

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

INARI AGRICULTURE, INC.,
Petitioner,

v.

PIONEER HI-BRED INTERNATIONAL, INC.,
Patent Owner.

Case No. PGR2024-00025
Patent No. 11,707,033

DECLARATION OF RAYMOND D. RILEY, PH.D.

Inari Exhibit 1003 Inari v. Pioneer
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I, Raymond D. Riley, Ph.D., hereby declare under penalty of perjury:

I. INTRODUCTION

1. My name is Raymond D. Riley, and I have been retained by counsel for Petitioner Inari Agriculture, Inc. (“Inari” or “Petitioner”) as an expert witness to provide analysis regarding U.S. Patent No. 11,707,033 (the “’033 Patent”), which I understand has been designated as EX1001. Specifically, I have been asked to consider the validity of claims 1-20 of the ’033 Patent (the “Challenged Claims”) in view of prior art, the non-obviousness and utility requirements, and the understanding of a person of ordinary skill in the art at the time of the invention as it relates to the ’033 Patent. I have personal knowledge of the facts and opinions set forth in this declaration and believe them to be true. If called upon to do so, I would testify competently thereto.

2. I am being compensated for my time at my standard consulting rate. I am also being reimbursed for expenses that I incur during the course of this work. My compensation is not contingent upon the results of my study, the substance of my expert opinions, or the outcome of any proceeding involving the challenged claims. I have no financial interest in the outcome of this matter or on the pending litigation between Petitioner and Patent Owner. My analysis here is based on my years of education, research, and experience, as well as my investigation and study of relevant materials, including those cited herein.

3. I may rely upon these materials, my knowledge and experience, and/or additional materials to rebut arguments raised by the Patent Owner. Further, I may also consider additional documents and information in forming any necessary opinions, including documents that may not yet have been provided to me.

4. My analysis of the materials produced in this proceeding is ongoing and I will continue to review any new material as it is provided. This declaration represents only those opinions I have formed to date. I reserve the right to revise, supplement, and/or amend my expert opinions stated herein based on new information and on my continuing analysis of the materials already provided.

II. BACKGROUND AND QUALIFICATIONS

5. I am an expert in the field of plant breeding and genetics. I have studied, taught, practiced, and researched in this field for over 45 years. I have summarized in this section my educational background, work experience, and other relevant qualifications. My curriculum vitae, which I understand has been designated EX1004, describes my background and experience.

A. Academic Training

6. I earned my Bachelor of Science degree in Soil & Crop Science with a second major in Agribusiness Management from the University of Wisconsin – Platteville in 1977. I earned a Master of Science degree in Plant Breeding and

Genetics from the University of Nebraska in 1980. In 1981, I earned a Doctor of Philosophy degree, in Plant Breeding and Genetics with a minor in Organization Behavior and Performance, also from the University of Nebraska. My dissertation entitled “Heritability of Mature Plant Traits in Sand Bluestem,” was directed to studies on inheritance of certain agronomically important traits in sand bluestem, a perennial tall-grass native to the Great Plains.

B. Selected Professional Experience

7. After completing my Doctor of Philosophy degree, I worked at Pioneer Hi-Bred International, Inc. (“PHI”), beginning in 1981. From 1981 to 1990, I was a research program manager and corn breeder. I was responsible for management of an integrated research program directed toward development of commercial corn. I was also responsible for commercial research interactions to effectively focus research efforts, communicate research results and enhance commercial success.

8. In that role, I developed several inbred and hybrids of commercial and germplasm significance. I was the co-inventor of a patent (U.S. Patent No. 5,491,295) for corn hybrid 3394, which at one point was the largest selling corn hybrid. PHI has stated that hybrid 3394 “became so dominant by the mid-90s that, by itself, it outsold the entire hybrid lineups of all competitor seed companies.” EX1019, “A Brief History of Corn – From Domestication to 1995,”

PHI (Dec. 19, 2022), <https://www.pioneer.com/us/agronomy/domestication-of-corn.html>.

9. From 1991 to 2000, I was a research director for PHI and, after DuPont's acquisition of PHI in October 1999, for DuPont. I was initially the research commercial liaison and director of corn breeding and product development efforts for Africa/Middle East/Pacific Rim. Later, I was responsible for North Central Corn-Belt corn product development. Later still, I was responsible for product characterization and commercialization (PCC) of corn for South America, Africa, Middle East, Asia and China. Each of these roles involved, among other things, working with or directing the activities of teams breeding and/or developing new inbred and hybrid corn varieties.

10. I then moved to Syngenta Seeds, where I worked from 2000 to 2015. From 2000 to 2003, I was Syngenta's Global Corn Seed Production Head based in Toulouse, France. From 2003 to 2004, I was the Global Head of Field Crops Research and Development. In these roles, I again worked directly with and/or directed the activities of teams breeding varieties of corn and other crops.

11. From 2004 to 2010, I was the head of NAFTA corn and soybean seeds research and development, based in Minnetonka, Minnesota. In that role, I developed a high-performance corn and soybean research and development team

that has repositioned Syngenta's corn and soybean product offerings to be among the best in the industry.

12. From 2010 to 2011, I was the global head, corn seeds research and development. In that role, I represented seeds research and development in the establishment of a global corn seeds strategy and managed Syngenta's global corn breeding and trait development portfolio.

13. From 2011 to 2014, I was the global head of germplasm technology. In that role, I led the establishment of a global cross crop plant breeding technical excellence program for application of breeding, statistical and emerging molecular biology technologies. I also established the "Syngenta Plant Breeding Academy" to enable ongoing state of the art skill development and networking of Syngenta scientists and our key collaborators.

14. From 2013 to 2014, I was the head of Traits Research, leading traits research teams responsible for GM (genetically modified) and non-GM traits for insect and disease resistance, yield, and stress tolerance. From 2014 to 2015, I was the Head of Computational Biology. In that role I established an integrated Computational Biology team to support Syngenta's research and development efforts spanning breeding, trait development (GM and Native) and chemistry.

15. From 2015 to 2018, I was the Senior Vice President of Product Development at Indigo Ag Inc. At Indigo, I led teams and projects focused on product development of microbiome-based crop production enhancing products.

16. Since 2018, I have worked as a consultant to a range of Ag Tech startups in areas spanning crop genetics, AI assisted breeding, gene editing, seed business strategy, biotech, microbial seed treatments, soil carbon sequestration and environmentally sustainable practices. Beginning in 2020 to present, I have also served as a member of the global Loam Bio Management Team at Loam Bio LLC, with a focus on research and development. Loam Bio develops programs to remove carbon from the atmosphere and store it in the soil, improving agricultural productivity.

17. As a leader of corn breeding teams and programs, it was my responsibility to ensure that investments in this area were delivering utility and supporting the commercial success of the company I was employed with, as well as the customers who utilized the developed product.

C. Patents

18. I am the inventor or a co-inventor of a number of patents in corn breeding and related fields including:

- a. U.S. Patent No. 5,159,133 (EX1092) entitled “Inbred Corn Line PHV37;”

- b. U.S. Patent No. 5,491,295 (EX1080) entitled “Hybrid Corn Plant and Seed;”
- c. U.S. Patent No. 10,624,351 entitled “Modulated Nutritional Quality Traits in Seeds” (related patents: US 11,178,876; US 11,766,045);
- d. U.S. Patent No. 10,640,783 entitled “Endophyte Compositions and Methods of Improvement of Plant Traits” (related patents: US 11,516,989); and
- e. U.S. Patent No. 10,645,938 entitled “Endophyte Composition and the Methods for Improvement of Plant Traits.”

III. LEVEL OF ORDINARY SKILL IN THE ART

19. In rendering the opinions set forth in this declaration, I was asked to consider the patent claims and the prior art through the eyes of one of ordinary skill at the time of the claimed invention, which I understand to be July 2, 2021—the filing date of the application that issued as the '033 Patent, and the earliest priority date to which the claims of the issued patent are entitled. I understand that the factors considered in determining the ordinary level of skill in a field of art include the level of education and experience of persons working in the field; the types of problems encountered in the field; the teachings of the prior art, and the sophistication of the technology at the time of the claimed invention. I understand that one of ordinary skill is not a specific real individual, but rather is a

hypothetical individual having the qualities reflected by the factors above. I understand that one of ordinary skill would also have knowledge from the teachings of the prior art, including the art cited below.

20. Taking these factors into consideration, on or before July 2, 2021, one of ordinary skill relating to the technology of the '033 Patent would have had a high level of skill. In particular, a POSA would have had a doctoral degree in plant breeding or a related field, at least five years of experience with corn breeding, and additional experience interfacing with laboratory-side personnel (including a computational biologist along with genetics specialists) as well as field-side personnel. Alternatively, additional experience could take the place of an advanced degree.

21. It has long been expected that substantial academic preparation was important to work as a corn breeder. For example, in a widely cited 1991 text entitled *Principles of Cultivar Development*, Walter Fehr described the academic experience expected for a plant breeder in terms that also applied in 2021:

To be capable of planning and conducting an effective plant breeding research program, a person needs an appropriate undergraduate and graduate education. The education includes a mixture of formal courses, independent research experience in working with an active research program, and informal interaction with students and faculty. Academic courses include plant breeding and those disciplines that contribute to cultivar development. Independent research gives

experience in planning, conducting, and interpreting experiments. Participation in an active research program is a means of obtaining practical experience with breeding techniques and methods. Informal interaction with students and faculty provides the opportunity to evaluate new ideas and concepts.

EX1016, Fehr, 8 (internal citation omitted). Indeed, the amount of education and experience required to run a successful breeding program has only increased over the years, especially as genetics, genomics, data science, and computational techniques have become increasingly important to breeding programs. In addition, an important aspect of the breeder's role is the ability to use breeding skills to create value for the company and enable business and customer (*i.e.*, farmer) success.

22. Before July 2, 2021, my level of skill in the art was at least that of one of ordinary skill. I am very familiar with the experience and knowledge of a POSA as of 2021. I held comparable positions to a POSA in the 1980s-90s. More recently, I have held positions in which I directed and/or worked with people who would be considered POSAs, including in leadership roles at PHI and Syngenta and in consulting roles. I am qualified to provide opinions concerning what one of ordinary skill would have known and understood at that time, and my analysis and conclusions herein are from the perspective of one of ordinary skill as of that date.

IV. MATERIALS CONSIDERED AND RELIED UPON

23. In reaching the conclusions described in this declaration, I have relied on the '033 Patent, the prior art, and other documents and materials cited herein. For ease of reference, the full list of documents that I have considered is included in **Appendix A**.

24. These materials comprise patents, related documents, and printed publications. Each of these materials is a type of document that experts in my field would have reasonably relied upon when forming their opinions.

25. I have also relied on my education, training, research, knowledge, and personal and professional experience in the relevant technologies and systems that were already in use prior to, and within the timeframe of the earliest priority date of the claimed subject matter in the '033 Patent, which is July 2, 2021.

V. LEGAL STANDARDS

26. I am not a lawyer and do not provide any legal opinions, but I have been advised that certain legal standards are to be applied by technical experts in forming opinions regarding meaning and validity of patent claims. I have applied the legal standards described below, which were provided to me by counsel for Petitioner.

A. Obviousness

27. I have been informed that a claim may be unpatentable under 35 U.S.C. § 103(a) if the subject matter described by the claim as a whole would

have been obvious in view of a prior art reference or in view of a combination of references at the time the alleged invention was made. I have been informed that obviousness is determined from the perspective of a hypothetical person of ordinary skill in the art (“POSA” or “person of ordinary skill”) and that the challenged claims of the patent should be read from the point of view of such a person at the time the alleged invention was made. I have been informed that a hypothetical person of ordinary skill is assumed to know and to have all relevant prior art in the field of endeavor covered by the patent in suit, and would thus have been familiar with each of the references cited herein, as well as the background knowledge in the art, and the full range of teachings they contain.

28. I have been informed that there are two criteria for determining whether prior art is analogous and thus can be considered prior art: (1) whether the art is from the same field of endeavor, regardless of the problem addressed, and (2) if the reference is not within the field of the patentee’s endeavor, whether the reference still is reasonably pertinent to the particular problem with which the patentee is involved. I have also been informed that the field of endeavor of a patent is not limited to the specific point of novelty, the narrowest possible conception of the field, or the particular focus within a given field. I have also been informed that a reference is reasonably pertinent if, even though it may be in a different field from that of the patentee’s endeavor, it is one which, because of

the matter with which it deals, logically would have commended itself to a patentee's attention in considering the problem.

29. I have also been informed that an analysis of whether an alleged invention would have been obvious should be considered in light of the scope and content of the prior art, the differences (if any) between the prior art and the alleged invention, and the level of ordinary skill in the pertinent art involved. I have been informed as well that a prior art reference should be viewed as a whole.

30. I have also been informed that in considering whether an invention for a claimed combination would have been obvious, I may assess whether there are apparent reasons to combine known elements in the prior art in the manner claimed in view of interrelated teachings of multiple prior art references, the effects of demands known to the design community or present in the market place, and/or the background knowledge possessed by a person of ordinary skill. I have been informed that other principles may be relied on in evaluating whether an alleged invention would have been obvious, and that these principles include the following:

- A combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results;

- When a device or technology is available in one field of endeavor, design incentives and other market forces can prompt variations of it, either in the same field or in a different one, so that if a person of ordinary skill can implement a predictable variation, the variation is likely obvious;
- If a technique has been used to improve one device, and a person of ordinary skill would recognize that it would improve similar devices in the same way, using the technique is obvious unless its actual application is beyond his or her skill;
- An explicit or implicit teaching, suggestion, or motivation to combine two prior art references to form the claimed combination may demonstrate obviousness, but proof of obviousness does not depend on or require showing an explicit teaching, suggestion, or motivation to combine;
- Market demand, rather than scientific literature, can drive design trends and may show obviousness;
- In determining whether the subject matter of a patent claim would have been obvious, neither the particular motivation nor the avowed purpose of the named inventor controls;

- One of the ways in which a patent's subject can be proved obvious is by noting that there existed at the time of invention a known problem for which there was an obvious solution encompassed by the patent's claims;
- Any need or problem known in the field of endeavor at the time of invention and addressed by the patent can provide a reason for combining the elements in the manner claimed;
- "Common sense" teaches that familiar items may have obvious uses beyond their primary purposes, and in many cases a person of ordinary skill will be able to fit the teachings of multiple patents together like pieces of a puzzle;
- A person of ordinary skill is also a person of ordinary creativity, and is not an automaton;
- A patent claim can be proved obvious by showing that the claimed combination of elements was "obvious to try," particularly when there is a design need or market pressure to solve a problem and there are a finite number of identified, predictable solutions such that a person of ordinary skill would have had good reason to pursue the known options within his or her technical grasp; and

- One should be cautious of using hindsight in evaluating whether an alleged invention would have been obvious.

31. I have further been informed that, in making a determination as to whether or not the alleged invention would have been obvious to a person of ordinary skill, the Board may consider certain objective factors if they are present, such as: commercial success of products practicing the alleged invention; long-felt but unsolved need; teaching away; unexpected results; copying; and praise by others in the field. These factors are generally referred to as “secondary considerations” or “objective indicia” of nonobviousness. I have been informed, however, that for such objective evidence to be relevant to the obviousness of a claim, there must be a causal relationship (called a “nexus”) between the claim and the evidence and that this nexus must be based on what is claimed and novel in the claim rather than something in the prior art. I also have been informed that even when they are present, secondary considerations may be unable to overcome primary evidence of obviousness (e.g., motivation to combine with predictable results) that is sufficiently strong.

32. I have been asked to consider the patentability of claims 1-20 (the “Challenged Claims”) of the ’033 Patent that are challenged in the Petition.

33. I have been informed that for PGRs, unpatentability must be shown under a preponderance of the evidence. I have been informed that to establish

something by a preponderance of the evidence one needs to prove it is more likely true than not true. I have concluded that the Challenged Claims are unpatentable under 35 U.S.C. § 103 (for obviousness) as described below, under both the preponderance of the evidence standard as well as the higher standard of clear and convincing evidence. The same is true for my conclusion, as also described below, that the Challenged Claims are unpatentable under 35 U.S.C. § 101 for lack of specific utility as well as under 35 U.S.C. § 112 for lack of written description or enablement.

B. Claim Construction

34. I have been informed that patent claims are construed from the viewpoint of a person of ordinary skill at the time of the alleged invention. I have been informed that patent claims generally should be interpreted consistent with their plain and ordinary meaning as understood by a person of ordinary skill in the relevant time period (i.e., at the time of the purported invention, or the so called “effective filing date” of the patent application), after reviewing the patent claim language, the specification and the prosecution history (i.e., the intrinsic record)

C. Utility

35. I have been informed that the statutory basis for the utility requirement is found in 35 U.S.C. § 101, which provides:

Whoever invents or discovers any new and *useful* process, machine, manufacture, or composition of matter, or any new and *useful*

improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title. (emphasis added)

36. I have been informed by counsel that the Supreme Court has interpreted the statute to mean that “one may patent only that which is ‘useful.’” *Brenner v. Manson*, 383 U.S. 519, 528-29 (1966). Specifically, the utility must be (i) specific, practical, and substantial. *Grunenthal GMBH v. Alkem Lab'ys Ltd.*, 919 F.3d 1333, 1345 (Fed. Cir. 2019). The utility must be “substantial” meaning a utility that “provides a specific benefit in currently available form.” *Ex parte Fisher*, 72 U.S.P.Q.2d 1020, 1025 (B.P.A.I. 2004).

37. Counsel has informed me that the courts have held that “inventions do not meet the utility requirement if they are ‘objects upon which scientific research could be performed with no assurance that anything useful will be discovered in the end.’” *In re '318 Pat. Infringement Litig.*, 583 F.3d 1317, 1324 (Fed. Cir. 2009). For example, an application for a proposed drug to treat dementia was held unpatentable where the applicant’s argument for utility was based only on “analytic reasoning” about the drug without any results of testing in animals or people. *Id.*, 1326-28.

38. Further, I also understand from counsel that the Supreme Court has cautioned that “a patent is not a hunting license,” meaning that “[u]nless and until a process is refined and developed to [the] point—where specific benefit exists in

currently available form—there is insufficient justification for permitting an applicant to engross what may prove to be a broad field” by obtaining a patent. *Brenner*, 383 U.S. at 534-36. Counsel has informed me that, for example, in a case involving expressed sequence tags (“ESTs”) in maize, the courts held that claims to specific ESTs were not patentable where the applicant’s only alleged utility were general uses of ESTs and the claimed ESTs were not tied to any specific utility, nor differentiate the claimed ESTs from any other ESTs. *In re Fisher*, 421 F.3d 1365, 1365-68 (Fed. Cir. 2005). Because the applicant “only disclosed general uses for its claimed ESTs, not specific ones that satisfy §101,” the claims were not patentable. *Id.* at 1374.

39. Finally, I understand that utility is determined as of the application filing date. *In re Brana*, 51 F.3d 1560, 1567 n.19 (Fed. Cir. 1995).

D. Indefiniteness

40. I have been informed that the statutory basis for the definiteness requirement is found in 35 U.S.C. § 112(b), which provides in relevant part:

(b) CONCLUSION.—The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the inventor or a joint inventor regards as the invention.

41. I have been informed by counsel that in litigation (i.e., when a patent owner sues another party alleging infringement), patent claims are determined to be indefinite if the “claims, read in light of the specification delineating the patent,

and the prosecution history, fail to inform, with reasonable certainty, those skilled in the art about the scope of the invention.” *Nautilus, Inc. v. Biosig Instruments, Inc.*, 572 U.S. 898, 901 (2014).

42. While I understand that “the definiteness requirement must take into account the inherent limitations of language,” patents “must be precise enough to afford clear notice of what is claimed, thereby apprising the public of what is still open to them.” *Nautilus*, 572 U.S. 909. The “reasonable certainty” standard reflects “the definiteness requirement’s public-notice function” and reduces the “innovation-discouraging ‘zone of uncertainty’ against which [the Supreme] Court has warned. *Id.* at 911.

43. In particular, I understand that claims are indefinite if their “legal scope is not clear enough that a person of ordinary skill in the art could determine whether a particular composition infringes or not.” *Geneva Pharms., Inc. v. GlaxoSmithKline PLC*, 349 F.3d 1373, 1384 (Fed. Cir. 2003).

VI. DESCRIPTION OF THE RELEVANT FIELD AND TIMEFRAME

44. I understand that the ’033 Patent issued from U.S. Patent Application No. 17/366,121, filed on July 2, 2021. I have been instructed by counsel to assume the relevant timeframe for my analysis in this declaration is on or before July 2, 2021.

45. Based on my review of this material, I believe that the relevant field for the purposes of the '033 Patent is, as identified above, corn breeding. For example, the patent discusses the “continuing goal of maize breeders...to develop stable, high yielding maize varieties and hybrids that are agronomically sound with maximal yield over one or more different conditions and environments.” EX1001, 1:23-26.

VII. OVERVIEW OF THE '033 PATENT

A. Subject Matter of the '033 Patent

46. The '033 Patent is directed to an inbred corn variety designated 1PNZQ23, which originated from a cross between inbred line PH1VKM and inbred line PH2DYM. EX1001, 37:60-64. The '033 Patent states that “[f]rom this cross, ears were selected based on genetic analysis predicting disease, insect, and agronomic phenotypic performance. Inbred 1PNZQ23 was developed by producing a doubled haploid from the F1 plants, selfing and using pedigree selection amongst the D1 lines, and selfing and bulking from the subsequent generations.” EX1001, 37:64-38:3. These techniques were well known to POSAs. Indeed, U.S. Patent No. 10,653,095 (“Heffner,” EX1007) published before the priority date, included the same disclosure—including the use of inbred lines PH1VKM and PH2DYM as the parents. *See* EX1007, 38:55-61; *see also* EX1020, Geiger, “Doubled Haploids in Hybrid Maize Breeding,” Maydica

54:485-99, 486 (2009) (“After artificial chromosome doubling the successfully treated seedlings are selfed leading to completely homozygous and homogeneous progenies (DH lines).”); EX1021, Weber, “Today’s Use of Haploids in Corn Plant Breeding” in *Advances in Agronomy*, Volume 123 (2014), 135 (“Haploid plants with fertile sectors are self-pollinated if possible.”).

47. Aside from the variety designation itself, the “Abstract,” “Background,” and “Summary” sections are essentially identical to those in multiple prior art patents such as Ross (EX1005), Carlone (EX1006), and Heffner (EX1007) and disclose information that would have already been well known to POSAs prior to the ’033 Patent’s July 2, 2021 filing date. *See* EX1100 (redline comparison of ’033 Patent against Ross); EX1101 (redline comparison of ’033 Patent against Carlone); EX1102 (redline comparison of ’033 Patent against Heffner).

