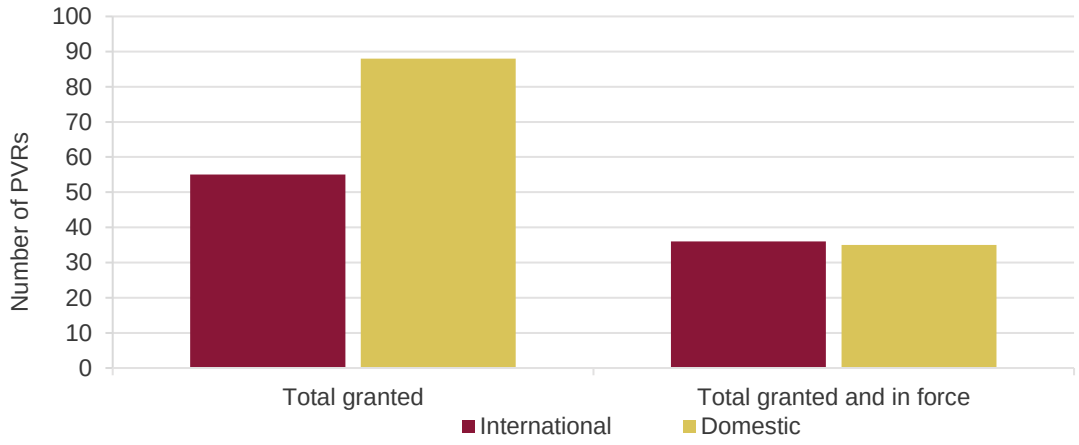
Without PVR, overseas breeders would not be incentivised to send their cultivars to New Zealand, and domestic would only be able to access older cultivars for which PVR protection would have expired. Thus, cultivars being developed overseas with important characteristics that address the challenges of the future such as disease and pest resistance, drought resistance, and improved sustainability would become unavailable. This can have severe implications for domestic food security, as the risks from crop failure would increase.

3.4.4 Apples, competition, and consumer choice

Apples have been grown in New Zealand since the first Europeans settled the country. The climate and soil in the Nelson and Hawke’s Bay area proved to be ideal for growing apples, and several orchards were planted. ‘Royal Gala’ and ‘Braeburn’ were two of the first cultivars developed in New Zealand. These cultivars gained popularity with growers and consumers around the world and are still grown and enjoyed to this day. In 2004, Prevar Limited, a joint venture company, was established to develop and commercialise new apple and pear cultivars for licensing in New Zealand and overseas.

The establishment of an internationally competitive breeding programme has contributed to increased choice for domestic consumers. As Figure 3.20 shows, as of 2022, there were 71 granted PVRs for apple cultivars, 35 of which were held by domestic breeders. Domestic breeders have a higher share of total PVRs granted compared to international breeders. This is because domestic breeders accounted for 80 percent of surrendered PVRs.

Figure 3.20 Apple PVRs granted and , domestic and international breeders

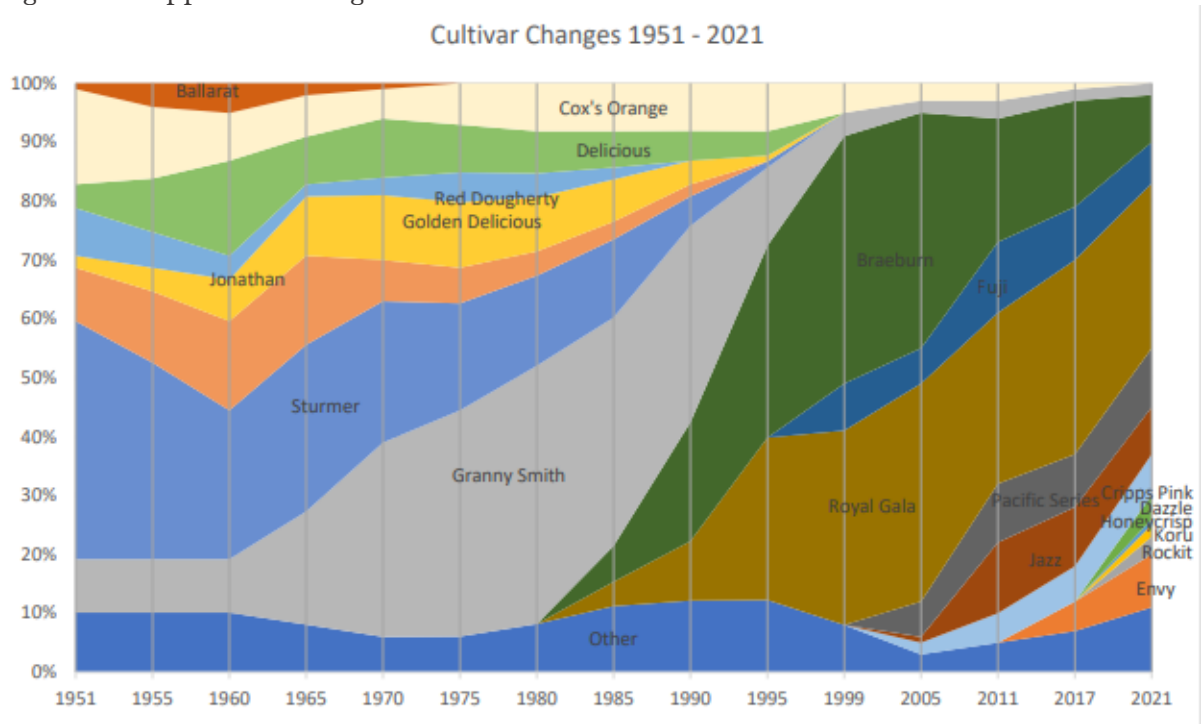


Source: Plant Variety Rights Office, 2022

Today, over 7,000 cultivars of apples are grown worldwide. Over the past decade, the New Zealand breeding programme has commercialised several new apple and pear cultivars domestically and globally. In the domestic market, these cultivars are not only competing with one another, but also with those bred overseas that are imported into New Zealand. The main markets we import from are the USA, China, and Australia. There are 45 applications currently that have been filed and are undergoing examination and testing for a PVR. Eight of these have been filed by domestic breeders. This indicates that there is robust competition in the sector in terms of the development of new and improved cultivars.

Figure 3.21 shows how domestic apple growing has evolved since the early days of apple breeding in New Zealand. In the 1990s, 'Braeburn' and 'Royal Gala' dominated the market and their shares continued to increase. Even today, these two cultivars remain popular amongst consumers and growers alike. However, the success of the domestic breeding programme has resulted in a number of new cultivars being introduced to the market over the past decade. In just the four years between 2017 and 2021, five cultivars gained a significant share. These include 'Honeycrisp', bred in the USA, and four New Zealand bred cultivars – 'Scilate' (commercialised under the trade mark Envy), 'PremA96' (trade mark Rockit), 'Plumac' (trade mark Koru), and 'PremA96' (trade mark Dazzle).

Figure 3.21 Apple cultivars grown in New Zealand[7]



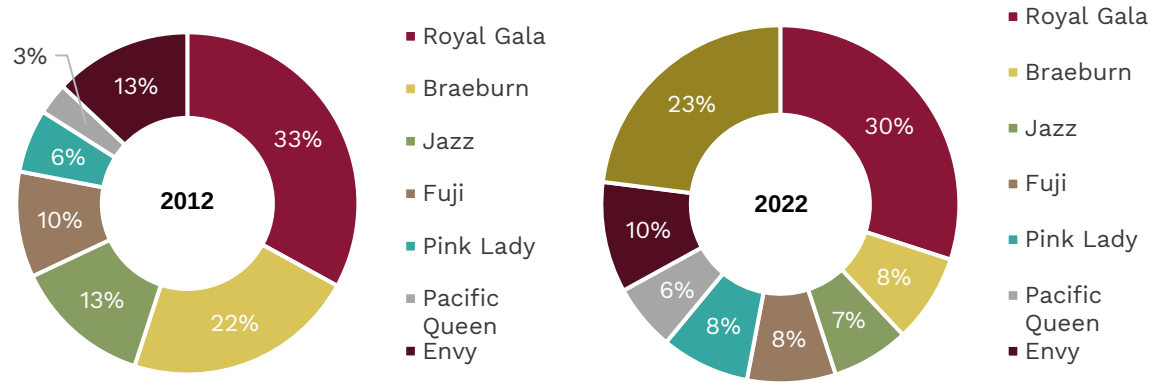
Source: New Zealand Apples and Pears

The change in the make-up of cultivars exported from New Zealand helps highlight how much consumer choice has grown in just the 10 years between 2012 and 2022. The share of 'Braeburn' has

[7] Figure taken from New Zealand Apples and Pears report which uses a combination of denominations and trademarks.

dropped significantly, and those of other cultivars have grown in size. This indicates that a range of new apple cultivars are now being grown, exported, and sold to domestic customers.

