OPEN POLLINATED CORN VARIETY TRIALS AND A DISCUSSION OF THE PRACTICAL IMPLICATIONS FOR OPEN POLLINATED CORN IN SMALL SCALE WHISKEY PRODUCTION

A Thesis

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by

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ABSTRACT

The goal of this study was to assess the feasibility of producing open pollinated (O.P) corn varieties as a grain source for the production of specialty whiskies. Low profit margins on corn grain as a commodity make it difficult for small to medium size farmers to grow corn competitively. Such farmers could benefit from a cash crop that could offer a higher profit margin. There is current popular interest in heirloom (old-time) grains, including O.P varieties. This may provide an opportunity for a distiller to develop a market for a specialty whisky using O.P. varieties. An advantage for O.P corn as a specialty crop for corn growers is the similarities in equipment, cultural practices, and inputs. No major conversion is needed.

Field studies were initiated to determine the production potential and reliability of O.P. varieties in New York environments, and to identify the best varieties. Comparative yield trials were conducted over two growing seasons in various locations. Varieties were selected on the basis of anticipated adaptation to New York growing conditions, potential for grain production and commercial availability of seed.

In 2001, seventeen open pollinated varieties along with a modern hybrid check were tested at Aurora, (central) and Kingston, (eastern), NY. In 2002, twenty varieties were planted at Aurora. Those considered earlier varieties were also planted at Bliss, (western). Also, in 2002, later varieties were planted at Kingston, and Pittsford, (western).

All trials were set up in randomized complete block designs. Treatments consisted of two adjacent rows of each variety with approximately 36-40 seeds planted within each block. Each trial consisted of three blocks. The plots were thinned to a density of 18,000 plants/acre.

Several major obstacles were observed First, yields of O.P. varieties were lower and more variable than yields of hybrids. The mean corn yield in bushels for New York State is 100.7 bu/acre (www.nass.usda.gov) averaged over the three years. (1999-2001). Many of the varieties in these trials occasionally performed at or above this level, but none consistently, except the hybrid checks. Stalks were also weak, blowing down in winds, and making harvest difficult. Perhaps most significantly, the data showed wide variation in variety performance between years and locations, even among the same varieties.

Premium alcoholic beverage producers could tolerate high O.P. grain costs if they could develop a market for a high value specialty whiskey featuring an O.P. corn source. However they would need reliable grain supplies. In these studies O.P. corn production was erratic, and not dependable from year to year, or site to site. This lack of dependability would present an unacceptable business risk. One possible solution might be to develop a product based mostly on readily available, inexpensive hybrid corn grain, mixed with a small amount of open pollinated grain.

If a business plan could be developed that protects against fluctuations of availability, the concept of using O.P. corn to differentiate a small batch premium alcoholic beverage might have potential for success. This could provide employment in the processing, distilling and bottling processes. And O.P corn might provide a profitable niche crop for a limited number of corn growers.

BIOGRAPHICAL SKETCH

The author was born in Worcester, Massachusetts, on March 19, 1974 to Paul Vincent and Patricia Francis Belsito along with a sister Elizabeth Kelly and a brother, Peter Joseph. He attended Paxton Center School and Wachusett Regional High School before graduating from the University of Massachusetts, Amherst with a Bachelor's degree in Plant and Soil Sciences. He worked in the San Francisco area for three years in sales and marketing before returning to the Northeast to work with Dr. William Pardee, Dr. William Cox and Dr Gerald White toward his Master's Degree.

To Courtney, Mom, and Dad

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INTRODUCTION

Corn, *Zea mays* L., has played a central role in the history of North America since the ancient Native Americans began to cultivate it 7000 years ago. (Wallace et al 1956). Native Americans were cultivating corn as a staple food in many parts of the continent when the first Europeans arrived in North America. It is estimated that over 50,000 acres of corn were being cultivated at the time of Columbus's arrival (Wallace et al 1956).

Through centuries of selection, Native Americans developed many different types of corn, for a variety of uses. The major types of corn developed prior to European arrival include all the types still important in modern agriculture. These include the botanical varieties *Zea mays L. var. indurate* (flint corn), *Zea mays. L. var. amylacea* (soft), *Zea mays L. va. everta* (pop), *Zea mays L. indentata* (dent) and Zea mays L. var. saccharata (sweet corn) (Wallace et al 1956) (Sturtevant 1899). Also, within each type, Native Americans developed numerous local varieties to adapt to specific site conditions and grower needs and preferences. Native Americans developed these types and varieties through selection of seed from plants that exhibited desirable traits, such as grain size, hardiness and days to maturity.

They grew different types and varieties at some distance from each other to reduce unwanted mixes through cross pollination. However they did not strictly control the pollination of each crop. This lack of parentage control, combined with numerous individuals selecting seed, led to wide diversity among corn varieties over the thousands of years of selection (Doebly, et al 1986). The incredible diversity within the species Zea maize includes mature plant heights from 18 inches up to 30 feet (Sturtevant 1899) and wide variations in seed shape, size and color.

Early European settlers adopted many of the Native American corn varieties as they settled over the continent. These farmers and their descendants carried on the tradition of selecting for desired traits. An abundance of genetic variation remained throughout the different corn populations grown in the United States.