48. For example, the Background sections of Carlone, Heffner, and the ’033 patent conclude by identifying a “continuing goal of maize breeders...to develop stable, high yielding maize varieties and hybrids that are agronomically sound with maximal yield over one or more different conditions and environments.” EX1001, 1:23-26; Carlone, 1:24-28; Heffner, 1:23-26.

49. The “Detailed Description” section likewise closely tracks multiple prior art patents such as Heffner. *See* EX1102 (redline comparison of ’033 Patent

against Heffner). Indeed, except for supporting citations to literature provided in Heffner, but absent from the '033 Patent, the following sections are substantially identical:

- Similar “Definitions” sections (compare EX1001, 4:46-14:67 with Heffner, 4:46-14:63)
- Identical “Phenotypic Characteristics” sections other than the designations themselves (e.g., 1PNZQ23 versus PH487D) (compare EX1001, 15:1-14 with Heffner, 14:64-15:10)
- Essentially identical “Genotypic Characteristics” sections other than the designations themselves (compare EX1001, 15:15-17:35 with Heffner, 15:1-17:38)
- Essentially identical sections on:
 - “Comparing ... to Other Inbreds” (compare EX1001, 17:36-18:7 with Heffner, 17:39-18:10);
 - “Development of Maize Hybrids” (compare EX1001, 18:8-19:3 with Heffner, 18:11-19:4);
 - “Combining Ability” (compare EX1001, 19:4-35 with Heffner, 19:5-36);
 - “Introduction of a New Trait or Locus” (compare EX1001, 19:36-21:37 with Heffner, 19:37-21:48);

- “Male Sterility and Hybrid Seed Production” (compare EX1001, 21:38-23:12 with Heffner, 21:49-23:34);
- “Develop[ing] Another Maize Plant” (compare EX1001, 31:40-32:4 with Heffner, 32:36-67); and
- “Industrial Applicability” (compare EX1001, 36:21-65 with Heffner, 37:16-60).

50. While the data in the ’033 Patent’s “Table 1” (“Variety Description Information”) varies slightly from that in the prior art tables, the differences are insubstantial, as discussed in further detail in Section IX.A below. There is no basis in the ’033 Patent or other reason to think that the traits would have fallen outside the range of expected outcomes from the breeding cross this line was developed from. *See, e.g.*, below, paragraphs 69-79 (comparing traits to prior art including disclosed parent and siblings); paragraphs 80-85 (discussing statistical analysis).

51. Moreover, the fields themselves (e.g., “branch angle” and “tassel length”) are taken verbatim from portions of a U.S. Department of Agriculture (USDA) form (EX1096) used in connection with applications for certificates under the Plant Variety Protection Act (PVPA). EX1008, 9; EX1009, 9; EX1010, 8. The characteristics in question facilitate assessing distinctiveness for purposes of the PVP—not utility or non-obviousness for purposes of the Patent Act. In

order to identify a distinctive variety in the days before genotyping was available, the practice developed of identifying a new variety using the set of characteristics identified by the USDA in the PVPA form.

VIII. TECHNICAL BACKGROUND AND STATE OF THE ART

52. By 2021, the art of corn breeding was well developed. As one of the world's most important staple crops, Maize (*Zea mays*; commonly known as corn) has been the subject of well-developed breeding and selection techniques dating back roughly nine thousand years.

53. Modern cross techniques date back to 1867, when plant breeders began directing pollen from one maize plant to another. In 1878–1881, crossing maize varieties to grow the production of commercial cultivars was proposed. EX1012, Lee, “Modern Maize Breeding,” in Bennetzen (ed.), *Maize Handbook* (2009), 140-42. Maize genes important for commercially relevant traits also began to be discovered. *Id.* A revolutionary step in maize breeding began with the demonstration of ‘hybrid vigor’ or heterosis in crossed inbred lines in 1909. *See, e.g.*, EX1013, Byerlee, “The globalization of hybrid maize, 1921–70,” *Journal of Global History* (2020), 15:1, 101-122 (“The exploitation of hybrid vigour was unique at the time to maize, which, unlike most other major crops, is an open-pollinating crop with separate male and female flowers. This characteristic greatly facilitated controlled pollination needed for in-breeding

parent lines over several cycles, and then crossing the inbreds to produce hybrids. With the right combination of inbred parents, the yield gain was as much as 50% above the yield of the parental OPVs, but more commonly averaged 15–20%.”); EX1015, Andorf, “Technological advances in maize breeding: past, present and future,” *Theoretical and Applied Genetics*, 132:817–849 (2019). In 1933, the first hybrid maize created by crossing inbred lines was introduced, and maize breeding started entering the “hybrid era.” *See* EX1013, Byerlee, 101; EX1012, Lee, 149.

54. Employment of modern genetics and molecular biology techniques in maize breeding started in the 1970s–1980s with the first regenerated plant from a cell culture and sequencing the first maize genes. EX1015, Andorf, 820-21. These modern techniques aided the identification of genes conferring desirable traits such as disease and/or insect resistance. Transgenic maize varieties began to emerge in the late 1990s, and transgenic hybrids that could confer insect resistance, herbicide tolerance, high lysine content, and drought-resistance were commercialized. EX1011, Lundmark, “Genetically Modified Maize,” *BioScience*, 57, 996 (2007).

55. Principles and methods of maize breeding and cultivar development to produce maize varieties with desirable traits have been described in various frequently cited textbooks and publications including, e.g., Fehr et al., *Principles of Cultivar Development*, (1987) (EX1016); Wych et al., *Production of Hybrid*

Seed, Corn and Corn Improvement, Chapter 9 (1988) (EX1017); Lee et al., Handbook of Maize, Modern Maize Breeding (2009) (EX1012); and Andorf et al., Theor Appl Genet. 132(3):817-849 (2019) (EX1015). Such principles and techniques are also well known and routinely practiced by those skilled in the art of maize breeding.

56. By selecting appropriate varieties for crosses, it became routine over time to use cross breeding to adjust phenotypes successively to generate the changes and improvements in desired characteristics.

57. Fehr's text sets forth some of the reasons why inbred lines are desirable:

One important purpose of inbreeding is the development of genotypes that can be maintained through multiple generations of seed production. Self-pollinated cultivars are reproduced for many generations without changes in their genetic composition. Reliable production of inbred commercial hybrid seed of a species is dependent on the availability of inbred parents whose genotype can be maintained.

Inbreeding has been used to reduce the frequency of deleterious recessive alleles in genotypes that serve as parents of a synthetic or a vegetatively propagated cultivar. One selfed generation [in other words, pollinating a plant by itself] may permit the expression and subsequent elimination of deleterious alleles without excessive

inbreeding depression occurring in lines selected for use as parents for population development.

Inbreeding increases the genetic variability among individuals in a population. Greater genetic variability among inbred progeny can increase the effectiveness of selection and the amount of genetic improvement in a breeding program.

EX1016, 106-107.

IX. GROUND 1-2: CLAIMS 1-20 ARE UNPATENTABLE AS OBVIOUS OVER THE PRIOR ART

58. In my opinion, Claims 1-20 are unpatentable as obvious over the prior art as of July 2, 2021. I describe in detail the basis for my opinion in this Section IX. At a high level, I reach this opinion because the variation from the original parent performance is very much within the range of what would be expected to be achieved by breeding a new line from the parental lines.

59. As the '033 Patent's Variety Description Information (Table 1) confirms, the inbred 1PNZQ23 variety covered by claim 1 has characteristics very similar to those in multiple other inbred varieties disclosed in the prior art. Notably, the greatest similarities in the comparisons I consider herein are between the sibling lines (the '033 Patent's 1PNZQ23 and Heffner's PH487D) both bred from the same parents through the same process and with the same breeding start year. As discussed further below, to the extent there are ostensible differences, nothing in the specification suggests any reason why such differences were

significant and/or unexpected as compared to prior art varieties. I say “ostensible” because it is unclear whether any apparent differences reflect a real difference between varieties in view of the lack of information that would be needed to understand environmental effects of the location where the data was collected—an issue typically addressed by using comparisons to other known reference lines.

60. Moreover, claims 2-20 recite standard applications for inbred corn variety (e.g., crossing the particular inbred variety with a different variety to create an F1 hybrid). Such applications would have been obvious for any known or obvious inbred corn line as of July 2, 2021.

A. Graham Factor Analysis Relevant to Grounds 1-2

61. I will now address: (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of skill in the art; and (4) any secondary considerations identified by the Patent Owner. I understand from counsel that these are known as the “Graham” factors and form the basis for assessing whether a claimed invention would have been obvious at the time of the patent application in question (here, July 2, 2021).

1. Scope and Content of the Prior Art

62. I discussed the general state of the art in Section VIII above.

63. In addition, Ross (EX1005), Carlone (EX1006), and Heffner (EX1007) are indisputable post-AIA §102(a)(1) prior art. The table below is

based on the “Table 1 – Variety Description Information” in each of the ’033 Patent, Ross, Carlone, and Heffner. It also includes a column for Lira (U.S. Patent No. 9,930,848, EX1066), which I understand the Patent Examiner identified as the “closest prior art.” EX1002, 101. However, as the table reflects, the varieties disclosed in Ross, Carlone, and Heffner are closer in numerous respects to the 1PNZQ23 variety claimed in the ’033 Patent.

	’033 Patent (1PNZQ23)	Ross (PH1VKM)	Carlone (PH2DYM)	Heffner (PH487D)	Lira (PH2RTZ)
Grain Texture	Dent	[Dent] ¹	[Flint-Dent] ²	Dent	Flint-Dent
MATURITY :					
Comparative Relative Maturity (days)	109	110	108	107	115
Emergence to 50% plants in silk (days)	55	49	49	51	63
Emergence to 50% plants in silk (heat units)	1348	1228	1228	1299	1352

¹ Bracketed data taken from corresponding PVP certificate. EX1008, 8.

² EX1009, 8.

	'033 Patent (1PNZQ23)	Ross (PH1VKM)	Carlone (PH2DYM)	Heffner (PH487D)	Lira (PH2RTZ)
Emergence to 50% plants in pollen shed (days)	55	50	49	54	66
Emergence to 50% plants in pollen shed (heat units)	1348	1256	1228	1374	1430
PLANT:					
Plant height (to tassel tip) (cm), mean (SE)	198.2 (7.88)	252.4 (8.32)	208.7 (8.91)	200.9 (6.55)	188.4 (5.98)
Ear height (to base of top ear node) (cm), mean (SE)	78 (6.35)	97.7 (10.78)	54.5 (8.07)	75.1 (9.43)	78.4 (7.35)
Length of Top Ear Internode (cm), mean (SE)	10.9 (1.49)	19.4 (0.79)	17.4 (0.91)	16.3 (1.38)	14.9 (1.62)
Number of Nodes Above Ground, mean (SE)	13.4 (0.73)	13.9 (0.44)	12.7 (0.48)	10.7 (0.46)	12.1 (0.74)
Anthocyanin of Brace Roots (1 =	2	3	2	2	4

	'033 Patent (1PNZQ23)	Ross (PH1VKM)	Carlone (PH2DYM)	Heffner (PH487D)	Lira (PH2RTZ)
absent, 2 = faint, 3 = moderate, 4 = dark)					
LEAF					
Width of Ear Node Leaf (cm), mean (SE)	9 (0.59)	9.8 (0.51)	9.7 (0.56)	8.2 (0.65)	9.6 (0.92)
Length of Ear Node Leaf (cm), mean (SE)	66.8 (2.93)	81.4 (2.08)	75.6 (3.49)	67.8 (4.68)	65.6 (4.14)
Number of Leaves Above Top Ear, mean (SE)	5.5 (0.5)	5.5 (0.5)	5.6 (0.49)	5.8 (0.51) ³	4.6 (0.5)
Leaf Angle (degrees) (at anthesis, 2 nd leaf above top ear to the stalk), mean (SE)	31 (4.64)	15.8 (3.37)	29.6 (4.21)	27.4 (10.79)	33.9 (5.28)
Leaf Color	V. Dark Green	V. Dark Green	V. Dark Green	V. Dark Green	V. Dark Green
Leaf Sheath Pubescence (1 = none to	7	6	6	6	3

³ PVP reports "6." EX1010, 7.

	'033 Patent (1PNZQ23)	Ross (PH1VKM)	Carlone (PH2DYM)	Heffner (PH487D)	Lira (PH2RTZ)
9 = peach-like fuzz)					
TASSEL					
Number of Primary Lateral Branches, mean (SE)	8.6 (2.5)	9.5 (2.25)	7.4 (1.96)	3.7 (1.73)	10.6 (2.82)
Branch Angle from Central Spike (degrees), mean (SE)	10.3 (5.12)	16.5 (6.02)	13.4 (4.71)	12 (5.34)	12.8 (4.1)
Tassel Length (from peduncle node to tassel tip) (cm), mean (SE)	56.7 (2.48)	64.1 (3.47)	64.3 (2.22)	53.9 (2.06)	47.9 (4.76)
Peduncle Length (from top leaf node to lower branch) (cm), mean (SE)	26 (2.46)	39.8 (3.08)	26.7 (1.42)	25 (2.92)	12.7 (1)
Central Spike	19.6 (1.53)	25.1 (2.72)	24.7 (1.87)	25.8 (1.99)	23.7 (3.48)

	'033 Patent (1PNZQ23)	Ross (PH1VKM)	Carlone (PH2DYM)	Heffner (PH487D)	Lira (PH2RTZ)
Length (cm), mean (SE)					
Flag Leaf Length (cm) (from flag leaf collar to tassel tip), mean (SE)	42.9 (2.03)	50.9 (3.14)	50.2 (1.63)	29.3 (2.41)	35.5 (4.1)
Pollen Shed (0 = male sterile to 9 = heavy shed)	8	9	9	7	3
Bar Glumes (1 = absent, 2 = present)	1	1	1	1	
Anther Color	Yellow	Light Green	Light Green	Pale Yellow ⁴	Pale Yellow
EAR (Unhusked ear)					
Silk Color	Red	Red	Red	Red	Red
Fresh Husk Color	Light Green	Light Green	Med. Green	Light Green	Med. Green
Dry Husk Color	White	White	White	White	White
Ear position at dry husk stage (1 = upright, 2 =	1	3	1	1	3

⁴ PVP reports "Yellow." EX1010, 8.

	'033 Patent (1PNZQ23)	Ross (PH1VKM)	Carlone (PH2DYM)	Heffner (PH487D)	Lira (PH2RTZ)
horizontal, 3 = pedant)					
Husk Tightness (1 = very loose to 9 = very tight)	3	3	1	4	7
Husk Extension (at harvest) (1 = short (ears exposed), 2 = medium (< 8 cm), 3 = long (8-10 cm), 4 = very long (> 10cm))	2	[1] ⁵	[1] ⁶	2	
Length of Interior Husk (cm), mean (SE)	16.7 (0.96)	18.8 (1.33)	18.7 (1.09)	14.8 (2.52)	24.6 (1.29)
EAR (husked ear data)					

⁵ EX1008, 10.

⁶ EX1009, 10.

	'033 Patent (1PNZQ23)	Ross (PH1VKM)	Carlone (PH2DYM)	Heffner (PH487D)	Lira (PH2RTZ)
Shank Length (cm), mean (SE)	12.2 (1.86)	7.6 (1.86)	11.2 (3.27)	11.6 (2.79)	8.9 (3.02)
Ear Length (cm), mean (SE)	14.5 (0.66)	14.8 (0.7)	15 (1.18)	14.2 (0.93)	18 (0.75)
Ear Diameter at mid-point (mm), mean (SE)	43.6 (1.56)	45.6 (1.17)	44 (2.05)	41.7 (1.5)	43.5 (1.36)
Ear Weight (gm), mean (SE)	122 (13.47)	130.8 (10.87)	128.5 (16.1)	118.1 (11.38)	137 (14.57)
Number of Kernel Rows, mean (SE)	16.8 (1.1)	17.4 (1.16)	19.1 (1.79)	16.3 (1.14)	14.9 (1.48)
Number of Kernels Per Row, mean (SE)	23 (2.22)	26.5 (1.56)	26.6 (2.94)	24.4 (3.24)	31.2 (2.82)
Kernel Rows (1 = indistinct, 2 = distinct)	1	1	2	2	2
Row Alignment (1 = straight, 2 = slightly curved, 3 = spiral)	1	1	1	1	2

	‘033 Patent (1PNZQ23)	Ross (PH1VKM)	Carlone (PH2DYM)	Heffner (PH487D)	Lira (PH2RTZ)
Ear Taper (1 = slight cylindrical, 2 = average, 3 = extreme conical)	2	2	2	2	2
KERNEL (Dried)					
Kernel Length (mm), mean (SE)	11.5 (1.04)	12.3 (0.44)	12.2 (0.62)	10.9 (0.5)	11.5 (0.8)
Kernel Width (mm), mean (SE)	7.5 (0.81)	7.7 (0.54)	7.4 (0.44)	7.6 (0.6)	8.5 (0.58)
Kernel Pericarp Color	Clear	Clear	Clear	Clear	Clear
Aleurone Color Pattern	Homozygous	Homozygous	Homozygous	Homozygous	Homozygous
Aleurone Color	Clear	Yellow ⁷	Yellow ⁸	Clear	Yellow
Hard Endosperm Color	Yellow	Yellow	Yellow	Yellow	Yellow-Orange
Weight per 100 Kernels	29.5	N/D	N/D	27.8	33.8

⁷ PVP reports “Pale Yellow.” EX1008, 10.

⁸ PVP reports “Pale Yellow.” EX1009, 10.

	'033 Patent (1PNZQ23)	Ross (PH1VKM)	Carlone (PH2DYM)	Heffner (PH487D)	Lira (PH2RTZ)
(unsized sample) (gm), mean (SE)					
COB					
Cob Diameter at mid-point (mm), mean (SE)	23.3 (1.06)	26 (0.98)	25.8 (1.12)	21.3 (1.57)	23.9 (1.25)
Cob Color	White	Pink-Orange	White	Pink	Buff

64. Ross, Carlone, and Heffner likewise disclose that the disclosed inbred lines provide “source[s] of breeding material that may be used to develop new maize inbred varieties.” EX1005, 36:66-37:1; EX1006, 36:60-63; EX1007, 32:38-41. In particular, all disclose the “production of double haploids...for the development of inbreds,” with an “F1 hybrid for which [the disclosed variety] is a parent can be used to produce double haploid plants.” EX1005, 38:47-50; EX1006, 38:43-46; EX1007, 34:9-12. This is the exact same technique disclosed in the '033 Patent itself using the parental inbred lines disclosed in Ross and Carlone:

Prior Art	'033 Patent
Ross (EX1005), 38:49-50 (“[A]n F1 hybrid for which PH1VKM is a parent can be used to produce double haploid plants.”) Carlone (EX1006), 38:45-46 (“[A]n F1 hybrid for which PH2DYM is a parent can be used to produce double haploid plants.”)	EX1001, 37:62-38:1 (“1PNZQ23 is an elite corn inbred line originated from a cross between inbred line PH1VKM and inbred line PH2DYM....Inbred 1PNZQ23 was developed by producing a doubled haploid from the F1 plants....

65. Ross and Carlone likewise disclose the “selfing,” “pedigree selection, and “bulking” techniques disclosed in the '033 patent following creation of the F1 plants. EX1005, 37:35-52; EX1006, 37:30-47. Indeed, Ross and Carlone expressly describe their respective “invention[s]” as encompassing methods of crossing the disclosed variety (PH1VKM in Ross, PH2DYM in Carlone) with another corn plant. EX1005, 37:16-25; EX1006, 37:11-20. And Heffner expressly describes creating a new inbred line by crossing Ross and Carlone—just like the '033 Patent itself. EX1001, 37:61-64; EX1007, 38:55-57.

66. Indeed, as discussed further in paragraph 98 below, the PH1VKM variety disclosed in Ross and the PH2DYM variety disclosed in Carlone were used as the parent for other inbred varieties as confirmed by other PHI patents, as described below at paragraphs 87-88.

67. It should also be noted that the specific measurement outcomes of many of the listed traits of any given inbred line will differ based on environmental conditions the plants are grown in, thus the use of comparative measurements to known lines *under the same conditions* is necessary to reliably differentiate a particular inbred line for many of the traits in Table 1. It should be noted that the error in estimating performance for a quantitative trait is a combination of errors from measurements within a trial (reported in Table 1), impacts from locations within years (which may or may not be reflected in Table 1 and is impossible to assess given that the '033 patent does not disclose location information), and impacts from different years (not included, but key for meaningful comparisons). Relatively speaking, impacts from different years constitute the largest of these sources of error, with impacts from locations within years the second most important, and variations from measurements within a single trial (i.e., involving single location over a single year) presenting the smallest source of error. Accordingly, slight differences in a given trait as reported in the respective Table 1 entries would not be sufficient on their own to distinguish an inbred line for many of the traits—much less to establish unexpected results as compared to the earlier lines.

2. Differences Between the Prior Art and the Claimed Invention

68. From a POSA's perspective, any differences between the prior art and the claimed invention are insubstantial and insignificant. Both the claims and the prior art are directed to stable inbred maize varieties for use in a variety of industrial applications as well as breeding other inbred and/or hybrid lines. Indeed, virtually all of the '033 Patent's specification is drawn verbatim from Heffner (as indicated in the above-noted comparison, EX1102) and is also highly similar to the disclosures in Ross and Carlone.

69. Moreover, as illustrated in the above table, the disclosed characteristics of the claimed 1PNZQ23 plant and its associated crop (i.e., corn ears) are highly similar to the disclosed characteristics of the identified prior art maize lines. Simply put, the disclosed properties concerning the claimed 1PNZQ23 variety fall well within the mainstream of corn phenotypes observed long before the '033 Patent's 7/2/2021 effective filing date, as will become apparent in the following paragraphs 63-79, which include comparisons to the prior art Ross (EX1005), Carlone (EX1006), and Heffner (EX1007) patents, as well as comparisons to other similar plant varieties to the claimed 1PNZQ23. It should also be noted that a POSA would be familiar with extensive genetic stock collections of corn showing considerable variation with respect to the traits

described in paragraphs 63, 69-79. A POSA would therefore be able to prepare crosses with these and other known varieties to achieve variations in the traits.

