Iowa Crop Variety Yield Testing: A History and Annotated Bibliography

Lorraine J. Pellack* and Douglas L. Karlen

ABSTRACT
Variety testing by U.S. agricultural universities, often in cooperation with experiment stations, and professional crop associations is recognized as an independent, unbiased validation of the viability of commercial crop varieties. In Iowa, variety testing has also been conducted by many private agricultural companies and individual farmers. Records for crop variety evaluations within the state can be traced back to 1871, well before the creation of the Iowa Agricultural Experiment Station in 1888. The Iowa Corn Yield Test (ICYT) is undeniably the most famous of the Iowa variety yield trials; however, corn (Zea mays L.) varieties were being tested long before that program was initiated. Furthermore, Iowa researchers have been conducting variety yield tests on many other field crops. Knowledge of how Iowa variety tests have been organized and published could be helpful to researchers looking for similar, long-term evaluations from other states and around the world. Variety tests from the past also have the potential to help guide new research efforts and may provide an important untapped resource for unique varietal data. As crop scientists and agronomists look to find new sources for biofuels, bio-products, and other industrial uses for various crops, data from historical varieties could be useful. The objective for this review is to provide an historic account with sections on varietal testing in Iowa. It is presented in chronological order followed by sections devoted to specific crops. A Supplemental Information file containing a detailed annotated bibliography is also provided.

THIS REVIEW PROJECT started with a simple question: Where were Iowa corn variety yield test reports published, particularly for the years prior to what is available online? In the process of delving into the history of Iowa crop experimentation and publication practices, test results for many other crops were discovered and the project expanded to include all Iowa crop variety tests. It also became apparent that difficulties in locating older variety test reports were not unique to Iowa. The purpose of this review is to provide a history of field crop testing in Iowa and to identify publications and other sources of information that may contain useful yield test results for individual crop varieties. Crop variety trials have been...
conducted and results have been recorded and published in Iowa for nearly 150 years. However, locating varietal yield information is often complicated by several factors including: different types of yield reports; different types of tests or contests; similar terminology with very different meanings; published reports disseminated in a somewhat scattershot fashion through Experiment Station, Extension, or USDA publications; results in unpublished theses/dissertations or university library archives; and, private company yield testing results which are generally proprietary and rarely distributed outside of the company. Current practice in most U.S. states is to provide performance trial reports online each year. Typically, websites only provide reports for the most recent years and the most popular crops.

In the last 80 years, the literature of crop science has focused almost exclusively on breeding hybrid varieties, primarily to increase crop yields and profitability for farmers. Agronomists conduct crop experiments, record detailed data in field notebooks, and then summarize results as part of published journal articles. Unfortunately, the detailed experiment results from individual studies have been relegated to the filing cabinet and/or published in reports with limited distribution. The raw data also occasionally forms the basis of graduate student theses and dissertations (again, limited distribution and not included in indexes to agronomy literature). As researchers retired, their files were discarded or left behind for the next researcher to use. On occasion, the files were donated to a university archive. Historic accounts traditionally give an overview rather than details of specific crop experiments. The two main publications summarizing U.S. field crop variety experiments (Fehr, 1984; Smith et al., 2014) focused exclusively on the impact of genetic improvements. Only a few of the chapters included information on varieties prior to hybrid development and performance trial reports were rarely included in the chapter references. In addition, since their goal was to summarize yield developments for specific crops, very little information was provided on experiments at individual localities.

**What are Crop Variety Trials?**

Within this article, the phrase “variety yield tests” refers to field experiments where different crop varieties were grown and evaluated primarily for yield, but sometimes for many other important characteristics (e.g., disease resistance, lodging resistance, emergence characteristics, growth and development rates, etc.). The test results were generally used to alert local farmers to best management practices for growing specific crops and recommended varieties within specific geographic areas or on specific types of soil. In addition to genetic differences, some of the historical tests also quantified the impact of other factors such as tillage, type of fertilizer, soil, or crop rotation on yields. In general, the original intent for developing crop variety trials was to increase yield and thus help farmers make better-informed decisions that would ultimately lead to higher profitability. In later years, chemical composition in addition to crop yield was quantified to help increase industrial market demand for specific crops.

“Variety trials range from the initial studies involving small plots (single plants or single rows) to replicated yield trials involving fairly large plots” (Petersen, 1994, p.2). Petersen provides introductory information on the pros and cons of specific types of variety trial experiment designs and devotes the remaining chapters to special problems in trials such as perennial crop trials, on-station vs. off-station trials, pasture trials, and intercropping research.

While there are many reasons for differences in crop yields, even those grown under nearly identical conditions, early experiment designs eliminated as many variables as possible. From the very beginning, accuracy and repetition were considered to be “absolutely necessary” and essential as well as making allowances for error (Convention of Friends of Agricultural Education, 1967, p.36–37). For information on the history of experimental design, replication and statistical analysis in varietal testing the reader is referred to LeClerg et al. (1962, p. 105–136). Variety yield test publications vary in the level of detail provided on experimental methods. They were often a simple summary; however, some researchers also supplied in-depth plot design, replication, and harvesting information. Hitchcock (1921) summarized experimental methods used at the Iowa Agricultural Experiment Station for small grains and corn and then also compared Iowa methods to those in use at other U.S. stations at the time.

It should be noted that not all crop yield publications contain varietal information. One example is farm valuation studies which depend primarily on soil productivity and crop yield. Traditionally, soil productivity evaluations were based on yield estimates that were fairly subjective and varied widely, thus resulting in land appraisals that were very inconsistent. Starting in the mid-1930s, data from crop yield tests began to be used as a measure of soil productivity (Huddleston, 1984, p. 301–305), but for those studies, the specific crop variety was neither tested nor considered relevant. Instead, yield tests used for farm valuations looked closely at soil types, depth of topsoil, and slope.

**What Initiated Individual Variety Testing in the United States?**

VARIETAL experiments were a large part of discussions predating the Hatch Experiment Station Act of 1887. The Convention of Friends of Agricultural Education, held in Chicago on 24–25 Aug. 1871, focused on three themes. The first theme, which took up almost half of the meeting transcript, and was clearly quite contentious, dealt with experimental methods in agriculture (Convention of Friends of Agricultural Education, 1967). One of the Convention outcomes was Report of the Committee on Experiments, which
outlined experiments they felt colleges should conduct. It included “Experiments in special culture with different varieties of grasses, grains, roots, plants, trees, etc.” (Convention of Friends of Agricultural Education, 1967, p. 108). In the early 1900s, as part of early meetings of the American Society of Agronomy, there were numerous discussions of experimental design and Wiancko (1907–1909, p. 29) asserted that “the all-around best variety of any crop can only be found after repeated tests of all the varieties available.” Given the number of available varieties, this was no small task.

Using corn as an example, E.G. Montgomery speculated that, there were “probably” about 1000 named varieties of corn and estimated that about three-quarters of them had been developed since 1840 (Montgomery, 1913, p. 78–79). Granted, many of these corn varieties were developed for specific geographic areas, climates, and/or soils around the world; however, it illustrates the massive number of seed choices available to farmers. There were 23 varieties of Dent corn principally grown in the Corn Belt (Bowman and Crossley, 1908, p. 424–446). Reid’s Yellow Dent was one of the most widely grown varieties, but even that variety had many strains developed and distributed by individual farmers. It did not take long for farmers to recognize that individual varieties had multiple characteristics that influenced not only yield but also composition and quality of the grain, and ease of harvesting. Therefore, as modern variety testing programs evolved, valuable report information included planting and maturity dates, emergence characteristics, plant growth, development and height, disease and insect resistance, nutrient use efficiencies, lodging characteristics, grain moisture content at harvest, and chemical composition. The composition measurements gradually led to further research to quantify seed characteristics including protein, oil quantity and quality, nutritional value, and other characteristics that could potentially influence other industrial uses. For an example of how these ancillary studies make use of Agricultural Experiment Station variety trials, the reader is referred to Schwarte et al. (2006) and Weiss (1950).