Corn for Whiskey

Corn, as well as being an important food crop, has often served as a carbohydrate source for the production of alcohol. Many 18th and 19th century farmers converted their corn crop to whiskey, for their own use, and for sale. Conversion to distilled spirits resulted in less bulk and lower transportation costs for the farmers' product. This was particularly important to farmers as lands opened up far from population centers.

Whiskey was so important to the farming economy that a group of farmers in western Pennsylvania, angry at heavy taxes being levied on whiskey, rebelled in 1794. The so-called "Whiskey Rebellion" was serious enough to force President Washington to call out the militia to maintain order. (http://earlyamerica.com, 2002).

Much corn whiskey was sold in regional inns and taverns in the 19th century. One of the most storied and celebrated of these taverns was Benny Haven's, located next to the West Point Military Academy. Benny Haven's Tavern was an attractive, if illicit, destination for many West Point Cadets. It is believed that memorable figures such as Edgar Allen Poe and Ulysses S. Grant frequented the tavern. Legends of Benny Haven's Tavern are still passed down at West Point, and are known to its graduates. (www.highlandshistory.org, 2002).

Development of modern corn

Because many different corn varieties were developed independently over the vast area of Central and North America, it is difficult to determine a well-defined lineage for corn and its many varieties. For example, possible early ancestors of New England flint corn can be found in the Mexican State of Chiapas (Wallace et al, 1956), but a plausible route north has never been established. Confusing and incorrect nomenclature has also led to great difficulties in determining where and when different varieties were developed and used. Varieties were most commonly referred to by a popular name that described a particular aspect of the ear, grain or plant.

Within most older varieties, phenotypic expression can differ widely under differing growing conditions. A 19th century farmer in New York might have thought he was growing a variety different from that of his neighbor a few miles up the road because the growth habits or ear size appeared to differ. This difference could have been due to variability within the variety rather than actual genetic differences.

Beginning around 1810, efforts increased to improve the available grain for seed in order to boost yields and improve reliability of the corn crop. Out of these efforts emerged two steps that led to the development of modern hybrids. The controlled crossing of divergent varieties begun in the early 1800's by a few pioneering growers was the first directed and recorded efforts to develop improved corn varieties. The beginning of modern hybrids followed in the late 1800's and early 1900's and drastically changed corn and its cultivation.

The period from around 1810 up to the development of hybrids may be the most important time in corn's history relative to the role it played in molding the modern history of the United States. Now not only were humans altering corn, but corn was altering what humans ate and where they lived. During this time, improvements in varieties as well as the mechanization of corn production increased

efficiencies enough to profoundly affect the development of the modern United States and the diet of its citizens.

Measured but steady improvements in corn yield increased production enough to begin the large-scale production of milk and meat products using corn. The result was an inexpensive staple animal feed, and with that a marked increase in the consumption of meat and dairy products in the U.S. The public's taste for food corn began to wane dramatically as corn fell out of favor as a diet staple and was replaced with higher consumption of animal products (Crabb, 1947).

The growth of at least two major cities and their surrounding economic regions in the early 1800's is due almost exclusively to improvement of corn yields. The Napoleonic Wars had caused shortages of food in Europe, so food exports out of the United States boomed. However the economies of the east coast states became too dependent on agriculture and exports, as illustrated by their almost complete shutdown during The War of 1812. As the war began, much of the food had already been exported and food supplies ran low. Transporting corn over long distances was expensive. This led to the practice of transporting corn on the hoof. Already demonstrated as feasible in 1804, it became widespread and very profitable as shortages loomed during the war (Walden, 1966).

Corn-fed livestock became a driving part of the economy in many regions and for cities like Buffalo, New York. The opening of the Erie Canal and the planting of corn in the large new agricultural areas surrounding Buffalo led to the city's development as the nation's livestock processing plant (Crabb, 1947). As settlers moved west, the corn and livestock industry moved with them, leading to explosions of growth in Ohio in 1850 and Chicago leading up to 1870.

One of the first steps in the development of new varieties that enabled these explosions was the work done by Joseph Cooper published in 1808, and by John

Loraine documented beginning in 1812. They were among the first to record the purposeful cross of different types of corn in order to get new varieties to meet their needs.

Cooper observed that planting small eared corn next to large eared strains helped produce more uniform ripening. Loraine recognized the value of crosses (he called them "mixtures") of "gourd seed and flint corn." He found the progeny were higher yielding and produced grain with a longer shelf life than either of the parents. This "mixture" became very popular, eventually dominating the corn-belt. In his own words originally published in 1825, "The results (of Loraine's experiments) seem to determine that … such mixtures are best suited for the purpose of farmers, in every climate of this country where corn is grown…mixing lets all good traits surface and bad traits leave" (Wallace et al, 1956).

The gourd seed/flint "mix" quickly came to dominate most corn growing areas. Many authors wrote extensively about it in their publications. Peter Browne, a professor at Lafayette College listed 35 varieties of corn in the Northeast in 1837 (Wallace et al, 1956) and the majority of them were gourd seed/flint "mixes". Reid's Yellow Dent, a widely popular variety still available today was originally developed from a gourd seed/flint cross. What is commonly known today as New England Flint was also likely developed from a gourd seed/flint cross. These pioneering crosses and the men who documented and worked with them began the modern chapter of corn and its role in forming the United States as we know it.