70. I will now address the characteristics set forth in Table 1 “Variety Description Information” of the ’033 Patent as compared to the corresponding data for Ross, Carlone, and Heffner, shown in the table above at paragraph 63 and discussed in greater detail in paragraphs 71-85 below. As an initial matter, however, I note (as also discussed in paragraphs 67-77 below) that the data for each variety is not directly comparable given the potentially different environmental conditions in which the varieties were grown. Unlike earlier PHI patents (as discussed in more detail in Section X.A below), the ’033 Patent lacks any head-to-head data such as strip test data permitting such comparisons.

71. Grain type, dent for the ’033 Patent, is the same as that reported for the sibling Heffner, the parent Ross, and similar to Carlone (reported as flint-dent). *See* paragraph 63. The designation “dent” indicates grain having dent characteristics.

72. The “Maturity” section addresses criteria related to the time to various stages observed for the line. *See* paragraph 63. The emergence to various stages of maturity is highly dependent on a number of factors including: the geographic location where the samples were planted, the soil conditions at the site, the weather conditions prevailing that season, and when within the season the crop

was planted. But the '033 Patent does not disclose such factors or even other data from which one could determine them (e.g., the location and growing season where the plants reflected in the table were grown nor the performance of other reference materials under the conditions where data was collected). As a result, the “Maturity” information presented in the '033 Patent, presented alone and without any comparative data, does not permit a definitive conclusion as to whether any of the results is significantly different from any other. Nonetheless, the results for 1PNZQ23 are within or similar to the range established by Ross, Carlone, and Heffner. Some of the maturity data shows that 1PNZQ23 required more days or heat units to reach respective maturity measures than in Ross, Carlone, and Heffner. This may be a result of the location or growing season. In any event, the maturity fall within the range of performance from potential parental source materials, as demonstrated by, for example, U.S. Patent No. 8,563,836, 33:10-15 (EX1093) (reporting 66 days and 1350 heat units to emergency to 50% of plants in silk and 67 days and 1382 heat units for emergence to 50% of plants in pollen shed). Accordingly, the Maturity data is not unexpected as compared to the data reported in Ross, Carlone, and Heffner.

73. The next category “Plant” includes characteristics related to the corn plant. *See* paragraph 63. Each of these characteristics are similar to those reported by Ross, Carlone, and Heffner. As discussed in greater detail below

(paragraph 80-85), I have compared the statistical data presented in the '033 Patent, Ross, Carlone, and Heffner for relevant characteristics. This information is shown in Appendix B. Reviewing Appendix B for the plant data shows that the 95% confidence interval for the '033 Patent data overlaps with the 95% confidence intervals for one or more of Ross, Carlone, and Heffner for each of the characteristics. For example, 1PNZQ23 is reported as having a mean plant height of 198.2 cm and a standard error of 7.88. Accordingly, the 95% confidence interval range would be 182.8 to 213.6 cm. The values reported for Carlone and Heffner each fall within this range. In particular, the confidence intervals overlap for 1PNZQ23 and Heffner for every category *except* for number of nodes above ground, and the number of nodes falls between the reported values for Ross and Carlone, confirming that this characteristic would be expected. I should also note that the statistical measures that the patents report only refer to variation within the particular population measured, and does not include the variation that would be expected for plants grown in a difference location within the same geographic area, an entirely different geographic area, or in a different season. I would expect these variations to be even larger than the variations reported for the measured populations. However, PHI has not provided location and growing year information. Specifically, plant height, ear height, and length of top ear internode are traits that all would be expected to be impacted by environmental stresses,

with more stressful conditions resulting in reduced values (in other words, smaller plants). Brace root anthocyanin refers to pigmentation levels in a portion of corn's root system. *See* EX1034, Merriam-Webster, 52 (definition of "anthocyanin" "any of various soluble glycoside pigments producing blue to red coloring in flowers and plants"). 1PNZQ23 is reported as having the same level of brace root anthocyanin as Carlone and Heffner.

74. The next category "Leaf" includes characteristics related to the corn plant's leaves. *See* paragraph 63. Each of these characteristics falls within or is similar to the range established by Ross, Carlone, and Heffner. For example, 1PNZQ23's width of ear node leaf falls between that reported by the parents (Ross and Carlone) and that reported for Heffner. As shown in Appendix B, the 95% confidence intervals for each of the characteristics overlap for the '033 and Heffner in every category. Although leaf angle is slightly higher, it is within the range reflected by the half-sibling reported in Lira. Additionally, leaf angle is also dependent on environmental conditions. EX1064 ("Previous research has shown that corn plants can alter their leaf angle in response to their environment."). In particular, leaf angle tends to be more upright when the plants are planted more densely and vice versa. *Id.* Finally, for leaf sheath pubescence, while 1PNZQ23's value (7) is slightly higher than the values of Ross, Carlone, and Heffner. The value is assigned based on a qualitative assessment by an observer. There can

also be errors in estimation of this trait based on the skill and alertness of the individual making the assessment. *See, e.g.*, EX1009, 7 (“Rate on scale from 1 = none to 9 = like peach fuzz”). In any event, leaf sheath pubescence is not a unique trait or a trait of perceived value in the marketplace.

75. The next category “Tassel” includes characteristics related to the corn tassel. *See* paragraph 63. Each of these characteristics falls within or is similar to the range established by with the exception of branch angle from central spike. However, despite this apparent difference, each of Ross, Carlone and Heffner, in fact the confidence intervals for each overlaps with that reported in the ’033 Patent. Anther color reported in the ’033 Patent is yellow as compared to pale yellow for Heffner. Additionally, the difference could be an interpretation of the individual taking the measurements or impact of sunlight conditions. Anther color is not of known value and the anthocyanin to make the color can be reduced or, alternatively, increased under some conditions.⁹ I also note that many of these

⁹ The anther is simply the pollen-containing structure within a male flower (called a “tassel”). *See* EX1034, Merriam-Webster, 52 (definition of “anther” “the part of a stamen that produces and contains pollen and is usu[ally] borne on a stalk”). The color of the anther does not have any technical or commercial significance to

characteristics such as tassel length, peduncle length, and flag leaf length are characteristics that would be affected by environmental stress, resulting in a smaller plant (under stressed conditions).

76. The next category “Ear (Unhusked ear)” includes characteristics related to the unhusked corn ear. *See* paragraph 63. Each of these characteristics falls within or is similar to the range established by Ross, Carlone, and Heffner. Differences in these categories can be the result of many factors, including vigor of the line, different stress conditions, and/or timing of data collection. For example, if the corn ear does not fill out well or if ear traits (kernel rows, kernels per row, etc.) are reduced, the ear is more likely to have more husk cover. Additionally, if the data was taken early in the season, husk tightness is usually high, (e.g., a 9) for all varieties. Overall, the differences in the husk tightness and husk extension values do not reflect an unexpected result from the perspective of a POSA. I also note that husk tightness and extension may be affected by the environmental conditions in which the plant is grown and are qualitative traits that are subject to interpretation. It is not apparent that there are any significant differences in such qualitative and environmentally-affected traits because the

the crop. It is used for identification purposes only and can be environmentally influenced.

'033 Patent lacks trial comparative data from the same environments relative to other inbreds of stated characteristics for these traits, which would be needed to reach a meaningful conclusion.

77. The next category “Ear (husked ear data)” includes characteristics related to the husked corn ear. *See* paragraph 63. Each of these characteristics falls within or is similar to the range established by Ross, Carlone, and Heffner. As reflected in Appendix B, the respective confidence intervals overlap for every characteristic for Carlone and Heffner and all but one characteristic for Ross. For example, 1PNZQ23’s ear length confidence intervals overlaps with that reported for Carlone and Heffner. None of the nominal differences reflect an unexpected result from the perspective of a POSA.

78. The next category “kernel” includes characteristics related to the dried kernel. *See* paragraph 63. Each of these characteristics falls within or is similar to the range established by Ross, Carlone, and Heffner.

79. The next category “cob” includes characteristics related to the cob. *See* paragraph 63. Each of these characteristics falls within or is similar to the range established by Ross, Carlone, and Heffner.

80. As previewed above, statistical analysis also confirms that the traits presented in the '033 Patent, Table 1, are not significantly different from the prior art. For most of the data types, Table 1 shows a value (*i.e.*, a mean) and a

standard error (SE). *See* EX1001, Table 1. With this information, it is possible to calculate a 95% confidence interval around the mean indicating, with 95% confidence, that the actual value falls within that interval.

81. When using standard error, the “95% confidence interval is obtained as the values $1.96 \times \text{SE}$ either side of the mean.” EX1035, Altman, “Standard deviations and standard errors,” *Brit. Med. J.*, 331:903 (2005).

82. If a number falls outside of the 95% confidence interval, that provides an indication that the value is at a commonly accepted level of difference to be considered statistically different from the reported value. On the other hand, if a value is inside of that range, then it is not shown to be statistically different. It should be noted that these statistical difference calculations are highly conservative as the confidence intervals are based on the environmental variation in the data used to make the measurement determination but do not consider the increased variation expected when measurements are taken from several diverse environments not represented in the statistical information provided on each of the referenced measurements. In other words, the confidence interval ranges would be even broader (and the overlap between the varieties greater) if the calculations accounted for this additional degree of environmental variation.

83. The values reported in Ross and Carlone provide a value, standard deviation, and number of measurements, rather than value and standard error.

This data may be used to generate standard error using the formula: $SE = SD/\sqrt{(\text{sample size})}$. EX1035, Altman. Then, the 95% confidence interval may be calculated as $\pm 1.96 \times SE$, as described above. This analysis omits traits for which there is no statistical information, such as colors and integer values for ear position, husk tightness, and the like.

84. The results are presented in Appendix B. As shown in Appendix B, the confidence intervals for Heffner overlap the confidence intervals for the '033 Patent in almost every line, indicated by the green highlighting. The only exceptions are number of nodes above ground and flag leaf length. However, the number of nodes are similar to that reported for each of Ross and Carlone, demonstrating that the value is not unexpected. Similarly, the flag leaf length falls between that reported in Heffner and that reported in Ross and Carlone, again demonstrating that the value is not unexpected. Moreover, there is no indication that the slight differences have practical significance. Indeed, the '033 Patent's specification does not indicate any such significance—much less suggest the differences constitute a surprising or unexpected result. In addition, the genetic analysis selection criteria described in the selection of the line of the '033 Patent, which I would have assumed to be among the primary breeding objectives for this breeding project, did not refer to any of these traits. *See* EX1001, 37:64-66 (“ears were selected based on genetic analysis predicting disease, insect, and agronomic

phenotypic performance”). In fact, the values provided in the ’033 Patent’s specification reflect to a POSA pretty poor indication of any breeding changes, much less progress.

85. Notably, this analysis is highly conservative in that it assumes for the sake of analysis that the data sets are comparable as well as repeatable (despite the different growing conditions that the datasets are likely to have come from).

3. Level of Ordinary Skill in the Art

86. The level of skill in the art in the corn breeding field as of 2021 was high. *See* Section III. Consistent with that high level of skill and the routine nature of crossing inbred lines to create new varieties, including crossing inbreds to create other inbreds with similar characteristics to the parent inbred, the Patent Owner itself repeatedly used the PH1VKM variety (disclosed in Ross) and the PH2DYM variety (disclosed in Carlone) as a parent line when breeding other maize varieties.

87. The PH1KVM (disclosed in Ross) and PH2DYM (disclosed in Carlone) varieties were repeatedly used as parental lines when breeding other corn varieties—as disclosed in at least nineteen other patents (EX1007, EX1036-EX1052, EX1057) that are indisputable §102(a)(1) prior art issued before 7/2/2020. (The total of nineteen is less than the sum of the number of patents associated with each parent individually (described in paragraphs 87-88) because

of the variety disclosed in Heffner sharing both parents.) Specifically, the PH1VKM variety (disclosed in Ross) is disclosed as a parent in at least four other patents, including one inbred patent (EX1007) and one hybrid patents (EX1057) issued more than one year before the '033 Patent's July 2, 2021 filing date, and another two inbred patents issued more recently and filed the same day as the '033 Patent (EX1053, EX1058), as reflected in the tables below.

Patent to Inbred Identifying PH1VKM Variety (disclosed in Ross) as a Parent Issued More Than One Year Before '033 Patent Filing Date		
Patent	Issuance Date	Breeding History
10,653,095 (EX1007) ("Maize inbred PH487D")	5/19/2020	38:55-61 ("Inbred Maize variety PH487D was developed by the following method. A cross was made between inbred line PH1VKM and inbred line PH2DYM. Inbred PH487D was developed by producing a doubled haploid from the F1 plants, selfing and using pedigree selection amongst the D1 lines, and selfing and bulking from the subsequent generations.")

Patent to Hybrid Identifying PH1VKM Variety (disclosed in Ross) as a Parent Issued More Than One Year Before '033 Patent Filing Date		
Patent	Issuance Date	Breeding History
9,737,020 (EX1057) ("Maize hybrid X08H753")	8/22/2017	15:12-14 ("Pioneer Brand Hybrid Maize Variety X08H753 is a single cross, yellow endosperm maize variety and can be made by crossing inbreds PHIV69 and PH1VKM.")

88. The PH2DYM variety (disclosed in Carlone) is disclosed as a parent in at least twenty-two other patents, including two inbred patents (EX1007 and EX1036) and sixteen hybrid patents (EX1037-EX1052) issued more than one year before the '033 Patent's July 2, 2021 filing date, and another four inbred patents issued more recently and filed the same day as the '033 Patent (EX1053-EX1056), as reflected in the tables below.

Patents to Inbreds Identifying PH2DYM Variety (disclosed in Carlone) as a Parent Issued More Than One Year Before '033 Patent Filing Date		
Patent	Issuance Date	Breeding History
10,653,095 (EX1007) ("Maize inbred PH487D")	5/19/2020	38:55-61 ("Inbred Maize variety PH487D was developed by the following method. A cross was made between inbred line PH1VKM and inbred line PH2DYM. Inbred PH487D was developed by producing a doubled haploid from the F1 plants, selfing and using pedigree selection amongst the D1 lines, and selfing and bulking from the subsequent generations.")
10,021,846 (EX1036) ("Maize inbred PH2WSG1")	7/17/2018	18:58-64 ("Inbred Maize variety PH2WSG1 was developed by the following method. A cross was made between inbred line PHVNV and inbred PHPCW. Inbred PH2WSK1 was developed by producing a doubled haploid from the F1 plants, selfing and using pedigree selection amongst the D1 lines, and selfing and bulking from the subsequent generations.")

Patents to Hybrids Identifying PH2DYM Variety (disclosed in Carlone) as a Parent Issued More Than One Year Before '033 Patent Filing Date		
Patent	Issuance Date	Breeding History
10,420,308 (EX1037) ("Maize hybrid X13M671")	9/24/2019	15:16-18 ("Pioneer Brand Hybrid Maize Variety X13M671 is a single cross maize variety and can be made by crossing inbreds PH41 F0 and PH2DYM.")
10,368,514 (EX1038) ("Maize hybrid X08M642")	8/6/2019	15:13-15 ("Pioneer Brand Hybrid Maize Variety X08M642 is a single cross maize variety and can be made by crossing inbreds PH2S9H and PH2DYM.")
10,238,072 (EX1039) ("Maize hybrid X05M941")	3/26/2019	15:18-20 ("Pioneer Brand Hybrid Maize Variety X05M941 is a single cross maize variety and can be made by crossing inbreds PH41BB and PH2DYM.")
10,117,397 (EX1040) ("Maize hybrid X13H149")	11/6/2018	15:14-16 ("Pioneer Brand Hybrid Maize Variety X13H149 is a single cross, yellow endosperm maize variety and can be made by crossing inbreds PHV92 and PH2WSG1.")
10,085,408 (EX1041) ("Maize hybrid X13H147")	10/2/2018	15:14-16 ("Pioneer Brand Hybrid Maize Variety X13H147 is a single cross, yellow endosperm maize variety and can be made by crossing inbreds PH17TB and PH2DYM.")
9,986,706 (EX1042) ("Maize hybrid X13K509")	6/5/2018	15:14-16 ("Pioneer Brand Hybrid Maize Variety X13K509 is a single cross, yellow endosperm maize variety and can be made by crossing inbreds PH2SRD and PH2DYM.")

9,968,060 (EX1043) ("Maize hybrid X13K543")	5/15/2018	15:23-25 ("Pioneer Brand Hybrid Maize Variety X13K543 is a single cross, yellow endosperm maize variety and can be made by crossing inbreds PH24R7 and PH2DYM.")
9,955,657 (EX1044) ("Maize hybrid X13K478")	5/1/2018	15:13-16 ("Pioneer Brand Hybrid Maize Variety X13K478 is a single cross, yellow endosperm maize variety and can be made by crossing inbreds PH2DNP and PH2DYM.")
9,955,661 (EX1045) ("Maize hybrid X13H148")	5/1/2018	15:14-16 ("Pioneer Brand Hybrid Maize Variety X13H148 is a single cross, yellow endosperm maize variety and can be made by crossing inbreds PHPAR and PH2WSG1.")
9,936,664 (EX1046) ("Maize hybrid X05K698")	4/10/2018	15:14-16 ("Pioneer Brand Hybrid Maize Variety X05K698 is a single cross, yellow endosperm maize variety and can be made by crossing inbreds PH2FYF and PH2DYM.")
9,877,447 (EX1047) ("Maize hybrid X08H721")	1/30/2018	15:14-16 ("Pioneer Brand Hybrid Maize Variety X08H721 is a single cross, yellow endosperm maize variety and can be made by crossing inbreds PH17RD and PH2DYM.")
9,877,457 (EX1048) ("Maize hybrid X08K212")	1/30/2018	15:14-16 ("Pioneer Brand Hybrid Maize Variety X08K212 is a single cross, yellow endosperm maize variety and can be made by crossing inbreds PH25KM and PH2DYM.")
9,872,476 (EX1049) ("Maize hybrid X08K208")	1/23/2018	15:14-16 ("Pioneer Brand Hybrid Maize Variety X08K208 is a single cross, yellow endosperm maize variety and can be made by crossing inbreds PH25BF and PH2DYM.")

9,861,062 (EX1050) ("Maize hybrid X13H963")	1/9/2018	15:6-8 ("Pioneer Brand Hybrid Maize Variety X13H963 is a single cross, yellow endosperm maize variety and can be made by crossing inbreds PH251H and PH2DYM.")
9,861,058 (EX1051) ("Maize hybrid X08H734")	1/9/2018	15:14-16 ("Pioneer Brand Hybrid Maize Variety X08H734 is a single cross, yellow endosperm maize variety and can be made by crossing inbreds PH1KYY and PH2DYM.")
9,814,197 (EX1052) ("Maize hybrid X13H974")	11/14/2017	15:14-16 ("Pioneer Brand Hybrid Maize Variety X13H974 is a single cross, yellow endosperm maize variety and can be made by crossing inbreds PH1D84 and PH2DYM.")

89. Corn breeding indeed was a sophisticated science by 2021, with multi-disciplinary teams harnessing computational biology and sophisticated understandings of the corn genome (which had been sequenced in 2009, per EX1018, Schnable et al., "The B73 Maize Genome: Complexity, Diversity, and Dynamics," Science, 2009, 326:1112) to create new varieties incorporated desired phenotypical features. These breeding efforts focused not only on the hybrid varieties sold to farmers, but also the "inbred" varieties used as the basis to create future hybrids.

90. As stated in each of the '033 Patent, the virtually identical Heffner prior art disclosing an inbred sibling, "[a] continuing goal of maize breeders is to develop stable, high yielding maize varieties and hybrids that are agronomically sound with maximal yield over one or more different conditions and

environments.” EX1001, 1:23-26; EX1007, 1:23-26. Given the competitive nature of the market, constant evolution and improvement of a company’s inbred lines was a commercial imperative.

91. And the high level of skill in the modern corn breeding field confirms such capability—POSAs were capable of breeding inbred lines to create essentially any desired inbred phenotypical trait in descendent inbred lines, at least within the ranges made possible by the existing gene pool as confirmed by the existence of the trait in one or more preexisting corn varieties (as is the case with all of the identified characteristics in the ’033 Patent, as discussed in paragraphs 68-85 above). For example, changes in grain color could be incorporated via established techniques such as locus conversions. EX1005, 24:30-33 (“Desired traits that may be transferred through locus conversion include...grain color (white)”); EX1006, 24:20-23 (same); EX1007, 20:6-9 (same).

4. Secondary Considerations

92. The ’033 Patent’s specification does not suggest any purportedly unexpected results or other potential secondary considerations of non-obviousness. On the contrary, the minor variations reflected in the reported properties of the claimed variety as compared to prior art varieties are well within the bounds of what a POSA would expect in the ordinary course of plant breeding. The similarity in data as between the ’033 Patent and Heffner (i.e., disclosing a

cross of the same two parental lines) further confirms that the '033 Patent does not disclose any properties a POSA would view as unexpected.

93. Notably, the '033 Patent itself does not report comparative data that would be useful in assessing the performance or utility of the claimed variety. For example, Table 1 only shows values for the claimed variety and no comparative data. Table 1 also does not include characteristics such as seeding vigor or stand count that might be used to show superior characteristics for an inbred line, much less grain yield stalk quality, or other key agronomic traits of a commercial corn hybrid, nor does it list performance for the traits included in the genetic analysis-based section of disease, insect, and agronomic phenotypic performance. *See* EX1001, 38:10-39:27. The '033 Patent also does not report data about the performance of any hybrids developed from the claimed inbreds. Data about hybrids would be critical to determining the value and utility of the inbred. For example, the hybrid might be judged with respect to characteristics such as selection index, yield, percentage moisture, disease, insect, agronomic phenotypic performance, and percentage barren plants. None of these are presented in the '033 Patent.

B. Ground 1: Claims 1-20 Are Unpatentable as Obvious Over Ross (EX1005) and Carlone (EX1006)

94. Ross and Carlone disclose the two parent varieties of the 1PNZQ23 variety claimed in the '033 Patent.

95. Specifically, the '033 Patent discloses that 1PNZQ23 “originated from a cross between inbred line PH1VKM and inbred line PH2DYM.” EX1001, 37:62-64. PH1VKM was disclosed in Ross, and PH2DYM was disclosed in Carlone. *See* EX1005, 1:32-33; EX1006, 1:32-33.

96. Ross and Carlone disclose that each of PH1VKM and PH2DYM, can be used “to Develop Another Maize Plant” and in particular is a “source of breeding material that may be used to develop new maize inbred varieties.” EX1005, 36:63-37:1; EX1006, 36:58-63. Each also discloses specific cross breeding techniques for producing such “new inbred” varieties. EX1005, 5:54-60; EX1006, 5:57-63.

