From a single seed

Tracing the Marquis wheat success story in Canada

to its roots in the Ukraine

by
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with a preface by

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History... celebrates the battlefields whereon we meet our death, but scorns to speak of the plowed fields whereby we thrive; it knows the names of the king's bastards, but cannot tell us the origin of wheat. That is the way of human folly.

Jean-Henri Fabre

Omnium rerum ex quibus aliquid acquitur nihil est agricultura melius, nihil uberius, nihil dulcius, nihil homine, nihil libero dignius.

Cicero

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Contents

Preface

by Dr. George Fedak

Stephan Symko was born in Dakniv, Western Ukraine (Halychyna) in 1911. He studied agricultural

science at the University of Louvain, Belgium, graduating in 1936. Back in Ukraine he married Julia Zuk and became the chief agricultural scientist in his native province of Halychyna (Galicia). He specialized in research on new varieties of cereals, especially wheat and rye, continuing his work even after the German occupation of Ukraine. After the war he left Ukraine with his wife and three children and eventually resettled in Canada. In 1949 he began a career at Agriculture Canada's Central Experimental Farm in Ottawa, where he worked in cereal breeding and research until he retired in 1976.

He focused on interspecific and tetraploid barley, winter barley, and winter triticale, creating an abundance of novel genetic stocks. Perhaps his most noteworthy achievement was in interspecific barley, for which he developed new crossing procedures to produce haploid progeny. His work remains widely recognized. The procedures he pioneered were adopted and expanded at the University of Guelph to the point that doubled haploids in barley have become standard tools for genetic studies and barley breeding programs world wide.

This monograph is a very personal testament of Mr. Symko's strong convictions about the significance and impact of Ukrainian wheats on world agriculture. It was during his years as a research biologist at Agriculture Canada that he became convinced of the contribution these wheats had made to world agriculture. As this fact was not well known in world plant-breeding circles, he set out to document it with the assistance of a 1976 Canada Council research grant. He began with the Red Fife story, the annals of Canadian spring wheat breeding, and the story of the settlement and development of Western Canada. He pursued this story with visionary zeal for 10 years, assembling a final manuscript of some 2,000 pages of information, written in Ukrainian, from some 1,000 references. This translated monograph is therefore just a portion of the total exercise.

The author passed away in 1992 without seeing his work published. This Internet publication will do justice to his efforts. It is a reminder of a forgotten heritage — the importance of Red Fife wheat and its successors, including Marquis and many later varieties, to Canada's agriculture and especially the development of the West. It is also a testament to the work of Canada's Experimental Farm System and the work of its pioneer scientists.

Introduction

Where did agriculture and the cultivation of wheat first begin?

There is a great deal of international literature on how agriculture was first established. There is even more on the appearance of the first seeds, the development of wheat and its origins. But the question never has been answered definitively.

Much of the West European literature points to ancient Mesopotamia as the place where the birth of civilization on Earth took place. However, I believe the idea that agriculture and civilization arose in the

valley of the Euphrates is based on speculation. There are other views: for example, Matthäus Much (1, pp. 195-227) suggests our most important cultivated plants — particularly cereals such as wheat, barley and millet — grew first in their wild form in Europe. He suggests that during the Ice Age, the European climate was rainy and foggy, with the atmosphere full of moisture both winter and summer. (2, p. 682) In such a climate it would have been possible for grass and the ancestors of the cereals to appear.

Wheat is one of the world's most ancient cultivated plants. Various archaeological excavations in Europe and Ukraine have provided new evidence on the early origins of agriculture. For example, Ukrainian archaeologist V. V. Khvoiko discovered a prehistoric settlement of grain growers who grew wheat, millet and rye in Trypillya, a village near Kyiv. (3A, pp. 769, 773, 789, 811; 3B pp. 1-2; 3C, pp. 281-309) The discovery of this so-called "Trypillya culture" suggests that Ukraine has played an important part in the early history of wheat.

For thousands of years, grain production has been one of the main fields of agriculture in Ukraine and Eastern Europe. Wheat has played a very important role in Ukrainian grain production. The Transcaucasus region is especially rich in grain and wheat varieties. Scientists of the former Soviet Union recorded numerous grain varieties there which are found nowhere else in the world. A few varieties of wild wheat can still be found in Ukraine, but generally they are more numerous in neighbouring areas. This suggests that the cultivation of wheat was more advanced in Ukraine, where grain growers had removed wild varieties from their fields long ago.

I believe that wheat was grown on the territory of modern Ukraine even at the time of the Trypillya culture. Over time it would have been exported to neighbouring countries. There is evidence, for example, that Ukrainian wheat reached Greece in the third century A.D. Excavations in 1945 near the city of Kaminets-Podilsky in Luka-Vrublevetska, Ukraine, found that wheat cultivation there had been widespread during the third and fourth centuries A.D.

It is the discovery of the Trypillya culture, however, that provides the earliest and most concrete proof that the Trypillya tribes were settled grain growers with a highly developed agriculture who grew wheat, millet, and rye. The reason for the development of this wheat culture is best explained in biological and agricultural terms.

Only a favourable climate can foster the creation of fertile soil. Biochemistry tells us that the establishment of fertile soil takes many millions of years. Some scientists believe that the most fertile soils, like the Ukrainian black soils (*chernozems*), are also the oldest. Given the geological structure of Ukraine, its fertile land and suitable climate, I suggest that Ukraine was the birthplace of the first cereal ancestors. Over time new plants with better nutritive qualities evolved through natural selection. Eventually various cereals appeared, including wheat.

Early History of Wheat

The agricultural literature features various works in different languages on the origins of wheat. The most credible assumption is that people began to use wheat for food in prehistoric times, beginning at least 15,000 years B.C.

Wheat as we know it in the millennia of this era is not the same as it was at the very beginning. The genetics of wheat show that its development is very complex. Today's grain has developed from three naturally occurring groups of wheat. Through natural crossings, mutations, and natural selection these have evolved into all the many varieties of wheat grown worldwide.

Of all cultivated plants, wheat has been the most important food product for humankind. Agriculture took many centuries to develop, and its early history is written not on parchment but on the memory of the creative human mind. This acquired knowledge was transferred to future generations through oral retelling. I believe this knowledge may well have been transmitted to us today from the world's first wheat farmers in Ukraine.

This is because the first Ukrainian grain growers had the major advantage of climate. Eventually, they would have started producing more than enough grain for their own use and exchanged the surplus for other food products from other tribes. Ukraine remains an agricultural centre today. Ukrainian grain seed has spread not only to neighbouring but also to more distant countries, where the cultivation of grain has expanded as a result.

History of Ukrainian Wheat

The history of plant cultivation on the territory of ancient Ukraine tells us that it was the source of a wide range and many ancient forms of a variety of food plants, especially cereals like wheat, rye, barley, millet, buckwheat and flax. Most significantly, early Ukrainian grain farmers practised breeding and selection of cultivated cereals, so that over time, their knowledge of cereal quality deepened and improved. Indeed, the cereals and wheat they produced first were probably adopted by both neighbouring and more distant countries, like Greece, Egypt and Rome.

The cultivation of wheat in Ukraine is mentioned by the Greek historian Herodotus. The fourth book of his *History* deals with Scythia, which includes the territory of today's Ukraine. Recording the knowledge current at the time, he writes that some Scythians practised agriculture. They could well have been ancestors of today's Slavs.

Herodotus records that wheat was an important commodity exported from the Scythian region to Greece: "In the time of Demosthenes, 400,000 medimnes (about 236 hecalitres or 651,000 bushels) of wheat were shipped from Bosphorus to the Greek port of Pyraeus every year."

"During the reign of the Emperor Leocon I (387 - 347 B.C.), the colony of Theodosia sent so much wheat to Athens that it not only provided for the whole Attica but made it possible to sell extra for 15

silver talents. Athens mainly paid for grain with precious metals, which allowed the Byzantine emperors to mint their own coin and hire Greek mercenaries. They also paid with decorated ceramics and other luxury products for household and personal use." Herodotus also records that the Persian king Xerxes met Pontian ships carrying wheat to the island of Aegina and the Peloponnesian peninsula while crossing the Hellespont. Much of this wheat was probably grown in what is now Ukraine.

He also describes trade routes: one went from Scythia (Ukraine) toward Asia in a northeasterly direction across the Urals, then due east to the banks of the Irtysh River, where some of the "emperor's" Scythians lived, then across the Altai and Tien Shan mountain ranges to Central Asia.

Another route connected India to the Black Sea region by way of modern Afghanistan, across the Hindu Kush mountain range to the Oksu (Amu Darya) River valley, and across the Caspian Sea and Sarmathian steppes to "Tanais" (the Don River). This route is important to the history of plant origins as some scientists, including N. V. Vavilov and others, believe that more wheat varieties are to be found in Afghanistan than anywhere else in the world. Because of this they speculate that the cultivation of wheat originated there.

However, this diversity of wheat in Afghanistan could have been transported there in antiquity from Ukraine by the same trading route. Furthermore these ancient wheats have been used by Afghani farmers without any selection or further development from that time until now. Meanwhile the Scythian farmers gradually improved their wheat varieties by using their own selection methods and getting rid of less useful varieties. In Ukraine, therefore, wheat cultivation developed, whereas in Afganistan it remained static. I believe Ukrainian grain was introduced into new areas as populations grew and trade between tribes and nations expanded by land and sea.

Ukrainian traders would have travelled thousands of kilometres to the far ends of the then-known world. In addition Phoenicia, a well developed, economically strong nation on the eastern shores of the Mediterranean, traded extensively along the entire Mediterranean coast. Phoenician traders would have bought wheat from the territory of ancient Ukraine, or Scythia, and sold it to other nations.

These nations sometimes fought each other. In about 500 B.C. Greece defeated Phoenicia but eventually was supplanted by Rome as the dominant economic power in the Mediterranean region. One effect of these wars was to disseminate plants across the new victorious empires. For example, the military expeditions of Alexander of Macedon through Persia and Asia Minor to India made the exchange of plants between those countries possible.

The territory of Ukraine became a rich centre for the reproduction and improvement of cereals because of its favourable climate and rich soil. Trading towns appeared along Ukraine's Black Sea coast to market the surplus grain. They were populated mostly by Greek colonists who traded Ukrainian wheat to the Mediterranean countries.

Of course, in spite of the archaeological evidence, not all researchers agree with the theory of the Scythian-Ukrainian origin of wheat. However, there is also historical evidence that the area of the Ukraine was known as the "bread basket" of the region and that grain growers there were known to have a high level of agricultural expertise. I believe wheat cultivation developed in Ukraine for other, perhaps even more important reasons.

Agricultural expertise has its own prerequisites. Grain growers cannot be nomads. They must have not only a superior knowledge of the fields but also a love of working those fields. This love grows with the success of their work. With each harvest, grain growers acquire more professional experience, learn the value of the fruits of their land and try to improve their quality. They learn about the local climate and its signs. Their daily work with nature forces them to develop logical thinking to manage their tasks and improve their lives. All this experience creates not only a strong farming culture but also a great love for the land. This love makes the farmers loyal to their country and makes them want to protect it.

If these characteristics of the farmer hold true, the ancient inhabitants of Ukraine would have shared them. The ancient forefathers of the Trypillya culture who lived in Ukraine would have transferred their agricultural knowledge faithfully to their descendants. They had come to that land, with its wonderful rich black soil, the *chernozem*, and stayed to till it, cherish it, and water it with their sweat. When invaders attacked, they fought for it, even gave their lives for it. Perhaps this is why Ukrainian grain is best.

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Among cultivated plants, wheat is considered to be the queen of cereals — the most important food for people. The word "wheat" means many different things to different people.

For the botanist, wheat is simply a grass.
For the chemist, it is a series of organic chemical formulas.
For the geneticist, it is an interesting organism which demonstrates many laws of heredity.
For the farmer, it is a cash crop.
For the merchant, it means business growth.
For the miller, it means groats, bran and many kinds of milled products.
For the baker, it means flour and the baking of bread.
For the labourer, it means work.
For the politician, where to buy or sell wheat is a difficult problem to solve.
For the religious, it is a symbol of plenty.
For the photographer and artist, it is a unique form of still life.
For the statesman and strategist, it is a powerful weapon of war.
For the biologist, it is solar energy made into grain through photosynthesis.
For millions of people all over the world, it means life and food.

For Ukrainians, wheat (*pshenyitsa*) is the most important grain. They treat it with respect and esteem

because their lives have always been so intimately connected to it. I do not know of any other nation that mentions wheat in their folk songs as often: I know of more than 83 that mention *pshenyitsa*. Wheat also figures prominently in Ukrainian poetry and literature.

Ukrainian wheat is the world's oldest wheat. The long-established agricultural tradition and varietal selection practised by Ukrainian grain growers over the millennia created an important place for wheat in their lives and established the high quality standard for Ukrainian crops in their competition with various natural diseases. Most important, Ukrainian wheat flour has set the world standard for bread quality and taste.

This can be explained as a mere coincidence of suitable climate and fertile soil. However, this is only indirectly true, as genetic studies show that all the features of Ukrainian wheat are hereditary. They are encoded in the gene set of the chromosomes in the nucleus of the wheat cell. These genes are transferred from generation to generation. When other wheat varieties are crossed with Ukrainian ones, the Ukrainian wheat gene characteristics become dominant in the new hybrids.

Why are these facts not better known? Because Ukraine has been an occupied country for much of its recent history. When Eastern Ukraine was occupied by Russia and Western Ukraine by Austria, and before that when all of Ukraine was governed by Poland, Ukrainian wheat exported abroad was registered under the name of the occupying country. Indeed it was only rarely that one could find out from the literature that this wheat was Ukrainian — in most cases the country of origin was given as Russia, Austria, or Poland, although there were often records of the town, research station or Black Sea port from which it had originated. Wheat exported from Western Ukraine, for example, was often listed as the one "from Halychyna" (Galicia).

In addition, some wheat exported from Ukraine was used for seed and planted on individual farms without any registration. If the farm achieved success using it, or it had a high yield, often a neighbour would try to grow it at his farm and name the "new wheat" after the person from whom he had bought it.

In the first half of the nineteenth century the cultivation of grain in Western Europe and the New World (America and Australia) was in its infancy. Then the population of Europe began to grow faster. There were new discoveries in physics, chemistry, biology, and especially genetics. The secrets of the invisible world were being revealed because of improvements in scientific instruments. Pasteur's discovery of bacteria, for example, was very significant in controlling human diseases. As a result, the European birthrate rose even faster.

As the population grew, the demand for bread and therefore the value of wheat increased. While the population had grown, the land under cultivation had stayed the same. People began to think about improving soils and cereal varieties. West European wheat at that time was of very poor quality, low-yielding, and susceptible to fungal diseases like rusts and moulds.

Ukrainian wheat was thus a gift to farmers who could get it. Their number increased as Ukrainian wheat continued to be exported. It would be shipped from Eastern Ukraine by rail and by river to the Black Sea ports, from where it went to the Mediterranean and beyond. Wheat from Galicia, or Halychyna (Western Ukraine), was exported mainly from the port of Danzig and from there to other countries by sea. It was sold on foreign markets as "Galician wheat."

People all over the world had been enjoying bread made from Ukrainian wheat, although in most cases it was known as Russian wheat. Seldom was it identified as Ukrainian. The first documented wheat export from Ukraine was to southern France in1826. Another was to Canada in 1842 (more on this later). In the first case, the wheat was shipped to Marseilles from Odessa; in the second, the wheat reached Canada from Western Ukraine by way of Danzig and Glasgow, Scotland.

About Wheat

In terms of area under cultivation, wheat is the most widely cultivated plant on Earth. In 1935, about 155 million hectares (ha) of the world's land area were wheat fields — about 1% of the world's land area or 1/6 of the total area under cultivation at that time. If the world's total land area is 130.52 million km^2 (13,052 million ha), the total area under cultivation in 1935 was about 950 million ha. (4, p. 19) Wheat cultivation worldwide is distributed very unevenly. However, it can grow from as far North as the Arctic Circle to the southernmost ends of the continents in the Southern Hemisphere.

The 1935 world harvest of wheat totalled 1,500 million centners. If all this wheat had been loaded into railway boxcars, the freight train would have circled the earth twice.

Almost the entire population of our planet eats wheat because of its good taste, good assimilation by the human body, and high nutritive value, with a protein content of 8-20% and up.

Classification of Wheat

Wheat belongs to the cereal family. To distinguish one variety or genus from another, it was necessary to establish a wheat classification based on its observed characteristics. Such observation began in earliest times: descriptions of different varieties are found in the works of the Greek and Roman historians. For example, Theophrastus, a student of Plato, wrote in his book *The Needs of the Plant* in about 300 B.C.: "... There are many kinds of wheat named after the areas where they grow — Libyan, Pontian, Frankish, Assyrian, Egyptian, and Sicilian. They differ in colour, size, shape, and individual characteristics, as well as their general attributes and particularly their value as food." Theophrastus catalogues numerous other differences. During the first century B.C. writers like Varo, Pliny, and Columellus cited, reviewed, and expanded on the writings of Theophrastus.

No one can say how people determined the quality of wheat in prehistoric times; however these Greek and Roman descriptions show that many of the primary wheat characteristics were already known by

those cultures. The wheat characteristics recorded by eighteenth-century botanists are similar to those found today. Most prominent among them was Tournefort, who recorded 14 varieties of wheat in 1719. The practical classification of wheat began with Linnaeus's work in 1753. In his *Species Plantarum* he describes seven varieties of wheat. Before 1922, wheat had been classified by some 37 authors, although their works seldom agreed: for example, only a few distinguished between winter and spring wheat.

Structure of the Wheat Kernel

The wheat kernel (caryopsis) has a dorsal (back) and ventral (front) side as well as a top and bottom. The ventral side has a deep crease extending from top to bottom. A brush structure is formed at the top of the caryopsis and the embryo exists at the lower dorsal surface.

The kernel consists of four parts: the seed coat (pericarp), the fruit coat (aleurone layer), the endosperm, and the germ, or embryo (Figure 1). The embryo consists of a scutellum (or cotyledon), which secretes enzymes to dissolve the endosperm starch to nourish the embryo during germination; a coleoptile, which becomes the first leaf at germination and shields subsequent leaves; and a coleorhiza, which encloses the primary root or radicle. The endosperm occupies about 76% of the whole kernel and consists of an arrangement of large and small starch granules deposited in a protein matrix (Figure 1). The proportions and arrangements of the components determine the hardness or softness of the kernel.

The aleurone layer is a single layer of large cells adjacent to the pericarp which secretes enzymes to dissolve endosperm starch cells during germination. The pericarp is the seed root and is responsible in part for giving seeds their typical red or white colour.

The colour of the wheat kernel can vary from white to deep red. These gradations are controlled by a series of three genes that affect the amount of pigment in the pericarp of the seed. A third variation imparts a deep purple pigment to the seed but it has not been used extensively in breeding.

The texture of wheat kernels can vary from hard and vitreous to soft and starchy. The degree of hardness is quite a complex trait which is determined by variations in the components of large and small starch granules that are bound into a matrix by a specific class of protein. Hence the four main classes of wheat are hard red, hard white, soft red, and soft white. The functionality of these wheat classes is further determined by a class of storage proteins called the gluten fraction. This fraction imparts a stickiness and elasticity to the dough, which in turn determines the baking quality of the flour (see sections on Milling Quality and Baking Quality below). The hard white grains can be confused with soft red ones.

In recent years (1960s-1970s) the structural details of the wheat kernel endosperm have been discovered with the help of the electron microscope. It has revealed that the cell's starch granules and

proteins are primary morphological structures. When the endosperm is milled, part of the kernel's protein base is destroyed and this releases the starch granules. However, the protein is so strongly attached to the surface of these starch granules that regular milling cannot separate it from them. This protein is therefore known as an attached protein. (5, p. 36)

Botanical Characteristics

Wheat belongs to the family *Gramineae*, subfamily *Hordeae*, tribe *Triticeae*, genus *Triticum*. This genus is very diverse. In Ukraine it is divided into two main groups: winter and spring wheat. In Western Europe there is a third (the so-called alternative) intermediate group, which has minor, local significance and can be planted either in the fall or very early in the spring. The wheat stalk may be either awned or awnless: this is true of both winter and spring wheat.

From a morphological point of view, wheat has a fibrous root system. At seed germination, both the radicle or primary roots, and a subcrown internode emerge: the latter gives rise to a crown near the soil surface. This structure gives rise to four to six tillers for each plant, with each tiller supported by secondary roots. The secondary root system can be quite extensive, reaching depths of up to two metres. It is responsible for supplying nutrients to the plant.

The stalks, or tillers of the plant, consist of five or six internodes. These are separated by dense structures called nodes, which give rise to the leaves. The stalks can be hollow or filled with pith. Wheat with pith-filled stalks is known as solid-stemmed. It offers resistance to insects such as the wheat stem sawfly. The leaves consist of two sections, the blades and the sheaths. The sheaths effectively strengthen the stalk and protect the growing apical meristem. Growth and development of the tillers occur by means of a telescopic action so that all leaves are fully expanded before the spike emerges from within the structure.

The spike of the wheat plant (Figure 2) consists of a central axis called a rachis. Each node of the rachis gives rise to a spikelet consisting of a pair of outer glumes that enclose three to four florets. Each floret consists of two outer integuments, called a lemma and a palea, that enclose the reproductive organs. The female reproductive structure is the feathery stigma that is attached to the ovary by a style. Each floret (Figure 3) contains three anthers, or male reproductive organs, supported by filaments. The stigmatic and anther structures mature simultaneously and mature pollen is shed onto the stigma. The pollen germinates on the stigma, which sends a pollen tube containing two male gametes down the style to fertilize the egg cell and polar nuclei. This gives rise to the embryo and endosperm, respectively, of the new seed.

This process is called self-pollination. Wheat is thus a typical self-pollinating plant, although up to 5% outcrossing can occur when stray pollen is present. The awns on all durum wheats and some bread wheats grow at the tips of the lemmas and to a lesser extent on the top of the outer glumes.

There are about 25 different species of wheat at the diploid, tetraploid, and hexaploid levels — that is, their genetic structure contains 14, 28, and 42 chromosomes respectively. The two main groups of commercial wheats are the durums (*Triticum durum*) and bread wheats (*Triticum aestivium*) with 28 and 42 chromosomes respectively. These originated and evolved naturally through a series of intercrosses among the diploid species. It is estimated that the commercial wheats were isolated about 10,000 years ago. The wild species are still a valuable source of useful agronomic traits for the continued improvement of cultivated wheats.

The durum wheats are grown commercially in drier regions of the country, for example, the brown soil zone of the central Prairies in Canada. They are characterized by having large, ovate-shaped, amber-coloured kernels that are very hard, almost flinty in texture. This class of wheats is used exclusively for pasta products throughout the world, as well as for other specialty products, such as cous-cous, in some countries.

The bread wheats encompass a wide range of different types classified largely by their growth habit and functionality. The various classes are combinations of winter or spring growth habit with white or red kernels and hard- or soft-textured kernels. For example, both spring and winter wheats include types with hard or soft and red or white kernels.

Bread is baked from the flour of varieties with hard kernels, predominantly the red type. They have a high protein content and high levels of predominantly two protein fractions, gliadins and glutenins. These impart elasticity to the dough during baking so that large loaves of bread can be produced.

The soft wheats typically have lower protein contents and lower levels of the two critical protein fractions. They are used in unleavened bakery products like pastries and breakfast cereals: indeed, white soft wheat flour is preferred for breakfast cereal processing.

Within any class of wheat there are numerous varieties that represent the efforts of plant breeders, who regularly produce new strains with improvements in yield, disease resistance, and seed quality. It is estimated that 25,000 different varieties of wheat have been produced worldwide.

Slavonic Terms in Wheat Nomenclature

Botanists use Greek and Latin terms to describe plant anatomy. In Latin the glume of the wheat floret is called *palea*; later, certain botanists replaced this term by the Greek word *lemma*. What is the origin of these two words?

I believe it is the ancient Slavonic language. Let me explain why. Early grain growers learned the anatomy of wheat and its floret from the terminology used in the area where it originated. Figure 3 shows the wheat floret with its reproductive organs, the stigma and anthers, surrounded by two strong glumes that form a coat to protect it. The glume has two “halves” which fall away from the ripe grain

and are eliminated as chaff at threshing time. The old Slavonic term for each of the glume halves was *polova*, meaning "half." This word may well have been changed into *paleva* or *palea* and adopted by the ancient Greeks and later the Romans.

