OWNERSHIP AND OBJECTIVITY: JUDGING VARIETIES FOR PLANT BREEDER'S RIGHTS IN AUSTRALIA

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To receive intellectual property protection under the International Convention for the Protection of New Varieties of Plants, new plant varieties must pass a Distinctness, Uniformity and Stability ('DUS') trial proving that they are distinct from existing varieties, uniform in their relevant characteristics, and stable across generations. This article examines how this scientific-legal judgement process occurs in Australia, contrasting its relatively decentralised approach with the centralised assessment systems used in most European countries. I argue that the pursuit of objective judgement is the central tenet of the plant breeder's rights systems, and that calls to increase objectivity with technological changes can obscure embedded value judgement and power relations. The DUS criteria serve to reinforce this objectivity, and to discipline mutable and heterogenous plant life into a form which approximates a consistent and identifiable object – a necessity for the operation of intellectual property law, despite consequences for agricultural genetic diversity and resilience.

I INTRODUCTION

What qualifies a group of plants as a variety worthy of receiving intellectual property protection? What makes two plant varieties the same or different, and who should make this determination? What testing processes are used to make these judgements? What is the role of technology in this process, and how is this likely to change in the future? Underlying these, a more fundamental normative question: *how should plants be judged*?

This article explores these questions through a detailed examination of how judgement occurs in Australia's plant breeder's rights ('PBR') system, a domestic implementation of the *International Convention for the Protection of New Varieties*

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of Plants (‘*UPOV Convention*’).[1] It compares the Australian system of relatively decentralised judgement to the more centralised systems of France, Germany, the Netherlands, and the United Kingdom, drawing on interviews and participant observation conducted in all five countries.[2] While my focus is on the operation of the Australian system, I discuss the centralised systems used in the European Union and United Kingdom (referenced collectively as ‘European systems’ for brevity) to draw out similarities and contrasts. As with all systems based on the *UPOV Convention*, Australia’s assessment process is centred around the three criteria required for rights to be granted – distinctness, uniformity, and stability, collectively referred to as the ‘DUS criteria’.[3] These criteria are judged through a ‘DUS trial’, also referred to as a ‘field trial’ or ‘growing trial’.

The design of intellectual property systems is inherently political and ethical, dealing as it does with questions of equity, distribution, and fair reward for work. This is particularly true of agricultural intellectual property, which has a direct impact on access to food through its influence on the rights of farmers and on the incentive structures for plant breeding.[4] Intellectual property regimes determine who can obtain rights, what incentives to create exist, and what form those rights (and accordingly the object of those rights) must take. While the value judgements embedded in laws are often self-evident, particularly in heavily politicised arenas such as criminal law, they can be less visible in technical areas of the law such as PBR. This mirrors a tendency towards the depoliticisation of regulation through technocratic control,[5] a process which draws on an image of science as purely technical, disinterested, and apolitical.[6]

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1 UPOV is an acronym for the International Union for the Protection of New Varieties of Plants (in French, the *Union internationale pour la protection des obtentions végétales*). The eponymous *UPOV Convention* sets out an international legal regime for providing intellectual property protection for new varieties of plants, which countries can implement internally: *International Convention for the Protection of New Varieties of Plants*, opened for signature 2 December 1961, 1861 UNTS 281 (entered into force 10 August 1968) (‘*UPOV Convention*’).

2 These semi-structured interviews were transcribed, and then thematically coded into the following categories: field trials, distinctness, uniformity, stability, comparator variety selection, training and expertise, genetic assessment, and reference collections. Interviews with Qualified Persons (experts accredited to certify new PBR applications) have been pseudonymised to comply with research ethics approvals.

3 *Plant Breeder’s Rights Act 1994* (Cth) s 43 (‘*PBR Act*’); International Union for the Protection of New Varieties of Plants (‘UPOV’), *General Introduction to the Examination of Distinctness, Uniformity and Stability and the Development of Harmonized Descriptions of New Varieties of Plants*, Doc No TG/1/3, 19 April 2002 (‘*General Introduction*’) <https://www.upov.int/export/sites/upov/publications/en/tg_rom/pdf/tg_1_3.pdf>.

4 Jack Ralph Kloppenburg, *First the Seed: The Political Economy of Plant Biotechnology* (University of Wisconsin Press, 2nd ed, 2004) 130–51.

5 Keller Easterling, *Extrastatecraft: The Power of Infrastructure Space* (Verso, 2014) ch 1; Erik Swyngedouw, ‘Apocalypse Forever? Post-political Populism and the Spectre of Climate Change’ (2010) 27(2–3) *Theory, Culture and Society* 213, 215; Aniket Aga, *Genetically Modified Democracy: Transgenic Crops in Contemporary India* (Yale University Press, 2021) 131.

6 Judith Tsouvalis, ‘Latour’s Object-orientated Politics for a Post-political Age’ (2016) 6 *Global Discourse* 26; Bruno Latour, ‘Scientific Objects and Legal Objectivity’ in Alain Pottage and Martha Mundy (eds), *Law, Anthropology, and the Constitution of the Social: Making Persons and Things* (Cambridge University Press, 2004) 73, 82.

I focus in this article on the various techniques and procedures used to make the legal-scientific apparatus of PBR more objective. Drawing on Lorraine Daston and Peter Galison's description of objectivity as an 'epistemic virtue' and an aspirational 'regulative ideal',[7] I discuss how objective judgement is viewed as an intrinsic good for the PBR system. Many aspects of PBR can only be understood as aiming at objectivity, including its standardised formal procedures, its deployment of empirical tests, and its ongoing turn toward technological automation and quantification through genetic assessment. While the goal of a PBR system is to incentivise the creation of new plant varieties, I argue that objectivity is the central ethic permeating the operation of plant breeder's rights, and that the objectivity of judgement processes is key to the legitimisation of intellectual property claims.

Daston and Galison describe objectivity as a historically-situated 'epistemic virtue', observing that 'ethos was explicitly wedded to epistemology in the quest for truth or objectivity or accuracy'.[8] These epistemic virtues acted, and continue to act, as regulatory ideals – aspirational models of how science should be conducted.[9] The way the regulatory ideal of objectivity structures scientists' behaviour and mindset recalls Foucault's concept of technologies of the self, 'which permit individuals to effect by their own means or with the help of others a certain number of operations on their own bodies and souls, thoughts, conduct, and way of being'.[10] Peter Pels notes that 'all scientific methodologies are technologies of the self, for they are meant to constitute a subject that is universal and transparent, a non-presence that can serve as a perfectly neutral carrier of truth'.[11] The epistemic virtue of objectivity is internalised, institutionalised, and subsequently engrained in scientific institutional cultures.

Despite thorough attempts at ensuring standardisation and objectivity, my research suggests that intuitive human judgement remains an important part of PBR assessments.[12] Alternatively described as tacit knowledge,[13] *metis*,[14] conjectural knowledge,[15] or skilled vision,[16] some forms of judgement are embodied, experiential, and difficult to systematise (or even to reduce to language). I discuss this as an

7 Lorraine Daston and Peter Galison, *Objectivity* (Zone Books, 2007) 233.

8 Ibid 204.

9 Ibid 233.

10 Michel Foucault, 'Technologies of the Self' in Luther Martin, Huck Gutman and Patrick Hutton (eds), *Technologies of the Self: A Seminar with Michel Foucault* (University of Massachusetts Press, 1988) 16, 18.

11 Peter Pels, 'The Trickster's Dilemma: Ethics and the Technologies of the Anthropological Self' in Marilyn Strathern (ed), *Audit Cultures: Anthropological Studies in Accountability, Ethics and the Academy* (Routledge, 2000) 135, 153.

12 Hamish MacDonald, 'Who Judges Plants? Scientific-Legal Judgement of Varieties for Plant Breeder's Rights' (2023) *The Journal of World Intellectual Property* 1, 10 <https://doi.org/10.1111/jwip.12276>.

13 See generally Haridimos Tsoukas, 'Do We Really Understand Tacit Knowledge?' in Stephen Little and Tim Ray (eds), *Managing Knowledge: An Essential Reader* (SAGE Publications, 2nd ed, 2002) 107; Natasha Myers, *Rendering Life Molecular: Models, Modelers, and Excitable Matter* (Duke University Press, 2015) 20.

14 See James C Scott, *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed* (Yale University Press, 1998) 177.

15 Carlo Ginzburg, 'Morelli, Freud and Sherlock Holmes: Clues and Scientific Method' (1980) 9(1) *History Workshop Journal* 5, 21.

16 Cristina Grasseni, 'Skilled Vision: An Apprenticeship in Breeding Aesthetics' (2004) 12(1) *Social Anthropology* 41.

example of another of Daston and Galison's epistemic virtues, that of 'trained judgement' – 'the necessity of seeing scientifically through an interpretive eye'.[17] Daston and Galison detail how 'unconscious criteria – "tacit", "sophisticated", "experience-based" pictorial judgements – came to be seen as a crucial component of day-to-day scientific routine',[18] presenting trained judgement as an epistemic response to mechanical objectivity while noting that 'each new regimen of sight supplements rather than supplants the others'.[19] As Galison summarises elsewhere, 'in the twentieth century there was an increased sense that judgment was needed – "expert judgment" – and it could be trained; we learn, in a way that is robust (other trained analysts make the same distinctions), how to separate a grand-mal seizure on an electroencephalogram from a petit-mal seizure'.[20] They link this development to the standardisation and collectivisation of scientific training.[21]

Mechanical objectivity and trained judgement do not necessarily conflict with one another. As Daston and Galison put it, '[t]hese experts did not reject "objective" instruments … on the contrary, they embraced instruments, along with shareable data and images, as the infrastructure on which judgement would rest',[22] such that '[i]n all sectors, personnel … were taught to see their scientific images as matters requiring computer-assisted quantification *and* trained judgement'.[23] Galison makes a similar argument, stating that 'part of objective depiction involved the deployment of well-trained judgment (not genius but training)'.[24]

Throughout this article, I discuss how trained judgement complements objectivity in the PBR system, by formalising and systematising those aspects of judgement which are not amenable to more mechanical or structural forms of objectivity. Trained judgement operates to support the objectivity of the PBR system, legitimising those aspects of assessing plants which cannot be translated into standardised procedures and equipment. Such assessments may involve the intuitive, subjective, and even unconscious weighing of many factors. Nonetheless, the convergence of expert assessments allows trained judgement to support rather than disrupt the pursuit of objectivity. As Daston and Galison observe, 'the complexity and nonmechanical nature of this identificatory process does not block the possibility of arriving at an appropriate and replicable set of discriminations'.[25]

I begin by exploring the history and fundamental assumptions of PBR: that intellectual property rights should cover living organisms and are required to incentivise innovative plant breeding. I then contrast the relatively decentralised system of PBR in Australia with the more centralised and rigorous European Union and United Kingdom regimes. I finish by examining the precepts and assumptions

17 Daston and Galison (n 7) 311.
18 Ibid 314.
19 Ibid 318.
20 Peter Galison and Winifred Elysse Newman, 'Interview with Peter Galison: On Method' (2021) 5(1) *Technology, Architecture and Design* 5, 8.
21 Daston and Galison (n 7) 327.
22 Ibid 329.
23 Ibid 330 (emphasis in original).
24 Galison and Newman (n 20) 7.
25 Daston and Galison (n 7) 333.

embedded in the legal criteria of distinctness, uniformity, and stability, and the place of PBR in industrial agriculture.