The success of individual varieties changed considerably within every geographic region due to variations in soil types and climate zones. Any variety can produce high yields within a specific area if growing conditions and management practices are optimum, but even with the same management practices, yields can be much lower in a different area of the county, state, or region. The success of a variety also depended on seed quality and crop management practices. During the early 20th century, improved farming practices (primarily adding lime, P, and K) increased productivity (i.e., yield per 0.41 ha [1 acre]) to a certain point for each type of soil, but after that, the emphasis shifted to crop breeding with a focus on achieving greater yields by producing high-yielding varieties. As a result, from 1910 to 1932, crop yields per 0.41 ha [1 acre] across the entire nation remained virtually constant but by 1937 they were clearly on the rise due to the increased use of hybrid varieties (USDA, 1962, p. 19).

Iowa Varietal Testing
Since the inception of organized crop variety testing, Iowa Agricultural Experiment Station researchers, like their counterparts in other U.S. states, have been continually developing and testing new crop varieties in each area and on different soil types within their states before recommending or discouraging specific varieties to farmers. Iowa crop variety trials initially included experiments on all types of field crops being grown in the state. The ultimate goal was to increase farm profitability through a combination of higher crop yields, lower production costs and education opportunities for farmers so they could develop more successful soil and crop management practices and thus achieve greater crop yields. Over time, the focus shifted to experiments on the most profitable crops—primarily corn, oat (Avena sativa L.), and soybean [Glycine max (L.) merill.]; however, Experiment Station researchers also continued to evaluate other field crops knowing that information would also be useful for other agronomists and Iowa farmers. In the 1930s, hybrid oat production was a very time intensive process so efforts to significantly improve that crop were not sustained (Thompson, 1940). Corn and soybean became the two main focal points for variety testing by Iowa researchers. This was easily justified because they were the most profitable for Iowa farmers to produce, and with the exception of a few periods when supply outstripped demand, markets for both have been fairly consistent.

Information on field crops produced in Iowa from 1866 to 1938 is available from Iowa Crop and Livestock Reporting Service (1938). Lists of specific crop varieties planted in Iowa from 1910 to 1929 are available in New Crop Varieties on Iowa Farms (Robinson, circa 1929). This provides yields and varieties for oat, wheat, barley (Hordeum vulgare L.), corn, sorghum [Sorghum bicolor (L.) Moench], soybean, sudan grass [Sorghum sudanense (Piper) Stapf], hubam clover [a unique varietal mixture of Melilotus officinalis and M. alba] and dalea [Dalea greggii]. Recommended crop varieties distributed to Iowa farmers from 1912 to 1963 for oat, wheat, barley, soybean, corn, sorghum and forage crops are provided in The Story of the Iowa Crop Improvement Association and Its Predecessors (Robinson and Knott, 1963, p. 130–131). As hybrid varieties were developed, and spread out among a large number of seed developers, good summaries of available varieties became somewhat tricky to locate; however, additional varietal information can be gleaned from the Seed Directory published annually by the Iowa Crop Improvement Association since 1909.

Results from Early Iowa Experiments
The earliest record of Iowa crop variety experiments is from 1871, pre-dating creation of the Iowa Agricultural
Experiment Station in 1888 by almost two decades. The Ninth Biennial Report for Iowa State Agricultural College includes information on 1.2 ha (3 acres) devoted to crop experiments. These were hardiness tests for specific varieties. Crops included spring and winter wheat, rye, winter oat, potato (Solanum tuberosum L.), and barley. It provides information on specific varieties planted and yields for each (Roberts, 1872). Biennial Reports exist for earlier years, but this was the first one to specifically include experimental information for field crops. The report also includes information from Charles E. Bessey (in the botany and horticulture department), who tested varieties of potato, tomato (Lycopersicon esculentum Mill.), cabbage (Brassica oleracea), beet (Beta vulgaris L.), and sweet corn. See True (1937) for information on early experiments in other U.S. states.

In 1894, C.F. Curtiss began incorporating “Experimental Crop Notes” into the Bulletin—Iowa Agricultural Experiment Station each year. The report covered winter wheat and root crops for stock. The 1895 report included winter wheat, oat, and corn. The 1896 report included those crops plus alfalfa (Medicago sativa L.) and potato. Information varied for each crop but included the number of hectares planted, planting and harvesting dates, and yields for each variety.

In 1904, The Iowa Agriculturist published an article, aimed at farmers, summarizing crop experiments being done by the Iowa Agricultural Experiment Station (Anonymous, 1904). The article describes experiments with corn breeding, reducing oat smut (along with a recommended cure—formalin), a variety test with fall wheat, cowpea [Vigna unguiculata (L.) Walp.] varieties, and forage experiments including three varieties of sorghum, five varieties of millet [Pennisetum glaucum (L.)] and 48 varieties of native and foreign grasses. Overall, the information provided was very generic, but it did include detailed information about eight varieties of cowpea being tested to determine which were best adapted to feed and which were better as fertilizing agents.

The examples given above are fairly typical examples of crop variety reports published during the early 1900s. Most reports were aimed at Iowa farmers although others were written for agronomists and researchers outside of Iowa. The name of a specific crop was rarely included in the article or report title, because they summarized experiments for several different crops. Additional examples of various crop experimental reports are presented in the Supplemental Information file for this article. Unfortunately, specific details regarding methods and results from those experiments are difficult, if not impossible, to locate. Some data may be found in early field notebooks contained in the Iowa State University Library, Special Collections & Archives Department (Allee, 1905–1908; Iowa Agriculture and Home Economics Experiment Station, 1931–ongoing; Iowa Crop Improvement Association, 1902–ongoing; Mosher, 1899–1979). In later years, Experiment Station researchers published journal articles with detailed methods and results from various crop experiments.

**Corn Testing in Iowa**

Early in the 20th century, plant breeders focused their attention on corn as it was rapidly becoming the most profitable crop for Iowa farmers. Early corn varietal testing in the state focused on the importance of good quality seed, especially proper storage to prevent moisture in the seed (Holden, 1905; Mosher, 1911). Later publications compared test results on the optimum number of kernels planted per hill for maximum yield per 0.41 ha (1 acre) (Mosher, 1962a, p. 23–28), fertilizer types and rates, and planting dates.

Perry Holden was hired by the Iowa State Agricultural College in the fall of 1902. He had previously worked at Funk Brothers Seed Company in Illinois and was determined to show farmers how to improve the quality of their seed. Holden had conducted experiments to prove that poor corn yields were mainly due to bad seed. At a Sioux County Farmers’ Institute meeting (in northwestern Iowa) in February 1903, farmers criticized Holden’s results as being not applicable to them because his tests were conducted in only one location, 200 miles away in central Iowa (Bliss, 1960, p. 34). It was well-known that northern Iowa farmers needed to plant an early maturing variety of corn due to the earlier onset of cold weather. The result was the creation of the Sioux County farm experimental plan (in cooperation with a group of farmers that attended the Farmers’ Institute) which was supported by County appropriations and land for the testing. The crop evaluations, conducted in cooperation with Iowa State College and the USDA, became the first County Cooperative Extension work conducted in the United States. These cooperative “Demonstration Farms” expanded rapidly to other areas of Iowa: 5 counties in 1904, 8 counties in 1905, and 10 in 1906 (Bliss, 1960, p. 36).