Similarly the Greek word for chaff, *achiron*, may be adapted from the Slavonic word *okhorona*, meaning protection, which is what the chaff is for the wheat spikelet. Finally there is another kind of chaff which sticks to the grain, known in Ukraine as *prylipka.* Here the old Slavonic word *liplyu*, or *leplyu* (to stick or adhere), may well have come into the Greek language in the form of *lepo*, which transforms the adverb *lepo* into *lema*, or *lemma*.

These three terms may well represent evidence of the antiquity and importance of the development of wheat cultivation on the territory of modern Ukraine. One of the great wheat historians of the former Soviet Union, M. M. Yakubintser, writes, "The territory of Ukraine was one of the world's major areas for both spring and winter wheat as early as the fourth century B.C."(6, p.17) He claims that traces of wheat were also found in the Northern Caucasus and Kazakhstan in the second century, as well as the upper Volga Valley at the end of the first century A.D. Ukrainian wheat thus may have spread to both neighbouring and distant countries. According toYakubintser both soft and hard wheat have been grown in the area since antiquity. He reports finds of hard wheat samples dating from the fourth century B.C. in Ukraine, others from the third century B.C. in the Transcaucasus (in Azerbaijan) and the tenth to twelfth centuries A.D. near the Don River in Bila Vezha. Samples of the hard wheat *Triticum spelta* excavated in Ukraine date from the fourth century B.C. (6, p. 18)

About Ukrainian wheat Yakubintser writes, "Ancient Ukrainian wheats, especially winter ones, were famous throughout the world — and not just as food grain. They played a very important role in world agriculture as seed grain, mainly because of their high quality and resistance to cold." (6, p. 31) This key quality of Ukrainian wheat — resistance to cold — can serve to introduce its contribution to the New World country first to use it: Canada.

Early History of Wheat Growing in Canada

This section is based on Chapter I, sect.1-5 of A.H. Reginald Buller's *Essays on Wheat*. (7, p. 1-12)

The earliest record of wheat cultivation in Western Canada is connected to the arrival of the Selkirk settlers in 1812. This small group of pioneers arrived from Scotland with the help of Lord Selkirk to colonize the 160,000 square miles of territory granted to him by the Hudson's Bay Company. The first group of 22 settlers came to the area where the Red River meets the Assiniboine on 30 August 1812 and planted the winter wheat they had brought with them from Scotland. In the spring of 1813 they also planted spring wheat of the same origin. In the fall of that year the settlers, whose number had grown to 100, reaped a very poor harvest from that first planting. In a letter to Lord Selkirk dated 17 July 1813 and preserved in the National Archives in Ottawa, Miles Macdonell, the governor of the settlement, writes: "The winter wheat crop was completely wasted because it was planted too late. The same thing

happened with the spring wheat, pea and English barley crops."

Their luck was no better the next year: the harvest of 1814 also failed. However, the persistent Scotsmen did not give up and their third attempt to grow wheat resulted in a decent harvest.

The first two bad harvests had been caused by inexperience: these settlers had been fishermen in Scotland, not grain farmers. They did not have a single plough or harrow among them. They worked the soil with hoes. Although their grain crops had failed, they had a good harvest of potatoes and turnips in 1813 and 1814. In the spring of 1815 they planted wheat and barley again but in June the northeastern Métis attacked and destroyed everything the settlers had built. The governor of the colony was also captured. Some families managed to escape to Upper Canada, while 13 households fled up the Jack River to settle in an area north of Lake Winnipeg called Norway House.

A relief expedition arrived from Montreal a few weeks after the colonists had been driven away. It was sent by Lord Selkirk and headed by Colin Robertson. The dispersed colonists were brought back to the original settlement. Those who returned were glad to see how everything they had planted had grown. That was their first grain harvest.

In 1816 the Métis attacked again, causing heavy damage. The next year the harvest was good but a hurricane destroyed everything in the fall. In 1818 there was a good harvest of wheat, potatoes, turnips, and peas. But their hopes were dashed again by the sudden arrival of billions of grasshoppers that covered the sky like a black cloud. They devoured every growing thing — even the leaves on the trees — over the last two weeks of July. The settlers had no way to continue farming. This cruel misfortune had been completely unexpected. People stared at the sky and wept.

The grasshopper plague of 1818 was not the only one recorded in the history of Canadian agriculture: it was repeated in 1864 and again in 1867. After the plague of 1818, the settlers moved to Pembina and avoided starvation by hunting buffalo.

In the early spring of 1819 the settlers returned to their old homesteads and planted the fields with their remaining seed grain. However, new grasshoppers appeared from the eggs laid the previous year, destroying everything by the end of June. In some places, the layer of grasshoppers on the ground was four inches thick. All the vegetation was destroyed. Even the water in rivers was poisoned, glutted with billions of grasshoppers. By 1820 no seed grain remained in the settlement.

New Seed-Wheat from the United States

In the spring of 1820 the Selkirk settlements sent some of their men to Prairie du Chien, Wisconsin, on the Mississippi River, to purchase new seed wheat. After a difficult three-month trek covering several hundred miles through the snow, the settlers bought 250 bushels (bu) of wheat at 10 shillings a bushel. The grain was transported by barge up the Mississippi to the point where it joins the Minnesota River,

across Big Stone Lake and from there to the Red River Valley. The settlers arrived with the seed in June and planted it right away. When the plants were full grown, the grasshoppers descended again and it seemed as if the pests would destroy everything a third time. For some unknown reason, however, the grasshoppers receded and did not come back. Because of the late planting, all of the crop did not ripen fully. Still, the grain was ripe enough and there was enough of it for the next year's planting. From 1820 on, the Red River settlers had no shortage of grain until 1868 when the grasshoppers returned and destroyed all the crops once more. (7, sect 6, p. 12-14)

The harvest of 1821 was not good so it was only possible to save enough grain for the next spring's planting. The settlers had no surplus food. The arrival of new Swiss emigrants had made the food shortage worse. As a result, the men went to Pembina to hunt buffalo again. These pioneer times and struggles are described in detail by A. Ross in his book *The Red River Settlement*. (7, p. 10)

The whole continent was very wild and harsh at that time. The land was overgrown, uncultivated and difficult to tame by the early European settlers. They found themselves under continuous attack by a seemingly hostile nature armed with an endless assortment of powerful natural weapons such as pests, plant diseases (rust, mould, rot), storms, floods, and rapid temperature changes.

There are no records on the varieties of wheat planted or the exact locations of the fields. Some authors mention that in certain places farmers had brought seed wheat with them from England to Canada. As it appears from these records, each variety was considered good if it gave any yield at all. In general it appears that there were no good varieties of wheat here at that time as there are frequent references to farmers looking for better varieties as if for a most valuable commodity.

The quality of spring wheat in the early part of the nineteenth century was poor. This created a problem. The Canadian climate was not always favourable for the cultivation of winter wheat, which in any case was often attacked by diseases like rust, which would destroy some or all of the crop. There were no varieties of wheat that could meet the growing season requirements of Canada's climate. In addition, the colony lacked skilled farmers. Otherwise Canada's vast territories might have produced immense quantities of grain very early on, which could have played a major role in the development of its economy.

A wheat crop of a size that would allow exports was just a dream, both for the pioneer farmers and for the government. This dream was to be fulfilled decades later with the appearance of Ukrainian wheat in Canada. It arrived at a small farm in Otonabee, Canada West, in 1842 — a quarter-century before Confederation — a harbinger of economic development for the New World and eventually all the wheat-growing countries of the world.

Origin of Red Fife Wheat

This famous wheat, commonly known as Red Fife or Scotch Fife in North America, is called "red"

because that is its colour when fully ripe and “Fife” after David Fife, the Ontario farmer who was the first to grow it in North America when he sowed it on his farm in 1842. The story of how it got there has taken on aspects of myth and legend. It takes place at various locations across two continents: one often needs to look ahead in time, then back, to understand how it happened. (This section is based on Buller, Chapter III, sect.23, p. 206-218.)

In 1860 J.W. Clarke, a Wisconsin farmer, harvested a bumper crop of Red Fife wheat averaging about 36 bu per acre. He was so pleased with this harvest that he wrote a letter to *The Country Gentleman and Cultivator* magazine describing his success and recommending this new variety of wheat to all farmers. Almost incidentally he introduced the originator of this wheat, David Fife, a farmer from Otonabee in Canada West, now Ontario.

Clarke’s letter obviously elicited interest in Canada because it was published in the March 1861 issue of *The Canadian Agriculturist*, accompanied by a letter from George Esson, a neighbour of David Fife, which was also published in *The Country Gentleman and Cultivator*. Esson’s letter explains how the famous wheat had first come to Canada and how he had found out about it. Both he and Fife had come to Canada from Tullyallen Parish, Kincardine, Scotland. He writes:

“About 1842, Mr. David Fife of Otonabee, Canada West, procured through a friend in Glasgow, Scotland, a quantity of wheat, which had been obtained from a cargo direct from Dantzic (the German port of Danzig, now Gdansk, Poland), at the time of spring sowing. As it came to hand just before spring seed time, and not knowing whether it was a fall or spring variety, Mr. Fife concluded to sow a part of it that spring, and wait for the result. It proved to be fall wheat, as it never ripened, except three ears, which grew apparently from a single grain; these were preserved, and although sowed the next year under very unfavourable circumstances, being quite late, and in a shady place, it proved at harvest to be entirely free of rust, when all the wheat in the neighbourhood was badly rusted. The produce of this was carefully preserved, and from it sprung the variety of wheat known over Canada and the Northern States, by the different names of Fife, Scotch and Glasgow. As the facts occurred in my immediate neighbourhood, and being intimately acquainted not only with the introducer, but with the circumstances, I can vouch for the correctness of the statement, and if necessary produce incontestable proof.” (7, p. 207-208)

This letter supports the proposition that the ancestors of Red Fife wheat originally may have been grown somewhere in Central or Eastern Europe. It is known that the wheat was originally shipped from Danzig to Glasgow, then sent on to David Fife in Ontario.

George Esson's letter to *The Country Gentleman and Cultivator* was hardly noticed at the time and was soon forgotten. As the Red Fife variety became more important over the years, various other stories were told. For example, here is one from *The Manitoba Daily Free Press*, 1883:

“The first Red Fife grown in Canada was on a farm owned by a person by the name of Fyfe in

Otonabee, County of Peterborough. Mr. Fyfe hired a Scotchman as a farm labourer. When his time expired with Mr. Fyfe, he decided on returning to his native country. Mr. Fyfe requested him to send a Scotch bonnet from Glasgow. When there, a vessel from the Black Sea was unloading wheat at one of the docks. He procured the full of the bonnet and sent it on the first opportunity to Mr. Fyfe. I have many times been on the same farm." (7, p. 210)

Here is a more colourful version of the story from Peterborough: "David Fife did not send for the seed. An acquaintance, strolling along the dock at Glasgow, found men unloading wheat. He knew that Fife had emigrated to Canada, and he also knew of a mutual friend who proposed to go out to the new country presently. The thought struck him to take a sample of the wheat which to his observation looked very good, and send it to Fife. He had nothing in which to hold the wheat, but there was a hole in the lining of his cap. He opened the lining at the hole, filled in a handful, and afterwards wrapped it up in paper. Fife received the seed and planted it. It all grew but rusted badly, except five heads, all from one stalk or root. Two of these heads were eaten by oxen leaving only three heads. The great probability is that the single grain from which the three heads grew was an accidental hybrid." (7, p. 211)

Buller also cites C.C. James, who connects the oxen episode to David Fife's wife: "Mrs Fife is entitled to share in her husband's honor, for, discovering the family cow contentedly making a meal of the growing clump of grain, she was in time to rescue a portion of it before it was too late." He ends by noting that a photograph of Mr. and Mrs. Fife had been taken and was to be published in several newspapers. (7, p. 211)

The area where the famous wheat was first grown is now known as the Midland District of Ontario, located between Toronto and Kingston, extending about 40 miles north of Lake Ontario, including parts of the counties of Durham, Northumberland, Peterborough and Hastings. (7, p. 212)

Otonabee lies at the southernmost tip of Peterborough County, with the Otonabee River to the west, Rice Lake to the south, Peterborough itself to the north and Hastings to the east. It was first settled in 1816. When the Fife family came to Canada and went to Otonabee to establish their future home at the start of the last century, it was already farming land, much of it owned by the Crown. The Fife farm was located about seven miles east of Peterborough.

At the time, local farmers grew a wheat variety known as Siberian. It had been introduced to Canada in the hope that it would survive the severe Canadian winters. But the Siberian wheat did not grow well: its yields were low and it was susceptible to rust. So David Fife wrote to Glasgow asking for samples of good seed wheat, which were shipped to him. But by the time the grain had arrived in Canada at the port of Smith's Creek (now Port Hope), it was too late for spring sowing so the samples were held in storage until the following spring. (7, p. 213)

Of course wheat is not grown in Glasgow. I believe that this variety was shipped there from Western

Ukraine (Galicia) under its old local name "Halychanka." When Austria began to grow it, it was called *Galizische Kolben*. According to Buller, "Efforts made to locate the territory from which the seed was derived were never successful, and the origin of the new wheat was looked upon as an accidental occurrence. From these small beginnings came the wheat that has so largely contributed to the agricultural reputation of this section of Ontario, and which has made the crops desirable to millers all over Canada." (7, p. 215)

No information on the development of Red Fife wheat between 1842 and 1860 was found in historic records or magazines in Canada or the United States, even though it soon became popular south of the border. "Red Fife" has never been the commonly accepted name for this wheat in the United States: most often it was called just plain Fife. With the growth of its popularity, it gained various other names. For example, growers who improved and distributed it would add their names to it: so Red Fife was also known as Bernard Fife, Herman Fife, MacKendry Fife, MacKissing Fife, Philsbury Fife, Wendon Fife, Wilcox Fife, etc. Eventually, the original name would disappear. Americans have also called this wheat Canadian Fife, Fife, Saskatchewan Fife and Scotch Fife. It continues to exist under these names to the present day. (8, p. 92)

I believe all of them are descendants of the Ukrainian Halychanka variety, mentioned in the old folk songs as "dear spring wheat." It has an old tradition in Ukraine and is a symbol of household happiness and prosperity. This variety was rated as export quality and grown primarily in Western Ukraine — in Halychyna and Volyn.

The cultivation of Galician wheat in the United States spread very quickly. Soon after the Clark article appeared in 1860, Red Fife was being grown in Idaho, Illinois, Iowa, Maine, Massachusetts, Michigan, Minnesota, Missouri, Montana, Nebraska, New Hampshire, New York, North Dakota, Oklahoma, Pennsylvania, South Dakota, Utah, Vermont, and Clark's own Wisconsin. (8, p. 92)

It is not known when Red Fife was first sown in Western Canada but we can assume that small quantities of it had already been grown in Manitoba by 1876 because 857 bu of Red Fife wheat were sent from Manitoba to Ontario for seed in that year. (7, p. 216) The population of the Red River area in 1870 totalled 12,800. However the land under cultivation was still very limited. There were no stores to buy household supplies: they had to be either produced at home or ordered from the Hudson's Bay Company (HBC). There were farms only between Upper and Lower Fort Garry on the Red River and along the northern bank of the Assiniboine River. (7, p. 30)

It was possible to produce grain only within two miles of those rivers. The first settlers to cultivate Canada's prairie soil successfully were Mennonites who had moved to the southern part of Manitoba from Ukraine in 1875. Among other things, they brought with them the wheat known as White Russian, which was later replaced by Red Fife. (7, p. 30)

A Revolutionary Discovery in the Milling of Wheat

Until 1882, the amount of wheat grown in Manitoba barely exceeded the local demand. Also, until 1870, all grain was milled between millstones at traditional water-powered mills. This method produced better flour from winter wheat, as it was impossible to separate out the bran from spring wheat with this process. Even a small amount of bran residue made the flour dark. Although the quality of flour made out of spring wheat was lower than that of winter wheat, good bread could still be made with spring wheat flour. The loaf rose well even if it was of a darker colour. However, because of the dark colour, the price for spring wheat was lower. (7, p. 31)

The technical revolution which took place in flour-milling between 1870 and 1880 facilitated wider growing of Red Fife and other spring wheat varieties in Western Canada and the American Great Plains. The first purifier capable of separating out 100% of the bran, even from spring wheat, was invented by the French engineer Perrigault and introduced into Minnesota in 1870. It ground wheat not with millstones but between steel rollers. This invention made it possible to make spring wheat flour that was every bit as good as that milled from the best winter wheat. It created a huge demand for spring wheat, whose flour was suddenly in demand throughout North America and on world markets. As a result, the demand for Red Fife seed in Canada grew and our wheat fields expanded. A large quantity of Red Fife seed was brought into Manitoba from Minnesota. (7, pp.30-31)

In 1878 a new rail line provided a direct transportation link between St. Paul and St. Boniface. Canadian farmers and grain traders were sure that there would be a good market for wheat in Western Canada as well, when the Prairies got their rail connection to the Pacific ports. (7, p. 32)

When Manitoba became the fifth province of the new Dominion in 1870, the flow of settlers from the south began. Eight years later immigrants were still arriving by land and by the Red River. Then on Dominion Day 1886 the first train to Vancouver went through Winnipeg. “Its engine, Canadian Pacific Railway No. 1, opened the rail line which will bring hundreds of millions of bushels of wheat to our ports to satisfy the world’s need for bread.” I believe that construction of the CPR was proposed and implemented as soon as possible in great measure because of the success of Red Fife wheat. Buller writes: “A grain of wheat is such a small thing: yet the development of Western Canada is connected to it so closely that it is not too much to say that without wheat, the great and prosperous city of Winnipeg, with its population of 200,000 (in 1917), its impressive buildings and cosmopolitan life, would have still been slowly growing”...“The engineers of the CPR overcame all the difficulties in their way because they were people of vision, who could imagine the golden grain under the blue dome of sky, laid on a tablecloth of fertile acres of prairie land...” (7, pp. 33-34)

This contribution to Canadian society was made possible at least in part by the Ukrainian Halychanka wheat, or Red Fife, as it was known then. In Buller’s words: “The high quality of the wheat in Canada’s Prairie provinces achieved universal renown. Canada became known as ‘the Grain Elevator of the British Empire.’ It is well remembered how Canada’s granary served the Allies during World War I — indeed, it is known by the whole world.” (7, p. 34)

In 1882 James Hartney imported a carload of Red Fife wheat into Manitoba. He sowed it on virgin soil and harvested a bumper crop. At the Winnipeg Fair he received first prize from the CPR and the HBC for the 10 best bushels of wheat. In 1882 the HBC also established a series of experimental farms along the railroad from Winnipeg to Calgary. Horses, ploughs, and workers were transported to each farm by train. Wherever they found open land or prospective fields along the rail line, the ploughs, horses, and workers were unloaded and the land ploughed and sown. By the fall the crop would be ready to harvest. The HBC then delivered the seed grain to the settlers, who had created an enormous demand for it. As a result, the availability of Red Fife seed increased rapidly throughout 1882 and 1883. (7, p. 217)

In addition, the firm of Traill, Maulson, and Clark had imported 10,000 bu of Red Fife wheat from Minnesota into Manitoba in 1883. To facilitate and improve the wheat harvest, the government permitted farms to import Red Fife into Canada duty-free. The CPR also helped the farmers by allowing them to transport the famous wheat free of charge for the same reason. The result was that after 1882 Red Fife displaced all other varieties such as Club, Golden Drop, and White Russian. Red Fife became the standard variety of wheat in Western Canada. (7, p. 218)

Judging from all the crop and quality records, Red Fife already was considered the best wheat, even in 1880. It had been the choice of most growers for 20 years and was widely known as the world's best spring wheat because of its high productivity and excellent milling and baking qualities. Its top grade, Manitoba No. 1 Hard, commanded the highest price on the British markets. (7, pp. 145-146) As *The Manitoba Daily Free Press* wrote in 1883, "Red Fife wheat is unbeatable."

The Experimental Farms

At about the same time, the Government of Canada decided to set up a series of experimental farms to improve Canada's agriculture, make professional and scientific assistance available to farmers, and generally facilitate the development of agriculture in this country.

In 1886 a Canadian parliamentary commission appointed pharmacist Dr. William Saunders as the first Director of the Dominion Experimental Farm in Ottawa and gave him the task of organizing Canada's experimental farms. At a time when biology was still in its infancy, Saunders was interested in plant breeding: he grew food plants like apple trees, gooseberries, currants, and raspberries. He spent his spare time improving these plants by means of new scientific crossing methods, with a good deal of success. He also established a program for the improvement of wheat. At first he ran the program himself with a few assistants. Eventually he managed to interest his sons in botany: both became professionals in the field. (7, 145)

Saunders spent his first year on the job travelling, studying Canada's soils and its unstable climate, and trying to find out what its farmers needed. In Western Canada he inspected the new wheat fields and the spikes of Red Fife waving in the wind, heavy with grain. In Saskatchewan he met a pioneer, Angus

MacKay, who became his assistant in wheat improvement. Saunders travelled throughout the Assiniboine and Indian Head Districts by horse and carriage. He covered hundreds of miles, stopping even at the smallest homesteads. Everywhere, he listened to what people had to say. What did farmers in this new country need? Some grain growers said, "We need to find a way to grow grain even when there's no rain from June to July" or "We need a wheat we can harvest before the August frosts." Others reported good harvests of Red Fife even in dry years. On his return he appointed MacKay Director of the Experimental Farm at Indian Head.

By the time he returned to Ottawa, Saunders had developed a good idea of what Canada's farmers needed. In particular, he recognized the value of Halychanka (Red Fife) wheat to the young nation's agriculture. Then he set to work to meet the various needs of Canada's grain growers by importing different wheat varieties from around the world. Some came from the Far North in Russia, near the Arctic Circle; some from northern Europe; some had been grown at different altitudes — from 500 to 11,000 feet, which is the limit for wheat growing, in the Himalayan mountains in India. Others came from the United States, Australia, and Japan. They were grown next to Halychanka (Red Fife) plots at all the experimental farms so their productivity could be compared to the Canadian standard as they ripened. (7, p. 146)

Saunders never says anything about Ukrainian wheat, even though many North American farmers already knew about Galician wheat. Most of the wheat varieties he tested came from the United States, Australia and Russia. Most were found to ripen at the same time or even later than the Halychanka (Red Fife). Some Russian and Indian varieties did ripen earlier; however, their milling and baking properties were inferior. Others produced such poor yields that they were dropped from the research program.

The main task was to generate a variety which would ripen earlier than the Galician wheat, but retain all of its characteristics.For a while Saunders had a great hope that the Russian Ladoga variety would be the most suitable for Canada because it grew at an altitude of 60 feet near Lake Ladoga, north of St. Petersburg, and at the same latitude as the research station 600 miles north of Winnipeg. It also ripened 10 days earlier than the Halychanka (Red Fife) variety and produced a large enough harvest. It seemed as if Ladoga was the future for Canada's wheat growers. (7, p. 146)

The Story of Ladoga Wheat

There is more detailed documentation and source material on the development and expansion of the Central Experimental Farm in the official reports of the Dominion Cerealist in Ottawa than in Buller. (7) To illustrate the contribution of Halychanka (Red Fife) wheat to the Canadian economy, one only need recall the level of agricultural knowledge at the time and read Saunders's notes on his experiments with this wheat in his 1888 report (Fife Wheat, p. 110):

"Varieties of the wheat known as Red and White Fife growing in the Canadian Northwest deservedly

stand among the best in the world, because the high quality of their flour commands the best prices. If they only ripened earlier, there would be nothing else to wish for."

Canadian officials were seeking to improve on the Galician wheat and hoped to find the ideal grain in Russia because its climate is similar to Canada's. Americans apparently shared this hope. The report notes that Professor J. L. Bud of Iowa accompanied Professor Charles Gibb of Abbotsford, Quebec, on a trip to Russia in 1882 to study the characteristics and resistance to cold of vegetables grown in the northern areas of that country. While there Gibb also made inquiries about early-ripening spring wheats.

He brought no samples back to Canada, however, and there is no record of the parts of Russia he visited. Still the dream of bringing Russian wheat to Canada persisted: we read that at the start of the winter of 1886 Agriculture Minister D. Carling wrote to Mr. Gegginger, a wheat trader from Riga, Latvia, who was apparently conducting studies of Russian cereals. (Ladoga Wheat, p. 3)

Gegginger shipped 100 bu of Ladoga seed to Canada — a substantial order. It was his opinion that the Ladoga variety met Canada's needs. Three-pound samples of Ladoga were sent for experimental planting to various farms all across the Dominion: 277 were distributed in Manitoba and the Northwest Territories and 1,200 pounds were given to the Commissioner for Indian Affairs for distribution among Indian agencies.