II TECHNOLOGIES OF OWNERSHIP

PBR presuppose private ownership of types of living organisms. Exclusive ownership of a class of self-replicating plants is the founding assumption underlying PBR, and the basic norm at the heart of the UPOV system. The extension of intellectual property rights to encompass plant varieties was a conceptual and technological development which occurred over a long period of time, building on changes in botany, plant breeding, and patent law.[26]

PBR arose from concerns over 'plant piracy', the professionalisation and institutionalisation of plant breeding,[27] the growth of the commercial seed and nursery industries,[28] non-legal mechanisms for preventing copying,[29] and the expansion of other forms of intellectual property laws.[30] An increase in private professional breeding brought with it a growing desire to generate economic returns from new varieties, and plant piracy was perceived as a threat to these returns. A range of national approaches were trialled throughout the 20th century, until the enactment of the *UPOV Convention* in 1961 to provide an internationally harmonised approach to plant intellectual property law.[31]

Developing a functional system of plant intellectual property depended on established bodies of scientific and technical knowledge, and on grafts from patent law.[32] The variability of plants was originally managed through breeding techniques: plant patents in the United States were limited to asexually reproduced species,[33] which were considered analogous to industrial copies due to their tendency to breed true.[34] Description requirements for plant patents were relaxed, due to the difficulty of accurately describing plant varieties.[35] When the *UPOV Convention* was developed, the DUS criteria of uniformity and stability were introduced as 'technical requirements'

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26 Brad Sherman, 'Taxonomic Property' (2008) 67(3) *Cambridge Law Journal* 560, 566 <https://doi.org/10.1017/S0008197308000676>.

27 Jay Sanderson, *Plants, People and Practices: The Nature and History of the UPOV Convention* (Cambridge University Press, 2017) 22–5.

28 Daniel J Kevles, 'New Blood, New Fruits: Protections for Breeders and Originators, 1789–1930' in Mario Biagioli, Peter Jaszi and Martha Woodmansee (eds), *Making and Unmaking Intellectual Property: Creative Production in Legal and Cultural Perspective* (University of Chicago Press, 2011) 253, 254.

29 Sanderson (n 27) 25–8.

30 Kevles (n 28) 264; Sanderson (n 27) 34; André Heitz, 'The History of the UPOV Convention and the Rationale for Plant Breeders' Rights' in UPOV, *Seminar on the Nature of and Rationale for the Protection of Plant Varieties under the UPOV Convention*, Doc No 697(E), 19–21 September 1990, 19 <https://www.upov.int/edocs/pubdocs/en/upov_pub_727.pdf>.

31 Heitz (n 30) 37.

32 Hamish MacDonald, 'Abstracting Plants: Legal and Scientific Judgement in Australia's Plant Breeder's Rights System' (PhD Thesis, University of Queensland, 17 May 2022) 10 <https://doi.org/10.14264/cf21e18> ('Abstracting Plants').

33 Robert C Cook, 'The First Plant Patent' (1931) 22(10) *Journal of Heredity* 313.

34 Alain Pottage and Brad Sherman, *Figures of Invention: A History of Modern Patent Law* (Oxford University Press, 2010) 162 <https://doi.org/10.1093/acprof:osobl/9780199595631.001.0001>.

35 Joseph Rossman, 'Plant Patents' (1931) 13 *Journal of the Patent Office Society* 7, 15.

imposed on plant breeders for the purpose of addressing and controlling the variability and instability of plant varieties, based on the already established technologies of plant breeding and taxonomy.[36] UPOV's characteristic system addressed difficulties with standardising the description of plant varieties, by establishing exact rules specifying which parts of the plant should be assessed and how.[37]

The UPOV system developed as a solution for discipling, identifying, and owning plant varieties, including those which reproduce sexually (contra United States plant patents). Since its enactment the *UPOV Convention* has passed through three Acts, each making significant modifications to the PBR system.[38] The UPOV system largely consists of a vast repository of technical documents, guidelines, processes, working groups, information documents, and legal resources.[39] Through these additions and alterations, it continues to adapt and refine its function of creating private property in plant varieties, continually integrating new techniques including genetic testing,[40] image analysis,[41] and machine learning.[42] The PBR system itself, as an international regime facilitating and normatively justifying the ownership of plant varieties, is continuously being monitored, assessed, and modified. Despite this, the foundational rationale of this system – that plant intellectual property is ultimately beneficial for society – remains disputed by some commentators.

Like all forms of intellectual property, PBR are generally considered to be an effective mechanism for generating private wealth.[43] Their utility for incentivising effective plant breeding is more challenging to assess, with studies yielding contradictory results.[44] Alongside critiques that PBR laws are ineffective at spurring innovation, objections include deontological arguments against the ownership of lifeforms,[45] arguments against increasing privatisation, consolidation, or monopoly

36 Heitz (n 30) 38; Sherman (n 26) 578–80.

37 MacDonald, 'Abstracting Plants' (n 32) 62.

38 See 'UPOV Lex', *UPOV* (Web Page) <https://upovlex.upov.int/en/convention>.

39 'UPOV Collection', *UPOV* (Web Page) <https://www.upov.int/upov_collection/en/>.

40 UPOV, Council of UPOV, *Guidelines for DNA-Profiling: Molecular Marker Selection and Database Construction ("BMT Guidelines")*, Doc No UPOV/INF/17/2, 21 September 2021.

41 UPOV, Office of the Union, *Image Analysis*, Doc No TWP/1/10, 9 June 2017 ('*Image Analysis*'); P Lootens et al, 'Comparison of Image Analysis and Direct Measurement of UPOV Taxonomic Characteristics for Variety Discrimination as Determined over Five Growing Seasons, Using Industrial Chicory as a Model Crop' (2013) 189(3) *Euphytica* 329 <https://doi.org/10.1007/s10681-012-0750-9>.

42 UPOV, Technical Working Party on Testing Methods and Techniques, *Machine Learning Innovar Project*, Doc No TWM/1/25, 1st sess, 19–23 September 2022.

43 Herman Mark Schwartz, 'Wealth and Secular Stagnation: The Role of Industrial Organization and Intellectual Property Rights' (2016) 2(6) *Russell Sage Foundation Journal of the Social Sciences* 226 <https://doi-org.10.7758/RSF.2016.2.6.11>; Dermot J Hayes, Sergio H Lence and Susana Goggi, 'Impact of Intellectual Property Rights in the Seed Sector on Crop Yield Growth and Social Welfare: A Case Study Approach' (2009) 12(2) *AgBioForum* 155.

44 Jay Sanderson and Kathryn Adams, 'Are Plant Breeder's Rights Outdated? A Descriptive and Empirical Assessment of Plant Breeder's Rights in Australia, 1987–2007' (2008) 32(3) *Melbourne University Law Review* 980; Cassandra Mehlig Sweet and Dalibor Sacha Eterovic Maggio, 'Do Stronger Intellectual Property Rights Increase Innovation?' (2015) 66 *World Development* 665 <https://doi.org/10.1016/j.worlddev.2014.08.025>; Community Plant Variety Office and European Union Intellectual Property Office, *Impact of the Community Plant Variety Rights System on the EU Economy and the Environment* (Report, April 2022) 58; Russell Thomson, 'The Yield of Plant Variety Protection' (2015) 97(3) *American Journal of Agricultural Economics* 762 <https://doi.org/10.1093/ajae/aau099>.

45 Vandana Shiva, *The Vandana Shiva Reader* (University Press of Kentucky, 2015) 139.

rights,[46] assertions that plant intellectual property promote genetic uniformity,[47] and broader critiques of the role of intellectual property in capitalism and colonialism.[48]

For the remainder of this article, I set aside important normative questions about the desirability of exclusive rights over plant varieties, the expansion of intellectual property, and the extension of proprietary logics to new domains of extraction. Instead, I focus on the specific national system of owning plants in Australia, contrasting this with the centralised testing systems of France, Germany, the Netherlands, and the United Kingdom.[49] I begin by exploring the most marked divergency between Australian and European systems: their approach towards selecting comparator varieties, which are compared with candidate varieties to establish distinctness.

III COMPARING COMPARATORS

One of the main purposes of DUS trials is to determine that the candidate variety is distinguishable from all existing varieties of common knowledge.[50] The idea behind this requirement is that if a variety is not physically distinguishable from an existing variety, it already exists and should not receive intellectual property rights. Distinctness is assessed by comparing the candidate variety to 'reference' or 'comparator' varieties (and in centralised testing systems, to other similar candidate varieties). Selecting appropriate varieties of common knowledge to serve as comparator varieties is important, as these are the varieties against which the candidate variety must be judged to determine whether they are distinct.[51]

The approach to comparator varieties is where the Australian PBR system most clearly differs from centralised approaches. Many countries, including the United Kingdom,[52] France,[53] the Netherlands,[54] and Germany[55] use centralised reference collections for the purposes of storing and selecting comparator varieties. In a

46 Pat Roy Mooney, *Seeds of the Earth: A Private or Public Resource?* (Inter Pares, 1980) 62–3.

47 Ibid; Vandana Shiva, *Monocultures of the Mind: Perspectives on Biodiverstity and Biotechnology* (Zed Books, 1993) 71.

48 Kloppenburg (n 4); Vandana Shiva, *Protect or Plunder? Understanding Intellectual Property Rights* (Zed Books, 2001).

49 Due to the United Kingdom's previous inclusion in the European Union, its PBR system is very similar to those of the other European Union countries I visited (which are themselves largely standardised). As a result, I often treat these collectively as 'European systems'.

50 *General Introduction* (n 3) 4.

51 IP Australia, 'Plant Breeder's Rights (PBR) Manual of Practice and Procedure' (Manual, 23 August 2023) pt 4 <https://manuals.ipaustralia.gov.au/pbr/part-4.-test-growing> ('PBR Manual').

