

Petition for *Inter Partes* Review of
U.S. Patent No. 11,140,841 B2

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

AARDEVO NORTH AMERICA, LLC
Petitioner

v.

Agventure B.V.,
Patent Owner

Case IPR2025-00136
U.S. Patent No. 11,140,841 B2
Issue Date: October 12, 2021

Title: HYBRID SEED POTATO BREEDING

**PETITION FOR *INTER PARTES* REVIEW
OF U.S. PATENT NO. 11,140,841 B2**

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List of Exhibits

Exhibit No.	Description of Document
1001	U.S. Patent No. 11,140,841 B2 issued to Willem Hendrik Lindhout et al. (filed Aug. 14, 2019, issued Oct. 12, 2021) (“’841 patent”)
1002	Declaration of Shelley Jansky, Ph.D. (“Jansky Decl.”)
1003	Declaration of David Douches, Ph.D. (“Douches Decl.”)
1004	H. de Jong and P.R. Rowe, <i>Inbreeding in cultivated diploid potatoes</i> , Potato Res., 14(1):74-83 (1971) (“Jong”)
1005	Chalermpol Phumichai et al., <i>Toward the development of highly homozygous diploid potato lines using the self-compatibility controlling Sli gene</i> , Genome, 48(6):977-984 (2005) (“Phumichai”)
1006	David M. Spooner et al., <i>Extensive simple sequence repeat genotyping of potato landraces supports a major reevaluation of their gene pool structure and classification</i> , PNAS, 104(49):19398-19403 (2007) (“Spooner”)
1007	Sherret S. Chase, <i>Analytical Breeding in Solanum Tuberosum L. – A Scheme Utilizing Parthenotes and Other Diploid Stocks</i> , Can. J. Genet. Cytol., 5(4):359-363 (1963) (“Chase”)
1008	Nathan M. Springer and Robert M. Stupar, <i>Allelic variation and heterosis in maize: How do two halves make more than a whole?</i> , Genome Res., 17:264-275 (2007) (“Springer”)
1009	John B. Bamberg et al., <i>Elite Selections of Tuber-bearing Solanum Species Germplasm</i> , Inter-Regional Potato Introduction Station, NRSP-6 (1994) (“Bamberg”)
1010	Certified Prosecution History for U.S. Patent No. 11,140,841 B2 (“’841 patent file history”)

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1011	Shelley Jansky, <i>Chapter 2: Breeding, Genetics, and Cultivar Development</i> ,” <i>Advances in Potato Chemistry and Technology</i> , pp. 27-62 (“Jansky 2009”)
1012	Zósimo Huamán and David M. Spooner, <i>Reclassification of Landrace Populations of Cultivated Potatoes (Solanum sect. Petota)</i> , <i>Am. J. of Botany</i> , 89(6):947-965 (2002) (“Huaman”)
1013	Hans Ross, <i>Potato Breeding - Problems and Perspectives</i> ,” <i>Advances in Plant Breeding (Supplement 13 to Journal of Plant Breeding)</i> , (1986) (“Ross”)
1014	Kingsley R. Stern et al., <i>Chapter 13: Genetics, Chapter 14: Plant Breeding and Propagation, and Chapter 23: Seed Plants: Angiosperms</i> , <i>Introductory Plant Biology</i> , pp. 224-265, 428-447 (11th ed. 2008) (“Stern”)
1015	F. L. Lauer et al., <i>Potato Improvement Through Parental Line Breeding - A Five Year Report of the North Central 35 Regional Project, NC-35</i> , <i>Am. Potato J.</i> , 39:282-287 (1962) (“Lauer”)
1016	Rodomiro Ortiz, <i>Analytical Breeding</i> , <i>Acta Hortic.</i> 622:235-247 (2003) (“Ortiz”)
1017	T.R. Tarn et al., <i>Chapter 8: Breeding Potatoes for Long-day, Temperate Climates</i> , <i>Plant Breeding Reviews</i> , 9:217-332 (1992) (“Tarn”)
1018	U.S. Department of Agriculture (USDA), <i>Potatoes 2008 Summary</i> , <i>Agricultural Statistics Board, NASS Report, Pot 6</i> (2009) (“USDA 2009”)
1019	H. De Jong and G. C. C. Tai, <i>Analysis of tetraploid-diploid hybrids in cultivated potatoes</i> , <i>Potato Res.</i> , 20:111-121 (1977) (“Jong and Tai 1977”)

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1020	H. De Jong and G. C. C. Tai, <i>Evaluation of Potato Hybrids Obtained from Tetraploid-Diploid Crosses</i> , I. Parent-Offspring Relationships, Plant Breeding, 107:177-182 (1991) (“Jong and Tai 1991”)
1021	J.A. Buso et al., <i>Tuber yield and quality of 4x-2x (FDR) potato progenies derived from the wild diploid species Solanum berthaultii and Solanum tarijense</i> , Plant Breeding, 122:229-232 (2003) (“Buso”)
1022	M.J. DeMaine, <i>The effects of inbreeding on the parental values of potato dihaploids</i> , Ann. Appl. Biol., 127:151-156 (1995) (“DeMaine”)
1023	A.R. Hallauer et al., <i>Chapter 8: Corn Breeding</i> , Corn and Corn Improvement, Agronomy Monograph, No. 18:463-564 (3rd ed. 1988) (“Hallauer”)
1024	Chalermpol Phumichai et al., <i>Expression of S-locus inhibitor gene (Sli) in various diploid potatoes</i> , Euphytica, 148:227-234 (2006) (“Phumichai 2006”)
1025	R. Eijlander et al., <i>Selection of vigorous and fertile S-homo- and heterozygous tester clones from self-incompatible diploid potato, Solanum tuberosum L.</i> , Euphytica, 97:97-111 (1997) (“Eijlander”)
1026	D.S. Falconer, <i>Chapter 14: Inbreeding and Crossbreeding I. Changes of Mean Value, Chapter 15: Inbreeding and Crossbreeding II. Changes of Variance, and Chapter 16: Inbreeding and Crossbreeding III. The Utilisation of Heterosis</i> , Introduction to Quantitative Genetics, pp. 247-291 (1960; 1967) (“Falconer”)
1027	T.J. Riggs, <i>Breeding F₁ hybrid varieties of vegetables</i> , Journal of Horticultural Science, 63(3):369-382 (1988) (“Riggs”)
1028	Svenja Meyer et al., <i>PoMaMo—a comprehensive database for potato genome data</i> , Nucleic Acids Research, 33:D666-D670 (2005) (“Meyer”)

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1029	M. W. Bonierbale et al., <i>A test of the maximum heterozygosity hypothesis using molecular markers in tetraploid potatoes</i> , Theor Appl Genet, 86:481-491 (1993) (“Bonierbale”)
1030	Kazuyoshi Hosaka and Robert E. Hanneman, Jr., <i>Genetics of self-compatibility in a self-incompatible wild diploid potato species Solanum chacoense. 1. Detection of an S locus inhibitor (Sli) gene</i> , Euphytica, 99:191-197 (1998) (“Hosaka 1998a”)
1031	Kazuyoshi Hosaka and Robert E. Hanneman, Jr., <i>Genetics of self-compatibility in a self-incompatible wild diploid potato species Solanum chacoense. 2. Localization of an S locus inhibitor (Sli) gene on the potato genome using DNA markers</i> , Euphytica, 103:265-271 (1998) (“Hosaka 1998b”)
1032	R.K. Bihman and K. Hosaka, <i>Production of inbred progenies of diploid potatoes using an S-locus inhibitor (Sli) gene, and their characterization</i> , Genome, 43:495-502 (2000) (“Bihman”)
1033	Pim Lindhout et al., <i>Towards F₁ Hybrid Seed Potato Breeding</i> , Potato Res., 54:301-312 (2011) (“Lindhout 2011”)
1034	Hielke De Jong, <i>Inbreeding in Cultivated Diploid Potatoes</i> , Univ. of Wisconsin, PhD dissertation Univ. of Wisconsin Library (1971) (“Jong thesis”)
1035	J.F. Crow, <i>90 Years Ago: The Beginning of Hybrid Maize</i> , Perspectives: Anecdotal, Historical and Critical Commentaries on Genetics, Genetics Society of America, 148:923-928 (1998) (“Crow 1998”)
1036	Corentin Clot et al., <i>The origin and widespread occurrence of Sli-based self-compatibility in potato</i> , Theoretical and Applied Genetics, 133:2713-2728 (2020) (“Clot”)

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1038	R. K. M. Hay, <i>Harvest index: a review of its use in plant breeding and crop physiology</i> , Ann. Appl. Biol., 126:197-216 (1995) (“Hay”)
1039	N. Richard Knowles and Gabor I. Botar, <i>Effect of altering the physiological age of potato seed-tubers in the fall on subsequent production in a short-season environment</i> , Can. J. Plant. Sci., 72:275-287 (1992) (“Knowles”)
1040	U.S. Provisional Application Serial No. 61/254,980
1041	James F. Crow, <i>Alternative Hypotheses of Hybrid Vigor</i> , Genetics, 33:477-487 (1948) (“Crow 1948”)
1042	R.H. Moll et al., <i>The Relationship of Heterosis and Genetic Divergence in Maize</i> , Genetics, 52:139-144 (1965) (“Moll”)
1043	S.K. Luthra et al., <i>Genetic Divergence and Its Relationship with Heterosis in Potato</i> , Potato J., 32(1-2):37-42 (2005) (“Luthra”)
1044	Yanli Lu et al., <i>Molecular characterization of global maize breeding germplasm based on genome-wide single nucleotide polymorphisms</i> , Theor. Appl. Genet., 120:93-115 (2009) (“Lu 2009”)
1045	Shelley Jansky, <i>Chapter 4: Breeding for Disease Resistance in Potato</i> , Plant Breeding Reviews, 19:69-155 (2000) (“Jansky 2000”)
1046	Kenneth S. Dodds and G. J. Paxman, <i>The Genetic System of Cultivated Diploid Potatoes</i> , Evolution, 16:154-167 (1962) (“Dodds”)
1047	S.J. Peloquin and R.W. Hougas, <i>Genetic Variation Among Haploids of the Common Potato</i> , Am. Potato J., 37:289-297 (1960) (“Peloquin”)

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1048	N.J. Van Suchtelen, <i>Investigation of Dihaploid Potatoes in the Netherlands</i> , Eur. Potato J., 9(2):64-68 (1966) (“Van Suchtelen”)
1049	Juan Alejandro Landeo, <i>Breeding Potential of Group Andigena Haploid Potatoes</i> , Univ. of Wisconsin-Madison, PhD dissertation, Xerox University Microfilms (1979) (“Landeo”)
1050	Shelley Hermundstad and S.J. Peloquin, <i>Tuber yield and tuber traits of haploid-wild species F₁ hybrids</i> , Potato Res., 29:289-297 (1986) (“Hermundstad”)
1051	Nov. 18, 2015 Response to Final Office Action, U.S. Application No. 13/504,156 (U.S. Patent No. 10,524,436) (“11-18-2015 Resp. to FOA”)
1052	Sept. 8, 2016 Amendment in Response to Non-Final Office Action Under 37 C.F.R. §1.111, U.S. Application No. 13/504,156 (U.S. Patent No. 10,524,436) (“9-8-2016 Am. Resp. to NFOA”)
1053	Jan. 30, 2019 Declaration of Willem Hendrik Lindhout Under 37 C.F.R. §1.132, U.S. Application No. 13/504,156 (U.S. Patent No. 10,524,436) (“436 Lindhout Decl.”)
1054	Mar. 8, 2016 Non-Final Office Action, U.S. Application No. 13/504,156 (U.S. Patent No. 10,524,436) (“3-8-2016 NFOA”)
1055	Aug. 29, 2018 Amendment Submitted with Request for Continued Examination, U.S. Application No. 13/504,156 (U.S. Patent No. 10,524,436) (“8-29-2018 Am. Req. Cont’d Examination”)
1056	M.T. Jackson et al., <i>Inbreeding and True Potato Seed Production</i> , Innovative Methods for Propagating Potatoes, Report of the XXVIII Planning Conference, CIP (Dec. 10-14, 1984)
1057	European Patent Office, Opposition to European Patent No. 3 536 146, Decision of Opposition Division Revoking Patent (Aug. 1, 2024)

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1058	John B. Bamberg and Max W. Martin, <i>Inventory of Tuber-bearing Solanum Species</i> , Catalog of Potato Germplasm (1993)
1059	João Vasco Silva et al., <i>Yield gaps in Dutch arable farming systems: Analysis at crop and crop rotation level</i> , Agricultural Sys., 158:78-92 (2017)
1060	<i>Exhibit Number Not Used</i>
1061	U.S. Department of Agriculture (USDA), <i>Potatoes 2009 Summary</i> , Agricultural Statistics Board, NASS Report (2010)
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1063	U.S. Department of Agriculture (USDA), <i>Potatoes 2011 Summary</i> , Agricultural Statistics Board, NASS Report (2012)
1064	U.S. Department of Agriculture (USDA), <i>Potatoes 2012 Summary</i> , Agricultural Statistics Board, NASS Report (2013)
1065	U.S. Department of Agriculture (USDA), <i>Potatoes 2014 Summary</i> , Agricultural Statistics Board, NASS Report (2015)
1066	U.S. Department of Agriculture (USDA), <i>Potatoes 2017 Summary</i> , Agricultural Statistics Board, NASS Report (2018)
1067	USDA National Plant Germplasm System, Details for: GS 2, <i>Solanum tuberosum</i> L., US-W4, available at https://npgsweb.ars-grin.gov/gringlobal/accessiondetail?id=1000069
1068	USDA National Plant Germplasm System, Details for: PI 675351, <i>Solanum tuberosum</i> L., ‘RH89-039-16’, available at https://npgsweb.ars-grin.gov/gringlobal/accessiondetail?id=1660370

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1069	Norma C. Manrique-Carpintero et al., <i>Genetic Map and QTL Analysis of Agronomic Traits in a Diploid Potato Population using Single Nucleotide Polymorphism Markers</i> , Crop Sci., 55:2566-2579 (2015)
1070	J. Rouppe van der Voort et al., <i>Mapping of the cyst nematode resistance locus Gpa2 in potato using a strategy based on comigrating AFLP markers</i> , Theor. Appl. Genet., 95:874-880 (1997) (“Voort”)
1071	Hans van Os et al., <i>Construction of a 10,000-Marker Ultradense Genetic Recombination Map of Potato: Providing a Framework for Accelerated Gene Isolation and a Genomewide Physical Map</i> , Genetics, 173:1075-1087 (2006)
1072	Ling Ma et al., <i>A nonS-locus F-box gene breaks self-incompatibility in diploid potatoes</i> , Nature Communications, 12:4142 (2021)
1073	Kimberly J. Felcher et al., <i>Integration of Two Diploid Potato Linkage Maps with the Potato Genome Sequence</i> , PLoS One, 7(4):e36347 (2012)
1074	John P. Hamilton et al., <i>Single nucleotide polymorphism discovery in elite north american potato germplasm</i> , BMC Genomics, 12:302 (2011)
1075	Peter G. Vos et al., <i>Development and analysis of a 20K SNP array for potato (Solanum tuberosum): an insight into the breeding history</i> , Theor. Appl. Genet., 128:2387-2401 (2015)
1076	Potato Pedigree Database – RH89-039-16, Pedigree Image Map, available at https://www.plantbreeding.wur.nl/PotatoPedigree/pedigree_imagemap.php?id=6839&showjaar=0&depth=8
1077	Declaration of Ingrid Hsieh-Yee, Ph.D.