There was great demand for this wheat, so another 100 bushels were ordered from Riga. This grain arrived in time for planting in the early spring of 1888. At harvest time, various locations reported that the Ladoga had ripened a full 10 days earlier than Red Fife. The 1889 report records the results: "At the Central Experimental Farm, a 14-acre field sown with Ladoga on 7 May 1887 was harvested 76 days later. The Ladoga ripened eight days earlier than Red Fife sown on the same day in the neighbouring field. On 17 May 1888 the same experiment with Ladoga was repeated. This time, Ladoga ripened in 81 days and Red Fife in 92 days. The difference was 11 days." (9, p. 7)

Ladoga *vs.* Red Fife

The quality of Ladoga wheat was a very important issue. The excellence of Halychanka (Red Fife) wheat and the well-known quality of its flour had established a demand for it at the highest price. It was very important to maintain this level of quality. It would be ill-advised to introduce a new lower-quality wheat that could undermine the standard of Canadian hard wheat. The original Ladoga seed shipment was therefore distributed to various experts for evaluation. Most of them rated it below N-1 and priced it four to five cents per bu below Red Fife.

This evaluation of Ladoga by the experts did not satisfy Saunders. He therefore sent another set of Ladoga samples, grown in Manitoba, for a second opinion by experts from the Boards of Trade in Montreal, Toronto, and Winnipeg as well as by W.W. Ogilvy in Montreal; F.E. Gibb, the Dominion Grain Inspector in Port Arthur; and F.T. Shutt, an Experimental Farm chemist. He attached a letter

dated 30 January 1898 to each sample. “It is well known that wheat farmers in northern parts of Manitoba and the Northwest Territories suffered a great deal of frost damage last year,” he wrote. “They are looking for a new variety that ripens a few days earlier than Red Fife and which could be harvested before the early frosts. They would rather grow a lower-quality wheat variety than again incur losses like those they have suffered recently.

“Given this situation, Ministry of Agriculture instructions to us are clear — we are to make every effort to look into this early-ripening, good-quality wheat that is closest to Red Fife. Accordingly, I think that the cultivation of this variety should be promoted by all practical means. The Minister’s request was for this wheat to be secured for areas where Red Fife does not do well. This was done to discourage, as much as possible, the introduction of soft and poorer-quality wheats and so maintain the current standard of grain in our Northwest, and at the same time satisfy the requirements of farmers and the population in that area.”

Responses to William Saunders’s Letter

Board of Trade, Montreal, 9 February 1888

“A meaningful comparison of samples of Ladoga wheat with Fife wheats is only possible if an equal amount of each is given to a miller and then, after grinding, the bread from each is baked and compared.”

Board of Trade, Toronto, 4 February 1888

This organization referred the request from William Saunders to its Committee of Millers, Grain Traders, Exporters and Grain Inspectors. Its report was as follows:

“The most commercially important test for samples of spring wheat is the percentage and quality of glutens it contains.Testing of the samples conducted by the Committee shows that they do not have a high enough gluten content and are no better than standard N-2 wheat grown in Ontario. As for the value of these samples compared to Red Fife, pure Red Fife would cost 11 to 12 cents more per bushel than samples 7, 4 and 13. Ladoga is a low-market, soft-wheat variety, and its value is the same as that of strongly frost-bitten Red Fife. In any case, flour made of Red Fife is superior and commands a higher price.

“Given the importance of maintaining the cultivation of hard wheat, which is in everyone’s interest, but most important to the farmers of the Northwest, the Committee is of the opinion that greater efforts should be made to expand its cultivation and, if a variety other than Red Fife is to be grown, priority should be given to a variety with best qualities and highest percentage.”

Board of Trade, Winnipeg, 16 February 1888

The main conclusions after an examination of Ladoga wheat were as follows:

"We consider that most of the samples sent are not fully ripened and do not have a good colour.

"The N-3 sample seems not to belong to the Ladoga variety, which is a fully soft wheat whose value would be N-3.

"The N-1 and 11 samples show signs of being damaged by frost.

"The N-2 looks too pale, which could be a result of a light frost or hot winds.

"The value of the best sample (N-13,) and the original one from Russia would be five cents below that of Red Fife for the purpose of milling. This opinion should be verified through milling or chemical analysis. Also, none of the 11 samples of Ladoga is similar to the original variety sent and for the most part each one is different.

"Your grain researcher maintains that cultivation of Red Fife should continue.A system of ground preparation for earlier sowing is expected to be invented soon to allow this valuable variety to ripen."

The verdict on the Ladoga samples is mixed. First, they were badly damaged by frost or hot winds and were not ripe. Second, they appear to be a mixture of different varieties. In general, they do not have the characteristics mentioned in the Saunders letter. The whole attempt to seek recognition of Ladoga as a standard variety for northern areas, therefore, seems very ill-advised.

First Report of W. W. Ogilvy,Montreal, 3 February 1888

Dear Sir:

My experience (with Russian wheats brought to southern Manitoba by Mennonites) is that these wheats degenerate in that area and that the best of them have never shown the excellence of Red Fife. Russian wheat is difficult to mill and its flour is never like Red Fife flour.

As to the notes on the early ripening of Ladoga: after a great deal of research and on the basis of my own experience, I can say that Red Fife ripens in time, produces a good crop, and its value is 10 cents higher per bushel than any other variety. Many of these experiments were conducted in Manitoba. Complaints about Red Fife in Manitoba are due to late sowing, the sheer extent of land under cultivation, the weather and cold nights in August; but I think that early sowing and favourable weather in August would eliminate them.

We should remember that Manitoba and the Northwest Territories are among the few areas where hard wheat is grown: we should therefore discourage the cultivation of soft wheat, which can grow on

three-quarters of the world's wheat fields, while hard wheat can grow only in Hungary, Ukraine, Dakota, and Minnesota. Farmers in Dakota plant Red Fife and its flour is known around the world. Manitoba soils are much better than Dakota and Minnesota soils and Red Fife would grow there better than in any other country. This is why I think it is necessary to encourage the cultivation of Red Fife as much as possible, and discourage other wheats.

I have numerous reports on the quality of Manitoba-grown Red Fife — all of them quite satisfactory. Enclosed please find copies of tests carried out in London comparing this wheat to other well-known varieties. Complaints about its late ripening are quite ill-advised: they can be attributed to the farmers or to cold nights in August — which can affect soft wheat just as much.

Yours truly,

W.W. Ogilvy

Saunders then sent Ogilvy a second set of Ladoga samples for assessment. The response appears below.

Second Report of W. W. Ogilvy, Montreal, 7 February 1888

Dear Sir:

Your reference to other authorities has been noted. The three samples of wheat you sent this time are better than the first, but they are not as good as Red Fife and will not produce good flour for sale. Sample N-13 is the best, N-2 is rather good —both would be rated N-1, hard. Sample N-14 contains a lot of the same soft grains from the first sowing and this indicates that it soon degenerates into a soft wheat...I am inclined to think that the weather between 8 and 26 April must have been poor for finishing, otherwise the Red Fife wheat would have ripened as early as the Russian one. I have strong convinctions about this on the basis of my previous experience. Accordingly, I believe that Red Fife should be sown in Manitoba in preference to other varieties, because I am sure that it is the best wheat for the area.

Yours truly,

W.W. Ogilvy

The above response appears to show that Saunders wanted to replace the top-rated Halychanka (Red Fife) with the less valuable Ladoga. However, I believe that his persistence may have been influenced by the wishes of his Minister of Agriculture.

Report of the Dominion Grain Inspector, Port Arthur, 24 December 1887

Dear Sir,

I am sending you the results of an inspection of a number of wheat samples grown in different areas of the Dominion from the seeds imported from Russia. I do not express any opinion on their milling quality, on any comparison with Red Fife, on the current crop growing in Manitoba, or on the samples you say you have sent to the best millers. Judging from the samples I received from you, I am inclined to think that this wheat from Russia is not likely to improve on light soils...A comparison between the N-3 and N-2 samples revealed such extreme differences that it is hard to believe that they grew from the same seeds.

If the millers confirm that the milling qualities of this wheat from Russia are equal to those of Red Fife and if it is documented that it ripens 10 to 15 days earlier, then there is no doubt about growing this wheat in Manitoba. Red Fife wheat produced a good crop in 1886 and in 1887, therefore I doubt that we need try something else to avoid ruining the current wheat market.
Yours truly,

Frank Gibb

Report from the Central Experimental Farm, Ottawa

Inspection of nine wheat samples received from W. Saunders: Ladoga from Riga, Russia, could be of N-1 grade, Northern. It is similar to this year's crop in Manitoba.

1. Ladoga, grown in Lethbridge, N.W.T. - grade N-1, frost-bitten, all hard, outside coating slightly cracked, the grain is a clean, low-milled sample.

2. Ladoga, grown in Edmonton, N.W.T. - grade N-2, Man. Hard wheat, all hard, pale.

3. Ladoga, grown in Surrey, Man. - grade N-1, spring, more than 50% soft.

4. Ladoga, grown in Brandon Hills, Man. - grade N-2, Man. Hard wheat, almost entirely hard, pale.

5. Ladoga, grown in Tatamagouche, N.S. - grade N-3, Northern. Very pale.

6. Ladoga, grown in Guysborough, N.S. - grade N-2, Canada. Hard wheat, pale.

7. Kuban, grown in Manitoba - grade N-1. (9, p. 19)

According to this report the Ladoga samples were damaged by frost, of pale and irregular grain, and in each case no better than Red Fife (Halychanka). Again Saunders's intention to replace Red Fife with

Ladoga is evident in all his letters.

The Ladoga and Onega varieties might have been local Ukrainian spring varieties brought to Russia and Siberia by Ukrainian settlers, or rather exiles after the Pereyaslav Treaty between Bohdan Khmelnytsky and the Russian Tzar. These varieties had been nicknamed “Skorospilka” (fast-ripener) or “Poltavka” because they ripened early and originated from the Poltava area in Ukraine.

Saunders had sent Ladoga seed to all the experimental farms as well as hundreds of farmers in the Northwest Territories, from whom he received very supportive responses after the harvest. At that time it was impossible to test for the quality of flour and baking characteristics from just a few pounds of wheat (today 100 grams is enough). So it was necessary to wait several years until a large enough quantity of Ladoga grain had been accumulated for test purposes.

Messrs. McLaughlin and Moore of Toronto’s Royal Mills agreed to conduct a proper baking quality test if a whole carload of Ladoga could be obtained. In 1892 the required amount of wheat was collected by Angus MacKay in the Indian Head, Prince Albert District in Saskatchewan and sent to Toronto. The wheat was ground at the Royal Flour Mill and the flour was given to the best bakeries in the city to test its baking quality. Buller writes: “The results of these [baking] tests were sadly disappointing, for Ladoga flour proved to be deficient in strength and produced bread which was very yellow in color and of a coarse texture. Thus the hope of replacing Red Fife by the earlier-ripening Ladoga, for export purposes, was completely shattered.” (7, p. 147)

Rediscovery of Halychanka (Red Fife) Wheat

When Saunders’s hopes for the Ladoga had been dashed, there was nothing to do but go back to the Red Fife (Halychanka) and develop a plan to cross it with other wheats to develop new varieties that met the requirements of the Canadian climate.

This renewed interest in the old Red Fife variety occurred by sheer chance: a European merchant had sent Saunders a sample of Galician (Halychanka) wheat. Thus 63 years after its initial arrival and discovery by David Fife in 1842, it was “rediscovered.” Saunders made the announcement in 1905 when he appeared before the Select Standing Committee on Agriculture and Colonization in Parliament, after reading George Essen's letter:

“This account has given rise to the idea that Red Fife is a Canadian wheat, that it originated with Mr. Fife in some wholly unaccountable manner or as a sport [sic] from a European variety. It always seemed to me probable that the kernel which Mr. Fife obtained was merely a seed of some common European variety which had found its way into the wheat from Danzig.” (7, p. 208)

“Last season, among our newly-imported European varieties, was one under the name of ‘Galician,’ obtained from a seedsman in Germany. (This variety is registered at the Cereal Division, Central

Experimental Farm, Ottawa under No. C.I. No. 2463 [573 OT. 216 - 217]). Now, Galicia lies about 300 miles inland from Danzig. This imported Galician wheat struck me at once as being very much like Red Fife, and I therefore sowed it last spring alongside Red Fife, and watched them both very carefully throughout the season. They proved to be identical at all stages of their growth as well as when the grain was harvested. A larger plot of Galician wheat furnished grain for milling purposes. This was ground, analyzed and baked. Red Fife from a plot in the same field was similarly treated. The two samples of flour were found to be alike in all respects, and thus the absolute identity of the two wheats was established. The firm from which the seed of the Galician wheat was obtained, informed me that the variety was procured by them many years ago from a farmer in Galicia. It seems, therefore, quite clear that the kernel of wheat which came into the hands of Mr. Fife, was a kernel of this Galician spring wheat, accidentally present in the cargo of winter wheat from Danzig, of which he obtained a portion. It is interesting to be able to throw this light on the subject of the origin of Red Fife, which has hitherto seemed very dark. There is no doubt that this variety is still grown in Europe, and so far as our tests have gone, it seems to be of the same quality there as it is here."

"It therefore seems certain: that Red Fife was originally grown in mid-Europe; that one of its kernels was conveyed in a cargo of winter wheat, *via* the Baltic and the North Sea, from Danzig to Glasgow; that a sample cargo containing the kernel in question was procured by some one at the Scottish port; that this sample was sent to David Fife at his farm in Ontario about the year 1842; that this single kernel germinated and produced a plant with three heads; that the kernels of these three heads, when sown the next year, gave rise to the wheat which became known as *Red Fife*; and that Red Fife is identical with a wheat known as *Galician* which was recently in cultivation in Galicia." (7, pp. 209-210)

This historic Canadian document reveals the true origin of Halychanka wheat. Another is an American document in Washington : "Red Fife grows under registration numbers 3329 and 3694. Although a lot of wheat samples were recently imported from Russia, only one of them contains real Red Fife. This sample (S.I.N-2463) came from Halychyna, which is somewhere in eastern Germany or western Russia." (10, p.11)

Wheat Crossings in Canada

After his tour of Western Canada, Saunders knew that new wheat varieties for the Canadian climate could be developed only through scientific crossing methods. Desirable hereditary properties of individual varieties had to be selected from the progeny of parents with the required genes.

The first crossings were carried out at the Central Experimental Farm in Ottawa on 19 July 1888. William Saunders, his sons A.P. and Charles, and their assistants W.T. Macoun and J.L. McMurray carried out hundreds of crossings, always with one of the descendants of the Halychanka (Red Fife) variety. (7, p. 148) The results were published in the Experimental Farm annual reports.

In 1892, A.P. Saunders was sent to Western Canada to conduct crossing experiments at the

experimental farms in Brandon (Manitoba), Indian Head (Saskatchewan), and Agassiz (British Columbia). All the grain obtained from these crossings was sent to Ottawa where the chief researcher made a selection from the next generations. By 1901, 58 new hybrids with the required characteristics had been selected and could become new varieties after further work. Some were sent to farmers in the West for further research in order to establish their practical value. Four hybrids turned out to be valuable enough to be used as commercial new varieties. They were:

PRESTON + STANLEY, obtained from a cross of **RED FIFE + LADOGA**, and

HURON + PERCY, obtained from a cross of **WHITE FIFE + LADOGA**. (7, p. 149)

These four crossings were carried out at the Central Experimental Farm in Ottawa. The first two were done by William, the other two by A.P. Saunders. These four wheats ripened a few days earlier than Red Fife but had some shortcomings, mostly in their milling and baking qualities. This made them unsuitable for export so they did not become popular. Preston, sometimes under a different name, was grown in the great central area of spring-wheat cultivation in the United States. (8, p. 150) White Fife is the result of a selection originating from the Halychanka (Red Fife) variety produced at the Central Experimental Farm. (11, p. 50) Its only difference from Red Fife is that its grain is white.

Discovery of Marquis Wheat

In 1903, grain research was headed by Charles Saunders, who established his headquarters at the Central Experimental Farm in Ottawa and carried out a review of a great number of selections there.

In 1904, he discovered a new variety called Marquis. It was a cross between the early-ripening Indian wheat Hard Red Calcutta and Red Fife made by his brother A.P. in 1892 at the Experimental Farm in Agassiz, British Columbia.

Hard Red Calcutta is a commercial name for a peculiar variety of wheat which is in fact a mixture of several varieties. So there is some doubt that this was the very type used as the maternal ancestor in this crossing. Several generations of crossings had resulted in a mixture of types, including Marquis. Studying spike after spike systematically for years, Charles Saunders had to make a judgement call on the quality of each wheat variety. During the winter of 1903-1904 he did not have a proper laboratory, a mill for grinding wheat, or an oven for baking bread. However, he would take a few grains from each stalk, chew them and decide on their probable flour and bread quality on the basis of the dough created in his mouth. The individual ancestors of the Marquis variety were produced between 1904 and 1906. In the winter of 1906-1907 the laboratory, which by now had equipment for flour milling and bread making, fully confirmed his original assessments, when teeth substituted for a mill and a mouth for an oven. (7, pp.155-156)

In 1907, 23 pounds of Marquis grain were sent from Ottawa to the Indian Head Experimental Farm for

a full-scale field trial. In 1908 the new grain was sent to the Experimental Farm in Brandon, Manitoba. In the spring of 1909 distribution of the new variety to the public began. Four hundred samples were sent to farmers throughout Western Canada. Marquis wheat was thus disseminated throughout Saskatchewan, Manitoba, Alberta, Ontario, and Quebec. It also found its way to Kamloops, British Columbia, then crossed into the United States. It attracted attention in every wheat-growing country because of the surprisingly high quality of its grain and flour, its early ripening (several days earlier than Red Fife), high yield, and the fact that its straw does not lie flat. The introduction of Marquis was the greatest practical triumph of Canadian agriculture. (7, p. 157)

The Fame of Marquis

When some American farmers — in North and South Dakota, Minnesota and neighbouring states — sowed small amounts of this new Canadian variety, the first harvest established its reputation. It was in 1912 that North Dakota first imported several carloads of this wheat. When the first Marquis harvest came to the large Minneapolis mills, the millers immediately noticed its excellent milling and baking qualities. Other Northwestern States soon followed suit: for example, the Toddy Russel Miller Milling Company in Minneapolis ordered 100,000 bu of Marquis from the Angus Mackay Farm Seed Company of Indian Head, near Regina, in the fall of 1913.

To be sure that this large shipment would be of first-class purity, the company hired Professor H. L. Bolly, Seed Commissioner for North Dakota, to inspect the fields from which the seed was to come. In 1914 Canada expanded its Marquis exports to Minnesota, North Dakota, Montana, Iowa, Nebraska, South Dakota, and Washington. That year saw fully half a million acres of American wheat fields sown with Marquis, yielding an American harvest of seven million bu — 3.36 million in Minnesota and the Dakotas alone. (7, pp. 158-160)

In the United States, Marquis wheat replaced, either wholly or in part, all spring varieties grown at that time and even some winter ones. It became popular in both the central and northwestern states. In 1918 American and Canadian farmers sowed Marquis on more than twenty million acres from southern Nebraska to northern Saskatchewan — a range of more than 800 miles.

General Characteristics of Marquis

Marquis is classified as a wheat of the Red Fife group. It differs from Red Fife in that its straw is shorter and does not lie flat; therefore its glumes are shorter and its kernel is shorter and broader. It ripens 98 to 135 days after planting, depending on the geographical area, which is three to four days before most of the Red Fife varieties. It is not resistant to rust, but because it ripens earlier, it is ready for harvest before rust development and so can be said to avoid rust. Also, because it ripens faster, it can grow farther north than Red Fife. These properties were especially important for Canada’s Prairie provinces. (7, pp. 171-172)

Prizes Awarded to Marquis (7, pp. 172-174)

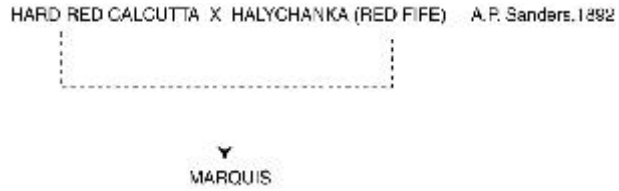
1. James J. Hill of the Great Northern Railway Company offered a gold cup worth US$1000 for the best bushel of hard spring wheat grown in the Unites States. Sir Thomas Shaughnessy challenged Hill to open the competition to Canada and when he refused, offered another prize of US $1000 in gold, on behalf of the Canadian Pacific Railway Company, for the best bushel of hard spring wheat grown in North America. In 1911 the international competition was held under the auspices of the New York Land Show and was won by Seager Wheeler of Rosthern, Saskatchewan, with a bushel of Marquis wheat. In 1910 Wheeler had harvested a yield of 250 pounds from just five pounds of seed grain. The wheat was grown in a field measuring 15' × 115' or about 1/19 of an acre, likely a world record for spring wheat.
2. A farmer named Holmes of Raymond, Alberta, won an award from the International Dry-Farming Congress for Marquis in 1912; Paul Garlach of Allan, Saskatchewan, won a similar award in 1913.
3. Seager Wheeler won international awards in 1914 and 1915; also one for the Kitchener variety, selected by him from Marquis in 1916.
4. Samuel Larcombe of Byle, Manitoba, won an international award at the Twelfth International Soil Products Exhibition in 1917.
5. Seager Wheeler won yet another international award at the Thirteenth International Soil Products Exphibition in Kansas City in 1918. He was introduced to the public as one of the best wheat growers on the continent.

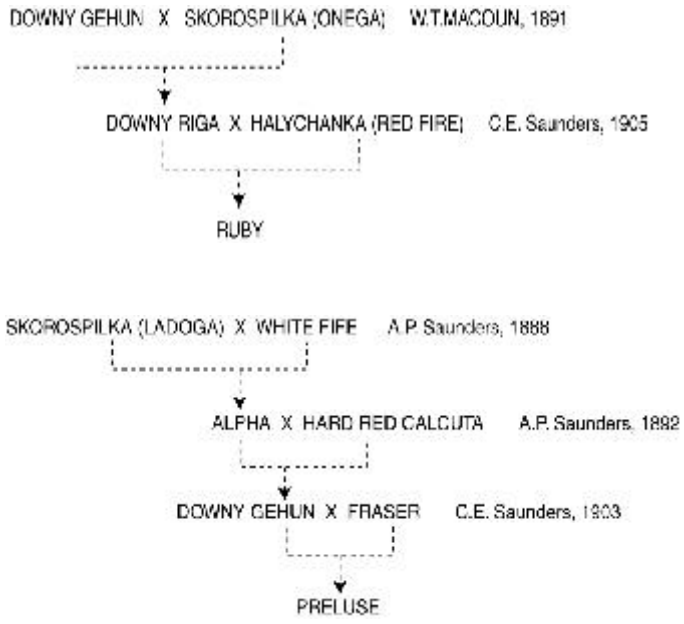
The awards for Marquis and its derivatives show that this hybrid had improved on the genetic properties of its Ukrainian Halychanka ancestor. (7, p. 174)

Ruby and Prelude

Northern wheat fields, with their shorter growing season, could be sown only with fast-ripening varieties. One of the new early-ripening varieties developed by William Saunders was given the name Prelude, probably because he was a music lover. This variety ripens fully two weeks earlier than Marquis, so was intended for northern areas — northern Saskatchewan, and northern and central Alberta. It reaches maturity even in Dawson City,Yukon. (7, pp. 183-184)

After Prelude, a new variety called Ruby was selected. It reached maturity even sooner — about two and a half weeks earlier than Red Fife. The genealogical charts for the Marquis, Ruby, and Prelude varieties are set out below. (7, pp. 184-186)





If we review the characteristics of their ancestors and those of subsequent generations, the characteristics selected with the help of crossing become obvious:

- Hard Red Calcutta and Gehun, from India, early maturity;
- Poltavka (Onega) and Poltavka (Ladoga), Ukrainian wheats from Russia, early maturity; and
- Halychanka (Red Fife) and Halychanka (White Fife), from Ukraine, excellent milling and baking qualities. (7, pp. 186-187)

Hard Red Calcutta

Hard Red Calcutta, the female parent of Marquis, was a wheat imported into Canada by William Saunders for research at the Experimental Farms. Samples were sent to farmers all across Canada. Twenty-eight were sent out in 1892: but even though it ripens two to three weeks before Red Fife, its small yield, tendency to shatter, very short straw, and other deficiencies caused it to fail as a commercial variety for Canadian conditions. (7, pp. 204-205)

In 1892 it was crossed with Red Fife in the hope of creating an early-ripening wheat with the quality of Red Fife. The generation after this crossing was diverse. No notes about the first generation (F1) survive, although there are some on the first generation of the Marquis hybrid in Buller. (7, p .205) Nor is there a single analysis of subsequent generations (F1, F2, F3, etc.). We do not know the generation in which the selection began: there was a mixture of varieties and characteristics. The type of Indian wheat used for crossing is also unknown. As Calcutta Red was a mixture of both red and white grains,

the colour of the maternal ancestor is similarly unknown.