Holden became famous for establishing the Iowa Corn Trains (also referred to as the Seed Corn Specials or the Iowa Corn Gospel Trains) and organizing the first U.S. state extension service in 1906. All of these activities were initiated well before the passing of the Smith–Lever Act which established the Cooperative Extension Service in 1914. As with the Farmers’ Institute presentations, Holden’s focus for the corn train demonstrations was on producing good seed corn (Bliss, 1960, p. 37–38; Holden, 1906, p. 20–21). The Rock Island Railroad offered to run a special train with a lecture car if Holden would give the talks. Common practice at the time was for farmers to save their best ears of corn, dry it, and store it to use as the following years’ seed; however, sometimes there was still moisture within the kernels. The moisture froze in the winter and damaged some of the seed. This caused poor germination rates when planted in the spring. Holden provided visible proof of this to farmers and taught them how to prevent damaged seed corn and how to test the seed. “The corn trains brought the work of the
college before masses of farmers in a very effective manner” (Bliss, 1960, p. 37–41). Instead of just lecturing to the farmers, he brought charts and seed boxes and other illustrative materials to visibly make his point. Prior to Perry Holden’s corn trains in 1904 and 1905, farmers were “inclined to treat advice from the agricultural colleges with more or less contempt.” The special railroad car method and demonstrations used to educate farmers were “adopted by other states with marked success” (Trigg, 1905). For more information on Perry Holden and the Corn Trains see “P.G. Holden and the Corn Gospel Trains” (Sizer and Silag, 1981). In 1906, after the Iowa Legislature enacted the Agricultural Extension Act making funds available for demonstration projects, Martin Mosher (who was a student under Holden and served as one of the lecturers on the corn trains in 1905) was put in charge of conducting corn yield tests at various county farms in Iowa for Holden. Mosher went on to become the first county extension agent in Iowa (in Clinton County) in 1912. After leaving Iowa for a job in Illinois, Mosher established corn yield tests in Woodford County, Illinois, in 1919 and then campaigned to have these tests initiated by the USDA in many other Corn Belt states (Mosher, circa 1922).

The first year of state-wide corn yield testing took place in Iowa in 1920 (Mosher, circa 1921, p. 1) with the establishment of the Iowa Corn Yield Contest. “In the early years the test provided a means of locating high yielding varieties and strains of open-pollinated corn. Later it served as a very excellent vehicle to demonstrate the advantages of good hybrids over open-pollinated varieties, and then to calling attention to the best hybrids” (Robinson and Knott, 1963, p. 64). Professor H.D. Hughes and Henry A. Wallace are credited by many as being “largely responsible for starting the Iowa Corn Yield Test in 1920” (Robinson and Knott, 1963, p. 64–65; Sprague and Cunningham, 1946, p. 36–37). Hughes was in charge of the Experiment Farm Crops Station work and Wallace was active in the development of hybrid corn and the promotion of good farming practices. Hughes became famous for inventing the rag-doll seed tester and the clover-seed scarifier, he discovered annual white sweetclover (*Melilotus alba* Medik.), and found a way to dry corn in the crib. Rather than patenting any of these things, he chose to give them to America’s farmers (Gregg, 1922). Henry A. Wallace1 published numerous articles and editorials in his family’s newspaper, *Wallace’s Farmer*, which was widely distributed and read throughout the Midwest. He also developed a high-yielding hybrid in 1924 that was the first hybrid to win a gold medal at the Iowa Corn Yield Contest. Realizing there was no place for farmers to buy hybrid seed, Wallace founded the first hybrid corn company in Iowa in 1926. This became the largest hybrid seed company in the world, now known as Pioneer Hi-bred Corn Company.

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1 Henry A. was the third Henry Wallace in his family. He was the most famous of the three. Both Henry A. and his father (Henry C.) served as U.S. Secretary of Agriculture.

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**Corn Shows and Growers’ Contests**

Growers’ contests are exactly what they sound like (i.e., organized events where farmers entered samples of their crops in contests with each other). There were many different types of contests over the years. The first in Iowa were the “corn shows”, which were popular from around 1890 to 1920. Farmers entered their corn into contests that were designed to give a prize to the sample that “gave indications of having the greatest yielding power” (Wallace and Bressman, 1923, p. 199). Winning ears were those which judges felt would produce the largest number of shelled kernels, but they were judged based only on a visual examination of the ears. Wallace obliquely referred to corn show contests as beauty contests.

In 1914, H.D. Hughes and Joe L. Robinson began a systematic comparison of the yielding power of different strains of Reid’s Yellow Dent entered in the corn shows. Unlike the corn shows, Hughes and Robinson grew the strains for 3 years under uniform conditions. They found yield differences of 1.2 Mg ha⁻¹ (20 bushels to the acre) among the various strains. This study was very striking in that the results definitely showed that corn–show winnings were not related to yielding capacity (Hughes and Robinson, 1929). Consequently, more and more emphasis came to be placed on field performance tests rather than on physical appearance of the corn ears.

In spite of this shifting emphasis on performance tests, farmers continued to enter crop contests and the contests flourished for many years. Prize money could amount to as much as US$1500 a year and winning strains tended to result in increased seed sales for those farmers. One such contest for corn was the Iowa Master Corn Grower’s Contests (a.k.a. Ten Acre Corn Yield Contest—which was reduced to a 2.1 ha [5 acre] contest in 1955). This was started by the Iowa Crop Improvement Association in 1938. These were locally sponsored events (e.g., by local Farm Bureau offices) in which the winning entries were submitted to the district-level contest and then to the state level. They originated as an attempt to establish uniform requirements for local and county contests on a state-wide basis. A problem had arisen due to each group developing their own regulations. “As a result various claims were made for the highest yield, but generally the requirements under which they were produced varied to such an extent that yields between groups were not comparable” (Robinson and Knott, 1963, p. 48). Variety information was inconsistently recorded in the early years and was later dropped from the entry form altogether. Two attempts were made to study the contest data and try to determine the causes for the highest yields, but there was too much inaccuracy and not enough detail to draw conclusions (Robinson and Knott, 1963, p. 56–57). Raw data from these contests are available in the Iowa State University Library, Special Collections and University Archives Department (Iowa Crop Improvement Association, 1902–ongoing).
Demonstration Farms and Variety Tests before 1910

As mentioned earlier, the first demonstration farm in Iowa was established in 1903 in Sioux County, to test seed quality and replicate Perry Holden’s seed corn experiments under local conditions. The first demonstrations undertaken in Sioux County were what later came to be known as the Farmers’ Variety Test. They were planned as demonstrations rather than experiments. In keeping with Holden’s farmer education theme, each farm provided “field days” with organized programs for the public in the early fall of each year. This gave farmers the opportunity to visit the plots, learn about the experiments and ask questions (Mosher, 1962a, p. 16, 20–21). Corn variety testing was also being conducted at the Iowa State Agricultural College before 1910. According to a Bulletin published by P.G. Holden and widely circulated to Iowa farmers in December 1905:

“Last Spring, the Agricultural Department secured seed from more than ninety different sources. The corn was all collected from farmers living within a radius of 10 miles from Ames. To secure samples of corn actually planted, the farmers were visited and the corn taken either directly from the planter boxes in the field or from the sacks which the seed corn was being planted” (Holden, 1905, p. 172–173).