As corn grew in economic importance, interest increased in controlled breeding as a way to improve yields. Men such as Leaming, Reid, Funk and Hogue put tremendous effort into not only improving corn varieties but also raising awareness among growers of the potential for improved varieties. In 1912, the

nation's first three billion bushel corn harvest took place. This was the beginning of the dominance of hybrid corn.

Over 99% of the corn grown today in the United States is hybrid corn. Hybrid corn seed is the result of forging a cross between distinct parents. The parents are usually inbred lines, the result of self-pollination, or single crosses between two inbreds.

Hybrids were developed for desirable qualities such as yield, pest resistance, stalk strength, uniformity, and days to maturity. The spread of hybrid corn began in earnest in the 1930's with the development of superior double-crosses (crosses of two single-crosses) that increased seed yield over open-pollinated varieties.

The development of high yielding inbreds beginning in the 1960's enabled growers to utilize single cross uniformity along with high yield and other desirable traits. The development and adoption of hybrids by modern corn growers is well documented and will only be mentioned briefly and for comparative purposes in this review of the literature. By 1942, when hybrids had been adopted in almost every important corn growing region, US growers could produce the same three billion bushels on almost 20% less land (Crabb, 1947). Improvements in hybrid cultivars have increased production even further relative to open pollinated varieties (Rusell, 1974, Rusell, 1984). By some estimates hybrids have increased yields by over 50% (Rusell, 1985).

This trend of decreasing variability and increasing production has worked well for many growers and perhaps the world. However the focus on a limited number of elite lines has caused great loss of genetic diversity. This narrows the resources from which today's breeders are able to draw upon to make tomorrow's improvements. The growing and testing of these older varieties will perhaps shed some light on possible sources of useful germplasm to help reinvigorate breeders' resources.

Today nearly all of the corn varieties grown commercially are hybrids. In any given area, modern hybrids dramatically out-produce older open pollinated varieties, often doubling their yield. This makes it nearly impossible for farmers who grow open pollinated varieties to compete directly in grain markets. Financial margins are too low for such reductions in yield to be tolerated.

However, some open pollinated (O.P.) varieties remain important. Some are grown for specialized niche markets. Many are maintained as germplasm sources for breeding programs. Some are grown by home gardeners, hobbyists, and persons interested in "heirloom" historical crops.

Whatever their use, O.P varieties are increasingly valued as sources of genetic diversity. Many believe that the trend toward the selection of fewer and fewer hybrids which are planted over increasing acreage has led to decreased genetic variation among commercially grown corn. A new examination of open pollinated varieties may increase the availability of stock germplasm making it easier for breeders to obtain more diversity in their breeding programs.

It may be possible for a limited number of farmers to market open pollinated corn as a cash crop in many different forms, as fresh ears, whole grains, or processed into food. Corn's potential for processing into alcohol beverages, products that often demand a high price, may make it feasible to increase profits even though yields may decline relative to hybrid corn.

The catalyst for this project was an idea, initiated by John Torgersen, a New York State resident and businessman. His goal is to recreate the type of whiskey that would have been served at Benny Haven's Tavern (mentioned above), and to use this as a marketing attraction.

In order to do this Mr. Torgersen desires to use authentic techniques and raw materials, including grains, in making whiskey. However hybrids were not available

at Benny Haven's time. In eastern New York flint and a few dent corns would have been popular. Corn for Benny Haven's whiskey would have been developed from a number of open pollinated varieties. The actual varieties used are not known, and some have probably been lost. So it is impossible to exactly duplicate the corn supply for Benny Haven's whiskey. However, the selection of open pollinated varieties in this research (with the exception of Nakomis Gold and E-95, both selected for modern growing conditions) was designed to fairly represent corn strains available to farmers at that time.

It was our goal to evaluate a number of available open pollinated varieties and to examine the feasibility, including the advantages and disadvantages of growing and relying on open pollinated varieties of corn as a source for raw materials in the small scale production of specialty whiskey.

MATERIALS AND METHODS

Selection of Varieties

Varieties for these studies were selected using several criteria. Since the objective of the research was to evaluate commercial production of the varieties, an attempt was made to select varieties for which seed might be available commercially. With the exception of the Longfellow variety, obtained through Frank Kutka's private collection most of the varieties used should be available through commercial sources. Efforts were made to select varieties for grain production rather than ornamental traits. There was an attempt to select seed adapted to northern growing regions. However, due to limited northern sources, several varieties came from R.H Shumway's Seed Company in South Carolina. Detailed information on maturity was not always available, so 2001 selections were not based on short/long season criteria. For 2002, we were able to use 2001 observations to allot varieties to short and long season sites. A complete list of varieties tested by year is shown in Tables 1 and 2. Logistics of obtaining seed in a timely fashion relative to the planting schedule produced some variation between the two trials in 2001.