Finding the lost notes on the analysis of selection of the Marquis variety would be of great interest to growers and geneticists today. It became a very important food product that powered the agricultural economy of both Canada and the United States in the first half of the twentieth century.

Crop Values of Marquis in Canada and the United States

Crop Value of Marquis Wheat in Canada, 1917-1918

Year	Total crop of wheat in the three Prairie provinces in bu	% of Marquis	Amount of Marquis in bu	Price/bu (US$)	Crop value of Marquis (US$)
1917	212,000,000	80%	169,600,000	2.00	339,200,000
1918	162,000,000	80%	129,000,000	2.00	259,200,000

Source: Buller (7, p. 243)

If the Ontario and Quebec harvests are added to those of the three Prairie provinces, the value of the Marquis harvest rises to $340 million and $260 million for 1917 and 1918 respectively.

Crop Values of Marquis Wheat Harvest in the Four Spring-Wheat States in 1917

	Total crop of wheat in bu	% of Marquis	Amount of Marquis in bu	Price/bu (US$)	Crop value of Marquis (US$)
Minnesota	57,965,000	46	26,663,900	2.00	53,327,800
North Dakota	56,000,000	43	24,080,000	2.00	48,160,000
South Dakota	52,024,000	43	22,370,320	2.00	44,740,640
Montana	17,963,000	45	8,083,350	2.00	16,166,700
Totals	183,952,000		81,197,570		162,395,140

Source: Buller (7, p. 243)

If the Marquis harvest in other American states is added to these four, its monetary value in 1917 comes to $170 million. (7, p. 244)

The spring wheat crop for 1918 was expected to total 342,855,000 bu by September, with about 257 million bu of this total reported by the major wheat-growing states of Minnesota, the two Dakotas, and

Montana. These four states also were expected to produce 15,050,000 bu of winter wheat, for a total of about 272 million bu. Their 1918 Marquis grain harvest totalled about 177 million bu. If the average price per bu was US$2.00, its value was US$354 million. Other states contributed another 86 million bu, probably one-half Marquis. Thus the total value of the harvest came to more than US $370 million. (7, p. 245)

Crop Values of Marquis in North America, 1917-1918

	Canada	United States	Total Value
1917	339,000,000	170,000,000	509,200,000
1918	259,200,000	370,000,000	629,200,000

Source: Buller (7, p. 245)

It appears from the above table that even though the Marquis variety was created in Canada, by 1918 more was grown in the United States than in Canada. (7, p. 245)

All these millions were paid for the descendants of a single grain of Halychanka (Red Fife) wheat from Ukraine that reached Canada in 1842. If it had not arrived, I believe these totals would have been much lower.

The recognition of the excellent baking qualities of this wheat by American millers and grain traders soon gave it immense commercial value. Most important, the development of Ukrainian wheat on the American continent became a significant asset for the Allies during World War I. Indeed, I believe Marquis helped the Allies win the war. In 1918 the Marquis harvest in Western Canada and the United States totalled more than 300 million bu — enough to make bread to feed 50 million people for a whole year. At US $2.00/bu, its value was more than US$600 million. (7, p. 246)

It is easy to quantify the prosperity this variety brought to the United States. The wealth it generated created a strong foundation for their agricultural economy. For example, the 1917 Marquis harvest in Minnesota alone brought a gain in wealth of more than seven million dollars. (7, p. 249) There were equally important intangibles — like the pride and sense of achievement generated by this immense economic accomplishment — not only for the farmers but the whole American government.

One measure of the impact of this variety on Canadian agriculture is the fact that about 80% of all wheat grown in Western Canada after 1918 was Marquis. It was grown on summer fallow land and yielded at least 20% more than the previously dominant variety — Red Fife. The 1918 wheat harvest totalled 162 million bu, an increase of 16 million bu. If we factor in Canada's unfavourable climate, which often caused rust or early frost damage to Red Fife, then the benefit to this country was even greater. (7, p. 254)

According to Mr. Milner, a former president of the Winnipeg Grain Exchange, the final figure for the years 1915-1918 was 376,448,400 bu. An annual increase of 25 million bu a year was directly attributable to the introduction of Marquis. As a result, more bread and other wheat products became available to more than two million Canadians. (7, p. 254-255)

Although wheat prices were lower then, the annual farm income generated in Western Canada by the Marquis variety increased from $11.2 million to $17.5 million by 1918. During World War I, wheat prices increased at least three times. Revenues from sales of Marquis filled the pockets of Canadian farmers with millions of dollars for many years. Taxes on sales of this wheat generated significant economic benefits for the federal government and made it possible to build elementary and secondary schools, agricultural colleges, and universities in the Western provinces. The careful, persistent work of Charles Saunders, together with the genetics of the Ukrainian ancestors of the Marquis variety, made a large contribution to Canada's early economic growth. (7, pp. 255-256)

The Marquis variety thrived under the growing conditions in Western Canada: this encouraged farmers to expand their wheat fields and also may have encouraged a large increase in the number of new farmers and immigrants. Indeed, the impact of the Marquis variety on Canadian agriculture was so great that it cannot be expressed merely in terms of bushels per acre or dollars per year.

Summary of the Importance of Marquis Wheat

1. Developed and introduced by Charles Saunders at the Central Experimental Farm in Ottawa, it originates from Ukrainian Halychanka (Red Fife) wheat.
2. It is a hard red spring wheat famous for its milling and baking qualities. It produces a higher yield and ripens an average of six days earlier than Red Fife.
3. Discovered in 1903 and first distributed to farmers in Western Canada in 1909, it was the dominant spring wheat in Canada and the United States by 1918.
4. Early Marquis harvests were huge:
   a. 1917 - more than 250 million bu worth $500 million; and
   b. 1918 - more than 300 million bu worth $600 million.
5. In 1917 because of the replacement of Halychanka (Red Fife) by Marquis, Canada's wheat yield rose by more than 16 million bu, worth some $32 million.
6. The replacement of the Bluestem, Fife, and Velvet Chaff varieties by Marquis increased the 1917 American wheat harvest by more than 10 million bu, worth $20 million.
7. In 1917 the replacement of lower-yielding varieties with Marquis increased the North American wheat harvest by more than 26 million bu, worth $52 million. The food crisis of 1917-1918 made this additional wheat crucial to the Allies during World War I.
8. Its great international success demonstrated the benefits of scientific research and development by governments, especially the establishment of the system of experimental farms in 1889. (Nos 1-8, from 7, pp. 257-258)
9. According to the Dean of the College of Agriculture in Saskatchewan, L.E. Kirk, "Marquis

variety was the highest-yielding wheat ever produced in the world." James Boyle of the College of Agriculture at Cornell University agreed: "The greatest single advance in wheat ever made by the United States was the introduction of that class of hard spring wheat known as Marquis wheat. The idea came to us free of charge from the Dominion of Canada's cerealist, Sir Charles E. Sanders. In the spring of 1903 he planted a single grain of this wheat. The following year there were 12 plants. Within 12 years these have multiplied into 250 million bushels." (12, p.13)

10. The development of this variety not only contributed to a vastly expanded wheat production and greater agricultural and economic prosperity, but also the arrival of great numbers of immigrants to the southern parts of the three western provinces as well as the beginning of Canada's northward expansion. Canada's wheat fields increased from 5,096,053 acres in 1906 to 9,335,400 in 1914 and 16,125,451 in 1918. By 1940 this area had expanded to 27,750,000 acres.
11. The value of wheat produced in the three western provinces between 1910 and 1948 comes to more than $17.5 billion. (12, p.15) More than 80% of this total was from Marquis wheat.
12. By 1949 Canada's grain-growing areas in Manitoba, Saskatchewan, and Alberta had expanded to some 200 million acres: 32,077,600 in Manitoba, 80,051,020 in Saskatchewan, and 87,449,600 in Alberta, all sown with Marquis and other varieties descended from the Ukrainian Halychanka (Red Fife) variety. (12, p.14)

The Kitchener and Quality Varieties

Kitchener is a selection of Marquis produced by Seager Wheeler at the Rosthern Experimental Farm in Saskatchewan in 1911. (7, p. 275) Its grain is darker and more oblong than Marquis, it ripens two to three days later, and its milling and baking qualities and the colour of its flour are inferior, although its yield is about the same and its straw is stronger. Kitchener is often rust-prone.

Quality is a selection of Marquis produced by Luther Burbank in Santa Rosa, California in about 1918. Its grain is white and larger than that of Marquis. Quality is one of the best white spring wheats for milling and bread baking. Its high yields, excellent quality, and adaptability to poorer soils made it quite popular in Manitoba; but its white grain, susceptibility to rust, and fast growth in rain eventually made it less popular. According to Mr. Burbank this wheat "is for all climates wherever wheat can be grown." (7, p. 235)

The Red Bobs Variety

It is difficult to trace all the names Halychanka wheat has been given by various growers and researchers. Here is the story of one:

Professor A.E. Blaunt worked at the Agricultural College in Colorado in 1880. There he produced many different wheat hybrids with Red Fife, which then became commercial varieties. He named them

after minerals: Amethyst, Feldspar, Granite, Gypsum, Hornblende, Quartz, Ruby, and Tourmaline. Some of these wheats were sent to a researcher by the name of W.J. Farrer in New South Wales, Australia, where he used the best of them as parents for his hybrids. (13, pp. 61-62)

Farrer did not indicate the origin of these Colorado wheats and gave some of them completely different names. These became known as the ancestors of his own hybrids. Thus the name of the original Ukrainian Halychanka (Red Fife) disappeared completely.

For example, Blaunt made two selections from the Ukrainian Halychanka (Red Fife) variety which he called Saxon Fife and Improved Fife as well as Blaunt's Fife, which became known commercially as Gypsum. Mr. Farrer received a sample of Gypsum and renamed it Blaunt's Lambrigg. He selected several plants, propagated them and gave them the new name of Bobs. This variety had white kernels along with some red ones, good yields and very good milling and baking qualities. From Australia it travelled to William Saunders in Canada. Later, Bobs was recognized in the United States. Commenting ruefully on the name changes, American researcher R. Ball wrote: "This is an example of our own grain going overseas and coming back to us renamed." (13, p. 62)

When Saunders received his sample of the Bobs variety, he acknowledged that its yields were better than those of Marquis but he did not want to introduce it into Western Canada because of its white grain. On the British grain markets Australia was known for white varieties, while Canada was famous for red ones. Canada had set its export standard for wheat to be as red as possible and its evaluation criteria were set so as to discourage the cultivation of white wheat.

The later development of the Red Bobs variety is described by Buller (7, p. 262): "Mr. Wheeler of Rosthern, Saskatchewan, ... who was engaged in making selections from Dr. Saunders' strain of Early Red Fife and of Preston, heard of Bobs, and, during the winter of 1907-08, secured a ten-pound sample of it from the Experimental Farm at Indian Head." One interesting conclusion was that there was no difference between Early Red Fife, Preston, and Australian Bobs (1909). The plants of the Bobs variety were also very uniform.

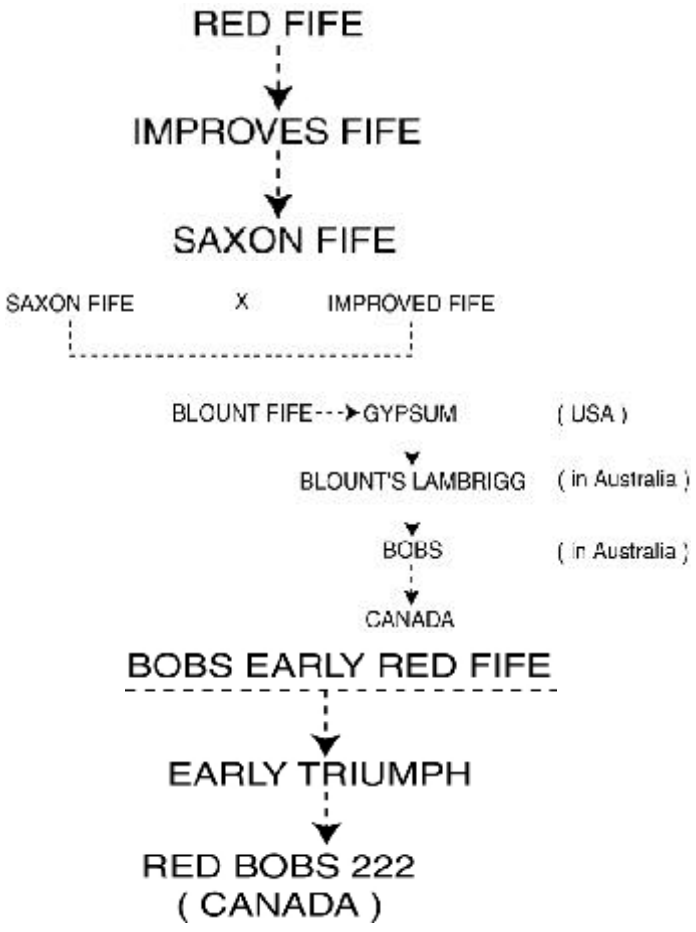
In 1910 Wheeler repeated his experiment on an area of a quarter-acre.The outcome was the same. The only difference was that Wheeler found some Bobs spears with red grains. Wheeler therefore called the Bobs from Australia White Bobs, and this red-grained variety Red Bobs. In 1911, he sowed grains from each spike in separate rows. The plants grown from these first red grains were quite diverse. Some of them were similar to Red Fife, some of them were awned along the whole spike, some had short awns at the end of the spike and sometimes the whole spike was similar to Red Fife. Some were tall, some short, some in between. The same was true of their ripening characteristics: some were early types, others later types. All of the grains were red.

This diversity of characteristics shows that a natural hybrid had been produced in Wheeler's field in 1909. It was the result of a cross between White Bobs, Red Fife, and Preston. Segregation was

demonstrated in the second generation in accordance with Mendel's laws. Buller's description of the selection details for the Red Bobs variety shows that in 1918 Red Bobs was already a completed variety. When a comparison of the Red Bobs, Marquis, and Kitchener varieties was done, Red Bobs was found to ripen a few days earlier than the other two.

There are two sources of information on the Red Bobs variety, assuming there was only one Red Bobs in Canada. The first, of course, is Buller (7, pp. 259-277); the other (11, p. 39) explains the origin of Red Bobs as a "reselection of the Early Triumph variety made at the University of Alberta and first distributed in about 1925." On the origin of Early Triumph he writes: "In 1910 Seager Wheeler of Rosthern, Saskatchewan, found a spike of wheat with red grains among the Australian Bobs wheat he was growing in parallel with the Early Red Fife variety. The generation with these red grains was called Early Triumph." (11, p. 22) Note that the authors of the second publication do not mention the details in Buller, who does not mention Early Triumph.

A summary on how Red Fife went from Canada to the United States and Australia, and then back again is presented in the charts below.



Early Triumph looks different from Red Bobs, while the quality of its flour is very similar to Marquis. It is therefore one of the high-value category wheats. Red Bobs has a somewhat better-quality flour than Marquis but it is of the same colour. Red Bobs is grown mainly in southern Alberta, where it thrives.

Wheat in Western Canada

I believe that the quality of Ukrainian wheat contributed to the rapid development of Western Canada at the start of the twentieth century and that this is clearly demonstrated in the increase of its wheat crops. Consider the following statistics from Buller (7, pp. 35-41): the 1904 harvest in Manitoba and Saskatchewan, when grain cultivation in Alberta was just beginning, totalled just 56 million bu. In 1906, however, the combined harvest in Manitoba, Saskatchewan, and Alberta had increased to 102 million bu. By 1913 it had more than doubled again, to 209 million bu. Just two years later it nearly doubled again, rising to over 360 million bu during the banner harvest of 1915.

This kind of explosive growth in wheat cultivation in the Prairie provinces established Canada as a major grain producer among Commonwealth countries. Referring to the great crop of 1915, Mr. W.E. Milner (14), the President of the Grain Exchange in Winnipeg, said in September 1916, "This has been one of the most phenomenal years in the history of the grain business in the Dominion of Canada. Our farmers, having been blessed by the hand of Providence, produced the largest crop ever grown in this country...our wheat crop reached [a total of] 376,448,400 bushels." (7, p. 35-36)

The 1916, 1917, and 1918 harvests fell short of the 1915 record, although they each topped 200 million bu. Saskatchewan was the largest wheat-growing province, followed by Manitoba and Alberta.

Acreage and Yield of Wheat for 1915

	Acreage	Bushels	Yield per acre
Saskatchewan	6,884,874	173,723,775	25.23
Manitoba	3,664,281	96,662,912	26.4
Alberta	1,637,122	58,830,704	35.94

Source: Buller (7, p. 36)

Average Yield of Spring Wheat in Bushels per Acre, 1908-1917

Manitoba 17.76
Saskatchewan 18.5
Alberta 22.5

More than 90% of wheat in Canada was being grown in the Prairie provinces. Between 1913 and 1917 these three provinces produced a combined total of 1,283 million bu of wheat, while the rest of Canada produced only 118 million bu. Canada also led the world in wheat production per capita. This was due to its small population in relation to the vastness of its wheat acreage (7, p. 38).

Per Capita Wheat Production in Selected Countries in 1917 (bu)

Canada	32
Argentina	25
Australia	17.5
Romania	14.5
Bulgaria	12.5
United States	7.5
United Kingdom	1.5

Per Capita Wheat Consumption in Selected Countries in 1917 (bu)

Canada	16.5
Argentina	11
France	9.5
Italy and Australia	7.5
United Kingdom	7

Exports of Wheat in 1913 (bu)

United States	154,760,000
Canada	151,975,000
Russia	130,596,000
Argentina	109,637,000
Holland	64,501,000
British India	54,711,000
Roumania	54,203,000
Australia	53,207,000
Germany	29,638,000
Belgium	15,898,000
Bulgaria	11,456,000
Austria-Hungary	1,730,000

This list clearly shows Canada in second place in 1913. By 1915-1916, however, world wheat exports had become very restricted because of the war. So Canada, with its enormous wheat surplus of 1915, became the world's top exporter, even ahead of the United States.

Export of Wheat in 1915-1916 (bu)

Canada 267,766,000
United States 239,526,000
Argentina 110, 390,000
Australia and New Zealand 63,249,000

In 1918 the farmers of Canada and the United States made special efforts to increase the wheat harvest in support of the war effort. The combined North American harvest came to more than 1,100 million bu. Each country's contribution, as estimated in October, stood at:

United States . . . . . 918,920,000 bu
Canada . . . . . 210,000,000 bu

The United States grew more than four times Canada's total because of a great drought in our Prairie provinces. Still, Canada could have grown much more wheat than the United States, as many potential wheat fields in the Prairies remained virgin land never touched by the plough (7, p. 41).

Wheat Grown in the Early Days

Canada grew primarily spring wheat. Winter wheat, which produces higher yields, was also grown, although the climate in Western Canada is not conducive to its cultivation. The table below gives the area sown with spring and winter wheat in the three Prairie provinces in 1918.

Number of Acres Devoted to Spring and Winter Wheat in 1918

	Spring Wheat	Winter Wheat
Alberta	3,187,000	58,000
Saskatchewan	9,101,000	—
Manitoba	2,616,000	2,000
Total	14,904,000	60,000

Source: Buller (7, p. 42)

Western Canada was almost exclusively a spring wheat area. Some winter wheat was grown, mainly in Alberta, although the 1918 winter wheat acreage in the three Prairie provinces totalled just 2/5 of 1% of Canada's wheat acreage. Climatic factors that destroy winter wheat include

1. very low winter temperatures;

2. relatively little snow, depending on the locality;
3. alternation of thaws and frosts in early spring; and
4. dry winds in the spring.

According to Buller, "...wheats sown in the spring are hard red varieties, the chief sorts being *Marquis* and *Red Fife*. The winter wheats, sown in the autumn, are chiefly *Turkey Red* and *Kharkov"* (7, p. 42). I believe that these wheats came to this continent from Western Ukraine.

The harvesting and threshing season was always the busiest part of the year in Western Canada. There was never enough local manpower to do all the work, so an additional 20,000-30,000 harvest workers would flock from the East of the Dominion and from the United States. (7, p. 47)

Buller again: "The western plains, in general, are very level and free from large trees, and hence are easy to break with the plough. The soil is thick and rich in humus..." (And, at harvest time, a vision of gold and blue: heavy spears of Ukranian wheat planted in Canada's soil waiting for the farmers and their machines.) "... There is no more exhilarating sight in the West than the prospect of the binders at work on the sea-wide, sky-skirted prairie, with the golden grain gleaming under the August sun and above and about all the cloudless blue dome of heaven. And when the last sheaf has been cut and the binders are silent, how splendid is the view across the gently rolling stubble fields: stook beyond stook...for a quarter mile, for half a mile...stooks cresting the distant horizon, ten thousand stooks all waiting to be threshed and each with its promise of bread, the gift of the New World to the Old. The unbroken expanses of the prairie create within one a sense of freedom which is best known only to those who dwell far from crowded cities, who plow and sow and reap, and whose daily toil causes them to commune unconsciously with Nature and thus to absorb something of her simplicity and her charm." (7, pp. 48-49) This was the great grain treasure brought to Canada by Ukrainian wheat.

The Great Wheat Funnel

Ukrainian wheat grew in abundance on the Prairies and filled the newly built elevators. A large railroad system extending across thousands of miles was constructed to meet the transportation needs of Western Canada. The main lines along the wheat routes were the Canadian Pacific, the Canadian Northern and the Grand Trunk Pacific. "Their main lines all focus upon Winnipeg, so that this city has become, as it were, the converging point of a great wheat funnel, the spout of which leads to the water-front of Lake Superior. Through Winnipeg, each working day of the crop year 1915-1916, on the average, there passed more than one thousand cars of wheat." (7, p. 49)

Buller's diagram (7, p. 50) of the eastbound transportation routes for wheat from Western Canada in 1913 shows that most of the wheat was transported by rail through Winnipeg to Port Arthur and Fort William. From there it was shipped across the Great Lakes to Montreal and Buffalo and then on towards the Atlantic Ocean along the St. Lawrence River, or by road to the ports of St. John, Halifax, Portland, Boston, New York, and Baltimore. (7, pp. 49-51)

Building Grain Elevators

A bumper crop of wheat could not be delivered quickly for export. It was necessary to store it sensibly and economically for an extended period. For this purpose, elevators were built near the rail lines. Farmers would bring their grain to the elevators where it would be weighed, cleaned, and dumped into immense bins for storage.

There were several types of elevators of various capacities. In 1916-1917 there were 1,384 railway stations in Western Canada next to 3,338 elevators with a capacity of 163,144,000 bu. (7, p. 54)

The elevator business was very well organized for the powerful grain industry. The elevators were equipped with the latest in technology to load and unload grain. The volumes of grain were immense: the Western Grain Inspection Division of the Department of Agriculture inspected 338,425,200 bu of wheat. Thirteen elevator terminals were built along the lakeshore in Port Arthur and Fort William, each with an average capacity of more than three million bu, for a total capacity of 41,750,000 bu, so that the grain could be loaded directly into the holds of the lake steamers. (7, p. 60)

These were ships designed and built to transport grain across the Great Lakes. They too were fitted with the latest equipment for loading and unloading grain. They had enormous capacities. One ship could hold the contents of seven trains, or 300 boxcars (15). The largest could hold nine train loads of wheat. They could load from 75,000 to 100,000 bu per hour and unload from 20,000 to 40,000 bu per hour, depending on the elevator machinery. These efficiencies of scale meant that water transport was always cheaper than transport by rail. (7, p. 65-66)

The Canada Grain Act

With the expansion of the grain trade in Canada, there were frequent complaints about the under-pricing and over-pricing of grain to farmers and buyers, respectively, and the generally dishonest business practices of some elevator companies. Short-changing on weight and grade and other fraudulent activities forced Parliament to enact legislation regulating the industry. *The Canada Grain Act* received Royal assent in 1912. It created an executive body — the Board of Grain Commissioners — to administer the legislation. The Act set out the standard grades for Prairie wheats and the loading rules. It also set standards for the characteristics by which wheat is graded. The Act thus provided grain growers and farmers with iron-clad legislative protection from abuse by the elevator companies at the time of grain delivery. (7, pp. 68-69)

When the wheat trade began, grading was based on samples. Eventually that system became inadequate, so a universal system for the grading and weighing of grain was introduced in 1884, first in Minneapolis and Duluth, then in Winnipeg.