This sample collecting technique is nearly identical to that of the Farmers’ Variety Test procedures found in the Demonstration Farm Reports (see Farmers’ Variety Test section below). Holden does not provide any details as to which varieties were tested, but summarizes the results saying that the only real differences in the yields appeared to be due to difference in vitality of the seed, not the variety. Holden also states in the “Condition of Seed Corn” section (Holden, 1905, p. 170) that:

“Last winter and spring more than 3300 samples of seed corn were sent to the Experiment Station at Ames to be tested. These samples came from every section of the state and were made up in each case of 200 kernels taken from 100 ears, this giving a representative of each man’s seed. These samples were given a careful germination test.”

On pages 171–172, Holden provided details of the germination test. Other tests he mentioned included: record of individual ears, corn planter test, and shrinkage experiments from 1898 to 1905. He also provided a table with nine varieties and the rates of shrinkage for each variety (p. 180). Again, these were very similar to what is available from the Demonstration Farm Reports starting in 1910. Data from corn experiments during 1904 to 1911 are in unpublished manuscripts (Mosher, 1962a).

Farmers’ Variety Tests

Farmers’ Variety Tests for 1910 to 1916 can be found in Demonstration Farm Reports (Iowa State University Cooperative Extension Service, 1910–1916). These demonstrations took place on farms in about a third of Iowa’s 99 counties (Mosher, 1962a, p. 31) and were almost exclusively corn variety tests. The 1913 Allamakee County report (Demonstration Farm Report no. 45, published in 1914) was the first to cover oat (and only oat). Other atypical Demonstration Farm Reports were: No. 51, Scott County—covered corn, potato, and alfalfa; No. 56, Blackhawk County—covered only oat; No. 59, Hardin County—covered corn and oat; No.62, Clinton County—covered corn and oat.

Demonstration Farm Reports included: Farmers’ Variety Tests, Introduced Variety Tests, Thickness of Planting Tests, and Single Ear Tests. Other tests included in later years were: Depth of Planting Tests; Butt, Middle, and Tip Kernel Tests; and, Individual Ear Germination Tests. Demonstration Farm Report no. 2 gives this description of the Farmer’s Variety Test:

“This test was made to determine the relative yields obtained from different men’s seed corn when grown under uniform conditions. Samples of seed corn were obtained from 80 farmers in the following manner. Men were sent throughout the county at planting time with instructions to obtain a sample of seed corn from every man whom they saw planting corn. It was also ordered that the samples be taken from the planter box or sack which contained the seed in the field, so that they would accurately represent the seed planted by the farmers in their own field. These 80 samples were taken to the county farm, planted in the same field, and treated nearly alike as possible.”

This process of collecting samples is nearly identical to that of the ICYT and was clearly a predecessor to it; however, none of the tests involving uniform planting conditions were conducted on a state-wide basis until the Iowa Corn Yield Test was initiated in 1920.

Iowa Corn Yield Test

Iowa Corn Yield Tests have been sought after by researchers (within the state as well as beyond Iowa borders) since Iowa was the first state in which this sort of yield testing took place. They are the most complete tests and the variety results became even more important as hybrids were developed. These concepts are touched on in multiple sources (Jenkins, 1936, p. 479, 481–482; Robinson and Knott, 1963, p. 65; Sutch, 2008, p.7).

Even though corn variety yield tests were being conducted in Iowa as early as 1883 most historical accounts and current publications point to 1920 as the first year of the ICYT. For example, 2015 was the 96th consecutive year of the Iowa corn tests according to the introduction of
2015 Iowa Crop Performance Tests–Corn. Confusion regarding the official “start date” is likely due to several slight wording changes in test reports and similarity with other tests at the time. The earlier corn tests were conducted at the Iowa State Agricultural College or only in a few counties, they were not state-wide. In 1920, announcements and results referred to the yield test as the *Corn Yield Contest* sponsored by the Iowa Corn and Small Grain Growers’ Association. By 1923, the name was changed to the *Iowa Corn Yield Test* (rather than Contest) to avoid confusion with other ongoing corn growing contests around the state. According to the first page of the 1920 *Corn Yield Contest* report, the Iowa Corn and Small Grain Association began the contest “to determine the highest yielding corn in each section of Iowa.” The Association did not intend to “replace or duplicate individual farm and county tests by these state wide trials, but rather...aid and supplement them” (Iowa Corn and Small Grain Growers Association et al., 1920–1967, p. 3). Like other contests with farmer-supplied entries of crop samples: the Iowa Corn Growers Association (ICGA) charged an entry fee to each competitor; awarded premiums, ribbons, and ribbons to the top yielders; and a trophy for the highest-producing corn in the state (Robinson and Knott, 1963, p. 64, 68). The difference between the ICYT and corn growers contests is that the ICYT seed was obtained from farmers, but grown under “absolutely uniform conditions of soil, cultivation and other factors” (Iowa Corn and Small Grain Growers Association et al., 1920–1967). A very detailed description of the fields, plots, planting and harvesting processes, including transportation difficulties to/from the fields by railroad for the Experiment Station staff, their equipment, and the entrant seeds is included in *The Story of the Iowa Crop Improvement Association* (Robinson and Knott, 1963, p. 74–83). Robinson also describes changes that occurred over the years in test policies as well as processes. Another, more detailed, description of the corn yield test technique is available from *Corn and Corn Growing* (Wallace and Bressman, 1923, p. 205) and includes a discussion of benefits and difficulties.

Published reports of individual corn variety tests in Iowa are available for 1892 to present with some gaps and overlap. This includes:

- 1892, 1895, and 1896: *Bulletin* (Iowa Agricultural Experiment Station), No. 16, 19, 32, 34.
- 1909–1915—see *Demonstration Farm Reports*.
- 1920, 1921, 1922—*Iowa Corn Yield Contest* (published as separate reports). The results of the 1920 and 1921 contest were also reported in a thesis: Foiles, L.E. 1922. *A Study of Strains of Corn Entered in the Iowa Corn Yield Contest*. M.S. thesis. Iowa State University, Ames.
- 1923–1934 were published as separate reports named *Iowa Corn Yield Test Results for [year]*. Short summaries of the corn variety test results for 1930/1931–1933/1934 were also included in the *Report on Agricultural Research* from the Iowa Agricultural Experiment Station in those years.
- 1935–1938 in *Bulletin/Experiment Station, Iowa State College of Agriculture and Mechanic Arts*.
- 1939–1958 in *Bulletin P/Agricultural Experiment Station, Iowa State College*.
- 1959–1968 in *Bulletin P/Agricultural and Home Economics Experiment Station, Iowa State University of Science and Technology*.
- 1969 issued solely within the *Pamphlet* a.k.a. *Pm series as Pm–449*.
- 1970–1985 were co-published as part of the *Miscellaneous Bulletin series as well as Pm–481, 494, 523, 548, 580, 603, and 660*.
- 1986–1998 were published only within the *Pamphlet series as Pm–660*.
- 1999–2005 were co-published in the *Pamphlet series as Pm–660* and also as a supplement to the *Iowa Farmer Today*.
- 2006-present are online at: http://www.croptestingle.iastate.edu/Corn/Reports.aspx

Most of the reports give a summary of recent year’s results, so even if the publication for a specific year is missing or unavailable, the results can still be found by looking in a slightly newer test report. In addition to the published ICYT reports, the raw data from 1920 to 1951 tests are available for use in the Special Collections and University Archives Department, Iowa State University Library (Allee, 1901–1969, Iowa Crop Improvement Association, 1902–ongoing; Mosher, 1899–1979). These files give much more detail than the annual test reports provide, but many are handwritten in pencil and have fold-out tables that are not amenable to scanning/digitizing. The raw data also provides lists of farmers, their county, and varieties. The amount of detail available varies for each year. A chart listing the types of information that was recorded for each year of the ICYT from 1920 to 1962 is available in Robinson and Knott (1963, p. 88–89).