Both years we included several samples of Reid's Yellow Dent (hereafter referred to as Reid's). This variety played an important role in the development of many hybrid lines available today. It is also likely that ancestors of Reid's may have been grown in Eastern New York in Benny Haven's time. Seed of Reid's is also the most commercially available of all the O.P. varieties tested. Reid's strains differ in maturity and somewhat in appearance, depending on where in the country the strain has been maintained. So we included seed from multiple sources of Reid's in both the 2001 and 2002 field trials.

We included seventeen O.P varieties in 2001, along with a modern hybrid check. 2001 tests were planted at Aurora, Cayuga County and Kingston, Ulster County, NY. Twenty varieties were planted at Aurora. Those considered earlier varieties were also planted at Bliss, Wyoming County. Later varieties were planted at Kingston, and Pittsford, Monroe County.

The following is a description of the varieties used.

Bloody Butcher

This variety, a dent type corn, is an open pollinated cultivar that has been grown in the U.S. since 1845. Available information on this variety indicates tall stalks up to twelve feet. (www.sitesalive.com, 2002). Little information is available on the origin of this variety. The kernels are red or contain red stripes and the cobs are also red. Kernels were used as meal, flour or animal feed.

Hickory King

A Virginian farmer developed Hickory King (www.agron.missouri.edu, 2002). Hickory King is described as a white dent that reaches maturity at 115 days. Ten to twelve rows of kernels are usually present. Ears are often roasted but are used in a variety of ways including meal and flour.

Reid's Yellow Dent

Reid's Yellow Dent, named after its originator, Robert Reid, was probably the most popular open pollinated yellow corn in the United States (www.sitesalive.com, 2002) during the 1800's. It originated in Illinois. Reid developed the variety in 1847 by

accidentally crossing two other varieties, Gordon Hopkins and Little Yellow. Considerable variation exists in Reid's Yellow Dent strains currently available, including short, medium and long season types (85-115 days). Depending on the maturity Reid's can do well in New York's longer season locations. Reid's is widely adapted to many northern corn-growing areas, especially the central and northern corn-belt. Ears are about ten inches long and produce 16 rows of kernels. The cob is usually red. Reid's Yellow Dent spread quickly after its introduction and came to dominate the Corn Belt region and other corn growing areas. As a result, many of today's inbred and hybrid lines claim Reid's Yellow Dent as part of their pedigree. (Gerdes et al, 1993). The Reid's Yellow dent in the 2001 trial was obtained from several sources, including R.H Shumway's Seed Company in South Carolina. The vReid's Yellow Dent used in 2001 and 2002 was obtained from a seed grower, Vaughn Emo, in Avoca, NY.

Lancaster Surecrop

The Hershey family in Pennsylvania developed Lancaster Sure Crop, a yellow dent, around 1860 (www.agron.missouri.edu 2002). When developing this variety, they focused on ear type and yield. They did not select for improved plant type and hence developed a variety with poor root and stalk quality. Lancaster Sure Crop germplasm, while not as prevalent as Reid's Yellow Dent, exists in a variety of modern and important lines. However, only a small amount of the Lancaster germplasm from the Hershey family's cultivar remains in modern lines, as the line has been much improved by breeding. Descendents of Reid's Yellow Dent and Lancaster Surecrop form the prominent United States heterotic parents, widely used in developing modern

hybrids.(www.agron.missouri.edu 2002). Lancaster Surecrop seed used in these trials was obtained from Vaughn Emo.

Silver King

Silver King is a white dent variety first developed in Illinois. The name Silver King has more recently been used to describe a sweet corn, but this is not related to the grain variety we grew in our trials. Silver King plants can be 10-12 feet tall. Maturity is about 115 days. Seed for our trials was obtained from R.H. Shumway, South Carolina.

Krug

Krug is a dent kernel corn, originating from a Reid's Yellow Dent and Goldmine cross and is similar to Reid's. Krug is a short season corn (90 days), well adapted to northern areas of the United States. Krug is respectable producer of silage or grain. Seed used in these trials was obtained from Vaughn Emo.

Boone County White

Boone County White is a medium season variety maturing in 115 days. This variety produces medium to large ears and was widely grown in Kansas and throughout the Corn Belt in the early to mid 1900's (TenEyck, 1910 Burlson, 1930). Plants can grow 10-12 feet tall. Seeds for our trials were obtained from R. H Shumway Seed Co.

Silvermine

Silvermine is a medium maturity variety (100-105 days). In the early 1900's it was popular throughout the Corn Belt as good grain producer (TenEyck, 1910; Burlison, 1930). Silvermine can grow 10-12 feet tall. Seed used in the 2001 trial was obtained from R.H. Shumway Seed Co.

E-95

E-95 is a modern open pollinated variety, maturing between 93 and 97 days. It has been selected for yield and standability. The seed used in this trial was grown in Gaylord, MN. It is a primarily a yellow corn that produces approximately 2% colored kernels (Viking Seed Catalog 2002). It was obtained from the Albert Lea Seed Co, Albert Lea, MN.