52 Animal and Plant Health Agency, 'DUS Protocols for Testing Plant Varieties', *Government of the United Kingdom* (Web Page, 5 December 2023) <https://www.gov.uk/guidance/dus-protocols-for-testing-plant-varieties>.

53 UPOV, *Arrangements for DUS Testing*, Doc No TGP/6: Section 2/1, 6 April 2005 11–15 ('*Arrangements for DUS Testing*').

54 Laura Piñán González, 'Experience of the Netherlands on DUS Examination' (Training Presentation, UPOV, 17 May 2017) <https://www.upov.int/edocs/mdocs/upov/en/upov_trainer_en_17/upov_trainer_en_17_09.pdf>.

55 Beate Rücker, 'Management of Variety Collections: Experience in Germany' (Seminar Presentation, UPOV, 18 March 2010) <https://www.upov.int/edocs/mdocs/upov/en/dus_seminar/session_6_3_de__beate.pdf>.

representative example of this approach, the French system, 'all new varieties and reference varieties are described and compared in the same environment'.[56] These reference collections 'are composed of varieties listed and/or protected in France and in the countries with similar environmental conditions',[57] and are 'updated each year: for each new variety, the breeder is asked to provide a seed sample and a variety description'.[58] These seeds are stored under carefully controlled conditions, particularly temperature and humidity.[59] Important vegetatively-propagated species are maintained all year round through repeated propagation.[60] Comparator varieties are then selected from this reference collection to be grown alongside the candidate variety, on the basis of factors which can include breeder-completed technical questionnaires describing the variety phenotypically, grouping characteristics, the expertise of government staff, databases, photo collections, living plant collections, DNA information, and external species experts invited to give advice.[61]

These reference collections aspire towards being a comprehensive bank of commercial varieties suitable for the climatic conditions of their location. Geographical, environmental, and climatic differences mean that centralised collections are region-specific.[62] DUS trials involve large numbers of varieties, sometimes encompassing the entire reference collection of a species, and all candidate varieties are grown and compared against one another. Accordingly, claims that an appropriate comparator variety was missed are vanishingly rare.[63] To enable systems of centralised testing, a network of actors, resources, and infrastructure is required: growing fields, laboratory equipment, botanical experts, support staff, plant material, industry contacts, seed storage facilities, and so on. As Mario Biagioli and Marius Buning observe in the context of patent law, 'IP is much more than a text, a doctrine, or a specific form of enunciation … it involves a staggering amount of infrastructure, technologies, and labor'.[64]

56 *Arrangements for DUS Testing* (n 53) 11.
57 Ibid 12.
58 Ibid.
59 Ibid. All of the DUS testing facilities I visited in France, Germany, the Netherlands, and the United Kingdom had extensive infrastructure for storage and climate-control.
60 *Arrangements for DUS Testing* (n 53).
61 These are sometimes termed 'walking reference collections': Raoul Haegans, 'Management of Variety Collections: Experience in the Netherlands' (Seminar Presentation, UPOV, 19 March 2010) <https://www.upov.int/edocs/mdocs/upov/en/dus_seminar/session_6_5_nl_haegens.pdf>. This was also gained through site visits in France, Germany, the Netherlands, and the United Kingdom.
62 This was confirmed during interviews at each of the testing centres I visited.
63 Ibid.
64 Mario Biagioli and Marius Buning, 'Technologies of the Law/Law as a Technology' (2019) 57(1) *History of Science* 3, 14.

Figure 1: DUS testing of carrots in Europe. These are harvested at a standardised time, allowing the DUS characteristics of the taproots to be compared.

Figure 2: DUS testing in the Netherlands. Varieties are planted in rows, with similar varieties placed next to one another to facilitate comparisons.

Figure 3: Permanent infrastructure for DUS testing in Europe.

Figure 4: DUS testing of succulents and carnivorous plants. The samples are randomised, with numeric labels attached to allow identification of physical specimens. Data collection is carried out with the aid of a software tool, which receives measurements and categorisations and outputs whether the variety is distinct, uniform, and stable according to UPOV protocols.

In European Union countries and in the United Kingdom, PBR are interlinked with national listing and seed certification regimes. These countries prohibit the marketing of most agricultural and horticultural crops unless they have received national listing, which requires both a DUS test and a Value for Cultivation and Use ('VCU') test to prove that a variety is agronomically satisfactory compared to the current state of the art.[65] Seed certification regimes test and accredit the health, purity, and germination rate of seeds.[66] Seed certification and national listing are often conducted by the same institutions responsible for PBR, as these regimes also rely on centralised expertise and resources.

65 'Guidelines for Conducting Agricultural VCU Testing and Variety Testing', *Bundessortenamt* (Web Page, March 2021) <https://www.bundessortenamt.de/bsa/en/variety-testing/national-listing/guidelines-for-conducting-agricultural-vcu-testing-and-variety-testing>; 'VCU Protocols and Procedures for Testing Agricultural Crops', *United Kingdom Government* (Web Page, 31 October 2023) <https://www.gov.uk/guidance/vcu-protocols-and-procedures-for-testing-agricultural-crops>.

66 Department for Environment, Food and Rural Affairs and Animal and Plant Health Agency, 'Apply to Have Seeds Certified for Marketing in England and Wales', *United Kingdom Government* (Web Page, 27 December 2023) <https://www.gov.uk/guidance/the-marketing-of-agricultural-and-vegetable-seed-varieties>; 'How French Seeds Are Certified', *SEMAE: French Interprofessional Organisation for Seeds and Plants* (Web Page) <https://www.semae.fr/en/how-french-seeds-are-certified/>.

Figure 5: Centralised storage of seeds in France. Seeds are sorted and stored in specialised climate-controlled rooms. They are retrieved and planted as comparator varieties in DUS trials as needed.

In Australia, no centralised variety collection exists. In contrast to more centralised assessment regimes, growing trials in Australia are primarily conducted by Qualified Persons – individual experts accredited to test specific plant species, often including their own varieties. Instead of a comprehensive collection of varieties, the most similar varieties of common knowledge are selected by the Qualified Person prior to the growing trial, approved by IP Australia, and then grown alongside the candidate variety for the DUS test. In Australia, the number of comparator varieties used frequently ranges from one to four,[67] in stark contrast to the multitudes of varieties used in European DUS tests. Without a centralised reserve of plant varieties to compare to the candidate variety, selecting comparator varieties assumes a particular importance, since the selection of comparators can directly impact on whether a PBR application is successful. As an official from Australia's Plant Breeder's Rights Office put it:

> In my view, the choosing of varieties of common knowledge is the most important thing that needs to be correct in the PBR application process, because we've found that if that is right, almost everything else can fall into place and works. Because if you're comparing your new variety to the most similar existing variety that's out there, and you're able to demonstrate that it's distinct from that variety, you've got over the biggest hurdle. … If you fail to include the most similar variety in the trail, then there's always that question out there, is there something more similar? So that's what we're always trying to achieve, is to make sure we've got the most similar variety included as a comparator variety in the trial.[68]

The choice of appropriate comparator varieties is significant for at least two reasons. First, this selection ensures the accuracy and legitimacy of the field trial, since an assessment of distinctness is meaningless unless it is made against the most similar varieties. A growing trial which failed to include the most similar known varieties could have its validity challenged on that basis, jeopardising the grant of PBR.[69] Secondly, selecting appropriate comparator varieties can pre-empt possible future challenges by including likely challengers, proving their distinctness and removing that avenue of challenge. One Qualified Person stated that they 'try and put anything that we believe might be a challenge. So an example of that is, if we know another IP company has something that they think might be similar, we normally include that into the trial as well'.[70] Including likely challenges prevents them from becoming an issue later. Once the assessment process is complete, IP Australia allows six months following public notice for objections, and the variety is then finalised;[71] including a potential challenger as a comparator variety effectively prevents the owner of this variety from objecting to the grant on the basis that the candidate variety was not distinct. Given the importance of this decision, and the lack of a central repository to select from, how are comparator varieties selected in the Australian system?

67 Analysis of the 2020 and 2021 editions of the *Plant Varieties Journal*: see 'Plant Varieties Journal', *IP Australia* (Web Page) <https://www.ipaustralia.gov.au/tools-and-research/professional-resources/ip-rights-journals/plant-varieties-journals>.

68 Interview with IP Australia Official.

69 Interview with Qualified Person 1.

70 Interview with Qualified Person 5.

71 *PBR Act* (n 3) s 35.

Figure 6: An Australian DUS trial for a variety of Agapanthus.[72]

Taxonomy provides an obvious starting point for selecting comparator varieties. All comparator varieties are selected from within the same plant grouping as the candidate variety, as determined by UPOV's Test Guidelines. The plant groupings used in the Test Guidelines are typically a single species, but can alternatively be a subspecies grouping, a collection of related species, or an entire genus.[73] To narrow the decision down further, the Australian Plant Breeder's Rights Office uses the UPOV concept of grouping characteristics, which are 'characteristics in which the documented states of expression, even where recorded at different locations, can be used to select, either individually or in combination with other such characteristics, varieties of common knowledge that can be excluded from the growing trial used for examination of distinctness'.[74] These operate to divide taxonomic categorisations into smaller groupings, limiting the number of possible comparator varieties.

72 Photo courtesy of Qualified Person 6.

73 'List All Test Guidelines by TG Reference', *UPOV* (Web Page) <https://www.upov.int/test_guidelines/en/list.jsp> ('Test Guidelines by TG Reference Database').

74 *General Introduction* (n 3) 12.

