2023 TofA #8 Archive PDF Kondra Canola FINAL August 4 2023 FINAL (File name WORD)

ABOUT TALES OF ALES:

Celebrating the Past, and Changing the Future: Stories about some University of Alberta Faculty of ALES Professors, Students and Alumni and their Achievements and Activities in the Past

The TALES are a series of stories written in retirement by Keith Briggs in 2021 – 2023 as Emeritus Professor of the Department of Agricultural, Food and Nutritional Science (AFNS), Faculty of Agricultural, Life and Environmental Science (ALES) at the University of Alberta. The TALES place into the record some notable agricultural science events and activities for the Archives, stories not previously told or elaborated that may be of interest to the academic, scientific and public communities. They feature Professors or other staff all found in the history of AFNS. The TALES have additional authors in some cases.

ABBREVIATED TITLE

The previously untold story about Dr. Zenon Kondra's 1960's research as co-breeder of the first Canola variety for Canada, named Tower,and his subsequent canola breeding achievements at the University of Alberta

FULL TITLE:

The previously untold story about Professor Zenon Kondra's 1960's research as co-breeder with Dr. Baldur Stefansson at the University of Manitoba, developing the first Canola variety for Canada, named Tower, and his subsequent canola breeding achievements as Professor of oilseed and special crops at the University of Alberta

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ACKNOWLEDGEMENTS:

Reviewers of this script include Professors Zenon Kondra, Habibur Rahman (AFNS Canola breeder) and Ed Tyrchniewicz (Past Dean, retired, and Professor Emeritus of the Faculty of ALES). Several non-scientists involved in the Canadian production of canola also read the script and all suggestions, editorial comments and corrections received from them are also gratefully acknowledged

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ABSTRACT:

Section (A) of TALES OF ALES #8 describes production and variety changes over time as rapeseed production in Canada transitioned into canola production as soon as this new crop was developed. Section (B) describes how Dr. Zenon Kondra's breeding work created the very first Canola variety in Canada at the University of Manitoba, in plant breeder Professor Steffanson's program, and then reset the bar to increase the yield potential in this new crop with its newly defined grain quality requirements. Kondra then focused on breeding adapted canola varieties for the Parkland zone of the western Canadian Prairies, with its short growing season but high yield potential. It also describes Kondra's continued successful breeding work at the University of Alberta, the ever -continuing funding challenges that beset the program on a yearly basis, and the foundational germplasm and facility improvements left as a legacy for the breeders who followed, Professors Stringam and Rahman. Kondra's variety Alto was one of the parents in the cross that Stringam (Kondra's academic replacement after his retirement) used to breed the variety Quantum, the variety that "saved the entire W. Canadian canola industry from production devastation from the new but debilitating disease called blackleg". A summary listing of all the varieties subsequently released by the University of Alberta up to 2022 is also included.

Please scroll down to continue reading! Thank you.

Colorful Canola, the subject matter of the research described in TALE #8, TALES OF ALES, also about Dr. Zenon Kondra

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TALES OF ALES #8 TITLE:

The previously untold story about Professor Zenon Kondra's 1960's research as co-breeder with Dr. Baldur Stefansson at the University of Manitoba, developing the first Canola variety for Canada, and his subsequent canola breeding achievements as Professor of oilseed and special crops at the University of Alberta

Section (A) of this chronology describes the changes that occurred in this oilseed crop over time in W. Canada. Section (B) describes University of Manitoba alumnus Dr. Zenon Kondra's research role in these changes, the latter mostly not previously publicly described or acknowledged anywhere. Section (C) briefly describes the additional achievements by the University of Alberta canola program after Dr. Kondra's retirement, as well as some other significant changes that subsequently occurred in Canadian canola breeding and production. Readers interested in learning more detail and other aspects of Canadian canola production and its history are recommended to visit the Canola Council of Canada website and the published variety description of Tower:

https://www.canolacouncil.org/canola-encyclopedia/history-of-canola-seed-development/

Stefansson, B. R. and Kondra, Z. P. 1975 Tower summer rape. Can. J. Plant Sci. 55: 343-344
https://doi.org/10.4141/cjps75-053

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Section (A): Production and Variety Changes over Time: Transitions from Rapeseed to Canola

Before they were both genetically altered by plant breeders to become the modern crop now known as Canola two species of rapeseed were grown in low acreage in both E. and W. Canada. They were *Brassica napus* (originating from Argentina, and earlier commonly called 'Argentine' rape) and *Brassica campestris* (introduced to Canada from Poland in the 1930's and earlier called 'Polish' rape). The seed oil quality from these species made it completely unsuitable in any use for human consumption because of very high levels of erucic acid which can cause increased fat deposition in the heart, and heart weakening. Until the 1950's rapeseed oil use was restricted to industrial applications, mainly as a lubricant in marine locations, with some expansion of Canadian production during and after World War 2 because of shortages of other industrial oil sources. Rapeseed breeding programs in W. Canada up to the 1960's nevertheless made significant improvements in the varieties available to producers, particularly for yield potential and disease resistance.