Petitioner respectfully requests institution of *inter partes* review (IPR) of United States Patent No. 11,140,841 B2 (“’841 patent” or “EX1001”), Claims 1-10.

I. INTRODUCTION

The ’841 patent should never have issued. The challenged claims recite diploid, fertile, and self-compatible potato lines that are inbred using self-compatibility genetics imparted by the *Sli* gene, along with methods for breeding such inbreds through selfing, and methods of making hybrid potato seed by crossing two such inbreds. But as explained in this Petition, the inventors did not invent diploid inbreeding in potatoes, did not discover the *Sli* gene for self-compatibility, and did not invent making hybrid seeds through the crossing of inbreds. On the contrary, the subject matter of the challenged claims was disclosed in the prior art, as were the claimed methods of hybrid seed generation through the crossing of inbreds. As set forth below, the challenged claims of the ’841 patent should be found unpatentable for anticipation and obviousness.

II. MANDATORY NOTICES UNDER §42.8(a)(1)

A. Real Parties-In-Interest under §42.8(b)(1)

In addition to Petitioner Aardevo North America, LLC, Aardevo B.V., the JR Simplot Company, and KWS SAAT SE & Co. KGaA are additional real-parties-in-interest.

B. Related Matters under §42.8(b)(2)

The '841 patent has no related matters as defined in 37 C.F.R. §42.8(b)(2). As explained below, Patent Owner's corresponding EP patent (EP 3,536,146) was revoked for lack of novelty by the Opposition Division of the European Patent Office on August 1, 2024. (EX1057.)

C. Lead and Back-Up Counsel under §42.8(b)(3)

Petitioner provides the following designation of counsel.

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D. Service Information §42.8(b)(4)

This Petition is being served by Priority Mail Express to the attorney of record for the '841 patent, 125771 – DENTONS US LLP, P.O. Box 1302, Chicago, IL, 60604. Petitioner consents to electronic service at the addresses provided above for counsel.

III. FEE PAYMENT

Petitioner requests review of 10 claims, with a \$41,500 payment.

IV. REQUIREMENTS UNDER §§42.104 AND 42.108

A. Standing

Petitioner certifies that the '841 patent is available for IPR and that Petitioner and named real-parties-in-interest are not barred or otherwise estopped.

B. Identification of Challenge

Petitioner requests institution of IPR of Claims 1-10:

Ground	Claim(s)	Basis for Challenge
1	1, 4, 7	Anticipated by Jong (EX1004)
2	1-7	Obvious over Jong, Chase (EX1007), and Bamberg (EX1009)
3	8-10	Obvious over Jong, Chase, Bamberg, and Springer (EX1008)

Ground	Claim(s)	Basis for Challenge
4	1-7	Obvious over de Phumichai (EX1005), Jong, Chase, Bamberg, and Spooner (EX1006)
5	8-10	Obvious over de Phumichai, Jong, Chase, Bamberg, Spooner, and Springer
6	1, 4	Anticipated by US-W4
7	5-10	Obvious over US-W4, Chase, Bamberg, and Springer
8	1, 4	Anticipated by RH89-039-16
9	5-10	Obvious over RH89-039-16, Chase, Bamberg and Springer

V. FACTUAL BACKGROUND

As detailed below, a POSA would have been confident by 2009 that diploid, fertile, self-compatible, and highly homozygous inbred lines could be made and crossed to create heterotic hybrid true potato seed.

A. Potato Taxonomy

Potato is the world's fourth largest food crop. (EX1002, ¶33.) Taxonomic classification of potato has been extensively studied. (EX1006; EX1002, ¶34.) By 2002 (and still today) all potato (*i.e.* wild and cultivated) belonged to the genus *Solanum*, and all cultivated potatoes belonged to a single species *Solanum tuberosum*. (EX1006, 0009; EX1012, 0001; EX1002, ¶¶36–40.) Older taxonomies had grouped potatoes into 1-21 distinct species. (EX1002, ¶37.) However, before 2009 the Phureja varieties referenced in certain prior art and as discussed below, had

been firmly classified into the single species *S. tuberosum*. Prior art describing studies with potato labeled as *S. phureja* was, before 2009, understood to describe species *S. tuberosum* potatoes. (EX1002, ¶¶39–40.)

B. Propagation

Potato can be propagated both vegetatively and sexually. The most common method of vegetative propagation involves growing tubers. (*Id.*, ¶¶41-43.) “Seed tubers” refers to vegetative pieces of a tuber capable of reproduction. (*Id.*, ¶41.) When a planted seed tuber is grown into a mature plant, the resulting “offspring” tubers are genetically identical (clones) of the parent potato. (EX1013, 0011, 0104-07.) Alternatively, “true potato seed” (“TPS”) refers to sexual propagation. (*Id.*, 0060-62.) TPS propagation occurs when pollen from a flower germinates and fertilize into a fruit or “berry” containing TPS. These seeds are genetically different from either parent, unless they result from selfing a homozygous plant (described below). (EX1014, 0038, 0046-47, 0057-60; EX1002, ¶¶42-43.)

C. Tetraploid Potato Breeding

Potato can have various ploidy levels, or sets of chromosomes in an organism’s cells. (*See* EX1002, ¶44.) Diploid (two) and tetraploid (four) are most commonly known ploidy levels. (EX1012, 0015-16.) Commercially, most cultivars are tetraploid *S. tuberosum* Group Tuberosum propagated via seed tubers (genetically identical clones to their parents). (*See* EX1002, ¶¶41, 45; EX1012,

To develop new commercial tetraploid cultivated varieties, a breeder sexually crosses two parental potato clones and plants the resulting seeds to grow an “F₁” population of offspring from which to select new genetic combinations. (EX1011, 0025; EX1013, 0026.)

Sexual crossing and screening of offspring in tetraploid potato is cumbersome because the chromosomes can harbor up to four variants (alleles) for every gene. (EX1002, ¶47.) The resulting tetrasomic inheritance is complex, making it difficult to make directed improvements; tetrasomic inheritance can allow deleterious recessive alleles to accumulate in the genome. (*Id.*; EX1011, 0020-22.)

Therefore, it is typical to grow 100,000+ seedlings annually from crosses among dozens of parental clones in a breeding program. (EX1011, 0025; EX1013, 0027-28; EX1002, ¶48.) The breeder selects tubers from each seedling for evaluation. A plant produced by a seed tuber is called a “hill.” (EX1002, ¶¶46-48.) It is common for this field evaluation to take 10 or more years before a suitable new cultivated tetraploid potato variety is created. (*Id.*; EX1015, 0001.)

D. Diploid Potato Breeding

There are many commercially successful cultivated varieties that are diploid, especially in South America. (EX1006, 0012.) Diploid potato breeding is genetically simpler than tetraploid, involving only two sets of chromosomes.

Diploidy simplifies inheritance patterns in crossing, as offspring can only inherit two alleles per gene. (EX1013, 0031; EX1016, 0001-03; EX1002, ¶49.)

Besides their commercial relevance for consumption, potato breeders value that various varieties of diploid *S. tuberosum* can impart desirable agronomic traits and expand the available genomic diversity. (EX1013, 0015; EX1045, 0005, 0011, 0013-14, 0018, 0020, 0023, 0025, 0026, 0028, 0030-31; EX1002, ¶¶50-51.)

Further, by 2009, breeders routinely created diploid potatoes from commercial tetraploid varieties, (EX1013, 0030-35), by simply applying pollen from a diploid *S. tuberosum* clone, a “haploid inducer,” to the stamen of a tetraploid variety, inducing gynogenesis (embryo production from an unfertilized egg cell). This results in diploid offspring containing genetic material only from the mother. (EX1002, ¶¶52-53.) Potato breeders term these diploid offspring “dihaploids” or “haploids.” Both terms mean two sets of chromosomes. (EX1017, 0010; EX1011, 0014-16; EX1013, 0015, 0033-34.)

Thus, by 2009, breeders considered it routine and “relatively easy” to produce diploid progeny (*i.e.* “dihaploids”) from tetraploid cultivated potato to then utilize in breeding programs. (EX1017, 0010; EX1016, 0001-03.) These diploid potatoes were crossed with many cultivated diploid breeding clones and with wild diploid species. (EX1011, 0014-16; EX1013, 0015; EX1016, 0001-03; EX1002, ¶53.)

E. Yield of Tetraploid Cultivars and Diploid Potato Selections

The average tuber yield for commercial tetraploid varieties in the U.S. in 2008 was 396 cwt/acre, which equals an average tuber yield of 1,111g per plant. (EX1018, 0005; EX1002, ¶54.) Plant breeders knew by 2009 that diploid clones could attain tuber yields equivalent to commercial tetraploids and even exceed them. (EX1019, 0001, 0007-08; EX1020, 0003-04; EX1021, 0002; EX1022, 0003; EX1002, ¶55.)

F. Inbred Creation and Hybrid Vigor in Commercial Crops Were Well Known

Plant breeding involves the concepts of homozygosity and heterozygosity. A homozygous plant has the same variant of a gene or “allele” at a given locus on each of its chromosomes (*e.g.* both copies of the flower color gene code for red flowers). (EX1002, ¶58.) A heterozygous plant, conversely, has different alleles at one locus (*e.g.* one copy codes for red and the second copy for white). (*Id.*; EX1014, 0025.)

Through a phenomenon known as “heterosis,” or “hybrid vigor,” it was well known across a wide array of vegetables and field crops that the crossing of two highly inbred plants creates hybrid offspring with a high degree of heterozygosity and performance characteristics significantly greater than either inbred parent. (EX1041, 0001; EX1035, 0001, 0004; EX1026, 0032-47; EX1027, 0004; EX1002, ¶57.) A hybrid population produced by crossing two inbreds is highly uniform because each inbred parent produces genetically uniform gametes. (EX1002, ¶63.)

Breeding programs for crops to create highly homozygous inbred parental

lines with agronomically desirable traits, so called “elite” inbreds, have long been known – as has the use of those inbreds in crosses to produce plants with a high degree of heterosis that can be useful for commercial growers. (*Id.*; EX1026, 0033; EX1023, 0009-21; EX1027, 0004-06; EX1002, ¶¶56, 63.) It was known that potato “exhibits strong hybrid vigor” and that because “high potato yield and vigor depend on interlocus and intralocus interactions, breeding strategies typically aim to maximize heterosis.” (EX1011, 0026.) Furthermore, it was understood that the most extreme heterosis effect would mean implementing a breeding strategy “to develop highly inbred clones at the diploid level and then combine genetically diverse diploids to produce heterotic hybrids.” (*Id.*) Thus, when considering a phenotype such as tuber yield, breeders would cross two highly inbred diploid parental lines that are sufficiently genetically distant, to create offspring exhibiting heterosis and a tuber yield higher than either parent. (EX1026, 0013, 0020, 0035; EX1011, 0026; EX1022, 0006; EX1002, ¶¶64.)

Inbreeding refers to the intentional creation of plants with high homozygosity at all loci across the genome. This can be accomplished in a variety of ways over generations, including: sib mating (when a progeny is crossed with its sibling), or selfing (when a plant is crossed with itself). (EX1014, 0038-39; EX1023, 0009-21; EX1002, ¶¶59.) Thus, it was well known that an inbred line exhibits a high degree of homozygosity and uniformity. By repeated selfing, over each generation, an

increase in homozygosity is achieved. In diploid plants, each round of selfing is expected to increase homozygosity by 50% with each round. Thus, high levels of homozygosity can be achieved after only a few generations of selfing. (EX1004, 0007; EX1002, ¶60.)

With increasing inbreeding, breeders sometimes initially see “inbreeding depression,” which may manifest as a lack of vigorous growth and fertility over increasing inbreeding rounds. However, a plant breeder is not prevented from “pushing through” inbreeding depression and continuing to self to higher homozygosity. (EX1002, ¶61.) It was known in potato that “inbreeding depression is largely spent on the initial unmasking of deleterious recessives, whether it be by selfing or by dihaploidisation. Subsequent generations, on average, do not show such a large reduction in vigour.” (EX1022, 0006.) Furthermore, potato breeders “hypothesized that continuous selfing may eliminate undesirable recessive alleles as they become homozygous, and may recover fertility with advancing generations.” (EX1037, 0006-07.) In fact, “[f]rom the point of view of the good performance of the progenies of the basic F1s and some of the inbred lines, it should be concluded that the establishment of inbred lines of diploid potato, comparable to those of maize, might be possible.” (EX1025, 0014.) Consequently, it was known that it was possible to rebound from initial inbreeding depression simply by continued selfing through the selection of plants presenting acceptable levels of fertility and vigor.

(*Id.*; EX1022, 0006; EX1002, ¶¶61-62.)

G. Molecular Markers and Their Use in Achieving Heterosis in Potato Breeding

By 2009, techniques using molecular markers to assist in potato breeding were well known. (EX1011, 0027-28; EX1002, ¶65.) Several genetic marker techniques, such as RFLP and SNP-based marker analysis, were known to the plant breeding community. (EX1028, 0001.) These genetic tools aided plant breeders in evaluating homozygosity and heterozygosity and confirming agronomically desirable traits. (EX1011, 0026-28.) For example, using molecular markers, a breeder can develop informed predictions when making a cross, as to whether two parents are sufficiently similar, or different, at various loci in their genome, such that they are likely to produce vigorous and highly heterotic offspring. (EX1029, 0001, 0008-10; EX1026, 0013, 0020, 0033, 0035; EX1002, ¶66.)

Potato breeders understood that to achieve a heterosis in a cross between inbred parental lines, the lines utilized in the cross needed to be genetically different to a sufficient degree. (EX1029, 0001, 0008-10.) By 2009, potato breeders recognized and understood that the genetic distance between parental inbred breeding lines was a variable that could be measured and optimized to inform future crosses on the road to achieving heterotic hybrid offspring. (EX1002, ¶66.)

H. Methods for Breeding of Diploid Homozygous Inbred Lines for Subsequent Heterosis Crossing to Generate True Potato Seed Were Known

Following the remarkable success of hybrid breeding using inbred lines in corn and the *Solanum* crops tomato and eggplant, prior art potato breeders pursued this technique in diploid potatoes. (EX1002, ¶67.) Several factors encouraged the breeders to pursue this goal and to expect success.

1. Breeding with Inbred Diploids Was Touted as Beneficial

As discussed, using diploid potatoes to develop inbred lines was desirable, in part because “the rate of progress towards homozygosity following selfing is much faster” than with tetraploids. (EX1004, 0007; EX1002, ¶68.)