The concept of grouping characteristics highlights the difficulties caused by plant-environment interactions. It is often not well understood how a variety's characteristics are expressed under differing environmental conditions, which creates the risk of running a trial where the comparator varieties are very different from the candidate variety (because the characteristics which ostensibly made the varieties suitable for comparison may be expressed differently than expected), or where varieties which would be very similar are excluded from the trial. This is a particular problem in Australia, a large and geographically diverse country, where varieties may be grown in a wide range of climatic conditions. To account for this, characteristics which are genetically stable, environmentally consistent, and reliably measurable are used to narrow down possible comparator varieties.[75] This presents a way to formalise what could otherwise be an unsystematic decision. An official at IP Australia explained how this is carried out, through a process of successive eliminations:

> Suppose you are doing a wheat variety, and it is a spring wheat variety. So the obvious choice will be you will be comparing it against spring wheat varieties. You can eliminate the varieties which are winter wheat, you don't need to compare them, because it is actually a grouping characteristic. … Then there is a characteristic in the guideline which is called the "pith in cross section". Some varieties have a very thick pith and some varieties are very thin, and if the candidate variety for PBR is a thick pith variety, you can exclude the varieties which are not thick pith varieties. So you can reduce that one. Then you can apply another grouping characteristic, maybe the duration. … If you apply 5 or 6 grouping characteristics, you narrow down your selection, you can come up with only a handful of varieties where you need to actually grow them side-by-side, and then compare them, and then you see if there is a difference or not.[76]

This process of selecting comparator varieties is intended to occur virtually, using digital filtering of a pre-categorised list of varieties. The Plant Breeder's Rights Office provides Qualified Persons with Excel documents containing lists of varieties within the relevant plant taxon, each with its characteristics already recorded. These documents contain filter functions, and the Qualified Person need only set these filters to match the grouping characteristics of the candidate variety. When used this way, the selection of varieties becomes the performance of a series of automatic and mechanical steps, with standardised labour processes designed to limit subjectivity in decision-making – the creation (and projection) of objectivity through formal processes.[77]

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75 Dirk Theobald, 'Grouping Characteristics: Experiences of Members of the Union in Measures to Improve the Efficiency and Effectiveness of DUS Testing' (Seminar Presentation, UPOV, 26 March 2012) <https://www.upov.int/edocs/mdocs/upov/en/tc_48/grouping_characteristics.pdf>.

76 Interview with IP Australia Official.

77 MacDonald, 'Abstracting Plants' (n 32) 170.

	A	B	C	D	E	F	G	H	I	J
1	Organ	Coleoptile	*Plant	Flag leaf	Plant	*Time of	*Flag leaf	*Ear	Culm	*Plant
2	context	anthocyanin colouration	growth habit	anthocyanin colouration of auricles	frequency of plants with recurved flag leaves	ear emergence	glaucosity of sheath	glaucosity	glaucosity of neck	length
3	Variety name	state of expression								
14	1995/074 TAMMIN		erect	absent or very weak	absent or very low	medium	strong	strong		medium
23	1996/178 QT5793		semi-erect				strong	medium	medium	medium

Figure 7: Extract from a spreadsheet used for determining comparator varieties for wheat.[78]

In practice, however, the decision of which comparator varieties to include can involve many other considerations, which cannot be easily represented in a spreadsheet or database. Because there is no central repository of plant varieties, comparator varieties must be obtained from regular commercial circulation, which raises a host of practical challenges and considerations. One Qualified Person described the factors that went into selecting comparator varieties:

> Experience, in knowing what's currently in the industry as the most recent commercialised variety that's as close to full comparison with what you're trying to do for the new variety. So that sort of experience, as much as anything else, but also what's available. Now there could be other [removed] mutations out there that either haven't gone through PBR yet, that haven't been planted commercially yet, that could be bigger, better, and probably a better comparator. But I don't know about them. Because they're either not in the public system, or I'm not aware of the breeder, or the person who owns them or whatever, and so you just can't include them. … And you'll get varieties of common knowledge that are better comparators overseas, but have never come to Australia. So I still can't use them, because they're not here in Australia. It's in Australia, see, so I can't use things from overseas in some cases, because they're not physically here in Australia, and we don't have a licence for it, nobody else has a licence, never been imported, may never come to Australia. So I can't use it, from that point of view. So you've got to find the variety of common knowledge for your territory, because the PBR really only applies to Australia, from that point of view, for the trialling we have to do. But you know, we could do the first trials here for a new variety that we'd bred in Australia, and then send that data all around the world for applications.[79]

While the grouping characteristic system attempts to conclusively determine the most similar known varieties through a formalised process of elimination, the actual decision can involve considerations of the recentness of commercialisation, knowledge of the industry, and the overall similarity of the varieties. Lack of knowledge of the variety, or the variety itself not having arrived in Australia, are

78 Excel file of 'Wheat PBR Varieties' taken from IP Australia, 'PBR QP Training Suite' (Online Course, 2021) ch 4 ('PBR QP Training Suite').

79 Interview with Qualified Person 8.

also cited as factors which could prevent a variety from being included in growing trials. To borrow a term from patent law,[80] the 'prior art' from which the candidate must be distinguished is legally imagined as encompassing the entire globe,[81] but in practice the absence of a variety in Australia makes it impossible to include in comparative growing trials.

Practical considerations and the Qualified Person's personal areas of expertise can also play a significant role in their selection. Little-known or difficult-to-access varieties (including those developed overseas) can be intentionally or unintentionally left out of a trial, while varieties which could be contentious are more likely to be included.[82] Formal accounts of the PBR system's comparator selection process present it as a comprehensive and objective filtering process to determine the most suitable comparator varieties, but this belies the complexity and contingency of the system in practice. Such accounts hide the considerable experience and tacit knowledge (trained expertise) which is required in the selection of comparator varieties.

The implementation of PBR in Australia is less standardised and formal than European systems, emphasising flexibility and adaptation rather than the rigorous objectivity of the centralised systems of the United Kingdom and the European Union. Proper selection of comparator varieties is entrusted to the trained judgement of Qualified Persons. It is likely that the reduced systematisation of the Australian system sometimes produces different outcomes from centralised European systems. For example, one Qualified Person noted that parental varieties are not always included in Australian trials, and suggested that the inclusion of parental varieties could reduce the likelihood of rights being granted.[83] Another detailed an instance where they felt that comparator varieties had been incorrectly selected.[84]

The European system exercises a much greater degree of regulatory control over plant property than Australia, which has no reference collections, no national listing system, and only a voluntary seed certification scheme administered by a not-for-profit company, the Australian Seeds Authority.[85] Interviewees in the European system argued that these extensive legal-scientific infrastructures are necessary to ensure that rights were not unfairly granted, and (in the case of national listing and seed certification) to protect farmers from inferior varieties.[86] The centralised infrastructure and expertise allows these forms of regulation to mutually support one

80 The base of information available at the time of the filing of a patent, against which inventive step is assessed: see Mark J Davison, Ann Louise Monotti and Leanne Wiseman, *Australian Intellectual Property Law* (Cambridge University Press, 2nd ed, 2012) 474.

81 *PBR Act* (n 3) s 43(2). This section states that a plant variety must be 'clearly distinguishable from *any other variety* whose existence is a matter of common knowledge' (emphasis added). The UPOV system is designed to harmonise plant intellectual property laws internationally through a globalised system of DUS testing.

82 Interview with Qualified Person 7.

83 Interview with Qualified Person 8.

84 Interview with Qualified Person 12.

85 'Welcome to Australian Seeds Authority', *Australian Seeds Authority Ltd* (Web Page) <https://aseeds.com.au/>.

86 Group interviews conducted at DUS testing facilities in France, Germany, the Netherlands, and the United Kingdom.

another. The downside of greater state control is the increased cost of supporting these institutions and of complying with regulations, which may disproportionately disadvantage smaller outfits if regulatory burdens become too great.[87]

Comparing the Australian system of selecting comparator varieties to the centralised systems of the United Kingdom and European Union highlights the ethical values which underly the ostensibly neutral technical infrastructure of PBR. Maintaining variety reference collections undoubtedly increases the probability that candidate varieties are compared to the most similar varieties of common knowledge. In turn, this reduces the chance that rights are granted unfairly (where they are not compared to the most similar varieties). In this sense, centralised reference collections contribute to the objectivity of PBR systems by minimising the trained expertise required by assessors. However, this legal-scientific rigour comes at a price: the substantial costs of maintaining a centralised reference collection must be borne, either by breeders (increasing the price of DUS testing, disproportionately affecting smaller breeders) or by the public. How much money and effort should be spent towards providing non-overlapping intellectual property rights for plant varieties? How should the pursuit of objective judgement be balanced against flexibility and cost-efficiency?

In most aspects of the PBR system there is a clear drive to achieve objectivity, through the elimination or minimisation of subjectivity or judgement. The measures taken within centralised testing systems to store and include all appropriate comparator varieties are in service of the epistemic virtue of objectivity. Objectivity is associated with truth, fairness, impartiality, universality, and freedom from bias.[88] Steps to increase objectivity in law are typically viewed as an intrinsic good: the attainment of objectivity 'does not seem to require further arguments'.[89] Objectivity is the paramount epistemic virtue, the pursuit of which is seen to justify the expense of centralised testing systems. Australia's decentralised system requires justification in UPOV documents, and the justification provided is that sufficient objectivity is created through practices of training, expertise, oversight, and audit.[90]

In Australia, the reduction in objectivity resulting from the lack of centralised testing facilities is addressed by entrusting tasks that would otherwise be conducted through standardised procedures and technologies to the trained judgement of experts. Australia compensates for a less rigorous, less mechanical objectivity with increased reliance on the epistemic virtue of trained judgement. Tacit expert judgement remains important in European systems, too, but to a lesser extent.

87 Dustin Chambers, Patrick A McLaughlin and Tyler Richards, 'Regulation, Entrepreneurship, and Firm Size' (2022) 61(2) *Journal of Regulatory Economics* 108 <doi.org/10.1007/s11149-022-09446-7>.

88 Cf Lorraine Daston, 'Objectivity and Impartiality: Epistemic Virtues in the Humanities' in Rens Bod, Jaap Maat and Thijs Weststeijn (eds), *The Making of the Humanities* (Amsterdam University Press, 2014) vol 3, 27, arguing that the concepts of impartiality and objectivity have histories 'which are distinct and not always harmonious': at 28.

89 Mark van Hoecke, 'Objectivity in Law and Jurisprudence' in Jaakko Husa and Mark van Hoecke (eds), *Objectivity in Law and Legal Reasoning* (Hart Publishing, 2013) 3, 8.

90 See, eg, *Arrangements for DUS Testing* (n 53). This UPOV document focuses on why objectivity will not be unduly undermined by the absence of centralised reference collections in Australia.

Examiners must still rely on personal judgement in narrowing down the most similar comparator varieties when there is only space to grow out a relatively small number of varieties, but this decision is much more constrained in centralised testing systems.

The appropriate size, cost, and rigour of technical-legal infrastructure for pursuing objectivity is just one ethical dimension of PBR systems. Other value assumptions are embedded in the UPOV system of DUS testing itself – assumptions concerning how plants should be conceptualised, what counts as breeding, and what sorts of varieties can receive intellectual property protection.

IV DECIDING DISTINCTNESS

PBR systems are based on the concept of plant varieties – discrete, consistent, and identifiable groupings of plants. To receive PBR, a variety must be clearly distinguishable from all other varieties of common knowledge.[91] If a variety is not phenotypically distinguishable from another variety, it is effectively considered to be part of that existing variety, rather than an original variety deserving of intellectual property rights.