97. Ross discloses that it is beneficial to further breed PH1VKM:

The development of a maize hybrid in a maize plant breeding program involves three steps: (1) the selection of plants from various germplasm pools for initial breeding crosses; (2) the selfing of the selected plants from the breeding crosses for several generations to produce a series of varieties, such as PH1VKM, which, although different from each other, breed true and are highly uniform; and (3) crossing the selected varieties with different varieties to produce the hybrids. **During the inbreeding process in maize, the vigor of the varieties decreases, and so one would not be likely to use PH1VKM directly to produce grain. However, vigor is restored when PH1VKM is crossed to a different inbred variety to produce a commercial F1 hybrid.** An important consequence of the

homozygosity and homogeneity of the inbred variety is that the hybrid between a defined pair of inbreds may be reproduced indefinitely as long as the homogeneity of the inbred parents is maintained.

EX1005, 22:40-56 (emphasis added). Carlone includes the same disclosure with reference to PH2DYM. EX1006, 22:30-46.

98. Consistent with these disclosures, PH1VKM and PH2DYM had each repeatedly been used as one of the parents for other maize varieties: PH1VKM was used as one of the parents in at least three other inbred lines (one of them—Heffner, EX1007—indisputable §102(a)(1) art) and at least one indisputable, prior art hybrid line. PH2DYM was used as one of the parents in at least six other inbred lines (also including Heffner and a second indisputable prior art patent, U.S. 10,021,846, EX1036) and at least sixteen indisputable, prior art hybrid lines. Paragraphs 87-88 above includes a table reflecting such previous crosses.

99. As Ross and Carlone disclose and these other crosses confirm, POSAs would have had reason to use PH1VKM and PH2DYM as patent inbred varieties to create a new inbred line. Indeed, Heffner already taught exactly that combination. EX1007, 38:54-61. POSAs would have reasons to create a wide array of new varieties using PH1VKM and PH2DYM to develop improved varieties to market and to enhance commercial opportunities. It was routine in the industry to create multiple inbred lines using the same two parental varieties (as Heffner already disclosed).

100. POSAs would have had a reasonable expectation of obtaining an inbred maize variety with PH1VKM and PH2DYM as parents, particularly given (1) the routine nature of the breeding techniques involved and (2) the multiple other instances already reported in which PH1VKM and/or PH2DYM had been used to breed other lines, including at least one indisputable prior art inbred line having both PH1VKM and PH2DYM as parents (Heffner).

1. Claim 1: Variety 1PNZQ23

101. Claim 1 encompasses a seed, plant part, or plant cell of variety 1PNZQ23. Variety 1PNZQ23's disclosed characteristics are highly similar to those in the PH1VKM and PH2DYM parents, and nothing in the specification or otherwise in the record suggests any property that a POSA familiar with well-known breeding techniques and the prior art as described herein would have viewed as surprising or unexpected over PH1VKM and PH2DYM. *See* paragraphs 63, 69-85 above. The record does not explain the significance of any differences between the claimed variety and known varieties. To the extent such differences exist, there is no basis from which to conclude they are significant or unexpected as compared to the PH1VKM and PH2DYM varieties disclosed in Ross and Carlone and touted in Ross and Carlone as a potential starting point for future inbred lines.

102. Indeed, none of the differences have any material commercial significance. In particular, none of them are relevant to the underlying goal identified in the '033 Patent of developing “stable, high yielding maize varieties and hybrids that are agronomically sound with maximal yield over one or more different conditions and environments.” EX1001, 1:23-26. Nor are they relevant to the nature of the '033 Patent's disclosed “Industrial Applicability.” EX1001, 36:21-65.

103. Statistical analysis of the '033 Patent data shows that most of the reported characteristics for the '033's 1PNZQ23 overlap with the values reported in Ross and Carlone for PH1VKM and PH2DYM when 95% confidence intervals are calculated (e.g., within 1.96 x standard error).

104. It was well-known in the art to cross inbreds to create other inbreds with similar characteristics to the parent inbreds and/or characteristics falling anywhere between the characteristics of the parent inbreds. Moreover, comparing the data presented in the '033 Patent with that in Heffner confirms that virtually all reported values (23 out of 25) overlap at the 95% confidence interval. *See* Appendix B. Put differently, the properties of the corn plants reported in the '033 Patent based on a cross of Ross and Carlone track what a POSA would have expected based on the data disclosed in Heffner—the prior art patent disclosing an earlier cross of Ross and Carlone.

105. The small number of non-overlapping values—in the case of Heffner, merely (1) number of nodes above ground and (2) flag leaf length¹⁰—are no basis from which to conclude that variety 1PNZQ23 is patentable, especially when environmental impact data is not provided. For one, even those categories falling outside of the 95% confidence intervals do not necessarily reflect a statistical difference in the values. The reported standard error only reflects the variation among a particular sample of the variety. It does not take into account the variation that would be expected for samples of the variety grown in different locations (but within a similar geographic area), which would be expected to be even larger. Nor does it account for variation expected for different geographic locations or different years, each of which would be expected to be larger again. Accordingly, the apparent differences in certain values do not necessarily indicate a statistical difference.

106. Further, the characteristics in question lack any material commercial significance. In particular, none of them are relevant to the '033 Patent's underlying goal of developing “stable, high yielding maize varieties and hybrids that are agronomically sound with maximal yield over one or more different

¹⁰ Similarly, as compared to Carlone, the categories not overlapping are ear height, length of top ear internode, tassel length, central spike length, and flag leaf length.

conditions and environments.” EX1001, 1:23-26. Nor are they relevant to the nature of the ’033 Patent’s disclosed “Industrial Applicability.” EX1001, 36:21-65. And nothing in the ’033 Patent’s specification suggests any reason why such differences were sufficiently significant or unexpected as to weigh more heavily than the numerous similarities between the 1PNZQ23 variety on the one hand and Ross and Carlone on the other.

107. Because the ’033 patent presents no data on hybrid crosses of the ’033 Patent, it is impossible to determine the degree to which any variation in such characteristics would be inherited by hybrid crosses of the 1PNZQ23 and, to the extent it is inherited, what impact it has on performance of the hybrid cross. The traits are only commercially relevant if they impact yield or other valued hybrid characteristics. This is because, as discussed below at paragraphs 150-155, even those characteristics that are specifically relevant in an inbred crop (e.g., those that improve seed production) are ultimately valuable to the extent they provide seed that will yield a satisfactory hybrid crop. In any event, there is no showing that the varieties claimed in the ’033 Patent provide improved hybrid producibility or any relevant inbred trait.

108. I have been informed that the Examiner distinguished the claimed 1PNZQ23 over the prior art on the basis that, as compared to a prior art inbred line, 1PNZQ23 “exhibits distinct aleurone color and genetic background.” These

distinguishing features are not a basis to distinguish the '033 Patent's 1PNZQ23 from Ross and Carlone for the following reasons:

- a. Aleurone Color. 1PNZQ23 is described as having a clear aleurone color, whereas Ross and Carlone have yellow aleurone color.¹¹ In any event, for many applications, the color of the aleurone is entirely irrelevant. Whether or not the aleurone color matters at all depends in part on the color of the endosperm.¹² The color of the endosperm and aleurone together have some relevance to a food-grade crop because some customers may prefer to use either white corn or yellow corn for consistency of a product's appearance. In the case of white food grade corn, a clear aleurone may be preferred so as not to

¹¹ Aleurone refers to a separate internal layer closer to the surface (the kernel pericarp), but still not exposed. *See* EX1034, Merriam-Webster, 30 (definition of "aleurone" "protein matter in the form of minute granules or grains occurring in seeds in endosperm or in a special peripheral layer").

¹² Endosperm refers to a corn seed's starchy interior. *See* EX1034, Merriam-Webster, 412 (definition of "endosperm" "a nutritive tissue in seed plants formed within the embryo sac by division of the endosperm nucleus").

give a yellow color to the product. However, the 1PNZQ23 has yellow endosperm, so the product would also be yellow, regardless of the clear color of the aleurone. Ross and Carlone each disclose yellow endosperm and aleurone. Accordingly, the combination of yellow endosperm and clear aleurone for 1PNZQ23 does not constitute a material difference over Ross and Carlone. Additionally, a POSA would understand that it is possible to obtain clear aleurone from a cross of Ross and Carlone because Heffner – also a cross of Ross and Carlone – discloses clear aleurone for the PH487D variety. Thus, a POSA would understand that aleurone color differences in the discussed range represent a trait that would be easily incorporated in a corn variety by a POSA, as confirmed by Heffner’s disclosure regarding the same breeding cross itself. Furthermore, reported aleurone values can vary depending on location/environmental effects or differences in the qualitative assessments made by various observers. While not necessary for my conclusion, it may well be the case that Ross, Carlone, and 1PNZQ23 would all yield exactly the same aleurone shade if grown under the same conditions and assessed by the same observer.

- b. Genetic Background. The '033 Patent's 1PNZQ23 was bred from a cross of Ross's PH1VKM and Carlone's PH2DYM. EX1001, 37:62-64. Accordingly, 1PNZQ23 shares its genetic background with Ross's PH1VKM and Carlone's PH2DYM.

109. As discussed above at paragraphs 68-85, each of the characteristics shown in the '033 Patent, Table 1 is comparable to the prior art, is not technically or economically relevant, or both, even without taking into consideration the increased variance from comparison of data collected across multiple uncharacterized environments.

110. Accordingly, claim 1 would have been obvious over Ross and Carlone.

2. Claims 2-20: Variations and Hybrids Related to 1PNZQ23

111. Claims 2-20 likewise would have been obvious over Ross and Carlone. They recite variations, hybrids, and related methods concerning the claimed inbred line. Claims 2-20 indeed essentially mirror the claim set in Heffner (EX1007), confirming that using and/or modifying inbred lines produced by crossing PH1VKM (i.e., Ross) and PH2DYM (i.e., Carlone)—as already disclosed in Heffner—in those ways would have been obvious.

Claim 1

A seed, plant, plant part, or plant cell of inbred maize variety 1PNZQ23, representative seed of the variety having been deposited under NCMA accession number 202301024.

Claim 2
The plant part of claim 1, wherein the plant part is an ovule or pollen.
Claim 3
An F1 hybrid maize seed of 1PNZQ23 produced by crossing the plant or plant part of claim 1 with a different maize plant.
Claim 4
An F1 hybrid maize plant or plant part produced by growing the maize seed of claim 3, wherein the plant part comprises at least one somatic cell of the F1 hybrid maize plant of 1PNZQ23.
Claim 5
A method for producing a second maize plant, the method comprising applying plant breeding techniques to the F1 plant or plant part of claim 4 to produce the second maize plant.
Claim 6
A method for producing a second maize plant or plant part, the method comprising doubling haploid seed generated from a cross of the plant or plant part of claim 4 with an inducer variety, thereby producing the second maize plant or plant part.
Claim 7
A method of making a commodity plant product comprising silage, starch, fat, syrup or protein, the method comprising producing the commodity plant product from the maize plant or plant part of claim 4.
Claim 8
A method of producing a maize seed derived from the variety 1PNZQ23, comprising:
a) crossing the plant of claim 1 with itself or a second plant to produce progeny seed; and
b) growing the progeny seed to produce a progeny plant and crossing the progeny plant with itself or a different plant to produce maize seed derived from the variety 1PNZQ23.
Claim 9
A method for producing nucleic acids, the method comprising isolating nucleic acids from the seed, plant, plant part, or plant cell of claim 1.

Claim 10
A converted seed, plant, plant part or plant cell of inbred maize variety 1PNZQ23, representative seed of the maize variety 1PNZQ23 having been deposited under NCMA accession number 202301024,
wherein the converted seed, plant, plant part or plant cell comprises a locus conversion, and
wherein the plant or a plant grown from the converted seed, plant part or plant cell comprises the locus conversion and otherwise comprises all of the physiological and morphological characteristics of maize variety 1PNZQ23 when grown under the same environmental conditions.
Claim 11
The converted seed, plant, plant part or plant cell of claim 10, wherein the locus conversion confers a property selected from the group consisting of male sterility, site-specific recombination, abiotic stress tolerance, altered phosphate, altered antioxidants, altered fatty acids, altered essential amino acids, altered carbohydrates, herbicide tolerance, insect resistance and disease resistance.
Claim 12
A maize seed produced by crossing the plant or plant part of claim 10 with a different maize plant.
Claim 13
A hybrid maize plant or plant part produced by growing the seed of claim 12, wherein the plant part comprises at least one cell of the hybrid maize plant.
Claim 14
A method for producing a second maize plant, the method comprising applying plant breeding techniques to the plant or plant part of claim 13 to produce the second maize plant.
Claim 15
A method for producing a second maize plant or plant part, the method comprising doubling haploid seed generated from a cross of the plant or plant part of claim 13 with an inducer variety, thereby producing the second maize plant or plant part.
Claim 16
A method of making a commodity plant product comprising silage, starch, fat, syrup or protein, the method comprising producing the commodity plant product from the maize plant or plant part of claim 13.

Claim 17
A method for producing nucleic acids, the method comprising isolating nucleic acids from the seed, plant, plant part, or plant cell of claim 10.
Claim 18
An F1 hybrid seed of 1PNZQ23 produced by crossing a plant or plant part of inbred maize variety 1PNZQ23
further comprising a transgene, representative seed of the inbred maize variety 1PNZQ23 having been deposited under NCMA accession number 202301024 with a different maize plant,
wherein the transgene is inherited by the F1 hybrid seed,
wherein the transgene was introduced into inbred maize variety 1PNZQ23 by backcrossing or genetic transformation.
Claim 19
A method of producing progeny seed, the method comprising crossing a plant grown from the seed of claim 18 with itself or a second plant to produce progeny seed.
Claim 20
A method of making a commodity plant product comprising silage, starch, fat, syrup or protein, the method comprising producing the commodity plant product from a maize plant or plant part of grown from the F1 hybrid seed of claim 18.

a. Claim 2: Ovule or Pollen From 1PNZQ23

112. Claim 2 depends from claim 1 and requires that “the plant part” be “an ovule” or “pollen.” EX1001, 39:34-35. Ross and Carlone disclose that maize plant parts include ovules and pollen. EX1005, 1:52-54; EX1006, 1:52-54. Each also include claims stating “the plant part is an ovule or pollen.” EX1005, 46:46-47; EX1006, 48:27-28. POSAs would have recognized that inbred lines created from Ross and Carlone likewise include both ovules and pollen. Similarly, Heffner (disclosing a prior art cross of Ross and Carlone) likewise has an

analogous dependent claim, further confirming the obviousness of claim 2.

EX1007, 40:22-23.

b. Claims 3-8: Hybrids Derived From 1PNZQ23 and Methods Related to Such Hybrids

113. Claim 3 is to “[a]n F1 hybrid maize seed of 1PNZQ23 produced by crossing the plant or plant part of claim 1 with a different maize plant.” EX1001, 39:37-39. Ross and Carlone disclose that hybrids are generated by crossing two inbred varieties (such as PH1VKM and PH2DYM, respectively—see EX1005, 11:41-42, 36:64-65; EX1006, 11:39-40, 36:59-60), and further that “F1” hybrids—the “first generation” of the cross—are desired because they are “more vigorous than their inbred parents.” EX1005, 22:19-24; EX1006, 22:10-14. Claim 3 is obvious in view of these disclosures in addition to the above-discussed reasons concerning claim 1. POSAs would have had reason to create the 1PNZQ23 inbred variety using PH1VKM and PH2DYM, and would further have had reason to use that inbred variety to create F1 hybrid seeds for commercialization.

114. Claim 4 is to a plant or plant part produced by growing the F1 hybrid seed of claim 3, and in particular to “at least one somatic cell of the F1 hybrid maize plant of 1PNZQ23.” It is obvious for the same reasons as claim 3 given that the purpose of creating an F1 hybrid seed is to grow an F1 hybrid plant. In its relevant sense, “somatic” is defined as “of, relating to, or affecting the body

esp[ecially] as distinguished from the germ plasm.” EX1073, Merriam-Webster’s Ninth New Collegiate Dictionary (1984) (defining somatic). “Somatic” does not narrow claim 4 in any significant way because a “[a]n F1 hybrid maize plant or plant part produced by growing the maize seed of claim 3,” which is an F1 hybrid maize seed of 1PNZQ23 (as provided in claim 3, from which claim 4 depends), will necessarily include a somatic cell of the F1 hybrid maize plant of 1PNZQ23. In short, a plant grown from a seed of a given variety has somatic cells of that variety.

115. Claim 5 concerns “[a] method for producing a second maize plant” by “applying plant breeding techniques to the F1 plant or plant part of claim 4.” Claim 5 would have been obvious given Ross’s and Carlon’s disclosure that plant breeding techniques can be used to cross an “F1 hybrid” with either another F1 hybrid or another inbred line. EX1005, 22:27-39; EX1006, 22:17-29.

116. Claim 6 concerns “[a] method for producing a second maize plant or plant part, the method comprising doubling haploid seed generated from a cross of the plant or plant part of claim 4 with an inducer variety.” Claim 6 would have been obvious for the same reasons as claim 5 and in further view of Ross’s and Carlone’s disclosures of the use of “Haploid induction systems” for maize in which “haploid plants from any genotype” may be created “by crossing a selected variety (as female) with an inducer variety.” EX1005, 38:60-39:6; EX1006,

38:56-39:2. Ross's and Carlone's claim 7 likewise parallels challenged claim 6 and further confirm the obviousness of crossing an inbred maize line, F1 hybrid or other derived breeding materials with an inducer variety to produce haploid seed. EX1005, 46:61-65; EX1006, 48:43-47.

117. Claim 7 concerns "[a] method of making a commodity plant product comprising silage, starch, fat, syrup or protein, the method comprising producing the commodity plant product from the maize plant or plant part of claim 4."

Claim 7 would have been obvious for the same reasons as claim 4 in further view of Ross's and Carlone's disclosure "of harvesting the grain of the F1 plant of variety [PH1VKM/PH2DYM] and using the grain in a commodity," such as "starches, syrups, proteins, ...and sugars." EX1005, 42:9-15; EX1006, 42:7-13.

POSAs would have understood that F1 hybrids created from the inbred line of claim 1 (which would have been obvious as discussed above) could be used for the same generic application. Ross's and Carlone's respective claims 8 likewise parallel challenged claim 7 and further confirms the obviousness of crossing an inbred maize line with an inducer variety to produce haploid seed. EX1005, 46:66-47:2; EX1006, 48:47-51.

118. Claim 8 concerns "[a] method of producing a maize seed derived from the variety 1PNZQ23, comprising: (a) crossing the plant of claim 1 with itself or a second plant to produce progeny seed; and (b) growing the progeny seed

to produce a progeny plant and crossing the progeny plant with itself or a different plant to produce maize seed derived from the variety 1PNZQ23.” Claim 8 would have been obvious for the same reasons as claim 5, which concerns a more specific method of generating a second-generation progeny plant derived from 1PNZQ23 using an F1 hybrid as the first-generation plant. EX1005, 47:3-12 (Ross’s substantially identical claim 9); EX1006, 48:52-61 (Carlone’s substantially identical claim 9).

119. Claims 3-8 likewise mirror claims 3-8 in Heffner—further confirming that it would have been obvious to use the 1PNZQ23 variety (itself obvious as detailed in V.A.B.1, and based on a cross of the same two parental inbred lines disclosed in Heffner) for hybridization purposes as claims 3-8 specify.

c. Claim 9: Nucleic Acids Isolated From 1PNZQ23

120. Claim 9 concerns “[a] method for producing nucleic acids” by “isolating nucleic acids from the seed, plant, plant part, or plant cell of claim 1.” Claim 9 would have been obvious for the same reasons as claim 1 in view of a POSA’s knowledge that it was routine to isolate nucleic acids from inbred maize lines—as confirmed by Ross and Carlone. EX1005, 14:55-57 (defining nucleic acid as “[a]n acidic, chainlike biological macromolecule...”); 47:13-15 (claim including “isolating nucleic acids from the seed, plant, plant part, or cell”); EX1006, 14:50-52, 48:62-64. Heffner likewise has an analogous dependent

claim—further confirming that there was nothing inventive about isolating nucleic acids from inbred corn plants, including crosses of Ross and Carlone as disclosed in Heffner. EX1007, 40:50-52.

d. Claims 10-17: Converted Seeds of 1PNZQ23

121. Claim 10 concerns “[a] converted seed, plant, plant part or plant cell of inbred maize variety 1PNZQ23” with “a locus conversion” such that “the plant or a plant grown form from the converted seed, plant part or plant cell comprises the locus conversion and otherwise comprises all of the physiological and morphological characteristics of maize variety 1PNZQ23 when grown under the same environmental conditions.”

122. Claim 10 would have been obvious for the same reasons as claim 1 (concerning variety 1PNZQ23) in further view of a POSA’s knowledge that locus conversions such as those recited in claim 10 were a routine technique to incorporate desirable traits into inbred maize lines— as further confirmed by Ross’s and Carlone’s disclosure that “[o]ne or more locus conversion traits” such as “male sterility, insect resistance, disease resistance or herbicide tolerance” can “be introduced into a single corn variety.” EX1005, 13:48-57; EX1006, 13:43-52; see also EX1005, 47:16-25 (substantially identical claim 11); EX1006, 48:65-49:8 (same); EX1005, 47:26-32 (claim to seed, plant, plant part or cell of claimed inbred variety with “a locus conversion” that “confers a property”); EX1006,

49:9-15 (same). Further, locus conversion technology was sufficiently advanced such that the additional trait(s) could be introduced without impacting the plant's "physiological and morphological characteristics."

123. Claim 11 depends from claim 10 and requires that the "confers a property selected from the group consisting of male sterility, site-specific recombination, abiotic stress tolerance, altered phosphate, altered antioxidants, altered fatty acids, altered essential amino acids, altered carbohydrates, herbicide tolerance, insect resistance and disease resistance." Claim 11 is obvious in view of Ross's and Carlone's respective claims 12, which are substantially identical. EX1005, 47:26-32; EX1006, 49:9-15. Ross and Carlone teach that "[o]ne or more locus conversion traits" such as "male sterility, insect control, disease control or herbicide tolerance" can "be introduced into a single corn variety." EX1005, 13:48-57; EX1006, 13:43-52. Ross and Carlone also separately discuss developing each of the properties recited in claim 11. EX1005, 30:11-36:51; EX1006, 30:4-36:46. Ross and Carlone use the term "altered phosphorus" where claim 11 refers to "altered phosphate." Both are referring to the same thing: phosphorus is an element that is obtained and used by plants as phosphate (i.e., phosphate ion (PO_4^{3-}), hydrogen phosphate ion (HPO_4^{2-}), or dihydrogen phosphate ion (H_2PO_4^-)). *See* EX1033 (defining phosphorus and phosphate). "[A]ltered phosphorus" or "altered phosphate" refers to improving the ability of the plant to

use phosphorus efficiently. See EX1005, 34:28-31 (referring to “[a]ltered phosphorus content” by introduction of a gene “adding more free phosphate”). It has long been appreciated that improving a corn variety’s ability to use phosphorus efficiently can reduce the amount of phosphorus to be added via fertilizers. See also EX1065, Fageria, “Phosphorus-Use Efficiency by Corn Genotypes,” J. Plant Nutrition, 20:1267, 1276 (1997) (“Phosphorous (P) deficiency is a principal yield-limiting factor for annual crop production in acid soils of temperate as well as tropical regions.”; “The use of P-efficient genotypes to increase and/or stabilize crop production has become increasingly attractive in recent years due to the high cost of fertilizers and to pollution problems.”).