Further, a systematic approach to inbreeding homozygous diploid potato for the creation of hybrids exhibiting heterosis was known before 2009. (EX1002, ¶69.) This methodology, termed “analytical breeding,” proposes all key steps that such a breeding program would entail: (1) reduction of tetraploid commercial germplasm to the diploid level (*i.e.* dihaploid induction); (2) crossing the dihaploids with other diploids to produce F₁ progeny known in the art to be “remarkably vigorous” and that are “increasing their heterotic diversity” for later hybrid crossing; (3) “[i]nbreeding of the diploid F₁ crosses...to fix desirable genetic material...[which] presents the plant breeder no problems of an unusual nature”; and (4) crossing the inbred lines that were “inbred...to homozygosity for genes controlling attributes of

economic importance” to “maximize the heterotic interaction in the final combination” to create “diploid hybrids.” (EX1007, 0006; EX1016, 0003; EX1056, 0009.) This analytical breeding method provided potato breeders with a roadmap for establishing a diploid inbreeding system that would lead to hybrid crosses exhibiting heterosis.

According to Chase, all the steps in the breeding system relevant to the ’841 claims “have in one or another line of research already been accomplished,” “[and thus] it is not unreasonable to expect that these operations can be carried out in stepwise fashion.” (EX1007, 0007.) Notably, Chase’s breeding program outlined sixty years ago is effectively identical to the breeding “scheme” that the ’841 inventors characterized as novel, as shown below. (EX1002, ¶70.)

Chase Steps	Chase Instructions (EX1007, 0006)	Breeding System Disclosed in ’841 Patent
(1) & (2)	“The first operation, step #1, is the selection of the [tetraploid] source material, that is, the clone or set of clones of the commercial potato...”; “Through reduced parthenogenesis, step #2, a series of diploid derivatives of the tetraploid source is created.”	Parental lines D1-D3, as further explained by the inventors’ breeding history disclosed during prosecution, are dihaploids produced by gynogenesis from tetraploid commercial cultivar source material. (EX1001, 11:9-26, 22:16-23:3, 29:62-30:7, 31:39-62, 46:1-47:12 (Table 6), Fig. 2; EX1010, 0532, 0537-39.)
(3)	“Next, step #3, comes the selection and clonal propagation from among the	Corresponds to claim step 5(a)&(b); D1, D2, and D3 were chosen from multiple choices, e.g., from among the D1-D19 of Table 6 of the ’841

	array of parthenotes of one or, preferably, several plants...”	patent. (EX1001, 11:9-26, 22:16-23:3, 29:62-30:7, 31:39-62, 46:1-47:12 (Table 6); EX1010, 0538, 1052.)
(4)	“This is followed by step #4 wherein the selected parthenote or parthenotes are crossed to a series of diploid species, varieties or selections.”	Corresponds to claim step 5(c)&(d); FIG 2. of the '841 patent provides the applicable diploid hybrids and resulting F ₁ progeny. (EX1001, 11:9-39, 22:16-23:3, 29:62-30:7, 31:39-64, Fig. 2; EX1010, 0531-33, 0545.)
(5)	“Inbreeding of the diploid F ₁ crosses, step #5...to fix desirable genetic material...[which] presents the plant breeder no problems of an unusual nature.”	Corresponds to claim step 5(e); FIG 2. of the '841 patent provides for inbreeding <i>via</i> selfing of diploid F ₁ plants that leads to F ₂ seeds deposited as AGVD1; inbreeding of diploid F ₁ plants <i>via</i> sib-mating (<i>i.e.</i> F ₁ (IVP08-207) X F ₁ (IVP08-206)) leading to “pseudo F ₂ ” seeds deposited as AGVD2; inbreeding <i>via</i> selfing of diploid F ₂ plants that leads to F ₃ deposited as AGVD17. (EX1001, 11:9-26, 22:16-23:3, 29:62-30:7, 31:39-62, Fig. 2; EX1010, 0533; <i>but see</i> EX1002, ¶70 noting inconsistencies between the text discussion in the patent, the breeding diagram shown in Fig. 2, and the statements in the Lindhout Declaration.)
(6) & (7)	Selecting (6) and then crossing (7) the inbred lines that have been “inbred...to homozygosity for genes controlling attributes of economic importance” to “maximize the heterotic interaction in the final combination” to create “diploid hybrids”	Corresponds to claim steps 5(f)&8(c), and the selecting (6) and crossing (7) steps of Example 5 of the '841. (EX1001, 52:30-52, 54:4-9.)

(8)	The “diploid hybrids are then manipulated to double their chromosome complements”	Example 5 further discloses diploid doubling to form tetraploids. (EX1001, 54:17-21.)
(9)	The “resulting tetraploids are crossed...to establish the heterotic tetraploid hybrid.”	Example 5 further teaches crossing those tetraploids. (EX1001, 54:21-23, 54:34-35.)

2. The *Sli* Gene Imparting Self-Compatibility Was Known as Useful for Inbreeding and True Potato Seed Production

While some diploid potatoes are self-incompatible, it has been long known that certain individuals, including the wild relative *Solanum chacoense*, were self-compatible. (EX1030; EX1031; EX1032, 0002; EX1011, 0010.) It was also known that the basis of this self-compatibility was genetic and could be bred by crossing into other diploid potatoes. (*Id.*; EX1002, ¶¶71-72.) Furthermore, a diploid *S. tuberosum* clone “US-W4” was known to be a source of self-compatibility that produced self-fertile and self-compatible offspring. (EX1002, ¶72; EX1004, 0006.)

US-W4 was extensively studied in a diploid inbreeding program where it was crossed with diploid clones identified as Phureja, and continually selfed until the S₅ generation, representing “the greatest degree of inbreeding ever imposed upon potatoes.” (EX1004, 0013.) These highly inbred S₅ diploid *S. tuberosum* populations were characterized as “fairly vigorous,” with a “high degree of uniformity,” and “about 97% homozygous.” (*Id.*, 0012-13.) One of the inbred diploid populations from this study achieved an average tuber yield of over 400g per

plant. (*Id.*, 0009; EX1002, ¶¶72.)

By 2009, self-compatibility in potato was well understood to derive from the gene called *Sli*. Potato lines containing *Sli* could be crossed with self-incompatible lines to produce self-compatible offspring. (EX1005, 0006.) Breeders relied on this to explicitly create a potato breeding system for diploid homozygous inbred lines for subsequent crossing to maximize heterosis and propagation via true potato seed. (*Id.*, 0005-06.) These breeders successfully crossed the *Sli* gene, and with it, self-compatibility, into *S. tuberosum* potatoes to create highly homozygous diploid potato lines to the S₄ generation. Breeders characterized these potatoes as possessing “considerable tuber yields.” (*Id.*, 0010.) Critically, *Sli* further opened the door for a “simple procedure” of “crossing with a *Sli* gene donor, then continued selfings” for “producing hybrid variety at the diploid level.” (*Id.*; EX1002, ¶¶73-74.)

3. By 2009, All That Was Left for Breeders to Practice These Methods Was Routine Breeding Work

Thus, by 2009, a POSA would have been confident that diploid, fertile, self-compatible, and highly homozygous inbred lines could be made and crossed to create heterotic hybrid true potato seed. Chase presented a detailed diploid breeding system that utilized homozygous inbred lines for creating hybrids exhibiting heterosis. Jong proved that a fertile, self-compatible, and highly homozygous inbred diploid *S. tuberosum* could exhibit tuber yield of over 400g per plant. Hosaka, Hanneman, Birhman, and Phumichai discovered the genetic underpinnings of *Sli*-

based self-compatibility and demonstrated the utility of the gene when incorporated into an inbred diploid breeding program to create hybrid offspring and produce true potato seed. (See EX1005, EX1030, EX1031, EX1032; EX1002, ¶75.)

Consequently, the potato breeding community merely needed to utilize the teachings of the prior art and apply it to their own germplasm. As discussed further below, the '841 inventors claimed to be first to do so, but they were not. And even if they were technically the first to practice any particular limitations of the '841 claims, such work was not inventive. Indeed, by an inventor's own admission made shortly after filing the '841 patent, their breeding scheme was "not new." (EX1033, 0001; EX1002, ¶75.)

VI. OVERVIEW OF THE '841 PATENT

The '841 patent has 10 issued Claims;¹ Claims 1, 5, and 8 are independent:

1. [a] A plant of a potato line, wherein said potato line is of the species *Solanum tuberosum* optionally comprising introgression segments of other tuber bearing *Solanum* species crossable to *Solanum tuberosum*,
[b] wherein said potato line is diploid, fertile, self-compatible,
[c] produces at least 200 grams fresh weight of tubers per plant, and
[d] at least 75% of the genomic loci in said potato line are homozygous,
[e] wherein said self-compatibility in said potato line is conferred by the S-locus inhibitor (*Sli*) gene, and wherein a copy of said gene is present in potato lines AGVD1, AGVD2, AGVD3, and AGVD17,

¹ For ease of reference, the claims are divided into labeled subparts.

representative seeds of said lines having been deposited with the NCIMB under NCIMB accession number 41663, NCIMB accession number 41664, NCIMB accession number 41665, and NCIMB accession number 41765, respectively.

2. The potato plant of claim 1, wherein said plant comprises at least one agronomically desirable trait selected from the group consisting of: insect tolerance, nematode tolerance, disease resistance, herbicide tolerance, cold tolerance, drought tolerance, flooding tolerance, tolerance to dry and wet rot, salinity tolerance, yellow flesh color, and cold-sweetening resistance.

3. The potato plant of claim 1, wherein said potato plant has a fresh weight of the foliage and shoots of at least 500 grams per plant at maturity.

4. A seed or tuber that produces the plant of claim 1.

5. [preamble] A method of producing a plant of a potato line, wherein said potato line is diploid, fertile, self-compatible, produces at least 200 grams fresh weight of tubers per plant, and at least 75% of the genomic loci in said plant line are homozygous, comprising the steps of:

(a) providing a first potato plant, wherein said first potato plant is the plant according to claim 1;

(b) providing a second potato plant, wherein said second potato plant is a diploid plant, and wherein said potato plant comprises any level of homozygosity;

(c) cross-pollinating said first potato plant and said second potato plant to produce seeds and collecting said seeds to thereby provide hybrid offspring seeds;

- (d) growing said hybrid offspring seeds to provide a population of hybrid offspring potato plants and selecting from said population a self-compatible potato plant;
- (e) inbreeding said self-compatible potato plant by selfing said self-compatible potato plant for between 1 to 8 selfings to thereby increase the degree of homozygosity in each successive generation; and
- (f) selecting within each generation of inbreeding for a fertile offspring plant, and providing a diploid, fertile, self-compatible potato plant, wherein at least 75% of the genomic loci in said plant are homozygous.

6. The method of claim 5, wherein said second potato plant is a donor for an agronomically desirable trait selected from the group consisting of: insect tolerance, nematode resistance, disease resistance, herbicide tolerance, cold tolerance, drought tolerance, flooding tolerance, tolerance to dry and wet rot, salinity tolerance, yellow flesh color, and cold-sweetening resistance.

7. A potato plant produced by the method of claim 5, wherein said potato plant is diploid, fertile, self-compatible, produces at least 200 grams fresh weight of tubers per plant, wherein at least 75% of the genomic loci in said potato plant are homozygous, and wherein said self-compatibility in said potato plant is conferred by the *Sli* gene.

8. [preamble] A method of producing a uniform diploid hybrid *Solanum tuberosum* potato seed, which seed, when sown produces a diploid, fertile, and self-compatible potato plant having a tuber yield expressed in grams of fresh weight of at least 200 grams and wherein said self-

compatibility trait is due to the presence of the *Sli* gene, said method comprising:

- (a) providing a first potato plant, wherein said first potato plant is a plant of a first potato line, wherein said first potato line is of the species *Solanum tuberosum* optionally comprising introgression segments of other tuber bearing *Solanum* species crossable to *Solanum tuberosum*, wherein said first potato line is diploid, fertile, self-compatible and wherein at least 75% of the genomic loci in said first potato line are homozygous, and wherein said self-compatibility in said first potato line is conferred by the *Sli* gene, wherein a copy of said gene is present in potato lines AGVD1, AGVD2, AGVD3, and AGVD17, representative seeds of said lines having been deposited with the NCIMB under NCIMB accession number 41663, NCIMB accession number 41664, NCIMB accession number 41665, and NCIMB accession number 41765, respectively, and wherein said first potato plant has a tuber yield expressed in grams of fresh weight of at least 200 grams;
- (b) providing a second potato plant, wherein said second potato plant is a plant of a second potato line, wherein said second potato line is of the species *Solanum tuberosum* optionally comprising introgression segments of other tuber bearing *Solanum* species crossable to, wherein said second potato line is diploid fertile, self-compatible and wherein at least 75% of the genomic loci in said second potato line are homozygous, wherein said self-compatibility in said second potato line is conferred by

Sli gene, wherein a copy of said gene is present in potato lines AGVD1, AGVD2, AGVD3, and AGVD17, representative seeds of said lines having been deposited with the NCIMB under NCIMB accession number 41663, NCIMB accession number 41664, NCIMB accession number 41665, and NCIMB accession number 41765, respectively, wherein said second potato plant has a tuber yield expressed in grams of fresh weight of at least 200 grams, and wherein said second potato plant contains at least 20% contrasting homozygous loci as determined by molecular marker analysis when compared to said first potato plant;

(c) cross-pollinating said first and said second potato plant and allowing said potato plant to produce berries with seeds; and

(d) collecting said seeds from said berries to provide hybrid potato seeds.

9. The method according to claim 8, wherein at least one of said first and said second potato plant comprises at least one agronomically desirable trait selected from the group consisting: of insect tolerance, nematode resistance, disease resistance, herbicide tolerance, cold tolerance, drought tolerance, flooding tolerance, tolerance to dry and wet rot, salinity tolerance, yellow flesh color, and cold-sweetening resistance.

10. A uniform hybrid F1 potato seed produced according to the method of claim 8.

(EX1001, 89:28-92:23; EX1002, ¶76.)

A. Person of Ordinary Skill in the Art

A person of ordinary skill in the art (“POSA”) would have knowledge of the scientific literature and have skills relating to plant breeding and the use of marker-assisted breeding before October 26, 2009. (EX1002, ¶15.) A POSA also would have knowledge of field, greenhouse, and laboratory techniques and strategies used in plant breeding. (*Id.*) Typically, a POSA would have had a doctoral degree in plant breeding, and possessed experience with plant breeding, including in potatoes. Alternatively, a POSA would be a plant breeder with relatively less educational background but commensurately greater experience working in the field of plant and potato breeding. A POSA would, if necessary, consult with a molecular marker expert for genetic advice regarding the selection of crosses.

B. Overview of the Specification

The ’841 patent describes creation of “diploid, fertile, self-compatible and essentially homozygous potato lines,” “methods for producing such plants,” and “hybrid seeds obtained by crossing such homozygous potato lines[.]” (EX1001, Abstract; EX1002, ¶77.) The specification admits that prior artisans have “suggested” the use of *Sli* derived from *S. chacoense* to develop “highly homozygous” lines for true potato seed production and heterosis breeding. (EX1001, 4:6-12.) The inventors claim that “no homozygous lines with good agronomic traits such as good tuber yield, have ever been reported[.]” but also

defined tuber yield of 200g per plant as “vigorous.” (*Id.*, 4:10-12, 4:51-54.)