Figure 3.22 Apple exports from New Zealand, 2012 and 2022



Source: US Foreign Agricultural Service

According to UPOV, an effective PVR system encourages the development of new cultivars where there is commercial viability. In other words, an effective PVR system can lead to the creation, and/or increase the availability, of new cultivars where there is some unmet market demand which would not be able to be satisfied by growers or farmers through existing cultivars. If PVR did not exist then there would be no commercial incentive for apple breeders in New Zealand. Domestic breeding activity would shrink significantly, and according to industry representatives, would potentially even disappear over time. This means that several successful cultivars such as 'PremA96', 'Scifresh', and 'Scilate' would not exist for consumers domestically and internationally. We would also be unable to import new cultivars from overseas that are currently available for domestic consumers to enjoy.

One of the focuses of the domestic breeding programme has also been to develop cultivars with different ripening times. This means that each cultivar is ready for harvest at different times during the year, which has allowed the apple season to be extended. Thus, consumers are able to enjoy apples for longer than was traditionally possible. Moreover, breeders are working on developing cultivars with improved nutritional benefits, such as high energy apples that offer healthier alternatives to traditional snacks.

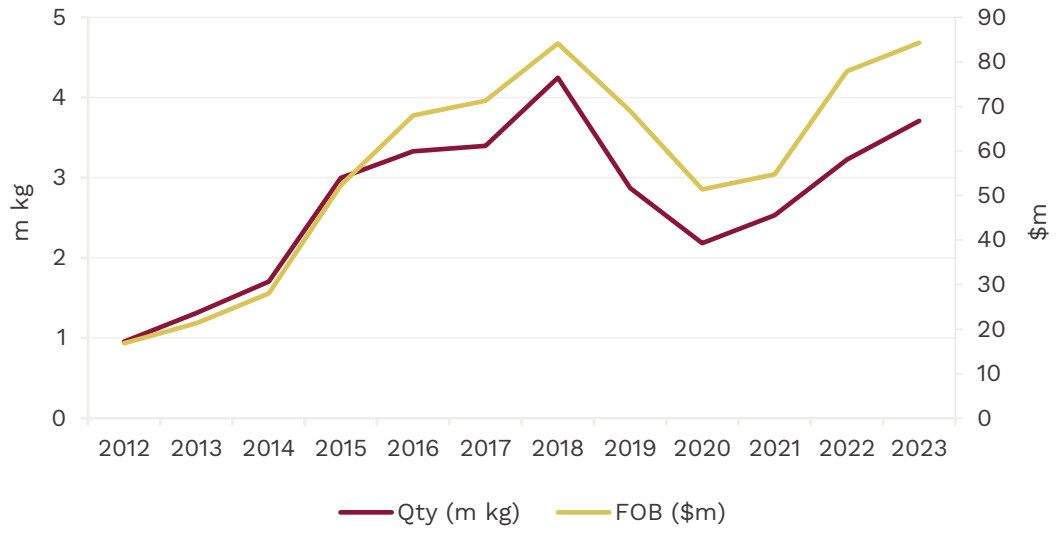
3.4.5 Cherries and exports

Cherry trees do best in temperate climates, with cold winters and hot, dry summers, such as Hawke's Bay, Marlborough, and Central Otago. This climate, New Zealand's southern hemisphere location, and proximity to Asia have enabled premium New Zealand grown cherries to become a luxury good. They are popular for Chinese New Year (late January and February) across East and Southeast Asia. Approximately 79 percent of New Zealand cherries, by value, are exported (New Zealand Horticulture Export Authority, n.d.).

Statistics New Zealand has recorded data on cherry exports since 2012.

Figure 3.23 shows, the volume of cherries exported from New Zealand has grown 288 percent, increasing from 956 tonnes in 2012 to 3,709 tonnes in 2023. At the same time, the free on-board value has increased by $67 million (401 percent) from $16.8 million in 2012 to $84.3 million in 2023.

Figure 3.23 New Zealand cherry exports, 12 months to June



Source: Stats NZ

New Zealand's cherries are predominantly grown in Central Otago, Marlborough, and Hawke's Bay. Central Otago produces most of the cherries grown in New Zealand, the majority of which are exported. Small volumes of pre-Christmas cherries are exported from Marlborough.

Hawke's Bay has seen expansion of pre-Christmas cherry production. The cherry cultivars grown in Hawke's Bay tend to be older cultivars more suited to the warmer climate and fewer winter chill days, and do not attract the premium returns achieved for Central Otago-grown cherries.

Taiwan is the largest market for New Zealand cherry exports, taking 48 percent of the exports by value and 44 percent by volume. The value of exports to this market has increased by 94 percent since 2015 to be $40.1 million in 2023.

China is the second largest market importing 19 percent of New Zealand's cherry exports by volume and 20 percent by value. Vietnam is the third largest market consuming 14 percent of exports by volume and 13 percent by value. Combined, these three countries consume 81 percent of New Zealand's cherry exports.

However, New Zealand's cherry industry has not always been as healthy as the fruits it produces. New Zealand cherry yields were drifting until a move to new cultivars at the dawn of the new millennium reset the industry, leading to growing productivity (Coriolis & Ministry for Business, Innovation and Employment, 2018).

There are 36 applications for PVR protection in the PVR register. Two cultivars, one which was granted protection in 1989 and the other in 1992, have been surrendered. There are 12 cultivars which have been granted protection which remain in force, all of which were applied for after 2003,

including five since 2018. A further 16 applications have been filed but not yet granted, including nine which were applied for in 2019, three in 2021, and two in 2022.

New cultivars have increased the quality and prices of New Zealand grown cherries. This has seen the industry grow from under 1,000 hectares in the 1990s to an estimated 1,500 hectares today. New Zealand competes with markets, like Chile, which can produce at a fraction of the cost. As a high-cost producer New Zealand needs to offer a premium product to compete in international markets. PVR protection enables the industry to introduce new cultivars sourced from large specialised overseas breeding companies. Stakeholders commented that the best genetics always win and that for New Zealand, with little to no domestic breeding, international cultivars are essential as without innovation New Zealand will be left behind.

New cherry cultivars are expanding the potential for increased grower returns through larger fruit size, more resistance to rain cracking, an extended harvest season, and improved appearance, quality, and taste. This has given growers and exporters of these new cultivars something unique that competitors do not have, providing a competitive advantage.

'Folfer' (sold under the trade mark Lani) is a dark, sweet, and early ripening cultivar. Its large size and crunchy texture reduce damage and product loss during transport. As an early ripening cultivar, it allows growers and exporters to get the cherry to market ahead of other cultivars. This allows exporters to get into Asian markets sooner and build the customer base for cultivars that ripen later.

At the other end of the season is the '13S20-09' (sold under the trade mark Staccato) cultivar. The Staccato cultivar are large crunchy red and black cherries with super sweet burgundy flesh, and a very small pit, which ripens ready for picking in late January and early February. Being large, firm, hard, and glossy it has excellent shipping potential. The very late maturity aligns well with meeting demand in Asian markets for a high-quality product that can be gifted in advance of Chinese New Year.

4 Meeting Te Tiriti obligations

Part 5 of the Plant Variety Rights Act 2022 (PVR Act 2022) was enacted to provide protection for kaitiaki (guardian / custodian) relationships with taonga species consistent with the Crown's obligations under Te Tiriti o Waitangi. Part 5 is a new addition to the PVR regime and implements the recommendations of Ko Aotearoa Tēnei: A report into claims concerning New Zealand law and policy affecting Māori culture and identity, a report into the Wai 262 claim (Waitangi Tribunal, 2011). Managing the requirements of Part 5 will impose an additional cost on the PVRO. This section briefly summarises what Part 5 provides for to help the Crown meet its Te Tiriti obligations, and attempts to identify these additional costs associated with Part 5 of the PVR Act 2022.