As mentioned earlier, Pioneer Hi-bred has also been heavily involved in corn hybrid development in Iowa. Their breeding program has been actively testing hybrid performance since 1924. Industry reports are often locked up in proprietary company files, however, Pioneer Hi-bred test results are available from two sources. Donald Duvick, a long-time employee and plant breeder for Pioneer Hi-bred, published a series of comprehensive, detailed articles cumulating results from corn performance trials of hybrids released by Pioneer Hi-bred from 1930 to 2000 (Duvick et al., 2004). A later publication by several other Pioneer researchers included information and data from 1930 to 2011 (Smith et al., 2014).
Oat

Varietal testing in Iowa was very different for oats than for corn—both in the testing process and the participating organizations. The Iowa Agricultural Experiment Station, and L.C. Burnett in particular, played a key role in the development and testing of oat varieties in the early years. According to H.D. Hughes, the Experiment Station was experimenting with oat in 1889 and reported that year on the performance of 15 varieties (Hughes, 1946, p. 45). “The job of getting out new varieties, especially adapted to the weather and soil conditions of Iowa and the Corn Belt generally, was not begun in an extensive way until 1907” (Hughes, 1945, p. 27). Hughes’ report, which summarizes oat production and variety development in Iowa pre-1945, includes considerable details for each oat variety in Iowa. He also highlights the work of L.C. Burnett who began Iowa oat variety testing in 1908 and published numerous bulletins and articles on the topic. Burnett has been described as “one of the most successful breeders of improved varieties of oat by the “pure-line” selection method in the United States” (Stanton, 1936, p. 357). Stanton also provided details on the oat varieties Burnett helped to improve.

“In 1909, the work in Illinois having been discontinued, the Iowa station was made the headquarters for the testing of the oat selections (in the U.S.).” At that time, the most extensive tests were being conducted at the Iowa and Cornell University experiment stations (Warburton et al. (1914), p. 2). “In 1912 (the Iowa Agricultural Experiment Station) reported on 48 varieties and in 1918 summarized 22 varieties that had been studied for 6 years and 17 varieties that had been studied for 10 years” (Hughes, 1946, p. 45). Hughes does not reference any specific documents; however, the dates match those of various Iowa Agricultural Experiment Station bulletins. For a detailed listing of these publications, see the Supplementary Information file associated with this article.

Seven years after L.C. Burnett began the Iowa oat improvement program, the first hybrid variety went out to farmers—the Iowa 103 in 1913 (Hughes, 1945, p. 43). When the first of the new oat varieties was available, farmers throughout the state were invited to test this variety on their own farms in cooperation with the Station, by planting a measured 0.41 ha (1 acre) in comparison with the variety they were growing. This method of distributing and testing the new Station varieties was continued from 1913 until 1938 (Hughes, 1945, p. 33–34). However, there were difficulties in threshing a small plot of grain and keeping it free from mixture with other varieties. This led to changes in the testing process and the establishment of the Standard Community Grain Trials.

Standard Community Grain Trials (SCGT) were a series of varietal experiments from 1938 to 1943 but very little information about them still exists. “Burnett initiated the Standard Community Grain Trials in 1938 to obtain more data and to show newer varieties locally” (Troyer, 2004, p. 181). The first pages of each “Leaflet F.C.” report of these trials provide a detailed description of the process. “These trials (were) conducted through a cooperation…between the Agronomy Section of the Agricultural Experiment Station, the Agricultural Extension Service and the various Farm Bureaus in the counties where the trials (were) conducted.” The SCGT were conducted in nine counties that “corresponded roughly to the principle soil areas in the state.” They covered oat and wheat. There were usually 30 to 50 trials in most years (Hughes, 1945, p. 34). For the full reports of each trial, see Burnett and Dyas (1940–1943).

Burnett extensively tested each variety for multiple years before sending it out to be used in the trials. “To begin with, each is planted in rows five feet long. Those that show enough stuff are planted again the next year in rows a rod long. Then if they continue to look good, they are moved up to 10-row plots, next to the special ‘elite’ nursery, and finally to the one-twentieth-acre plots, and the standard community grain trials out in the state” (Thompson, 1940, p. 14).

The Quaker Oats Company sponsored an Oats Improvement Program (starting in 1964) in Iowa and then later expanded it to include the top oat producing states: Minnesota, North Dakota, South Dakota, and Wisconsin. The goal was to teach high school students “the principles of growing milling quality oat through participation in a yield contest” and the results “provided practical, on-farm evidence that oat yields in Iowa and the United States could be substantially higher with careful management.” Students selected a cultivar from a list of those acceptable for their state but “no other management variables were specified.” The student project yields were 47% higher than average Iowa farm yields (Marshall et al. (1992), p. 193–194). Unfortunately, yield data that Marshall provided was from unpublished reports supplied by a Quaker Oats Company employee (A. Bruce Roskens) in 1990 and Marshall did not include any variety−specific information. The program ended in 2000 when PepsiCo bought Quaker Oats and the original yield data has disappeared within company walls.

Published reports of oat variety tests in Iowa are available for 1889 to present with some gaps and overlap. This includes:

- 1871, see Roberts (1872).
- 1889, 1891, 1898–1934, Bulletin (Iowa Agricultural Experiment Station), No. 6, 15, 96, 128, 175, 227, 344
- 1909–1912, see also USDA Department Bulletin, No. 99
- 1910–1923, see also USDA Department Bulletin, No. 1343
- 1916–1938, see Thurman (1940).
- 1940–1943, see Burnett and Dyas, 1940–1943, Leaflet FC, No.11, 13, 15–16
1992

Soybean

Soybean evaluations at the Iowa Agricultural Experiment Station can be traced as far back as 1898, but the first year that soybean hectares were mentioned in agricultural statistics reports as being harvested for the bean (rather than hay) was in 1923. It was not until the 1930s that the soybean crop began to have a real impact on Iowa agriculture (Hughes, 1941/1942, p. 19–25). Hughes provides an excellent history of soybean experiments in Iowa from 1910 to 1940. Although he does not provide information on yields for specific varieties, he does summarize which were recommended for specific time periods and lists individual researchers and key Iowa State College publications during this time period.

A surprisingly large number of soybean varieties were tested in Iowa in the early 1900s. “One hundred and fifty-seven varieties of soybean have been under observation at Ames” (Hughes and Wilkins, 1925). “Soybeans for Iowa” is one of the best sources of information on early soybean variety testing in Iowa. This Bulletin reported the results of variety tests covering 6–to-10-year averages and most of the cultural studies were 5 to 8 years in length. It provides information on the varieties and yields from 1915 to 1924 and has very comprehensive, detailed information on cultural methods. Although Wilkins was listed as the second author on many Iowa soybean publications, he was the leader of the soybean project at Iowa State College until his death in 1936 (Anonymous, 1944) and he co-authored many other articles on soybean varieties and production with H.D. Hughes.