To address this purported problem, the inventors propose to have developed a diploid, fertile, self-compatible, and essentially homozygous potato line that yields at least 200g. (*See also* EX1002, ¶78.) They propose a breeding scheme where such plants are selfed 1 to 8 times to obtain a diploid, self-compatible, and essentially homozygous plant retaining 200g yield. (EX1001, 5:22-49; *see also* EX1002, ¶79.) Optionally, the breeding scheme also includes crosses using donor lines for an agronomically desirable trait such as insect or disease resistance, cold tolerance, etc. (EX1001, 6:11-28.) The specification describes the creation of hybrid potato seed by crossing two such inbred lines, preferably when such lines have at least 20% contrasting homozygous loci as shown by molecular markers. (*Id.*, 6:5-10, 7:5-11.) As explained herein, each aspect of these supposedly inventive potato lines and breeding scheme was disclosed in the prior art. (*See also* EX1002, ¶80; §VI.)

The inventors describe the creation of a few diploid potato lines produced “by repeated selfing of a self-compatible plant comprising the *Sli* gene derived from *S. chacoense*[.]” (EX1001, 4:44-45, 26:45-54.) These lines include AGVD1, AGVD2, and AGVD3, each of which was obtained by crossing a *Sli* donor (“H”)² with donor

² As indicated by the patent, the “H” line used by the inventors was obtained from the Hosaka laboratory responsible for the discovery of *Sli*, whose research is described in several of the prior art references cited herein. (*See* EX1001, 11:11-12,

plants (“D1” or “D2”) carrying desirable agronomic traits followed by further selfing, crossing, or backcrossing. (*Id.*, 22:16-57, 29:47-30:21.) The inventors also disclose AGVD17, apparently made later, by performing further selfing of AGVD1. (*Id.*, 22:58-23:3, Fig. 2; *see also* EX1002, ¶81.) Further information about the breeding history for these lines and the donor lines was disclosed in the file history. (EX1010, 0525-52.)

The inventors provide a greenhouse yield evaluation of a few lines, including two F₂s derived by a single selfing of the progeny of the *Sli* donor line with lines D1 and D2, respectively, along with two other backcrossed lines. (EX1001, 31:19-33:26.) Only one selfed F₂ produced more than 200g tubers; homozygosity data were not reported. (*Id.*, Table 2.) The inventors encountered inbreeding depression, just as in the prior art. (*Id.*, 32:9-17, 32:60-66; EX1002, ¶82.) Only two of the F₂ populations and none of the backcross populations “showed a reasonable level of self-compatibility.” (EX1001, 33:3-4.) The inventors claimed to obtain lines of “[i]ntermediate/high” tuber yield, but never quantify this supposed characteristic nor identify which lines supposedly support that assessment. (*Id.*, 33:7-9, Table 4; EX1002, ¶83.) Example 3 further describes a SNP-based molecular marker platform. (EX1001, 33:28-47:11; *see also* EX1002, ¶84.) Example 4 provides a

29:47-55, Col. 46 (Table 6); EX1002, ¶¶70, 81, 99, 147; EX1005; EX1024; EX1030; EX1031; EX1032; EX1037.)

further round of selfing (F_3) of the F_2 populations as described Example 2, with data disclosed only for homozygosity, not yield. (EX1001, 47:12-51:20; *see also* EX1002, ¶85.) Last, the inventors provide a prophetic hybrid breeding scheme for eventual development of a commercial variety. (EX1001, 51:22-54:38; *see also* EX1002, ¶86.) The inventors do not describe ever producing uniform hybrid seed by crossing inbred lines or obtaining hybrids yielding at least 200g, as required by Claim 8. (EX1002, ¶87.)

The specification repeatedly contends wrongly that no breeder had previously created highly inbred diploid lines, and that their approach of using repeated selfing to obtain diploid self-compatible plants was novel. (*See* EX1001, 24:61 (“[t]his is an entirely new approach...”); 24:65-67 (“unlike the prior art methods the procedures are performed using diploid plant lines, instead of tetraploid plants”); 25:1 (“this radically new approach...”); 19:59-60 (“properties, heretofore never attained together in a single potato line...”); 20:51-54 (“now, for the first time, provides plants having a level of homozygosity that is above 25%, and preferably above 75% and that is combined with fertility, self compatibility and plant vigour”); 21:14-16 (“diploid potato plants resulting from inbreeding, and attaining homozygosity of at least 25% or 50% on the alleles are invariably weak growers”); 24:25-26 (“it has proven impossible to provide the combination of all these features in a single potato plant (line).”); EX1002, ¶88.) As explained herein, these

statements were wrong and mischaracterized the art.

C. The 2009 Provisional Priority Documents

The '841 patent claims priority to two applications filed on Oct. 26, 2009 – U.S. Provisional 61/254,980 (EX1040) and EP document 09013474 (EX1010, 0380-415). (*See also* EX1002, ¶89.) Neither 2009 application supports the limitations of the challenged claims. For example, neither 2009 application discloses *any* potato line that has at least 75% homozygosity and produces at least 200g per plant, limitations required by every claim. Further, the 2009 applications have no disclosure of the *Sli* self-compatibility gene by name, no disclosure of the “H” line that the inventors used as their source for *Sli*, no disclosure of the D1-D3 “donor” lines, no disclosure of any tuber yields, and no disclosure of the “highly preferred” AGVD17 line. (*Id.*; EX1001, 23:52-60; EX1002, ¶90.)

D. '841 Prosecution History

During prosecution, Agventure sought claims covering *any* diploid, fertile, self-compatible potato lines at least 50% homozygous and producing a 200g tuber yield, along with methods for producing such inbred lines by repeated selfing, and crossing methods for producing hybrids. (EX1010, 0110-12.) These were rejected, on §112 grounds and for obviousness over Phumichai and other prior art. (EX1010, 0417-55.) In response, Agventure added limitations requiring that self-compatibility be conferred by *Sli* and referencing four deposited *Sli*-containing lines. (EX1010,

0520-23.) Agventure argued against Phumichai, contending it “proposes an inbreeding technique for obtaining homozygous potatoes,” (just like the challenged claims) this could not render the claims obvious because the technique “is not performed with *S. tuberosum*.” (EX1010, 1036.) This statement was wrong, and mischaracterized the settled taxonomy that places Phureja within the species *S. tuberosum*. (See also EX1002, ¶¶93-95.)

Inventor Lindhout also submitted a declaration arguing that the claims were valid under §112 and providing the breeding history. (EX1010, 0535-52 (“Lindhout Declaration”).) The Lindhout declaration makes several important admissions that are pertinent to the Petitioner’s challenge:

- Success in practicing the claimed invention “is not unpredictable” [*id.*, ¶5];
- As of 2009 a POSA would have been able to use any *S. tuberosum* diploid donor to generate lines practicing all the limitations of the plant claims – including the prior art US-W4 line [*id.*, ¶¶15, 21]; and
- The inventors’ source of *Sli* was known and available to any POSA [*id.*, ¶24].

(*Id.*, 0535-52; EX1002, ¶¶96-100.)

The Examiner maintained his §112 and §103 rejections in view of additional prior art from the Hosaka group. (EX1010, 0917-59.) In response, Agventure

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further amended to add the *Solanum tuberosum* species limitation, increase the homozygosity minimum to 75%, and add the 200g yield limitation to the breeding method claims, and submitted declarations from potato breeders regarding §112. (EX1010, 1028-58.) Following Examiner interviews, Agventure secured allowance after submitting further claim amendments, which were ultimately adopted as Examiner amendments, mainly incorporating limitations from the plant claims into the breeding method claims. (EX1010, 2670-74.) In the reasons for allowance, the Examiner primarily credited the declarations as persuasive. (EX1010, 2684-94.)

As explained in this Petition, the Examiner erred in allowing the claims by overlooking disclosures of other prior art and misunderstanding the art. (*See* §X.)

E. Corresponding EP Patent 3,536,146 Was Revoked

Patent Owner's corresponding European Patent was recently revoked by the Opposition Division of the EPO. (EX1057.) Based on the relevant legal standard, the plants of that patent's Claim 1 were found to lack novelty over the same US-W4 potato discussed herein. (EX1057, 0010-12; EX1002, ¶91.)

VII. CLAIM CONSTRUCTION

Petitioner does not believe claim construction is necessary at this time.

VIII. THE CHALLENGED CLAIMS ARE UNPATENTABLE

A. Prior Art References Cited in Proposed Grounds

The recited priority date of the '841 patent is October 26, 2009. As noted above, the claims are not supported by the provisional priority applications. But even if the claims were determined to have the 2009 priority date, each reference in the Grounds qualifies as prior art under 35 U.S.C. §102(b).

This Petition is also supported by the declarations of Drs. Shelley Jansky and David Douches, both renowned experts in potato breeding. (EX1002, ¶¶5-9; EX1003, ¶¶5-10.)

1. Jong [EX1004]

Jong is a journal article, published by May 6, 1971, and is §102(b) prior art.

Jong discloses early efforts at imposing a high degree of inbreeding on diploid potatoes through the use of crosses between high-performing diploid potatoes and self-compatible potato US-W4. Jong achieved a series of inbred lines through these methods that were diploid, fertile, self-compatible, vigorous, and highly homozygous – work the '841 inventors claimed had not previously been done. Jong specifically articulated the motivations and expectation of success in developing highly inbred diploid lines for hybrid breeding in potatoes – the same goal the '841 inventors claim to address. (EX1004, 0006-07; EX1002, ¶¶106-109.)

Jong published similar and more detailed work in his 1971 thesis, which a POSA interested in Jong's results would have consulted for additional information. (See EX1034; EX1002, ¶109; EX1077, ¶¶36-59.)

2. Phumichai [EX1005]

Phumichai is a journal article, published on November 29, 2005, and is §102(b) prior art.

Phumichai represents the work of the Hosaka group that discovered *Sli* as the genetic basis of self-compatibility. As this group had proposed since 2000 (EX1032), Phumichai represents the use of *Sli*-based breeding to develop highly inbred, fertile, self-compatible, and diploid potatoes – for the express purpose of eventual hybrid breeding to obtain vigorous F₁ offspring that could be propagated by seed. (EX1005, 0005-06, 0010; EX1002, ¶¶110-113.)

3. Spooner [EX1006]

Spooner is a journal article, published on December 4, 2007, and is §102(b) prior art. Spooner provides taxonomy confirming that Phureja are within the species *S. tuberosum*—not a distinct species. (EX1006, 0009, 0012; EX1002, ¶¶114-116.)

4. Chase [EX1007]

Chase is a journal article, published in December 1963, and is §102(b) prior art.

Chase discloses a systematic approach to inbreeding homozygous diploid potato for creating hybrids between said lines to achieve heterosis, termed “analytical breeding,” which proposes all key steps that such a potato breeding program will undergo. (*See* §V.H.1; EX1002, ¶¶117-121.)

5. Springer [EX1008]

Springer is a journal article, published on January 25, 2007, and is §102(b) prior art.

Springer studied the importance of allelic variation for heterosis in maize, the canonical crop for hybrid vigor. Using molecular markers and other genetic tools, Springer quantified the degree of allelic variation between inbred parents for establishing heterosis in hybrid offspring. (EX1008, Abstract, 0006-07, 0012; EX1002, ¶¶122-123.)

6. Bamberg [EX1009]

Bamberg was published in 1994, and is §102(b) prior art. Bamberg was published by NRSP-6, the working potato genebank, part of the U.S. National Plant Germplasm System (NPGS). (EX1077, ¶¶24-35.) Bamberg lists accessions of potato germplasm available to the public, and provides data on their agronomically desirable traits. (EX1002, ¶¶124-126.)

B. Ground 1: Claims 1, 4, and 7 Are Anticipated by Jong

1. Claim 1

(a) Claim 1[a]

If the preamble is limiting, it is disclosed by Jong. (EX1002, ¶127.) Jong discloses several novel potato plants developed by crossing a well-known, self-fertile *Solanum tuberosum* Group Tuberosum plant (US-W4), with either: i) a *Solanum tuberosum* Group Phureja plant selected from Phu PI 195191, Phu PI 225708.1, or Phu PI 225675.1, or ii) a *Solanum tuberosum* Group Stenotomum plant, Stn PI 230513.1. (EX1004, 0006-07.)

Each of the newly developed potato lines, together with their parent crosses is described as follows:

US-W 5309	(Phu PI 195191	×	US-W4)
US-W 5314	(Phu PI 225708.1	×	US-W4)
US-W 5315	(Phu PI 225675.1	×	US-W4)
US-W 5328	(Stn PI 230513.1	×	US-W4)

<i>S. tuberosum</i> Group Phureja and Stenotomum	X	<i>S. tuberosum</i> Group Tuberosum
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(*Id.*, 0007³; EX1002, ¶128.)

The resulting Jong potato lines meet the claim limitations in two ways. First, Group Phureja, Stenotomum, and Tuberosum plants are all *Solanum tuberosum* species. (See §V.A.) Using this accepted nomenclature, the progeny of all the

³ Unless otherwise noted, all labels are added.

crosses in Jong are within the claimed *Solanum tuberosum* species. (EX1002, ¶129.) Second, regardless of the nomenclature, Jong’s potato plants still meet this claim element by virtue of their parentage. Jong’s crosses between US-W4 (*S. tuberosum*) with Phureja or Stenotomum potato plants created progeny that were “of the species *Solanum tuberosum* optionally comprising introgression segments of other tuber bearing *Solanum* species crossable to *Solanum tuberosum*.” (*Id.*, ¶¶130-131.)

(b) Claim 1[b]

The potato lines described by Jong are diploid, fertile, and self-compatible. (EX1002, ¶132.) Jong consistently describes the plants that were created and tested as diploid. (EX1004, 0006, 0013; EX1002, ¶133.) Further, Jong tested and reported the cross-fertility and self-compatibility of each plant in Table 4. (EX1004, 0011, Table 4; EX1002, ¶135.) Self-compatibility is reported under the column “Self-” while cross-fertility is reported for both reciprocal crosses using pollen or ovules from under columns “Pollen-” or “Ovule-.” S₂ potato lines had non-zero values for all indicated measurements, demonstrating that the plants were fertile and self-compatible, comporting with the inventors’ definition of fertility. (*Id.*; EX1001, 18:45-51; EX1002, ¶¶134-136.)

(c) Claim 1[c]

Jong discloses two potato lines, US-W5309 and US-W5315, that exhibit greater than 200g fresh weight of tubers per plant at the S₂ generation. (EX1004, 0009, Table 1; EX1002, ¶¶137, 139.) Both of these lines maintained greater than 200g yield across two rounds of reproduction via tuber. (EX1004, 0009, Table 1.)

Jong further reports that several subsequent generations of their plants maintained vigorous phenotypes, suggesting that more inbred lines also produced at least 200g of tubers per plant, especially when interpreted using the inventors' definition, which expressly links the term "vigor" with tuber yield of 200g or more. (EX1004, 0012; EX1001, 16:53-59; EX1002, ¶¶137-138.) Indeed, a POSA would know from the Jong thesis that it was Jong's highest-yielding new plants (US-W5309 and US-W5315) that were inbred to the S₅ generation. (See EX1034, 0010.)