4.1 About Part 5 of the Plant Variety Rights Act 2022

Part 5 of the PVR Act 2022 covers two types of plant species – indigenous and non-indigenous species. Indigenous plant species are native plant species that occur naturally in New Zealand, or have arrived in New Zealand without human assistance. Non-indigenous plant species of significance are defined as plant species believed to have been brought to New Zealand before 1769 on waka migrating from other parts of the Pacific region and listed in the regulations as a non-indigenous plant species of significance.

Part 5 recognises and respects the Crown's obligations under the principles of Te Tiriti o Waitangi through protecting kaitiaki relationships with taonga species and mātauranga Māori in the PVR system, by:

- Providing additional procedures that will recognise and protect kaitiaki relationships
- Providing for a Māori Plant Varieties Committee (the Committee) to administer those procedures, to make determinations about kaitiaki relationships, and to have advisory functions
- Enabling the nullification or cancellation of PVRs that have adverse effects on kaitiaki relationships.

A key role of the Committee is to consider PVR applications referred to it by the Commissioner of Plant Variety Rights (the Commissioner) and to make decisions on registrability based on kaitiaki relationships.

In a case where an iwi, hapū, individual of Māori descent, or Māori entity asserts that they have a kaitiaki relationship with the plant cultivar that is the subject of a PVR application, the Committee must consider whether that person, iwi, hapū, or other entity has demonstrated their kaitiaki relationship with the relevant plant cultivar and associated mātauranga Māori.

If a kaitiaki relationship has been demonstrated, the Committee must then consider the kaitiaki's assessment of the effect of a grant of the PVR on their relationship, any agreement to mitigate adverse effects reached between the breeder and the kaitiaki, and whether there is any evidence that the parties have not acted in good faith during their engagement (if any).

4.2 What Part 5 will look like in practice

Because the Committee has yet to be established, and Part 5 has not been tested, it is difficult to know how the Act's requirements concerning indigenous plant species and non-indigenous plant species of significance will operate in practice. In this subsection we identify the legislative requirement for the Committee's membership, functions, role and processes.

4.2.1 Membership of the Māori Plant Variety Rights Committee

Before any applications covered under Part 5 can be considered Section 57 of the PVR Act 2022 requires that the Commissioner must establish the Committee. The PVR Act 2022 does not specify the number of members on the Committee, but members must be qualified for appointment having regard to that person's knowledge of mātauranga Māori, tikanga Māori, te ao Māori, and taonga species. The Commissioner must also consider whether the proposed member has the mana, standing in the community, skills, knowledge, or experience to participate effectively in the Committee and to contribute to carrying out the functions of the Committee.

4.2.2 Functions of the Māori Plant Variety Rights Committee

Section 58 of the PVR Act 2022 sets out the functions of the Committee. These are to:

- Issue engagement guidelines and provide advice to applicants for PVR and kaitiaki status
- Consider PVR applications referred to it by the Commissioner and make decisions under Part 5
- Advise the Commissioner whether the approval of a proposed denomination is likely to be offensive to Māori
- Provide advice to the Commissioner on any information relevant to the novel, distinct, uniform, and stable criteria required for granting a PVR.

4.2.3 Role of the Māori Plant Variety Rights Committee

The role of the Committee is to assess and determine whether a PVR, if granted, will or could have adverse effects on one or more kaitiaki relationships with the plant variety. In carrying out its role the Committee must, if an iwi, hapū, individual of Māori descent, or Māori entity asserts that they have a kaitiaki relationship with the plant variety that is the subject of the PVR application, assess that relationship (if any) and the effect of granting a PVR. The Committee can also consider the nature of any kaitiaki relationships that Māori in general have with the plant variety that is the subject of the application, and the effect on those relationships of granting a PVR.

The matters that the Committee may take into account include the effects of any PVR already granted in relation to the plant species that is the subject of the application, the purposes of the PVR Act 2022, and whether any adverse effects on a kaitiaki relationship with the plant species can be mitigated by an agreement or undertaking.

It is also the role of the Committee to publicly notify its rules about hearing and timing requirements for the making and hearing of submissions, responding to information requests from the Committee and others, and convening hui.

4.2.4 Process to be adopted by Māori Plant Variety Rights Committee

The Committee must, where practicable, consider any submissions made in accordance with the times and procedures set out in the Committee's rules. Submissions can come from applicants, an iwi, hapū, individual of Māori descent, or a Māori entity that asserts they have a kaitiaki relationship with a plant cultivar, and any organisation that the Committee considers represents Māori generally or significant Māori interests (and any evidence given by an expert on behalf of any of those iwi, hapū, individuals, entities, or organisations). In addition, the Committee may conduct any investigations it considers appropriate to carry out its functions (including requesting further information from any party, or by convening hui).

The Committee must also comply with the rules of natural justice, act as quickly as practicable in the circumstances, and provide written reasons for every determination.

4.2.5 Decision by Māori Plant Variety Rights Committee, request for reconsideration, nullification and cancellation, and appeals

If the Committee is satisfied that that there is no kaitiaki relationship, or there is a kaitiaki relationship, but it is unlikely to be affected, or any adverse effect on the relationship will be adequately mitigated by an agreement between the parties, or set out in an undertaking by the breeder, it must inform the Commissioner that the application should proceed. If the Committee is not satisfied it must inform the Commissioner that the PVR application must be declined.

The PVR Act 2022 allows for a request for reconsideration of the Committee's decision. Within 10 working days of the decision, an applicant or any iwi hapū, individual of Māori descent, or Māori entity may request reconsideration of a decision on the basis that further information was not available to the Committee when it made its decision. The Committee must then review the decision and notify the Commissioner and parties of the reconsideration decision.

Section 69 allows that a person may apply to the Commissioner for the nullification or cancellation of a PVR to which this Part 5 applies, who must then refer this application to the Māori Plant Varieties Committee. If the Committee determines that there was an adverse effect on a kaitiaki relationship with a plant species at the time a PVR was granted for that variety, it must inform the Commissioner that the PVR must be nullified. If it determines that the PVR holder has breached any condition of the grant of the PVR, or any undertaking made by the PVR holder before, at, or after the time of the grant, it must inform the Commissioner that the PVR must be cancelled. However, if the PVR holder makes a further undertaking that is acceptable to the Committee it can dismiss the application and inform the Commissioner that an existing or new condition must be imposed as a formal condition of the PVR holder continuing to hold the PVR.

Finally, section 71 allows for any person aggrieved by a decision made by the Committee to appeal to the Māori Appellate Court within 28 days.

4.3 PVRO costs of the Māori Plant Variety Rights Committee

As the Committee has yet to be established there is significant uncertainty of what it will cost to operate. Members will need to be appointed and rules agreed upon before costs can accurately be quantified. Based on the legislative framework this subsection highlights where costs to the PVRO are likely to occur.

4.3.1 Cost of operating the Māori Plant Variety Rights Committee

The extent of the cost for each application will depend on a number of factors including the number of parties with a kaitiaki relationship, any agreements reached between the parties in advance, the extent of investigations necessary, any hui that are required, requests for reconsideration, application for nullification or cancellation, and any appeals.

Section 60 provides that members of the Māori Plant Varieties Committee are entitled, in accordance with the fees framework, to remuneration for services as members at a rate and of a kind determined by the Commissioner, and to be reimbursed for expenses incurred by them in undertaking the functions and duties of the Committee. The Revised Fees Framework for members appointed to bodies in which the Crown has an interest (Cabinet Office, 2022) sets the daily fee rates for members of the Committee. As Table 4.1 shows, the rate for the Committee chair ranges from $226 to $1,265 per day, depending on experience, and for members between $165 and $952.

Table 4.1 Cabinet fee framework daily fee rates for all other committees and other bodies

Level	Fees range – chair	Fees range - members
1	$594 - $1,265	$446 - $952
2	$429 - $974	$319 - $616
3	$308 - $633	$226 - $435
4	$275 - $402	$209 - $297
5	$226 - $292	$165 - $226

Source: Cabinet Office

There are currently two committees in place to consider IP applications under the context of values, concepts, practices, and knowledge associated with Māori culture: the Māori Trade Marks Advisory Committee and the Māori Patents Advisory Committee. While not a direct comparison, these committees provide the best indication of what the PVRO costs are likely to be for the Māori Plant Variety Rights Committee.

The members of the Māori Trade Marks Advisory Committee advise on whether the proposed use or registration of a trade mark that is, or appears to be, derivative of a Māori sign, including text and imagery, is, or is likely to be, offensive to Māori. The Committee currently has five members who fall within level three in the Cabinet fees framework.

