

A STUDY OF WINTER WHEATS WITH SPECIAL REFERENCE
TO STANDARDIZATION AND HYBRIDIZATION.

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REFERENCE TO STANDARDIZATION AND HYBRIDIZATION.

Major Thesis in Agronomy submitted to

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A STUDY OF WINTER WHEATS WITH SPECIAL REFERENCE TO STANDARDIZATION AND HYBRIDIZATION.

Wheat has for ages stood unrivalled among the farinaceous grains as food for man. The position is well deserved. It is easily grown and has a wide natural adaptation to soil and climatic conditions. It has the food elements in a form and proportion well suited to the needs of the human body. The characteristic, however, which places wheat in an outstanding position among the grains is that quality of the gluten which, with the addition of yeast, produces a light bread not to be obtained in any other way.

The origin of wheat is not definitely known. It is most generally believed to have arisen in the valleys of the Tigris and Euphrates. It has been cultivated by man since before the time of known history.

Common wheat (Triticum vulgare) is derived from the family Graminae in the following manner:

<u>Family</u>	<u>Tribe</u>	<u>Sub-tribe</u>	<u>Genus</u>	<u>Species</u>	<u>Race</u>
Graminae	Hordeae	Triticeae	Triticum	T. sativum	T. sativum tenax
<u>Sub-race</u>					
Triticum sativum vulgare					

The objects of this study have been: First, to describe in some detail the available varieties of winter wheat and from these descriptions to form groups of those varieties which are alike in essential characteristics, the object being to show that many so-called varieties are so much alike that no distinction of practical significance can be made between them. Second, to make crosses between

wheats of distinctly different characteristics in an attempt to combine the good characters of both. Third, to make crosses between widely differing groups, if possible.

Wheat breeding, by selection or crossing or both, has been systematically carried on for many years in the United States, Canada, Great Britian, France, Germany and other of the leading countries.

Canada, working on Red Fife at the Dominion Experiment Farm, has put out wheats of such a grade that they are already widely used in that region.

England, at Cambridge, is working especially on immunity from yellow rust (Puccina glumorum), and high yield.

Before the recent European conflict Sweden had fifteen and Germany had eighty four breeders at work on wheats.

Many individual farmers have vastly improved their yield by isolating a single promising plant and preserving its progeny. It is estimated that William Farrer of New South Wales, by the production of Federation wheat alone, added millions sterling to the nation's wealth.

The experiment stations of many of the states have been importing seed from Russia, India, Austria, Japan, and smaller amounts from the Mediterranean region. The varieties from Southern Russia, such as Kubanka, Crimean, Turkey and Russian, seem to do best in this country. The club wheats of the Pacific and Palouse regions were brought from Chili, Australia, and France. The Fife wheats of our Northern Plains and Canada probably came from Russia.

From the above varieties and the local varieties have arisen an enormous number of varieties and so-called varieties, many of which serve only to confuse the buyer and have little or nothing to justify their separation from the better known parent varieties.

With this condition in view, over one hundred varieties of wheat and barley were collected for this study. About fifteen of these were barley. Each of these varieties was described according to a form used for cereals by the Bureau of Plant Industry. Some non-essential details were omitted. The blank, as used, is as follows:

Leaves (on internodes over 3 cm. long) Number _____
Length of second from top _____ cm.; width, _____ mm.
Sheath: Green, blue-green, purplish; glaucous; smooth, scabrous, glabrous, pubescent, pilose setose.
Blade: Long, medium, short; broad, medium, narrow; acuminate, acute, obtuse; thick, thin, weak, strong. Smooth, scabrous; glaucous; glabrous, pubescent, pilose, setose.
Venation: Prominent, not prominent.
Auricle: White, green, white with purple tips, purple; smooth; pilose, setose; number of hairs _____.
Ligule: Length, _____ mm.; entire, lacerate; acuminate, acute, obtuse; white, greenish, purple.
Culm: Height _____ cm; diameter at base, _____ mm.
Size: stout, medium, slender.
Strength: strong, medium, weak.
Color: White, greenish, yellow, brown, purple; glaucous.
Pubescence: Nodes (densely, thinly) barbed; adjacent culm and sheath pilose.
Peduncle: Length, _____ dm; diameter, _____ mm.
Stout, medium, slender; straight, flexuous; glaucous.
Structure: (1 inch from head), solid, semi-solid, hollow.
Apex exsertion _____ cm; erect, inclined, nodding.
Inflorescence: Flattened transversely to or parallel with face of spikelets.
Density: Lax, medium, dense; Nodes per dm. _____.
Shape: Conical, cylindrical, fusiform, clavate, oblong, ovate, oval, obovate, umbelliform. Base: acute, obtuse.
Apex: acute, obtuse.
Rachis: No. of nodes _____; No. sterile _____; strong, medium, fragile.
Spikelets: Number _____; No. sterile, base _____; apex, _____; appressed, spreading.
Fertility: All fertile, lateral sterile.
Kernels: Exserted, included; number of _____.
Rachilla: Stout, medium, slender.
Glumes: Broad, medium, narrow; short, medium, long.
Shape: Linear, lanceolate, ovate.
Texture: Coriaceous, chartaceous, membranaceous.
Color: whitish, yellow, yellowish-brown, grayish-brown, brown, purple, violet, red, bluish, black; streaked, uniform; shining, dull.
Surface: Smooth, scabrous; glabrous, glabrate, ciliate.
Keel: Broad, medium, narrow; depressed, flat, prominent; smooth, scabrous, ciliate.
Beak: Broad, medium, narrow; obtuse, acute, acuminate; length _____ mm.
Shoulder: Broad, medium, narrow; oblique, rounded, square; apiculate, auriculate.