Nakomis Gold

Nakomis Gold is estimated to mature in slightly over 100 days. It is a mostly yellow kernel corn with kernel type ranging form flinty dent to flint. Its pedigree is varied and includes Hopi and Zuni ancestors and Cateto flints. It is an improved variety that was selected primarily by Walter Goldstein at Michael Fields Agricultural Institute in Wisconsin. Nakomis Gold was selected to grow at the higher populations grown by modern farmers. Therefore it offers greater stalk strength and higher corn borer resistance than most open pollinated varieties. However it does not match modern hybrids in these characteristics. (Goldstein et al 1998)

Seneca Indian

Seneca Indian is colorful multi-colored ornamental flint from New York. It matures in approximately 110 days. This variety produces large ears and the leaves and stalks are usually a deep purple. Plants are average between 7 and 9 feet. The seed used in the 2001 trial was obtained from Johnny's Seeds in Albion, Maine (Johnny's Seeds Catalog, 2002)

Minnesota 13

Minnesota 13 originated in the St. Paul area around 1900 (www.ontariocorn.org, 2002). It played an important role as a source of inbred lines in hybrid corn breeding. Albert Lea provided the seeds for these trials. (Gethi et al, 2002).

Iroquois White

Iroquois White is an ancient, white, heirloom corn originating among the Iroquois Six Nations. Recently, this variety has been in danger of extinction. In an attempt to prevent this, the Iroquois in New York State have attempted to develop a cottage industry around the corn (www.slowfoodusa.org, 2003). Seed for this trial was obtained through Jane Mt. Pleasant, an associate professor at Cornell University but is not readily available in large quantities.

Golden Glow

Golden Glow is considered a short season variety and has been important in America grain production for sometime. Golden Glow was originally developed at the University of Wisconsin. Present Michigan strains have been further improved by ear-to-row work under supervision of the Michigan Agricultural College. Golden Glow has a "rather smooth tapering ear and growthy, leafy stalk." (Rather, 1924).

Greenfield 114

Greenfield 114 was developed by Greenfield Farms located in Wapakoneta, Ohio. Their website indicates that the variety has good standability and ear height is rather uniform. It is considered a 114-day season corn. Exact origin is unknown. (http://www.greenfieldfarms.org/, 2003).

Beasely's Red

According the Plantdatabase.com Beasley's red is a 111 to 120 day variety. It has yellow and red kernels and plants are expected to reach 8 to 10 feet at maturity (plantsdatabase.com, 2003).

Henry Moore

Henry Moore seed was obtained by Leonard Barries located in Illinois.

Northwestern Dent

A well known dent variety, Northwestern Dent, has played an important role in the development of many modern inbred lines (www.agron.iastate.edu). The variety is often mentioned in connection with the Minnesota Agricultural Experiment Station. Northwestern Dent is a red corn. Is has been available since at least the 1920's. (www.spanglerseed.com). Seeds used in these trials were obtained from Frank Kutka, Cornell University

Early Butler

Early Butler is an early dent variety. Also called "king of the earliest", this variety originated in Grand Valley, Pennsylvania. It played an important role in hybrid line development (Labate et al, 2003), and was used in 1961 to develop an inbred line used

for breeding research (Motta et al, 1999). Seeds used in these trials were obtained from Frank Kutka.

Wisconsin 25

Wisconsin 25 was originally developed and produced by the Spooner Agricultural Research Station in Spooner, Wisconsin (www.uwex.edu, 2003). It is a dent variety. Frank Kutka provided the seeds used in these trials.

Table 1. 2001 Trials: Varieties of Corn and Sources of Seed for Aurora and Kingston.

Variety	**Source**	**Kingston**	**Aurora**
Seneca Indian	Johnny's Seeds Maine	Yes	Yes
Reids Yellow Dent	Leonard Barries Illinois	Yes	Yes
Reids Yellow Dent V	Vaughn Emo New York	Yes	Yes
Hickory King	R.H. Shumway's South Carolina	Yes	Yes
Lancaster Sure Crop	Vaughn Emo New York	Yes	Yes
Goliath Silo	R.H. Shumway's South Carolina	Yes	Yes
Trucker's Yellow	R.H. Shumway's South Carolina	Yes	Yes
Silver Mine	R.H. Shumway's South Carolina	Yes	Yes
Silver King	R.H. Shumway's South Carolina	Yes	Yes
Bloody Butcher		Yes	No
Wapsee Valley	Vaughn Emo New York	Yes	Yes
Krug	Vaughn Emo New York	Yes	Yes
Boone County White	R.H. Shumway's South Carolina	Yes	Yes
Ralph's		Yes	Yes
Nakomis Gold	Walter Goldstein Wisconsin	Yes	Yes
E95	Albert Lea Seed Minnesota	No	Yes
Minnesotta 13	Albert Lea Seed Minnesota	No	Yes

Table 2. 2002 Trials: Varieties of Corn and Sources of Seed for Aurora, Bliss, Pittsford and Kingston.