This system allowed the farmer to sell or store wheat according to the grade assigned to it by the grain

inspector. Grades or classes of wheat are numerous and varied, depending on the farmer, the environment where the wheat was grown, whether there are any admixtures with other varieties or even other cereals, and the milling quality. (7, p. 70) *The Canada Grain Act* established four statutory grades of wheat:

Number 1 Manitoba Hard	This wheat must be sound and very clean; the weight of one bushel must be no less than 60 pounds, and must be composed of at least 75% of Hard Red Fife or Marquis. The first variety, Red Fife, was the standard wheat for Western Canada. When the Marquis variety appeared, the Board of Grain Commissioners added "or Marquis."
Number 1 Manitoba Northern	This wheat must be sound and very clean, weighing not less that 60 pounds to the bushel and must be composed of at least 60% of Hard Red Fife or Marquis.
Number 2 Manitoba Northern	This wheat must be sound and reasonably clean, of good milling qualities...weighing not less than 58 pounds to the bushel and must be composed of at least 45% of Hard Red Fife or Marquis.
Number 3 Manitoba Northern	Any wheat not good enough to be graded No. 2 is graded No. 3 at the discretion of the Inspector. (7, pp. 72-73)

There was one more class (No.1 Hard White Fife), although very little was grown in Western Canada. This was another Ukrainian wheat selected from the Halychanka (Red Fife) variety.

Classification, or grading by the grain inspector, was a most important element of the grain trade in Western Canada. Wheat was bought, sold, transported, and stored by grade. If the wheat for sale was graded too low (that is, below its true value), the farmer lost money and the miller or buyer gained undeserved profits. If the wheat was graded too high, the farmer gained and the miller lost. The position of grain inspector in the early years was thus a very difficult one. Over time grain classification in Canada became fully established. Its development and implementation is described fully by Buller. (7, pp. 75-118)

The Impact of World War I on the Grain Trade

The war destroyed the grain trade organization in Canada and the United States. First the volume of trans-Atlantic wheat cargo dropped. As a result, Western Europe had bread shortages. Delivery of wheat to Western Russia was similarly cut off. Indian and Australian wheats were unavailable because

of a lack of transportation and Argentina had no surplus wheat. The Western Allies thus were dependent totally on North American wheat for their food supply. (7, p. 123) Only the wheat sent to Canada from Ukraine 72 years before the war was left to support the Allied cause.

Just when the Allies needed more wheat from Canada, however, its workforce had been sent to the front. There was a great lack of agricultural workers. The resultant demand for more manpower raised not only the workers' wages but also the price of wheat. (7, 123-125)

Expansion of the Milling Industry

Before the war Canada had been mainly an exporter of grain which was milled into flour in the European countries. The war, however, made it necessary to expand Canada's industrial mill capacity. New mills were built in Western Canada and in other areas with low-cost power and transportation. These strategic points included Fort William on Lake Superior, Keewatin and Kenora on Lake of the Woods, Winnipeg, and other places with railway connections. The war saw the number of Canadian flour mills rise to 710, with a daily production capacity of 125,000 barrels. During the great food crisis in 1917-1918, Canada supplied the Allies with 10 million barrels of additional wheat exports. Fully 50% of the flour from the mills in Western Canada was exported, with Great Britain the largest importer. (7, p. 136)

An interesting aside: Buller describes a set of millstones located at the entrance to the office of the Lake of the Woods Milling Company in Winnipeg as having been brought to Western Canada by Russian Doukhobors. (7, pp.136-137) However, these stones might have been brought over just as easily by Molokans (sectarians from Ukraine), Ukrainian Mennonites, or other Ukrainian immigrants recorded as Austrians or Russians by Canadian immigration authorities. They can serve to introduce a word on the contribution of Ukrainian wheat to Canada's economy.

The Value of Ukrainian Wheat to Canada's Economy

Ukrainian wheat was indeed a blessing for Canada. It came from two different geographic areas: spring wheat from Halychyna (Western Ukraine), and winter wheat and hard spring wheat from the Dnieprо region of Eastern Ukraine. Canada was the first to grow these wheats on the new continent. The high quality and yields of Red Fife and Marquis meant that everyone who sowed them prospered. Ukrainian wheat was a factor in attracting the increasing numbers of new immigrants from Europe to Canada's vast territory, mostly to Western Canada and Ontario. Americans moved north too: farmers from Iowa, Illinois, Minnesota, and the Dakotas with start-up money, energy, and experience could earn up to five times their American incomes in Canada.

In1900 there were 1,870,000 acres sown with wheat in Canada's Prairie provinces. By 1910 there was a 35% increase in this acreage to 8,395,000 acres. The 1901 wheat harvest totalled 62,820,282 bu, which more than doubled to 150,439,600 bu by 1910. As harvests grew, so did their monetary

value: between 1910 and 1952 the three Prairie provinces generated more than $22.8 billion of income from wheat. Ukrainian wheat thus created prosperity for people in the West while establishing an economic base and trade activity for the industries of the East. Western agricultural products provided work for people on land and on ships at sea, were responsible for the highest percentage of rail transport operations, and for years were Canada's most important export commodity. The grain trade was also a major source of commercial loans for Canadian banks.

Wheat production in the Prairies has been the most noticeable development of Canada's agricultural economy. According to Professor MacGibbon in *The Canadian Grain Trade*, Saskatchewan farmers would earn 66% of their annual cash income from wheat. In Alberta the figure was 50%, while in Manitoba before 1939, wheat farmers earned twice the income of cattle ranchers.

Average Wheat Acreage, Yields, and Monetary Value, 1937-1941

Grade of Wheat	Area under Cultivation (acres)	Production (bu)	Value ($)
Spring Wheat	25,065,000	363,586,000	211,743,000
Winter Wheat	707	19,586,000	14,632,000
All Wheats	25,772,000	383,172,000	226,375,000

Obviously spring wheat was Canada's most valuable grade. We exported about 40% of our harvest then and have been the largest grain exporter in the world since 1948. (16, p. 426) The greatest acreage under cultivation was in 1940, at 27.75 million acres. The largest wheat harvest was in 1952, at 664 million bu in the Prairies and 688 million bu for all of Canada. Saskatchewan was the largest wheat producer in the world at that time. In 1952 it produced 435 million bu.

In the words of Prime Minister Bennett to Parliament in 1936: "Wheat has become vitally important to our national economy. Why? Because you can plant it in spring and harvest it in the fall... During the last quarter century the area between the Great Lakes and the mountains of Western Canada has produced millions of dollars of new benefits year after year..." (17, p. 23)

During World War I the great wheat surplus harvested in Western Canada was an important factor in the ultimate victory of the Allies. It was just as important during World War II. As British High Commissioner to Canada Malcolm MacDonald said in a 1943 speech in Ontario: "Without the help of Canadian farmers, Britain would have lost the war in less than two years. Canada has given the British population vital economic support. If people had to go hungry, they would not have maintained the level of health to survive four years of war, so far, in good physical, mental, and intellectual health." (17, p. 23)

I believe that all these benefits to the economic development of Canada were created by Ukrainian

wheat because it is of exceptional quality. The next section describes how wheat quality is defined.

The Quality of Wheat, Flour, and Bread

The usual characteristics of wheat varieties, which include yield, height and strength of straw, and time of ripening, are more or less obvious to the farmer when he observes them in the field. Most farmers assess the worth of a particular variety under specific growing conditions on the basis of these known characteristics. However, the value of any given variety can only be determined after the grain has been milled into flour and the flour baked into bread. It is impossible to recognize this value from the outward appearance of the plants of a given variety, although preliminary conclusions can be drawn on the basis of a wheat grain specimen that has been softened by soaking in water. But the wheat grain is not the final product. It must be processed by the miller, made into bread by the baker and judged by the consumer, who gives the final assessment on the quality of this wheat.

Most North American grain farmers used to care far less about the quality of the flour than about the variety which produced the greatest yield. When wheat first began to be sown here, farmers worked hardest at producing as much grain as possible and generally accepted variable levels of bread quality. The quality of the wheat grain and the kind of bread it would produce began to be taken into account only after top-quality Ukrainian wheat arrived in North America.

Wheat quality begins with its constituent parts. The hard spring wheat kernel, on average, contains about 68% starch, 18% protein, 2% fats, 2% ash, and 2% cellulose. The proportion of these components varies. The starch, protein, and fats comprise the nutritive components. Cellulose is not digested so its nutritive value is zero.

Key Factors in Assessing Wheat Quality

When the word “quality” is used to describe the wheat kernel, it acquires more or less variable meaning. The grain may serve more than one purpose, so its value or quality depends on the particular purpose for which it is used. A miller who wants to produce high-grade semolina flour for pasta needs a wheat rich in gluten. A miller who wants to produce flour for cakes or crumbly products wants a wheat that is low in protein but high in starch content. In both cases the miller talks about a high “quality” that best meets his need to produce a particular product.

Most of the wheat grown in Canada is intended to meet the needs of bread baking. Its quality is defined by how suitable it is for the production of flour for baking bread. In other words, one must rate first the wheat’s “milling quality,” or its ability to create flour, and second its “baking quality,”or the quality of the bread made from its flour.

Milling and Baking Qualities of Halychanka (Red Fife) Wheat

Flour made from the Ukrainian Halychanka (Red Fife) variety had been shown to have the best milling and baking qualities. These qualities defined the true value of this wheat and commanded the highest market price. That is why farmers in Western Canada grew it in the largest possible quantities.

The quality of wheat is a very complicated question defined by a number of independent factors. These are described by Charles Saunders in *Quality in Wheat* (18, p. 6-28) and later summarized by C.H. Bailey (19, p. 10, cited in 7, pp.198-199). Buller notes the comprehensiveness of Saunders's research : "... he not only crosses wheats, selects their progeny, propagates the selections on plots and in fields, and records all their field characteristics, such as yield and earliness, but... he also carries out all the needful baking and milling tests himself in his own laboratory."

At that time British millers wanted Canadian spring wheat that had not only a hard red grain that produced a white flour and absorbed a lot of water but also one with the greatest strength, or elasticity, during baking. The Canadian wheat's strength of flour not only produced the best loaf but also had an unequalled capacity for mixing with other flours. British millers had a lot of their own soft wheat which produced a weak flour. The strong Canadian flour, when mixed into the weak British flour, improved the latter to the level of standard flour and at the same time raised its price. Halychanka (Red Fife) wheat was thus in great demand on the British market. (7, p. 200)

William Saunders, when sending new varieties for testing to the Canadian West, made sure that they met the British requirements: that is, a flour strength equal to or greater than that of the Halychanka (Red Fife) variety. (7, pp. 200-201)

Milling Quality

The milling quality of wheat depended on two factors: the quantity of the flour produced and the colour of the flour. These factors were related. By separating as much of the flour as possible from the bran, the miller could obtain the greatest yield of flour, but the process would darken its colour. On the other hand, if the miller wished to produce the whitest flour, its yield would drop. The miller therefore had to balance these two factors to achieve the greatest gain from any given variety.

Some varieties of wheat produced both high yield and good colour when milled and so were said to be high-quality milling wheats. The flour yield was determined by testing during milling and was given as a percentage of the wheat milled, while flour colour was defined by a description or by a point scale. Colour was important to consumers, who demanded white bread. In general, the best flour had to be as white as possible, somewhat similar to the colour of cream.

Baking Quality

The baking quality of a flour is defined by the elasticity (strength) of the gluten, the volume and crust of

the loaf, and the quantity of water absorbed. The volume of the loaf and the strength of the gluten may be considered together, as loaf volume depends on the elasticity of the wet gluten in the dough. The yeast acts on the starch and produces carbon dioxide (CO_2) and alcohol. The dough mass fills with CO_2, the volume of the dough increases, and the dough rises. If the dough is not subjected to the baking temperature, the elasticity of the walls around the gas-filled spaces reaches its limit, the walls break, the gases are released, and the dough contracts and returns to its original volume.

During the bread-making process, however, the dough is placed into an oven before it reaches its greatest volume. At this point the walls of the gas-filled spaces begin to harden as the gluten stiffens, the yeast organisms die and gas production ceases. The gluten in the flour gives the walls of the spaces their elasticity, which keeps the accumulated gases from escaping. Obviously, the capacity of the membrane depends on the elasticity of the gluten. This capacity is usually determined by means of a baking test, which allows the membrane to expand while retaining its form, and by the uniformity of the membrane. The size of the baked loaf is a very important assessment factor: its quality is more difficult to define than its volume, however, because the important features here are the distribution of the spaces and the thickness of their walls (Figure 4).

During the mixing of the dough for baking, water is added to the flour until the dough becomes fully formed. The amount of water absorbed by the dough ball depends on the quality of the flour. The water-absorbing capacity is a very important factor for the baker because the greater the capacity to absorb water, the more bread can be baked from a barrel of flour. The weight of a loaf after baking is also very important to the baker: it defines the water-holding capacity of the flour, which defines the productivity of the bread.

Wheat and Flour Quality

The best definition of these terms is found in *Quality in Wheat* by Charles Saunders: "In analyzing the quality of wheat, one must understand this from two points of view, the miller's and the baker's. These two frequently confuse the terms 'milling quality' with 'baking quality.' The miller wants above all to obtain a high yield of flour, while the baker requires a flour with the appearance and strength for his particular purpose. Wheat of excellent quality, therefore, when milled, may produce flour that is utterly inedible, while a poor sample of some shrivelled wheat may produce a small yield of flour with excellent baking qualities.

"In speaking of flour, the terms 'quality' and 'strength' are frequently used as if they have the same meaning, which is not true. The term 'strength' has a very clear definition, although other meanings sometimes are added to this term. 'Quality'clearly defines its suitability for the intended purpose. A flour of high quality for pastries is a flour of low strength, while a flour of high quality for the production of very white bread or for mixing to improve the strength of a weak flour must be of high strength." (18, pp. 7-8)

The influence of the environment — climate, especially the amount of rainfall during the last phases of plant development, elevation, soil composition, manuring — on the chemical composition of the wheat kernel cannot be denied. The great producer countries of strong wheats with a rich protein content (Central and Western Canada, the Great Plains in the United States, Argentina, and Australia) are countries with a summer season that is warm and dry. Soft varieties, on the other hand, that have a high yield but are poor in protein (gluten), thrive in the countries of Western and Central Europe, Scandinavia, England, Holland, Belgium, Germany, and the greater part of France, where there is a marine climate that is humid and variable. But high protein (gluten) content in wheat is a varietal characteristic, specific and hereditary, which is only partly dependent on environment.

The wheats of Ukraine have the best qualities for both baking and milling. The quality of their gluten and thus their bread-baking value is clearly a specific, varietal, and hereditary characteristic. This has been established by W. and C. Saunders (20, 18 items) in Canada, F. B. Guthrie (21, 12 items) in Australia, and S. Ochnelle (22, 43 items, n/a) in Germany, among others.

The bread-baking value of the American varieties of Halychanka (Red Fife and White Fife) wheat has in no way degenerated over the course of 15 years of cultivation in England. E. Schribeax made the same observation about the Manitoba and Marquis varieties (23, 10 items) which were introduced into France during World War I.

Numerous tests in various countries have demonstrated the specific characteristics of "bread-baking value." It is therefore possible to create, through breeding, varieties with good bread-baking qualities even in climates that are not very favourable. For example, the Svea 2 (Sea II) variety, which has very good milling and baking qualities, was created at the Svalov experimental station. I believe that through the laws of heredity, Ukrainian wheats have passed on their excellence to all the best varieties throughout the world.

This is supported by V. Lathouvers (in the second volume of his *L'Amelioration du Froment* [24, p. 82], which is based on the work of J. H. Schollenberg and J. A. Clark). He writes:

"Among the best American varieties for bread-baking, both authors cite:

T. vulgare, winter wheat - red grain, hard: Turkey, Kharkiv, Kenred; in Minnesota: Minturkey.

Triticum vulgare - red grain, hard: Marquis, Red Fife; in rust-infested regions: KOTA.

T. durum - Kubanka (in Minnesota).

Mindum - in rust-infested regions: Monad Akme.

T. vulgare - winter wheat, red grain, soft: Red Rock Minhardy, Odessa.

T. vulgare - white grain: Bobs, White Federation."

All of these Ukrainian varieties have been crossed into the North American varieties.

World Wheat Quality

The professional literature in the early years of the century includes numerous studies to determine flour and bread-baking quality and the value of different varieties. Wheat quality analysis had grown into a very large field of research. Factors studied included climate, the composition of soils at the time of sowing, time of harvesting and degree of ripening. The results of this type of research showed that Ukrainian wheats and the hybrids derived from them exhibited the most desirable characteristics. A number of examples follow.

Manley Champlin and C. H. Goulding (25, p. 287): "Red Fife wheat was tested along with Marquis, over a period of eight years. In two cases, in 1914 (Table 2) and in 1917 (Table 5), it scored somewhat better than Marquis but in no case was this difference significant." Ball and Clark (26): "Numerous tests present milling findings that Marquis is equivalent to or superior to samples of Red Fife and 'Bluestem' wheat." Similar results were published by Saunders (n/a, p.) in North Dakota and A.C. Arny and C.H. Bailey in Minnesota. (27) In Winnipeg F. J. Birchard wrote: "These tests (1915 and 1916 harvests) were not able to establish any significant difference between Marquis and Red Fife wheat in terms of their milling and baking quality."(28, 2 items)

The work of Champlin and Goulding (25) in particular showed that Galician wheat had the best milling and baking qualities. Their tests analyzed six groups of spring wheats.

One group consisted of the Marquis, Red Fife, Kitchener, and Red Bobs varieties. Their genealogy shows that all four originate from Halychanka (Red Fife), with only Kitchener and Marquis of hybrid origin. Test comparisons of these four varieties showed that all of them were of the same quality, with very insignificant deviations.

A second group included White Bobs, White Fife, and Tailor's Wonder. These varieties represent a group of white wheats which are generally considered soft. In most cases, the white colour of the wheat is due to the fact that they do not have the red pigment in the bran, but this pigment has no relation to the internal composition of the grain. The white grain is generally soft and has a starchy structure which also gives it an opaque quality. There is less gluten in a white wheat and therefore its quality and price are lower. Even though the White Bobs and White Fife varieties were white, however, they had all the other characteristics of the red wheats: for example, they were more vitreous and were considered to be hard wheats. One minor difference was that White Fife had a somewhat rougher glume. Tests on these two varieties showed that white wheats were not all soft and that both varieties belonged with the high-quality hard red wheats.

In conclusion the authors wrote: “White Fife was tested over a period of six years (1914-1919) and proved itself equal to Red Fife. Indeed over the last three years its qualities were superior.”(29, p. 290) This study affirms the great stability of the hereditary bank and high genetic value of the Halychanka (Red Fife) variety.

The wheat that grew in Canada’s Prairie provinces was predominantly hard red spring wheat with a high protein content — which was the reason it was in high demand on world markets. The average protein content in Canadian wheat was about 13.6%, although in some localities it could be as high as 20%, while the world average was only about 10%. The quality of its Ukrainian ancestors also gave Canadian wheat a high water absorption capacity. Its flour produced dough with excellent kneading qualities, suitable for great variations in fermentation and large substantial loaves of bread with an excellent crust.

Canadian flour produced excellent bread even when mixed with poor-quality flour. This allowed countries with similar but poorer-quality wheats to make their domestic flour go further and improve their bread. Thus Britain would buy flour from the whole world and its millers would mix it into the British flour to make it suitable for domestic baking and everyday use. Canada’s task was to maintain a consistently high wheat quality standard, as more than 75% of our wheat was exported overseas.

The U.S. Department of Agriculture has kept detailed information on the bread yield from different kinds of flour for many years. Their findings on the quantity of bread that could be baked from one 106-pound barrel of flour milled in various countries in 1956 are as follows (No. 256, p. 25):

	Weight of bread in pounds
Canada	293
United States	289
Russia	289
Australia	286
Argentina	285
England	285
Italy	285
Germany	283

A British committee investigating the quality of baking different types of wheat placed them in this order:

	Points
I Northern Canadian Spring	100
U.S. No. 1 Northern Spring	100
U.S. No. 1 Red Winter	85
Russian “Girka”	85
Argentina	80
Indian White Select Karachi	75

Breeding High-Quality Wheat Varieties

From its earliest beginnings, wheat research at the Central Experimental Farm in Ottawa focused on the production of high-quality, early-maturing varieties. The greatest efforts were spent on combining the strengths of the Ukrainian Halychanka (Red Fife) with early-maturing varieties.

Throughout the whole program to improve existing varieties of wheat or produce new varieties through crossings, this wheat, with its rich hereditary genetics, stands out. The system for the selection of individual plants which had been practised before had not been very successful. From the very beginnings of the program there existed a desire to find certain methods that could demonstrate or estimate the grain quality of the selected plants. Such methods were unknown in the laboratories of the time. The Ukrainian farmer, however, has always had his own "laboratory" in his mouth, between his teeth. He knew how to give an approximate and sometimes even a very accurate assessment of the quality of any given wheat. He would take a small handful of spikes, rub them between the palms of his hands, blow away the dust and husks, and pop the grain into his mouth: a quick chew and a taste and he knew what the wheat was worth. This old method, tested and true, is probably as ancient as wheat.

We have noted already that it was also used by Charles Saunders. By merely chewing, he had been able to distinguish with considerable accuracy the qualities of wheat kernels from individual stalks in the crossings at the Central Experimental Farm. Indeed, he continued to use this "chewing method" for years before he acquired appropriate laboratory testing equipment.

The new laboratory was a great help in determining wheat quality. Its equipment could mill small samples of grain into flour, from which test breads could be baked. The future of Canada's wheat industry was forged there. The building housing the old Cereal Division now has heritage status because it was there that William Saunders, and later his sons, bred the world's best new wheat varieties. Their ancestor was the Ukrainian Halychanka, known as Red Fife in Canada.

Charles Saunders's notes and commentary affirm this variety as the best: it was the wheat against which he measured all the new hybrids. For example, in the following passage from his bulky personal notebook he writes: "[the new hybrid] Markham is not to be kept at all, unless it is *earlier* or *stronger* than Red Fife." (p. 72, January 1905) In his 1907 report he describes the prerequisites for wheat research: "This requires a certain amount of patience and a fairly good set of teeth. These two attributes may be considered as essential to all wheat breeders." (Bulletin 57, p. 9)

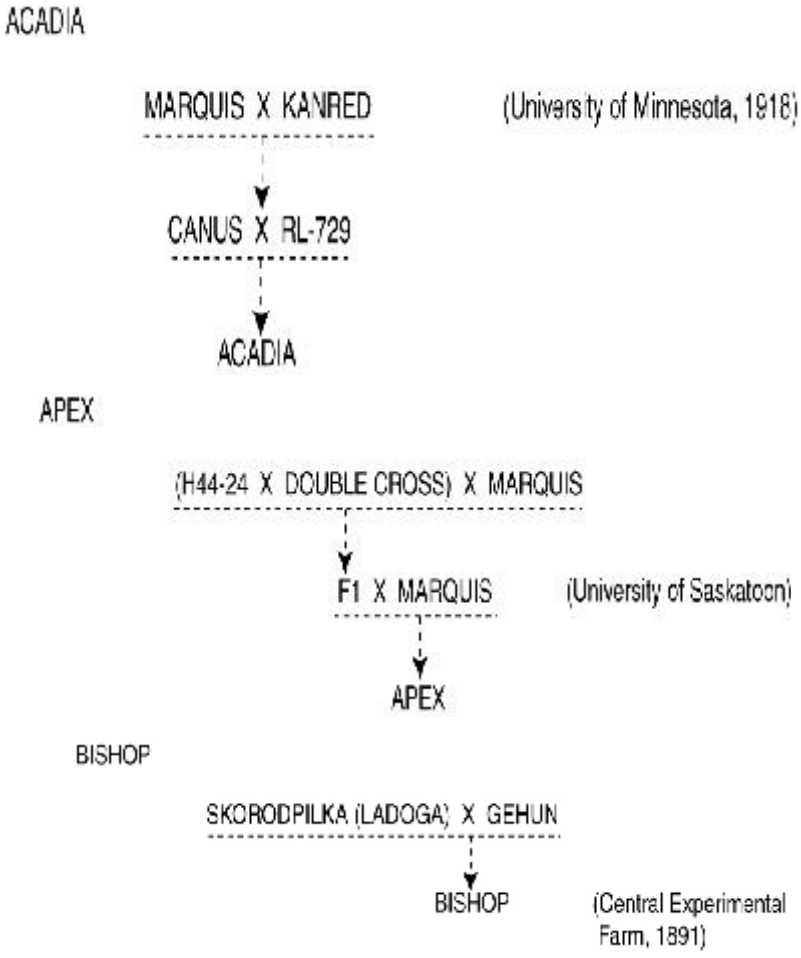
The Ottawa notebook sheds light on the early history of the wheat industry in Canada. Ottawa is also where the great "Registration Book" listing all the wheat crossings made with the Halychanka (Red Fife) variety is kept. Figure 5 shows the first few pages of both Saunders's notebook and the

Registration Book, which have not been published before.