Lemma, Lower: Broad, medium, narrow; long, medium, short.
Texture: Corniaceous, characetous, membranaceous; fragile.
Color: Whitish, yellow, yellowish-brown, grayish-brown, purple, violet, red, bluish, black; streaked, uniform.
Surface: Smooth, scabrous; glabrous, glabrate, ciliate, pubescent; on veins.
Keel: Broad, medium, narrow; smooth, scabrous, ciliate
Awns: Wanting, deciduous, partly deciduous, persistent; few, medium, numerous; apical, throughout.
Form of Awn: Simple, trifurcate; geniculate.
Size: Length mm.
Texture: Fragile, flexible.
Position to axis: Parallel, spreading (widely), recurved.
Lemma, Middle: Color: Whitish, yellow, yellowish brown, grayish-brown, brown, red, bluish, black; streaked, uniform.
Surface: Smooth, scabrous, glabrous, glabrate, ciliate, hairy, partly hairy; on veins.
Kernel:
Lemma: Adherent, non-adherent.
Size: Large, medium, small.
Shape: Linear, oblong, elliptical(narrowly, broadly), ovoid, lenticular, spherical.
Base: Acute, obtuse;
Apex: Acute obtuse.
Crease: Deep, medium, shallow; wide, medium, narrow.
Cross section: Cheeks flat, plump, angular.
Endosperm: Starchy, partly starchy, horny, very horny, granular.
Scutellum: Round, lyre-shaped, tongue-shaped; broad, narrow, shallow, deep.
Hardness:
Color: White, buff, cream, yellow, pale amber, amber red, red, red-brown, brown, dark brown, bluish black; not uniform; dull, shining.

For eleven of the varieties the description was incomplete because of the ravages of mice and rats. A few were lost entirely

It is obviously impossible in a paper of this length to write down the description of all the varieties according to the above form.

These plants were grown in greenhouses and as a result may be modified somewhat in some characters, such as nodding and color.

Since these descriptions were too bulky and unwieldy for any extended comparison of the individual varieties, it was decided to place the varieties in classes based on their more important and

more constant characters. Accurate description was found to be extremely difficult even in the gross characters on account of the great individual and seasonal variation. For example, eighty percent of the plants grown one season averaged below 75 cm. in height of culm while eighty five percent of those described from a different lot grown during another season fell into the class above 75 cm. in height of culm. This is an extreme case but the principle holds for much of this work. Fortunately most of the notes were obtained from plants grown the same season. The exceptions to this are: Extra Early Windsor, Imperial Amber, Miller's Pride, New Soules, Pride of Genesee, Red Clawson, Red Wave, Rural New Yorker, Winter Fife. These varieties, which were obtained from New York, tended to longer culm and more plump and starchy kernel.

The classes and varieties included in them will be given here with the varieties arranged in alphabetical order under each class:

BARLEY

Blade:

Long (over 18 cm.): Austrian Hanna, Black Hulless, Chevalier, Servian, Two Row Black, Two Row Hulless, V.P.I. No. 118.

Short (under 18 cm.): Blue Barley, Gatami, Hauschen, Hordeum Spontaneum, Manchury, Red's Triumph, White Hulless.

Width:

Under 10 mm.: Hauschen, Hordeum Spontaneum, Triumph Reds.

10 to 14 mm.: Austrian Hanna, Blue Barley, Chevalier, Gatami, Manchury, Servian Two Row Black, V. P. I. No. 118, White Hulless.

Over 14 mm. : Black Hulless, Two Row Hulless.

Culm:

Height:

Under 45 cm.: Hordeum Spontaneum.

45 to 60 cm.: Austrian Hanna, Black Hulless, Blue Barley, Chevalier, Gatami, Hauschen, Manchury, Red's Triumph, Servian, Two Row Black, Two Row Hulless, V. P. I. 118, White Hulless.

Diameter at base:

Under 2.5 mm.: Blue Barley, Hardeum Spontaneum, Two Row Black.

2.5 to 3.5 mm.: Austrian Hanna, Chevalier, Gatami, Hauschen, Manchury, Two Row Hulless, V. P. I. No. 118, White Hulless.
Over 3.5 mm.: Black Hulless, Reds Triumph, Servian.
Erect or nodding: All nodding in culm or rachis.

Spike:

Density (nodes per dm.)

Under 25: Hordeum Spontaneum, White Hulless.

From 25 to 35: Austrian Hanna, Black Hulless, Blue Barley, Chevalier, Gatami, Two Row Black, Two Row Hulless.

Over 35: Hauschen, Manchury, Reds Triumph, Servian, V. P. I. No. 118.

Total nodes in rachis:

Under 20: Black Hulless, Gatami, Hordeum Spontaneum, White Hulless.

From 20 to 30: Austrian Hanna, Blue Barley, Hauschen, Manchury, Reds Triumph, Servian, Two Row Black, Two Row Hulless, V. P. I. No. 118.

Over 30: Chevalier.

Number Sterile Nodes:

Less than 2: Austrian Hanna, Blue Barley, Hordeum Spontaneum, Reds Triumph, Two Row Black, Two Row Hulless, White Hulless.

From 2 to 5: Black Hulless, Gatami, Manchury, V.P.I. No. 118.

Over 5: Chevalier, Hauschen.

Kernel exerted: Servian.

Two rowed: Austrian Hanna, Chevalier, Hauschen, Hordeum Spontaneum, Two Row Black, Two Row Hulless, V. P. I. No. 118.

Six rowed: Black Hulless, Blue Barley, Gatami, Manchury, Reds Triumph, Servian, White Hulless.