124. Claims 12-17 depend directly or indirectly from claim 10 and otherwise parallel the limitations of claims 3-7 and 9, respectively. They would have been obvious for the same reasons as claim 10 and in further view of the above-discussed reasons why dependent claims 3-7 and 9 would have been obvious. The above discussions apply equally to converted seeds incorporating locus conversions, which impart additional properties but otherwise do not impact the variety or how it can be used.

125. Claims 10-17 likewise mirror claims 10-17 in Heffner—further confirming that it would have been obvious to use the 1PNZQ23 variety (itself obvious as detailed in V.A.B.1, and based on a cross of the same two parental

inbred lines disclosed in Heffner) for purposes of making and using converted seed as claims 10-17 specify. EX1007, 40:53-42:3.

e. Claims 18-20: F1 Hybrid Derived From Variety 1PNZQ23 with a Transgene

126. Much like dependent claim 3, claim 18 recites an F1 hybrid seed produced by crossing a plant or plant part of 1PNZQ23 with another variety. However, it includes the additional requirement that (1) “1PNZQ23 further compris[es] a transgene”; (2) “the transgene is inherited by the F1 hybrid seed;” and (3) the transgene was incorporated by “backcrossing or genetic transformation.” As Ross and Carlone disclose, incorporating a transgene into a corn variety is one particular technique for incorporating a locus conversion (as discussed in connection with claim 10). EX1005, 13:48-57; EX1006, 13:43-52. Ross and Carlone also disclose that backcrossing is a technique for incorporating locus conversions in general and transgenes in particular. EX1005, 23:62-67; EX1006, 23:52-57. Claim 18 would have been obvious for the same reasons as above-discussed claims 3 and 10 and in further view of these additional disclosures in Ross and Carlone.

127. Claim 19 concerns “[a] method of producing progeny seed” by “crossing a plant grown from the seed of claim 18 with itself or a second plant to produce progeny seed.” It parallels above-discussed claim 5 aside from (1) the more specific requirement concerning the nature of the starting F1 hybrid seed;

and (2) the fact that claim 19 refers to “progeny seed” rather than a “plant” itself. Claim 19 accordingly would have been obvious for the reasons discussed above in connection with claims 5 and 19.

128. In particular, POSAs would have understood that Ross’s and Carlone’s disclosures of crossing an “F1 hybrid” with either another F1 hybrid or another inbred line (EX1005, 22:57-67; EX1006, 22:47-57) was applicable to F1 hybrids created by crossing inbred varieties incorporating transgenes.

129. Claim 20 parallels claim 7 (i.e., “[a] method of making a commodity plant product....”) aside from reciting the plant of claim 18 rather than claim 4. Claim 20 would have been obvious for the same reasons as claim 7.

130. Claims 18-20 likewise mirror claims 18-20 in Heffner—further confirming that it would have been obvious to use the 1PNZQ23 variety (itself obvious as detailed in V.A.B.1, and based on a cross of the same two parental inbred lines disclosed in Heffner) for purposes of making and using an F1 hybrid seed incorporating a transgene as claims 18-20 specify. EX1007, 42:4-19.

C. Ground 2: Claims 1-20 Are Unpatentable as Obvious Over Heffner (EX1007)

131. Heffner discloses PH487D—a prior art inbred variety created by crossing the same two parents (the varieties disclosed in Ross and Carlone) as were crossed to create the claimed 1PNZQ23 and having very similar properties to those of the 1PNZQ23. EX1001, 37:62-64; EX1007, 38:55-61; above, paragraphs

63, 69-75, Appendix B, EX1102. Accordingly, Heffner teaches POSAs to prepare an inbred variety, similar to the claimed variety, by crossing the same two parent varieties.

132. Heffner was not the basis of a rejection during examination, despite its identical parentage, substantially identical disclosures, and highly similar traits as compared to the '033 Patent. EX1002, 95-102; *see also* EX1102 (redline comparison). Indeed, despite Heffner's genotypical and phenotypical similarities, the Examiner inexplicably stated that "[t]he closest prior art is US Patent Number 9,930,848." EX1002, 101.

133. Heffner also discloses that PH487D can be used "to Develop Another Maize Plant" and in particular is a "source of breeding material that may be used to develop new maize inbred varieties." EX1007, 32:36-41. It also discloses specific cross breeding techniques for producing such "new inbred" varieties. *Id.*, 5:37-44.

134. Consistent with these disclosures, PH487D was previously used as one of the parents for another maize variety. EX1060, 11:19-21.

135. As Heffner itself discloses and the other prior art cross confirms, POSAs would have had reason to use PH487D as the starting point to create other maize varieties as recited in certain dependent claims (*see, e.g.*, EX1001, 39:37-52

(claims 3-6)). The nature of the maize market confirms the reasons to create a wide array of new varieties using PH487D as the starting point.

136. POSAs would have had a reasonable expectation of obtaining an additional maize varieties with PH487D as a parent, particularly given (1) the routine nature of the breeding techniques involved, (2) Heffner's disclosure that its claimed variety can be "used to develop hybrids for commercialization" and also "used to develop new maize inbred varieties" (EX1007, 17:40-43, 32:37-41) and (3) the previous instance already reported in which PH487D had been used as a parent to obtain another line (EX1060, 11:19-21).

1. Claim 1

137. Claim 1 encompasses a seed, plant part, or plant cell of variety 1PNZQ23. 1PNZQ23's disclosed characteristics are at a minimum highly similar to its sibling PH487D's characteristics as disclosed in Heffner, and nothing in the '033 Patent's specification or otherwise in the intrinsic record suggests any property of 1PNZQ23 that POSAs would have viewed as surprising or unexpected over PH487D. *Supra* §IX.A.2.

138. Comparing the values disclosed in Heffner with their 95% confidence intervals against the 95% confidence intervals for the values disclosed in the '033 Patent shows that 23 of the 25 values fall within the confidence intervals. *See* Appendix B (green highlighting indicating values within range). This

demonstrates that the differences for most measurements are likely not statistically significant. The only characteristics falling outside the 95% confidence interval are: number of nodes above ground and flag leaf length. *See* Appendix B. However, there is no indication, even if these characteristics are physically different, that the differences have any meaning to the performance of the plant or have any commercial significance. Of course, it remains unclear the degree to which any difference may be due to difference in growing conditions and location for the samples. In any event, as discussed for the respective characteristics at paragraphs 68-85, the values for 1PNZQ23 all fall within or are similar to the ranges established by the prior art.

139. The record does not explain the significance of any differences between the claimed variety and known varieties. To the extent such differences exist, there is no basis from which to conclude they are significant or unexpected as compared to the PH487D variety disclosed in Heffner and touted therein as a potential starting point for future inbred lines. Indeed, none of the differences have any material commercial significance. In particular, none of them are relevant to the underlying goal identified in the '033 Patent of developing “stable, high yielding maize varieties and hybrids that are agronomically sound with maximal yield over one or more different conditions and environments.”

EX1001, 1:23-26. Nor are they relevant to the nature of the '033 Patent's disclosed "Industrial Applicability." EX1001, 36:21-65.

140. Again considering the two characteristics relied upon by the Examiner (see paragraph 108), I conclude that these features are not a basis to distinguish the '033 Patent's 1PNZQ23 from Heffner's PH487D for the following reasons:

- a. Aleurone Color. 1PNZQ23 and PH487D both have clear aleurone. See paragraph 63. As described above at paragraph 108, because 1PNZQ23 has yellow endosperm and thus a product would also be yellow, the combination of yellow endosperm and clear aleurone for 1PNZQ23 does not constitute a material difference over Heffner's clear aleurone and yellow endosperm.
- b. Genetic Background. The '033 Patent's 1PNZQ23 and Heffner's PH487D were both bred from the same two parents. EX1001, 37:62-64; EX1007, 38:56-57. Accordingly, 1PNZQ23 and PH487D share common genetic background. In any event, the '033 Patent does not disclose the genome of the 1PNZQ23 and does not identify any particular degree of similarity or difference as relevant.

141. As discussed above at paragraphs 69-85, each of the characteristics shown in the '033 Patent, Table 1 is either within the range established by the

prior art, is not technically or economically relevant, or both. Accordingly, claim 1 would have been obvious over Heffner.

2. Claims 2-20

142. Claims 2-20 are likewise unpatentable as obvious over Heffner for the same reasons detailed immediately above concerning claim 1 and for the additional reasons explained in §IX.B.2 concerning why claims 2-20 are obvious over Ross and Heffner indeed has disclosures paralleling the disclosures in Ross and Carlone identified in §IX.B.2 concerning claims 2-20. In particular:

	Relevant Disclosures in Heffner (EX1007)
Claim 2	12:35-42 (“plant part” includes “pollen” and “ovule”); 40:22-23 (“The plant part of claim 1, wherein the plant part is an ovule or pollen”)
Claims 3-4 and 12-13	18:12-20 (“F1 hybrids” sought as “commercial hybrids” because they “are more vigorous than their inbred parents”)
Claims 5, 14, and 19	18:57-60 (disclosing crossing “F1 hybrid” with “third inbred”)
Claims 6 and 15	34:20-24 (disclosing “[h]aploid induction systems” in which “haploid plants from any genotype” may be created “by crossing a selected variety (as female) with an inducer variety”)

	Relevant Disclosures in Heffner (EX1007)
Claims 7, 16, and 20	37:55-60 (“The seed of maize variety PH487D, the plant produced from the seed, the hybrid maize plant produced from the crossing of the variety, hybrid seed, and various parts of the hybrid maize plant and transgenic versions of the foregoing, can be utilized for human food, livestock feed, and as a raw material in industry.”)
Claim 8	18:57-60 (disclosing crossing “F1 hybrid” with “third inbred”); 40:29-32 (claim 5)
Claim 10	18:4-7 (“locus conversion of PH487D for herbicide tolerance”); 18:7-9 (“locus conversion for insect or disease resistance”); 19:38-40 (“PH487D represents a new base genetic variety into which a new locus may be introgressed”); 11:2-31 (“A locus conversion refers to plants within a variety that have been modified in a manner that retains the overall genetics of the variety and further comprises one or more loci with a specific desired trait...”); 20:27-32 (“At least one, at least two or at least three and less than ten, less than nine, less than eight, less than seven, less than six, less than five or less than four locus

	Relevant Disclosures in Heffner (EX1007)
	conversions may be introduced into the plant by backcrossing, introgression or transformation to express the desired trait”)
Claim 11	11:22-31 (“A locus conversion ...comprises one or more loci with a specific desired trait, such as male sterility, insect resistance, disease resistance or herbicide tolerance or resistance.”); 40:64-41:3 (“locus conversion confers a property selected from the group consisting of male sterility, site-specific recombination, abiotic stress tolerance, altered phosphate, altered antioxidants, altered fatty acids, altered essential amino acids, altered carbohydrates, herbicide tolerance, insect resistance and disease resistance”)
Claim 18	11:28-30 (“Examples of single locus conversions include... transgenes”); 20:40-42 (“Transgenes transferred via backcrossing typically function as a dominant single gene trait and are relatively easy to classify.”); 26:1-32:35 (identifying particular types of transgenes)

143. Heffner’s own claims 2-20 likewise parallel Challenged Claims 2-20—further confirming that it would have been obvious not only to cross the two

parental inbred lines disclosed in Heffner, but also to use the resulting inbred line as the basis for the routine practices recited in claims 2-20:

Claim in '033	Corresponding Claim in Heffner
2	2 (EX1007, 40:22-23)
3	3 (40:24-25)
4	4 (40:26-28)
5	5 (40:29-32)
6	6 (40:33-37)
7	7 (40:38-41)
8	8 (40:42-49)
9	9 (40:50-52)
10	10 (40:53-63)
11	11 (40:64-41:3)
12	12 (41:4-5)
13	13 (41:6-8)
14	14 (41:8-11)
15	15 (41:12-16)
16	16 (41:17-20)
17	17 (42:1-3)
18	18 (42:4-12)

Claim in '033	Corresponding Claim in Heffner
19	19 (42:13-15)
20	20 (42:16-19)

X. GROUND 3: CLAIMS 1-20 LACK SPECIFIC UTILITY

144. Claims 1-20 are unpatentable for the separate and independent reason that the claimed invention “lacks a specific and substantial utility” as required by §101. I describe in detail the basis for my opinion in this Section X. At a high level, I reach this opinion because the utility described in the '033 Patent is lacking as compared to the stated purpose and use as well as the prior methods established by POSAs for describing utility.

145. Nothing in the '033 Patent’s specification suggests any “specific benefit” provided by the claimed invention. Nothing in this particular patent’s specification establishes that claims 1-20 are a “useful improvement” over earlier corn varieties.

146. Here, however, the '033 Patent only disclosed general uses for the 1PNZQ23 variety, not specific utility that satisfies §101. Nothing in the specification of this particular patent establishes that claims 1-20 are a “useful improvement” over earlier corn varieties—for example, the PH487D variety disclosed in Heffner and based on a cross of the same two parental lines used to create the 1PNZQ23 variety disclosed in the '033 Patent. For example, the '033

Patent's "Industrial Applicability" section is essentially identical to those in Ross, Carlone, and Heffner. See EX1001, 36:21-65; EX1005, 42:6-49; EX1006, 42:5-48; EX1007, 37:17-65. Nothing in the record suggests any utility specific to the 1PNZQ23 variety itself beyond that generic to any species of corn.

147. Likewise, to the extent the '033 Patent suggests particular phenotypical differences between the claimed 1PNZQ23 variety and prior art varieties, it never even expressly identifies such differences—much less explains why they confer some specific benefit not already available from the prior art. Instead, as I previously noted, the relevant table ("Variety Description Information") is drawn essentially verbatim from certain fields in a form (EX1096) prepared by the USDA and used in connection with PVPA certificates.

148. Nothing in the '033 Patent suggests any reason why the claimed variety's properties have such characteristics and the potential for significant utility. Any suggestion to that effect would instead necessarily flow from POSAs' preexisting knowledge concerning corn in general rather than being based on the specification's actual disclosures regarding the claimed variety in particular.

149. I have reviewed the '033 Patent with reference to the utility requirement of §101. I have concluded that the '033 Patent does not disclose that the claimed subject matter has specific utility.

150. Given that the claimed maize variety is an inbred variety, POSAs would understand that any such utility would be in the form of generating beneficial hybrids when crossed. This understanding is corroborated by the descriptions in the '033 Patent of the Combining Ability and Hybrid comparisons (EX1001,19:4-35) and the '033 Patent's description of Industrial Applicability (EX1001, 36:21-65). However, the patent shows no data on such characteristics, nor of performance on the very relevant traits described in the patent as genetic analysis-based selection criteria.

151. As explained above, the standard practice in the industry is for seed producers to develop inbred varieties that are crossed with other inbred varieties to yield a hybrid variety. That seed producer then sells the hybrid variety to farmers to be grown as an agricultural crop. Accordingly, with a limited exception I discuss below, it is the quality of the ultimate *hybrid* variety that is of the greatest interest to determining whether the inbred as value. A hybrid variety is judged by many characteristics, which include the yield, comparative relative maturity (CRM), disease resistance, quality of the corn grain for a particular purpose (e.g., food grade, milling, livestock feed, cellulose, fuel, etc.), and the like.

152. Characteristics to be improved by plant breeding include: yield, resistance to pests, seed composition, forage quality, tolerance to mineral stresses, tolerance to environmental stresses, adaptability to mechanization, standability

(the ability to remain upright), stability of performance across years and locations, and photoperiod response (the amount of light required by the variety). EX1016, Fehr at 2-7.

153. The partial exception to the value of the inbred variety being in the hybrid varieties, as discussed in the previous paragraph, is that there are certain breeding characteristics in the inbred variety that affect its ability to yield a good hybrid crop. These parental traits of an inbred line include, for example, the ability of the male plant to provide sufficient pollen, the yield potential of a female parent, and the ability of the female parent to produce high quality seed which maintains seed performance and viability. However, this is only a partial exception, because the ultimate goal is still to achieve a successful hybrid crop. Furthermore, even if parental traits of the inbred line were the objectives of the breeding program, the measured traits and asserted benefits (utility), as outlined above, would have been different than the trait values disclosed in Table 1 of the '033 Patent.

154. In addition to the normal commercial market of the company breeding the inbred line, there is also a market for selling/licensing inbred varieties to other seed producers. However, the value of the inbred variety on this market is also based on the same considerations as stated above, that is, the quality

of the hybrid variety produced and quality of the inbred as a breeding stock, and not on the trait values described in Table 1 of the '033 Patent.

155. The upshot of the foregoing is that one needs actual data about the performance of the inbred variety based on its ability to be used as a parent to breed a hybrid with superior customer value and seed production traits in order to determine whether it has utility. A corn breeding program will most certainly generate any number of inbred varieties that are substantially useless if those lines cannot generate a good hybrid as judged by the commercial business and their customers.

156. I have carefully reviewed the '033 Patent to try to identify any disclosure showing that the claimed inbred variety has been shown to have utility for its intended purpose, i.e., as a parental line capable of breeding suitable hybrids. I do not see any such indication. The section on Industrial Applicability (36:21-65) describes ways in which corn may be used, but in no way ties the claimed inbred to any of these uses. Nor do the reported traits tie the claimed inbred to any of these uses. Moreover, the section appears identical to that of numerous other PHI patents as discussed above.

A. Analysis of Patents at Issue in *J.E.M. Ag Supply*

157. Counsel informs me that the 17 patents in the chart below were at issue in the case *J.E.M. Ag Supply, Inc. v. Pioneer Hi-Bred Int'l, Inc.* and that, in

that case, the Supreme Court held that newly developed plant breeds were eligible for utility patent protection if the claims satisfy all statutory requirements, including utility and non-obviousness. 534 U.S. 124, 127, 145 (2001).

158. A review of the patents at issue in *J.E.M.*, which were PHI's patents, shows that each included at least some comparisons, supported with data, between the claimed variety and earlier varieties.

159. For example, U.S. Patent No. 5,491,295 (EX1080, "Niebur," on which I am a co-inventor as discussed in Section II.C above), described Hybrid 3394 as "characterized by superior yield for maturity, excellent seedling vigor, very good roots and stalks, and exceptional stay green." EX1080, 2:66-3:3. Niebur included Example 1 comparing Hybrid 3394 with nine other hybrids, including six PHI hybrids and three from other suppliers. EX1080, 8:15-18:35. Among many other points of comparison, the Example 1 data showed that "[hybrid] 3394 has higher yield and grain harvest moisture, but lower test weight than [hybrid] 3503"; "[hybrid] 3394 has higher yield, grain harvest moisture, and test weight than [hybrid] 3417"; "[hybrid] 3394 is higher yielding but has lower grain moisture and test weight than [hybrid] 3398"; "[hybrid] 3394 outyields and has higher test weight but slightly lower grain moisture than [hybrid] 3379"; and so on with respect to the other comparators. EX1080, 8:18-54.

160. Niebur Example 2 provides strip test data comparing hybrid 3394 to the same six PHI hybrids and two of the three competitor hybrids used in Example 1. A strip test is a method for growing two or more varieties under substantially the same conditions so that data obtained for the varieties may be compared. The “strip” is a set of rows of a particular variety that is adjacent to a second strip with a second variety, and so on. Niebur describes a typical example in which strips of different hybrids were grown to obtain the comparative data presented in Niebur:

Comparison data was collected from strip tests that were grown by farmers. Each hybrid was grown in strips of 4, 6, 8, 12, etc. rows in fields depending on the size of the planter used. The data was collected from strip tests that had the hybrids in the same area and weighed. ... The number of comparisons represent the number of locations or replications for the two hybrids that were grown in the same field in close proximity and compared.

EX1080, 17:41-51. All of the other patents at issue in the *Pioneer v. J.E.M.* case also included strip test and/or other comparative data permitting direct comparisons. By contrast, the '033 Patent does not include any strip test data or other comparative information.

161. As summarized in Niebur, “[t]he results show Pioneer Brand Hybrid 3394 had a yield advantage over compared hybrids except Pioneer Hybrid 3398 where it had a disadvantage of 2.8 bushels per acre. 3394 had a slight moisture disadvantage against Pioneer Hybrids 3503, 3417, and 3362, and Garst Hybrid

8532. [Hybrid] 3394 showed a greater income advantage to the farmer based on adjusted gross income over all hybrids compared except Pioneer Hybrid 3398 where the disadvantage was \$4.18 per acre. With the exception of Pioneer Hybrid 3398, 3394's yield and income advantage plus its advantage for other characteristics over these hybrids will make it an important addition for most of the areas where these hybrids are grown." EX1080, 17:58-18:67.

162. Finally, in Example 3, Niebur included a comparison of key characteristics for the claimed hybrid 3394 as compared to the other six PHI hybrids and three competitor hybrids. EX1080, 19:58-21:39. In view of the data, Niebur concludes that "[hybrid] 3394 yielded well for its maturity, yielding equally well at both high and low plant population densities" and had "very good stay green and seedling vigor compared to the other hybrids." 20:65-21:1. In sum, "[hybrid] 3394 has overall excellent yield and agronomic characteristics which should make it an important hybrid in its area of adaptation." EX1080, 21:2-3.

163. Indeed, hybrid 3394 exhibited superior stay green as compared to hybrid 3398, which exceeded performance of hybrid 3394 in other categories. EX1080, Table 3 (showing STGR of 8 for 3384 compared to 3 for hybrid 3398); 5:10-14 (defining stay green ("STGR") as "the measure of plant health near the time of black layer formation (physiological maturity)"; "A high score indicates better late-season plant health...").

164. In short, the '295 Patent included data demonstrating that hybrid 3394 was superior in at least some significant characteristics as compared to other hybrids.