The Māori Trade Marks Advisory Committee has the support of two Intellectual Property Advisors from IPONZ: an “expert advisor” and a “liaison officer”. The expert advisor is experienced in practices and procedures for the examination of trade mark applications, and is present at each meeting of the Committee as an information source on the examination process. The liaison officer acts as liaison between IPONZ and the Committee, and provides administrative support including organising and attending Committee meetings, recording minutes, processing correspondence, and distributing materials.

The Māori Patents Advisory Committee advises the Commissioner on whether commercial exploitation of such inventions would likely be contrary to Māori values. The Committee currently has three members and the average cost per application is $1,365, excluding any hui, and has an average of three to four cases per year.

These examples provide quite a wide range, but reflect the reality that some cases are relatively straightforward, and others may be contentious requiring multiple requests for information and hui. Having an application considered by either committee does not cost the applicant extra. However, given the more complex nature of the kaitiaki relationships that are likely to be assessed by the Māori Plant Variety Rights Committee the cost is expected to be greater.

4.3.2 Cost to support the Committee and breeders of taonga species to identify kaitiaki relationships

The Waitangi Tribunal, in the Wai 262 report, stated that "one of the practical issues that researchers and Crown officials told us they would like resolved is the question of how to identify who is a kaitiaki and who is not." The Tribunal suggested a kaitiaki registration system, and said that kaitiaki should be able to register their interest in taonga species. The Tribunal acknowledged that identifying kaitiaki of taonga species is more difficult "because the species are not the creations of kaitiaki communities, and many taonga species can be found in various parts of the country. Many communities will have their own mātauranga about the species, and in some cases, there will be multiple kaitiaki, all of whom will have a genuine interest."

In its report, the Tribunal had in mind "a register like that suggested for taonga works that allows kaitiaki communities to record their status in respect of particular species within or sourced from their rohe. The provenance of the genetic and biological material will give one hapū or iwi priority over the others. Even if other iwi have broader interests, the iwi or hapū from whose territory the material is taken should be treated as the relevant kaitiaki in the first instance."

Establishing, populating, and maintaining the register will come at a cost and require input from other organisations including Land Information New Zealand, and the Māori Land Court. Without an indication of the scale of such a database we were unable to quantify this cost.

4.4 Scale of applications likely to be subject to Part 5

The PVR register contains 39 botanical genera that have been identified as indigenous plant species or non-indigenous species of significance to Māori. Of these plant species, all except for *Ipomea batatas* (sweet potato/kūmara), which is a vegetable, were classified as ornamentals and forest trees. Since 1975, 281 applications have been made for PVR registration for these plant cultivars.

Table 4.2 Top 10 PVR applications for plant species of significance to Māori 1975-2023

Plant species common name	Count
Leptospermum (Mānuka)	44
Hebe	35
Cordyline (Cabbage tree)	33
Phormium (New Zealand flax)	27
Pittosporum	25
Coprosma	22
Clematis	22
Corokia	6
Aristotelia (Wineberry)	6
Ipomea batatas (Sweet potato/kūmara)	6

Source: IPONZ plant variety rights register

In the past five years, between 2018 and 2022, 11 applications have been made for PVR protection of indigenous species. All 11 applications were made by New Zealand based applicants. *Hebe* was the most common species for which PVR protection was applied, with three applications in five years. *Griselinia*/Broadleaf (two applications) was the only other cultivar over this period with more than one application. Single applications were made for varieties of *Leptospermum, Pittosporum, Coprosma, Corokia, Pseudowintera,* and Sedge.

Looking at a longer period, from 2013 to 2022, 50 applications were made. The annual number of applications has ranged from zero in 2021 and 2022, to 10 in 2015. Indigenous and/or non-indigenous species of significance that have been bred overseas will not need to be considered by the Māori Plant Varieties Committee. Of the 50 applications over the 10-year period, 39 were from New Zealand breeders of taonga species.

Given these historic trends it is likely that the Māori Plant Varieties Committee could be asked to review two to four applications per year.

In the short- to medium-term there may be a reduction in the number of applications until there is a greater understanding between Māori and breeders of taonga species over how Part 5 may work in practice. In one case we heard of a possible application being made earlier than originally anticipated to avoid the need to consult when Part 5 comes into force. Additionally, indigenous cultivars bred offshore are not subject to Part 5. There is already breeding of indigenous plant species in Australia, Europe, and North America.

5 Cost recovery and PVR

The cost recovery model in the public sector refers to a mechanism or approach used to recover the costs associated with providing goods or services by public entities. It is commonly used when a government entity or public organisation offers specific services or products that have a direct cost attached to them. The objective of the cost recovery model is to make sure that the revenue generated from users or beneficiaries covers the expenses incurred in delivering the goods or services. This approach reduces reliance on government funding or subsidies and promotes financial sustainability. The cost recovery model can help reduce the burden on public finances, improve the efficiency of service delivery, and ensure the sustainability of public services.

The cost recovery model must strike a balance between cost recovery goals and broader public policy objectives. While cost recovery is important, considerations such as affordability, equity, and the public interest must also be considered. It requires careful consideration of social impact, affordability, and the appropriate allocation of costs to avoid excluding certain groups or compromising access to critical services.

The 'Guidelines for Setting Charges in the Public Sector' were initially released by the Treasury in 1999. In 2017 the guidelines underwent a review due to ministerial concerns regarding the need for transparency in cost recovery charges enforced by the public sector (New Zealand Treasury, 2017). These guidelines provide advice on the issues to consider and on engaging stakeholders in the development of cost recovery proposals. The objective is to ensure that the charges are efficient and effective while providing stakeholders with insight into the costs underlying the charges they pay.

The guidelines note that “there are some circumstances where charging at less than full cost may be appropriate. A decision to charge at less than full cost recovery would need the shortfall to be made up from general taxation. The advice on cost recovery charges should provide a good case for why general taxation should contribute to the costs of an activity, as taxation has economic costs and also affects budget constraints. In some circumstances, full cost recovery would lead to a situation where the cost recovery regime undermines the policy objectives. In these cases, a policy decision may be made to partially recover costs. For example, full cost recovery of civil court proceedings may create a cost barrier that inappropriately limits access to justice.”

Like all IP schemes in New Zealand, the PVR scheme is intended as a full cost recovery model. This is the same. The granting of an IP right enables one person to accrue benefits and excludes others from its use for a certain period of time, as well as providing broader benefits of IP schemes in incentivising innovation and creativity. In particular for PVR, section 3 of the PVR Act 2022, sets out one objective being to promote innovation and economic growth by incentivising the development and dissemination of new plant varieties, while providing an appropriate balance between the interests of plant breeders, growers, and society as a whole. Each of New Zealand’s other IP schemes have similar objectives[8].

[8] For instance s3(a)(i) describes one purpose of the Patents Act 2013 as being to “promote innovation and economic growth while providing an appropriate balance between the interests of inventors and patent owners and the interests of society as a whole”

Similar to all IP schemes, New Zealand's PVR scheme achieves its objectives and results in benefits that extend well beyond those to the owner of a PVR. Plant breeders are incentivised to develop new cultivars knowing they will get an adequate return on investment, and New Zealand as a whole receives flow-on economic, environmental, and other social benefits. A notable benefit provided by the PVR scheme is in having Part 5 that brings benefits to New Zealand in terms of meeting some of the Crown's obligations to Māori under Te Tiriti. It should be noted that these Part 5 benefits go further than any existing IP scheme.

5.1 PVR applicants' view on costs

PVR applicants rarely consider the costs associated with obtaining and maintaining PVR protection in isolation. What these costs included, and how applicants viewed their costs, depended on a number of factors including plant type, whether they were an international or domestic player, the economic viability of their plant, including the size of the market, and the size of their own operation. Thus, how stakeholders viewed PVR-related costs reflected these differences in the context they operated in.

Variety importers and/or agents generally import a number of cultivars every year. These are then tested in New Zealand conditions, and successful varieties are commercialised. Success rates can vary between plant types but are generally around one in 10 to one in 20. Because success is not guaranteed, even in the case of cultivars that have been successfully commercialised overseas, importers generally bring in multiple cultivars at a time. The costs of importing and commercialising all these cultivars are often lumped together. This includes the costs associated with Customs and quarantine, shipping, and PVR-related costs, including the application fee and the trial and examination fees. It should be noted that all importers considered the biggest, and fastest increasing, costs to be those associated with Customs and quarantine.

