# Patents and Vegetable Crop Diversity


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*Editor's Note: Post Professor Paul Heald has been working with UGA Anthropology doctoral candidate Susannah Chapman on a comprehensive study of the role patents play in the diversity of commercially available crops. To date, their work has been published in three papers. The following is based on the second paper, which specifically addresses the role of patents in vegetable crop diversity today.*

Contrary to conventional wisdom, the 20th century was not a disaster for vegetable crop diversity. A complete inventory of all North American commercial seed catalogs undertaken in 1903 and 2004 both reveal around 7,000 different varieties offered for sale.[1]

Because only a little more than 400 of the modern varieties date from 1903 or earlier, the data suggest an impressive amount of innovative activity between 1903 and 2004.

About 6,500 of the 2004 varieties are 20th century innovations or imports, suggesting that thousands of other new varieties came and went in the years between 1903 and 2004.

## What drives the cycle of continuing innovation: patented inventions, unpatented creations or importation?

The data presented herein strongly suggest that the intellectual property system[2] (including the Plant Patent Act, the Plant Variety Protection Act and utility patents [collectively hereinafter "patents"]) plays an insignificant role in vegetable crop diversity, with the possible exception of corn.

The vegetables chosen for study were part of a unique inventory undertaken by the U.S. Department of Agriculture in 1903 that listed every variety of 69 different vegetables available in commercial seed catalogs in 1901-02.

Forty-two[3] of those vegetable types have been subject to the same inventory process conducted by the Seed Savers Exchange six times since 1981.[4]

The comparison of the 1903 inventory with the 2004 inventory permits a direct measurement of how many of the 2004 varieties are 20th century innovations or imports, as opposed to old-timers.

The 6,499 "new" varieties available in 2004 were studied to determine which are subject to pending or expired patents.

In addition, data was gathered from the U.S. Patent Office and the USDA Plant Variety Protection Office on all varieties, including those never commercialized, among each of the 42 vegetable types. This new data set permits the first comparison of the overall number of patents granted to the number of patented varieties actually commercialized.

For each vegetable, the accompanying spreadsheet on the next page lists the number of varieties available commercially in 2004, the number of patents issued for new varieties and the number of patented varieties that were commercially available in 2004.

## Common Vegetables Excluding Corn

Upon evaluation of the data, it was found that few patented vegetables have ever been commercialized and, as a result, patents do not seem to be a driving force in the marketing of new vegetable varieties.

Omitting corn, of the 6,674 varieties of common vegetables available in commercial catalogs in 2004, only 191 were subject to pending patents, while another 74 were subject to expired patents.

Therefore, only 4 percent of available varieties have ever been subject to private intellectual property rights, which supports the conclusion that the vast majority of extant diversity in the U.S. vegetable market is due to local innovation or importation.[5]

However, patent rights seem to play a marginally more important role in some vegetable types than others.

For example, of the 771 types of garden and field beans available in 2004, 78 of them were subject to pending or expired patents, a rate of slightly more than 10 percent.

Similar rates are shown for lettuce and watermelon: 520 available varieties of lettuce were subject to 60 expired or pending patents, with 162 varieties of watermelon subject to 20 expired or pending patents. Also, peas approached a 15 percent rate (36/249 or 14.5 percent).

On the other hand, several vegetable types have no commercially available varieties subject to patents, including asparagus, broccoli, carrots, garlic and spinach.

Perhaps the most telling is tomatoes, where 1,536 varieties in 2004 were subject to only 2 pending and 3 expired patents.[6]

Irrespective of commercialization, some vegetables have been subject to more patenting activity than others.

### More Seed Diversity Ø More Consumer Choices

It is interesting to note that the variety of non-corn vegetables seen in commercial seed catalogs far exceeds the diversity we see on supermarket shelves and in massive farming operations.

The data do not suggest monoculture is not a problem in those markets, but rather shows that a wide variety of germplasm is available to address future needs to breed disease-resistant, pest-resistant and drought-resistant vegetable strains. Moreover, this pool seems unaffected by the operation of intellectual property law.

Patents have been issued on 441 varieties of garden and field beans, 363 varieties of lettuce, 308 varieties of peas and 84 varieties of tomatoes.