Variety	Source	Aurora	Bliss	Pittsford	Kingston
Longfellow	Frank Kutka New York	Yes	No	Yes	Yes
Reid's Yellow Dent	R.H. Shumway's South Carolina	Yes	No	Yes	Yes
Reid's Yellow Dent V	Vaughn Emo New York	No	Yes	No	No
Reid's Yellow Dent	V. Kucyk	No	Yes	No	No
Reid's Yellow Dent	Leonard Barries Illinois	Yes	No	Yes	Yes
Lancaster Sure Crop	Vaughn Emo New York	Yes	No	Yes	Yes
Trucker's Yellow	R.H. Shumway's South Carolina	Yes	No	Yes	No
Wapsee Valley	Vaughn Emo New York	No	Yes	No	No
Krug	Vaughn Emo New York	Yes	Yes	No	Yes
Nakomis Gold	Walter Goldstein Wisconsin	No	Yes	No	No
E95	Albert Lea Seed Minnesota	No	Yes	No	No
Iroquois White	Jane Mt. Pleasant New York	No	Yes	No	No
Golden Glow	Frank Kutka	No	Yes	No	No
Greenfield 114	Frank Kutka	Yes	No	Yes	Yes
Beasley's Red	Frank Kutka	Yes	No	Yes	Yes
Henry Moore	Leonard Barries Illinois	Yes	No	Yes	Yes
Northwestern Dent	Frank Kutka New York	No	Yes	No	No
Early Butler	Frank Kutka New York	No	Yes	No	No
Wisonsin 25	Frank Kutka	No	Yes	No	No
Minnesotta 13	Albert Lea Seed Minnesota	No	Yes	No	No

Site Selection

All the trials were planted in New York State. Site selection was based on several criteria. An attempt was made to use sites that offered differences in season length. In 2001 Aurora, Cayuga County in central New York was chosen as representative of shorter season areas. A longer season trial was conducted in Kingston, Ulster County, in southeastern New York. Kingston was also chosen for its proximity to planned commercial production areas (near West Point).
All trials were planted among larger fields of corn planted as part of other research. In 2002 additional areas were planted for redundancy. Trials in Aurora and Kingston were repeated. Additional trials were planted in Pittsford, Monroe County, and Bliss, Wyoming County, both in western NY.

Cultivation

Each trial location was harvested and planted by technicians of Cornell's Plant Breeding Department corn project. A starter fertilizer of 10N-20P-10K was applied at a rate of 320lbs/acre. Successive fertilizer application, weed control and insect control practices varied by location as local growers managed the fields based on the needs of their surrounding corn plantings. Notes on standability and other plant traits were taken by the author.

Trials

All the trials were set up as randomized complete blocks. Treatments consisted of two adjacent rows of each variety with approximately 36-40 seeds planted within each block. Each trial consisted of three blocks. The plots were thinned to a density of approximately 18,000 plants/acre.

Planting and Harvesting Dates

2001

The 2001 trial in Kingston was planted May 3. Aurora was planted on April 23. Harvest was completed onj October 26 in Kingston and October 22 in Aurora.

2002

In 2002 Kingston was planted May 4 and Aurora was planted on May 25. Bliss was planted May 22 and Pittsford was planted June 10. Harvest dates for the four locations respectively were November 7, November 10, October 14, and November 16.

Growing Conditions

2001

Aurora experienced 2621 growing degree days (GDDs), above the average of 2421 for this location. Rainfall of 16.9 inches was recorded, less than the average of 20.7 inches.

The trials in Kingston also had higher than average GDDs, 2844 versus 2689. Kingston was considerably drier than average in 2001. It received 16.1 inches compared to an average of 23.0 inches (Cornell Cooperative Extension, 2001 Hybrid Corn Trials).

2002

The growing season in 2002 was challenging. The season started very wet with cool temperatures. Warm temperatures and dry conditions dominated the later parts of the season. All four locations had more GDDs than average. Kingston was the closest to average with 2686 GDDs, 17 higher than average. Bliss had 2313 GDDs versus an average of 2117 GDDs. Aurora averages 2653 GDDs but had 2763 GDDs in 2002. Pittsfield beat its average of 2667 GDDs by 207.

Rainfall for the growing season in each location was as follows: Kingston 23.9 inches (Avg. =24.1), Bliss 29.5 inches (Avg. =24.0), Aurora 24.6 inches (Avg. =21.49), and Pittsford 17.3 inches (Avg. =18.7).

RESULTS

The results show significant variation between varieties and between the same varieties at different locations (see table 3 and 4). In 2001 and 2002 most varieties produced higher yields at Kingston than at Aurora. Again in 2002 the varieties performed better at Kingston than other locations. The one exception was Krug, which performed better at Bliss. Trucker's Yellow performed poorly in 2002 but did very well in 2001. Longfellow, planted as part of the 2002 trials in three locations, performed poorly in all three locations.

Very few varieties performed well in multiple locations or over both years. Reid's Yellow Dent and Reid's Yellow Dent V were the most consistent in both locations in 2001 but, performance of Reid's Yellow Dent varied drastically from location to location in 2002. It did poorly at Pittsfield and Aurora while performing well in Kingston, 97.3 bu/acre, and at Bliss, 93.4.

Table 3: Yield, percent moisture, standability, and test weight of different corn varieties in 2001.

Aurora 2001.