From the perspective of domestic breeders, PVR costs are again considered as being one component of the investment that they make in breeding and bringing a new cultivar into the market. The majority of large domestic breeders we interviewed said that they invest millions in their plant breeding programmes every year. This includes large fixed costs such as labour costs and capital investments. These costs remain the same regardless of how many varieties they register for PVR protection. By the end of the process, once a cultivar has been released to the market, PVR costs make up a small component for those large breeders, but this may not be the same for small breeders as discussed in section 5.5.1 below.

5.2 PVR fees in New Zealand

A PVR application goes through several phases before it can be granted or refused. A breeder makes an application, a preliminary examination occurs, the cultivar is tested in a growing trial (undertaken by the PVRO, by the applicant, or by another approved party), and lastly, there is a final examination leading to the grant decision. The current PVR fees were set in 2022 and there are four main types of fees:

- Application fee – this is the initial fee payable when an application is submitted. It covers the acceptance of the application, a preliminary examination for newness and the

denomination, document checks, and arrangements for testing. The fee also includes administration costs and several of the fixed costs required to maintain the PVRO. The current fee is $625.

- Growing trial fee - this fee which covers the variety collection or trial design and field evaluation as well as any other associated costs to carry out the necessary field work when a growing trial and/or evaluation is carried out by or the PVRO. The growing trial arrangement varies for different plant species. The fees for each are included in Table 5.1.
- An examination fee, which covers the cost of drafting the variety description and the final examination is payable towards the end of the examination period for every application. The current fee is $770.
- Annual renewal fee –an annual fee to keep the grant of a plant variety right in force for the upcoming year. It is paid in the year following a PVR being granted. Currently all plant varieties pay the same for an annual renewal fee, regardless of how long the grant has been in force, or the plant variety. This fee serves to fund general costs of running the system and incentivises the cessation of a PVR when it longer needed. The current fee is $385.

The Fees Order also sets out fees for a compulsory licence application ($1,000), cancellation or nullification of application ($350), and a request for a hearing ($850).

5.2.1 Previous analysis of the cost recovery model and fee update

In 2022 IPONZ conducted a review on the costs associated with providing an efficient PVR scheme. The review found that the costs incurred by the PVRO can be classified into direct and indirect costs. Direct costs include personnel and contracts for outsourced growing trials and variety collections, while indirect costs include overheads from MBIE and management fees (Ministry of Business, Innovation and Employment, 2023).

The PVR scheme was set up based on full cost recovery, meaning that users of the scheme are expected to cover the full cost of operating the PVRO. However, the PVRO is currently operating at a deficit due to a decrease in the volume of applications and rising fixed costs over the years. The total cost to operate stands at $1.39 million per year. Costs incurred by the PVRO include personnel to carry out the services, outsourced growing trials, variety collections, travel, office expenses and departmental overheads. The revenue generated from PVR fees was around $0.58 million, resulting in a deficit of $0.81 million.

The review found moving to a full cost recovery model would ensure that the fees charged across the granting process are paid for by the applicant for specific plant varieties. This approach aligns with Treasury's fee setting guidance. However, it goes on to note that to maintain a viable regime, there is a level of fixed costs that need to be maintained regardless of the level of volumes of applications. As the volume of applicants has fallen since 2002, this has resulted in fewer applications across which to spread fixed costs. The review found that a full cost recovery model would therefore result in significant increases for all fee payers and present a cost prohibitive barrier for some companies, especially small to medium sized businesses and breeders.

The PVRO estimated that such a significant increase in fees across the board would likely reduce applications by roughly half, and identified that maintaining the PVR regime on a full cost-recovery basis would undermine the policy objectives of the regime, as it would necessitate substantial fee increases, thereby presenting a barrier to applicants, which is against the principles of UPOV-91.

5.2.2 Current PVR fees

Following the review, and the passing of the PVR Act 2022, new fee structures were introduced. The fee structure did not adjust fee levels to recover the full cost of the regime. Instead, Crown funding has been identified to provide a level of funding from 2022/23 to 2024/25, following which a new regime must be in place for 2025/26 where MBIE will seek to set costs at full cost recovery levels, if appropriate (Ministry of Business, Innovation and Employment, 2022).

The fee levels for the PVR regime are based on partial cost recovery rather than full cost recovery, with the new fees projected to generate a revenue of $0.92 million, indicating a higher cost recovery of approximately 70 percent. In the Cabinet Paper the Minister recognises that the interim Crown funding allows for increased funding per annum to mitigate the impact of fee increases, and states that "I agree that innovation in plant breeding is crucial for the environment, primary industries and other areas of the economy. The final proposed fees reflect a balance between achieving these policy objectives and ensuring the continued integrity, operation, and maintenance of the PVR scheme."

The PVR regulations 2022 revised the fees which are shown in Table 5.1. The fees charged vary depending on the type of plant cultivar. Fees are significantly lower for fruit PVR rights compared to crops and vegetables. The first year cost to applicants for agriculture and vegetable varieties is $6,600, while fees for the fruit sector amount to $3,600.[9] For trials that go beyond one year, there is also an annual fee.

Table 5.1 PVR fee structure 2022

Fee category	Fee ($)
Application fee (Single)	625
Examination fee (Single)	770
Growing trials	
Agriculture and vegetable Seed propagated varieties per year	4,200
Vegetatively propagated varieties per year	2,800
Fruit and nut Strawberry varieties per year	290
All other fruit and nut varieties - Year one	530
All other fruit and nut varieties - Subsequent annual	700
Ornamentals Roses per year	130
All other ornamental varieties - Year one	310
All other ornamental varieties - Subsequent annual	450
Pasture grasses, white clover per year	4,510
Fungi grass endophytes, other fungi per trial	2,800
Annual renewal fee	385

Source: Plant Variety Rights Office

[9] The fee is a cost to the applicant and revenue for the PVRO.

The PVR fee structure does not include growing trial costs associated with use of specific testing centres or trials organised by the applicant and directed and approved by the PVRO, which includes many fruit cultivars. These are done at the applicant's expense, for example, trial costs for apples and stone fruit can range from $8,000 to $10,000.

5.3 Impacts, advantages, and disadvantages of cost recovery models

In general, there is a strong case for regulators to recover the administrative costs of regulation so that an industry's costs reflect the full costs of production. The case may, however, be weakened if there is a risk that cost recovery would be inconsistent with a policy objective, or would undermine competition, and if fees or levies that are designed to avoid such problems become costly.

5.3.1 Benefits of full cost recovery

The argument for full cost recovery is that recovering the administrative costs of regulatory services can improve the efficiency of resource use. The Productivity Commission's 2014 report Regulatory Institutions and Practices identifies that "building the full costs of production (including the administrative costs of regulation) into products encourages users of regulatory services to adjust their use of those services in line with their willingness to pay, and this discourages frivolous use of regulatory services and tells consumers choosing between products the full costs of their choices."

The Independent Pricing and Regulatory Tribunal in New South Wales (2014) noted that cost-reflective pricing enables consumers and producers to make informed decisions on the services demanded and supplied. This further reduces the potential for government to provide services that cost more than the value consumers place on them (or more than the benefits they create).

The Australian Productivity Commission (2001) identified that appropriately structured charges can also motivate regulators to look for better ways to provide services. Cost recovery reduces the call on taxation revenue to fund regulators, and so decreases the costs of tax.

Finally, recovering the costs of regulation may also appear more equitable, in the sense that less of the cost of regulation will be paid by those taxpayers who do not benefit from the regulations or use the regulated products.

The Ministry of Primary Industries (MPI) First Principles Review of cost recovery arrangements (2018) notes that "full cost recovery maximises incentives to ensure that those who use MPI's services are aware of the full costs of participating in markets, and will only do so when the benefits of participation outweigh the costs. Equally, it maximises incentives for those who create risks to take steps to reduce these risks, and can incentivise MPI to provide services efficiently, particularly where fixed charges are used. In the long term, this will influence the level of service supplied and support more efficient use of resources."

MPI continues to say that in many cases, industry is able to internalise charges into cost structures and this is an efficient way to ensure that downstream or indirect beneficiaries contribute to costs. For example, cost recovery from the meat industry means that consumers face a portion of these costs through the price they pay for meat.

5.3.2 Potential impacts of full cost recovery

In a submission to the Australian Productivity Commission's review of the cost recovery arrangements of Commonwealth Government regulatory, administrative and information agencies, the Australian Chamber of Commerce and Industry (2000) identified some of the consequences of moving to a full cost recovery model. The submission looked at four case study agencies (National Industrial Chemicals Notification and Assessment Scheme, National Registration Authority for Agricultural and Veterinary Chemicals, Therapeutic Goods Administration, and the Australia New Zealand Food Authority) that moved to full cost recovery and identified impacts on innovation, competition, the environment, and the economy.