However, fewer than 5 patents have been issued on varieties of brussels sprouts (2), cabbage (2), carrots (4), eggplant (3), garlic (4), spinach (1) and turnips (1).

## Commercialization of Patents

Omitting corn, 1,675 patents have been issued as of October 2009. What is more interesting, however, is the rate at which these patents have been commercialized.

Excluding corn, 265/1,675 or 16 percent of all vegetable varieties that have ever been patented were commercially available in 2004. This is an intriguing number.

Those conversant with the economic literature on patenting are familiar with the assumption that only a small percent of patents are ever commercialized, perhaps as low as 2 to 5 percent.[7]

Compared to typical inventors, it appears that creators of new plant varieties are several times more likely to get their innovations to the market.

In fact, the historical commercialization rate for patented vegetables is probably higher than 16 percent, given that some previously commercialized patented varieties almost certainly dropped out of the market before 2004.[8]

The data add significantly to our understanding of the relationship between patenting and commercialization activity.

On the other hand, as noted earlier, 96 percent of the diversity in the vegetable crop market is due to non-patented innovation or importation of new varieties, suggesting that despite the surprisingly high commercialization rate, the patent system remains an insignificant source of overall innovation.

Commercialization rates for particular patent vegetable varieties do not vary dramatically.

Exceptions include watermelons, where 56 percent that have ever been patented (20/36) were still commercially available in 2004. Also on the high side are peppers, at 23 percent.

The vegetables that attract the most patenting activity (beans and lettuce) do not stray too far from the norm of 16 percent.

On the low side, only about 5 percent of

patented peanut and tomato inventions were still commercially available in 2004.

Although full data on obsolescence cycles are not yet available for the varieties studied, the data show that 74 of the commercialized varieties in 2004 were subject to expired patents. This means about 4.4 percent (74/1,675) of all vegetable patents ever issued subsist in formerly patented commercialized inventions that are at least 20 years old.

If assumptions are correct that less than 5 percent of patents are *ever* commercialized, it is remarkable to see almost 5 percent of plant patents still commercialized 20 years after their invention. This suggests innovations in vegetable markets have a longer shelf life than non-plant innovations.

## Corn

Corn appears to be *sui generis* among the 1903 varieties inventoried (although a cursory look at patenting data suggests that soybeans and canola, both outside the present study because 1903 data are not available, may be similar).

First of all, there are almost as many corn patents (1,564) as patents for all other vegetables studied (1,675).

The proportion is even more striking in the field of utility patents, where 675 out of 854 patents studied were issued for new varieties of corn.