The presumption that varieties should be visibly distinguishable has been challenged by recent advances in genetic testing and by the increasing phenotypic similarity between varieties in some species, with some commentators suggesting that genetic testing should be allowed to prove distinctness between phenotypically identical varieties, or without assessing the plant phenotype at all.[92] As some complex traits such as yield cannot feasibly be assessed in DUS trials in many species, these commentators argue that agronomically superior (but visually indistinguishable) varieties are excluded from PBR due to the phenotypic focus of DUS trials.[93] For the time being, however, distinctness is assessed phenotypically.

In UPOV systems, the assessment of distinctness is conducted characteristic-by-characteristic, where a characteristic is a tightly specified aspect of a plant which can be measured or classified, which in aggregate can generate a formalised textual representation of the plant variety. Candidate varieties are grown alongside comparator varieties, so that they are equally influenced by environmental and climatic factors. To be proven distinct, a variety must be clearly distinguishable in at least one characteristic from every other variety. This generally means a difference of at least two notes in a single characteristic (where a note is a quantification of a specific characteristic, as shown in the examples below).

91 *General Introduction* (n 3) 4.

92 Chin Jian Yang et al, 'Overcoming Barriers to the Registration of New Plant Varieties under the DUS System' (2021) 4(1) *Communications Biology* 302:1–10 <https://doi.org/10.1038/s42003-021-01840-9>; Seyed Hossein Jamali, James Cockram and Lee T Hickey, 'Is Plant Variety Registration Keeping Pace with Speed Breeding Techniques?' (2020) 216(8) *Euphytica* 131 <https://doi.org/10.1007/s10681-020-02666-y> ('*Is Plant Variety Registration Keeping Pace with Speed Breeding Techniques?*').

93 Yang et al (n 92) 3.

	English	français	deutsch	español	Example Varieties Exemples Beispielssorten Variedades ejemplo	Note/ Nota
1. (*)	PQ VG					
	Seed: color	**Semence : couleur**	**Samen: Farbe**	**Semilla: color**		
	white	blanche	weiß	blanco	Verpia	1
	yellow	jaune	gelb	amarillo	Durango	2
	brown	marron	braun	marrón	Oaklin	3
	black	noire	schwarz	negro	Kagraner Sommer 2	4
2. (*)	QN MS/VG	(a)				
	Plant: diameter	**Plante : diamètre**	**Pflanze: Durchmesser**	**Planta: diámetro**		
	very small	très petit	sehr klein	muy pequeña	Tom Thumb	1
	small	petit	klein	pequeña	Gotte à graine blanche	3
	medium	moyen	mittel	media	Clarion, Verpia	5
	large	grand	groß	grande	Great Lakes 659	7
	very large	très grand	sehr groß	muy grande	El Toro	9

Figure 8: Excerpt from the table of characteristics for lettuce (Lactuca sativa L).[94]

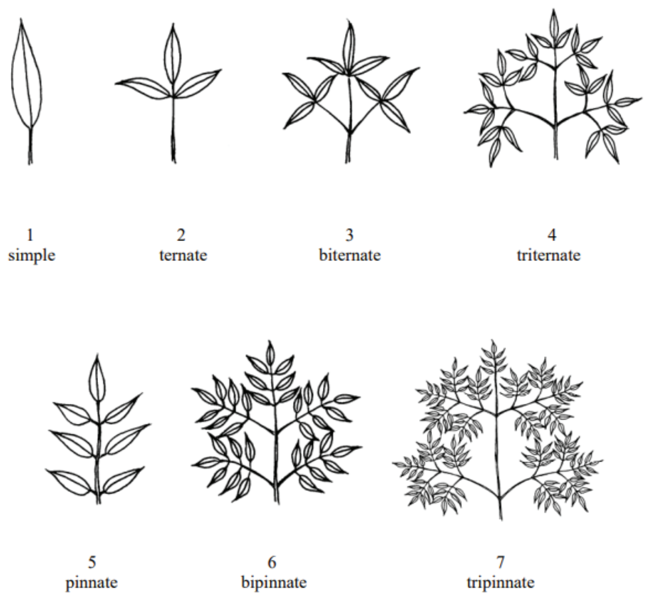
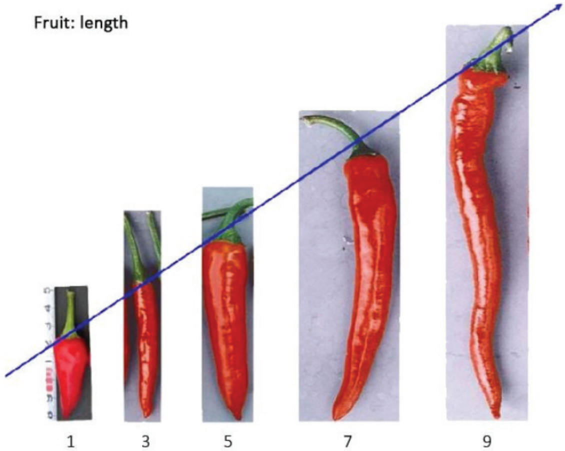


Figure 9: Qualitative variation of leaf type in Clematis (Clematis L).[95]

94 UPOV, *Guidelines for the Conduct of Tests for Distinctness, Uniformity and Stability: Lettuce*, Doc No TG/13/11 Rev.2, 26 October 2021, 9 (‘*DUS Guidelines: Lettuce*’).

95 UPOV, *Guidelines for the Conduct of Tests for Distinctness, Uniformity and Stability: Clematis*, Doc No TG/215/1 Rev., 28 March 2007, 23.



States of expression	Notes
very short	1
very short to short	2
short	3
short to medium	4
medium	5
medium to long	6
long	7
long to very long	8
very long	9

Figure 10: Quantitative variation of fruit length in chili.[96]

The design of DUS trials varies by species, and IP Australia provides several possible trial options.[97] A completely randomised design refers to a field trial where the planting order of each individual plant is randomised and stored separately. This method borrows from blind randomised controlled trials used in scientific studies, aiming to prevent the person administering the growing trials from knowing which plants belong to which varieties. This prevents the intentional or inadvertent favouring of particular varieties, constraining the subjectivity of the grower in the pursuit of objectivity. A randomised block design refers to conducting randomised trials in multiple blocks, to minimise environmental influence. A pairwise design consists of pairing each plant from a candidate variety with the comparator varieties, and a split plot design refers to a situation where the varieties are separated into distinct plots. The level of DUS trial rigour, and the objectivity of the trial, is partially dependent on the trial design selected, and as a result randomised blinded trials are recommended by IP Australia.[98]

96 Tadao Mizuno, 'General Introduction to the Examination of DUS' (Forum Presentation, East Asia Plant Variety Protection Forum, 22 January 2018) 33.

97 UPOV, *Trial Design and Techniques Used in the Examination of Distinctness, Uniformity, and Stability*, Doc No TGP/8/5, 56th ord sess, 28 October 2022; 'PBR Manual' (n 51) pt 4; Interviews with IP Australia Officials.

98 Interview with Qualified Person 12.

Figure 11: Australian growing trial for a variety of Coprosma with a split plot design.[99]

The flexibility of trial arrangements is managed by requiring approval from the Plant Breeder's Rights Office for all DUS trial arrangements, and through consistent communication between Qualified Persons and PBR officials. As a Qualified Person explained,

> before we can do anything, as QP or anything, they have to approve everything that happens. They approve the whole plan, all that sort of stuff. … There's a communication all the way through, to make sure it's going to comply with what they need, the trials are OK, and all that sort of stuff.[100]

Another Qualified Person summarised that 'it's important that everything be treated the same'.[101] The trial design is mutually decided upon by the Qualified Person and the Plant Breeder's Rights Office, with emphasis on the identical treatment of varieties in the pursuit of an objective decision.

The number and magnitude of characteristic differences required for a variety to be found to be distinct was described by Qualified Persons with a degree of vagueness, involving several overlapping considerations. These included the number of differences, the degree of each difference, the commercial value of each

99 Photo courtesy of Qualified Person 6.
100 Interview with Qualified Person 8.
101 Interview with Qualified Person 6.

difference, and the possibility of environmental influence on that difference. A representative account from a Qualified Person is as follows:

> If a significant single trait is the only difference between the two, that'll normally be enough if it's a significant one. If it was leaf length, for example, was the only thing it was different in, and one was medium and one was long, then probably on its own, they'd look at it and say, 'we really don't think that's enough to give that full distinctness of what you're going to have.' Because maybe there is a climatic influence or whatever else, you could put it [somewhere] cooler, warmer, wherever, and there won't be enough for us.[102]

The determination of distinctness clearly involves a significant element of trained expertise on the part of Qualified Persons and PBR officials, and an inherent degree of subjectivity. This was also the case in European systems, where interviewees frequently described the peculiarities of their species of expertise and the crucial importance of hands-on experience and practice.[103] Nonetheless, extensive steps are taken to standardise this assessment, and officials noted the successes and shortcomings of these efforts towards standardisation of assessment, along with the enduring role of the tacit knowledge of examiners:

> We do have a lot of UPOV guidance on how to determine 'clearly distinguishable', and that's why we very much depend on the UPOV test guidelines and technical protocols around determining distinctness, uniformity, and stability and so on. For example, the different types of characteristics determine how you can consider whether something is clearly distinguishable or not. So for a qualitative characteristic where you're looking at something which is absent or present, for example, it's easy. It's either absent or present, it's very clear. That's the simplest, simplest case. But then you also get the QN characteristics, the quantitative characteristics where you're on a linear scale, and you're looking for that sufficient distance apart, perhaps with no overlap and so on, that allows you to make that decision that the two varieties are clearly distinguishable. Plant height might be an example there. You want something which, in the UPOV terminology we use short, medium, tall, for example, and states such as short to medium or medium to tall; in those sorts of cases, we would look at having at least two states apart, so you might have a short plant height and a medium plant height and consider them to be clearly distinguishable. At the end of the day, that's not as clear, obviously, as a qualitative one. At the end of the day, it's up to the examiner to be satisfied that the varieties are clearly distinguishable.[104]

To reduce subjectivity as much as possible, standardisation of assessment processes is pursued through technological means. One example is the use of specifically-calibrated cameras to assist with selecting from standardised colour charts, as described by a Qualified Person:

> This camera, we basically put it on a fruit leaf, flower, press the button and it basically does the colour scale of it and registers that against the Royal Horticultural Society colour charts and clicks up a bunch of options for you, and you pick the closest one. So it takes some of that guesswork out of it.[105]

102 Interview with Qualified Person 9.
103 Group interviews and site visits at DUS testing facilities in France, Germany, the Netherlands, and the United Kingdom.
104 Interview with IP Australia Official.
105 Interview with Qualified Person 12.