Lemma (lower) color:

Yellow: Austrian Hanna, Blue Barley, Chevalier, Hordeum Spontaneum, Manchury, Reds Triumph, Servian, Two Row Hulless, V. P. I. No. 118, White Hulless

Brown: Black Hulless, Hauschen.

Bluish: Gatami, Two Row Black.

Awned (simple): Austrian Hanna, Black Hulless, Blue Barley, Chevalier, Gatami, Hauschen, Hordeum Spontaneum, Manchury, Reds Triumph, Servian, Two Row Black, Two Row Hulless, V. P. I. No. 118

Awned (compound): White Hulless.

Lemma (middle) color:

Yellow: Austrian Hanna, Black Hulless, Blue Barley, Chevalier, Hauschen, Hordeum Spontaneum, Manchury, Reds Triumph, Servian, Two Row Hulless, V. P. I. No. 118, White Hulless.

Bluish: Gatami, Two Row Black.

Kernel:

Broad: Hauschen, Two Row Black.

Oblong: Austrian Hanna, Black Hulless, Blue Barley, Chevalier, Gatami, Hordeum Spontaneum, Manchury, Reds Triumph, Servian, Two Row Hulless, V. P. I. No. 118, White Hulless.

Crease:

Deep: Hordeum, Spontaneum, Servian.
Shallow: Austrian Hanna, Black Hulluss, Blue Barley, Chevalier, Gatami, Hauschen, Manchury, Reds Triumph, Two Row Black, Two Row Hulless, V. P. I. No. 118, White Hulless.

Cross Section:

Cheeks angular: Hordeum Spontaneum, Servian.
Cheeks plump: All others as named just above under "shallow crease".

Endosperm:

Starchy: Hordeum Spontaneum, White Hulless.
Partly starchy: Austrian Hanna, Black Hulless, Gatami, Manchury, Reds Triumph, Two Row Black, Two Row Hulless, V. P. I. No. 118.
Horny: Blue Barley, Chevalier, Hauschen, Servian.
Lemma non-adherent: Black Hulless, Two Row Hulless.
Lemma adherent: All others described.

Color:

White: Austrian Hanna, Blue Barley, Chevalier, White Hulless.
Yellow: Hordeum Spontaneum, Manchury, Reds Triumph, Servian, Two Row Hulless, V. P. I. No. 118.
Brown: Hauschen.
Bluish Black: Black Hulless, Gatami, Two Row Black.

From this abbreviated classification the varieties were compared as to similarity in essential characteristics. The majority of the varieties under consideration stood out with decided individual characters to distinguish them from all the others. Only a few exceptions were found.

Two Row Hulless and V. P. I. No. 118 were found to agree in the following points: Blade (second from top) over 18 cm. long and 12 mm. wide. Culm 50 cm. or over in length and 3 mm. in diameter. Spike dense, (over 30 nodes per dm.) Nodes in rachis over 30. Less than 3 nodes sterile. Culm nodding. Spike two-rowed, kernel included. Lemmas (lower and middle) yellow. Lower lemma awned. Kernel medium size, oblong. Crease shallow. Cross section rounded. Endosperm partly starchy. Color of kernel yellow. The only marked difference observed in these two varieties is the non-adherence of the lemma in Two Row Hulless.

Manchury and Red's Triumph agree in the following descrip-

tion: Blade 10 to 14 mm. wide. Culm 45 to 60 cm. in height, nodding. Twenty five to thirty five nodes per dm., and 20 to 30 nodes per spike. Kernel included. Spike six rowed. Lemmas yellow. Kernel yellow, medium size, oblong. Crease shallow. Cross section rounded. Endosperm partly starchy. Lemma adherent.

Beyond these two small classes no two varieties could be found which were similar in even the fundamental characters. This condition however, is to be expected since the barleys in this country, as a whole, are comparatively new and hence have not been exploited by sub-dividing varieties on the smaller and unimportant differences to form new varieties.

The wheats, which are older and more widespread, will be found to fall into groups containing several varieties which resemble each other quite closely.

WHEAT.

Length of leaf (second from top):

Under 20 cm.: Farmer's Friend, Fretes, Hickman, Miracle, Oatk, Rudy, Red Wave, Turkey Red.

From 20 to 30 cm.: Alaska, Dawson's Golden Chaff, Early Red Chief, Eclipse, Economy, Einkorn, Emmer, Extra Early Windsor, Fish Head, Fulcaster, Fultz Mediterranean, Gold Coin or Forty Fold, Imperial Amber, Kubanka, Lebanon, Long Amber, Marquis, Marouam, Miller's Pride, New American Banner, New Soules, Nixon, Poulard, Pride of Indiana, Pride of Genesee, Red Clawson, Red Cross, Red Russian, Sibley's New Golden, St. Louis Grand Prize, Tennessee Fultz, Winter Fife

Over 30 cm.: Farmer's Trust, Haynes Blue Stem, Polish, Poole, Rural New Yorker.

Width of leaf:

Under 6 mm.: Fretes, Hickman, Nixon, Red Cross, Rudy, Turkey Red.

From 6 to 12 mm.: Alaska, Dawson's Golden Chaff, Early Red Chief, Eclipse, Economy, Einkorn, Emmer, Extra Early Windsor, Farmer's Friend, Farmer's Trust, Fish Head, Fulcaster, Gold Coin, Fultz Mediterranean, Haynes Blue Stem, Imperial Amber, Kubanka, Lebanon, Long Amber, Marquis Miracle, New American Banner, New Soules, Oatk, Polish, Poole, Poulard,

Pride of Genesee, Red Clawson, Red Russian, Red Wave, Sibley's New Golden, St. Louis Grand Prize, Tennessee Fultz, Velvet Chaff, V. P. I. No. 8, Winter Fife, Wonder.