- Innovation - In the four case studies, the policy of full cost recovery added to the cost of developing a new product without providing any value-add to the product, thus reducing the incentive for business to conduct research and development.
- Competition - The relatively small size of the market meant that there was not a significant return for businesses to market their product in Australia. The cost of registrations reduced the potential returns to investors.
- Environment - In some circumstances, the additional costs from full cost recovery saw business decide not to apply to register more environmentally friendly products. The costs of assessment prohibit the import of these products given the relatively small market.
- Economy - The negative impacts of full cost recovery are not isolated to businesses that register products under these schemes. The combination of the reduced incentive to be innovative, reduced competition, and restricted access to new technologies impacted upon the economy as a whole. This reduced the competitiveness of businesses internationally, which in turn affected employment and economic growth.

Similar feedback was received from submitters to MPI's First Principles Review of their cost recovery arrangements. Submitters suggested that cost recovery has negative impacts on export and business growth. They noted that compliance costs impact on their ability to remain competitive, and that it is not always possible to pass these costs on to consumers. Submitters recommended that the goal of doubling primary industry exports by 2025 should be specifically captured in MPI's cost recovery objectives.

MPI (2018) agreed that it is important to consider how charges might impact on market competitiveness (or other regulatory objectives), and in some cases it may be appropriate to consider recovering less than full costs, or phase in cost recovery. This is reflected in MPI's cost recovery policy which includes a description of circumstances where government may choose not to recover, to share costs, or to phase in cost recovery.

5.4 PVR cost recovery in other jurisdictions

Recovering full costs (including indirect costs) is a common starting point for all countries. However, the organisational structures in other jurisdictions this make it difficult to accurately compare how costs are recovered. For example, other jurisdictions have systems for the regulation of agriculture and horticulture markets and production for which separate fees are charged. Although these

schemes are quite separate and have very different objectives from PVR they provide funding for common services and activities.

The governments of Australia, the UK, and the USA all use a principle based cost recovery approach set out in official guidance. Australian Government Cost Recovery Policy requires that Commonwealth entities should generally set charges to recover the full cost of providing specific activities. The United States Congress has mandated that the Patent and Trademark Office should achieve substantially full cost recovery across its functions. In the United Kingdom the Plant Varieties and Seeds services, including Variety Listing in Great Britain and Northern Ireland and Plant Breeders' Rights, operate with the principle of full cost recovery.

When fees in the UK were reviewed in 2014, concerns were expressed by the breeding industry regarding the detrimental effect that the fee increases would have on breeding programmes for minor agricultural crops. However, a general exemption from fee increases for all such crops was determined to undermine the objective of full cost recovery and not be in the interest of the UK taxpayer. In the USA, the United States Patent and Trademark Office provide discounts in some instances for patent applicants who qualify for small entity or micro entity status. A 60 percent discount on most patent-related fees is available to those who establish small entity status, and 80 percent to those who establish micro entity status.

In 2022 MBIE (2022) compared the cost of obtaining a PVR in different countries, including examination and granting. This did not include the cost of growing trials as the testing arrangements vary between countries. These range from broad centralised systems to the breeders carrying out all testing. New Zealand is unique in that it operates a mixed system with centralised testing for some species and breeder testing for others, with arrangements in between.

Although the PVR remains valid for a comparable period, 20-25 years from the date of the grant, as Table 5.2 shows PVR fees varied from $2,000 to $10,000 depending on the plant type. Many countries charge a certification fee upon a right being successfully granted, so the calculation for the total fee is application plus examination plus certification (where applicable). All fees have been converted to their equivalent in New Zealand Dollars (NZD).

Table 5.2 Comparison of fees to other countries

	New Zealand	Australia	Canada	European Union	Japan	United Kingdom	United States of America[10]
Cost to obtain ($NZ)	1,395	2,495	1,510	4,354	641	1,726	8,059
Annual renewal fee ($NZ)	385	434	362	536	434	345-808	N/A
Annual applications	94	316	338	3,427	713	130	444
Annual renewals	1,278	2,768	1,995	29,010	8,299	1,166	8,310

Source: MBIE

[10] USDA PVPO

Where the cost of obtaining or renewing a PVR is less than in New Zealand, this can primarily be due to the higher volume of applications and renewals. The higher volumes provide economies of scale by providing a greater base across which to spread fixed costs. Part 5 of the PVR Act, which is unique to New Zealand, will bring additional costs to the system that will need to be funded.

5.5 Expected impact of cost recovery models

Given that the current pricing structure fails to recover the full cost of the PVR scheme, we have assumed that the impacts of a partial cost recovery model would remain consistent with the current operation and pricing of the PVR scheme. Therefore, we addressed the impacts, advantages, and disadvantages of the PVR scheme moving to a full cost recovery model that would see existing fees double to make up the current shortfall.

Engagement with stakeholders across the range of users of the PVR scheme identified a clear pattern of responses and likely reactions from industry participants. Responses varied depending on their size or role within the PVR system, and their status as either a breeder or an importer of cultivars bred overseas. It is also important to note that because applicants do not view PVR-related costs in isolation, discussions around the potential impact of an increase in fees focused heavily on how other costs are evolving.

For government this means that a reduction in PVR applications will probably lead to a need to increase fees by more than the current deficit. Each time the cost to PVR licence holders increases, it is likely to reinforce a cycle of falling applications, requiring further increases to fees.

5.5.1 Breeders

The impacts of the move to a full cost recovery model will vary for small and large breeders. While the fees associated with obtaining a PVR are considered to be a cost of doing business, the ability to absorb a large fee increase depends on factors such as size of the industry for a plant type and the scale of breeding activity.

Large breeders

For large breeders that spend millions of dollars annually developing and registering new cultivars, the cost of PVR fees is a fraction of the overall costs of breeding and commercialising new plant cultivars. Therefore, the move to a full cost recovery model is unlikely to have a significant impact on their decision to develop and register new cultivars, or their ability to obtain an economic return in a full cost recovery model.

Domestic breeders informed us that they only apply for PVR protection if they intend to commercialise a cultivar, and that the ability to recover the costs of development and PVR protection are just some of the factors that inform this decision. When the breeder has access to large markets and a wide range of customers, they are able to spread the costs of development and PVR protection across these markets reducing the impact of increased PVR costs. Thus, breeders that develop varieties for export markets will have a greater ability to recoup such costs compared to those developing varieties for the domestic market. One stakeholder commented that for a large

breeder seeking PVR protection in multiple countries the impact of exchange rate fluctuations would be likely to have a greater impact than the decision to increase fees in New Zealand.

Small breeders

At a time when plant breeding is becoming more concentrated in large commercial breeding programmes, smaller commercial breeders and recreational breeders (backyard breeders) are likely to be impacted by any move to recover the full costs of the PVR scheme. Smaller breeders are commonly focused on plant cultivars targeted at smaller or niche markets, particularly ornamentals and forest trees, where the opportunity to generate significant commercial returns is more limited than for fruit breeders. This is because of the small size of the domestic market, and the lack of an export market. This is also true for those who breed varieties suited to the New Zealand climate, such as pasture breeders, as they are limited in their ability to recover costs from markets overseas. With much smaller markets across which to spread the increased cost, there is likely to be a reduction in the number of smaller breeders developing cultivars for these markets. In the case of some plant types, such as ornamentals, much of the breeding and development of new cultivars is undertaken by small breeders. For instance, one rose breeder we engaged with said that only a handful of professional breeders still exist in New Zealand. An increase in PVR-related costs would further reduce the economic viability of these operations and pose as a barrier to entry for potential new entrants, who are more likely to have smaller operations.

If small breeders cannot afford the same level of protection as larger breeders for their innovations, they may struggle to compete, leading to market imbalances. This could include a dominance of large breeders and the decline of breeding activity for certain plant types. For example, if ornamental breeders no longer consider plant breeding to be worth investing in, it could have a further detrimental impact on the already declining domestic ornamentals industry. Moreover, given that growers are generally able to sell PVR-protected varieties at a premium, they may see their profits declining, forcing them to exit the market.