165. In another example, U.S. Patent No. 5,453,564 discloses inbred corn line PHTE4. EX1078 ("Chapman"). Chapman describes PHTE4 as a variety that "produces hybrids that are high yielding and flower early. PHTE4 hybrids have above average seedling vigor, test weight and staygreen. PHTE4 hybrids also have above average resistance to brittle stalks." EX1078, 7:13-16. Chapman discloses "the traits and characteristics of inbred corn line PHTE4 ... in comparison with other inbreds and in hybrid combination." EX1078, 9:62-65.

166. Chapman's Tables 3A-3E present comparisons between inbred line PHTE4, on the one hand, and inbred lines PHN15, PHNV4, PHJ40, PHT46, and PHBW8, respectively. EX1078, col. 11-16. From these data, Chapman concludes that "PHTE4 has lower yield and grain harvest moisture but higher test weight compared to PHN15"; "PHTE4 has lower yield and higher grain harvest moisture than PHNV4"; "PHTE4 has higher yield and grain harvest moisture but lower test weight compared to PHJ40"; "PHTE4 has a higher yield than PHT46"; "PHTE4 has lower yield and grain harvest moisture but higher test weight compared to PHBW8." EX1078, 9:67-10:26.

167. Chapman's Table 4A compares "PHNV4 to PHTE4 crossed to the same inbred testers"; Table 4B compares "PHNV4 to PHTE4 crossed to the same kinbred testers"; Table 4C compares "PHTE4 to PHBW8 crossed to the same kinbred testers." EX1078, col. 15-18. From this data, Chapman conclude that "[t]he PHTE4 hybrids have higher yield and grain harvest moisture" as well as "better seedling vigor and higher early stand count" when compared to the PHNV 4 hybrids, and higher grain harvest moisture and better seedling vigor than the PHRE1 hybrids. EX1078, 10:33-43.

168. Finally, Chapman's Tables 5A and 5B compare hybrids of PHTE4 to hybrids of PHBW8 and PHRE1, respectively. EX1078, col. 17-18. Chapman concludes that PHTE4 and PHBWB shows similar yield when test weight when crossed to the same inbred, but "[t]he PHTE4 hybrid is taller with higher ear placement compared to the PHBW8 hybrid." EX1078, 10:53-54. The "PHTE4 hybrid has significantly higher grain harvest moisture," better test weight, and lower ear placement than the PHRE1 hybrid. EX1078, 10:57-59.

169. Accordingly, Chapman discloses information showing that the claim PHNV4 was superior in at least some relevant respects.

170. Examples of disclosures for these and the other patents in the *J.E.M.* case are set forth in the following chart:

Hybrid	Patent No.	Notable Disclosures
3394	5,491,295 (EX1080)	“Hybrid Corn Plant & Seed” 2:66-3:3 (“This hybrid corn plant is characterized by superior yield for maturity, excellent seedling vigor, very good roots and stalks, and exceptional stay green. It is widely adapted, but performs best in the Central and Eastern Corn Belt.”) 4:50-55 (defining “PERCENT WINS”: “For yield, moisture, income, populations, stand, roots, and test weight, it would be the percentage of comparisons that the hybrid to be patented yielded more, had lower harvest moisture percentage, had greater income per acre, had better stalks, had better roots, and had higher test weight, respectively, in strip tests.”) 5:36-45 (“Pioneer Brand Hybrid 3394 is a single cross, yellow endosperm, dent corn hybrid with superior yield in its maturity. It has stable yield across

Hybrid	Patent No.	Notable Disclosures
		environments, has above average grain appearance with average test weight, and has exceptional stay green. 3394 has excellent seedling vigor and very good drought tolerance. The inventor has observed that the leaf angle is semi upright and the leaf is short and wide, which is a unique characteristic of this hybrid. The hybrid has the potential to form an abscission layer and drop ears free from the husk.”) 8:15-18:35 (Example 1 – “Research Comparisons” of Hybrid 3394 against nine other hybrids—six from Pioneer and three from competitors) 17:40-20:55 (Example 2 – “Strip Test Data for Hybrid 3394” against nine other hybrids—six from Pioneer and three from competitors) 20:58-21:4 (Example 3 – “Comparison of Key Characteristics for Hybrid 3394”)

Hybrid	Patent No.	Notable Disclosures
	5,506,367 (EX1083)	“Inbred Corn Line PHP38” 6:20-36 (“Inbred corn line PHP38 is a yellow, dent corn inbred that provides an acceptable male or female parental line in crosses for producing first generation F1 corn hybrids. PHP38 is best adapted to the central and eastern regions of the United States. Hybrids of PHP38 also possess very good drought tolerance and stability of yield which makes them extremely well-adapted for the hot, arid growing areas of the Western United States. The inbred can be used to produce hybrids from approximately 111-126 relative maturity based on the Minnesota Relative Maturity Rating System for harvest moisture of grain. PHP38 should make a good female since it has acceptable yield, good early vigor, and good early stand establishment. PHP38 would also be acceptable as a male because of its pollen yield. The inbred in hybrid combination has excellent stay green and overall disease tolerance.

Hybrid	Patent No.	Notable Disclosures
		PHP38 has excellent stalks and above average roots. PHP38 hybrids generally have very good grain quality and high test weight.”) 11:44-20:45 (“Inbred and Hybrid Performance of PHP38”)
	5,567,861 (EX1087)	“Inbred Corn Line PHN46” 6:7-16 (“Inbred corn line PHN46 is a yellow, dent corn inbred that provides an acceptable male parental line in crosses for producing first generation F1 corn hybrids. PHN46 is best adapted to the Central Corn Belt of the United States. The inbred can be used to produce hybrids from approximately 110-122 relative maturity based on the Minnesota Relative Maturity Rating System for harvest moisture of grain. PHN46 should make an excellent male since it has high pollen yield. The inbred in hybrid combination has good yield, stay green, stalks, and roots.”)

Hybrid	Patent No.	Notable Disclosures
		9:63-24:40 (“Inbred and Hybrid Performance of PHN46”)
3489	5,557,035 (EX1086)	“Hybrid Corn Plant & Seed (3489)” 4:41-43 (“3489 is a very high yielding, widely adapted, stable 108 CRM hybrid. 3489 has above average yield across all environments.”) 7:24-38 (“Pioneer Brand Hybrid 3489 has exceptional yield for its maturity. The hybrid is widely adapted and very stable which will make it an excellent companion hybrid to many of the hybrids in its area of adaptation....It has had top yield for four straight years beginning with very early experimental topcross testing. Compared to the closest existing hybrid (3417), 3489 has resistance to brittle stalk, resistance to heavy infection of common rust, tolerance to less solar

Hybrid	Patent No.	Notable Disclosures
		radiation and the ability to withstand excessive wet soil conditions.”)
	5,444,178 (EX1077)	“Inbred Corn Line PHHB4” 7:16-26 (“PHHB4 brings together more yield in hybrids than either parental line. In hybrid combination PHHB4 has desirable plant and ear height, resistance to brittle stalk, and resistance to common rust. Hybrids of PHHB4 do well in both dry and wet years compared to the closest prior art, but are especially better in wet years. Inbred corn line PHHB4 is a yellow, dent corn inbred and provides an acceptable female parental line in crosses for producing first generation F1 corn hybrids. PHHB4 is adapted to most regions of the United States but does best in Nebraska, Iowa, Illinois and Indiana.”) 9:44-16:53 (“Examples – Inbred and Hybrid Performance of PHHB4”)

Hybrid	Patent No.	Notable Disclosures
	5,633,427 (EX1089)	“Inbred Corn Line PHHB” [Continuation of the '178]
	5,347,081 (EX1076)	“Inbred Corn Line PHK56” 6:10-20 (“PHK56 is best adapted to the Central Corn Belt of the United States. The inbred can be used to produce hybrids from approximately 106-118 relative maturity based on the Minnesota Relative Maturity Rating System for harvest moisture of grain. PHK56 would make a good male because it is a good pollinator with good pollen yield. In hybrid combinations PHK56 provides high yields, has low grain moisture at maturity and performs under stress as well as good conditions. It also has good roots, low ear placement, and gray leaf spot tolerance.”) 9:63-12:20 (examples concerning PHK56’s “inbred and hybrid performance”: “These results show that

Hybrid	Patent No.	Notable Disclosures
		PHK56 hybrids offer significant advantage over commercial products that are sold for yield and other important agronomic traits.”)
3559		
	5,453,564 (EX1078)	“Inbred Corn Line PHTE4” 7:13-16 (“PHTE4 produces hybrids that are high yielding and flower early. PHTE4 hybrids have above average seedling vigor, test weight and staygreen. PHTE4 hybrids also have above average resistance to brittle stalks.”) 9:60-10:62 (“In the examples that follow, the traits and characteristics of inbred corn line PHTE4 are given as a line in comparison with other inbreds and in hybrid combination.”)
	5,495,069 (EX1081)	[Continuation of the ’564]

Hybrid	Patent No.	Notable Disclosures
	5,569,822 (EX1088)	[Continuation of the '069]
	5,534,661 (EX1084)	“Inbred Corn Line PHKW3” 13:46-24:15 (“In the examples that follow, the traits and characteristics of inbred maize line PHKW3 are given as a line in comparison with other inbreds and in hybrid combination....”) 13:52-14:6 (disclosing data indicating that claimed PHKW3 was “taller,” had “higher ear placement,” and had “significantly lower grain harvest moisture” as compared to either parent).
3730	5,689,036 (EX1091)	“Hybrid Maize Plant and Seed (3730)” 5:32-36 (“This hybrid maize plant is characterized by high yield, strong stalks, excellent early season growth and rapid dry-down after reaching maturity. It is best

Hybrid	Patent No.	Notable Disclosures
		adapted for the North Central Region of the United States.”) 10:38-44 (“Hybrid 3730 demonstrates an unexpected, excellent early season growth that is very rapid relative to other hybrids for its maturity. In addition, Hybrid 3730 has very good stalks and rapid dry-down after reaching maturity. Hybrid 3730 also demonstrates improved staygreen over other hybrids in its maturity.”) 12:25-16:67 (“Research Comparisons” against hybrids 3723, 3733, 3714, and 3563) 17:1-25 (“Strip Test Data for Hybrid 3730” against five other hybrids: “Hybrid 3730 has a yield advantage over all of the hybrids. Hybrid 3730 has an income/acre advantage over all but one of the hybrids, 3723, which has a similar income per acre as 3730. The income per

Hybrid	Patent No.	Notable Disclosures
		acre advantage ranged from \$3.46 to \$13.80. Hybrid 3730's yield and income advantage plus its advantage for other characteristics over these hybrids will make it an important addition for most of the areas where these hybrids are grown.") 18:1-25 ("Comparison of Key Characteristics for Hybrid 3730:" "Hybrid 3730 has good drydown and early growth when compared to the other hybrids. Hybrid 3730 has overall high yield and other good agronomic characteristics which should make it an important hybrid in its area of adaptation.")
	5,545,813 (EX1085)	"Inbred Maize Line PHRF5" 9:59-10:2 ("Inbred maize line PHRF5 is a yellow, dent maize inbred that is best suited as a female in crosses for producing first generation F1 maize hybrids. Inbred maize line PHRF5 is best adapted to the North Central region of the United States and can be used to

Hybrid	Patent No.	Notable Disclosures
		produce hybrids from approximately 99 relative maturity based on the Comparative Relative Maturity Rating System for harvest moisture of grain. Inbred maize line PHRF5 yields well for its maturity, has good stalks and good roots. Inbred maize line PHRF5 has good early season growth and good staygreen. Although PHRF5 has a somewhat lower resistance to Brittle Snap than other inbreds, PHRF5 demonstrates good stalk lodging resistance.”) 13:5-22:59 (providing “performance examples of PHRF5,” including performance of hybrids)
34R06	5,557,035 (EX1086)	[covered above]
	5,444,178 (EX1077)	[covered above]
	5,633,427 (EX1089)	[covered above]

Hybrid	Patent No.	Notable Disclosures
	5,347,081 (EX1076)	[covered above]
35N05	5,502,272 (EX1082)	“Hybrid Corn Plant and Seed (3563)” Abstract (“This hybrid corn plant is characterized by excellent yield potential, good test weight, and fast drydown. It performs best from Indiana/Ohio West.”) 8:5-14:28 (Example 1—“Research Comparisons” between 3563 and three other Pioneer hybrids along with one DeKalb hybrid) 13:29-16:20 (Example 2—“Strip Test Data” comparison between 3563 and three other Pioneer hybrids along with one DeKalb hybrid)

Hybrid	Patent No.	Notable Disclosures
		15:22-47 (“Comparison of Key Characteristics for Hybrid 3563....Relative to the hybrids compared, 3563 <i>has higher test weight and better grain appearance.</i> ”)
	5,463,173 (EX1079)	“Inbred line PHR61” 5:63-66 (“Inbred corn line PHR61 is a yellow, dent corn inbred that is best used as a female in crosses for producing first generation F1 corn hybrids. PHR61 is best adapted to the North Central Region of the United States.”) 6:2-14 (“PHR61 has consistent high hybrid yields for its grain moisture maturity. PHR61 has excellent stalks, stay green, and grain quality... Inbred PHR61 provides hybrids which, although adapted to cool Northern climates, perform exceptionally well in warm growing seasons which occasionally occur in the Northern Corn Belt of the United States.”)

Hybrid	Patent No.	Notable Disclosures
		9:55-11:1 (“Inbred and Hybrid Performance of PHR61” as compared to six other Pioneer inbred lines)
	5,347,081 (EX1076)	[covered above]
34K77	5,534,661 (EX1084)	[covered above]
35R57	5,689,034 (EX1090)	“Inbred Maize Line PH24E” 9:55-10:9 (“Inbred maize line PH24E is a yellow, dent maize inbred that is best suited as either a male or female in crosses for producing first generation F1 maize hybrids. Inbred maize line PH24E is best adapted to the Northcentral region of the United States and can be used to produce hybrids from approximately 106 relative maturity based on the Comparative Relative Maturity Rating System for harvest moisture of grain. As an inbred per se, maize

Hybrid	Patent No.	Notable Disclosures
		line PH24E is a high yielding female with a resistance to barrenness. Inbred PH24E exhibits good cold test results, good stalks and dark green plants. As an inbred per se, PH24E exhibits excellent resistance to barrenness which makes it a reliable seed production parent. Inbred PH24E demonstrates excellent general combining ability. When in hybrid combination, PH24E exhibits high yield for its maturity with a stability over different environments across the Northcentral Corn Belt. PH24E hybrids have excellent roots, good stalk strength and quality and short plant stature. PH24E hybrids' short plant stature and associated reduced crop residues, make them well adapted to conservation tillage cropping systems. PH24E hybrids perform well from the eastern to western edges of the Northcentral Corn Belt.”) 13:1-26:30 (“Performance Examples of PH24E,” including hybrid performance”).

Hybrid	Patent No.	Notable Disclosures
3563	5,502,272 (EX1082)	[covered above]
	5,463,173 (EX1079)	[covered above]
	5,347,081 (EX1076)	[covered above]
3751	5,082,992 (EX1075)	“Inbred Corn Line PHP02” 4:66-5:1 (“Inbred corn line PHP02 is a yellow dent corn inbred that gives superior characteristics in hybrid combination and is an excellent parental line in crosses for producing first generation F1 corn hybrids.”) 5:21-25 (“The inbred is adapted over a wide area of the northern Corn Belt and can be used advantageously in hybrids from approximately 95-114 RM based on the

Hybrid	Patent No.	Notable Disclosures
		Minnesota Relative Maturity Rating System for harvest moisture of the grain.”)

171. These disclosures in the patents at issue in the *J.E.M.* case identified particular reasons why the claimed varieties had specific value separate and apart from other corn varieties. In fact, during the *J.E.M.* case, the U.S. Patent Office signed a legal brief stressing that the patents at issue (including my own patent) disclosed “readily identifiable benefits to farmers.” EX1030, 28. I agree with the Patent Office’s characterization.

172. By contrast, the ’033 Patent does not identify any such specific value or benefit to farmers.

XI. GROUND 4: CLAIMS 1-20 ARE INDEFINITE

173. Claims 1, 10, and 18 of the ’033 Patent all refer to “inbred maize variety 1PNZQ23,” with “representative seed” of the variety “having been deposited under NCMA accession number 202301024.” EX1001, 39:32-34, 40:5-7, 40:48-50:

- Claim 1: A seed, plant, plant part, or plant cell of *inbred maize variety 1PNZQ23, representative seed of the variety having been deposited under NCMA accession number 202301024.*

- Claim 10: A converted seed, plant, plant part or plant cell of *inbred maize variety 1PNZQ23, representative seed of the maize variety having been deposited under NCMA accession number 202301024* wherein the converted seed, plant, plant part or plant cell comprises a locus conversion, and wherein the plant or a plant grown from the converted seed, plant part or plant cell comprises the locus conversion and otherwise comprises all of the physiological and morphological characteristics of maize variety 1PNZQ23 when grown under the same environmental conditions.
- Claim 18: An F1 hybrid seed of 1PNZQ23 produced by crossing a plant or plant part of *inbred maize variety 1PNZQ23* further comprising a transgene, *representative seed of the inbred maize variety 1PNZQ23 having been deposited under NCMA accession number 202301024* with a different maize plant, wherein the transgene is inherited by the F1 hybrid seed, wherein the transgene was introduced into inbred maize variety 1PNZQ23 by backcrossing or genetic transformation.

174. The other claims all refer back—whether directly or indirectly—to claim 1, claim 10, or claim 18:

- claims 2, 3, 8, and 9 refer back to claim 1;
- claim 4 refers back to claim 3, which refers back to claim 1;
- claims 5-7 refer back to claim 4, which refers back to claim 3, which refers back to claim 1;
- claims 11-12 and 17 refer back to claim 10;
- claim 13 refers back to claim 12, which refers back to claim 10;
- claims 14-16 refer back to claim 13, which refers back to claim 12, which refers back to claim 10; and
- claims 19-20 refer back to claim 18.

175. Given this structure, a POSA would recognize that the scope of claims 1-20—in other words, the extent of what they cover—depends on the meaning of “inbred maize variety 1PNZQ23” and “representative seed.” But neither of these phrases is a term of art in the plant breeding field. Nor does the ’033 Patent (EX1001) or its prosecution history (EX1002) indicate the boundaries of what the terms—and in turn claims 1-20 as a whole—cover.

A. The '033 Patent Does Not Provide Reasonable Certainty Concerning the Meaning of “Inbred Maize Variety 1PNZQ23” and How It Differs From Variety PH487D as Disclosed in Heffner

176. “Inbred maize variety 1PNZQ23” does not have any meaning to a POSA outside of the '033 Patent itself. It appears to be an arbitrary codename—along the lines of PHI’s traditional practices when naming new varieties. For example, U.S. Patent No. 5,159,133 (EX1092)—identifying me as the inventor—concerns “inbred corn line PHV37.” “PHV37” likewise was an arbitrary codename. Unlike the '033 Patent, however, U.S. Patent No. 5,159,133 does not have claims referring to “representative seed.” Instead, claim 1 (which all of the other claims directly or indirectly reference) simply recites “inbred corn seed designated PHV37 having ATCC accession No. 75222.” In other words, the claims define PHV37 by reference to the seed deposited with ATCC. By contrast, and as illustrated above, the claims of the '033 Patent merely describe the deposited seed as “representative seed” of 1PNZQ23.

177. While the '033 Patent repeatedly references “1PNZQ23,” nowhere does it actually identify the boundaries of what this variety constitutes. Aside from the different codename, the specification instead is largely identical to that of Heffner (EX1007), which as discussed in §IX.B.1 discloses a prior art inbred line (PH487D) sharing the same two parents as the '033 Patent. The similarities between the '033 Patent and Heffner are reflected in EX1102—a redline

comparison between the two patents. As the comparison shows, most paragraphs of the two specifications are exactly the same aside from the different codenames (“PH487D” for Heffner versus “1PNZQ23” for the ’033 Patent) and certain typographical artifacts (e.g., “germplasm” for “germ plasm”). In certain other instances, Heffner’s specification includes citations omitted from the ’033 Patent. Compare, e.g., Heffner (EX1007), 15:47-65, with EX1001, 15:51-63:

Heffner	'033 Patent
Genetic marker profiles can be obtained by techniques such as Restriction Fragment Length Polymorphisms (RFLPs), Randomly Amplified Polymorphic DNAs (RAPDs), Arbitrarily Primed Polymerase Chain Reaction (AP-PCR), DNA Amplification Fingerprinting (DAF), Sequence Characterized Amplified Regions (SCARs), Amplified Fragment Length Polymorphisms (AFLPs), Simple Sequence Repeats (SSRs) which are also referred toas Microsatellites, and Single Nucleotide Polymorphisms (SNPs). For example, see Berry et al. (2002),	Genetic marker profiles can be obtained by techniques such as Restriction Fragment Length Polymorphisms (RFLPs), Randomly Amplified Polymorphic DNAs (RAPDs), Arbitrarily Primed Polymerase Chain Reaction (AP-PCR), DNA Amplification Fingerprinting (DAF), Sequence Characterized Amplified Regions (SCARs), Amplified Fragment Length Polymorphisms (AFLPs), Simple Sequence Repeats (SSRs) which are also referred to as Microsatellites, and Single Nucleotide Polymorphisms (SNPs).

“Assessing Probability of Ancestry Using Simple Sequence Repeat Profiles: Applications to Maize Hybrids and Inbreds”, Genetics, 2002, 161:813-824, and Berry et al. (2003), “Assessing Probability of Ancestry Using Simple Sequence Repeat Profiles: Applications to Maize Inbred Lines and Soybean Varieties”, Genetics, 2003, 165: 331-342. Particular markers used for these purposes may include any type of marker and marker profile which provides a means of distinguishing varieties.	Particular markers used for these purposes may include any type of marker and marker profile which provides a means of distinguishing varieties.
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178. By comparison, there are no instances in which the '033 Patent cites literature omitted from Heffner. None of these distinctions offers a POSA any understanding concerning the difference between “inbred maize variety PH487D” as disclosed and claimed in Heffner versus “inbred maize variety 1PNZQ23” as disclosed and claimed in the '033 Patent. Aside from the differences in codenames themselves, there are only three distinctions between Heffner and the '033 Patent that would even arguably suggest a difference between the varieties:

- (1) one additional sentence in the “Breeding History” section;
- (2) slightly different data in Table 1 (“Variety Description Information”) —although in most instances not statistically significant even aside from the lack of information concerning locations and growing seasons, as discussed in Section IX above and reflected in Appendix B); and;
- (3) different depositories, accession numbers, and deposit dates for the deposited seeds (compare EX1001, 37:33-40 with EX1007, 38:26-34).