Over 12 mm.: Maronam, Miller's Pride, Pride of Indiana, Rural New Yorker.

Culm:

Height:

Under 50 cm.: Economy, Hickman.

From 50 to 75 cm.: Alaska, Dawson's Golden Chaff, Early Red Chief, Eclipse, Einkorn, Emmer, Farmer's Friend, Farmer's Trust, Fretes, Fulcaster, Fultz Mediterranean, Gold Coin, Haynes Blue Stem, Lebanon, Long Amber, Marquis, Miracle, New American Banner, Nixon, Oatk, Poole, Poulard, Red Clawson, Red Cross, Red Russian, Rudy, Sibley's New Golden, St. Louis Grand Prize, Tennessee Fultz, Turkey Red, Velvet Chaff, Wonder.

Over 75 cm.: Extra Early Windsor, Fish Head, Imperial Amber, Kubanka, Maronam, Miller's Pride, New Soules, Polish, Pride of Genesee, Pride of Indiana, Red Wave, Rural New Yorker, V. P. I. No. 8, Winter Fife.

Diameter:

Under $2\frac{1}{2}$ mm.: Einkorn, Emmer, Fretes, Fulcaster, Turkey Red.

From $2\frac{1}{2}$ to $3\frac{1}{2}$ mm.: Early Red Chief, Eclipse, Economy, Extra Early Windsor, Farmer's Friend, Farmer's Trust, Fish Head, Fultz Mediterranean, Gold Coin, Haynes Blue Stem, Hickman, Imperial Amber, Kubanka, Lebanon, Long Amber, Marquis, Miracle, Maronam, Miller's Pride, New American Banner, New Soules, Nixon, Oatk, Polish, Poole, Poulard, Pride of Indiana, Red Clawson, Red Cross, Red Russian, Red Wave, Rudy, Rural New Yorker, Sibley's New Golden, St. Louis Grand Prize, Tennessee Fultz, Velvet Chaff, V.P.I. 8, Winter Fife.

Over $3\frac{1}{2}$ mm.: Alaska, Dawson's Golden Chaff, Pride of Genesee, Wonder.

Culm erect: Alaska, Early Red Chief, Economy, Einkorn, Emmer, Extra Early Windsor, Farmer's Trust, Fish Head, Fretes, Fultz Mediterranean, Haynes Blue Stem, Hickman, Marquis, Miracle, Maronam, New American, Banner, New Soules, Nixon, Poulard, Pride of Indiana, Red Clawson, Red Wave, Rural New Yorker, Rudy, St. Louis Grand Prize, Tennessee Fultz, Velvet Chaff, Winter Fife, Wonder.

Culm nodding: Dawson's Golden Chaff, Eclipse, Farmer's Friend, Fulcaster, Imperial Amber, Kubanka, Lebanon, Long Amber, Miller's Pride, Oatk, Polish, Poole, Pride of Genesee, Red Cross, Red Russian, Sibley's New Golden, V. P. I. No. 8.

Spike?

Density (nodes per dm.):

Under 16: Early Red Chief, Polish.

From 16 to 25: Dawson's Golden Chaff, Eclipse, Economy, Extra Early Windsor, Farmer's Friend, Farmer's Trust, Fish Head, Fretes, Fulcaster, Fultz Mediterranean, Haynes Blue Stem, Hickman, Imperial Amber, Kubanka, Lebanon, Long Amber, Marquis, Miracle, Marouam, Miller's Pride, New American Banner, New Soules, Nixon, Oatk, Poole, Pride of Indiana, Pride of Genesee, Red Clawson, Red Cross, Red Russian, Red Wave, Rudy, Rural New Yorker, Sibley's New Golden, St. Louis Grand Prize, Tennessee Fultz, Turkey Red, Velvet Chaff, V. P. I. No. 8, Winter Fife.

Over 25: Alaska, Einkorn, Emmer, Poulard, Wonder.

Total Number of nodes:

Under 18: Emmer, Poulard, Rudy.

From 18 to 25: Dawson's Golden Chaff, Early Red Chief, Eclipse, Economy, Extra Early Windsor, Farmer's Friend, Farmer's Trust, Fish Head, Fretes, Fulcaster, Fultz, Mediterranean, Haynes Blue Stem, Hickman, Imperial Amber, Kubanka, Lebanon, Long Amber, Marquis, Miracle, Marouam, Miller's Pride, New American Banner, New Soules, Nixon, Oatk, Polish, Poole, Pride of Indiana, Pride of Genesee, Red Clawson, Red Cross, Red Russian, Red Wave, Rural New Yorker, Sibley's New Golden, St. Louis Grand Prize, Tennessee Fultz, Turkey Red, Velvet Chaff, Wonder, Winter Fife.

Over 25: Alaska, Einkorn, V. P. I. No. 8.

Number of fertile spikelets:

Under 14: Einkorn, Emmer, Farmer's Friend, Hickman, Polish, Poulard, Turkey Red.

From 14 to 20: Alaska, Dawson's Golden Chaff, Early Red Chief, Eclipse, Economy, Extra Early Windsor, Farmer's Trust, Fretes, Fulcaster, Fultz Mediterranean, Haynes Blue Stem, Kubanka, Lebanon, Long Amber, Marquis, Miracle, Marouam, Miller's Pride, New American Banner, New Soules, Nixon, Oatk, Poole, Pride of Indiana, Pride of Genesee, Red Clawson, Red Cross, Red Russian, Red Wave, Rudy, Rural New Yorker, Sibley's New Golden, St. Louis Grand Prize, Tennessee Fultz, Velvet Chaff, Wonder, Winter Fife.

Over 20: Fish Head, V. P. I. No. 8.