(d) Claim 1[d]

Jong teaches, in keeping with basic principles of diploid genetics, that heterozygosity is reduced by 50% every generation of selfing. (EX1004, 0007; EX1002, ¶¶140-141.) A POSA would thus estimate that, even assuming that Jong's initial hybrid "S₀" plants are 0% homozygous (which is unlikely), the S₂ generation described in of Jong would be expected to be at least 75% homozygous. (EX1002, ¶¶142-143.) Plants of subsequent generations, including the S₅ lines referenced in (EX1004, 0012-13), would be expected to have even higher

homozygosity, and indeed Jong estimated its disclosed S₅ plants to be 97% homozygous, well beyond the low threshold of 75% of the claim. (EX1002, ¶141.)

(e) Claim 1[e]

Jong does not identify the genetic factor conferring self-compatibility, because it had not yet been discovered, but this was inherently disclosed by the US-W4 plant Jong used to cross self-compatibility into his new lines. Jong attributes this self-compatibility to US-W4, which was known to be self-compatible. (EX1004, 0006; EX1002, ¶¶145-149.)

Subsequent analyses confirmed that Jong's W4 necessarily derived its self-compatibility from the S-locus gene inhibitor (*Sli*), as recited in the claims and present in the '841 patent's deposited lines. (EX1036, 0002.) A review of the genetic sources of self-compatibility for potatoes showed that Jong's W4 contained the identical source of self-compatibility as the *Sli* gene studied by the Hosaka laboratory, described in EX1037 (Phumichai and Hosaka). (EX1036, 0002; EX1002, ¶¶147-148.) This material was also the same source for *Sli* used by the inventors. (See §VI.B.) Accordingly, Jong's potato plants have their self-compatibility conferred by the same S-locus inhibitor (*Sli*) employed in the '841 patent and present in the claimed deposited lines. (See *id.*; EX1002, ¶149.) In this way, Jong discloses Claim limitation 1[e]. (EX1002, ¶144.)

2. Claim 4

Claim 4 adds the trivial limitation of a seed or tuber that produces the plant of Claim 1. It is anticipated by Jong. (EX1002, ¶152.) Jong discloses both seeds and tubers capable of producing plants according to Claim 1. (EX1002, ¶¶150-151.) Specifically, Table 1 of Jong, describes US-W5309 and US-W5315 plants meeting the elements of Claim 1. Jong discloses that “[o]bservations were made on populations grown from true seed and from tubers.” (EX1004, 0007.)

3. Claim 7

Claim 7 recites a potato plant with the identical characteristics recited by Claim 1, in the context of a product-by-process claim referencing the inbreeding method of Claim 5. Plants from Jong’s US-W5309 and US-W5315 lines anticipate this claim because they exhibit the recited characteristics. (EX1002, ¶155.) Anticipation for product-by-process claims is based on the product itself, irrespective of the method employed. *See, e.g., In re Thorpe*, 777 F.2d 695, 697-98 (Fed. Cir. 1985); (*see also* EX1002, ¶154.) Thus, the method steps recited in Claim 5 are immaterial to the validity of Claim 7. The discussion of Claim 1 above demonstrates how Jong’s potato lines meet every limitation of claim 7: the lines are diploid, fertile, self-compatible, produce at least 200g of fresh tuber weight, display at least 75% homozygosity, and self-compatibility is conferred by the *Sli* gene. (*See* §VIII.B.1; *see also* EX1002, ¶153.)

C. Ground 2: Claims 1-7 Are Obvious Over Jong, Chase and Bamberg.

1. Claim 1

Claim 1 is obvious over Jong. As discussed in the anticipation arguments above, Jong discloses potato plants of the species *Solanum tuberosum*, said plants being diploid, fertile, self-compatible, producing at least 200g of tubers per plant, with at least 75% homozygosity, and wherein self-compatibility is conferred by *Sli*. (See §VIII.B.1; EX1002, ¶156.) Because “anticipation is the epitome of obviousness,” *In re McDaniel*, 293 F.3d 1379, 1385 (Fed. Cir. 2002), Jong also renders Claim 1 obvious.

Nevertheless, to the extent the 75% homozygosity limitation is not considered to be taught by Jong, it was obvious. Jong reports a “rapid increase in homozygosity following selfing at the diploid level.” (EX1004, 0006.) Further, Jong describes that “[t]he number of generations needed to reduce heterozygosity by 50 per cent by inbreeding is 1 in diploids.” (*Id.*, 0007.) Jong further estimated that “the diploid S₅ generation is about 97% homozygous” (*id.*, 0013), far exceeding the claimed 75% homozygosity. Given the stated goal of increasing homozygosity in the inbred diploid lines, a POSA would be motivated to continue to self to obtain inbreds that were at least 75% homozygous, and given that relatively low threshold would have expected success in only a few generations of selfing. (EX1002, ¶¶157-158.)

2. Claim 2

Claim 2 depends from Claim 1 and adds the trivial limitation that the plant comprise one of a broadly-scoped list of agronomically-desirable traits. The claim is obvious over Jong and Bamberg. (EX1002, ¶159.)

Jong does not expressly discuss the recited agronomic traits of Claim 2 in the context of his new lines. However, these lines would be expected to maintain at least one of the claimed traits, based on many of those traits being present in the parental lines. (EX1002, ¶160.) Jong's US-W5309 and USW5315 are crosses of US-W4 with PI195191 and PI225675, respectively. (EX1004, 0007.) PI195191 exhibits disease resistance (ring rot, blackleg), nematode resistance (golden, horsenettle, northern rootknot, Osborne cysts), and insect tolerance (tarnish beetle). (EX1009, 0024, 0027, 0029, 0032, 0033, 0045.) Similarly, PI225675 exhibits disease resistance (potato virus X, late blight, blackleg) and insect tolerance (flea beetle, tarnish beetle). (*Id.*, 0013, 0018, 0024, 0038, 0045.) Thus, multiple resistance traits were known to be possessed by the direct parents of US-W5309 and US-W5315 and many would be expected to be maintained in the progeny. (EX1002, ¶¶161-163.)

It would have further been obvious for a POSA to select a plant from the resulting progeny of the US-W5315 or US-W5309-based crosses that maintained at least one of the resistance traits via routine testing. A POSA would have been

motivated to do so given the benefit of maintaining agronomically desirable traits, and would have had an expectation of success for identifying such a plant, given the presence of so many traits in the parents.

3. Claim 3

Claim 3 depends from Claim 1 and adds the trivial limitation that the plant further provide at least 500g fresh weight of foliage and shoots (“foliage”) per plant at maturity. Claim 3 is obvious over Jong and Bamberg. (EX1002, ¶164.)

The '841 patent does not report foliage weight for any particular plants. Instead, the patent teaches that “vigorous” plants would be expected to provide at least 500g foliage. (EX1001, 5:2-4; EX1002, ¶165.) Similarly, Jong does not directly report the foliage weight of its inbreds, but instead discloses that, despite inbreeding depression, fairly vigorous lines were obtained even after five rounds of selfing – far beyond the S₂ generations which yielded over 400g tubers. (EX1004, 0009, 0012.)

Further, a POSA would have been easily able to extrapolate the likely foliage weight of Jong’s inbred lines from known information about the harvest index (“HI”) of potatoes. (EX1002, ¶166.) HI refers to the proportion of plant weight that accounts for the marketable portion (tubers for potatoes). (*Id.*) HI for potatoes is the percentage of tuber weight vs. total weight of the foliage portion plus tubers, and is reported for *S. tuberosum* as 47% to 62%. (EX1038, 0004; EX1039, 0003.) Given

this, a POSA would expect that Jong's lines would have yielded at least approximately 500g foliage; indeed since Jong reported average tuber yields from at least nine plants, some of which must have exhibited yields higher than the reported average, a POSA would have expected even higher yields of both tuber and foliage than the averages reported in Jong. (EX1002, ¶¶166-168.)

This is especially true since the parental line of US-W5315 was scored in Bamberg as being an outstanding accession for vine and flowering vigor. (EX1009, 0004, 0055, 0058.) A POSA would have been motivated, when applying Jong's methods to obtain vigorous inbred lines, to select plants with over 500g foliage, and would have expected success based on Jong's reports, known HIs, and the known properties of Jong's parental lines. (EX1002, ¶¶168-169.)

4. Claim 4

Jong discloses multiple seed and clonal (tuber-propagated) generations of potato plants demonstrating the elements of Claim 1, thereby anticipating Claim 4. (See §VIII.B.2; EX1002, ¶170.) Considering these disclosures and the desirability of obtaining both seed and tubers for propagation of the plants of Claim 1, Claim 4 was obvious.

5. Claim 5

Claim 5 is obvious over Jong and Chase. Claim 5 recites a method of crossing the plants of Claim 1 with a second diploid plant to create a hybrid plant, then selfing

the hybrid to produce an inbred plant. As discussed above, Jong discloses the potato plants of Claim 1, and, in combination with Chase, describes the hybridization and inbreeding/selfing methods of Claim 5. (EX1002, ¶171.)

If the **preamble** is limiting, it is disclosed by Jong. As noted above, Jong discloses several diploid, fertile, self-compatible potato plants producing at least 200g of tubers and at least 75% homozygosity. (See §VIII.B.1; EX1002, ¶¶172-173.)

(a) Step 5(a)

Jong discloses multiple plants according to Claim 1, including the US-W5309 and US-W5315 lines. (See §VIII.B.1; EX1004, 0009, Table 1, 0007; EX1002, ¶174.)

(b) Step 5(b)

Since Jong discloses multiple diploid potato plants (including US-W5309 and US-W5315), one of those could be chosen as the second plant of step (b). Alternatively, a POSA could choose any diploid parent given the claim's broad language, for example, for some agronomically desirable trait. (EX1002, ¶175.)

(c) Step 5(c)

Jong and Chase disclose this hybrid crossing step. Jong's breeding began with an initial cross pollination between two diploid parental lines, (EX1004, 0007); a POSA would have found it obvious to replicate this hybrid cross with different plants. (EX1002, ¶¶176-179.) This would include a new hybrid cross between any

of later generation potato plants disclosed in the reference, including S₂ lines from US-W5309 or US-W5315. (*Id.*)

Jong further discloses collecting seeds from crosses. (EX1004, 0011 (Table 4); EX1002, ¶180.) Using cross-pollination to produce seeds are basic, trivial plant breeding concepts to a POSA.

Table 4. Effect of inbreeding on flowering and fertility.

Level of inbreeding ¹	Clones planted ²	Per cent stand ³	Per cent flowering ⁴	Fertility in per cent of flowering clones ⁵			Seeds/fruit for fertile plants ⁶		
				Self- ⁷	Pollen- ⁸	Ovule- ⁹	Self- ⁷	Pollen- ⁸	Ovule- ⁹
S ₀	21	95	100	47	85	86	12	54	76
S ₁	50	91	54	16	34	23	9	36	34
S ₂	44	74	54	16	41	47	6	38	30

¹ *Inzuchtgrad – Degré de consanguinité*

² *Anzahl gepflanzter Klone – Clones plantés*

³ *Prozent Pflanzenentwicklung – Situation en %*

⁴ *Prozent Blühzustand – % de floraison*

⁵ *Fertilität in % der blühenden Klone – Fertilité en % des clones fleurissant*

⁶ *Samen/Frucht für fruchtbare Pflanzen – Semences par fruit chez les plantes fertiles*

⁷ *Selbst – Auto*

⁸ *Pollen- – Pollen-*

⁹ *Eizellen – Ovule*

Tabelle 4. Einfluss der Inzucht auf den Blühzustand und die Fruchtbarkeit.

Tableau 4. Effet de l'autofécondation sur la floraison et la fertilité.

(EX1004, 0011 (Table 4).)

The breeding scheme to create inbreds, outlined in Claim 5, was described in Chase. (*See* §V.H.1; EX1007, 0005-06; EX1002, ¶181.) A POSA would have found it obvious to apply the well-known breeding methods disclosed in Chase to lines like Jong's as part of that effort. (EX1002, ¶181.)

(d) Step 5(d)

Jong describes growing its hybrid offspring and selecting for self-compatibility by inbreeding (i.e. selfing) its lines through multiple generations (S₀-

S₅). (EX1004, 0012.) Because selfing requires self-compatibility, Jong expressly discloses selection for that trait. (EX1002, ¶182.) Jong further tracks the closely related concept of self-fertility rates through each generation. (*Id.*, ¶183.) This step is also expressly suggested by Chase's breeding scheme. (*See* §V.H.1; EX1007, 0006-07; EX1002, ¶184.)

(e) Step 5(e)

Jong describes at least 5 rounds of inbreeding to increase homozygosity of its self-compatible hybrids, taking its inbreds to at least S₅. Thus, a POSA would be motivated to similarly undergo rounds of selfing to create new inbred lines. (EX1002, ¶185.) Further, there is nothing inventive about performing any number of rounds of selfing, as a POSA would know that each round would further increase homozygosity and fix desirable traits, and that only a sufficiently large number of plants for each round would be needed to overcome inbreeding depression, if any, and identify self-compatible offspring plants from within each population. (*See also* EX1026, 0033 ("the inbreeding programme must start with a very large number of lines..."); EX1002, ¶186.) This step is also expressly suggested by the breeding scheme of Chase. (*See* §V.H.1; EX1007, 0005-07; EX1002, ¶187.)

(f) Step 5(f)

As noted above, Jong teaches selection for fertile offspring, through its multi-generational selfing. These selfings result in self-compatible, fertile lines. (EX1004,

0011 (Table 4).) The inbreds would necessarily be diploid, because all the parents are diploid. (EX1004, 0006; EX1002, ¶188.) This step is also expressly suggested by the breeding scheme of Chase. (*See* §V.H.1; EX1007, 0005-07.) Jong teaches continued inbreeding to produce inbreds exhibiting at least 75% homozygosity. (EX1004, 0013; EX1002, ¶188.) Therefore, a POSA would have been motivated to inbreed to at least 75% homozygosity and would have expected success since the recited 75% threshold is not high and would be expected after only at most a few rounds of selfing. (EX1002, ¶¶142, 189.)

Obviousness Rationale - A POSA would have been motivated to produce additional diploid, fertile, and self-compatible inbred lines based on (1) Jong's success in producing the US-W5309 and US-W5315 inbred lineages, as described in Ground 1; and (2) Jong's recommendation to produce additional inbreds to induce maximum hybrid vigor in commercial hybrids, in combination with Chase's description of breeding steps to accomplish that goal. As Jong stated:

Considering the success with hybrid vigour in other crops, this area certainly warrants further investigation in potatoes, especially on the diploid level where advanced inbred lines can be obtained in a relatively short time. A broader genetic base will probably be necessary to develop more diverse inbred lines that can be used as parents to produce maximum hybrid vigour.