Any reduction in domestic breeding as a result of a return to full cost recovery for funding for PVR would be likely to lead to reduced innovation and competition, with fewer domestically bred plant cultivars available to New Zealand's primary industries and consumers. This would have flow on effects for the economy, the environment, and society. These benefits include improved pastures that increase the productivity of dairy farming, fruits and vegetables that require fewer pesticides, new kiwifruit cultivars that are resistant to diseases, or an increase in the value of New Zealand exports in international markets.

Domestic plant breeding also promotes improved environmental outcomes. Environmental impacts are of increasing importance to consumers, and addressing them is a major part of the Government's Food and Fibre Industry Transformation Plan (Ministry for Primary Industries, 2022). The plan identifies an opportunity for the sector to transform from being seen only as a global provider of dairy and meat commodities, to being recognised as a global leader in environmental excellence, providing both traditional and emerging foods that are high-quality and nutrient rich. The transformed sector is expected to deliver more value per unit of output, lifting productivity, and underpinning an economy that delivers a high-wage, low emissions future for all.

5.5.2 Importers of cultivars bred overseas

Since the PVR scheme was established, over half of the applications (56 percent) have been made by, or on behalf of, overseas breeders. However, from 2013 to 2022 two thirds of applications were for cultivars bred overseas. Just as PVR fees are part of a larger total cost for breeders, importers of protected cultivars bred overseas see PVR fees as part of an overall cost that includes the import, quarantine, and legal costs. However, the PVR fee is a much greater proportion of the overall cost to be recovered. In addition to these costs, importers of cultivars bred overseas are required to pay royalties back to the overseas breeder which restricts the value importers can recover to pay increased PVR fees and remain competitive.

Stakeholders said that an increase in PVR costs would increase their overall costs associated with importing and/or developing a cultivar. The severity of these cost increases was evaluated within the context of how other costs were evolving, most importantly, Customs and quarantine costs. Stakeholders pointed out that these cost increases in particular were becoming an increasing concern, and higher PVR fees would add to overall costs, having a real impact on profitability. This would force them to reconsider the thresholds for sales that would allow them to maintain current profit margins.

While the majority of importers of cultivars bred overseas commented that they are already selective in the cultivars they bring to New Zealand, an increase in PVR fees would mean they are likely to become even more selective and reduce the number of cultivars they import. Although testing and experiences overseas can show the likely outcomes in New Zealand, importers can only truly know if a cultivar will be successful in New Zealand when it is grown in our conditions. For example, a cherry cultivar that had not performed well overseas was brought to New Zealand and was subsequently found to grow well here and is now a growing export cultivar. Bringing in fewer cultivars will reduce the chances of success as well as reduce the number of cultivars available to New Zealand growers and consumers. It should be noted that not all applicants believed that raising the hurdle to obtain a PVR application would lead to worse outcomes. For instance, one cultivar importer noted that the current system, which provides a subsidy to all applicants, may be encouraging some applicants to protect too many varieties, increasing the cost burden on the PVRO. An alternate system, where subsidies were provided based on individual need, depending on a pre-determined set of criteria, was considered too potentially be fairer.

If New Zealand cultivar importers become more risk averse as a result of higher PVR costs and choose not to bring a cultivar into New Zealand that subsequently becomes a desired cultivar by consumers, given the time required for importing, quarantine, testing, and granting, there is the potential that New Zealand could miss out on opportunities. If other countries opt to import the cultivar and complete the PVR process earlier, this will enable them to establish growers ahead of New Zealand.

It would not be possible for New Zealand to have internationally competitive domestic breeding programmes for every plant species. Increasing fees is likely to reduce the number of plant types and cultivars that importers bring into New Zealand to explore new opportunities and target new markets. Smaller importers, in particular, will be less likely to take risks to establish new horticultural industries in New Zealand. Increasing the PVR cost increases the risk for importers who

may need to import a number of cultivars to discover which grow best in New Zealand conditions. Importers are less likely to bring in new or innovative cultivars to New Zealand. This would reduce the options available to growers, who are essentially competing with growers internationally to obtain access to the newest varieties. One international breeder of cherries said that if costs were to increase to such an extent that they were spending more than what they could recover from the small New Zealand market, then they would stop shipping material to New Zealand. Ultimately growers would then be limited to growing older varieties, consumers would have fewer options, and opportunities to generate higher export revenue would decline.

Finally, imported cultivars can be used in domestic breeding. A reduction in the number of plant cultivars coming into New Zealand will reduce the options for domestic breeders to use traits to innovate and create new cultivars that evolve from cultivars that are imported from overseas, or to use traits from imported cultivars in the breeding process.

References

5+ A Day. (n.d.). *Potatoes*. Retrieved from https://www.5aday.co.nz/facts-and-tips/fruit-vegetable-info/potatoes/

Australian Productivity Commission. (2001). *Cost recovery by government agencies.* Retrieved from https://www.pc.gov.au/inquiries/completed/cost-recovery/report/costrecovery1.pdf

Australian Seed Federation. (2022). *Assessment of the sales volume and value of the Australian pasture seed industry.* Retrieved from https://www.asf.asn.au/wp-content/uploads/2022/03/ASF-Pasture-Metrics-Report-2022.pdf

Awokuse, T.O., & Yin, H. (2010). Does Stronger Intellectual Property Rights Protection Induce More Bilateral Trade? Evidence from China's Imports. *World Development, 38.*1094-1104.

Belrose Inc. (2018). *World Apple Review.* Retrieved from https://www.e-belrose.com/wp-content/uploads/2022/10/2022-World-Apple-Review-2018.pdf

Bergadá, P., Rapela, M. A., Enriquez, R., Risso, D., & Frers, J. (2016). *Generating value in the soybean chain through royalty collection: an international study*. Retrieved from https://www.urupov.org.uy/wp-content/uploads/2020/10/isfinternationalsoybeanstudy2016.pdf

BERL. (2021). *Economic impact 2021 Arable Food Industry Council.* Retrieved from https://www.afic.co.nz/wp-content/uploads/2022/07/AFIC-Economic-Impact-2021.pdf

Cabinet Office (2022). *Revised Fees Framework for members appointed to bodies in which the Crown has an interest.* Retrieved from https://www.dpmc.govt.nz/sites/default/files/2022-10/co-22-2-revised-fees-framework.pdf

Campi, M. (2017). The effect of intellectual property rights on agricultural productivity, *Agricultural Economics,* 48 (3):327-339. *10.*1111/agec.12337

Carew, R., Florkowski, W.J., & Meng, T. (2017). Intellectual property rights and plant variety protection of horticultural crops: evidence from Canada. *Canadian Journal of Plant Science*, 97(5): 737-754. https://doi.org/10.1139/cjps-2016-0239

Charity R. N., Johann F. K., & Binganidzo, M. (2019). The Effects of Plant Breeders' Rights on Wheat Productivity and Varietal Improvement in South African Agriculture, *Sustainability,* 11(12) 10.3390/su11123378.

Coriolis & Ministry for Business, Innovation and Employment. (2018). *Investment opportunities in the New Zealand cherry industry.* Retrieved from https://static1.squarespace.com/static/62b234e5b82e3f577d752b01/t/631e9d317188887fbaa68351/1662950719618/iFAB_2018_ego_cherries_100_LR.pdf

Di Fonzo, A., Nardone, V., Fathinejad, N., & Russo, C. (2019). The Impact of Plant Variety Protection Regulations on the Governance of Agri-Food Value Chains. *Social Sciences*, *8*(3): 91, https://doi.org/10.3390/socsci8030091.

European Union Intellectual Property Office and the Community Plant Variety Office of the European Union. (2022). *The impact of the community plant variety rights system on the EU economy and the environment.* Retrieved from https://cpvo.europa.eu/sites/default/files/documents/cpvr_study_full_report_0.pdf

Foundation for Arable Research. (2023). *New Zealand's arable industry*. Retrieved from https://assets.far.org.nz/files/display/8728/far-2-pager-web.pdf

Fresh Facts. (2021). *New Zealand horticultural exports.* Retrieved from https://www.freshfacts.co.nz/files/freshfacts-2021.pdf

Galushko, V. (2012). Do stronger intellectual property rights promote seed exchange: evidence from U.S. seed exports? *Agricultural Economics, 43* (1) https://doi.org/10.1111/j.1574-0862.2012.00620.x

Harmer, M., Stewart, A. V., & Woodfield, D. R. (2016). Genetic gain in perennial ryegrass forage yield in Australia and New Zealand. *Journal of New Zealand Grasslands*, 133-138.