Glumes, color:

Yellow: Alaska, Dawson's Golden Chaff, Economy, Farmer's Friend, Fish Head, Fretes, Fulcaster, Fultz Mediterranean, Haynes Blue Stem, Hickman, Lebanon, Marquis, Nixon, Oatk, Rudy, Tennessee Fultz, Turkey Red, V. P. I. No. 8.

Brown: Early Red Chief, Eclipse, Einkorn, Emmer, Farmer's Trust, Gold Coin, Imperial Amber, Kubanka, Long Amber, Miracle, Marouam, New American, Banner, Polish, Poole, Poulard, Pride of Indiana, Red Cross, Red Russian, Sibley's New Golden, St. Louis Grand Prize, Velvet Chaff, Wonder.

Lemma, (Lower) Color:

Yellow: Alaska, Dawson's Golden Chaff, Early Red Chief, Eclipse, Economy, Emmer, Farmer's Friend, Fish Head, Fretes, Fulcaster, Fultz Mediterranean, Haynes Blue Stem, Hickman, Lebanon, Marquis, Miracle, Nixon, Oatk, Tennessee Fultz, V. P. I. No. 8, Wonder.

Whitish: Einkorn, Marouam, Turkey Red.

Yellowish-brown: Farmer's Trust, Gold Coin, Long Amber, New American Banner, Polish, Poole, Price of Indiana, Red Cross, Red Russian, Rudy, Sibley's New Golden, St. Louis Grand Prize, Velvet Chaff,

Grayish-brown: Kubanak, Poulard.

Surface:

Pubescent: Fish Head, Haynes Blue Stem, Polish, Poulard, Pride of Genesee, Red Wave, Velvet Chaff, Winter Fife.

Smooth: Alaska, Dawson's Golden Chaff, Early Red Chief, Eclipse, Economy, Einkorn, Emmer, Extra Early Windsor, Farmer's Friend, Farmer's Trust, Fretes, Fulcaster, Fultz Mediterranean, Hickman, Imperial Amber, Kubanka, Lebanon, Long Amber, Marouam, Marquis, Miller's Pride, Miracle, New American Banner, New Soules, Nixon, Oatk, Poole, Pride of Indiana, Red Clawson, Red Cross, Red Russian, Rudy, Rural New Yorker, Sibley's New Golden, St. Louis Grand Prize, Tennessee Fultz, Turkey Red, V. P. I. No. 8, Wonder.

Awned: Alaska, Eclipse, Einkorn, Emmer, Farmer's Friend, Farmer's Trust, Fretes, Fulcaster, Imperial Amber, Kubanka, Lebanon, Marouam, Miracle, Miller's Pride, Oatk, Polish, Poulard, Pride of Genesee, Red Cross, Rudy, Sibley's New Golden, Turkey Red, Velvet Chaff, Wonder.

Awnless: Dawson's Golden Chaff, Early Red Chief, Economy, Extra Early Windsor, Fish Head, Fultz Mediterranean, Gold Coin, Haynes Blue Stem, Hickman, Long Amber, Marquis, New American Banner, New Soules, Nixon, Poole, Pride of Indiana, Red Clawson, Red Russian, Red Wave, Rural New Yorker, St. Louis Grand Prize, Tennessee Fultz, V. P. I. No. 8, Winter Fife.

Middle Lemma Color:

Whitish: Alaska, Dawson's Golden Chaff, Eclipse, Economy, Einkorn, Emmer, Farmer's Friend, Farmer's Trust, Fish Head, Fretes, Haynes Blue Stem, Hickman, Kubanka, Marouam, Miracle, New American Banner, Nixon, Oatk, Polish, Poole, Poulard, Pride of Indiana, Red Cross, Red Russian, Sibley's New Golden, St. Louis Grand Prize, Tennessee Fultz, Turkey Red, V. P. I. No. 8, Wonder.

Yellow: Early Red Chief, Fulcaster, Fultz, Mediterranean, Lebanon, Long Amber, Marquis, Rudy, Velvet Chaff.

Kernel:

Size:

Large :: Dawson's Golden Chaff, Early Red Chief, Imperial Amber, Marouam, Polish, Poole, Rural New Yorker, Sibley's New Golden, St. Louis Grand Prize, Wonder.

Medium: Alaska, Eclipse, Economy, Emmer, Extra Early Windsor, Farmer's Friend, Farmer's Trust, Fish Head, Fretes, Fulcaster, Fultz Mediterranean, Gold Coin, Hickman, Kubanka, Lebanon, Long Amber, Marquis, Miracle, Miller's Pride, New American Banner, New Soules, Nixon, Poulard, Pride of Indiana, Pride of Genesee, Red Clawson, Red Cross, Red Wave, Red Russian, Rudy, Tennessee Fultz, Turkey Red, V. P. I. No. 8,

Small: Einkorn, Haynes Blue Stem, Oatk, Velvet Chaff, Winter Fife.

Shape:

Oblong: Economy, Emmer, Extra Early Windsor, Fretes, Fulcaster, Kubanka, Polish, Poulard, Rudy, Velvet Chaff.

Broad: Alaska, Dawson's Golden Chaff, Early Red Chief, Eclipse, Einkorn, Farmer's Friend, Farmer's Trust, Fish Head, Fultz Mediterranean, Gold Coin, Haynes Blue Stem, Hickman, Imperial Amber, Lebanon, Long Amber, Marouam, Marquis, Miracle, New American Banner, New Soules, Nixon, Miller's Pride, Oatk, Poole, Pride of Genesee, Pride of Indiana, Red Clawson, Red Cross, Red Russian, Red Wave, Rural New Yorker, Sibley's New Golden, St. Louis Grand Prize, Tennessee Fultz, Turkey Red, V. P. I. No. 8, Wonder, Winter Fife.