(EX1004, 0013; EX1002, ¶190.) As explained above, creation of a pool of fertile

and diploid inbred lines was a known prerequisite to successful hybrid breeding in many crops, including potato. (*See* §V.H; EX1007, 0004-05, 0006.) A POSA further would have expected success at creating additional inbreds based on (1) Jong's success in producing inbreds from US-W5309 and US-W5315; and (2) Jong's statement that such new inbreds could be produced especially at the diploid level. (EX1004, 0009, 0013.) It was thus obvious for POSA to employ the standard breeding methods described in Jong and Chase to produce additional inbred potato lines. (EX1002, ¶¶190-191.) Further, a POSA would have been motivated to introduce agronomically desirable traits as part of the crossing step described in elements 5(b) and (c), using lines such as those taught by Bamberg.

Agventure's arguments that development of the inbred plants via the method of Claim 5 was not obvious because breeders would not persist in a large-scale breeding program with selections based on fertility as opposed to tuber yield are wrong. (*See* EX1010, 0547-48; EX1051, 0018-20; EX1052, 0030; EX1053, 0002-0003; EX1002, ¶¶101-104, 192.) As the prior art shows, researchers pursuing inbred diploid lines for hybrid breeding did not select for tuber yield and instead were focused on fertility. (EX1002, ¶102.) These researchers expected reduction in fertility from repeated selfing, but because fertility is an essential requirement for continued inbreeding by selfing, only fertile plants could be carried forward as part of an inbreeding program. Thus, the supposedly novel idea of selecting for fertility

rather than yield is not just obvious but actually the most likely way the inbreeding programs of the prior art (just like the inbreeding programs of the challenged patent) could have worked. (*Id.*)

Similarly, a POSA would not be dissuaded by inbreeding depression. On the contrary, depression in terms of fertility and vigor was a known feature of all inbreeding programs, not just in potatoes but other key diploid crops such as corn. (*Id.*, ¶103.) It was well known before 2009 that inbreeding depression could be overcome with a sufficiently large breeding population, and that these depressing effects would stabilize over repeated rounds of selfing due to the elimination of harmful homozygous alleles from the overall breeding population. (*Id.*, ¶¶61, 103.) As a result, the prior art explaining the known challenges associated with inbreeding population is not a teaching away. *See Meiresonne v. Google*, 849 F. 3d 1379, 1382-83 (Fed. Cir. 2017).

6. Claim 6

Claim 6, like Claim 2, merely adds the same limitations regarding agronomically desirable traits to the “second plant” recited in the inbreeding method of Claim 5. (EX1002, ¶193.) The claim is thus obvious over Jong in view of Bamberg for the same reasons set forth above for Claim 2. (*See* §VIII.C.2.) As discussed above for Claim 5, US-W5309 and US-W5315 are proposed as the first or second potato plants of Claim 5. Both of these proposed lines would be expected to

contain agronomically desired traits derived from their parental accessions, and would have been obvious selections for further breeding. (*Id.*; EX1002, ¶¶194-196.) Indeed, the prior art recognized the importance of transferring “useful agronomic traits” to offspring as part of diploid inbreeding. (EX1022, 0006; EX1007, 0006.)

7. Claim 7

Claim 7 is nothing more than the obvious outcome of practicing the obvious method of Claim 5. It merely recites a progeny plant produced by the method of Claim 5 that maintains the same performance characteristics recited for the parents of those progeny (and for the plant of Claim 1). (EX1002, ¶198.) Jong and Chase disclose both and render the claim obvious. A POSA in possession of the method of Claim 5 would find any plants produced by that process obvious. (*Id.*, ¶¶197-198)

D. Ground 3: Claims 8-10 Are Obvious Over Jong, Chase, Bamberg, and Springer

1. Claim 8

Claim 8 recites a method of producing uniform diploid hybrid *Solanum tuberosum* potato plants by crossing two inbreds as described in Claim 1 (i.e., diploid, fertile, self-compatible and at least 75% homozygous). The only substantive limitation unique to the breeding steps of Claim 8 is the requirement that the second parent must exhibit at least 20% “contrasting homozygous loci” as determined by molecular markers compared to the first parent. (Claim 8(b).) As discussed in the anticipation ground above, Jong discloses at least two distinct inbred potato plants

displaying the phenotypes recited in the claim, and also describes the hybridization cross that one would use to create hybrids.

If the **preamble** of Claim 8 is limiting, it is disclosed by Jong. Jong discloses the benefits of hybrid breeding, and develops inbreds exhibiting the recited limitations. A POSA crossing US-W5309 and US-W5315 from Jong, for example, would have an expectation of success in a sufficiently large offspring population that at least some plants would exhibit the recited tuber yield, diploidy, fertility, and self-compatibility limitations (conferred by the *Sli* gene), because each of the parents would also exhibit these phenotypes, and a POSA could easily select for these features from the progeny. (See §VIII.C.5; EX1002, ¶¶200-201.)

(a) Step 8(a)

Jong discloses a US-W5309 “first potato plant” comprising the recited limitations. (See discussion of US-W5309 in §VIII.B.1; EX1002, ¶202.)

(b) Step 8(b)

Jong discloses a US-W5315 “second potato plant” comprising the recited limitations. (See discussion of US-W5315 in §VIII.B.1; EX1002, ¶¶203-205.)

Further, it would have been obvious for a POSA to use parental plants with at least 20% contrasting homozygous loci to elicit hybrid vigor in the progeny. (EX1002, ¶204.) The phenomenon of hybrid vigor/heterosis has been described in the literature for over a century. (EX1041, 477.) Indeed, “it has become commonly

accepted that crosses of more distantly related parents show greater heterosis than crosses of more closely related parents.” (EX1042, 0005.) The same was true for potatoes. (EX1043, 0005; EX1002, ¶¶206-207.)

Thus, well before 2009, genetic distance between inbred parents (*i.e.* contrasting homozygous loci) was widely recognized as a result-effective variable for hybrid vigor that a POSA would be motivated to optimize through routine experimentation. There is nothing in the challenged patent indicating that the recited “at least 20% contrasting homozygous loci” limitation is a critical threshold. Indeed, the inventors never attempted to measure vigor of any hybrid cross made according to Claim 8 or otherwise show why 20% as opposed to some other threshold was critical for success in practicing the method of Claim 8. (EX1002, ¶208.) Failure to establish any criticality means this claim limitation is, at best, a result-effective variable that cannot rescue the otherwise obvious limitations from invalidity. *See DuPont v. Synvina*, 904 F.3d 996, 1008 (Fed. Cir. 2018); *see also Mexichem v. Honeywell*, IPR2013-00576, Paper 50, 19-20.

Furthermore, hybrid crosses using parents with at least 20% contrasting homozygous loci based on molecular marker analysis was known. For example, Springer studied maize inbreds known to produce high heterosis when crossed, and determined based on SNP molecular marker analysis that “44% of the sequences contained at least one polymorphism in [one parent] relative to [the other].”

(EX1008, 0007; EX1002, ¶206.) Springer also disclosed “[a]s the genetic distance between the parental inbreds increases, there is generally an increase in heterosis.” (EX1008, 0012.) In another study, SNP-based studies showed that “[l]ong-term selection for hybrid performance has contributed to significant allele differentiation between heterotic groups at 20% of the SNP loci” and that “[c]rosses between genetically divergent lines generally produce better-performed hybrids than crosses between closely related parents.” (EX1044, 0001, 0002.) A POSA would thus have been motivated by the teachings of the prior art, including Springer, to cross two inbred lines with at least 20% contrasting homozygous loci, as determined by molecular marker analysis, and had a reasonable expectation of success in the combination. (EX1002, ¶207.)

(c) Step 8(c)

As noted above, Jong teaches cross-pollination to produce hybrids. (EX1004, 0007, 0013; §VIII.C.5; EX1002, ¶209.)

(d) Step 8(d)

A POSA would understand that Jong’s call to cross inbred clones with high combining ability also encompasses the step of collecting the resulting potato seeds, to grow the resulting hybrid plant. (EX1004, 0011, 0013; EX1002, ¶¶210-211.)

Obviousness Rationale – A POSA would have been motivated to cross highly homozygous, diploid, fertile, and self-compatible inbred lines based on Jong’s

recommendation that inbred lines could be used to produce hybrid vigor in commercial hybrids. (§VIII.C.5; EX1004, 0013; EX1002, ¶¶212-213.) A POSA would also have an expectation of success at creating uniform hybrids based on Jong’s demonstration that lines based on US-W4 were fertile, and could produce seeds. Jong’s inbreds were highly homozygous and uniform, and would thus be expected to produce uniform seeds. (EX1002, ¶¶213-214.) For example, Jong estimated that their “fairly vigorous” S₅ lines were about 97% homozygous, and observed that many of the S₅ lines exhibited a “high degree of uniformity,” as would be expected for highly inbred plants. (EX1004, 0012-13.) Like the inbreeding methods of Claim 5, Claim 8’s hybrid breeding scheme was described in Chase. (See §V.H.1; EX1007, 0006-07.) Springer disclosed the importance of genetic distance to achieving heterosis. (EX1002, ¶215.) A POSA would have found it obvious to apply the well-known breeding methods disclosed in Chase to lines like those disclosed in Jong. (See *id.*; §V.H.1; EX1007, 0006-07.)

2. Claim 9

Claim 9, and like claims 2 and 6, recites the same list of agronomically desirable traits and is obvious in view of Jong in view of Bamberg for the same reasons. (See §§VIII.C.2 & VIII.C.6; EX1002, ¶¶216-217.)

3. Claim 10

Claim 10 simply recites the “uniform hybrid F1 potato seed” produced according to the obvious method of Claim 8. A POSA in possession of the method of Claim 8 would find any plants produced by that exact process to be obvious. (*See* EX1002, ¶218.) A POSA would further expect uniformity in those seeds, given that Jong reported a “high degree of uniformity” as was expected for inbreds. (*See* §VIII.D.1; EX1002, ¶219.)

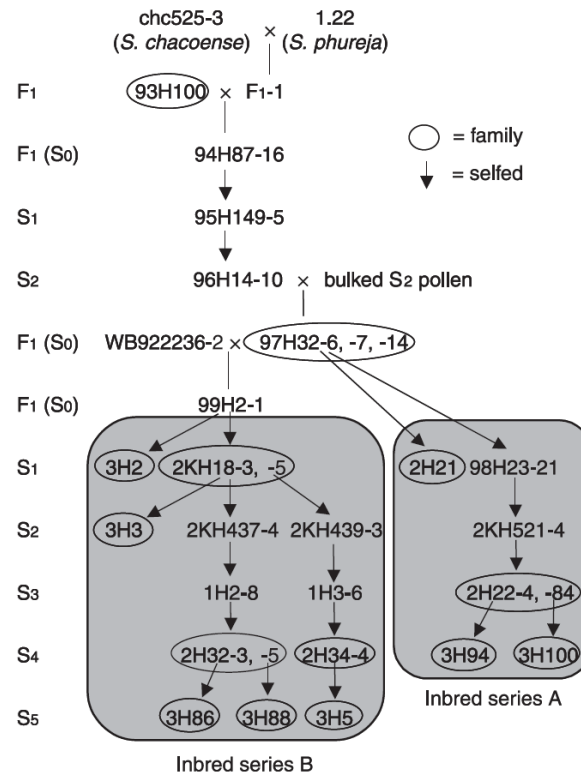
E. Ground 4: Claims 1-7 Are Obvious Over Phumichai, Jong, Chase, Bamberg, and Spooner.

1. Claim 1

(a) Claim 1[a]

If the preamble is limiting, it is disclosed by Phumichai. (*See* EX1002, ¶¶220-221.) Specifically, Phumichai produced highly inbred plants of a cross between *S. tuberosum* Group Phureja and *S. chacoense*, as shown in Figure 1.

Fig. 1. Two inbred series, A and B, developed from 97H32-6.



(EX1005, 0007, Fig. 1.)

The breeding history disclosed in Phumichai includes a cross of an *S. tuberosum* potato with another *Solanum* species. Because the claim also expressly allows for “optionally comprising introgression segments of other tuber bearing *Solanum* species crossable to *Solanum tuberosum*,” the lines of Phumichai are *S. tuberosum* as recited in Claim 1. (EX1002, ¶¶222-223.)

Agventure distinguished Phumichai by arguing that, although it admittedly “proposes an inbreeding technique for obtaining homozygous potatoes” – exactly as claimed in the challenged claims – Phumichai’s technique is supposedly not performed with *S. tuberosum* because those authors worked with Phureja. (See

§VI.D; EX1010, 1036.) Agventure’s prosecution-inspired arguments contending that Phureja and Tuberosum are distinct species were unsupported by any evidence.

That is likely because the argument is disproven by the accepted classification of Phureja within *Solanum tuberosum*. (See §V.A; EX1002, ¶¶222-223.) The prior art demonstrates that there is no phenotypical, morphological, or genetic evidence that would support separate classification of Phureja and Tuberosum as separate *Solanum* species. (EX1006, 0009, 0012; EX1012, 0011-12.) Phureja varieties were placed in a “cultivar-group” within the species *S. tuberosum* by 2002, and by 2007 even this distinction was abandoned and Phureja was placed firmly within the species *S. tuberosum*. (EX1006, 0012.) Varieties described as “*S. phureja*” would thus be recognized, by a POSA in 2009, not to be a distinct species, but being within *S. tuberosum*.

Indeed, Agventure’s supposed species distinction between Tuberosum and Phureja is contradicted by the ’841 patent. For example, the molecular markers used by the inventors to assess homozygosity were derived from the sequence of the DM1-3 plant. (EX1001, 33:32-35.) Per the patent, DM1-3 belongs to the “*Solanum tuberosum* Group Phureja.” (*Id.*, 33:57-61.) The inventors thus used the accepted taxonomy placing Phureja within the *S. tuberosum* species:

This resulted in **279** and **453** unique BLAST hits representing the occurrence of only one copy in the potato genome sequence of *Solanum tuberosum* Group Phureja DM1-3 516R44 (C1P801092) as known hitherto (Potato Genome Sequencing Consortium, www.potatogenome.net). (*Id.*; EX1002, ¶95.)

Accordingly, Phumichai's disclosure of plants identified as "Phureja" or "*S. phureja*" is an express disclosure of *S. tuberosum* as recited in the challenged claims, further complementing the express disclosures of Jong. (EX1002, ¶¶36-40, 115-116, 222.)

(b) Claim 1[b]

Phumichai teaches introduction of *Sli* into several *S. tuberosum* Group Phureja cultivated inbred lines that meet the relevant claim limitations. (*See* EX1002, ¶¶224-225.)

Diploid- Phumichai developed inbred Series A and B from a *S. tuberosum* Group Phureja x *S. chacoense* diploid hybrid comprising the *Sli* gene, the resulting progeny of which remained diploid. (EX1005, 0010; EX1002, ¶226.)

Fertile and self-compatible- Phumichai maintained fertility and self-compatibility by successfully selfing until at least the S₅ generation. (EX1005, 0010; EX1002, ¶227.)