Independent Pricing and Regulatory Tribunal. (2014). *Review of funding framework for local land services NSW.* Retrieved from https://www.productivity.govt.nz/assets/Documents/d1d7d3ce31/Final-report-Regulatory-institutions-and-practices.pdf

Index Mundi. (2023). *New Zealand Wheat Yield by year.* Retrieved from https://www.indexmundi.com/agriculture/?country=nz&commodity=wheat&graph=yield

Jördens, R. (2010). Benefits of plant variety protection. *WIPO Mag*, *3*, 20.

Kolady, D. E., & Lesser, W. (2009) Does Plant Variety Protection Contribute to Crop Productivity? Lessons for Developing Countries from US Wheat Breeding, *The Journal of Intellectual Property, 12* (2) https://doi.org/10.1111/j.1747-1796.2009.00354.x

Lammerts van Bueren, E. T., Struik, P. C., van Eekeren, N., & Nuijten, E. (2018). Towards resilience through systems-based plant breeding. A review. Agronomy for sustainable development, 38, 1-21.

Macdonald, B. (2020). *What bread says about our food security.* Retrieved from https://www.renews.co.nz/what-bread-says-about-our-food-security/

Mamias, S. (2018). *The floriculture supply-chain: characteristics and prospects.* Retrieved from https://unionfleurs.org/wp-content/uploads/2018/11/UF_Characteristics-of-the-Flower-Supply-chain-_FEB-2018.pdf

Maskus, K. E. (2000). Intellectual property rights and economic development. *Case W. Res. J. Int'l L.*, *32*, 471.

Ministry for Primary Industries. (2018). *Cost recovery at MPI: findings from the first principles review of MPI's cost recovery arrangements.* Retrieved from https://www.mpi.govt.nz/dmsdocument/30849-Supporting-information-for-Cost-Recovery-at-MPI

Ministry for Primary Industries. (2022). *Food and beverage draft industry transformation plan*. Retrieved from https://www.mpi.govt.nz/dmsdocument/54505-Food-and-Beverage-Draft-Industry-Transformation-Plan

Ministry for Primary Industries. *Situation and outlook for primary industries.* Retrieved from https://www.mpi.govt.nz/dmsdocument/57298-Situation-and-Outlook-for-Primary-Industries-SOPI-June-2023

Ministry of Business, Innovation and Employment. (2019). *Options paper: Review of the Plant Variety Rights Act 1987.* Retrieved from https://www.mbie.govt.nz/assets/b79142e0a7/options-paper-review-of-the-plant-variety-rights-act-1987.pdf

Ministry of Business, Innovation and Employment. (2022). *Plant Variety Rights Regime Fees Review 2022: release of discussion document and reprioritisation of funding* (Cabinet paper). Retrieved from https://www.mbie.govt.nz/dmsdocument/20235-plant-variety-rights-regime-fees-review-2022-release-of-discussion-document-and-reprioritisation-of-funding-proactiverelease-pdf

Ministry of Business, Innovation and Employment. (2023). *Plant Variety Rights scheme fees review 2022: cost recovery impact statemen* (briefing paper). Retrieved from https://www.mbie.govt.nz/dmsdocument/26227-plant-variety-rights-scheme-fees-review-2022-proposed-fees-cost-recovery-impact-statement-proactiverelease-pdf

Minyu, Z., Sheldon, I., & Jihyun, E. (2018). The role of intellectual property rights in seed technology transfer through trade: evidence from U.S. field crop seed exports, *Agricultural Economics, 49 (4)*: 423-434, doi.10.1111/agec.12426.

Naseem, A., Oehmke, J. F., & Schimmelpfennig, D. E. (2005). Does Plant Variety Intellectual Property Protection Improve Farm Productivity? Evidence from Cotton Varieties. *AgBioForum 8:* 100–107.

Natural Resources Defense Council. (2022). *Neonicotinoids 101: the effects on humans and bees.* Retrieved from https://www.nrdc.org/stories/neonicotinoids-101-effects-humans-and-bees

New Zealand Horticulture Export Authority. (n.d.). *Kiwifruit and kiwiberry*. Retrieved from https://www.hea.co.nz/2012-05-11-03-05-28/kiwifruit-trade

New Zealand Horticulture Export Authority. (n.d.). *Summerfruit (cherries, apricots, peaches, nectarines, plums).* Retrieved from https://hea.co.nz/2012-05-11-03-05-28/summerfruit-trade#:~:text=total%20export%20value.-,Cherries.,of%20the%20exports%20by%20value

New Zealand Kiwifruit Growers. (2022). *2022 Kiwifruit Book.* Retrieved from https://www.nzkgi.org.nz/wp-content/uploads/2022/11/J002821_NZKGI_KF_Book_2022_RGB.pdf

New Zealand Productivity Commission. (2014). *Regulatory institutions and practices*. Retrieved from https://www.productivity.govt.nz/assets/Documents/d1d7d3ce31/Final-report-Regulatory-institutions-and-practices.pdf

New Zealand Treasury. (2017). *Guidelines for setting charges in the public sector.* Retrieved from https://www.afic.co.nz/wp-content/uploads/2022/07/AFIC-Economic-Impact-2021.pdf

NZ Flour Millers Association. (n.d.). *Wonders of wheat.* Retrieved from https://flourinfo.co.nz/learn/wheat

Perrin, R. K., Kunnings, K., & Ihnen, L.A. (1983). Some Effects of the US Plant Variety Protection Act of 1970. Economics Research Report 46. Raleigh, NC: North Carolina State University.

Plant & Food Research. (2023). Annual Report 2022. Retrieved from https://assets.ctfassets.net/y9no91j9bwnp/76IIOJPTXrkFc36AE8oHiR/ddebabb499cf3c704e53d712a9392ac8/plant-and-food-research-annual-report-2022.pdf

Ratnayake, I. (2016). *The experiences of New Zealand floriculture export producers in the changing international market: what can be done to strengthen the sector's capabilities?* Retrieved from https://openrepository.aut.ac.nz/server/api/core/bitstreams/33fe2425-192c-4ae1-8f50-04c35643f910/content

Ritchie, H. (2022). *After millennia of agricultural expansion, the world has passed 'peak agricultural land'.* Retrieved from https://ourworldindata.org/peak-agriculture-land

Smale, M., Singh, J., Di Falco, S. & Zambrano, P. (2008). Wheat breeding, productivity and slow variety change: evidence from the Punjab of India after the Green Revolution. Australian *Journal of Agricultural and Resource Economics, 52:* 419-432. https://doi.org/10.1111/j.1467-8489.2008.00435.x

Stats NZ. (2023). Overseas merchandise trade: March 2023. Retrieved from https://www.stats.govt.nz/information-releases/overseas-merchandise-trade-march-2023/#:~:text=March%202023%20monthly%20values%20are,a%20deficit%20of%20%241.3%20billion

The Australian Chamber of Commerce and Industry. (2000). *Cost recovery: ACCI submission to the Productivity Commission*. Retrieved from https://www.pc.gov.au/inquiries/completed/cost-recovery/submissions/australian_chamber_of_commerce_and_industry_/sub070.pdf

UPOV (2005). *UPOV report on the impact of plant variety protection*. Retrieved from https://www.upov.int/edocs/pubdocs/en/upov_pub_353.pdf

Voss-Fels, K. P., Stahl, A., & Hickey, L. T. (2019). Q&A: Modern crop breeding for future food security. BMC biology, 17(1), 1-7.

Waitangi Tribunal. (2011). *WAI262: Waitangi Tribunal report 2011.* Retrieved from https://forms.justice.govt.nz/search/Documents/WT/wt_DOC_68356054/KoAotearoaTeneiTT1W.pdf

World Intellectual Property Organisation. (2006). *The impact of Plant Variety Protection*. Retrieved from https://www.wipo.int/wipo_magazine/en/2006/04/article_0004.html

Wyatt, S., Moore, D., Boyle, R. (2019). *What is really innovation in our plant-based sectors.* Retrieved from https://www.mbie.govt.nz/assets/72ecc56436/what-is-really-driving-innovation-in-our-plant-based-sectors.pdf

Zespri Kiwifruit. (2023). *Zespri Annual Report 2022/23.* Retrieved from https://www.zespri.com/content/dam/zespri/nz/publications/annual-reports/Zespri-Annual-Report-2022-23-V2.pdf

Zsögön, A., Peres, L. E., Xiao, Y., Yan, J., & Fernie, A. R. (2022). Enhancing crop diversity for food security in the face of climate uncertainty. The Plant Journal, 109(2), 402-414.