Further Development of Wheat Varieties in Canada

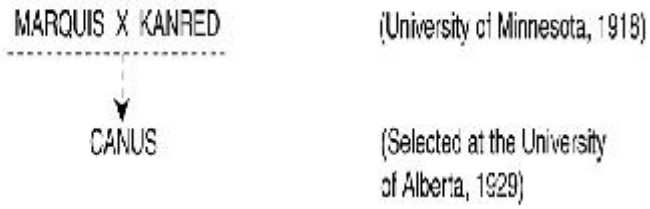
Ever-increasing numbers of immigrants flocked to Canada. Our economy and agriculture expanded. An increasing number of ploughs furrowed wide fields in the new land, which farmers sowed with the golden grain of Ukrainian wheat. The Canadian climate is not uniform however: its variations created differing needs that required different varieties of wheat. These were being created in large numbers at experimental farms from Ottawa to Vancouver.

What follows is the genealogy of these new varieties, all of them quickened by the genetic blood of Halychanka (Red Fife) wheat.

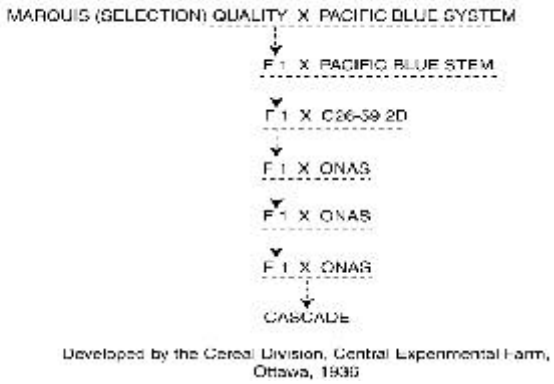


Bishop had been researched extensively since 1904 with very good results, especially in the Far North. It was not registered as a commercial variety because its grain was white.

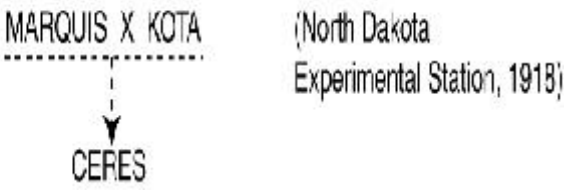
CANUS



CASCADE



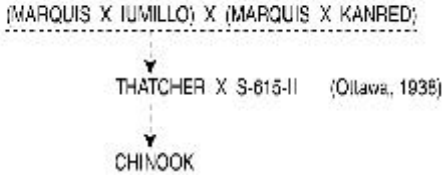
CERES



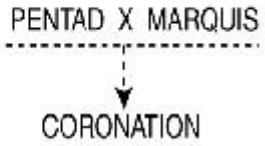
Ceres was introduced into Canada for research at the Experimental Farm in Brandon, Manitoba, in 1924. It was licensed in 1928.

It was a high-quality, Marquis-level variety which became popular very quickly among the farmers of Manitoba until 1935, when it was attacked by a severe rust disease and replaced by more rust-resistant varieties.

CHINOOK



CORONATION



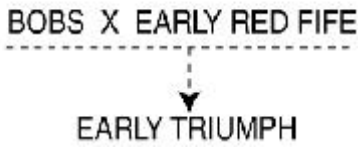
(From a cross at the Dominion Laboratory of Cereal Breeding, Winnipeg)

A selection made by the, Cereal Division, Ottawa
Registered in 1943

Early RED FIFE

Selection from Red Fife (made at the Cereal Division, Ottawa, 1903)

EARLY TRIUMPH



Early Triumph matures three days earlier than Halychanka (Red Fife).

GARNET

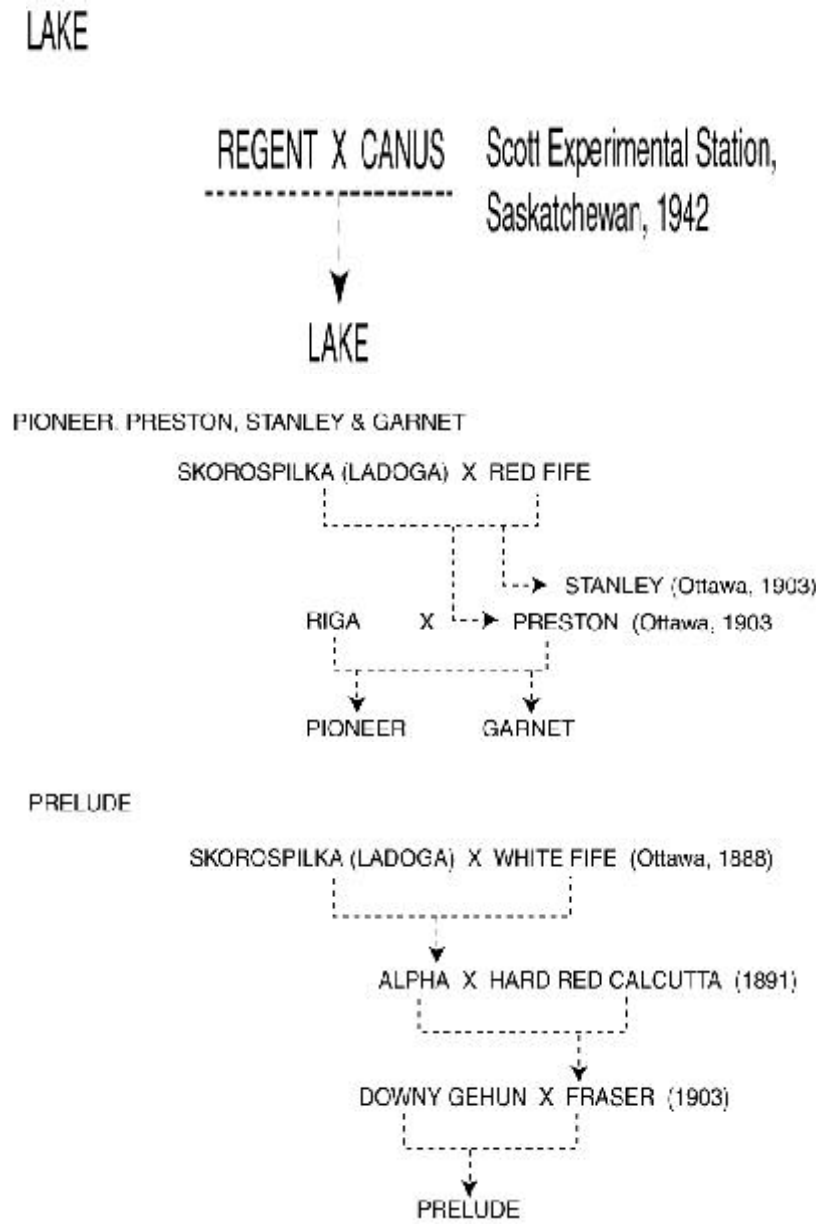
GARNET

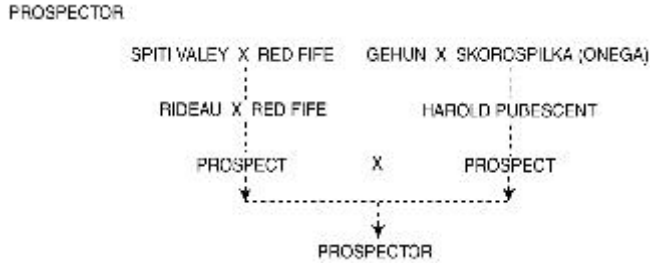
(From a cross by C.E. Saunders Central Experimental Farm, Ottawa, 1905).

HURON & PERCY

KITCHENER

Selection from Marquis made by Seager Wheeler in Rosthern, Saskatchewan, 1911.



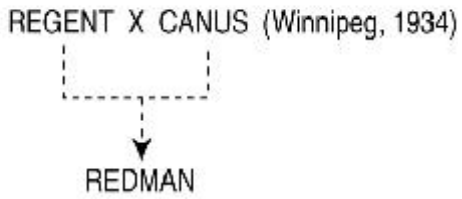


This hybrid (Prospector) initially was known as Ottawa 444.

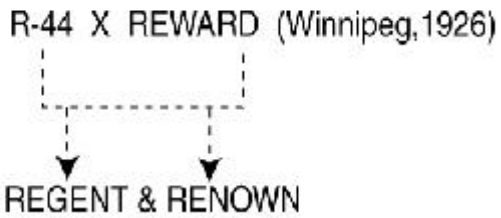
Spike, awnless; grain red, medium hard; straw not very strong. Baking quality and colour of flour very good (30, p. 8-9).

There are some inconsistencies in the literature on the origin of the Renfrew variety. *The Handbook of Canadian Cereal Varieties* states that this is a selection from Marquis. Another writer disagrees (31, p. 10): "The history of the Renfrew variety is not known definitively, but is believed to originate from a crossing between Marquis and Red Fife."

REDMAN



REGENT & RENOWN



The first (Regent) was still grown in Manitoba in 1953 (11%), the second (Renown) in 1950 (3%).

RELIANCE

KANRED X MARQUIS

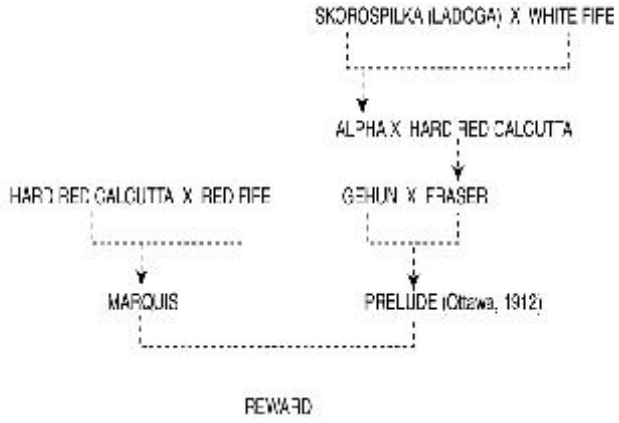
↓

RELIANCE

Registered in Canada in 1932. Several thousand acres under cultivation near Alberta-Saskatchewan border

From a cross made by the United States Department of Agriculture in co-operation with Oregon, California, Montana, North Dakota and Minnesota Experimental Stations, 1917

REWARD



(30, p. 9)

SELKIRK

(McMURACHY X EXCHANGE) X REDMAN[3] (Winnipeg, 1939)

↓

SELKIRK

SAUNDERS

C-26-447 X THATCHER[7] (Ottawa, 1938)

↓

SAUNDERS

TYPE Io (Red Fife H)

This was a selection from Red Fife made at the Central Experimental Farm. It has the same milling and baking qualities as Marquis, although it matures somewhat later.

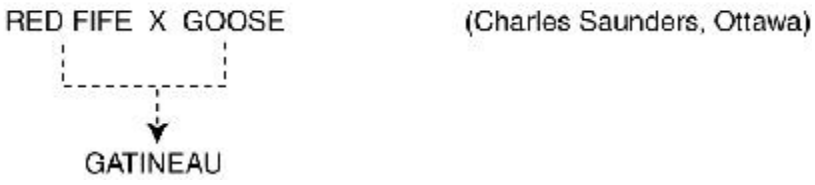
WHITE FIFE

White Fife was a selection from Red Fife made at the Central Experimental Farm in 1903.

WHITE RUSSIAN

White Russian was a selection from Red Fife made at the Central Experimental Farm in 1889. It was grown at Indian Head in 1889. It differs from Red Fife mainly in that its straw is longer and its spike denser. This variety is also known under other names, such as Wellman Fife, and is perhaps the most noted. (8, p. 95) It is very rarely grown on the Prairies but is more common in New Brunswick, Nova Scotia, and Prince Edward Island.

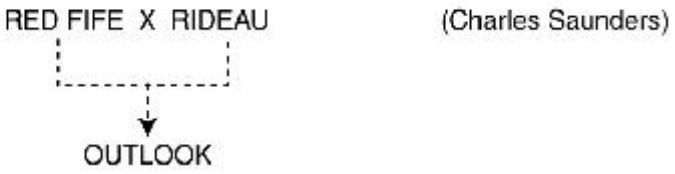
GATINEAU



There is considerable doubt about the origin of this variety. It is not distinctly defined in the literature. For example, in Clark (8, p. 188) the Goose variety is said to be the same as the Ukrainian Arnautka wheat, while on page 198 it is said to be Polish wheat (*Triticum polonicum*).

Both of these varieties belong to the "durum" group of wheats, which have 28 chromosomes. The Red Fife variety, however, belongs to a group that has 42 chromosomes. It is not clear which variety was used here as the varietal parent. Moreover, crossings of two different chromosomal groups are fairly complicated. There are no analytical reports on this hybrid. A brief description of the Gatineau variety notes that: "It combines numerous good qualities of both parents; although not an early variety, it may show itself to be of value in a dry region where the season is quite long." (32, p. 29)

OUTLOOK



WHITE FIFE C

This selection differs very slightly from the White Fife variety. By all accounts it is practically identical to Red Fife, except for the yellow colour of its bran.

There are other Ukrainian wheats that have made a large contribution to the development of Canada's agriculture and economy. These include hard wheat *(Triticum durum)* and winter wheat.

Hard Wheat (*Triticum durum*)

This wheat belongs to the spring wheat group. It is tetraploid, with 28 chromosomes in its cell nucleus. Durum grows best in regions with a warm and dry climate, is particularly resistant to drought and very resistant to rusts and smuts (loose smut). Its grain is very hard (hence the name), almost transparent-amber, and either white or red in colour, depending on the variety. Because of its high gluten content, its flour is used for making various kinds of dough, mainly pastas, so that it is commonly known as macaroni wheat. Its grain is the hardest of all the wheats, always has a very short beard (or awn), and is elongated in shape, like rice. It has became important only in recent years (1960s).

Hard wheat requires hot, dry weather during maturation. In damp regions or when it matures in damp weather, its leaves are attacked by various fungal diseases, while the grain accumulates too much starch and its quality deteriorates significantly. Pastas, semolinas, and various kinds of cereals are made from hard wheat. Some varieties are suitable for baking bread; others are not.

The climate of southern Ukraine is excellent for the cultivation of hard wheat. In Western Europe, hard wheat from Ukraine has always commanded the highest price. All the commercial varieties of this wheat have an awned, very dense spike.

Ukrainian Hard Wheat Varieties in Canada

In 1907 the Dominion Cerealist's Report had presented the results (pp. 220-221) of hard wheat experiments in Ottawa involving a number of Ukrainian varieties: Biloturka, Kubanka (number 5639), Goose, Harnivka, and Yellow Harnivka. Of these Charles Saunders wrote: "For many reasons, it appears that Biloturka and Kubanka (number 5639) are in fact the same variety. The bread made from Kubanka and Biloturka flour was excellent quality, bright, yellowish in colour. The bread made from the other varieties was of a decidedly lower quality, although the Goose and Harnivka products were of the same poor quality."

In his 1908 report he wrote: "The most promising varieties of spring (macaroni-class) wheat were milled and baked to test their bread-making qualities...the strongest wheats from these three groups are about equal in strength: for example, Kubanka, Red Fife, and Turkey Red. Similarly, the weakest have

about the same level of weakness. Each class has varieties at all levels of flour strength."

In the 1909 report (p. 211) he reiterated that the Kubanka and Biloturka varieties were identical and suitable for making pastas, semolinas, and cereals, as well as excellent bread of a rich yellow colour.

Another publication provides information on the origin of hard wheats on the North American continent: "Kubanka and Pelissier are direct introductions from Ukraine." (33, p. 294) The authors do not shed light on the route these wheats took to get to the new continent. They were likely brought over by Ukrainian peasant immigrants, as well as Mennonites, who first settled in the United States where they cultivated them. From there the wheats would have made their way into Canada.

Kubanka variety, Ottawa 37 is a pure line, a selection from Kubanka, that came here from the United States (Washington, No. 5639).

A study on the Kubanka variety describes its agricultural characteristics in detail. Kubanka holds a very important place in southern Saskatchewan. Its suitability for dry soils and a dry climate has been demonstrated in both the United States and Canada. Its strongly developed awns and very strong root system easily withstand extreme heat. It is also very resistant to rusts. Kubanka is excellent for pastas and semolinas as well as puffing and various kinds of pastries. It has the best milling qualities of all the durum wheats. (34, pp. 1-7)

Winter Wheat

Canada grows less winter wheat than spring wheat. The first commercial harvest of hard winter wheat in Canada was in 1902. It was grown on the Spring Coulee, Alberta farm of E. E. Thompson, who imported a whole carload of the Turkey Red (originally from southern Ukraine) and Nebraska varieties. Thompson's grain was widely propagated for seed. More than four million bu of hard red winter wheat were produced in Alberta in 1908; all of it originated from that carload.

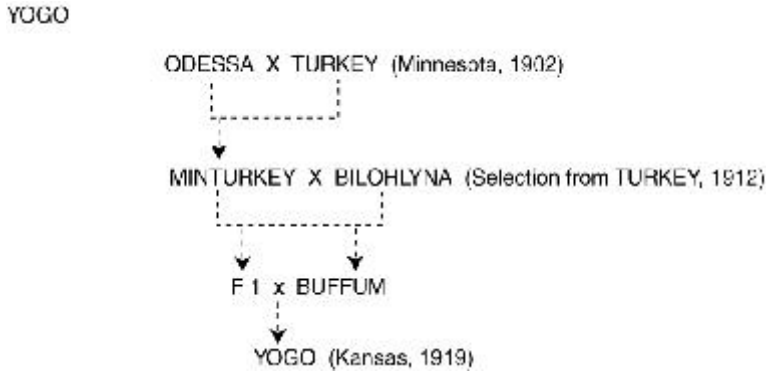
In 1907 the Lethbridge Experimental Farm, which had been set up for research on winter wheat, brought in several bushels of each of several leading varieties of winter wheat from the Kansas State College of Agriculture. One was called Kharkiv. It proved to be very suitable and became the most important variety in the district. The area sown with winter wheat expanded very quickly. By 1911 more than 300,000 acres had been sown with this wheat. Southern Alberta was the most important winter wheat growing area in the Prairie provinces. The best yields were produced in the southwestern corner of the province, from the foothills of the Rocky Mountains to about 40 miles east of Lethbridge and from the Montana border to about 60 miles north of Lethbridge. The high precipitation and snow cover in the western parts of this area provide more shelter and protection for the winter wheat, and perhaps allow it to be more successful than in the eastern parts.

In Bulletin No. 180 (p. 2) of the Department of Agriculture the authors note the origin of Red Turkey

winter wheat: it was a Ukrainian wheat which had been grown in the Crimea and therefore was called Krymka. It belonged to the group of Crimean hard winter wheats or Krymki [Ukr. pl. of Krymka]. As the cultivation of Krymka winter wheat increased in Canada over time, this Ukrainian wheat received various new names: Alberta Red, Winter, and Turkey Red.

The wheats known by these names were identical to the Ukrainian wheat variety known by the name of Kharkiv. Kharkiv wheat was introduced to the United States from the city of Kharkiv on two separate occasions in 1900 in the hope that this variety would be more resistant to frost. In Bulletin No. 180 (pp. 3-4) this same variety of Ukrainian wheat is presented as Turkey Red, like the one introduced into the United States from Kharkiv in 1900 and sent from Kansas State College to Lethbridge in 1907. The Kharkiv variety is therefore the most widely cultivated one in Alberta. For many years it has been Canada's most frost-resistant variety.

The first annual report of the Lethbridge Experimental Farm indicates that Odessa, a Ukrainian variety of soft winter wheat, also grew there and had been grown in the Cardston and Pincher Creek districts for at least 20 years before 1907. Winter wheat cultivation grew steadily until 1913 when the great blight of root rot first made its appearance.



This variety received a Canadian licence in 1948 as Yogo K.A.N. 2502.

Yogo was created at the experimental farm in Manhattan, Kansas. At first it was grown on farms in Montana in the autumn of 1932; five years later it was introduced into Alberta where it is grown fairly widely. This wheat is the main variety in southeastern Saskatchewan.

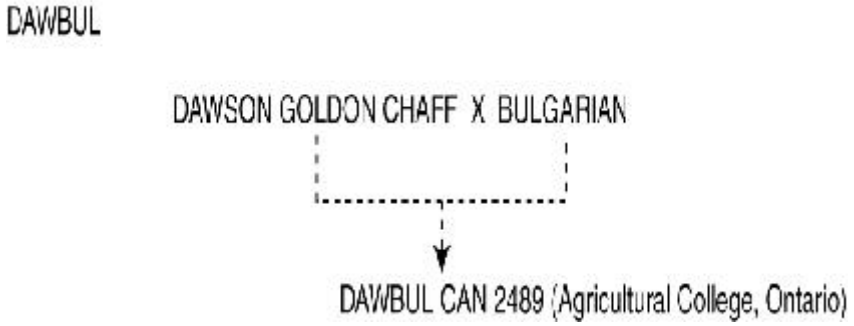
Yogo is strongly resistant to numerous varieties of stinking smut and very resistant to frost. It also mills very well and produces a large amount of very high-quality flour of a cream colour. It is very easily differentiated from Turkey Red by its sparse spikelets and its new shape.

This very productive wheat is derived entirely from Ukrainian wheat (see chart), although over the course of its cultivation on this continent, American names were given to the derived selections and their

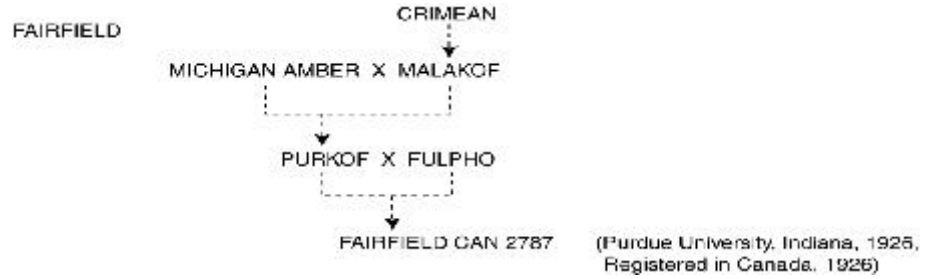
hybrids.

This variety is a twin of the Minturkey variety because it originates from the same parents, although it is from a different selection. After a crossing of the two Ukrainian wheats, one selection had the technical number Min. No. 1505, which in 1920 was named Minhardi. The other selection, Min. No. 1507, had already been named Minturkey in 1919. The Minhardi variety is the most frost-resistant of all the wheats grown in the continental United States.

A 1945 report states that 20 different varieties of winter wheat were sown at seven experimental stations affiliated with the Lethbridge Experimental Farm. At the Whitla, Foremost, Pincher Creek, and Claresholm stations, at least 90% of all the varieties survived. In Craigmyle and Drumheller 100% of two lines of the Kharkiv variety survived, as did 90% of the Yogo and Minhardi; the rest survived at rates ranging from 0 to 90%. In the tests carried out in Acadia Valley, all of the varieties were completely destroyed by frost.



There are no data on the origin of the Dawson Golden Chaff variety. I suspect that it too may be a Ukrainian variety whose origin and true name have been lost. The parent known as Bulgarian is the Crimean winter wheat variety which was brought in from Ukraine.



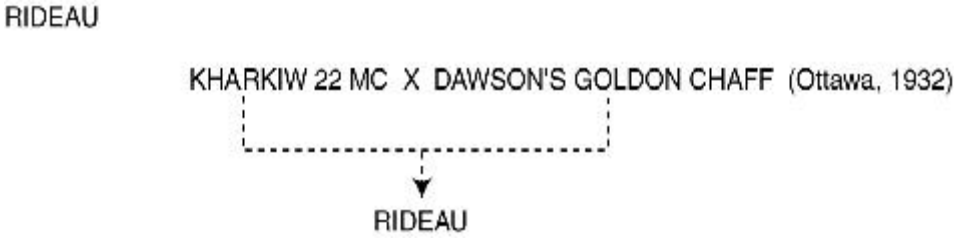
Fairfield grows in the southwestern parts of Ontario. One of its parents is Malakof, a selection from the Ukrainian Krymka variety.

Fulhio is a selection from the Fultz variety, which is a selection from the Lancaster variety. Lancaster is identical with the very widespread Mediterranean variety, which originated in Ukraine. These name changes have created a great deal of confusion. I believe that they were in fact of Ukrainian origin because of their high quality.