179. However, as explained in the following paragraphs below, these distinctions would not actually assist in a POSA in understanding the line between inbred maize variety PH487D” as disclosed and claimed in Heffner versus “inbred maize variety 1PNZQ23” as disclosed and claimed in the ’033 Patent. The question has to be asked, are they “representative” of each other?

1. Breeding History

180. First, the ’033 Patent includes one additional sentence in the “Breeding History” section, which still reflects the same two parental varieties disclosed in Heffner. *Compare*, Heffner (EX1007), 38:55-61, with EX1001, 37:60-38:3:

Heffner	'033 Patent
Inbred Maize variety PH487D was developed by the following method. A cross was made between inbred line PH1VKM and inbred line PH2DYM. Inbred PH487D was developed by producing a doubled haploid from the F1 plants, selfing and using pedigree selection amongst the D1 lines, and selfing and bulking from the subsequent generations.	Inbred Maize variety 1PNZQ23 was developed by the following method. 1PNZQ23 is an elite corn inbred line originated from a cross between inbred line PH1VKM and inbred line PH2DYM. <u>From this cross, ears were selected based on genetic analysis predicting disease, insect, and agronomic phenotypic performance.</u> Inbred 1PNZQ23 was developed by producing a doubled haploid from the F1 plants, selfing and using pedigree selection amongst the D1 lines, and selfing and bulking from the subsequent generations.

181. But this sentence merely describes routine breeding techniques—recapitulating earlier teachings in the '033 Patent concerning “genotypic analysis” and appearing verbatim in Heffner. *See* EX1007, 32:37-55, which is identical to EX1001, 31:40-59 aside from the different codenames. Indeed, as both Heffner and the '033 Patent disclose in identical sentences appearing in the “Background Sections” (which indeed are identical in their entirety aside from the '033 Patent having a space in “germplasm”), “[t]he breeder’s goal” is to obtain “various

desirable traits” including “resistance to diseases and insects” and “better agronomic characteristics.” EX1007, 1:11-17.

182. Moreover, nothing in the '033 Patent discloses any information concerning how exactly the inventor selected ears based on this analysis—much less how it distinguishes variety 1PNZQ23 (as claimed in the '033 Patent) from variety PH487D (as claimed in Heffner). Instead, as previously noted, the sentence in question merely recapitulates long-standing practices. Selecting ears “based on genetic analysis predicting disease, insect, and agronomic phenotypic performance” was a well-known practice long before the priority date. For example, techniques known as marker-assisted selection (MAS) or genomic selection (GS) were well-known long before the filing date of either Heffner (June 14, 2019) or the '033 Patent (July 2, 2021). *See, e.g.*, EX1031, Lande, “Efficiency of Marker-Assisted Selection in the Improvement of Quantitative Traits,” *Genetics* 124:743-56 (1990). Notably, Heffner himself (i.e., the inventor of the prior art patent) had published an earlier paper describing genomic selection (GS), “a form of MAS that simultaneously estimates all locus, haplotype, or marker effects across the entire genome to calculate genomic estimated breeding values.” EX1032, Heffner, “Genomic Selection for Crop Improvement,” *Crop Science*, 49:1-12 (2009).

183. I also note that while the '033 Patent describes 1PNZQ23 as an “elite...inbred line” whereas Heffner simply describes PH487D as an “inbred line,” the “elite” description is a subjective characterization merely suggesting that the developer of the variety viewed it as a promising basis for new hybrid varieties. But no such hybrids are disclosed in either Heffner or the '033 Patent—unlike PHI’s traditional practice when filing patent applications on new inbred lines. See Section X above.

2. Variety Description Information

184. While certain fields in the '033 Patent’s “Variety Description Information” (Table 1) differ slightly from those in Heffner’s “Variety Description Information” (Table 1), these distinctions do not provide reasonable certainty to a POSA concerning the meaning of “1PNZQ23” and how it differs from Heffner’s variety PH487D.

185. As shown in the comparison table and discussed in paragraphs 63, 69-85 above, many of the reported values and colors are literally identical in both tables, and numerous others fall within the same ranges such that any distinctions are not statistically significant.

186. For example, both tables report identical grain texture, level of anthocyanin of brace roots, leaf color, silk color, fresh husk color, dry husk color,

ear position at dry husk stage, husk extension, row alignment, ear taper, kernel pericarp color, aleurone color pattern, aleurone color, and endosperm color.

187. Indeed, with respect to reported colors, Heffner and the '033 Patent are identical in all respects aside from anther (with Heffner reporting “light yellow” and the '033 Patent reporting “yellow”) and cob color (with Heffner reporting “pink”) and the '033 Patent reporting “white”). A POSA would not view these reported distinctions as material differences—particularly in the absence of information concerning the circumstances under which the characteristics were recorded (e.g., whether the same individual conducted both assessments, whether they were performed under the same conditions, etc.). Furthermore, I note that the PVP certificate corresponding to Heffner’s PH487D variety reports an anther color of “yellow” (EX1010, 8)—just like the '033 Patent’s 1PNZQ23. As for cob color, it is one of the many characteristics that can vary materially even within a single variety depending on the environmental conditions in which the seed is grown. Such conditions influence the amount of anthocyanin (i.e., soluble glycoside pigments) generated by the plants, which in turn dictates the color of the cob. Accordingly, the very same seed could yield corn plants with white cobs and other corn plants with slightly pink cobs depending on the conditions in which they are grown.

188. Likewise, to the extent Table 1 in the '033 Patent reports different numerical values from Table 1 in Heffner, it is impossible for a POSA to draw any conclusions from those distinctions given that (1) the properties in question vary significantly depending on environmental conditions, yet (2) neither Heffner nor the '033 Patent discloses the conditions under which the data were generated. Even identical seeds can yield plants with markedly different characteristics depending on the conditions in which the plants are grown. For example, many of the physical properties of a corn plant grown in North Dakota under cold and wet conditions would be very different from those of a plant grown from the exact same seed in Iowa under hot and dry conditions.

189. Both Heffner and the '033 Patent implicitly acknowledge this and disclose crossing the claimed varieties with others to derive seed “having essentially the same morphological characteristics as” the claimed variety “when grown in the same environmental conditions.” EX1001, 34:41-43; EX1007, 35:37-40.

190. But nowhere does the '033 Patent ever disclose the environmental conditions under which the data in Table 1—the only morphological characteristics disclosed in the specification—were generated. Nor does Heffner disclose such information. These omissions mark a departure from PHI's traditional practice of disclosing the location and in most instances growing

season in which data were collected. For example, all seventeen of the patents at issue in the *J.E.M.* case (*see supra* §X.A) disclosed the location where the data were generated, and sixteen of the seventeen also disclosed the growing season:

- EX1075, U.S. Patent No. 5,082,992, 5:66-68 (“The data given in the Variety Description Information (Table 1) was collected primarily at Johnston, Iowa.”)
- EX1076, U.S. Patent No. 5,347,081, 8:14-17 (“Data for Items B, C, D, E, F, and G is based primarily on a maximum of two reps from Johnston, Iowa grown in 1988, plus description information from the maintaining station.”)
- EX1077, U.S. Patent No. 5,444,178, 8:68-9:2 (“Data for Items B, C, D, E, F, and G is based primarily on a maximum of two reps from Johnston, Iowa grown in 1992, plus description information from the maintaining station”)
- EX1078, U.S. Patent No. 5,453,564, 9:13-15 (“Data for Items B, C, D, E, F, and G is based primarily on a maximum of two reps from Johnston, Iowa grown in 1992, plus description information from the maintaining station.”)
- EX1079, U.S. Patent No. 5,463,173, 8:11-14 (“Data for Items B, C, D, E, F, and G are based primarily on a maximum of four reps from

Johnston, Iowa grown in 1989 and 1990, plus description information from the maintaining station.”)

- EX1080, U.S. Patent No. 5,491,295, 7:24-25 (“Items B, C, D, E, F, and G are based on a maximum of two reps of data primarily from Johnston, Iowa in 1990.”)
- EX1081, U.S. Patent No. 5,495,069, 9:7-9 (“Data for Items B, C, D, E, F, and G is based primarily on a maximum of two reps from Johnston, Iowa grown in 1992, plus description information from the maintaining station.”)
- EX1082, U.S. Patent No. 5,502,272, 6:58-59 (“Items B, C, D, E, F, and G are based on a maximum of two reps of data primarily from Johnston, Iowa in 1990.”)
- EX1083, U.S. Patent No. 5,506,367, 9:28-30 (“Data for Items B, C, D, E, F, and G is based primarily on a maximum of two reps from Johnston, Iowa grown in 1988, plus description information from the maintaining station.”)
- EX1084, U.S. Patent No. 5,534,661, 11:47-49 (“Data for Items B, C, D, E, F, and G is based primarily on a maximum of four reps from Johnston, Iowa grown in 1993 and 1994, plus description information from the maintaining station.”)

- EX1085, U.S. Patent No. 5,545,813, 11:47-49 (“Data for Items B, C, D, E, F, and G is based primarily on a maximum of four reps from Johnston, Iowa grown in 1993 and 1994, plus description information from the maintaining station.”)
- EX1086, U.S. Patent No. 5,557,035, 10:11-12 (“Items B, C, D, E, F, and G are based on a maximum of two reps of data primarily from Johnston, Iowa in 1993.”)
- EX1087, U.S. Patent No. 5,567,861, 8:13-15 (“Data for Items B, C, D, E, F, and G is based primarily on a maximum of two reps from Johnston, Iowa grown in 1989, plus description information from the maintaining station.”)
- EX1088, U.S. Patent No. 5,569,822, 8:59-61 (“Data for Items B, C, D, E, F, and G is based primarily on a maximum of two reps from Johnston, Iowa grown in 1992, plus description information from the maintaining station.”)
- EX1089, U.S. Patent No. 5,633,427, 9:31-33 (“Data for Items B, C, D, E, F, and G is based primarily on a maximum of two reps from Johnston, Iowa grown in 1992, plus description information from the maintaining station.”)

- EX1090, U.S. Patent No. 5,689,034, 11:46-48 (“Data for Items B, C, D, E, F, and G is based primarily on a maximum of 2 reps from Johnston, Iowa grown in 1994, plus description information from the maintaining station.”)
- EX1091, U.S. Patent No. 5,689,036, 12:21-22 (“Data for Items B, C, D, E, F, and G is based primarily on a maximum of two reps from Johnston, Iowa grown in 1994.”)

This information provides a POSA with context for understanding the environmental conditions giving rise to the reported data.

191. But the '033 Patent does not provide any such context. Without such context concerning the relevant environmental conditions, Table 1 in the '033 Patent does not provide reasonable certainty concerning the boundaries of “inbred maize variety 1PNZQ23” and how they differ from those of Heffner’s variety PH487D. Indeed, to the extent there are distinctions between Table 1 in the '033 Patent and Table 1 in Heffner, many (for example, the lower mean number of kernels per row and more days to emergence to 50% plants in silk) merely suggest that the plants reflected in the '033 Patent’s Table 1 were grown under harsher conditions—particularly during early stages of the growing season prior to plant flowering (at which point corn plants growth is largely directed to reproduction, giving rise to the ears themselves).

3. Deposit

192. The deposit of seed also fails to provide reasonable certainty concerning the scope of “variety 1PNZQ23” and the Challenged Claims as a whole. As discussed in paragraphs 173-175 above, claims 1-20 describe the deposited seed merely as “*representative seed* of” variety 1PNZQ23—begging the question of what makes the deposited seed representative. But as discussed in §XI.B below, “representative seed” is not a term of art, and the ’033 Patent fails to explain the intended boundaries.

B. The ’033 Patent Does Not Provide Reasonable Certainty Concerning the Meaning of “Representative Seed”

193. “Representative seed” is not a term of art. For example, it does not appear in the glossary prepared by the Crop Science Society of America.

EX1072. Nor does it appear in the USDA’s Agricultural Biotechnology Glossary. EX1067.

194. Further, the ’033 Patent does not explain how far removed a seed, plant, plant part, or plant cell may be from the deposited seed, yet still sufficiently close such that the deposited seed should be deemed to be a “representative seed.”

195. Setting aside the claims themselves, the ’033 patent refers to “representative seed” only twice—both times merely replicating the claim language and noting that “representative seed of said inbred maize variety 1PNZQ23 has been deposited.” EX1001, 34:25-26, 34:38-39. Nothing in this

paragraph or elsewhere in the intrinsic record indicates what makes the deposited seed “representative” of variety 1PNZQ23—let alone how much variation is possible while still qualifying as variety 1PNZQ23. Instead, both references to “representative seed” in the specification highlight the lack of reasonable certainty as to what the phrase means. Different observers could reach different conclusions depending on their subjective perspectives. Likewise, there could be variation in the “representative sample” that would include scope far beyond that described in the patent. *See* EX1068, Merriam-Webster, Ninth New Collegiate Dictionary, 1000 (1984) (defining “representative” as “serving to represent” or “serving as a typical or characteristic example”).

196. The first usage describes “maize seed derived from the inbred maize variety 1PNZQ23” and having “92%, 93%, 94%, 95%, 96%, 97%, 98% or 99% of the same polymorphisms for molecular markers as the plant or plant part of inbred maize variety 1PNZQ23.” EX1001, 34:27-30. But nothing in this passage or elsewhere in the specification identifies such molecular markers. Instead, the next sentence refers generically to the “Panzea database” (*id.*, 34:30-33)—a website that concerns corn genetic diversity in general and lacks any specific reference to variety 1PNZQ23. The researchers responsible for the Panzea website sequenced “hundreds of maize lines” and thereby identified “millions of polymorphisms.”

EX1059, “Genotypes,” <https://www.panzea.org/genotypes>. Nothing in the record indicates any polymorphisms characteristic of 1PNZQ23 as a variety.

197. The second sentence likewise describes “maize seed derived from the inbred maize variety 1PNZQ23” and “having essentially the same morphological characteristics as maize variety 1PNZQ23 when grown in the same environmental conditions.” EX1001, 34:41-43. But nothing in this passage or elsewhere in the specification identifies such distinguishing morphological characteristics and ties them to particular environmental conditions. As I explained in paragraphs 70, 72-76, 105 above (and as the passage itself implicitly acknowledges), even identical seeds can yield very different plants depending on the conditions in which the plants are grown. But nowhere does the ’033 Patent ever disclose the environmental conditions under which the data in Table 1—the only morphological characteristics disclosed in the specification—were generated.

198. By contrast, I note that none of the patent claims on inbred lines at issue in the *J.E.M.* case described the deposited seed as “representative” (even though those earlier patents *did* disclose the environmental conditions used to generate the data, as discussed in paragraph 190 above). Instead, the claims were drafted more narrowly—typically with language describing the varieties as (i) “having” a certain deposit accession number or (ii) having “all the physiological

and morphological characteristics” of a variety—linking the varieties more clearly to the deposits:

U.S. Patent No. 5,506,367 (EX1083)	1. Inbred corn seed designated PHP38, having ATCC accession No. 75612. 2. A corn plant produced by the seed of claim 1. 3. A tissue culture of regenerable cells of the plant of claim 2. 4. Tissue culture according to claim 3 comprising regenerable cells of a plant part selected from meristematic tissue, anthers, leaves, embryos, pollen, and protoplasts thereof. 5. A corn plant regenerated from the regenerable cells of a tissue culture of claim 4, said plant possessing all the physiological and morphological characteristics of the inbred corn plant designated PHP38. 6. An inbred corn plant having all the physiological and morphological characteristics of the plant of claim 2.
U.S. Patent No. 5,567,861 (EX1087)	1. Inbred corn seed designated PHN46, having the ATCC Accession No. 97133. 2. A corn plant and its parts produced by the seed of claim 1.

	3. An inbred corn plant having all the physiological and morphological characteristics of the plant of claim 2. 4. A corn plant regenerated from the regenerable cells of a tissue culture of inbred corn plant PHN46 and having ATCC accession No. 91733, the regenerated plant being capable of expressing all the physiological and morphological characteristics of inbred corn plant PHN46 deposited under ATCC accession No. 91733. 5. A tissue culture of regenerable cells of corn plant PHN46 having ATCC accession No. 91733. 6. Tissue culture according to claim 4 comprising regenerable cells of a plant part selected from meristematic tissue, anthers, leaves, embryos, and pollen, and protoplasts thereof. 7. A process to produce a hybrid corn seed which gives rise to a hybrid corn plant having alleles which, when expressed, contribute to hybrids which are adapted to the central corn belt and which exhibit improvement in the traits of: yield, stay green, stalks and roots,
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	compared to similarly adapted hybrids, comprising the steps of: (a) planting, in pollinating proximity, seed of corn inbred line PHN46 having ATCC accession No. 91733 and another inbred line, not PHN46; (b) cultivating corn plants resulting from said planting, said corn plants having a male and female reproductive system; (c) inactivating the male reproductive system prior to pollination of the plants of either the female inbred line; (d) allowing natural cross pollinating to occur between the inbred lines; and (e) harvesting seeds produced on said inactivated plants of the inbred line. 8. F₁ hybrid corn seed produced by crossing the inbred corn plant PHN46, having ATCC No. 91733, with another corn plant that is not PHN46, and plants and parts thereof produced from the F₁ hybrid seed.
U.S. Patent No. 5,444,178 (EX1077)	1. Inbred corn seed designated PHHB4 and having ATCC Accession No. 97048.

	2. A corn plant produced by the seed of claim 1. 3. A tissue culture of regenerable cells of a corn plant wherein the tissue regenerates plants having all the physiological and morphological characteristics of PHHB4. 4. Tissue culture according to claim 3, the tissue culture selected from the group consisting of leaves, pollen, embryos, roots, root tips, anthers, silk, flowers, kernels, ears, cobs, husks, stalks, and cells and protoplasts thereof. 5. A corn plant regenerated from a tissue culture of claim 3 wherein the regenerated plant has a genotype capable of expressing all the physiological and morphological characteristics of inbred corn plant PHHB4. 6. A process to produce a hybrid corn seed which gives rise to a hybrid corn plant having alleles which, when expressed, contributes to high yield, brittle stalk resistance, and common rust resistance in wet and dry
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	years, when compared to similarly adapted hybrids, comprising the steps of: (a) planting, in pollinating proximity, seed of corn inbred line PHHB4 and another inbred line, not PHHB4; (b) cultivating corn plants resulting from said planting, said corn plants having a male and female reproductive system; (c) inactivating the male reproductive system prior to pollination of the plants of either the female inbred line; (d) allowing natural cross pollinating to occur between the inbred lines; and (e) harvesting seeds produced on said inactivated plants of the inbred line. 7. Hybrid seed produced by: (a) planting, in pollinating proximity, seeds of corn inbred lines PHHB4 and another inbred line, not PHHB4;
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	(b) cultivating corn plants resulting from said planting, said corn plants having a male and female reproductive system; (c) inactivating the male reproductive system prior to pollination of the female inbred line; (d) allowing natural cross pollinating to occur between said inbred lines; and (e) harvesting seeds produced on said inactivated plants of the inbred line. 8. Hybrid plants grown from seed of claim 7.
U.S. Patent No. 5,633,427 (EX1089)	1. Parts of a plant produced by a seed designated PHHB4 and having ATCC accession number 97048. 2. Parts of a F₁ hybrid corn plant grown from a F₁ hybrid corn seed produced by crossing inbred corn plant PHHB4, having ATCC accession number 97048, with another corn plant that is not PHHB4.
U.S. Patent No. 5,347,081 (EX1076)	1. Inbred corn seed designated PHK56, having the ATCC Accession No. 75677. 2. A corn plant produced by the seed of claim 1.

	3. An inbred corn plant having all the physiological and morphological characteristics of the plant of claim 2. 4. A tissue culture of regenerable cells of the plant PHK56. 5. A tissue culture according to claim 4 comprising regenerable cells selected from meristematic tissue, anthers, leaves, embryos, and pollen protoplasts therefrom. 6. A corn plant regenerated from the regenerable cells of a tissue culture of claim 5 having all the physiological and morphological characteristics of inbred corn plant PHK56. 7. An F₁ hybrid corn plant and seed thereof produced by crossing an inbred corn plant produced from seed identified as PHK56 and having ATCC accession number 75677, with another, different corn plant.
U.S. Patent No. 5,453,564 (EX1078)	1. Inbred corn seed designated PHTE4 and having the genotype of ATCC Accession No. 97065. 2. A corn plant produced by the seed of claim 1.

	3. A tissue culture of regenerable cells of a plant of the inbred corn line PHTE4 wherein the tissue regenerates plants having all of the physiological and morphological characteristics of PHTE4. 4. A tissue culture according to claim 3, the tissue culture selected from the group consisting of leaves, pollen, embryos, roots, root tips, anthers, silk, flowers, kernels, ears, cobs, husks and stalks, and cells and protoplasts thereof. 5. A corn plant regenerated from a tissue culture of a plant of inbred corn line PHTE4 and having all of the physiological and morphological of PHTE4. 6. Hybrid seed produced by: (a) planting, in pollinating proximity, seeds of two parental lines, one of the parental lines being PHTE4, and the other parental line having a genotype different from PHTE4; (b) cultivating corn plants resulting from said planting; (c) preventing pollen formation by the plants of one of the parental lines;
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	(d) allowing natural cross pollinating to occur between said parental lines; and (e) harvesting seeds produced by the plants which do not form pollen. 7. Hybrid seed produced by hybrid combination of plants of inbred corn seed designated PHTE4 and having ATCC Accession No. 97065 and plants of a parental line having a genotype different from PHTE4. 8. Hybrid plants grown from seed of claim 7. 9. A tissue culture of the regenerable cells of the corn plant generated from seed produced by hybrid combination of plants of inbred corn seed designated PHTE4 and having ATCC Accession No.97065 and plants of a parental line having a genotype different from PHTE4.
U.S. Patent No. 5,569,822 (EX1088)	1. Parts of a plant produced by a seed designated PHTE4 and having ATCC accession number 97065. 2. Parts of a F₁ hybrid corn plant grown from a F₁ hybrid corn seed produced by crossing inbred corn plant

	PHTE4, having ATCC accession number 97065, with another corn plant that is not PHTE4.
U.S. Patent No. 5,534,661 (EX1084)	1. Seed of maize inbred line designated PHKW3 and having ATCC Accession No. 97435. 2. A maize plant produced by the seed of claim 1 and its plant parts. 3. Pollen of the plant of claim 2. 4. An ovule of the plant of claim 2. 5. A maize plant having all the physiological and morphological characteristics of the plant of claim 2. 6. A male sterile maize plant otherwise having all the physiological and morphological characteristics of the plant of claim 2. 7. A tissue culture of regenerable cells of an inbred maize plant PHKW3, wherein the tissue regenerates plants capable of expressing all of the morphological and physiological characteristics of the maize plant named PHKW3, the seed of which have been deposited and have ATCC Accession No. 97435.