In 1937, Martin G. Weiss took over the leadership of soybean projects at Iowa State College and began something officially called Soybean Variety Tests in Iowa. Weiss was called to active military duty in January 1942 (World War II) and soybean work was taken over by Charles R. Weber and then Robert R. Kalton when Weber was also called into military duty. In 1937, “[t]he field soybean variety yield tests conducted at Ames consisted of four sub-projects, namely, Soybean Variety Test, Soybean Rod 2-Row Test, Rod Row Test, and Soybean Hay Variety Test” (Burnett and Reddy, 1937). Descriptions and results of these are available on p. 54 to 107 of the Soybean Investigations Annual Report for 1937. The types of tests conducted varied slightly each year.

Unlike other Iowa field crops, research on soybean became organized and disseminated as part of regional efforts in 1936 with the organization of the Regional Soybean Industrial Products Laboratory. This was a joint venture between the U.S. Department of Agriculture and the Agricultural Experiment Stations of the 12 states in the north-central region. Regional variety tests were organized and implemented by this Laboratory (Weiss, 1949, p. 150). Soybean varietal test results for each state were included within one of two series—Results of the Cooperative Uniform Soybean Tests (1941–1965) and Uniform Soybean Tests (1966–present). Each series was divided into two separate publications, one for northern states and one for southern states. The title of the North region varied over time including North Central States, North Central Region, and Northern Region. Results for northern states (which includes Iowa) for 2003 to present are online at: https://ag.purdue.edu/btny/Extension/Pages/extpubs.aspx

Soybean was often called soy beans or soya beans and spelled as two separate words rather than one. Since they were originally grown as a forage crop, and also sown in with other crops (such as corn) as a companion crop, it can be challenging to locate yield results. Published reports of soybean variety tests in Iowa are generally available for 1900 to present, although there are a few gaps and some overlap. This includes:

- 1900–1901, Bulletin (Iowa Agricultural Experiment Station), No. 45 and 55
- 1910–1929, New Crop Varieties on Iowa Farms (by Joe Robinson at 1929)
- 1913–1921, see Knobbs (1922).
- 1915–1924, Bulletin (Iowa Agricultural Experiment Station), No. 288
- 1916–1938, see Thurman (1940).
- 1939–1946, Agronomy series no. 41 and 59
- 1943–1948, RSLM No. 195
- 1958–1962, Agronomy series no. 591
- 1960–1996, AG series, No. 18–* (the rest of the report number changed each year to include the last digit of the year the report was issued—e.g., AG-18–5 was used for trials for 1965, 1975, 1985, 1995, etc.)
- 1997–2010, AG series, no. 18 (rev.)
2006–present, on the Iowa Crop Performance Testing website (click on Soybeans/Reports to access the older ones)

For complete details on these publications, see the Supplemental Information file for this article.

Soybean variety yield information is also available from the Iowa Soybean Yield Contest results. This was a growers’ contest (a.k.a. Five Acre Soybean Yield Contest) and was created at the request of the Iowa Soybean Processors in 1941 (Robinson and Knott, 1963, p. 58). The Iowa Corn and Small Grain Growers’ Association conducted the soybean contests and modeled them after the Master Corn Grower’s Contests as locally sponsored events (e.g., by local Farm Bureau offices) in which the winning entries were submitted to the district-level contest and then to the state level. Iowa State University Library Archives records for these contests from 1938 to 1943 contain only lists of entrants, winners, and county name. Variety yield information was included for the Iowa Soybean Yield Contest from 1944 to 1967 (Iowa Crop Improvement Association, 1902–ongoing). For many years, the results of the Master Soybean Growers’ Contest were reprinted and made available as part of the Iowa Corn and Small Grain Growers Association annual report in the Iowa Year Book of Agriculture.

Strayer Seed Farms (in Hudson, IA) saw the usefulness of growing soybean for human foods and, in 1936, were the first to produce specialty soybean in Iowa. George M. Strayer, through his company Agricultural Exports Inc., was instrumental in increasing the export market for soybean in the mid-1950s. Strayer was the first to export a specific variety of soybean (Jade) useful for food processing companies. He succeeded in proving there was a market for them and soon other big U.S. grain companies began offering the high quality, high oil soybean to export markets (Bernard, 1978).

For more details on the growth of U.S. soybean production and soybean marketing efforts see Strayer (1962). The first-ever report specific to specialty soybean was the 1993 Iowa Specialty Soybean Test Report. At the time, 50% of all soybean grown in the state were specialty soybean (Heck, 1994). The 1994 and 1995 versions were called Iowa Gold Specialty Soybean Test Report. All three of these publications were published within the AG series from the Iowa State University Extension and were issued as inserts in the February 1994, 1995, and 1996 issues of Iowa Soybean Review. These publications were partially funded using Soybean Checkoff Program funding. Specialty soybean test results for 2000 to 2004 are available as part of Iowa State Research Farm Progress Reports.

Other Iowa Crop Performance Tests

Alfalfa

Alfalfa is one of the most common forage crops. Unlike corn and soybean, “a planting of alfalfa is exposed to 3 or more years of summer and winter climatic stresses, at least 10 harvests, and numerous pest insects, diseases, and nematodes. The crop is harvested numerous times in one season, produces several regrowths, goes through a dormancy period, and fixes nitrogen each year. Several years of multiple annual harvests are needed to collect yield and adaptation data” (Barnes, 1988, p. 18). Alfalfa is high in protein and has proven useful in a myriad of ways including, restoring N to soil, breaking down fertilizers and other contaminants in soil and water, as a food source high in antioxidants, and the stems can be gasified and burned to produce electricity (Russelle, 2001). It is one of many crops being tested for use in biomass production.

Alfalfa production in Iowa gradually increased from 1909 up through 1914 and then experienced a major surge in 1915. From 1930 to 1939, alfalfa hay was being harvested on 305,860 ha (746,000 acres) in Iowa and from 1940 to 1949 it was harvested on 368,590 ha (899,000 acres) (Bolton, 1962, p. 38). Bolton’s Alfalfa book is one of the few publications to provide individual U.S. state statistics for alfalfa production separate from other types of hay.

Early publications related to Iowa field crops usually lumped alfalfa in with other hay crops; however, in later years, as alfalfa became known as the “Queen of Forages,” it became easier to locate alfalfa-specific variety and yield information. Published reports of alfalfa variety experiments in Iowa are available for 1897 to 2007 with some gaps and overlap. For a detailed listing of these publications, see the Supplemental Information file associated with this article.

Barley

“Barley varieties are classified as either six-row or two-row depending on the physical arrangement of the kernels on the plant. Six-row barley is grown primarily in North Dakota, Minnesota, South Dakota, and Idaho. Two-row barley is grown in Montana, Idaho, Colorado, Wyoming, Washington, Oregon, and California” (Taylor et al., 2016). As demonstrated in this quote, Iowa is rarely mentioned as a state that produces barley and yet records for agricultural statistics in the United States show barley was being grown on Iowa farms in 1866, albeit only 27,060 ha (66,000 acres) were harvested that year. Barley was at its peak in 1899 and then steadily decreased until 1927–1938 when it resurfaced for a short time (Iowa Crop and Livestock Reporting Service, 1938, p. 432). This pattern is typical of many barley-producing
areas in the early years. Barley was susceptible to disease that came with corn production. As corn production increased in an area, barley production shifted West and North to areas where there was no corn. In the 1930s the grain industry began paying premiums “for high grades of certain [barley] varieties which stimulated considerable interest in the crop.” This encouraged farmers to grow specific varieties more suitable for use in malting industries (Burnett and Reddy, 1937).