Crease:

Deep: Early Red Chief, Economy, Einkorn, Emmer, Fish Head, Fultz Mediterranean, Hickman, Imperial Amber, Lebanon, Long Amber, Miracle, New Soules, Nixon, Oatk, Pride of Genesee, Pride of Indiana, Red Russian, Red Wave, Rudy, Rural New Yorker, Tennessee Fultz, Velvet Chaff.

Medium: Alaska, Dawson's Golden Chaff, Eclipse, Farmer's Friend, Farmer's Trust, Fretes, Fulcaster, Kubanka, Marquis, Miller's Pride, New American Banner, Polish, Poole, Poulard, Red Clawson, Red Cross, Sibley's New Golden, St. Louis Grand Prize, Turkey

Red, V. P. I. No. 8, Wonder, Winter Fife.

Shallow: Extra Early Windsor, Haynes Blue Stem, Marouam,

Endosperm:

Starchy: Einkorn, Extra Early Windsor, New Soules, Red Wave.

Partly starchy: Early Red Chief, Farmer's Trust, Fretes, Fultz Mediterranean, Gold Coin, Imperial Amber, Lebanon, Miller's Pride, Nixon, Poole, Pride of Genesee, Red Clawson, Rudy, Rural New Yorker, St. Louis Grand Prize, Tennessee Fultz, V. P. I. No. 8, Winter Fife.

Horny: Dawson's Golden Chaff, Eclipse, Economy, Farmer's Friend, Fish Head, Haynes Blue Stem, Hickman, Long Amber, Marquis, Miracle, New American Banner, Oatk, Pride of Indiana, Red Cross, Red Russian, Sibley's New Golden, Turkey Red, Velvet Chaff.

Cross section:

Rounded: Early Red Chief, Fish Head, Fretes, Fulcaster, Fultz Mediterranean, Hickman, Long Amber, Miracle, New American Banner, New Soules, Nixon, Miller's Pride, Oatk, Pride of Genesee, Pride of Indiana, Red Clawson, Red Russian, Red Wave, Rural New Yorker, Sibley's New Golden, St. Louis Grand Prize, Tennessee Fultz, Turkey Red, Winter Fife.

Angular: Alaska, Dawson's Golden Chaff, Eclipse, Economy, Einkorn, Emmer, Farmer's Friend, Haynes Blue Stem, Lebanon, Marquis, Marouam, Polish, Poulard, Red Cross, Rudy, Velvet Chaff, V. P. I. No. 8, Wonder.

Color (Kernel):

Yellow: Alaska, Dawson's Golden Chaff, Eclipse, Economy, Einkorn, Extra Early Windsor, Farmer's Friend, Farmer's Trust, Fish Head, Fretes, Fulcaster, Fultz Mediterranean, Haynes Blue Stem, Hickman, Imperial Amber, Kubanka, Lebanon, Long Amber, Miracle, New American Banner, New Soules, Nixon, Oatk, Polish, Poole, Poulard, Pride of Indiana, Pride of Genesee, Red Clawson, Red Cross, Red Russian, Red Wave, Rudy, Rural New Yorker, Sibley's New Golden, St. Louis Grand Prize, Tennessee Fultz, Turkey Red, Velvet Chaff, V. P. I. No. 8, Wonder, Winter Fife.

Brown: Early Red Chief, Emmer, Marquis, Marouam, Miller's Pride.

Although these classes were made quite broad, no two varieties were found to agree in all the characters considered. Varieties were then grouped according to agreement in the essential points and these groups were subsequently carried through the less important classes, as many points of likeness as possible being added.

The following description applies to the varieties Dawson's Golden Chaff, Eclipse, Farmer's Friend and Red Cross: Culm, 50 to 75 cm. in height, nodding; 16 to 25 nodes per dm.; total number of nodes per spike, 18 to 25; lower lemma yellow (yellowish brown in Red Cross); middle lemma whitish; kernel yellow, broad, (elliptical to ovoid); cross section rounded; endosperm horny; crease medium depth.

Dawson's Golden Chaff differs from the others of the group in being awnless and somewhat larger in some dimensions, such as diameter of culm.

The varieties Fish Head, Fultz Mediterranean, Long Amber, New Soules, Nixon, Pride of Indiana, Red Russian, agree in the following description: Leaf 20 to 30 cm. long; culm $2\frac{1}{2}$ to $3\frac{1}{2}$ mm. in diameter; density of spike medium (16 to 25 nodes per dm.); total number of nodes per spike, 18 to 25; awns wanting, kernel yellow, broad (elliptical to ovoid), medium size; cross section rounded; crease deep.

These varieties differ in the starchiness of the endosperm and color of chaff. The variety Fish Head possesses marked pubescence on the chaff in contrast to the others of the group.

Alaska, Farmer's Friend, Fretes, Fulcaster, and Turkey Red conform to: Height of culm, 50 to 75 cm.; glumes yellow; lemma awned; kernel medium size, yellow, with medium depth of crease.

They differ in shape of kernel and amount of starch contained therein. Alaska has a branching of the rachis not found in the other varieties.

Eclipse, Farmer's Trust, Kubanka, Miracle, and Red Cross have: culm, $2\frac{1}{2}$ to $3\frac{1}{2}$ mm. in diameter; density of spike medium, (16 to 25 nodes per dm.); total number of nodes, 18 to 25; number of fertile spikelets, 14 to 20; chaff smooth; glumes, brown.

They differ in hardness of endosperm and shape of kernel.