(c) Claim 1[c]

Phumichai developed several inbred lines with the homozygosity and fertility limitations of the claims, exhibiting “considerable tuber yields” at the S₄ level. (EX1005, 0010.) A POSA would interpret “considerable tuber yields” in terms of potential tuber yield when grown in appropriate conditions, in accordance with accepted standard yields for *S. tuberosum* Phureja (*i.e.*, likely well above 200g per plant). (EX1002, ¶¶229-230.) For example, a prior art study of several Phureja varieties disclosed a mean tuber yield per plant from nearly 600g to nearly 800g. (EX1022, 0003.) A POSA would thus conclude that Phumichai disclosed inbred lines capable of producing at least 200g of tuber per plant under appropriate grown conditions. (EX1002, ¶230.) A POSA would also know, as noted in Grounds 1 and 2, that Jong expressly disclosed diploid, fertile, and self-compatible lines which produced well over 200g tuber per plant, and thus would have had a reasonable expectation of success in obtaining such plants. (*Id.*, ¶228.)

(d) Claim 1[d]

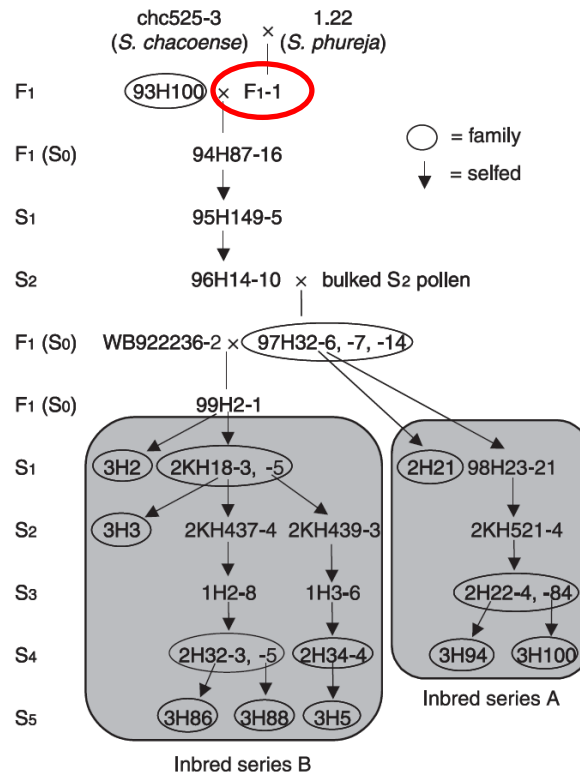
In addition to the disclosures of Jong discussed in Grounds 1 and 2, Phumichai reported “highly homozygous” lines with much greater than 75% homozygosity. (EX1002, ¶231.) Specifically, Phumichai reported S₄ lines with 89.3% homozygosity (series A, 10.7% heterozygous), and S₅ lines with 91.4% homozygosity (series B, 8.6% heterozygous). (EX1005, Abstract; EX1002, ¶232.)

The series A were the same as those described as exhibiting “considerable tuber yields.” (EX1005, 0010.)

(e) Claim 1[e]

The purpose of Phumichai’s work was to apply their *Sli* gene discoveries to inbreeding with diploids. By their own admission, the ’841 inventors believed Phumichai’s germplasm was the source for *Sli* in their breeding, employing line “H” as the *Sli* donor for their crosses. (EX1001, 29:47-53; EX1010, 0531.) As noted above, the parental line in the crosses disclosed in Phumichai is F₁-1:

Fig. 1. Two inbred series, A and B, developed from 97H32-6.



(EX1005, 0007, Fig. 1.) The lines disclosed in Phumichai thus have the same *Sli* gene as the recited deposits. (EX1002, ¶¶234-236.) And as discussed above, Jong

likewise disclosed self-compatible diploid lines. A POSA in 2009 would have readily combined Phumichai's teachings on *Sli*-based inbreeding to Jong's disclosures of highly inbred, self-compatible diploid lines producing tuber yields meeting the limitations of Claim 1. (*Id.*, ¶¶233, 237.)

Obviousness Rationale – A POSA would have combined Jong with Phumichai. Both are addressed to the same topic (inbreeding with self-compatible diploid potatoes for the purpose of heterosis breeding), and both are within the same field of potato breeding. (*Id.*, ¶237.) A POSA would have looked to Spooner to confirm the longstanding taxonomy of Phureja within the species *S. tuberosum*. As explained above, a POSA would have been motivated to obtain a diploid, fertile, and self-compatible potato with the relatively meager claimed performance characteristics of 75% homozygosity and 200g tuber yield. Jong disclosed successful creation of such lines, and Phumichai showed that *Sli*-based breeding could be used to undertake several rounds of selfing to obtain highly homozygous and vigorous plants. (*Id.*, ¶237.) As discussed for Grounds 2 and 3, a POSA would have found it obvious to employ the well-known breeding scheme of Chase to accomplish these goals and would have expected success based on the prior art. (*See* §V.H.1; EX1007, 0006-07.)

2. Claim 2

Phumichai, Jong, and Chase all provide motivation for introgressing agriculturally desirable traits into inbred lines. Phumichai produces diploid, fertile, and self-compatible plants using *Sli* to impart self-compatibility, and suggests the production of additional inbreds. (EX1005, 0010.) Jong also creates several diploid, fertile, self-compatible, and high-yielding inbreds. (EX1004, 0013.) Chase likewise teaches an inbreeding scheme that includes crossing steps to introduce beneficial traits. (EX1007, 0006.) A POSA would be motivated to breed agronomically desirable traits into other lines by, for example, crossing lines like Jong's with those of Phumichai for the same reasons discussed in Ground 2. (*See* §VIII.C.2; EX1009; EX1002, ¶¶238-241.) A POSA would have an expectation of success with the proposed introgression of a resistance trait based on Phumichai's successful inbreds and characterization of their creation as a simple procedure. (EX1005, 0010.)

3. Claim 3

Claim 3's recitation of foliage yield is obvious for the same reasons explained in Ground 2. (*See* §VIII.C.3; EX1009, 0004, 0055, 0058; EX1002, ¶242.) Based on known HIs for potato and the known vine vigor of Jong's parental lines per Bamberg, a POSA would have been motivated to select inbreds exhibiting at least 500g of foliage, and would have expected success in obtaining them.

4. Claim 4

Claim 4 is obvious over Phumichai. (EX1002, ¶¶243-245.) Phumichai discloses potato lines meeting the elements of Claim 1. (*See* §VIII.E.1.) Phumichai's lines were produced through successive rounds of sexual reproduction, including collecting and growing true seeds. Phumichai discloses the collection of seeds from inbred series A S₁-S₄ plants, which meet the elements of Claim 1. (EX1005, 0008, Table 1; EX1002, ¶245.) Separately, Phumichai also teaches tubers grown from their plants. (*See* §VIII.E.1; EX1002, ¶246.)

5. Claim 5

Claim 5's method for inbreeding is rendered obvious by Phumichai's teachings combined with Chase and Jong. (EX1002, ¶247.) If the **preamble** is limiting, it is disclosed by Phumichai and Jong, which discloses several novel diploid, fertile, self-compatible potato plants. (*See* §§VIII.C.5, VIII.E.1; EX1002, ¶248.) Jong and Chase also disclose the claimed method for producing these plants, as shown in each of the elements, below.

(a) Step 5(a)

Phumichai discloses a plant according to Claim 1, as discussed above. (*See* §VIII.E.1.) For example, Phumichai, alone or in combination with Jong, discloses inbred series A meeting all the elements of Claim 1. (*Id.*; EX1005, 0008, Table 1; EX1002, ¶249.)

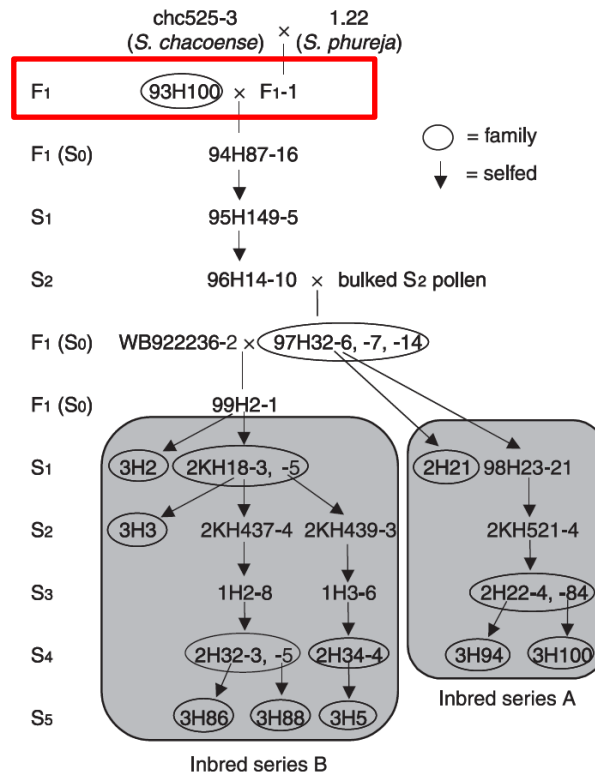
(b) Step 5(b)

Phumichai discloses several other diploid plants available for the claimed breeding method, including, for example plants from inbred series A and B. A POSA could use any of the diploid plants disclosed by Phumichai. (EX1002, ¶250.) Alternatively, a POSA would have also been motivated to cross one of the advanced inbreds from the high tuber yield series A (first plant) of Phumichai with a US-W4 inbred second potato plant from Jong such as those described in Grounds 1 and 2. (See §§VIII.B.1, VIII.C.5; EX1002, ¶251.) Indeed, a POSA could select any diploid plant for this cross.

(c) Step 5(c)

Phumichai's disclosed breeding begins with an initial cross pollination between the two diploid parents, 93H100 and F₁-1:

Fig. 1. Two inbred series, A and B, developed from 97H32-6.



(EX1005, 0007, Fig. 1; EX1002, ¶253.) A POSA would have found it obvious to replicate the hybrid cross described by Phumichai with different plants, including a new hybrid cross between a series A and/or series B inbred, or a US-W4 based diploid plant, as discussed above. (EX1002, ¶254.) Phumichai further collected seeds from crosses, which would further motivate a POSA to do the same. Phumichai shows counts of harvested seeds from each of its crosses, including its first F₁ hybrid cross. (EX1005, 0008, Table 1; EX1002, ¶255; *see also id.*, ¶252.)

(d) Step 5(d)

Phumichai describes growing hybrid offspring and selecting for self-compatibility by selfing its lines through multiple generations (S₀-S₄). (EX1005,

0007, Fig. 1.) Because selfing requires self-compatibility, it represents a selection for that trait. (EX1002, ¶257.) Phumichai further tracks self-fertility rates through each generation, which would encourage a POSA to do the same. (EX1005, 0010; EX1002, ¶258.) Jong and Chase likewise disclose this step. (*See* §VIII.C.5; *see also* EX1002, ¶256.)

(e) Step 5(e)

Phumichai describes at least four rounds of inbreeding to increase homozygosity of its self-compatible inbreds, taking Series A to at least S₄ and other inbreds to S₅ with over 90% homozygosity. (EX1005, 0010; EX1002, ¶¶259-261.) Jong and Chase likewise disclose this step. (*See* §VIII.C.5.)

(f) Step 5(f)

As noted above, Phumichai teaches selection for offspring through repeated selfing, resulting in self-compatible, fertile lines. (EX1005, 0008, Table 1.) Phumichai reports continued inbreeding, retaining their status as fertile and self-compatible, and exhibiting higher than 75% homozygosity among its genomic loci. (*Id.*, 0010; EX1002, ¶¶262-263.)

Obviousness Rationale – Phumichai produces several diploid, fertile, and self-compatible potato plants using the *Sli* gene to impart plants with self-compatibility, and suggests the production of additional inbreds using the *Sli* gene donor. (EX1005, 0010.) Thus, a POSA would have been motivated to cross one of

Phumichai's lines (e.g., a plant from S₄ or later inbred series A with "considerable tuber yields") with a second diploid plant and then selfing to obtain additional diploid inbred plants. (EX1005, 0010; EX1002, ¶¶267-268.) And as described above, the breeding scheme for creation of inbreds outlined in Claim 5 was described in Chase. (See §V.H.1; EX1007, 0006-07.) A POSA would have found it obvious to apply the well-known breeding methods disclosed in Chase using plants like those disclosed in Jong and Phumichai. (EX1002, ¶266.)

A POSA would have an expectation of success, for example for the purpose of introgression of a resistance trait based on Phumichai 2005's successful inbreds and characterization of the creation of new inbreds as a "simple procedure." (EX1005, 0010; EX1002, ¶267.) It would have been obvious for a POSA to simply repeat the breeding methods described in Phumichai (as well as Jong and Chase) to produce additional inbred plants, as recited in Claim 5. (EX1002, ¶¶269-270.) Even assuming the performance characteristics of the preamble (200g tuber yield, >75% homozygosity) are required for the offspring plants recited in final step (f), those performance characteristics were known to be relatively low and achievable based on the prior art.

As noted for Ground 2, to the extent Agventure argues that development of the inbred plants via the method of Claim 5 was not obvious because breeders would not persist in a breeding program with selections based on fertility as opposed to

tuber yield, those arguments are wrong. (*See* §VIII.C.5.) Indeed, Phumichai itself disproves this by disclosing that in their study they “paid little attention to tuber yield.” (EX1005, 0010; EX1002, ¶¶264-265.) Similarly, a POSA would not be dissuaded by inbreeding depression for the same reasons discussed in Ground 2. (*See* §VIII.C.5.)

6. Claim 6

Claim 6 is rendered obvious by Phumichai in combination with Chase and Jong, for the same reasons disclosed in connection with Ground 2. (*See* §VIII.C.6; EX1002, ¶271.) A POSA would be motivated to use a diploid donor line providing agronomically desirable traits for the second plant of Claim 5, because it was known to use such crosses to introgress desirable traits into inbreds. (EX1002, ¶272.)

7. Claim 7

Both Phumichai and Jong disclose the breeding method recited in Claim 5, as well as the parental lines to which the method would be applied recited in Claim 1. (EX1002, ¶¶273-274.) A POSA in possession of the method of Claim 5 would find any plants produced by that exact process obvious. Separately, claim 7 as a product-by-process claim is rendered obvious by Phumichai’s series A inbred lines, because they exhibit the recited phenotypic features of the claim as discussed in connection with Claim 1 above. (*See* §VIII.E.1; EX1002, ¶275.)

F. Ground 5: Claims 8-10 Are Obvious Over Phumichai, Jong, Chase, Bamberg, Spooner, and Springer

1. Claim 8

Claim 8 is rendered obvious by Phumichai in view of Jong, Chase, Bamberg, Spooner, and Springer. As discussed above, Phumichai and Jong each disclose inbred plants displaying the phenotypes recited in the claim, and those references plus Chase describe the hybridization cross used to create hybrids. (*See* §VIII.E; EX1002, ¶276.)