Another technological standardisation occurs in the measurement of Brix (the percentage of sucrose by weight): ‘we use a digital … refractometer. So basically you squeeze the juices of the variety into there and it tells you what its Brix, so, its sugar level is’.[106] Automated image analysis is another example.[107] Technological solutions are particularly useful for this kind of standardisation, as they can be black boxed prior to their use. This presents less opportunity for the subjectivity of the assessor to interfere, since the instrument has already been standardised prior to its use – although it is worth noting that some technologies, such as the colour camera, still ultimately rely on the examiner’s judgement and skill to some extent.

Statistical approaches are also used in the assessment of distinctness for certain characteristics. Statistics are particularly useful for proving distinctness which is not visually apparent, or which may operate over a gradient:

> for example, it might be the percentage of skin colour, from that point of view. So you can measure stuff and take a series of measurements, statistically analyse it and say that this one here is 80% skin colour, this one’s 65% skin colour, but on the measurements that I’ve done across, you know, a couple of hundred fruit, this one is definitely statistically significantly different, and more, than the other one.[108]

Statistics are regularly used to prove distinctness for measured traits such as lengths of specific plant parts. Unlike uniformity and stability, statistics demonstrating distinctness are published in the detailed varieties descriptions in the Australian *Plant Varieties Journal*.[109]

Statistical Table			
Organ/Plant Part: Context	**‘Raptor’**	**‘Graza 53’**	**‘Lavish’**
☒ Plant: length (cm)			
Mean	150.00	145.93	140.28
Std. Deviation	5.64	6.58	7.00
LSD/sig	3.77	P≤0.01	P≤0.01
☐ Panicle: length (cm)			
Mean	40.13	32.65	33.50
Std. Deviation	3.99	2.84	2.47
LSD/sig	1.85	P≤0.01	P≤0.01

Figure 12: Statistical table for the oat variety ‘Raptor’.[110]

106 Interview with Qualified Person 12.
107 Lootens et al (n 41); *Image Analysis* (n 41).
108 Interview with Qualified Person 8.
109 See ‘Plant Varieties Journal’ (n 67).
110 North Dakota State University Research Foundation, ‘Application for “Raptor”’ (2021) 34(1) *Plant Varieties Journal* 226, 228; *AU Plant Breeder’s Rights No 2020/177*, filed 20 August 2020 (Granted on 7 March 2022).

In recent decades, the rise of molecular genetics has led to new ways of analysing, classifying, and abstracting plants. As early as 1931, commenters proposed 'the use of genes and chromosomes in identifying distinct varieties'.[111] It was argued at the time that this was

> probably the only accurate and scientific method which can be used, for it is conceivable that the same plant under different soil, weather and the other environmental conditions might change to such an extent as to be hardly recognisable by mere external description.[112]

The environmental independence of genetic assessment methods remains a key argument for their use today, as does the removal (or at least minimisation) of subjectivity in judgement.[113]

Currently, genetic testing is very rarely used during DUS trials, in both Europe and Australia. Its main application is in the selection of comparator varieties, where in European systems it is used in a small number of species to narrow down the range of possible comparator varieties by excluding varieties which are genetically distant from the candidate varieties.[114] On the rare occasions that genetic information is used for assessing DUS characteristics, it is for the purpose of providing evidence of the existence of a phenotypic characteristic. The UPOV Ad Hoc Subgroup of Technical and Legal Experts on Biochemical and Molecular Techniques rejected a proposal to use molecular markers as characteristics themselves, noting that

> using this approach, it might be possible to use a limitless number of markers to find differences between varieties. The concern was also raised that differences would be found at the genetic level which were not reflected in morphological characteristics.[115]

The uses of molecular markers endorsed by the Biochemical and Molecular Techniques group were those uses where molecular markers directly corresponded to phenotypic characteristics. These are particularly useful for characteristics which 'cannot be consistently or easily observed in the field, or require additional special arrangements (such as disease resistance characteristics)'.[116] Other common examples are herbicide and pesticide resistance. In these cases, the molecular marker is a part of the gene 'construct', which comprises all of the genetic material inserted into the plant during genetic modification.[117] As a result, the presence of the marker indicates the existence of the desired phenotypic trait with sufficient certainty to be used to prove the existence of the associated phenotypic trait.

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111 Rossman (n 35) 15.

112 Ibid 15.

113 Seyed Hossein Jamali, James Cockram and Lee T Hickey, 'Insights into Deployment of DNA Markers in Plant Variety Protection and Registration' (2019) 132(7) *Theoretical and Applied Genetics* 1911, 1912–13 <https://doi.org/10.1007/s00122-019-03348-7> ('*Insights into Deployment of DNA Markers*').

114 Group interviews conducted at DUS testing facilities in France, Germany, the Netherlands, and the United Kingdom.

115 UPOV, *Possible Use of Molecular Markers in the Examination of Distinctness, Uniformity and Stability (DUS)*, Doc No UPOV/INF/18/1, 45th ord sess, 20 October 2011, 8.

116 Ibid 4.

117 Ibid annex 1.

Various arguments have been made about how advances in genetic testing will influence plant intellectual property. These include the views that 'dramatic technological advances in plant breeding, particularly in the major cereal crops, have brought the threat of obsolescence to existing PVP [plant variety protection] systems';[118] that 'the efficiency of phenotype-based assessments of plant variety protection and registration could be improved by the integration of DNA-based testing';[119] and that 'the plant variety concept – the lynchpin of the PVP system – is obsolete and needs to be jettisoned in favour of a more technologically suitable alternative'.[120] These criticisms assert that PBR systems are founded on outmoded phenotypic assessments of varieties, and should be updated or overhauled to keep pace with modern genotypic conceptualisations of plants.

This debate hinges on whether distinctness should be assessed through genetic assessment, morphological assessment, or some combination of both. The phenotype is more easily judged, recorded, and monitored, and the technological foundation of UPOV is constructed on phenotypic assessment. However, the phenotype is expressed differently under different environmental conditions, and its assessment is seen to require a greater degree of subjective human judgement. Some commentors also argue that phenotypic DUS testing is not appropriate for variety innovations aimed at increasing agronomic traits such as yield, which may not have the kind of discrete and observable characteristic differences required to pass DUS tests.[121] The genotype is perceived as more stable and environmentally independent than the phenotype,[122] and genetic DUS systems could be much faster (and therefore much cheaper) than phenotypic trials.[123] However, plant genotypes require sophisticated equipment and expertise to measure, and do not necessarily provide transparent information about the physical plants which unfold from

118 Mark D Janis and Stephen Smith, 'Technological Change and the Design of Plant Variety Protection Regimes' (2007) 82(3) *Chicago-Kent Law Review* 1557, 1560.

119 *Insights into Deployment of DNA Markers* (n 113) 1911.

120 Laurence R Helfer, 'The Demise and Rebirth of Plant Variety Protection: A Comment on "Technological Change and the Design of Plant Variety Protection Regimes"' (2007) 82(3) *Chicago-Kent Law Review* 1619, 1622.

121 Yang et al (n 92) 3.

122 There is mounting evidence that the genotype is neither stable nor environmentally independent. See Evelyn Fox Keller, 'The Postgenomic Genome' in Sarah S Richardson and Hallam Stevens (eds), *Postgenomics: Perspectives on Biology after the Genome* (Duke University Press, 2015) 9, 25:

I am proposing that today's genome, the postgenomic genome, looks more like an exquisitely sensitive reaction (or response) mechanism – a device for regulating the production of specific proteins in response to the constantly changing signals it receives from its environment – than it does the pregenomic picture of the genome as a collection of genes initiating causal chains leading to the formation of traits.

123 *Insights into Deployment of DNA Markers* (n 113); *Is Plant Variety Registration Keeping Pace with Speed Breeding Techniques?* (n 92); Yang et al (n 92).

them.[124] Finally, carrying out genetic tests still requires trained expertise and interpretation, and it is not a given that genetic testing provides consistent and standardised results.[125]

Drawing legal boundaries with genetic testing requires agreed thresholds and testing methodologies for each plant species.[126] As such, the fundamental arbitrariness which exists in drawing property boundaries is not removed, but rather is relocated to the point where genetic thresholds are selected. The relationship between phenotype and genotype also presents an unresolved problem. As a PBR official put it:

> The main problem here is … when we look at the genome of an organism, whether it's a plant or animal, a very small portion of that genome is actually expressed. And if we just go for random DNA polymorphisms, those polymorphisms may not be expressed in the phenotype. So you may see DNA differences, but you don't see a phenotypic difference. So there is a problem there.[127]

Genetic difference does not necessarily correspond with phenotypic difference, which is a problem for an intellectual property system based on abstracting the physical, phenotypic characteristic of plant varieties.

A switch to a genetic basis for assessment would require extensive standardisation of genetic testing procedures, and sufficiently high resolution of sampling so that genetic results reflect the phenotype of the variety. Hallam Stevens observes that:

> Genomes are objects that are computationally reconstructed from thousands of (sequencing) experiments – we cannot "see" a genome except using the mathematical, statistical, software, and hardware tools that construct them in various ways inside computers.[128]

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124 John Dupré, 'The Polygenomic Organism' in Sarah S Richardson and Hallam Stevens (eds), *Postgenomics: Perspectives on Biology after the Genome* (Duke University Press, 2015) 56, 56:
The complexity of the relation between genotype and phenotype has been explored quite extensively insofar as growing insights into gene/environment interactions, epigenetics, alternative splicing, and so on have made it clear that the extent to which genotype determines phenotype is extremely limited.
Paul Davies, *The Demon in the Machine* (Allen Lane, 2019) 87–8:

> The biggest surprise comes if the experimenters chop off the aberrant supernumerary head of a two-headed worm. You might expect this to rid the worm of any further two-headed aspirations, but it turns out that if the remainder of the worm is then cut in half two new two-headed worms are made! This is a dramatic example of *epigenetic inheritance* at work … The key point is that all these monster worms have identical DNA sequences yet dramatically different phenotypes … somehow, the physical properties of the organism (in this case, the stable states of the electric circuits) convey altered morphological information from one generation to the next.

125 Urko M Marigorta et al, 'Replicability and Prediction: Lessons and Challenges from GWAS' (2018) 34(7) *Trends in Genetics* 504; CJ Jones et al, 'Reproducibility Testing of RAPD, AFLP and SSR Markers in Plants by a Network of European Laboratories' (1997) 3(5) *Molecular Breeding* 381.

126 Jay Sanderson, 'Essential Derivation, Law and the Limits of Science' (2006) 24(1) *Law in Context* 34, 45–6 ('*Essential Derivation*'); Charles Lawson, 'Plant Breeder's Rights and Essentially Derived Varieties: Still Searching for Workable Solutions' (2014) 36(8) *European Intellectual Property Review* 499.