Variety	Bu/Acre	% Moist.	Standability	Test Weight
Seneca Indian	43.0	22.9	2.3	50.7
Reids Yellow Dent Emo	78.0	34.8	3.7	45.3
Reids Yellow Dent V	82.0	32.0	5	45.7
Hickory King	35.8	30.1	2	43.7
Lancaster Sure Crop	75.6	32.4	5	51.9
Goliath Silo	40.5	31.6	2.3	34.9
Trucker's Yellow	76.8	29.0	3.7	55.4
Silver Mine	77.5	31.7	3.3	54.5
Silver King	44.5	29.3	2	45.6
Wapsee Valley	100.2	25.3	6.3	41.9
Krug	83.7	30.5	3	47.5
Boone County White	46.5	32.0	2.7	48.1
Ralph's	67.1	31.1	3.3	55.0
Nakomis Gold	71.4	26.7	5	51.9
E95	70.7	26.4	6.3	48.6
Hybrid Check Agway 6001	146.5	28.13	6.7	56.2
Mean	71.2	29.7	3.9	48.6
Coefficient of Variation	23	14	30	25
Least Significant Difference	27.6	7.3	2	19.4
Standard Deviation	16.6	4.3	1.2	11.7

Table 3: 2001 Results (Continued).

Kingston 2001.

Variety	Bu/Acre	% Moist.	Standability	Test Weight
Seneca Indian	51.2	19.4	6.0	50.7
Reids Yellow Dent Emo	101.1	27.2	9.0	51.2
Reids Yellow Dent V	72.3	23.6	8.7	53.3
Hickory King	99.4	34.6	9.0	48.5
Lancaster Sure Crop	85.3	29.4	8.7	51.5
Goliath Silo	32.3	29.8	9.0	48.6
Trucker's Yellow	120.7	31.0	9.0	50.1
Silver Mine	81.6	30.1	9.0	53.0
Silver King	76.2	29.3	9.0	51.3
Wapsee Valley	80.0	19.1	7.7	56.5
Krug	72.4	24.2	8.3	52.1
Boone County White	155.5	33.1	9.0	48.4
Ralph's	100.3	17.8	8.3	53.8
Nakomis Gold	58.6	19.1	8.3	49.6
Bloody Butcher	90.5	27.9	7.6	50.6
Hybrid Check Agway 6001	87.63	23.6	9.0	53.0
Mean	85.4	26.2	8.5	51.4
Coefficient of Variation	39.5	24	11	7.6
Least Significant Difference	39.0	9.7	1.1	6.6
Standard Deviation	33.73	6.3	.94	3.9

Table 4: Yield, percent moisture, standability, and test weight of different corn varieties in 2002.

Aurora 2002.

Variety	Bu/Acre	%Moist.
Longfellow	21.5	1.7
Reids Yellow Dent Emo	30.9	14.7
Reids Yellow Dent Shumways	15.4	31.4
Lancaster Sure Crop	19.5	23.3
Trucker's Yellow	35.5	28.7
Krug	39.2	24.1
Greenfield 114	50.6	28.8
Beasley's Red	22.4	18.9
Henry Moore	36.9	32.8
HybridPioneer34B23	113.2	30.9
Mean	38.53	23.54
Coefficient of Variation	49	30
Least Significant Difference	32	12.1
Standard Deviation	18.8	7.1

Table 4: 2002 Results (Continued).

Bliss 2002.

Variety	Bu/Acre	% Moist.	Test Weight
Reids Yellow Dent Emo	93.4	31.7	54.9
Reids Yellow Dent V Emo	78.4	32.0	54.9
Wapsee Valley	131.7	29.3	58.0
Krug	96.7	34.0	52.5
Nakomis Gold	137.3	31.5	58.2
E95	92.2	31.5	56.1
Iroquois White	98.9	29.4	55.0
Golden Glow	163.1	31.5	52.9
Northwestern Dent	92.1	31.2	53.9
Early Butler	118.1	29	55.4
Wisonsin 25	104.2	27.2	54.7
Minnesota 13	93.1	30.9	55.1
Bloody Butcher	101.3	34	51.5
HybridPioneer 38K06	91.53	27.9	55.4
Mean	107.3	23.54	54.8
Coefficient of Variation	32	7.0	2.9
Least Significant Difference	57.2	3	2.6
Standard Deviation	34.05	1.8	1.6

Table 4: 2002 Results (Continued).

Kingston 2002.

Variety	Bu/Acre	% Moist.	Test Weight
Longfellow	62.6	25.2	50.73
Reids Yellow Dent Emo	97.3	30.0	51.4
Lancaster Sure Crop	74.3	30.4	46.3
Krug	82.3	24.8	53.3
Greenfield 114	129.2	28.3	53.9
Beasley's Red	98.9	22.2	53.4
Henry Moore	97.3	28.6	52.3
HybridPioneer 34B23	240.6	24.8	59.7
Mean	111	26.8	52.6
Coefficient of Variation	24	9	8.7
Least Significant Difference	47	4.41	7.9
Standard Deviation	27.14	2.5	4.6

Table 4: 2002 Results (Continued).

Pittsfield 2002.