| Vegetable Crop | Varieties Available in 2004 | Plant Patents | Utility Patents | Plant Variety Protection Certificates | Total Patents | Commercialized Patents Pending | Commercialized Expired Patents | 1903 Varieties Available in 2004 |
|---|---|---|---|---|---|---|---|---|
| Artichoke | 13 | 16 | 1 | 3 | 20 | 2 | 0 | 2 |
| Asparagus | 13 | 28 | 0 | 0 | 28 | 0 | 0 | 3 |
| Lima Bean | 69 | 0 | 0 | 10 | 10 | 0 | 0 | 10 |
| Garden/Field Bean | 771 | 0 | 14 | 427 | 441 | 58 | 20 | 34 |
| Beets | 92 | 0 | 7 | 0 | 7 | 0 | 0 | 13 |
| Broccoli | 32 | 0 | 14 | 7 | 21 | 0 | 0 | 1 |
| Brussels Sprouts | 14 | 0 | 2 | 0 | 2 | 0 | 0 | 2 |
| Cabbage | 81 | 0 | 2 | 0 | 2 | 0 | 2 | 21 |
| Carrot | 127 | 0 | 0 | 4 | 4 | 0 | 0 | 14 |
| Cauliflower | 55 | 0 | 2 | 17 | 19 | 2 | 1 | 3 |
| Celeriac | 14 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| Celery | 66 | 0 | 11 | 20 | 31 | 3 | 1 | 8 |
| Collards | 14 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| Field Corn | 242 | 0 | 675 | 889 | 1,564 | Not Available | Not Available | 15 |
| Cress | 29 | 0 | 0 | 0 | 0 | 0 | 0 | 8 |
| Cucumber | 133 | 0 | 1 | 1 | 2 | 2 | 0 | 15 |
| Eggplant | 102 | 0 | 0 | 3 | 3 | 1 | 0 | 4 |
| Endive | 48 | 0 | 0 | 1 | 1 | 0 | 0 | 3 |
| Garlic | 274 | 3 | 1 | 0 | 4 | 0 | 0 | 0 |
| Kale | 52 | 0 | 1 | 0 | 1 | 0 | 0 | 9 |
| Kolrabi | 15 | 0 | 1 | 0 | 1 | 0 | 0 | 3 |
| Leek | 66 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| Lettuce | 520 | 0 | 52 | 311 | 363 | 54 | 6 | 25 |
| Muskmelon | 200 | 0 | 4 | 23 | 27 | 0 | 2 | 16 |
| Mustard Greens | 42 | 0 | 6 | 2 | 8 | 0 | 0 | 5 |
| Okra | 51 | 0 | 0 | 1 | 1 | 0 | 0 | 3 |
| Onion | 222 | 0 | 1 | 59 | 60 | 2 | 5 | 21 |
| Parsley | 52 | 0 | 0 | 1 | 1 | 0 | 1 | 9 |
| Parsnip | 21 | 0 | 0 | 1 | 1 | 1 | 0 | 2 |
| Sweet/Field Pea | 249 | 0 | 2 | 306 | 308 | 21 | 15 | 19 |
| Peanut | 21 | 0 | 3 | 67 | 70 | 3 | 1 | 4 |
| Peppers | 647 | 6 | 3 | 31 | 40 | 8 | 1 | 14 |
| Radish | 138 | 0 | 1 | 6 | 7 | 1 | 4 | 19 |
| Rutabaga | 29 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| Salsify | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| Spinach | 31 | 0 | 0 | 1 | 1 | 0 | 0 | 4 |
| Squash | 456 | 0 | 5 | 11 | 16 | 11 | 6 | 21 |
| Sunflower | 110 | 0 | 18 | 35 | 53 | 2 | 3 | 1 |
| Swiss Chard | 66 | 0 | 0 | 1 | 1 | 1 | 0 | 1 |
| Tomato | 1,536 | 4 | 23 | 57 | 84 | 2 | 3 | 45 |
| Turnip | 38 | 0 | 1 | 0 | 1 | 0 | 0 | 12 |
| Watermelon | 162 | 0 | 3 | 33 | 36 | 17 | 3 | 11 |
| Total | 6,916 | 57 | 854 | 2,328 | 3,239 | Not Available | Not Available | 417 |
| Total w/o Corn | 6,674 | 57 | 179 | 1,439 | 1,675 | 191 | 74 | 402 |

Note: The names of the commercially available varieties, with the exception of corn, are available from Heald and Chapman. The larger uncompleted project tracks several fruit and vegetable types from 1900 to 2005 to analyze time-sensitive trends and exogenous variables not captured in the table above.

Although more research needs to be done, the data may provide evidence of a large-market effect.[9]

The value of the 2008 U.S. corn crop was $47 billion,[10] while the value of the entire non-corn U.S. vegetable crop in 2008 was only $21 billion.[11]

The lure of potential profits may be driving innovation in the corn field, but is there a causal connection between innovation and patenting activity?

By contrast, in 2004, there were 1,536 varieties of tomatoes commercially available, yet there have only been 84 tomato patents granted in U.S. history.

Clearly, innovation does not require a patent system for tomatoes, why should it for corn? And why do we see so much innovation in the much smaller market for tomatoes?

The size of the U.S. corn crop clearly makes it a special case, but precisely how size effects patenting behavior and innovation in that market, if it does at all, will not become clear until further study is completed.

Unfortunately, commercialization data will be difficult to obtain without the cooperation of the large seed corn companies. Even where company Web sites list available product varieties, they are not matched with their corresponding patents,[12] and unlike all other crop varieties, corn patents on file at the USPTO do not typically list varietal names.