With the exception that Gold Coin has a more angular, horny kernel, the varieties Gold Coin, Long Amber, New American Banner, Pride of Indiana, and Red Russian may be described by: Leaf, 20 to 30 cm. long; culm, $2\frac{1}{2}$ to $3\frac{1}{2}$ mm. in diameter; density of spike, medium (16 to 25 nodes per dm.); nodes per spikelet, 18 to 25; fertile spikelets, 14 to 20; glumes brown, lemma (lower) yellowish brown; awns wanting; kernel yellow, medium size, broad with rounded cross section; endosperm horny.

Fish Head, Fultz Mediterranean, Marquis, Nixon, Tennessee Fultz, and V. P. I. No. 8 have in common: Leaf, 20 to 30 cm. long; culm $2\frac{1}{2}$ to $3\frac{1}{2}$ mm. in diameter; density of spike, medium (18 to 25 nodes per dm.); glumes and lower lemma yellow; awns wanting; kernel yellow, medium size, broad (elliptical to ovoid).

Fish Head has pubescent chaff and with Marquis has more horny endosperm than the other varieties. The plants of Fish Head and V. P. I. No. 8 average somewhat larger than those of the remainder of the group.

Eclipse, Farmer's Friend, Red Cross, Sibley's New Golden, Turkey Red; culm, 50 to 75 cm. in height; density of spike, medium; nodes per spike, 18 to 25; awns present; chaff smooth; kernel yellow, medium size, broad with medium depth of crease and horny endosperm.

The color of chaff is variable in this group. Turkey Red averages smaller than the others of the group in several dimensions.

Early Red Chief, Fultz Mediterranean, Nixon, and Tennessee Fultz have: Leaf, 20 to 30 cm. long; culm, 50 to 75 cm. high, and $2\frac{1}{2}$ to $3\frac{1}{2}$ mm. in diameter; erect; nodes per spike, 18 to 25; fertile spikelets, 14 to 20; awns wanting; kernel broad, plump; crease deep, endosperm partly starchy. Color of kernel and chaff varies in this group. Early Red Chief has a larger kernel than the other varieties of the group.

In viewing these classes it becomes evident that for any given purpose to which ordinary wheats are put, there are now in use a considerable number of varieties which can be distinguished from each other only by careful examination. These varieties have been originated for the most part by men who develop a temporarily improved strain of a standard variety and scatter the seed under a new name. If this seed be an improvement, (which is by no means always the case), it often reverts to the parent form in a short time. Thus the presence of such a large number of very similar forms under separate names has nothing to recommend it and adds only confusion to the wheat grower's work.

The foundation of permanent improvement of wheats lies in the crossing of these varieties of good type upon each other or upon closely related forms without the species. In the past the development of seed has been quite largely by selection. While selection is an essential part of the improvement of any stock, it is not sufficient in itself. When the seed has been reduced to a pure line no further advance can be made by this method, since the variation will be only fluctuating and will constantly revert to a norm. By crossing the degree of variation is increased enormously and in proportion about as the dissimilarity of the parents in the cross. Crossing also makes possible the combination of the good qualities of both parents

into one individual. The vigor of the plant is markedly increased by crossing for at least several generations.

With these facts in mind crosses were attempted between varieties of *T. vulgare* having distinctly different characters, and between more widely differing forms, as for example, *T. vulgare* on *T. polonicum*. Crosses were also attempted between closely related genera but without success.

The crosses will be listed with the male parents arranged alphabetically. Of these, 26 percent of the barley crosses and 33 percent of the wheat crosses produced seed.

OATS ON WHEAT

Wild Oat from Palestine X Poole.

BARLEY ON WHEAT

Hordeum Spontaneum X Poole.

White Hulless X Economy.

Two Row Black X Poulard.

White Hulless X Poulard.

WHEAT ON BARLEY

Poulard X Two Row Hulless.

Poulard X Two Row Black.

The variety Poulard was practically the only wheat maturing at the right time for crossing with barley.

BARLEY ON BARLEY

Black Hulless X Hauschen.

Two Row Hulless X Manchury.

Black Hulless X Chevalier.

Two Row Hulless X Chevalier.

Black Hulless X Manchury.

Two Row Hulless X Red's Triumph.

Blue Barley X Manchury.

Two Row Hulless X 2 Row Black

Hauschen X Manchury.

White Hulless X Chevalier.

Red's Triumph X Manchury.

White Hulless X Chevalier.

Red's Triumph X Two Row Hulless.

White Hulless X Manchury.

Two Row Black X Manchury.

White Hulless X Manchury.

Two Row Black X Red's Triumph.

White Hulless X Red's Triumph

Two Row Black X Two Row Hulless.

WHEAT ON WHEAT

Alaska X Lebanon.	Marquis X Polish.
Dawson's Golden Chaff X Jones Long- berry Red	" X Turkey Red.
" " X Extra Early Windsor.	Mediah X Gold Coin.
Diamond Grit X Red Cross.	" X New American Banner.
Early Red Clawson X Egyptian	New American Banner X Rochester Red
Eclipse X Pride of Indiana.	New Malakoff X Jones Mammoth Amber.
" X Dawson's Golden Chaff.	Nixon X Diamond Grit.
Farmer's Trust X Red Wave.	Poole X Seneca Chief.
" " X Michigan Amber.	Polish X Wonder.
" " X Fish Head.	Poulard X Miracle.
" " X Hickman.	Poulard X Poole.
" " X New Soules.	Pride of Genesee X Nixon.
Fish Head X Miracle.	" " " X Ulta.
" " X Swamp.	" " " X Miller's Pride.
" " X Velvet Chaff.	Red Cross X Imperial Amber.
Frete's X St. Louis Grand Prize.	" " X Ulta.
Fulcaster X Alaska.	" " X Pride of Indiana.
Fulcaster X Long Amber.	Reliable X Tennessee Fultz.
Fultz Mediterranean X Gypsy.	Rochester Red X Early Red Clawson.
" " X Seneca Chief.	" " X Texas Red.
" " X Diamond Grit.	Sibley's New Golden X Pride of Ind.
Imperial Amber X Farmer's Trust.	" " " X Jones Winter Fife
Jones Winter Fife X Sibley's New Golden.	Tennessee Fultz X Fulcaster.
Kubanka X Dawson's Golden Chaff.	" " X White Kloud.
" X New American Banner.	Turkey Red X Dawson's Golden Chaff.
" X V. P. I. No. 8.	" " X Hungarian.
Lebanon X Red Cross.	" " X White Kloud.
" X Red Wave.	V. P. I. No. 8 X Kubanka.
" X Rochester Red.	Wonder X Early Red Clawson.
Marouam X Fish Head.	" X Long Amber.
" X Early Harvest.	" X Polish.