127 Interview with IP Australia Official.

128 Hallam Stevens, 'Networks: Representations and Tools in Postgenomics' in Sarah S Richardson and Hallam Stevens (eds), *Postgenomics: Perspectives on Biology after the Genome* (Duke University Press, 2015) 103, 119.

Accordingly, choices about database structures and visual representations have ‘a determinative effect on the knowledge and objects produced’.[129] Jay Sanderson points out that ‘the methodology used to study genetic similarities will only be a sampling strategy’, and as a result, ‘estimations of similarity or dissimilarity are often influenced by the methodology used for that particular experiment’.[130] These considerations, and the dramatic differences between plant species, suggest that any shift towards genetic testing of distinctness is likely to happen slowly, one species at a time. A slow transition would also need to sustain the validity of existing rights granted on the basis of the plant phenotype. Interviewees were divided on the probability and feasibility of such a shift occurring.[131]

A shift towards a genetic assessment system could also carry practical consequences for individuals and organisations involved with PBR. Most significantly, judging distinctness with genetic testing could disadvantage breeders and organisations who lack access to genetic technology and expertise, who would be unable to assess the likelihood of receiving intellectual property rights prior to the DUS process. Many interviewees also expressed the view that phenotypic trials would still be required to confirm uniformity and stability, which would limit the time- and cost-saving potential of genetic DUS assessment.

Examination of how distinctness is judged evidences a desire to achieve objectivity in the assessment and representation of plant varieties by implementing ‘procedures that would, as it were, move nature to the page through a strict protocol, if not automatically’.[132] These procedures include the use of strictly defined characteristics, the application of measurement and statistics, and the introduction of technological methods for standardising judgement. Nonetheless, trained expertise still plays a key role in DUS assessment and will continue to do so into the foreseeable future. Genetic techniques offer the potential for attaining greater technoscientific objectivity in judgement, but the ultimate arbitrariness of genetic thresholds of difference means that subjective judgement is relocated rather than removed. Geneticising PBR also carries the risk of disadvantaging some actors within the system.

Framings of ‘technological improvement’ and ‘objective judgement’ can obscure the underlying ethical and distributional considerations that law always involves. The genetic uniformity mandated by the criteria of uniformity and stability provides another example of this.

V STANDARDISING PLANTS

Uniformity and stability requirements are necessary to transform a plant variety into a consistent, standardised, and identifiable class of plants, which can then be

129 Hallam Stevens, *Life Out of Sequence: A Data-Driven History of Bioinformatics* (University of Chicago Press, 2013) 171.

130 *Essential Derivation* (n 126) 45.

131 Interviews and site visits in Australia, France, Germany, the Netherlands, and the United Kingdom.

132 Daston and Galison (n 7) 121.

effectively regulated as private property. Uniformity and stability are the criteria which ensure that a small group of plants (those which are assessed during a DUS trial) can stand in for an entire variety. This requirement in intellectual property law is a variation of a persistent problem in the philosophy of scientific epistemology: 'how could an individual stand for a class without idealization or even selection? How could a universally valid working object be extracted from a particular depicted with all its flaws and accidents?'.[133] In PBR systems, the mutability and variability of plants is addressed using the legal-scientific technologies of uniformity and stability. By enforcing genetic standardisation, these criteria allow a small group of plants in a field trial to represent – and subsequently generate – a new plant variety.

Uniformity refers to consistency between the individuals within a plant grouping, while stability refers to consistency across generations. Uniformity in the UPOV system is judged on a characteristic-by-characteristic basis.[134] The specific method of assessing uniformity depends on the characteristic in question and is outlined in the UPOV test guidelines which set out assessment procedures for each species.[135]

The 'off-type count' method of uniformity assessment consists of counting the number of non-conforming plants for a given characteristic. It is therefore suitable for characteristics where a binary division between conforming and non-conforming individuals can be drawn through observation. If the off-type count exceeds a certain specified threshold for a given characteristic, the variety is not uniform. The off-type thresholds are specified in the UPOV test guidelines for each plant grouping.[136] Like the assessment of distinctness, the judgement of which plants are off-type involves relies on the trained expertise of the assessor.[137]

The 'relative variance' method is based on the principle that the candidate variety should not be significantly less uniform than the comparator varieties for any given characteristic in a statistical sense.[138] This method involves calculating the relative variance of the candidate variety (the ratio between the variance of the candidate variety and the average variance of the comparator varieties) for a given characteristic. This is then compared to a table of F statistics to determine if the difference between the variances is statistically significant, depending on the sample sizes used. This is repeated for each characteristic assessed with the relative variance method.[139] Statistics are typically calculated automatically by formulas contained in pre-prepared spreadsheets which are filled out with measurements during data collection.[140]

Like uniformity, stability is assessed using one of two methods. For asexually propagated varieties, stability is inferred from uniformity, in what is known as the 'indirect' method of examination.[141] This effectively means that stability is not

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133 Ibid 250.
134 *General Introduction* (n 3) 6.
135 'Test Guidelines by TG Reference' (n 73).
136 See, eg, *DUS Guidelines: Lettuce* (n 94).
137 Interviews in France, Germany, the Netherlands, and the United Kingdom.
138 'PBR Manual' (n 51) pt 4.
139 'PBR QP Training Suite' (n 78) ch 6.
140 Site visits in France, Germany, the Netherlands, and the United Kingdom.
141 Ibid. 'PBR QP Training Suite' (n 78) ch 6.

considered an issue for asexually reproduced plants; asexual reproduction is seen to guarantee stability, in much the same way as it does for United States plant patents.[142]

For sexually propagated varieties, the 'direct' method is used: the variety is taken to be stable if it remains constant over two generations. This is assessed by growing seed samples from two generations side-by-side and checking that they are sufficiently similar.[143] Similarity in stability for quantitative characteristics is assessed by comparing the difference between the mean measurements of each characteristic with the 'Least Significant Difference' statistic, a method for determining whether the mean value of a characteristic of the candidate variety is statistically different from the mean value of the comparator variety (that is, whether the null hypothesis can be rejected). If the difference between means is smaller than the value of the Least Significant Difference, that characteristic is stable.[144]

As with the assessment of distinctness, various techniques are used to limit the subjectivity of the assessor in the service of objective judgement of uniformity and stability. These include standardised procedures, measurement and statistical analysis, and technological solutions. Genetic testing has also been proposed for use with uniformity and stability assessments.[145] The objectivity strived at by PBR systems contributes towards making plant varieties *into objects*, by creating strong scientific-legal claims for the reliability, consistency, and legitimacy of plant varieties as stable objects of intellectual property. For plant varieties to function as objects of property, they must be sufficiently bounded and stabilised.

The purpose of the uniformity and stability criteria are to reduce variation within a plant variety as much as possible, allowing the variety to be described and preventing it from drifting from its description. In short, they aim to *fix* a variety into a standardised object form. This has implications for the breeders and varieties which are eligible to receive PBR, and for the genetic diversity of the varieties which emerge with PBR.

The UPOV system has been criticised for contributing to the expansion of neoliberal capitalism,[146] for excluding certain forms of plant breeding,[147] for being designed around the agricultural systems of wealthy industrialised countries,[148] and

142 Pottage and Sherman (n 34) 162–5.

143 'PBR Manual' (n 51) pt 4.

144 'PBR QP Training Suite'(n 78) ch 6.

145 Yang et al (n 92) 7.

146 Kloppenburg (n 4) 140–51; David J Jefferson, 'Compliance with Resistance: How Asia Can Adapt to the UPOV 1991 Model of Plant Breeders' Rights' (2020) 15(12) *Journal of Intellectual Property Law & Practice* 1012, 1013.

147 Jefferson (n 146) 1019; Asanka Perera and Kamalesh Adhikari, 'From Neglect to Protection: Recognising the Importance of Farmers' Varieties in Sri Lanka' in Kamalesh Adhikari and David J Jefferson (eds), *Intellectual Property Law and Plant Protection: Challenges and Developments in Asia* (Routledge, 2020) 161 <https://doi.org/10.4324/9780429059520>; Susannah Chapman, 'The (In)Visible Labour of Varietal Innovation' in Jenny Bangham, Judith Kaplan, and Xan Chacko (eds), *Invisible Labour in Modern Science* (Rowman & Littlefield, 2022) 163, 164.

148 David J Jefferson, 'Plant Breeders' Rights Proliferate in Asia: The Spread of the UPOV Convention Model' in Kamalesh Adhikari and David J Jefferson (eds), *Intellectual Property Law and Plant Protection* (Routledge, 2020) 12, 14; Sanderson (n 27) 8.

for contributing to biodiversity loss through the promotion of genetic monocultures.[149] Plant groupings which are not sufficiently genetic homogenous will not meet uniformity and stability requirements, and will accordingly be ineligible for PBR. Varieties bred using traditional methods and practices (sometimes called farmers' varieties, heritage varieties, traditional varieties, or landraces) are thus excluded from the PBR system.[150] Similarly, plant groupings which are intentionally developed to be genetically heterogenous (such as Composite Cross Populations) cannot receive plant breeder's rights. Given the urgent need to mitigate the environmental harms of industrial agriculture by increasing agricultural biodiversity and sustainability,[151] and the increased vulnerability of agricultural monocultures to pests, pathogens and climatic conditions compared to more genetically diverse farming practices,[152] this incentive structure appears problematic.

A response to this critique is that genetic uniformity is a practical prerequisite for granting intellectual property rights in plant varieties. Relaxing standards of uniformity and stability would result in much 'broader' varieties, making it more challenging to define how far the intellectual property monopoly extends and whether it has been infringed in a given case. Relaxing uniformity and stability requirements without making other changes is likely to result in larger intellectual property rights and greater monopoly power for variety owners.

It is important to note that DUS tests are not conducted exclusively for intellectual property eligibility. In many countries, certain species are not permitted to be marketed without first being entered onto 'national variety lists', a legal technology often called variety registration.[153] In most European countries, agricultural and vegetable plant varieties cannot be marketed without variety registration, which requires passing a DUS test.[154] Genetic uniformity is effectively

149 Sanderson (n 27) 9; Susan Isiko Štrba, 'Legal and Institutional Considerations for Plant Variety Protection and Food Security in African Development Agendas: Solutions from WIPO?' (2017) 12(3) *Journal of Intellectual Property Law & Practice* 191, 201.

150 Kamalesh Adhikari, 'What Does It Mean to Protect Farmers' Varieties as Intellectual Property?' in Kamalesh Adhikari and David J Jefferson (eds), *Intellectual Property Law and Plant Protection* (Routledge, 2020) 177, 181.