If the **preamble** is limiting, it is taught by both Phumichai and Jong which disclose the benefits of hybrid breeding, and develop inbreds exhibiting the claimed phenotypes. (EX1002, ¶¶277-280.) A POSA crossing Phumichai's inbred series A with lines like those disclosed in Jong, for example, would have a high expectation of success that the resulting hybrid population would exhibit all of the recited tuber yield, diploid, fertile, and self-compatible elements. (*See* §§VIII.B.1, VIII.D.1; EX1002, ¶280.)

(a) Step 8(a)

Jong discloses a “first potato plant” displaying all the recited features, for example US-W5315. (*See* §**Error! Reference source not found.**VIII.B.1; EX1002, ¶281.) Phumichai also discloses plants meeting these criteria. (*See* §VIII.E.1; EX1002, ¶281.)

(b) Step 8(b)

Phumichai discloses a series A inbred “second potato plant” displaying all the recited features of the claim. (*See* §VIII.E.1; EX1002, ¶283.) Alternatively, Jong teaches a “second potato plant” meeting the requirements of this claim element as discussed in Ground 3. (EX1002, ¶282.) Also as discussed in Ground 3, it would have been obvious for a POSA to use parents with at least 20% contrasting homozygous loci, given the long-recognized role of genetic distance between parental inbreds as a result-effective variable for eliciting hybrid vigor as disclosed in Springer. (*Id.*, ¶284.) Either of Phumichai or Jong’s “second potato plants” would likely meet this requirement, given their different lineages; the level of contrasting loci would be easily determinable through molecular marker analysis. (*See* §VIII.D.1; EX1008; EX1002, ¶284.)

(c) Step 8(c)

Both Phumichai and Jong teach crossing plants. A POSA would therefore be motivated to follow the same procedure. Phumichai demonstrates that its inbreds are fertile, and indicates that they would be useful for hybrid breeding: “these advanced inbreds may be valuable genetic stocks for studying the mechanism of heterosis and for producing hybrid variety at the diploid level.” (EX1005, 0010; EX1002, ¶285.) Similarly, Jong teaches cross-pollination to produce hybrids,

(EX1004, 0013), and the goal of Chase's analytical breeding scheme is to obtain beneficial hybrids by crossing inbreds. (EX1007, 0005-07.)

(d) Step 8(d)

Both Phumichai and Jong recommend using diploid inbreds to produce hybrid varieties. (*See* EX1005, 0010; *see also* EX1004, 0013.) A POSA would understand that Phumichai and Jong's call to produce hybrids also encompasses the step of collecting the resulting potato seeds, so as to grow the resulting hybrid. (EX1002, ¶¶286-287.)

Obviousness Rationale – A POSA would have been motivated to cross highly homozygous, diploid, fertile, and self-compatible inbred lines based on Phumichai's recommendation that inbred lines could be used to produce hybrid vigor in commercial hybrids, as noted above. (EX1005, 0010.) And like the arguments for inbreeding methods in Claim 5, the breeding scheme for hybrids outlined in Claim 8 was described in Chase. (*See* §V.H.1; EX1007, 0006-07.) A POSA would have found it obvious to apply Chase's well-known methods to lines like those disclosed in Jong, knowing from Springer the importance of genetic distance for heterosis. A POSA would also have an expectation of success at creating hybrids based on Phumichai's demonstration that its inbred lines were highly homozygous, remained fertile, and thus were capable of hybridization. (*See, e.g.*, EX1005, 0008, Table 1.) Jong's inbreds based on the crosses using US-W4 were similarly fertile, highly

homozygous, and uniform. (*See, e.g.*, EX1004, 0013; §VIII.D.1.) It would have been obvious for a POSA to carry out the claimed hybrid breeding methods to produce uniform hybrid potato plants, as recited in the claim. (*See also* EX1002, §§VI.E., VI.F.1(f).)

2. Claim 9

Claim 9 is rendered obvious by the disclosures of both Phumichai and Jong in view of Bamberg as discussed for claims 2 and 6. (*See* §VIII.D.2; EX1002, ¶289.)

3. Claim 10

A POSA in possession of the method of Claim 8 would find any seeds produced by that process obvious, and would expect those hybrid F₁ seeds to be uniform. (*See* §§VIII.D.3, VIII.F.1; EX1002, ¶290.)

G. Ground 6: Claims 1 and 4 Were Anticipated by US-W4

Claims 1 and 4 are broad enough to be anticipated even by well-known diploid breeding material that was available decades before the inventors began their work. For example, the US-W4 line disclosed in Jong as a self-compatibility donor meets all the limitations of Claim 1. US-W4 is *Solanum tuberosum*, is diploid, fertile, and self-compatible, and was available before 2009. (EX1058, 0013; EX1067; EX1002, ¶¶291-300.) Indeed, a manuscript including '841 inventors expressly refers to US-W4 as “diploid” and “SC” (self-compatible). (EX1036, 0003.) It is also well-established that US-W4 carries the same *Sli* gene for self-compatibility as the

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Agventure deposited lines. (*See* §VIII.B.1(e); EX1036, 0002; EX1002, ¶299.)

Further, experimental evidence shows that US-W4 produces 200g yield and is at least 75% homozygous: In trials conducted by expert breeder Shelley Jansky US-W4 yielded over 200g tubers per plant. (EX1002, ¶¶297-298.) Using a well-accepted SNP assay, expert breeder Doug Douches confirmed US-W4 is also at least 75% homozygous. (EX1003, ¶40.) Because US-W4 was supplied (and disclosed in the art) as a tuber, it also anticipated Claim 4. (EX1002, ¶301.)

Because the US-W4 disclosed in the art and evaluated in Petitioner's experiments necessarily meets all limitations of the plant recited in claims 1 and 4, the standard for inherent anticipation is met. *Monsanto v. DuPont*, 878 F.3d 1336, 1342-45 (Fed. Cir. 2018); *Telemac Cellular v. Topp Telecom*, 247 F.3d 1316, 1327-28 (Fed. Cir. 2001). It is indisputable that the US-W4 material studied in Petitioner's experiments was available to a POSA before 2009, and that it had sufficient stability such that the same plant lines described in the art can be evaluated for their inherent characteristics today. (EX1002, ¶300.)

H. Ground 7: Claims 5-10 Are Obvious over US-W4, Chase, Bamberg, and Springer.

As discussed above in Ground 2, the inbreeding method claims 5-7 were obvious when plants like those disclosed in Jong are combined with the teachings of Chase and Bamberg. (*See* §VIII.C.) Likewise, the hybrid breeding methods of claims 8-10 are obvious in further view of Springer as discussed in Ground 3. (*See*

§VIII.D.) In the same way, and for the same reasons, these claims were also obvious in the context of the disclosure of the plant US-W4, which as shown above meets all the limitations of claims 1 and 4. (EX1002, ¶302.)

I. Ground 8: Claims 1 and 4 Were Anticipated by RH89-039-16

Yet another example of disclosed and available breeding material is the RH89-039-16 line used by the inventors themselves, which also meets all the limitations of Claim 1.

RH89-039-16 was described in several prior art references, such as Voort. (EX1070, 0002; EX1002, ¶¶303-304.) RH89-039-16 is *Solanum tuberosum*, is diploid, fertile, and self-compatible, and was available before 2009. (EX1068; EX1070; EX1002, ¶¶305-308.) A manuscript by '841 inventors expressly describes RH89-039-16 as “diploid” and “SC” (self-compatible). (EX1036, 0003.) Further, experimental evidence shows that RH89-039-16 produces the required 200g yield and is at least 75% homozygous: In published trials, RH89-039-16 was found to yield tubers in excess of 200g per plant. (EX1002, ¶¶309-310; EX1059, 0007 (Table 2); EX1018, EX1061-EX1064; EX1069, 0006 (Table 1).) Applying well-accepted SNP genotyping, expert breeder Doug Douches confirmed that RH89-039-16 is also at least 75% homozygous. (EX1003, ¶41.) RH89-039-16, containing US-W4 in its breeding history, also unsurprisingly carries the same *Sli* gene for self-compatibility as the Agventure deposited lines. (EX1036, 0002; EX1002, ¶311.) RH89-039-16

material was available and was the same material described in the art. Because RH89-039-16 was supplied (and disclosed in the art) as a tuber, it also anticipated Claim 4. (EX1002, ¶312.)

The patent's description of RH89-039-16 as "essentially heterozygous" is misleading (and factually wrong). As shown above, RH89-039-16 is *in fact* at least 78% homozygous, and in any event the patent admits that its low-density SNP analysis used only 100 markers that were selected "with a preference" for markers found to be *heterozygous* in RH89-039-16. (EX1001, 34:37-46.)

As with US-W4, because the RH89-039-16 reported in the art and evaluated in Petitioner's experiments necessarily meets all limitations of the plant recited in claims 1 and 4, the standard for inherent anticipation is met.

J. Ground 9: Claims 5-10 Are Obvious over RH89-039-16, Chase, Bamberg, and Springer.

Ground 9 is like Ground 7, as applied to the RH89-039-16 plant. As discussed above in Ground 2, the inbreeding method claims 5-7 were obvious when plants like those disclosed in Jong are combined with the teachings of Chase and Bamberg. (See §VIII.C.) Likewise, the hybrid breeding methods of claims 8-10 are obvious in further view of Springer as discussed in Ground 3. (See §VIII.D.) In the same way, and for the same reasons, these claims were obvious in the context of the disclosure of the plant RH89-039-16, which as shown above meets all the limitations of claims 1 and 4. (EX1002, ¶313.)

IX. NO SECONDARY CONSIDERATIONS OF NONOBVIOUSNESS

There are no secondary considerations to counter the Petition's strong obviousness grounds. (EX1002, ¶¶314-322.) For example, Agventure cannot point to any supposed "industry praise," because any such praise would refer to inbreeding with diploid potatoes using *Sli*-based self-compatibility – subject matter that was firmly in the prior art. *See, e.g., S. Ala. Med. Sci. Found. v. Gnosis S.P.A.*, 808 F.3d 823, 827 (Fed. Cir. 2015) (praise lacked nexus because it was directed to a method already known in the prior art); (EX1002, ¶316.)

Likewise, the inventors cannot argue the invention provided unexpected results. There would be nothing unexpected about using *Sli*-based inbreeding in diploid potatoes to obtain lines with the meager performance characteristics of the claim, nor was there anything unexpected about applying the prior art methods for inbreeding or hybrid crossing. (EX1002, ¶¶317-320.) When compared with the closest prior art, nothing unexpected was achieved in the performance of the potato lines the inventors did disclose. *See, e.g., Kennametal, Inc. v. Ingersoll Cutting Tool Co.*, 780 F.3d 1376, 1385 (Fed. Cir. 2015).

The inventors also cannot claim solution of a long-felt need, because any "solution" provided in the specification was no different than the plants disclosed in the prior art, and the obvious breeding methods to be used with such plants. *See, e.g., Celgene Corp. v. Peter*, 931 F.3d 1342, 1352-53 (Fed. Cir. 2019); (EX1002,

¶321.) Petitioner reserves the right to rebut any asserted evidence of secondary considerations.

X. THE BOARD SHOULD REACH THE MERITS OF THE PETITION

No basis exists under either §314(a) or §325(d) for discretionary denial. The §325(d) inquiry asks: (1) whether the same or substantially the same art was previously presented to the Office, and if so (2) whether Petitioner has demonstrated that the Examiner erred in a manner material to the patentability of challenged claims. *Advanced Bionics, LLC v. Med-El Elektromedizinische*, IPR2019-01469, Paper 6, 8. Examples of “material error” include “misapprehending or overlooking specific teachings of the relevant prior art where those teachings impact patentability of the challenged claims.” *Id.*, 8-9.

The arguments and evidence presented herein were not before the Examiner during prosecution of the ’841 or its parent ’436, and therefore, do not constitute “the same or substantially the same prior art or arguments” under §325(d). Chase, Bamberg, Spooner, and Springer are all new references never considered during prosecution. Further, although Jong was cited in an IDS, there is no evidence that it was properly considered. (EX1010, 0118.) *Bowtech, Inc. v. MCP IP, LLC*, IPR2019-00379, Paper 14, 18-19 (“[A] reference that was neither applied against the claims nor discussed by the Examiner does not weigh in favor of exercising our discretion under § 325(d).”) (collecting cases).

Errors made by the Examiner in examination of the parent '436 apparently caused further error in the examination of the broader claims of the '841 patent. Specifically, the Examiner erred in accepting Agventure's inaccurate representations across both prosecution histories that the Phureja plants disclosed in Phumichai were not of the species *S. tuberosum*. As a result, the Examiner misapprehended the significance of Phumichai's disclosures. Indeed, the record of the '841 and its parent '436 (with the same Examiner) suggests that the Examiner understood that Phumichai expressly disclosed the same methods for *Sli*-based inbreeding with diploid potatoes recited in the challenged claims. (See EX1010, 0447-49; EX1054, 0020-28.) However, the Examiner was only dissuaded from maintaining Phumichai-based rejections because of Agventure's misleading argument that Phumichai's work was not a disclosure of *Sli*-based inbreeding in *S. tuberosum*. (See EX1010, 1036; EX1052, 0027-29; EX1055, 0013.) As explained above, Agventure's prosecution-inspired arguments were flatly contradicted by the accepted teachings of the art that Phureja and *S. phureja* are *S. tuberosum* potatoes. (See §§V.A, VIII.E.1; EX1002, ¶¶93-95.) The Examiner further erred by failing to recognize the tuber yield statements in Phumichai.

The Examiner also erred with respect to Jong, disclosed in an IDS but never used in any rejection, by overlooking specific disclosures, such as Jong's express disclosures of diploid, fertile, self-compatible potatoes that were highly homozygous

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and which gave tuber yields exceeding the claims' requirements, and the use of such plants for inbreeding and hybrid crossing. (See §§VIII.B-F.) The prosecution history reflects a significant gap in the Examiner's evaluation of art and arguments regarding Jong's teachings. See *Advanced Bionics*, Paper 6, 9-10; *Apple v. Koss*, IPR2021-00381, Paper 15, 28-29.

XI. CONCLUSION

Petitioner respectfully requests institution of IPR.

Dated: November 4, 2024

Respectfully submitted,

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CERTIFICATE OF COMPLIANCE WITH WORD COUNT

Pursuant to 37 C.F.R. §42.24(d), I certify that this petition complies with the type-volume limits of 37 C.F.R. §42.24(a)(1)(i) because it contains 13,978 words, according to the word-processing system used to prepare this petition, excluding the parts of this petition that are exempted by 37 C.F.R. §42.24(a) (including the table of contents, a table of authorities, mandatory notices, a certificate of service or this certificate word count, appendix of exhibits, and claim listings).

DATED: November 4, 2024

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CERTIFICATE OF SERVICE

I hereby certify, pursuant to 37 C.F.R. Sections 42.6 and 42.105, that a complete copy of the attached **PETITION FOR INTER PARTES REVIEW OF U.S. PATENT NO. 11,140,841 B2**, including all exhibits (**Nos. 1001-1059 and 1061-1077**) and related documents, are being served via PRIORITY MAIL EXPRESS on November 4, 2024, the same day as the filing of the above-identified document in the United States Patent and Trademark Office/Patent Trial and Appeal Board, upon Patent Owner by serving the correspondence address of record with the USPTO as follows:

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