Barley production in the United States is once again on the rise due to an increase in microbreweries or craft breweries starting in the 1980s and the promotion of whole grain health benefits. This includes not only the fiber content but also research investigations that tie it to lower cholesterol and blood glucose levels (Ullrich, 2011, p. 3). Currently, barley is used for livestock feed, human food, and malt production. “Each of these uses is best met with specific barley varieties. About three-quarters of barley production is used for food/malt purposes, and the remainder is used as animal feed” (Taylor et al., 2016).

Published reports of barley variety experiments in Iowa are available for 1892 to 2007 with some gaps and overlap. Results of early field crop experiments in Iowa were published annually and the list of included crops changed each year. In 1892 it included corn, barley, and ensilage (Kent, 1892). The next issue that included barley was in 1900 (Atkinson, 1901). Information on other Iowa reports that include barley variety test results is available in the Supplemental Information file associated with this article.

### Flax

Flax has had a rocky history as a field crop. In pioneer days, it was considered to be a crop that was only suitable for planting on “new ground.” Once a field had been planted to flax, the following year’s crops exhibited significantly poorer yields and were prone to disease. With the introduction of disease-resistant varieties, it became profitable to grow on Iowa farms. “In states leading in flax production from 1925 to 1934, flax has given higher acre returns than spring wheat, barley, or oats” (Reddy and Burnett, 1936, p. 4). Some of this value was due to it fitting into crop rotations the same as oat and other small grains (it was the ideal crop to follow corn) and it was harvested and threshed with the same equipment. The only difference was the cost of the seed. In Iowa, flax was primarily grown in northwestern counties (Burnett and Johnson, 1944).

According to data from the National Agricultural Statistics Service, production of flax in Iowa started dwindling in the 1950s and has not been grown commercially in Iowa since 1971. Iowa State University researchers began flax experiments again in 2004. For example, variety test results from experiments in 2005 are mentioned in an Iowa State University (ISU) thesis from 2010 (Gailans, 2010, p. 1), in several ISU Extension publications within the PM series—No. 2020 and 2058, and in the ISU Northwest Research and Demonstration Farm Reports for 2004. Published reports of flax experiments at the Iowa Agricultural Experiment Station are available for 1921 to 1972. For a detailed listing of these publications, see the Supplemental Information file associated with this article.

### Sorghum

Sorghum was popular among pioneer farmers and is mainly grown in drought regions. Although it did not make the historical crops list in the 1938 Iowa Year Book of Agriculture (Iowa Crop and Livestock Reporting Service, 1938), sorghum was being grown in Iowa in the 1800s. In 1869, there was a push from the Iowa State Agricultural Society for farmers to produce more sorghum syrup as it provided a much higher value per .41 ha (1 acre) than other crops. Sorghum was estimated to generate $71.94 per .41 ha (1 acre) while wheat was only $20.07 and corn only $15.82 per .41 ha (1 acre) (Schaffer, 1870, p. 16–18).

Relatively little has been published about sorghum variety testing in Iowa. There was a very brief mention of Iowa Experiment Station work on sorghum varieties in a 1936 article on “Sorghum Improvement”:

> “Other selected strains of the Black Amber type of sorgo have been developed, including the Ames Amber by the Iowa Agricultural Experiment Station. Selected natural hybrids of the variety have resulted in the isolation of such varieties as Folger, Colman, and possibly Red Amber. Folger was selected by a farmer of that name, living near Shenandoah, Iowa, during the eighties. Waconia Orange, selected and distributed by the Waconia Sorghum Mills, Cedar Rapids, Iowa, is a new, distinct strain of Orange sorgo” (Martin, 1936, p. 547).

The Iowa Sorghum Performance Test was created in 1958 and led by R.E. Atkins, J.G. Wheat, and C.D. Hutchcroft (Robinson and Knott, 1963, p. 115–117) to test combine type grain sorghum variety yields. Also referred to as Sorghum Performance Trials, these tests were conducted as part of the Iowa Crop Improvement Association research in cooperation with Iowa State University. “[T]o help defray the expenses of the test, an entry fee of $20 was charged for each entry tested in each field. The entrant had the option of entering any hybrid in one or more fields.” Robinson and Knott provide details of planting arrangements and harvesting for the first years of these tests. The tests continued in Iowa up through 1989 and results were published with the AG series as AG-16 each year.

Starting in 2008, Dr. Salas Fernandez initiated a sorghum breeding program for biofuel production at Iowa State University (using sweet sorghum). The main goal of the program is to conduct research that leads to and supports the development of sorghum germplasm for biofuel production adapted to Iowa (Fernandez, n.d.).
Outside of Iowa, there is a National Sorghum Producers Yield Contest sponsored by the National Sorghum Producers. This contest provides farmers the opportunity to compete with farmers across the U.S. Sorghum Belt. One of their webpages has a list of the U.S. sorghum hybrid trial results that are available online for each U.S. state.

Wheat (Spring and Winter) and Triticale

Like sorghum, wheat is another crop that was primarily grown in Iowa during the mid-to-late 1800s. Unlike sorghum, record high wheat prices in the mid-2000s resulted in a resurgence of interest in spring wheat production in Iowa (Gibson, 2008).

During the Civil War, Iowa ranked second nationally in wheat production (Schwieder, 1996, p. 134). It remained a profitable crop in Iowa until 1870 (Speer, 1889, p. 199). Even though Iowa agronomists encouraged farmers to move away from wheat in favor of corn, farmers continued to grow wheat. “In 1875 Iowa wheat production reached its peak. It took a disaster in the form of grasshopper plagues to finally drive farmers away from producing wheat. They switched to corn, which they fed to livestock” (Schwieder, n.d.).

Wheat variety tests are somewhat different from other Iowa crops in that some reports covered all types of wheat, others were specific to winter wheat or spring wheat, and additional reports covered wheat and triticale. As a cross between wheat and rye, triticale (× Triticosecale) has shown promise as: a forage crop; a replacement for corn in animal feed; a viable option in biofuel production; and, if different varieties are developed more fully, as a food grain (Hansen and Tyler, 2012). Research on triticale varieties in Iowa is likely to expand even more in the near future. Published reports of wheat and triticale variety experiments in Iowa are available for 1889 to 2008 with some gaps and overlap. For a detailed listing of these publications, see the Supplemental Information file associated with this article.

Other Field Crop Testing in Iowa

Many other less formal crop experiments have taken place at the Iowa Agricultural Experiment Station over the years. This includes crops such as sugar beet, cowpea, potato, clover, and many forage grasses. Results from these were often summarized and included in articles aimed at farmers in magazines such as Iowa Farm Science or educational leaflets in the Circular series issued by Iowa State University Extension. For a listing of these, see the Supplemental Information file for this article.