Since only the first generation of the hybrids from these crosses has been observed no report can be made on the splitting of the Mendelian units. Some notes were made, however, on the dominance of certain characters in the crosses. These will be noted briefly after each cross.

Barley Crosses.

Black Hulless X Chevalier. The brown chaff and bluish kernel of Black Hulless dominant over the yellow chaff and whitish kernel of Chevalier. The adherent lemma and two rowed character of Chevalier dominant over the non-adherent lemma and six rowed character of Black Hulless.

Two Row Black X Two Row Hulless. Bluish chaff and kernel and adherent lemma of Two Row Black dominant over the yellow chaff and kernel and non-adherent lemma of Two Row Hulless.

Two Row Hulless X Red's Triumph. Two-rowed character of Two Row Hulless dominant over the six-rowed Red's Triumph.

White Hulless X Manchury. The compound awn of White Hulless dominant over the simple awn of Manchury.

White Hulless X Chevalier. The compound awn of White Hulless dominant over the simple awn of Chevalier. The two rowed character of Chevalier dominant over the six-rowed character of White Hulless.

Wheat Crosses.

Farmer's Trust X Michigan Amber. Awnlessness of Michigan Amber dominant over awned character of Farmer's Trust.

Fultz Mediterranean X Gypsy. Selfed.

Jones Winter Fife X Sibley's New Golden. Awnlessness and pubescent chaff of Jones Winter Fife dominant over awns and smooth chaff of Sibley's New Golden.

Lebanon X Rochester Red. Awnlessness of Rochester Red dominant.

Lebanon X Red Wave. Awnlessness of Red Wave dominant.

Marquis X Polish. The hybrid resembles Polish but has denser head and fewer awns than typical Polish.

Mediterranean X Emmer. Apparently selfed.

Mediah X New American Banner. Awnlessness of New American Banner dominant.

Nixon X Diamond Grit. Selfed.

Poulard X Miracle. Hybrid with longer and heavier head.

Polish X Wonder. Selfed apparently.

Pride of Genesee X Miller's Pride. Smooth chaff of Miller's Pride dominant.

Pride of Genesee X Nixon. Awnlessness and smooth chaff of Nixon dominant.

Pride of Genesee X Ulta. The hybrid bore the awns and pubescent chaff of Pride of Genesee.

Red Cross X Ulta. The hybrid bore the smooth chaff of Red Cross.

The variety Ulta was not available for comparison in the last two crosses mentioned.

Reliable X Tennessee Fultz. Awnlessness of Tennessee Fultz dominant.

Rochester Red X Early Red Clawson. Awnlessness of Early Red Clawson dominant.

Red Cross X Imperial Amber. Hybrid appears intermediate in size.

Tennessee Fultz X White Kloud. - Hybrid awnless.

Turkey Red X White Kloud. Awnlessness of White Kloud dominant.

Summary and Conclusions.

There are, at present, a vast number of so-called varieties of *Triticum vulgare* distributed throughout this country, many of which resemble each other so closely that careful study can show no reason for their existence as separate varieties. This by no means discredits the production of worthy new varieties.

The members of the following groups of wheats have been found to agree quite closely in essential characters:

1. Dawson's Golden Chaff, Eclipse, Farmer's Friend, Red Cross.
2. Fish Head, Fultz Mediterranean, Long Amber, New Soules, Nixon, Pride of Indiana, Red Russian.
3. Alaska, Farmer's Friend, Fretes, Fulcaster, Turkey Red.
4. Eclipse, Farmer's Trust, Kubanka, Miracle, Red Cross.
5. Gold Coin, Long Amber, New American Banner, Pride of Indiana, Red Russian.
6. Fish Head, Fultz, Mediterranean, Marquis, Nixon, Tennessee Fultz, V. P. I. No. 8.
7. Eclipse, Farmer's Friend, Red Cross, Sibley's New Golden, Turkey Red.
8. Early Red Chief, Fultz Mediterranean, Nixon, Tennessee Fultz.

Judging from the comparatively few varieties of barley which were available for this study, this cereal has not been sub-divided into insignificant varieties as have the wheats.

Attempts to cross oats on wheat, barley on wheat, and wheat on barley produced negative results.

Crosses of barley on barley, and wheat on wheat, showed the following characters to behave as Mendelian units:

Characters in Barley.

<u>Dominant</u>	<u>Recessive</u>
Adherent lemma	Non-adherent lemma
Bluish chaff	Yellow chaff
Brown chaff	Yellow chaff
Bluish kernel	Whitish kernel
Bluish kernel	Yellow kernel
Compound awn	Simple awn
Two-rowed spike	Six-rowed spike.

Characters in Wheat.

<u>Dominant</u>	<u>Recessive</u>
Awnlessness	Awns
Glabrous chaff	Pubescent chaff