151 Salvatore Ceccarelli and Stefania Grando, 'Return to Agrobiodiversity: Participatory Plant Breeding' (2022) 14(2) *Diversity* 126 <https://doi.org/10.3390/d14020126>; Miguel A Altieri and Victor Manuel Toledo, 'The Agroecological Revolution in Latin America: Rescuing Nature, Ensuring Food Sovereignty and Empowering Peasants' (2011) 38(3) *Journal of Peasant Studies* 587 <https://doi.org/10.1080/03066150.2011.582947>.

152 Alice KE Ekroth, Charlotte Rafaluk-Mohr and Kayla C King, 'Host Genetic Diversity Limits Parasite Success beyond Agricultural Systems: A Meta-Analysis' (2019) 286(1911) *Proceedings of the Royal Society B: Biological Sciences* 20191811:1–9 <https://doi.org/10.1098/rspb.2019.1811>; JB Smithson and JM Lenné, 'Varietal Mixtures: A Viable Strategy for Sustainable Productivity in Subsistence Agriculture' (1996) 128(1) *Annals of Applied Biology* 127<https://doi.org/10.1111/j.1744-7348.1996.tb07096.x>; CC Mundt, 'Use of Multiline Cultivars and Cultivar Mixtures for Disease Management' (2002) 40 *Annual Review of Phytopathology* 381 <https://doi.org/10.1146/annurev.phyto.40.011402.113723>; Emily R Reiss and Laurie E Drinkwater, 'Cultivar Mixtures: A Meta-Analysis of the Effect of Intraspecific Diversity on Crop Yield' (2018) 28(1) *Ecological Applications* 62 <https://doi.org/10.1002/eap.1629>.

153 Michael Halewood and Isabel Lapeña, 'Farmers' Varieties and Farmers' Rights: Challenges at the Crossroads of Agriculture, Taxonomy and Law' in Michael Halewood (ed), *Farmers' Crop Varieties and Farmers' Rights: Challenges in Taxonomy and Law* (Routledge, 2016) 1, 5.

154 Interviews in France, Germany, the Netherlands, and the United Kingdom.

mandated for all species with national listing requirements that include a DUS component, which has the practical effect of prohibiting the sale of landraces, heirloom varieties, and farmers' varieties in countries with such regulations.

As of January 2022, the European Union has introduced the legal category of 'Organic Heterogenous Material', allowing genetically and phenotypically diverse plant populations to be marketed without first obtaining national listing.[155] This is a step towards legally permitting the circulation of genetically diverse plant populations. As this category is designed for the organic sector, Organic Heterogenous Material 'must have been produced under organic farming conditions for at least one generation for annual species and two generations for biennial and other perennial species'.[156] Varieties which do not meet the requirements of organic certification will remain unmarketable if they cannot pass DUS trials.

Even where the law does not actively prohibit non-uniform varieties, there is no question that plant breeder's rights and associated regulations are deeply interconnected with capitalised industrial agriculture.[157] Mechanised industrial production over geographically diverse locationally requires standardised inputs with specific qualities and characteristics, which in turn necessitates plant varieties that are uniform and stable. Agricultural industries are often involved in the design of DUS testing systems, ensuring that varieties are sufficiently homogenised for the specific mechanised processes used for a given species.[158] PBR, and seed certification regimes, can serve to guarantee the identity and reliability of varieties for industries which require highly specific inputs. From this perspective, the objectivity of PBR systems provides a regulatory ideal, which helps ensure that rigorous controls are employed in the production of standardised agricultural inputs.

Despite this interlinkage, intellectual property rights are not the main cause of agricultural monocultures and genetic uniformity. Intellectual property is just one tool for enforcing and certifying the standardisation of agricultural lifeforms demanded by long-distance industrial production and trade, and is not the sole (or even primary) driver of genetic standardisation. This can clearly be seen in Australia, where commercially important plant varieties are frequently not protected by PBR. They are instead controlled contractually, through closed supply chains of growers.[159] Alternatively, crops can be controlled through patents, on crops themselves where this is allowed, or on specific genetic sequences in locations where patenting of plants directly is prohibited.[160] Market forces also push towards agricultural standardisation: growers who attempt to sell heterogenous produce may find themselves penalised by distributers, purchasers, and consumers. This in turn encourages the standardisation of varieties by breeders.

155 'Regulations on Organic Heterogeneous Material', *Bundessortenamt* (Web Page) <https://www.bundessortenamt.de/bsa/en/seeds/organic-heterogeneous-material>.

156 Seeds 4 All, 'Organic Heterogeneous Material: A New Marketing Regime for Diversified Seed Populations'(Leaflet, 1 February 2022) 3 <https://liberatediversity.org/wp-content/uploads/2022/02/OHM_Booklet_S4A.pdf>.

157 Kloppenburg (n 4); Jefferson (n 146) 1013.

158 Site visits in France, Germany, the Netherlands, and the United Kingdom.

159 Interviews with Qualified Persons, PBR officials, and variety managers.

160 Carlos M Correa, Juan I Correa and Bram De Jonge, 'The Status of Patenting Plants in the Global South' (2020) 23(1–2) *Journal of World Intellectual Property* 121 <https://doi.org/10.1111/jwip.12143>.

The technologies of standardisation used within PBR systems are therefore better understood as a symptom rather than a cause of industrialised agriculture. While imposing legal constraints of uniformity and stability does have consequences for agricultural genetic diversity (and therefore for agricultural resilience in the face of changing environmental conditions), standardisation and homogeneity are imposed by market structures even in the absence of intellectual property rights.

VI CONCLUSION

Examining the material practices of PBR reveals a deeply embedded affinity and drive for objective judgement. This epistemic virtue manifests in the careful selection of comparator varieties or the use of comprehensive reference collections, in the intricate division of plant varieties into defined characteristics, in the detailed DUS trial protocols followed by examiners, in the debate around standardised genetic testing, and in the requirements of genetic homogeneity for new plant varieties.

The cause of this commitment to objectivity is complex and multifaceted. The value of objectivity is deeply embedded in Western legal and scientific traditions, due to its association with universalised truth stripped of subjectivity. Both law and science draw their power from their claim to universality. Science aims at achieving a disembodied and disinterested view, a universalised perspective that Thomas Nagel has called 'the view from nowhere',[161] and that Donna Haraway has described as 'the god trick of seeing everything from nowhere',[162] 'disembodied vision',[163] and 'the view from above, from nowhere, from simplicity'.[164] In a similar way, the power of the rule of law is seen as deriving from its impartial judgement, lack of situated contingency, and basis on abstract rules on principles.[165]

In a legal context, objectivity is associated with generality, universality, and fairness. Mark van Hoecke notes that

> in legislation, 'objectivity' has mainly been translated into the general principle of the 'generality', the general scope of statutory rules and into the equality principle. … At the level of adjudicating the law, 'objectivity' has been translated into 'neutrality', most notably the neutrality of the judges deciding cases.[166]

Objectivity also carries strong rhetorical force, to the extent that something which is objective 'does not seem to require further arguments';[167] objectivity almost appears a synonym for 'truth' itself. For PBR, objective judgement implies that the legal rights have been fairly granted and are therefore universally valid (within the jurisdictions that recognise the right).

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161 Thomas Nagel, *The View from Nowhere* (Oxford University Press, 1986).

162 Donna Haraway, 'Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective' (1988) 14(3) *Feminist Studies* 575, 581.

163 Ibid 590.

164 Ibid 589.

165 Timothy Mitchell, *Rule of Experts: Egypt, Techno-Politics, Modernity* (University of California Press, 2002) 53; Mark van Hoecke, 'Objectivity in Law and Jurisprudence' in Jaakko Husa and Mark van Hoecke (eds), *Objectivity in Law and Legal Reasoning* (Hart Publishing, 2013) 3.

166 Ibid 4.

167 Ibid 8.

This drive for objectivity is not all-encompassing, however. It is interlinked with a reliance on trained expertise in the aspects of judgement where human judgement and intuition cannot be replaced by standardised procedures or instruments. Tacit knowledge and embodied skills remain important in the selection of comparator varieties, the judgement of distinctness, and the assessment of off-types. Trained judgement operates to support objectivity by formalising those aspects of judgement which are difficult, or impossible, to standardise.

While the Australian system is less rigorous than European systems in its pursuit of objective judgement, this is justified by supervisory procedures which minimise the subjectivity of the assessor as much as possible while retaining the affordability and flexibility of decentralised judgement. More importantly, the training and expertise of Qualified Persons justifies their reliance on tacit skill and knowledge in assessing plants. Supervision, training, and expertise all operate to legitimise the 'subjectivity' of expert judgement. Daston and Galison describe how in the history of scientific epistemology, 'by the mid-twentieth century, objectivity and subjectivity no longer appeared like opposite poles; rather, like strands of DNA, they executed the complementary pairing that underlay understanding of the working objects of science'.[168] In the PBR system, too, the epistemic ideals of objectivity and trained judgement operate in tandem, the latter serving to formalise those aspects of judgement which cannot easily (or cost-effectively) be standardised and automated.

Debates around assessing distinctness with genetic tests highlight the ongoing appeal of technoscientific innovation as a means of increasing objectivity. These debates also demonstrate how value judgements and power relations can be obscured by calls for modernisation or technical improvement of the law. While genetic testing does hold promise for increasing the speed, affordability, and objectivity of assessment, it also faces an array of practical issues and risks disadvantaging smaller breeders.

For plant varieties to function as valid items of intellectual property, and as reliable inputs in geographically dispersed production and supply chains, they must be constrained as solid and consistent objects with a limited scope. This standardisation is achieved through the requirements of uniformity and stability, which intrinsically limit genetic diversity. This issue is particularly pronounced where DUS trials are required for mandatory variety registration, although alternative legal channels like those implemented for Organic Heterogenous Material in the European Union may provide a viable solution for marketing less-uniform varieties.

While objectivity carries associations of fairness, impartiality, and freedom from bias, this does not necessarily mean that 'objective' systems produce beneficial outcomes. Critiques highlight that PBR are interconnected with industrialised agriculture, genetic monocultures, and capitalistic consolidation of agricultural industries, all of which continue to wreak devastation around the world. While PBR are a symptom rather than a driver of this much larger process, their example suggests that ostensibly neutral legal-scientific objectivity (buttressed with trained judgement) is not a sufficient guiding principle for legal and scientific systems. Intellectual property rights should be conceived of as an area of public policy, not as an apolitical right arising intrinsically from the act of invention.

168 Daston and Galison (n 7) 361.