Tests for specific crops were often co-sponsored or co-conducted with professional crop associations (e.g., the Iowa Crop Improvement Association, the American Soybean Association, the National Oat Conference, etc.), USDA research centers (such as the U.S. Regional Soybean Laboratory) and agricultural companies or specific grain industries. Researchers from the Experiment Station were often active members of these associations. Some research records reside with the organizations and others have been transferred to university archives. The largest group was the Iowa Crop Improvement Association. Raw data and records from this group are on file in the Iowa State University Library, Special Collections and University Archives Department.

Harder to find, but just as interesting, are crop variety yield tests conducted by individual farmers. In Iowa, one of the more famous was the Dennis Gustafson Plot Tests, in Crawford County. Gustafson began conducting variety tests in 1963 for his own information but his fame grew as he increased the number of varieties being tested and seed companies began including this information in their advertisements. For example, a 12 Jan. 1969 ad in the Des Moines Register for Crow’s Hybrid Corn “won Dennis Gustafson plot tests!” In 1967, he tested 55 varieties and in 1968 increased it to 165 varieties, with a lot of help from volunteers in the area. He was inundated with requests for a booklet outlining results of his tests each year (Anonymous, 1968). Experiment Station staff were also happy to educate farmers wanting to test varieties on their own farms. They provided fairly detailed instructions on how to lay out the plots, keep records, harvest, and interpret the results (Wallize, 1968).

YIELD TESTING PUBLICATIONS IN OTHER U.S. STATES

Agricultural Experiment Stations in a large number of U.S. states have been testing crop varieties for many years. A Ph.D. dissertation by Ludwig Auer (Auer, 1963) provides an appendix listing field crop variety yield reports from many U.S. states up through 1963. Although he includes an impressive list of references for each crop, it should only be considered a starting point for locating test results.

Founders of state agricultural experiment stations recognized the need for publications from the very beginning and established recommendations for core publications (Knoblauch et al. (1962), p. 143–157) but the actual practices varied somewhat at each station. Over time, publications became divided into two main types—those aimed at the general public and those with detailed research results. Publications aimed at the general public were often issued by state cooperative extension offices while the more technical research publications were issued by Experiment Stations. Beyond this, it was also standard practice to produce in-house (often mimeographed) research reports for station staff, some of which were also shared externally on request by interested farmers, USDA scientists, and researchers in private industry. Variety yield test results were often partially reprinted or summarized in journal articles authored by primary investigators, specialized professional association newsletters, or used as the basis for graduate student theses. The small two to four page mimeographed reports were not widely distributed and were usually only kept in researcher office files. Some of these have been donated to university library archives over
Table 1. Summary of known Iowa field crop variety yield testing results. Gap years may (or may not) have actually been published. In some years, weather conditions destroyed experiments or made yield test results impossible to compare.

<table>
<thead>
<tr>
<th>Crop</th>
<th>Years covered in known publications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barley</td>
<td>1871, 1892, 1900, 1911–1943, 1946–2008</td>
</tr>
<tr>
<td>Corn</td>
<td>1892, 1895–1896, 1904–present</td>
</tr>
<tr>
<td>Flax</td>
<td>1921–1972</td>
</tr>
<tr>
<td>Oat</td>
<td>1871, 1889, 1891, 1898–present</td>
</tr>
<tr>
<td>Rye</td>
<td>1871, 1882–1883</td>
</tr>
<tr>
<td>Sugar beet</td>
<td>1888–1894, 1897, 2008–2009</td>
</tr>
<tr>
<td>Triticale</td>
<td>2002–2008</td>
</tr>
</tbody>
</table>

the years. Results for some U.S. states may be stored in a private company archive or in association files rather than in a publicly accessible research library.

Agricultural experiment station publications have been digitized in some U.S. states (most notably those from Texas A&M, Colorado State University, Kansas State University, Cornell University, and the State University Libraries of Florida); however, there are many, many more that have not yet been digitized. This is due to a lack of available funding, incomplete collections, and (to be honest) a lack of knowledge about their existence in libraries or archives due to staffing turnovers and the ephemeral nature of some publication series.

HathiTrust Digital Library (https://www.hathitrust.org/) contains some U.S. agricultural experiment station publications but can be extremely confusing to search through given the somewhat generic nature of publication titles such as Bulletin or Circular and numerous publication title changes over the years. Only those published prior to 1923 are likely to be available in full-text through HathiTrust due to copyright restrictions.

The National Agriculture Library in Beltsville, MD, also maintains a large collection of state agricultural experiment station publications. Although many are not individually cataloged, and only sporadically included in AGRICOLA, they can be perused on site.

**SUMMARY AND CONCLUSIONS**

Iowa researchers have been conducting crop variety tests with a wide range of crops in formal and informal testing environments for almost 150 years (Table 1). What started as a hodgepodge of grower contests, student projects, and individual farmer testing efforts gradually became a unified, statewide program of variety testing by the Iowa Crop Improvement Association and the Iowa Agricultural Experiment Station under uniform growing conditions. Private seed companies also conducted their own variety tests but the Experiment Station tests were considered to be more impartial due to their anonymized testing processes. Each year, variety test results were used to help farmers make informed decisions about profitable varieties and improve production processes. Results also informed crop breeding efforts to increase yields per acre and stave off food shortages due to weather catastrophes and an ever-increasing world population. The most successful varieties were those which were higher profit for farmers and also had a plethora of industrial uses. In Iowa, corn variety test records are easier to locate than those of other crops and, surprisingly, these tests were taking place well before the founding of the Iowa Corn Yield Test in 1920; however, a lot of confusion exists between results from corn shows, corn contests and corn variety tests as well as growers’ tests and those of the Iowa State Agricultural Experiment Station. Each field crop developed its own unique pattern of research and publication practice and results for some crop variety tests were distributed wider than those of other crops.

There are many untapped sources for varietal data, mentioned above and included in the Supplemental Information file for this article. The majority of which are not available online. Agronomists should be encouraged to check with their nearest land grant university library archives for historic agricultural experiment station publications, crop association records, master's theses, field notebooks, and/or manuscript records of individual local crop researcher records. Investigating crop experiment history in a specific U.S. state and identifying the leading researchers for that crop can aid in locating data on crop experiment results, whether from performance trial results or other written accounts authored by the primary researchers.

Variety tests from the past have the potential to inform new research efforts today. A recent *Nature Plants* editorial asserts that heritage varieties are vital to future crop breeding efforts and to counter problems of future food security (Anonymous, 2016). This concern is echoed by others such as Noldin et al., who maintain that “commercial varieties have reduced genetic variability compared with the diversity of the cultivated species because elite materials are used recurrently in breeding programs. Such a situation constitutes a bottleneck that challenges future response to selection” (Noldin et al., 2017, p. 660). As agronomists look to find new sources for biofuels and other industrial uses for various crops, data from previously grown varieties could be useful. The results of earlier tests can be used in longitudinal studies or serve as the basis for additional types of previously untested characteristics. For example, Specht and Williams (1978) examined soybean cultivars released to producers from 1902 to 1977 to screen them for heat tolerance and correlate that to yields. Since heat tolerance was not one of the factors included in early trials, they obtained historic cultivars from the Regional Soybean Research Laboratory in Illinois, planted the varieties and measured the results from 1977 to 1979. Re-testing heritage varieties utilizing modern production methods could also improve yield results or prove viable.
for new industrial purposes. Reloooking at historic variety tests through a different lens has the potential to yield new perspectives and creative solutions but, for trials conducted outside of Iowa, it may take some detective work to locate them.

Conflict of Interest Disclosure
The authors declare no conflicts of interest.

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