O.A.S. Variety 104 CAN 2392

According to Department of Agriculture publications, this variety has the same unknown origins as the Dawbul variety. However, there are differences in the description and morphology of the spike: the O.A.S. variety has a white raceme and its spike as it appears in the photograph has a sharply pointed tip.

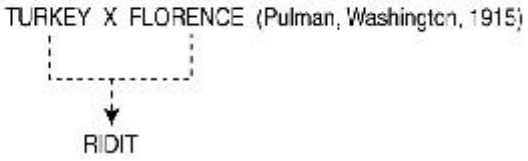
Kharkiv M. S. 22 is a leading variety of hard red winter wheat from southern Alberta. (35, p. 114)



This variety is decidedly more resistant to cold than Dawson. It has grown in eastern Ontario since1941.

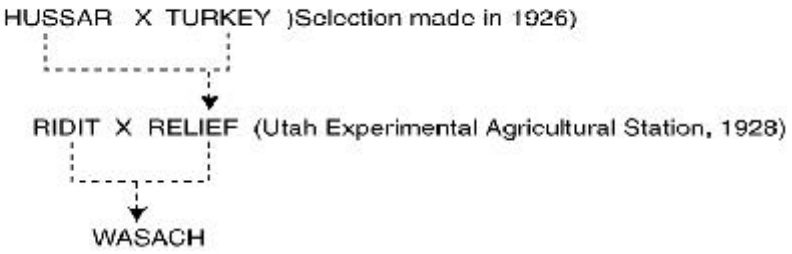
The RIDIT CAN 2404 variety originates from the following crossing:

RIDIT



It was licensed in Canada in 1938 and is grown in British Columbia's Okanagan Valley.

WASACH



This variety is resistant to dwarf bunt. Designated for the North Okanagan region in British Columbia, it is a type of hard red winter wheat.

Crossings of Winter Wheat

Winter wheats in Canada have not undergone as extensive a development of new varieties as the spring wheats. In the annual reports, records of winter wheat crossings at the Central Experimental Farm are rare and they scarcely figure at all in the Prairie experimental farm annual reports. Thus it appears that Canada was completely satisfied with the old Ukrainian varieties and at some point introduced varieties from the United States. These were Ukrainian hybrids bred at experimental stations in the United States where they were produced to meet the broader American climatic needs as well as the professional interests of U.S. breeders.

Yield Comparisons between Winter and Spring Wheats

The yields of winter and spring wheats depend in large measure on the time when the rains fall in the spring and early summer. The most critical droughts occur late in June and at the beginning of July. Winter wheats grow more rapidly than spring wheats during the drought periods. Because of this they suffer less damage and produce a somewhat higher average yield over many years.

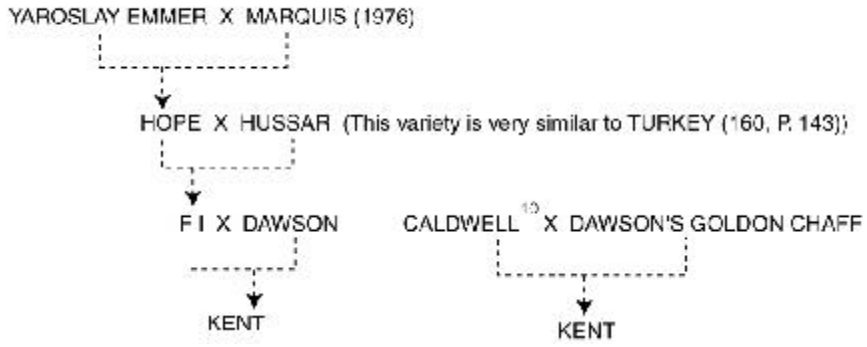
At the Lethbridge Experimental Farm, over a period of 18 years (1929-1946 inclusive), Kharkiv winter wheat yielded an average of 19.7 bu/acre, as opposed to 18.1 bu/acre from Marquis spring wheat (Bulletin No. 180. p. 11).

The yields of different winter wheats grown in southern Alberta show very little difference. Yield tests carried out on the dry fields at the Lethbridge Experimental Farm over a period of six years (1940-1946) produced the following average yields from four widely propagated varieties:

Kharkiv M.C. 22	35.3 bu/acre
Kharkiv (a line from Lethbridge)	35.0 ” “
Yogo	35.0 ” “
Jones Fife	33.6 ” “

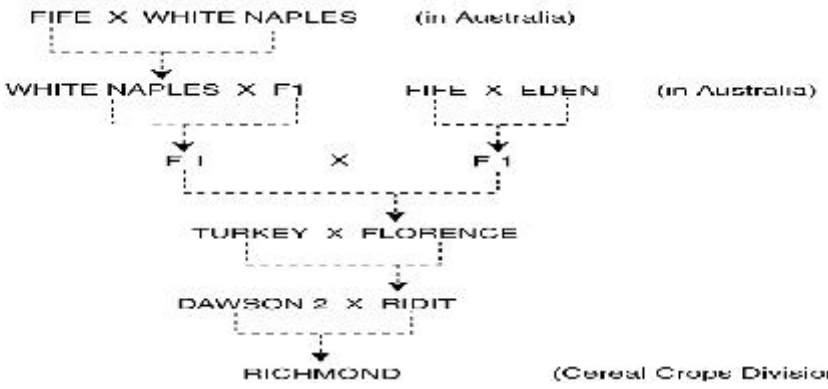
(Bulletin No.180, p. 11)

KENT



No. 295, grown at the Ministry of Agriculture, Ontario, Canada

RICHMOND



Richmond is superior to the three main varieties (Genessee, Dawbul, and Cornell 595) in its resistance to cold and produces a fair quality of soft wheat flour. It has a high yield and, although susceptible to loose smut, is resistant to stinking smut.

The Kent variety possesses hereditary attributes of the Ukrainian spring wheat Halychanka and of Ukrainian winter wheat from the eastern parts of Ukraine. Thus it combines two very distant geographic areas of Ukraine as well as characteristics of both winter and spring wheats. Kent was the last winter

wheat released for cultivation and is described in the 1958 Bulletin No. 295 a.

Growing winter wheat was a risky proposition in Western Canada because of the danger of frost — in late autumn before the first snowfall, during the winter if the snow cover had been blown away, or worst of all in springtime after the snow had melted and the plant had already sprouted. For this reason winter wheats were grown in very small quantities in a few regions by very few growers. (7, p. 42) It is perhaps unfortunate that breeders did not take advantage of Canada's harsh climate to develop the world's most frost-resistant winter wheat. Winter wheat has always been less important in Canada, however, because our spring varieties produce adequate wheat harvests.

Frost and rust are the two main enemies of wheat. Each can destroy the entire crop or seriously damage both its milling and baking qualities. Rust was more common in the damper climates of Manitoba and eastern Saskatchewan while frost was prevalent in the more northerly districts. To minimize these dangers, which often damaged the crop near the end of the growing season, it was necessary to select early-maturing varieties. Up till then only two varieties — Red Fife and Marquis — met these requirements in combination with high yields and excellent quality. Numerous other varieties were tested, some with great success, but none with the quality of the Halychanka (Red Fife) or its descendant Marquis.

How New Varieties Were Bred

Breeders at the Central Experimental Farm procured samples of many different wheat varieties from around the world. It is instructive to look at the program of crossings as a whole in the Reports of the Dominion Cerealist to see which varieties were selected to breed the new varieties that would meet the new agricultural requirements.

For example, the report for 1926 lists the following crossings (p. 4):

REWARD	X	QUALITY	BARLETTA	X	MARQUIS	
428 B	X	REWARD	CERES	X	MARQUIS	
GARNET	X	REWARD	MARKILLO	X	EARLY RED FIFE	
GARNET	X	482 B	AURORE	X	MARQUIS	
GARNET	X	AURORE	SUPREME	X	REWARD	
SUPREME	X	GARNET	CERES	X	GARNET	
SUPREME	X	QUALITY A	BARLETTA	X	SUPREME	
GARNET	X	EARLY RED FIFE	MARKILLO	X	REWARD	
GARNET	X	RENFREW	CERES	X	RENFREW	

All of the above 18 crossings clearly originate from Halychanka (Red Fife) wheat. Various combinations were made to select the best possible characteristics for future varieties of wheat. This persistent use of Ukrainian-sourced varieties for crossings again highlights their value.

The Garnet variety plays a key role seven times in these combinations. It matures five days earlier than Marquis, depending on the locality, and is especially suitable for regions where early frosts do not permit cultivation of either Marquis or Red Fife.

In the report for 1927 we see the following table:

Promising Crossings Presently Being Tested

CERES	X	REWARD	MARKILLO	X	928002-35
CERES	X	928002-35	MARQUIS	X	GARNET
CERES	X	929 B	MARQUIS	X	929 B
GARNET	X	928002-35	SUPREME	X	REWARD
GARNET	X	929 B	SUPREME	X	928002-35
HARD FEDERATION	X	REWARD	SUPREME	X	929 B
HARD FEDERATION	X	928002-35			

The above crossings were made to obtain a wheat variety with a high yield, good bread-baking quality, and a high resistance to various plant diseases.

Here are the crossings reported in 1928 (p. 6):

EARLY TRIUMPH	X	REWARD	MARQUIS	X	GARNET
HOPE	X	EARLY TRIUMPH	MARQUIS	X	REWARD
HOPE	X	REWARD	HARD FEDERATION	X	928002-35
CERES	X	REWARD	HARD FEDERATION	X	REWARD
CERES	X	928002-35	SUPREME	X	REWARD
GARNET	X	REWARD	27-1556	X	MARKILLO
26-1542	X	REWARD	MARKILLO - 26-15	X	928002-35
Winter Wheat					
KHARKIV Mc22	X	DAWSON'S GOLDEN CHAFF			
KANRED	X	DAWSON'S GOLDEN CHAFF			

I believe the spring wheat varieties in all three reports are simply Ukrainian wheats with non-Ukrainian names. Their hereditary characteristics combine high yields with excellent milling and bread-baking qualities.

Other varieties that deserve mention include the generation produced by crossings between Marquis and Garnet, and also other crossings between Reward and Garnet.

The 1929 report lists more crossings (reciprocal crossings were also made) on p. 12:

EARLY TRIUMPH X REWARD HOPE X REWARD
HOPE X 928 Z REWARD X 928 Z
REWARD X 928 Z EARLY TRIUMPH X 928 Z
HOPE X EARLY TRIUMPH SUPREME X 928 Z

Further on we read: "A broad number of selections from the crossings made in 1924 are being grown in field trials. Among them are several combinations from the Marquis X Garnet crossing, which display the desired combination of the early maturity of Garnet and certain attributes of Marquis. Some of the attributes of these selections and the question of which ones to choose, as well as how and where they should be grown commercially, are being studied at our experimental farms in Scott and Rosthern, Saskatchewan. The information on some lines there is very gratifying and promising."

Another group of selections showing considerable promise originated from the following crossings:

GARNET X MARQUIS - IUMILLO II-59
MARQUIS X MARQUIS - IUMILLO II-59
MARQUIS X IUMILLO II-59 X REWARD

Yet another group of promising selections was derived from the following crossings:

REWARD X GARNET 22-17482 B X REWARD
SUPREME X REWARD 482 B X GARNET
SUPREME X GARNET 22-17

The above list features some very interesting, early-maturing selections — mainly originating from 482 B, the earliest variety yet grown in Ottawa. It was derived from the following crossing made several years earlier:

YELLOW FIFE X POLTAVKA (ONEGA X GEHUN)

The parent known as 482 B is very valuable. I believe that it is in fact a local Ukrainian variety with a very early-maturing hereditary attribute, which the researcher attempted to transfer by means of crossings to a new hybrid to meet the needs of the Canadian climate.

The testing of the new wheat varieties that came from crossings with Halychanka (Red Fife) wheat became more and more extensive. In order to investigate the baking quality of the flour, a new laboratory with the most modern equipment was constructed in 1929. Some 600 samples of different wheat varieties were studied and analyzed there.

Additional comparative reviews and analyses of the Marquis, Garnet, and Reward varieties were obtained from Manitoba, Saskatchewan, and Alberta and were thoroughly studied. For example,

numerous new rust-resistant lines originated from the hybrid combinations below:

PENTAD X MARQUIS H-44-24 X MARQUIS
H-44-24 X REWARD DOUBLE CROSS X CERES

These were sent to the Dominion Rust Laboratory in Winnipeg to test their rust resistance. Some of these samples also had excellent bread-baking qualities.

A large number of selections from the following four crossings made in Brandon, Manitoba, were investigated at the same experimental farm. The first three combinations produced varieties that had excellent milling and bread-baking qualities.

CERES X REWARD 1656 X REWARD
REWARD X HOPE REWARD X MARQUILLO,

Evaluation of Varieties and Selections

The creation of new varieties of wheat or other grains is relatively easy, if done over an extended period of time. Verifying and establishing the agricultural value of a newly produced variety of grain, on the other hand, is fairly difficult. A new variety must be studied for a period of at least three years, in different local climates and on different soils. The technical procedures are also complex because they require suitable methods and skilled personnel. In general it takes several years and the exertion of highly developed powers of observation, curiosity, and persistence on the part of the investigator before the new variety is released for general cultivation. New problems might appear or new plants with valuable characteristics may be discovered and selected to parent new crossings.

Numerous tests have shown that the original Ukrainian wheats possess a valuable store of genetic material. Over many years of research in Canada these wheats, and the new hybrids derived from them, became the source material for the production of newer and better varieties of Canadian wheat. I believe that the success in breeding new varieties within the Experimental Farm system is based on the Halychanka (Red Fife) wheat, with its countless derived crossing generations. This is recognized, in passing, in the report for 1930-1933 (pp. 10-11):

... " the Red Fife variety of wheat, the standard variety of Canada, is very well known and requires more than a passing reference.

"In the search for the 'perfect' early-maturing wheats, crossings were made not only between GARNET X REWARD but also between REWARD X BOBS, REWARD X CERES, REWARD X SUPREME, MARQUIS X GARNET, CROWN X PRELUDE, etc. Several similar crossings as well as a number of selections raised from Reward are included in the research that will be carried out in 1934 at the Experimental Farms in Scott, Lacombe, and Beaverlodge."

In the report for 1934-1937 we read: “Many of the crossings reported in the preceding reports were investigated and rejected for various reasons but some, which met the desired requirements, were kept. From these the following, which have been shown as further generations, are being investigated:

EARLY RED FIFE	X	REWARD . . . . . for early maturation and yield — 3 lines;
MARQUIS	X	GARNET . . . . . for early maturation, yield, quality, and resistance to bunt — 2 lines;
482 B	X	REWARD . . . . . for extraordinary early maturity and quality — 9 lines;
REWARD	X	GARNET . . . . . for early maturity and quality of yield — lines; and
BOBS	X	PRELUDE . . . . . for early maturity and yield — 1 line.

“In addition to these, numerous crossings were made in the following years, including

PRELUDE	X	CANUS . . . . . for early maturity and yield;
REWARD	X	(GARNET X QUALITY) . . . . . for quality, yield, and early maturity;
REWARD	X	(ALASKA X REWARD) . . . . . for early maturity and quality; and
KANUS	X	REWARD . . . . . for yield and early maturity.”

The best of the early-maturing wheats were studied every year by the so-called “special early wheat group” in Ottawa; at Swift Current, Indian Head, Melfort, and Scott in Saskatchewan; at Lacombe and Beaverlodge in Alberta; and at the Experimental Farm in Vermilion at the Edmonton Agricultural School.

Soft Wheat Varieties

The Cereal Division in Ottawa established a research program to tackle a new problem area in the breeding of soft wheat for baking cakes and pastries. These varieties are low in protein (about 9 - 10%); the best have a soft grain, are starchy and principally white in colour. For the most part, the agronomic features of the typical soft varieties made them unsuitable for cultivation in the Canadian climate. After many long trials, however, a number of varieties with the desired characteristics were produced. These were used as parents for crossings with some of the best varieties. They are listed in the report for 1934-1937 (p. 23):

ONAS	X	QUALITY A
PACIFIC BLUESTEM	X	QUALITY A
QUALITY	X	PENNY
QUALITY	X	PILCROWN 4A
DAWSON’S GOLDEN CHAFF	X	QUALITY A
FLORENCE	X	QUALITY A
FORD	X	QUALITY A

To breed for resistance to rust in these soft wheats, one of the best Hope and Reward hybrids from

Brandon was utilized most prominently.

Rust-Resistant Varieties

Although the bulk of the spring wheat breeding program was concentrated at the Rust Laboratory in Winnipeg, some of the work was researched at the Experimental Farm in Ottawa in order to breed rust-resistant varieties for conditions in Eastern Canada. The following crossings were made for this purpose, as recorded in the report for 1934-1937 (p. 24):

CANUS	X	RL 729	CANUS	X	C-26-44.5
CANUS	X	C-26-59.2H	CANUS	X	19-975-D2

CANUS is a selection made at the University of Alberta in 1918 from a crossing of MARQUIS X KANRED.

Varieties Resistant to Stinking Smut, Drought, and the Hessian Fly

To breed resistance to stinking smut (it smells like rotten fish) or bunt, crossings were made with resistant varieties. For the first series of crossings, the Martin and Reward varieties were used. In this group (according to the report for 1934-1937) there were 17 lines in the trials. Most of them were as early maturing as Reward but were also resistant to bunt.

Another series of crossings featured seven lines that were very interesting in that they originated from crossings made in 1926 between Garnet and Reward. Not only were they resistant to bunt and as early-maturing as Reward, but in two cases they also had a higher yield.

Tests on numerous varieties and types of wheat over the course of many years have shown that some varieties can withstand drought better than others. These so-called “drought-resistant” types often surpassed others not only in yield but also in height. Straw height is a very important factor in Western Canada especially in dry years: the taller straw makes it possible to harvest with a combine harvester, which cuts the spikes above the often numerous weeds so that the grain is not choked with litter. The popularity of hard (durum) wheat in dry regions has contributed to the development of wheats with taller straw. A series of crossings to select such high-yield, drought-resistant varieties was done at the Experimental Farm in Ottawa in cooperation with the University of Alberta.

In some districts of Western Canada wheat cultivation has suffered a considerable amount of damage from the Hessian fly (*Mayetiola destructor*). Hard wheat is less affected by this pest than ordinary wheat. A program to breed a variety resistant to the Hessian fly was established at the Experimental Farm in Swift Current.

Hybrids Sent to the Experimental Farms

Some of the numerous crossings made at the Experimental Farm in Ottawa were sent out for further testing at the Experimental Farms in Morden, Manitoba; Swift Current, Saskatchewan; and others. Hybrids were made from crossings between the following varieties (report for 1934-1937, p. 25):

R.L. 729 X REWARD X REWARD
(RELIANCE X 21-1001 A 28-2 X 21-1001 A 28-2
CANUS X C-26 44.7
(RELIANCE X R.L. 729) X RELIANCE
R.L. 729 X RELIANCE
M.S. 9727 X R.L. 729
CANUS X REWARD

The drought of 1937 allowed the drought-resistant characteristics of the families and lines to be revealed on a very large scale.

To establish early-maturing varieties for different regions, the following crossings between early-maturing varieties were made:

Beaverlodge, Alberta

482 B X REWARDSUPREME X REWARD
SUPREME X 928002-35(428 B X GARNET) X REWARD
REWARD X EARLY TRIUMPH F8
REWARD X (QUALITY A X REWARD) F5
CANUS X 59.2H F3

Indian Head, Saskatchewan

(SUPREME X REWARD) X REWARD
EARLY TRIUMPH X 928Z F8
REWARD X (GARNET X QUALITY) F5
REWARD X (QUALITY X REWARD) F5
CANUS X 59.2H F3

Lennoxville,Quebec

CANUS X 59.2H F3
PRELUDE X CANUS F3
(RELIANCE X 21-1001 A 28-2) X 21-1001 A 28-2 F3

(RELIANCE X R.L. 729) X RELIANCE F5

Nappan, Nova Scotia

R.L. 729 X RELIANCE in F6
R.L. 729 X REWARD in F5

From the above names and numbers it is impossible to know what the varieties were or where they originated. Some varietal names are given and the genealogy has already been set out earlier: but it is the crossing numbers that are new here. The 1934-1937 report lists the genealogy of these numbered varieties at the end as follows:

R.L. 729 = MARQUIS X
M.S. 9727 = MARQUIS
CANUS = MARQUIS X KANRED
RELIANCE = MARQUIS X KANRED
21 - 1001 = REWARD X EARLY RED FIFE
C-26-59.2H = REWARD X HOPE
975 D = BOBS X PRELUDE
482 B = (SKOROSPILKA) (ONEGA - GEHUN) X YELLOW FIFE
928 L = MARQUIS X PRELUDE
R.L. 704 = H-44-24 X MARQUIS

The letters “R.L.” before the numbers identify the Rust Laboratory in Winnipeg.

To make record-keeping easier, breeders usually do not use the full name of the parents but label new crossings with a number. These numbers are a sort of key that every breeder records in a notebook. In the Canadian literature, these numbers have been recorded quite accurately so that they can be compared when necessary.

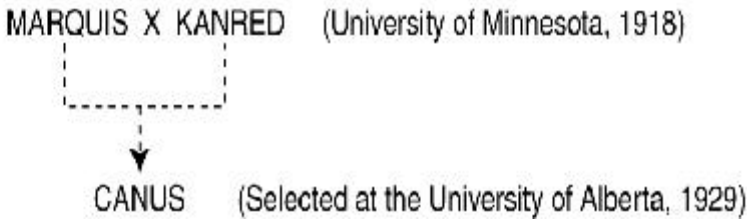
The reports and publications on the history of wheat breeding in Canada document thousands of different crossings from which thousands of very valuable selected plants have been raised. As noted above, the breeders were selecting mainly for high yield, early maturity, and milling/bread-making quality. Almost nothing has been preserved from the thousands of crossings with deficient qualities. Only the best were kept.

Having traced the ancestry of these hybrids, I can say that there is not a single variety selected from these crossings that does not originate from Ukrainian Halychanka (Red Fife) wheat.

The reports for every year record the breeding work carried out. Every account of all of the best varieties or the crossings made from them confirms that they are derived from ancestors of Ukrainian

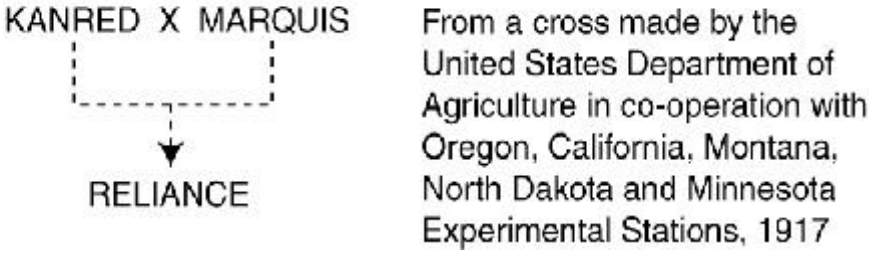
Halychanka (Red Fife) wheat. A subsequent list of some of the hybrids mentioned above is published in the report for 1938-1948. (p. 13, Table 3) All of the varieties listed in that report are bred from Ukrainian Halychanka (Red Fife) wheat as well. To these, the varieties bred from this wheat in the United States should be added.

CANUS

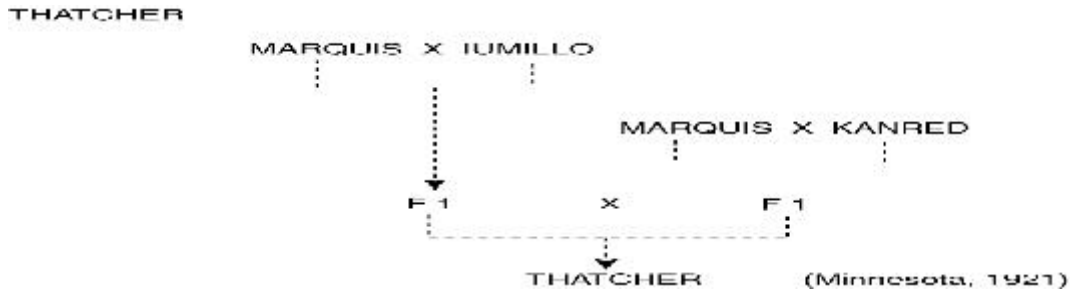


LEE

RELIANCE



There is a disagreement on the origin of the Reliance variety between the Handbook and Newman (43), who states that it is derived from Marquis X Kanred (p. 4).



THATCHER is resistant to most forms of black stem rust in the field but is susceptible to covered smut and leaf rust. It is very resistant to loose smut.