Variety	Bu/Acre	% Moist.	Test Weight
Longfellow	10.9	19.2	14.5
Reids Yellow Dent Emo	47.4	33.1	48.1
Reids Yellow Dent Shumways	26.1	33.0	36.3
Lancaster Sure Crop	25.3	32.7	40.9
Trucker's Yellow	23.7	30.4	36.1
Krug	34.7	32.7	47.3
Greenfield 114	35.9	30.8	46.7
Beasley's Red	19.9	25.7	29
Henry Moore	14.3	22.7	22.3
HybridPioneer 34B23	98.1	31.3	54.2
Mean	33.65	29.1	37.5
Coefficient of Variation	30	24	25
Least Significant Difference	17	12.15	16.1
Standard Deviation	10.0	7.1	9.5

DISCUSSION OF RESULTS

The variation between locations can be contributed to a number of factors. Differences in length of growing season was certainly one cause of variability between locations. Seeds of several varieties were from South Carolina, and so were better adapted to the longer growing season in Kingston. Very few of the varieties, with the possible exception of those from Minnesota, had been selected for a growing seasons as short as that at Aurora. The poor performance of varieties in Pittsfield, NY (2002) was due to a violent wind storm that badly lodged nearly all plants shortly before harvest.

In 2001 the Aurora plots also experienced a strong swirling wind storm, this in August, that knocked over much of the test as well as other hybrid plots surrounding it. Although the plants continued to grow and produce grain, many were left partially or fully prostrate. This led to increased losses due to birds and squirrels. It also increased harvest losses, since many ears could not be picked up by the combine.

Several varieties tended to produce more yield than others across tests. Wapsee Valley and Reid's Yellow Dent showed the most promise for use in commercial production environments. None of the varieties showed impressive results on a consistent basis. Perhaps the most significant trend in the data was the wide variation in performance from year to year and location to location, even among the same varieties.

PRACTICAL AND ECONOMIC DISCUSSION

The mean corn yield in bushels for New York State is 100.7 bu/acre (www.nass.usda.gov) averaged over the three years. (1999-2001). Many of the varieties in these trials occasionally performed at or above this level, but none consistently, except the hybrid checks. At first glance it seems doubtful that any of

these varieties might have potential to compete with modern hybrids in commercial enterprise. However marketing the best open pollinated varieties as a specialty crop might develop profitability. However, before a positive conclusion is drawn one must consider two major points.

1. Yields of open pollinated varieties were lower and more variable than yields of hybrids. For O.P production to be profitable over modern hybrids, growers would need higher prices to cover their growing costs and risk, and to gain a profit potential. This would demand a market that would value the historic or heirloom nature of these hybrids enough to pay a significantly higher price for the grain.

Premium alcoholic beverage producers might provide such a market. The "Benny Havens" whiskey proposal suggested by John Torgerson might fit this model. (See page 8). The cost of the raw material (corn) would play a minor role in such an operation. An increase in this cost should not have a large impact on margins. In fact, a premium price for the alcohol based on the sales appeal of the ingredients (heirloom corn vs. modern) might actually increase margins.

2. Predictability of results is the second concern. Hybrid varieties were adopted quickly and universally because of their improved performance and perhaps more importantly, consistency. Results of these trials do not indicate that any of the open pollinated varieties tested match commercially successful varieties in consistency of yield or standability.

Agriculture is a very unpredictable industry. Producers are dependent on many variables that often fluctuate wildly. Environmental conditions, as well as market conditions, including the cost of fuel and consumer demand make it very difficult to plan for specific prices. Tools to cope with this unpredictability, such futures markets and crop insurance have been developed for large commodity crops. Specialty crop

producers do not have such tools to help protect against price volatility and fluctuations in production.

The market for this specialty use is too small at this stage to tolerate wide fluctuations in production. Premium alcoholic beverage producers can tolerate higher production costs but will not be able to tolerate unpredictable availability of inputs. If an entire crop fails than production would need to be halted for the year. This is an unacceptable business risk.

On the scale of production that is being considered (probably a few acres) there are few feasible ways to insure a sufficient crop. Over planting is one solution but multiple farmers in varied locations would be needed. The logistics and cost of over planting enough to guarantee success on an annual basis would increase costs to a point that is unsustainable. Considering the unpredictability of the O.P. corn production, the development of a product that is differentiated based on its presence seems like a very risky venture.

Possible solutions include developing a product based mostly on readily available, inexpensive hybrid corn grain, mixed with a very limited amount of open pollinated grain, even as low as a handful per batch. This could offer the best of both worlds. The label could still claim the presence of historically authentic ingredients, yet supply would no be wholly dependent on a crop that is wildly unpredictable. Another idea would be to use New York grown inputs but ship them to an existing distillery, which at this time would have to be out of state. The New York image would be maintained for marketing purposes but the initial financial lay out is minimized. A long-term business strategy could be to eventually produce the whiskey locally once the brand is successful, but by out sourcing at least in the start up phases risk is minimized.

If a business plan could be developed that protects against higher prices of inputs and more importantly the fluctuations of availability, the concept of using open pollinated corn to differentiate a small batch premium alcoholic beverage has the potential to be successful. It must be done in such a way as to minimize risk and maximize any potential benefit.

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