	8. A tissue culture of claim 7, the tissue culture selected from the group consisting of leaves, pollen, embryos, roots, root tips, anthers, silk, flowers, kernels, ears, cobs, husks, stalks, cells and protoplasts thereof. 9. A maize plant regenerated from a tissue culture of claim 7, capable of expressing all the morphological and physiological characteristics of inbred PHKW3, the seed of which have been deposited under ATCC Accession No. 97435. 10. A method for producing first generation (F₁) hybrid maize seed, which gives rise to a hybrid maize plant having alleles that, when expressed, contribute to hybrids that are high yielding with good drought tolerance, high test weight and very good grain quality, comprising crossing the plant of claim 2 with a different inbred parent maize plant and harvesting the resultant first generation (F₁) hybrid maize seed. 11. The method of claim 10 wherein inbred maize plant PHKW3 is the female parent.
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	12. The method of claim 10 wherein inbred maize plant PHKW3 is the male parent. 13. An F₁ hybrid seed and plant, and its parts, grown therefrom produced by crossing an inbred maize plant according to claim 2 with another, different maize plant.
U.S. Patent No. 5,545,813 (EX1085)	1. Seed of maize inbred line designated PHRF5 and having ATCC Accession No. 97374. 2. A maize plant produced by the seed of claim 1 and its plant parts. 3. Pollen of the plant of claim 2. 4. An ovule of the plant of claim 2. 5. A maize plant having all the physiological and morphological characteristics of the plant of claim 2. 6. A male sterile maize plant otherwise having all the physiological and morphological characteristics of the plant of claim 2. 7. A tissue culture of regenerable cells of an inbred maize plant PHRF5, wherein the tissue regenerates plants capable of expressing all of the morphological and physiological characteristics of the maize plant

	named PHRF5, the seed of which have been deposited and have ATCC Accession No. 97374. 8. A tissue culture of claim 7, the tissue culture selected from the group consisting of leaves, pollen, embryos, roots, root tips, anthers, silk, flowers, kernels, ears, cobs, husks, stalks, cells and protoplasts thereof. 9. A maize plant regenerated from a tissue culture of claim 7, capable of expressing all the morphological and physiological characteristics of inbred PHRF5, the seed of which have been deposited under ATCC Accession No. 97374. 10. A method for producing first generation (F₁) hybrid maize seed which gives rise to a hybrid corn plant having alleles that, when expressed, contribute to hybrids which are adapted to the north central corn belt with a relative maturity based in CRM of approximately 99 and have a very good seedling vigor, comprising crossing the plant of claim 2 with a different inbred parent maize plant and harvesting the resultant first generation (F₁) hybrid maize seed.
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	11. The method of claim 10 wherein inbred maize plant PHRF5 is the female parent. 12. The method of claim 10 wherein inbred maize plant PHRF5 is the male parent. 13. An F₁ hybrid seed and plant, and its parts, grown therefrom produced by crossing an inbred maize plant according to claim 2 with another, different maize plant.
U.S. Patent No. 5,463,173 (EX1079)	1. Inbred corn seed designated PHR61 and having ATCC Accession No. 97123. 2. A corn plant and its parts produced by the seed of claim 1. 3. An inbred corn plant having all the physiological and morphological characteristics of the plant generated from the seed of claim 1. 4. A corn plant regenerated from a culture of tissue taken from a plant according to claim 2 and selected from the group consisting of meristematic tissue, immature embryos, microspores, protoplasts, and pollen.

	5. A process to produce a hybrid corn seed which gives rise to a hybrid corn plant having alleles which, when expressed, contribute to hybrids which are adapted to the northern corn belt and which also perform well during warm growing seasons that occasionally occur in the northern corn belt compared to similarly adapted hybrids, comprising the steps of: (a) planting, in pollinating proximity, seed of corn inbred line PHR61 having ATCC accession no. and another inbred line, not PHR61; (b) cultivating corn plants resulting from said planting, said corn plants having a male and female reproductive system; (c) inactivating the male reproductive system prior to pollination of the plants of either the female inbred line; (d) allowing natural cross pollinating to occur between the inbred lines; and (e) harvesting seeds produced on said inactivated plants of the inbred line.
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	6. F₁ hybrid corn seed and plants therefrom produced by crossing inbred corn plant PHR61 having ATCC No.-- with another corn plant that is not PHR61.
U.S. Patent No. 5,689,034 (EX1090)	1. Seed of maize inbred line designated PH24E and having ATCC Accession No. 97925. 2. A maize plant and its parts produced by the seed of claim 1 and its plant parts. 3. Pollen of the plant of claim 2. 4. An ovule of the plant of claim 2. 5. A maize plant having all the physiological and morphological characteristics of the plant of claim 2. 6. A male sterile maize plant otherwise having all the physiological and morphological characteristics of the plant of claim 2. 7. A tissue culture of regenerable cells of an inbred maize plant PH24E, wherein the tissue regenerates plants capable of expressing all the morphological and physiological characteristics of the maize plant named PH24E, the seed of which have been deposited and have ATCC Accession No. 97925.

	8. The tissue culture of claim 7, the tissue culture selected from the group consisting of leaves, pollen, embryos, roots, root tips, anthers, silks, flowers, kernels, ears, cobs, husks, stalks, cells and protoplasts thereof. 9. A maize plant regenerated from the tissue culture of claim 7, capable of expressing all the morphological and physiological characteristics of inbred PH24E. 10. A method for producing first generation (F₁) hybrid maize seed comprising crossing a first inbred parent maize plant with a second inbred parent maize plant and harvesting the resultant first generation (F₁) hybrid maize seed, wherein said first or second parent maize plant is the maize plant of claim 2. 11. The method of claim 10 wherein inbred maize plant PH24E is the female parent. 12. The method of claim 10 wherein inbred maize plant PH24E is the male parent. 13. An F₁ hybrid seed grown therefrom produced by crossing an inbred maize plant according to claim 2 with another, different maize plant.
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	14. An F ₁ hybrid plant and its parts grown from the seed of claim 13.
U.S. Patent No. 5,082,992 (EX1075)	1. Inbred corn seed designated PHP02 having ATCC accession No. 75077. 2. A corn plant produced by the seed of claim 1. 3. Tissue culture of the plant of claim 2. 4. Tissue culture according to claim 3 comprising regenerable cells of a plant part selected from meristematic tissue, anthers, leaves, embryos, protoplasts, and pollen. 5. A corn plant regenerated from regenerable cells of a tissue culture according to claim 4. 6. An inbred corn plant having all the physiological and morphological characteristics of the seed of claim 1. 7. A method to produce a novel hybrid corn seed comprising the steps of: a) planting in pollinating proximity seeds of corn inbred lines PHP02 and another inbred line; b) cultivating corn plants resulting from said planting until the time the plants bear flowers;

	c) emasculating the flowers of the plants of either inbred line; d) allowing natural cross pollinating to occur between said inbred lines; and e) harvesting seed produced on said emasculated plants of the inbred line. 8. An F₁ hybrid corn plant and seed thereof produced by crossing an inbred corn plant according to claim 2 with another, different corn plant.
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199. To summarize, PHI's earlier patents on inbred lines provided *more* information than the '033 Patent (including the comparative data discussed in section X.A above, as well as environmental conditions under which the reported properties were obtained), yet concluded with narrower claims that did not present the ambiguity created by the reference to "representative seed" in the '033 Patent claims.

XII. CONCLUSION

200. As explained above, the Challenged Claims of the '033 Patent are rendered obvious by the combinations discussed above and the Challenged Claims are unpatentable under 35 U.S.C. § 103.

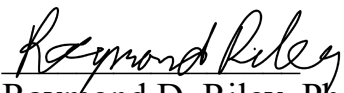
201. Further, the Challenged Claims of the '033 Patent lack specific utility and are therefore unpatentable under 35 U.S.C. § 101.

202. Moreover, the Challenged Claims of the '033 Patent fail to provide reasonable certainty concerning their outer boundaries and are therefore unpatentable as indefinite under 35 U.S.C. § 112.

203. In signing this declaration, I understand that the declaration will be filed as evidence in a review proceeding before the Patent Trial and Appeal Board of the U.S. Patent and Trademark Office. I acknowledge that I may be subject to cross examination in the case and that cross examination will take place within the United States. If cross examination is required of me, I will appear for cross examination within the United States during the time allotted for cross examination.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of the Title 18 of the United States Code and that such willful false statements may jeopardize the results of these proceedings.

Executed on: 4/25/2024


Raymond D. Riley, Ph.D.

APPENDIX A MATERIALS CONSIDERED

Exhibit	Description
1001	U.S. Patent No. 11,707,033
1002	Prosecution History of U.S. Patent No. 11,707,033
1005	U.S. Patent No. 9,572,319 (“Ross”)
1006	U.S. Patent No. 9,706,732 (“Carlone”)
1007	U.S. Patent No. 10,653,095 (“Heffner”)
1008	Plant Variety Protection Certificate No. 201700133
1009	Plant Variety Protection Certificate No. 201700146
1010	Plant Variety Protection Certificate No. 202000334
1011	Lundmark, C. Genetically Modified Maize. <i>BioScience</i> 2007, 57, 996
1012	Lee, E.A.; Tracy, W.F. <i>Modern Maize Breeding</i> , in Handbook of Maize: Genetics and Genomics; Bennetzen, J.L., Hake, S., Eds.; Springer: New York, NY, USA, 2009; pp. 141–160. ISBN 978-0-387-77863-1
1013	Byerlee, D., <i>The Globalization of Hybrid Maize, 1921–1970</i> , J. Glob. Hist., 15:101–122 (2020)
1015	Andorf et al., <i>Technological advances in maize breeding: past, present and future</i> , Theor Appl Genet., 132(3):817-849 (2019)
1016	Fehr et al., Principles of Cultivar Development (1987)
1017	Wych et al., Production of Hybrid Seed, Corn and Corn Improvement, Chapter 9 (1988)
1018	Schnable et al., The B73 Maize Genome: Complexity, Diversity, and Dynamics, <i>Science</i> , 326:1112-1115 (2009)
1019	“A Brief History of Corn – From Domestication to 1995,” Pioneer Hi-Bred International, Inc. (Dec. 19, 2022), https://www.pioneer.com/us/agronomy/domestication-of-corn.html
1020	Geiger, <i>Doubled Haploids in Hybrid Maize Breeding</i> , <i>Maydica</i> 54:485-99 (2009)
1021	Weber, <i>Today’s Use of Haploids in Corn Plant Breeding</i> in <i>Advances in Agronomy</i> , Volume 123 (2014)
1030	Brief for the United States as Amicus Curiae Supporting Respondent, <i>J.E.M. AG Supply, Inc. v. Pioneer Hi-Bred Int’l, Inv.</i> , 534 U.S. 124 (2001) (No. 99-1996) (filed January 2001)
1031	Lande, “Efficiency of Marker-Assisted Selection in the Improvement of Quantitative Traits,” <i>Genetics</i> 124:743-56 (1990).
1032	Heffner, “Genomic Selection for Crop Improvement,” <i>Crop Science</i> , 49:1-12 (2009).

Exhibit	Description
1033	Excerpts from Encyclopaedia Britannica
1034	Excerpts from Merriam-Webster's Collegiate Dictionary (11th ed. 2006)
1035	Altman, <i>Standard deviations and standard errors</i> , Brit. Med. J., 331:903 (2005)
1036	U.S. Patent No. 10,021,846
1037	U.S. Patent No. 10,420,308
1038	U.S. Patent No. 10,368,514
1039	U.S. Patent No. 10,238,072
1040	U.S. Patent No. 10,117,397
1041	U.S. Patent No. 10,085,408
1042	U.S. Patent No. 9,986,706
1043	U.S. Patent No. 9,968,060
1044	U.S. Patent No. 9,955,657
1045	U.S. Patent No. 9,955,661
1046	U.S. Patent No. 9,936,664
1047	U.S. Patent No. 9,877,447
1048	U.S. Patent No. 9,877,457
1049	U.S. Patent No. 9,872,476
1050	U.S. Patent No. 9,861,062
1051	U.S. Patent No. 9,861,058
1052	U.S. Patent No. 9,814,197
1053	U.S. Patent No. 11,758,864
1054	U.S. Patent No. 11,744,204
1055	U.S. Patent No. 11,622,520
1056	U.S. Patent No. 11,582,939
1057	U.S. Patent No. 9,737,020
1058	U.S. Patent No. 11,730,115
1059	"Genotypes," panzea.org/genotypes
1060	U.S. Patent No. 10,912,266
1064	"Corn Leaf Angle Response to Plant Density," Pioneer Hi-Bred International, Inc. (Dec. 19, 2022), https://www.pioneer.com/us/agronomy/corn-leaf-angle-response-plant-density.html
1065	Fageria, "Phosphorus-Use Efficiency by Corn Genotypes," J. Plant Nutrition, 20:1267 (1997)
1066	U.S. Patent No. 9,930,848
1067	"Agricultural Biotechnology Glossary," U.S. Department of Agriculture, https://www.usda.gov/topics/biotechnology/biotechnology-glossary .

Exhibit	Description
1068	Merriam-Webster, Ninth New Collegiate Dictionary (1984)
1069	U.S. Patent No. 11,659,803
1070	U.S. Patent No. 11,666,020
1071	U.S. Patent No. 11,696,545
1072	Crop Science Society of America, “Glossary of Crop Science Terms,” https://www.crops.org/publications/crops-glossary/browse/r/
1073	Excerpts from Merriam-Webster’s Ninth New Collegiate Dictionary (1984)
1075	U.S. Patent No. 5,082,992
1076	U.S. Patent No. 5,347,081
1077	U.S. Patent No. 5,444,178
1078	U.S. Patent No. 5,453,564
1079	U.S. Patent No. 5,463,173
1080	U.S. Patent No. 5,491,295
1081	U.S. Patent No. 5,495,069
1082	U.S. Patent No. 5,502,272
1083	U.S. Patent No. 5,506,367
1084	U.S. Patent No. 5,534,661
1085	U.S. Patent No. 5,545,813
1086	U.S. Patent No. 5,557,035
1087	U.S. Patent No. 5,567,861
1088	U.S. Patent No. 5,569,822
1089	U.S. Patent No. 5,633,427
1090	U.S. Patent No. 5,689,034
1091	U.S. Patent No. 5,689,036
1092	U.S. Patent No. 5,159,133
1093	U.S. Patent No. 8,563,836
1096	USDA Agricultural Marketing Service, Objective Description of Variety—Corn (<i>Zea mays</i> L.), https://www.ams.usda.gov/sites/default/files/media/28-Corn%20ST-470-28%202015.pdf
1100	Comparison between EX1001 (’033 Patent) and EX1005 (Ross)
1102	Comparison between EX1001 (’033 Patent) and EX1007 (Heffner)

Appendix B

	US Patent No. 11,707,033			
	Variety: 1PNZQ23			
	95% CI			
	Value	SE	Low CI	High CI
PLANT:				
Plant height (to tassel tip) (cm), mean (SE)	198.2	7.88	182.8	213.6
Ear height (to base of top ear node) (cm), mean (SE)	78	6.35	65.6	90.4
Length of Top Ear Internode (cm), mean (SE)	10.9	1.49	8.0	13.8
Number of Nodes Above Ground, mean (SE)	13.4	0.73	12.0	14.8
LEAF:				
Width of Ear Node Leaf (cm), mean (SE)	9	0.59	7.8	10.2
Length of Ear Node Leaf (cm), mean (SE)	66.8	2.93	61.1	72.5
Number of Leaves Above Top Ear, mean (SE)	5.5	0.5	4.5	6.5
Leaf Angle (degrees) (at anthesis, 2nd leaf above top ear to the stalk), mean (SE)	31	4.64	21.9	40.1
TASSEL:				
Number of Primary Lateral Branches, mean (SE)	8.6	2.5	3.7	13.5
Number of Secondary Branches, mean (SE)	1.2	0.96	-0.7	3.1
Branch Angle from Central Spike (degrees), mean (SE)	10.3	5.12	0.3	20.3
Tassel Length (from peduncle node to tassel tip) (cm), mean (SE)	56.7	2.48	51.8	61.6
Peduncle Length (from top leaf node to lower branch) (cm), mean (SE)	26	2.46	21.2	30.8
Central Spike Length (cm), mean (SE)	19.6	1.53	16.6	22.6
Flag Leaf Length (cm) (from flag leaf collar to tassel tip), mean (SE)	42.9	2.03	38.9	46.9
EAR (Unhusked ear):				
Length of Interior Husk (cm), mean (SE)	16.7	0.96	14.8	18.6
EAR (Husked ear data):				
Shank Length (cm), mean (SE)	12.2	1.86	8.6	15.8
Ear Length (cm), mean (SE)	14.5	0.66	13.2	15.8
Ear Diameter at mid-point (mm), mean (SE)	43.6	1.56	40.5	46.7
Ear Weight (gm), mean (SE)	122	13.47	95.6	148.4
Number of Kernel Rows, mean (SE)	16.8	1.1	14.6	19.0
Number of Kernels Per Row, mean (SE)	23	2.22	18.6	27.4
KERNEL (Dried):				
Kernel Length (mm), mean (SE)	11.5	1.04	9.5	13.5
Kernel Width (mm), mean (SE)	7.5	0.81	5.9	9.1
COB:				
Cob Diameter at mid-point (mm), mean (SE)	23.2	1.06	21.1	25.3

US Patent No. 9,572,319 (Ross)						Within Overlap?
Variety: PH1VKM						
	95% CI					
Value	St Dev	No.	SE	Low CI	High CI	
252.4	8.3	20	1.9	248.8	256.0	-
97.7	10.8	20	2.4	93.0	102.4	-
19.4	0.8	20	0.2	19.1	19.7	-
13.9	0.4	20	0.1	13.7	14.1	Yes
9.8	0.5	20	0.1	9.6	10.0	Yes
81.4	2.1	20	0.5	80.5	82.3	-
5.5	0.5	20	0.1	5.3	5.7	Yes
15.8	3.4	20	0.8	14.3	17.3	-
9.5	2.3	20	0.5	8.5	10.5	Yes
1.7	0.7	20	0.1	1.4	2.0	Yes
16.5	6.0	20	1.3	13.9	19.1	Yes
64.1	3.5	20	0.8	62.6	65.6	-
39.8	3.1	20	0.7	38.5	41.1	-
25.1	2.7	20	0.6	23.9	26.3	-
50.9	3.1	20	0.7	49.5	52.3	-
18.8	1.3	20	0.3	18.2	19.4	Yes
7.6	1.9	20	0.4	6.8	8.4	-
14.8	0.7	20	0.2	14.5	15.1	Yes
45.6	1.2	20	0.3	45.1	46.1	Yes
130.8	10.9	20	2.4	126.0	135.6	Yes
17.4	1.2	20	0.3	16.9	17.9	Yes
26.5	1.6	20	0.3	25.8	27.2	Yes
12.3	0.4	20	0.1	12.1	12.5	Yes
7.7	0.5	20	0.1	7.5	7.9	Yes
26.0	1.0	20	0.2	25.6	26.4	-

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U.S. 9,706,732 (Carlone)							Within Overlap?
Variety: PH2DYM							
	95% CI						
Value	St Dev	No.	SE	Low CI	High CI		
208.7	8.91	20	1.992337	204.8	212.6	Yes	-
54.4	8.07	20	1.804507	50.9	57.9	-	-
17.4	0.91	20	0.203482	17.0	17.8	-	-
12.7	0.48	20	0.107331	12.5	12.9	Yes	-
9.7	0.56	20	0.12522	9.5	9.9	Yes	-
75.6	3.49	20	0.780388	74.1	77.1	-	-
5.6	0.49	20	0.109567	5.4	5.8	Yes	-
29.6	4.21	20	0.941385	27.8	31.4	Yes	-
7.4	1.96	20	0.438269	6.5	8.3	Yes	-
0.9	0.73	20	0.163233	0.6	1.2	Yes	-
13.4	4.71	20	1.053188	11.3	15.5	Yes	-
64.3	2.22	20	0.496407	63.3	65.3	-	-
26.7	1.42	20	0.317522	26.1	27.3	Yes	-
24.7	1.87	20	0.418145	23.9	25.5	-	-
50.2	1.63	20	0.364479	49.5	50.9	-	-
18.7	1.09	20	0.243731	18.2	19.2	Yes	-
11.2	3.27	20	0.731194	9.8	12.6	Yes	-
15.0	1.18	20	0.263856	14.5	15.5	Yes	-
44.0	2.05	20	0.458394	43.1	44.9	Yes	-
128.5	16.10	20	3.600069	121.4	135.6	Yes	-
19.1	1.79	20	0.400256	18.3	19.9	Yes	-
26.6	2.94	20	0.657404	25.3	27.9	Yes	-
12.2	0.62	20	0.138636	11.9	12.5	Yes	-
7.4	0.44	20	0.098387	7.2	7.6	Yes	-
25.8	1.12	20	0.25044	25.3	26.3	Yes	-

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US Patent No. 10,653,095 (Heffner)				Within Overlap?
Variety: PH487D				
	95% CI			
Value	SE	Low CI	High CI	
200.9	6.55	188.1	213.7	Yes
75.1	9.43	56.6	93.6	Yes
16.3	1.38	13.6	19.0	Yes
10.7	0.46	9.8	11.6	-
8.2	0.65	6.9	9.5	Yes
67.8	4.68	58.6	77.0	Yes
5.8	0.51	4.8	6.8	Yes
27.4	10.79	6.3	48.5	Yes
3.7	1.73	0.3	7.1	Yes
0.7	0.56	-0.4	1.8	Yes
12.0	5.34	1.5	22.5	Yes
53.9	2.06	49.9	57.9	Yes
25.0	2.92	19.3	30.7	Yes
25.8	1.99	21.9	29.7	Yes
29.3	2.41	24.6	34.0	-
14.8	2.52	9.9	19.7	Yes
11.6	2.79	6.1	17.1	Yes
14.2	0.93	12.4	16.0	Yes
41.7	1.50	38.8	44.6	Yes
118.1	11.38	95.8	140.4	Yes
16.3	1.14	14.1	18.5	Yes
24.4	3.24	18.0	30.8	Yes
10.9	0.50	9.9	11.9	Yes
7.6	0.60	6.4	8.8	Yes
21.3	1.57	18.2	24.4	Yes

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