Improving Winter Wheat

As noted above, the cultivation of winter wheat in Canada was concentrated mainly in Ontario, although in later years it expanded across a large area in Alberta and southwestern Saskatchewan (Progress Report of the Dominion Cerealist for1938-1948, p. 16).

It was also planted in British Columbia, Quebec, and Nova Scotia at very small concentrated locations. Alberta growers cultivated Kharkiv and Yogo, the best known varieties there, while Yogo was grown also in Saskatchewan.

The area under cultivation in Ontario ranged from 546,100 acres in 1946 to 858,500 in 1948 with an average of about 700,000 acres for the 1938-1948 period. The yield per acre ranged from 22 bu in 1943 to 33.3 bu in 1944 and the average yield for this whole period of time was 28.3 bu per acre. The average annual yield was about 20 million bu of which some six million were used for the production of cake flour.

Productivity of the Winter Wheat Harvest in Eastern Ontario, 1938-1940

RIDEAU . . . . . 39.9 bu per acre
DAWSON GOLDEN CHAFF . . . . . 38.1 “ ”
KHARKIV . . . . . 31.8 “ ”

One of the first tasks for the winter wheat breeding program in Ottawa was to produce a high-yield, frost-resistant wheat that could be grown in eastern Ontario and other parts of the province where the winters are more severe than in western Ontario. Many crossings were made between known varieties with a high frost resistance and more productive varieties.

There was an equally pressing need for varieties that were resistant to loose smut and bunt. Several crossings were made with the Ridit variety, which is resistant to loose smut. These crossings produced

the following hybrids:

Ottawa 1968-18L	=	D.G.C.	X	RIDIT
Ottawa 2619 A	=	D.G.C.2	X	RIDIT

The Kharkiv variety not only brought high-quality genes to Canadian wheat but contributed to the breeding of highly frost-resistant varieties. Just as the Ukrainian Halychanka (Red Fife) wheat contributes excellent flour and bread-baking qualities to Canada's spring wheats, the Kharkiv variety introduced its high resistance to frost into our winter wheats.

Press Reports and Other Writings on Halychanka (Red Fife) Wheat

The Manitoba Daily Free Press, 1883

"Messrs. Traill, Maulson, and Clark have obtained four loads of Red Fife seed, a total of 2,000 bushels, in connection with their undertaking to introduce this most important variety to farmers in the province. They have prepared to import 10,000 bushels and are prepared to increase the quantity, if the orders appear. To date, orders have been received for six freight cars and numerous additional orders have begun to arrive. Even if there were no more than 10,000 bushels ordered by the farmers this year, it has been established that, allowing for two bushels of seed per acre and a harvested yield of 20 bushels per acre, this amount would represent 100,000 bushels, or about all that would be used for the following year. The product of this second sowing will no doubt get to the general market and enhance the reputation of Manitoba as a major grain producer.

"In undertaking to introduce the necessary delivery to the country of this type of wheat, Messrs. Traill, Maulson, and Clark were guided by the following principle: they did not see why Manitoba, possessing the best-quality soils, should not grow the best-quality wheat. It would be in the interest of the farmers and the millers, and of the province as a whole, if this was done. They consider Red Fife wheat to be the best in every respect; that is, appropriate for this climate. This is very clearly illustrated in the case of some Mennonite settlers whose 'White Russian' wheat was found to be of very poor quality, with a yield of no more than 10 bushels per acre. At the same time, farms in this same settlement where Red Fife wheat had been sown are producing from 20 to 25 bushels per acre of excellent grain.

"Our experience over the past year has shown that Red Fife wheat adapts better than soft varieties such as Club, Golden Drop, or White Russian which grow in the climatic conditions of this country. It was tested during the past summer, on account of the sudden and stormy weather changes from long-lasting drought to heavy rains and then intense heat.

"Another advantage of Red Fife wheat, according to Mr. Clark, is that it is free from attacks by loose smut. Observations from last year showed that where loose smut was found on fields where the Red Fife variety was growing, in every case it belonged to the soft varieties — soft wheat grains that had

been mixed into the former variety. Red Fife is in demand among millers on account of its adaptability to the new system of milling by grinding between rollers and also on account of the fineness of the bran and the amount of gluten in the grain. It is expected that the cultivation of this wheat in more northerly zones will have an effect on the further development of its excellent qualities. This account is said to confirm past experience.

"It is believed that Red Fife wheat originates from a shipment of Hirka wheat from southern Ukraine which was sent to Scotland and then forwarded by a friend to the renowned Mr. Fife, who lived near Coburg, Ontario. As the grain was improved through cultivation in Ontario and through a gradual move into more northerly latitudes, it was believed that further improvements would continue on to the furthest possible northern reaches of wheat cultivation. It is expected that next year's harvest will surpass the quality of seed imported to date and that its quality is good.

"The first pure Red Fife seed imported by farmers and sown to replace the present grain was bought at a high price, which will also be obtained from the harvest produced this year.

"MILLERS PAY UP TO TEN CENTS MORE PER BUSHEL FOR THIS WHEAT. But the farmers who grow it will receive an even better price for the first few years as they sell their surplus to their neighbours and to the new settlers coming in. Another benefit from this is that by the general introduction of the best wheat, the quality of grain throughout the province will expand in a northwesterly direction. With the best soils and other advantages, it is necessary to sow first-class seed in order to place Manitoba among the first rank of wheat producers. On the other hand it is not easy to evaluate the unfortunate consequences which may arise for the entire country from the cultivation of low-quality grain so early in our history. The area under cultivation this spring gives rise to the belief that the next harvest will produce a great surplus of grain over and above the milling needs of the country: thus the task of replacing the best grain must proceed without delay so that the quality of the grain for export is not diminished.

"The Dominion Government is encouraging the introduction of Red Fife for the entire sowing season by authorizing its importation duty-free. The CPR also supports this idea by shipping seed grain of this variety without payment for transport. In spite of all these incentives, many farmers will not be able to buy sufficient seed of this variety to sow all of their plowed land; but one may expect that a large number will be able to get enough of this grain so that by next year they will sow only Red Fife. On the other hand many farmers will undoubtedly grow much more than they will need for themselves and sell the surplus for seed.

"Messrs. Traill, Maulson, and Clark have taken special precautions to import only perfectly pure grain. Mr. Clark returned one evening from Minnesota where he had made arrangements for the export, cleaning, and loading of the grain into new sacks with a capacity of two bushels. On returning he appointed one of his clerks there to look after this order.

"The Department of Agriculture has issued special directives on this matter and Mr. Acton Beavers, the Deputy Minister of Agriculture and Statistics, has worked energetically to discharge this responsibility. Most recently he has issued the following announcement."(36)

The Government Circular on Red Fife Wheat, 1883

"From the Department of Agriculture:

"As it has been proved beyond any question that Red Fife wheat is in every respect the most lucrative variety for cultivation in Manitoba and that great losses have been borne by farmers who have sown soft wheat varieties, the Department of Agriculture has taken measures to provide assistance for the delivery of Red Fife for seeding purposes. Because there is not a sufficient amount of pure seed in the province to fulfill the needs, an application has been made to the Minister of Customs to permit pure Red Fife grain to be imported for seeding purposes without payment of duties.

"An application was placed with Messrs. Traill, Maulson, and Clark, grain merchants in Winnipeg, who had arranged to bring out a large transport of selected Red Fife from Minnesota, to thoroughly clean and supply 500-bushel cartloads at a price of $1.30 per bushel. It will be delivered to every CPR station, packed in two-bushel lots in cotton sacks at 27 cents each. Messrs. Brown, Oldfield, and Co. and Mr. R. R. Kite and Co., seed merchants from Winnipeg, have also organized delivery of this wheat. It will be on sale either in whole cartloads or in smaller amounts, depending on demand. The prices for orders may be obtained from them.

"It has been proposed that various electoral agricultural branches and societies in the province participate in the distribution of the pure grain, permitting their secretary-treasurers to take orders from persons in their own districts so that cartloads may be obtained and the payment of high prices avoided when smaller amounts are ordered. Messrs. Traill, Maulson, and Clark are selling for cash. A full cartload order requires a cash deposit of $250 with the difference payable on loading, even before the grain is reloaded from the station to which it is to be sent. The orders are to be sent directly to one of the three firms mentioned above, as early as possible and not later than the end of March because the orders may exhaust the entire supply."

The news account above is very significant because it presents the general consensus of the time on the question of the sowing of wheat in Manitoba and is a testimonial on the perceived value of Halychanka (Red Fife) wheat. It also illustrates the support for and the understanding of the remarkable value of this variety within the Department of Agriculture.

Of course, this wheat had already come to Canada more that four decades earlier, in 1842, but it had not been recognized and taken advantage of at the time. Such accidental events can sometimes establish prosperity and create a flourishing economy for a society or an entire country. If an American farmer had not received a small amount of this wheat from David Fife, sowed it, made money with it

and revealed its extraordinary value to the press, the Halychanka (Red Fife) wheat might well have been lost to this whole continent. Truly, the development of this wheat in North America owes him a great deal. What a strange, roundabout journey for a small Ukranian grain of wheat! From Ukraine to Ontario, from Ontario to the United States, then to Manitoba, and back to Ontario, and then throughout Canada.

"Harvesting Wheat in the Yukon," 1920

Under this heading, an early Department of Agriculture report ends with: "In 1920, experimental fields of Marquis wheat produced up to 50 bushels, while the next year wheat of the Ruby variety produced 54 bushels per acre. The very dry weather in 1922, however, allowed the Prelude variety to produce only 24.5 bushels per acre." (37, p.158) So Red Fife descendants could thrive as far north as the Yukon.

Let us go back to the situation in 1884. When Red Fife returned to Canada after 41 years, this nation needed to rebuild its agriculture. Canada's agricultural economy could grow only if it was built on a strong foundation. It was meant to be the country's most important industry but it was also a way of life. The Dominion government had indeed expended enormous efforts and resources in organizing the Experimental Farms: but the first pillar of success in the development of Canada's agriculture was none other than Halychanka (Red Fife), the superb Ukrainian wheat which had come to Canada by sheer happenstance. And its subsequent success speaks for itself.

"Salute to Canada's Great Pioneer," 1933

In the August 1933 issue of *The Canadian Magazine*, R. S. Kennedy wrote: "Then Red Fife arrived, a wheat variety that not only strengthened the foundations of the old Canada and built the new province of Manitoba but also was one of the ancestral parents of all of the most important new varieties that have been formed through crossings and that made the New Canada an actual fact and not some dubious experiment.

"Red Fife is a true Canadian-born child, although like all of us except the Indians, its ancestor was an immigrant. It matured, displayed all the distinguished qualities expected of it, and from it sprang all of those thousands of millions of bushels of Red Fife, which, first in Ontario and then in Manitoba, parts of Saskatchewan, and Alberta, were exported to promote Canada and establish its unrivalled reputation for wheat quality.

"If city dwellers think they are hearing and reading too much about wheat, they are wrong. Wheat is the basis of the commercial success of Canada. Agricultural products are now and should always remain its main export, and although wheat is without reservation the only agricultural product with which we can compete on world markets, it is one which came first and has stayed on, one which opened and is still opening new lands to settlers, and which, in a world of changing conditions has diversified our

agriculture and caused villages and, later, towns to spring into existence. Ontario has completed this process, Manitoba is half done, while Alberta and Saskatchewan are just beginning. But they owe it all to this wheat, which has helped them through a gentle labour and an easy birth at the greatest possible speed."

The Country Gentleman and Cultivator, 1926

The author focuses on Red Fife's most famous child: "Some people say that Marquis, the best known of American wheats, the king of the northwestern Prairies, is the ordinary result of a series of good luck and happenstance. Others, and there are more of these, think that it was Dr. C. Saunders who discovered Marquis wheat through his detailed research into the breeding of wheat plants. The nation of Canada has in fact rewarded Dr. C. Saunders with an annual pension of $5,000. But the true history of how this early-maturing, high-yield wheat arrived to bless the settlers in the Northwest has more than one hero."

He begins with William Saunders: "In 1886, a Commission of the Parliament of Canada brought in pharmacist, W. Saunders, to establish the Experimental Farms. He had the vision that things could grow in the black soil in the short hazardous summer of the Canadian Northwest. He tried everything from roses to turnips, from hardwoods to unknown wheats from the Himalayan mountains. The early-maturing Marquis wheat emerged from this ... research." He also notes Saunders's talent for selecting assistants: Thomas Sharp, William Macoun, and Angus Mackay.

"[By 1903] old W. Saunders was approaching seventy. He was still working hard, slowly, incessantly, a machine-like type of worker. And his weighty experiments grew: 41, then 65, followed by 72, and now 119 varieties of wheat he investigated year after year in Ottawa. There were too many varieties there, so he hired his son, Dr. Charles Saunders, to bring some order into these new wheats. It seems strange to present Charles as a hunter of wheat...lean, tall, not very healthy, he cared most about music. He had a doctorate in chemistry, yet for several years he had studied singing in New York and London.

"An unlikely hunter of wheat? And yet, if old William had not set his son to work, perhaps Marquis wheat would never have been discovered. For it was among these excellent wheats that Charles found Marquis from among the five offspring of Red Fife and Hard Red Calcutta created from a selection made in Agassiz at the farm of Thomas Sharp in 1892." (41, p. 12)

Halychanka (Red Fife) Wheat in the Professional Literature

There is quite a number of articles and publications that address the origin of Halychanka (Red Fife) wheat in Canada. (38, 3 items) Charles Saunders wrote an important one in 1905 (39), which, although not well known, makes an important contribution to the history of Canadian wheat; but let me begin with one he wrote in 1911 in a French scientific publication:

"I would like to say a few words about the origin of Red Fife. It is generally considered to be a Canadian wheat but in reality it has been shown to be a variety cultivated in Europe under the name "Spring wheat from Galicia ...". This wheat was introduced to Canada in a fairly simple way. A ship laden with winter wheat travelled from Danzig (now Gdansk, Poland) to Glasgow and some of this ship's load was sent from Glasgow to Canada. A certain farmer who received this wheat, Mr. David Fife, not knowing what sort of wheat this was, sowed it in the spring. A single plant matured (winter wheat sown in the spring will not form spikes because it has not undergone a cold winter).

This plant attracted the attention of Mr. Fife and from it he developed the variety which is generally known under his name in America. However, I have shown by researching its cultivation, milling and bread-baking qualities, that this plant of spring wheat Mr. Fife received was not some mutant produced in Canada, but that it belonged to a variety cultivated in the middle of Europe and was accidentally present as a single grain in this shipment of winter wheat.

"We also have another variety that is well known in Canada under the name of White Fife, which is practically identical to Red Fife in every respect with the exception only that it has a pale bran coat. I was never able to discover the origin of this wheat but it seems certain that it is derived from Red Fife. We have also used this variety as a parent for crossings, for the purpose of obtaining a variety with excellent baking qualities."(40, p. 291)

An article in *The Grain Grower's Guide* (No. 968, 7 June 1916, p. 274) entitled "Canadian Wheat History," by S.S. James of the Department of Agriculture surveys the entire history of Red Fife wheat from all sources up to that time, including the testimony of Dr. Charles Saunders in Parliament and a detailed description of how Red Fife got to Manitoba.

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It is an unfortunate fact that the excellence of Ukrainian wheat often has been credited to Russia, to other neighbours of Ukraine, or other countries. For example, in a publication of the Department of Agriculture by three of Charles Saunders's co-workers, Red Fife is deemed German: "Red Fife was introduced to Canada by way of a dispatch of some wheat that had been shipped out in Danzig, Germany, and a sample had been sent to Mr. David Fife in Peterborough by way of a friend in Glasgow in 1842." Another writer, T. Rose (45) agrees: "Our best-known wheat variety in Canada was Red Fife. It originated from a sample of winter wheat imported from Danzig, Germany."

Another publication of the Department of Agriculture opts for Polish origins: "Red Fife was introduced to Canada through a transport of wheat from Danzig, Poland. A sample, which was sent to Mr. David Fife in Peterborough, Ontario, by a friend in Glasgow, 1842 ...".

More typically, Red Fife is believed to be Russian. Thus the author of an official publication (42, p. 99) writes that Red Fife was "...a selection from Russian sources." Of the White Russian variety, which is a selection from Red Fife (43, p. 51), another writer asserts (44, p. 100) that "White Russian ...is a

variety of Russian origin." According to a third, "Galicia was a part of Russia in 1842...[therefore] Red Fife is a Russian variety." (16, p. 427) But Galicia was not part of Russia in 1842: it was occupied mainly by Austria from the eighteenth century until the breakup of the Habsburg Empire in 1918. Halychanka (Red Fife) wheat was never Russian.

Indeed, the so-called Russian wheats, introduced from the northern territories of Russia to Canada, all originated from Ukraine. For example, K. A. Flyaksberger (4) notes that all Russian wheats originated from Ukraine (the so-called "Poltavka" varieties). Moreover, this is supported in the Canadian literature, especially by C. Saunders (46) and Buller (7).

Canada's Centennial saw a collection of studies (47) devoted exclusively to wheat breeding in Canada but only one author mentioned Red Fife. Another study (48, p. 234) suggested that Red Fife was ..." a variety of spring wheat that had been developed by one farmer in Ontario from a packet of British wheat sent to him from Scotland. This was the Red Fife wheat."

There is one writer, however, who reveals the true source from which Canada obtained Halychanka (Red Fife) wheat: "First of all we have to note that the Carpathian basin and the adjacent areas, mainly western Ukraine, must have been important as a historical region of wheat quality. Although there is a huge variety of forms there, the old local populations belong to one basic type. The main agricultural characteristics of this type are a good winter hardiness, resistance to drought, early maturation, good clearing, a red grain, excellent quality, a small- to medium-sized spike that is not compacted, and a slight susceptibility to fungal diseases. They are mainly winter wheats but in northwestern Ukraine (Galicia) awnless spring wheats also appear. This area is considered to be the birthplace of the Red Fife wheat." (49, p.11-13)

There are quite a few other sources on the origin of Halychanka(Red Fife) wheat in addition to the above, scattered throughout various books and periodicals in Canada and abroad. See, for example, one of the English books. (50, p. 378) All of them, however, agree on the origin of this wheat: "it originated in Galicia."

Our Debt to Ukraine

Almost all of the agricultural literature from the time of the tsars should be published under this heading. For the best cereals came to Russia from Ukraine. Indeed, the agricultural literature of Canada and every other country that has benefited from Ukrainian wheat by producing its own varieties, on its own soils and in its own climate should also come under this heading.

Unfortunately the contribution of Ukrainian wheat to Canada and the world cannot be defined accurately because of a lack of recorded information on its development from its arrival in 1842 to the present. There are extensive records on Halychanka (Red Fife) in various reports from the Experimental Farms on the initial and subsequent crossings of this wheat with others. But some of the

records have not been collected yet, while many are missing. A record of all the crossings from which these extraordinarily valuable varieties originated, showing in raw numbers the wealth they brought to this country, would benefit all of us.

I believe that the valuable genetic qualities of Ukrainian wheat have become a kind of genetic wheat bank for the world, a repository of valuable genetic characteristics, which have served:
a) directly, by providing a food base for the whole world; and
b) indirectly, by creating new, high-quality, high-yield wheat varieties through crossings.

Only because of a strange and very unlikely accident did Ukrainian wheat, in the form of a single grain, find its way to Canada — and not to the address of some experimental farm or famous breeder but to the field of an ordinary farmer. The entire development of Canada's wheat industry, the most renowned in the world, is due mainly to this single Ukrainian grain of wheat.

The professional literature has taken note of the importance and success of the Halychanka (Red Fife) "local" variety of spring wheat. Most of this book has been devoted to a study of this variety as well as its numerous derived hybrids, the most famous of which is Marquis.

Records on the Halychanka (Red Fife) variety are found in the Galician Chronicle as far back as the time of King Yaroslav Osmomysl (1171-1187). The fact that the genetic characteristics of the Halychanka variety are based on a selection process reaching back to the twelfth century shows why this practical agricultural variety is so unique and so valuable. Its stability, or homozygosity, certainly deserves the attention of every serious plant breeder or geneticist. This variety was not reared on experimental fields but cultivated over centuries in the fields of Ukrainian peasants and known there as the "local" variety.

In time, as we have seen, its value was recognized in Canada and the United States. Those who deserve recognition for its development in Canada include the pioneer farmer David Fife, William Saunders and his son Charles Saunders, and their successors — the scientists who carried on their work at the Department of Agriculture. For the achievement of raising Canada to rank as one of the world's great producers of spring wheat belongs in great measure to Canada's breeders who developed varieties that could thrive in local conditions. Indeed, no other country's plant researchers have made a greater contribution to their national treasury than Canada's. Their achievement, spanning a period of more than half a century, is a true legend in the annals of scientific achievement.

Conclusion: The Three Pillars

To me, the history of Canada's leading varieties is important because it connects Ukraine and Canada in what I believe is an important chapter of the history of world agriculture. It has three equally important elements: the Halychanka (Red Fife) Ukrainian wheat, the pioneer David Fife who brought it to Canada, and the pioneer wheat breeders who developed our many successful strains from it. These

elements have not yet received the recognition they deserve in the literature. As this study is intended to contribute toward this recognition, let us consider, in concluding, these three pillars, on which I believe Canada's success in wheat research rests.

Halychanka (Red Fife) Wheat

The value to Canada of this wheat may be summed up as follows:
1. Thousands of institutions, industries, provinces, towns, factories, cereal farmers, and large businesses have benefited from the harvest of Red Fife wheat and of its derivative varieties.
2. In 1842 a small area of David Fife's field was Canada's first experimental farm.
3. Bountiful harvests over the next few years multiplied the amount of grain. Red Fife wheat made Ontario a wheat-producing province.
4. The settlement of the Prairies would likely not have succeeded as well, and the Sifton immigration may not have taken place. The year 1908 would not have seen towns such as Winnipeg, Regina, Saskatoon, and Edmonton built where they are now. At best, the Prairies would have been cattle-ranching country.
5. Ontario Red Fife wheat found its way west, where it became the most important factor in pushing back the prairie grass and establishing thousands of prosperous farmers.
6. This was the first and greatest contribution to the economic wealth of western Canada and other parts of Canada. It pushed the borders of the Prairies hundreds of miles to the north and opened up vast expanses of new land.
7. Up until 1905 the wheat from the Otonabee farmer retained its dominance over all other Canadian varieties.
8. Halychanka (Red Fife) was the wheat that gave Canada the proud title of "Granary of the Empire."
9. Red Fife wheat was the prime factor not only in the development of the West and in making Canada one of the world's grain producers but also in the establishment and expansion of numerous towns and in the development of this relatively young country into a rich, economically strong, industrial nation.

David Fife

This photograph of David Fife and his wife Jane Beckett (Figure 6) hangs in the Agricultural Hall of Fame in Toronto. This farmer introduced Red Fife wheat to Canada. From his farm in Otonabee it spread to Illinois and Ohio in the United States, and then to Manitoba, Saskatchewan, and Alberta.

David Fife came to Canada with his parents and brothers in 1820 and settled in Otonabee on Lot 22, Concession 4, Lot E ½. When he grew up and married, he settled on Lot 23 W ½, from which he cleared the brush and large trees. In his third year of growing the spring wheat which originated from that one famous grain, David Fife harvested half a bushel of grain, which he shared, in part, with his friends. Its subsequent history has been retold above.

Certain eminent Canadians have recognized the achievement of David Fife. For example, Senator J.J.

Duffus of Peterborough saluted the pioneer farmer David Fife and his generation in a Senate speech on 19 January 1955 and published in the *Peterborough Examiner* on Thursday, 20 January 1955. In it he presented a plan to create a "permanent living monument" in honour of David Fife.

This project, organized by the Senator with the help of the Society of the David Fife Memorial, saw the erection in 1964 of a stone cairn out of ordinary field stone, with a brass plate inscribed with a brief history of Red Fife (Figure 7) on the Trans-Canada Highway eight miles to the east of Peterborough. The official unveiling was carried out by Donald Fife, a descendant. The plaque honouring David Fife was moved to nearby Lang Pioneer Village in 1977.

Canada's Wheat Breeders

The growth in the eminence of Canada as one of the great world producers of spring wheat has continued to increase because of the persevering work of Canada's researchers and breeders. In no other country have wheat researchers made so great a contribution to the national development of agriculture. Working with limitless patience and stubborn determination, they have created thousands of new early wheat varieties and generated millions of dollars for Canada every year. Their work represents an enormous scientific achievement.

Because of them, the hereditary "blood" of Halychanka (Red Fife) wheat, which came from Western Ukraine and was the leading variety of spring wheat in Canada for many years, continues as the hereditary base of the leading Canadian wheat varieties to the present day.

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