## Conclusions

This study and its predecessor can help evaluate two common claims about IP protection for plants: 1) "IP results in increased genetic uniformity and, where diversity still exists, increased genetic erosion;"[13] and 2) "If plant breeders were not able to protect the plant varieties they develop from unauthorized reproduction, there would be less incentive for them to develop improved plant varieties."[14]

Patent law is likely neither the genetic erosion boogie man nor the carrot-of-invention savior at least when it comes to the diversity of vegetable crops as measured by their availability in commercial seed catalogs. Apart from corn, evidence gathered so far points to the irrelevancy of patent law.

**All three of Heald and Chapman's papers published to date can be found at:**

Crop Diversity Report Card for the Twentieth Century: Diversity Bust or Diversity Boom?
*http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1462917*

Patents and Vegetable Crop Diversity
*http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1507228*

Apple Diversity Report Card for the Twentieth Century: Patents and Other Sources of Innovation in the Market for Apples
*http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1543336*

## Endnotes

1 Paul J. Heald and Susannah Chapman's first paper, *http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1462917*, revealed there was not a significant loss in vegetable crop diversity as was previously accepted based on a 1983 study.

2 Plant patents for asexual reproduction (grafting and other forms of clonal propagation) became available in 1930, protection for sexual reproduction (seeds) became available in 1970, and utility patents for plants have been available since 1985. See Plant Patent Act, 35 U.S.C. § 161-63; Plant Variety Protection Act, 7 U.S.C. § 2321-2582; and Ex parte Hibberd, 227 U.S.P.Q. 443 (Bd. Pat. App. & Int. 1985).

3 The vast majority of the 27 vegetables inventoried in 1903 but not inventoried in 2004 consist of species that were never commercially important, e.g., burnet, chufas, flag, grass nuts, martynia, orach, rampion, roquette, scolymus, scorzonera or skirret. Also, our first study looked at a total 48 vegetables. Three were dropped for reasons of obscurity: cardoon, chicory and corn salad. The other three reductions came from combining lima beans into the general "garden/field bean" category and combining sweet corn, popcorn and field corn into "field corn."

4 Both the USDA in 1903 and the Seed Savers Exchange in 2004 inventoried all vegetable varieties listed for sale in every commercial seed catalog distributed in the United States and Canada. See W.W. Tracy, Jr., American Varieties of Vegetables for the Years 1901-02, 21 Bureau of Plant Industry Bulletin 7 (1903); Kent Whealy, Garden Seed Inventory: An Inventory of All Seed Catalogs Listing Non-Hybrid Vegetable Seeds in the United States and Canada (2005).

5 The third paper in this series addressed the question of the ratio of varieties between local innovation and importation. Only data from apples, not included in this study, has been collected so far. With apples, the ratio of local innovation to importation in the 20th century is 3:1.

6 Twenty-three different varieties of tomatoes have been patented under the utility patent system. In those cases, some of the inventors failed to provide a varietal name in their patent applications, so some of them may have been commercialized yet not counted here.

7 See, for example, Mark Lemley, Rational Ignorance at the Patent Office, 95 N.W. L. Rev. 1495, 1501, 1504 (2001) (estimating that only 5 percent of patents are ever licensed; about 2 percent are litigated).

8 Of the 265 patented varieties commercialized in 2004, just 74 were subject to expired patents while 191 were covered by pending patents. Not surprisingly, more recent inventions were more likely to be commercialized, suggesting that a significant number of patented inventions commercialized in earlier years had exited the market.

9 Analysts of foreign direct investment have noted that larger markets capture a disproportionate share of investment. See Daniel Lederman & William Maloney, Natural Resources: Neither Curse nor Destiny (2007). ("economies with large markets will get a disproportionately large share of increasing returns industries").

10 See *http://www.ncga.com/files/pdf/WOC2009MetricStatBook.pdf.*

11 See *http://www.ers.usda.gov/Briefing/Vegetables/.*

12 See, for example, Pioneer's product list for ZIP code 30605 by going to *http://www.pioneer.com/web/site/portal/menuitem.0128f8e2dab251f7bc0c0a03d10093a0/* and selecting "corn grain" from the drop-down menu on the right side under "Seed Products & Traits."

13 The Crucible Group, PEOPLE, PLANTS, AND PATENTS: THE IMPACT OF INTELLECTUAL PROPERTY ON TRADE, BIODIVERSITY, AND RURAL COMMUNITIES 17 (1994).

14 See *http://www.monsanto.com/foodinc/seeds_patents.asp.*