The breeding of new varieties and their producer adoption were two activities completely central to the emergence of a new oilseed crop later called Canola. To register a new variety a breeder must include it in Prairie-wide field tests compared to the best current varieties, and demonstrate superior performance in these trials, which are run by cooperating researchers in aptly named Cooperative Trials. The agronomic, seed quality, disease resistance and other traits of the variety are then evaluated by the W. Canada Canola / Rapeseed Recommending Committee. Lines that meet the current standards of this committee are then recommended for cultivar registration by the Federal Canadian Food Inspection Agency (CFIA) and, if approved, can then be legally produced and marketed in Canada. Breeders and growers have many organizations which support and advise about this crop. They include Provincial Growers Associations, the

Canadian Canola Council of Canada, the Canadian Oilseed Processors Association, and the Canadian Grains and Oilseed Exporters Association, who all cooperate to ensure that the emerging canola crop gains and maintains a very favorable international reputation in the oilseed market.

Table 1, necessarily something of a tabular 'tour de force', contains much very detailed information but shows in one place all the early variety-driven history of this crop in the Western Prairies, with a focus on the varieties from Kondra's research. It is an update from Kondra's 1985 but not widely circulated University of Alberta article 'Canola production and cultivar development in Canada' (University of Alberta Agriculture and Forestry Bulletin ,Volume 8, 1985).

Table 1 highlights three distinct 'Eras' in the evolution of rapeseed/canola: 1. The Rapeseed Era where only rapeseed quality varieties were grown and commercial grain yields were low, but there were still some gains made in the potential yield of newer varieties; 2. The Transition Era where there was a gradual switchover from only rapeseed quality varieties grown to where only Canola quality varieties were grown and all rapeseed quality varieties were removed from production (a transition not commercially complete until around 1983); 3. The Canola Era (continuing) where only Canola quality varieties are produced, and the focus is now nearly completely on breeding higher yield, higher oil and protein content, disease resistance and improved field production agronomic characteristics. By the 2020's 95% of the canola acreage is now *Brassica napus* type because very popular herbicide resistant varieties became readily available in this species. There are also now a few *B. napus* varieties sufficiently early maturing to replace past use of the earlier maturing but lower yielding *Brassica rapa* species, for regions with very short growing seasons.

Without viewing all the detail, several clear yield and production trends are obvious from the information in columns 3 and 4 of Table 1. The main one (column 4) is the dramatic increase achieved in on-farm yield potential started during the Transition era and continuing in a dramatic manner since the Canola crop was Trademarked by the W. Canadian Oilseed Crushers in 1978 with a guarantee of <5% erucic acid in the grain. The Canadian Canola Council took over the Trademark in 1980 and changed the standard to <2%. That outcome raised the demand and per bushel price and created a surging interest in this new crop. On-farm yields in the Canadian Prairies recently (e.g. 2020) average more than double those when Canola first emerged as a preferred oilseed crop in the late 1960's. This has occurred for many reasons including new yield genetics in the varieties, development of hybrid varieties, use of herbicide tolerant varieties where potential yield loss from weeds can be controlled, disease resistant varieties, and a technologically advanced set of agronomic management practices and equipment that together all promote improved harvestable yield of grain with a high physical grade. In addition, the international recognition of the nutritional and health benefits of canola oil in human diets, especially the USA designation of this oil as 'Generally Regarded as Safe' (GRAS Certification in the USA Food Safety System) greatly increased export demand. Seeded acreage soared to record levels by 2020, but further increase is now limited by potentially high disease pest risk when canola is grown in short duration rotations with other crops. It is useful here to restate the related Canadian Canola Council's definition of Canola used for its Trademark and License: 'Canola oil must have less than 2% erucic acid and the seed must contain less than 30 µmol of glucosinolates per gram of air-dried oil-free meal'. This quality standard is one guaranteed in all marketed Canola grain, worldwide.

Inspection of columns 5 and 7 in Table 1 reveals that the University of Manitoba under the program direction of Professor Baldur Stefansson was a very important source of new varieties (marked as UofM, Table 1) during the 'Rapeseed' Era, through 'Transition' and also into the 'Canola' Era. Stefansson's work on rapeseed started in 1952 and continued until his retirement in 1986, with his first rapeseed variety Tanka (*B. napus*) released in 1963. Similar varietal importance was also true for those bred in Dr. Keith Downey's federally funded program at Agriculture and Agri-Food Canada (AAFC) which started in 1951 and continued until his retirement from AAFC in 1993. Both of these researchers received many prestigious awards in recognition of this important work and they are together often described as the 'Fathers of Canola'. Details are well described at the Canola Council of Canada website cited earlier, and in many other publications. Dr. Stefansson passed away in 2002, but left a very major legacy from his visionary canola R & D goals and achievements.

Table 1 Canadian Rapeseed and Canola Production, with a Focus on University of Alberta Varieties (1943 – 2007)
Notes: Yield Index = % yield vs yield of commercial seed of each original species (*B. napus* yield is 120% of *B. campestris*);

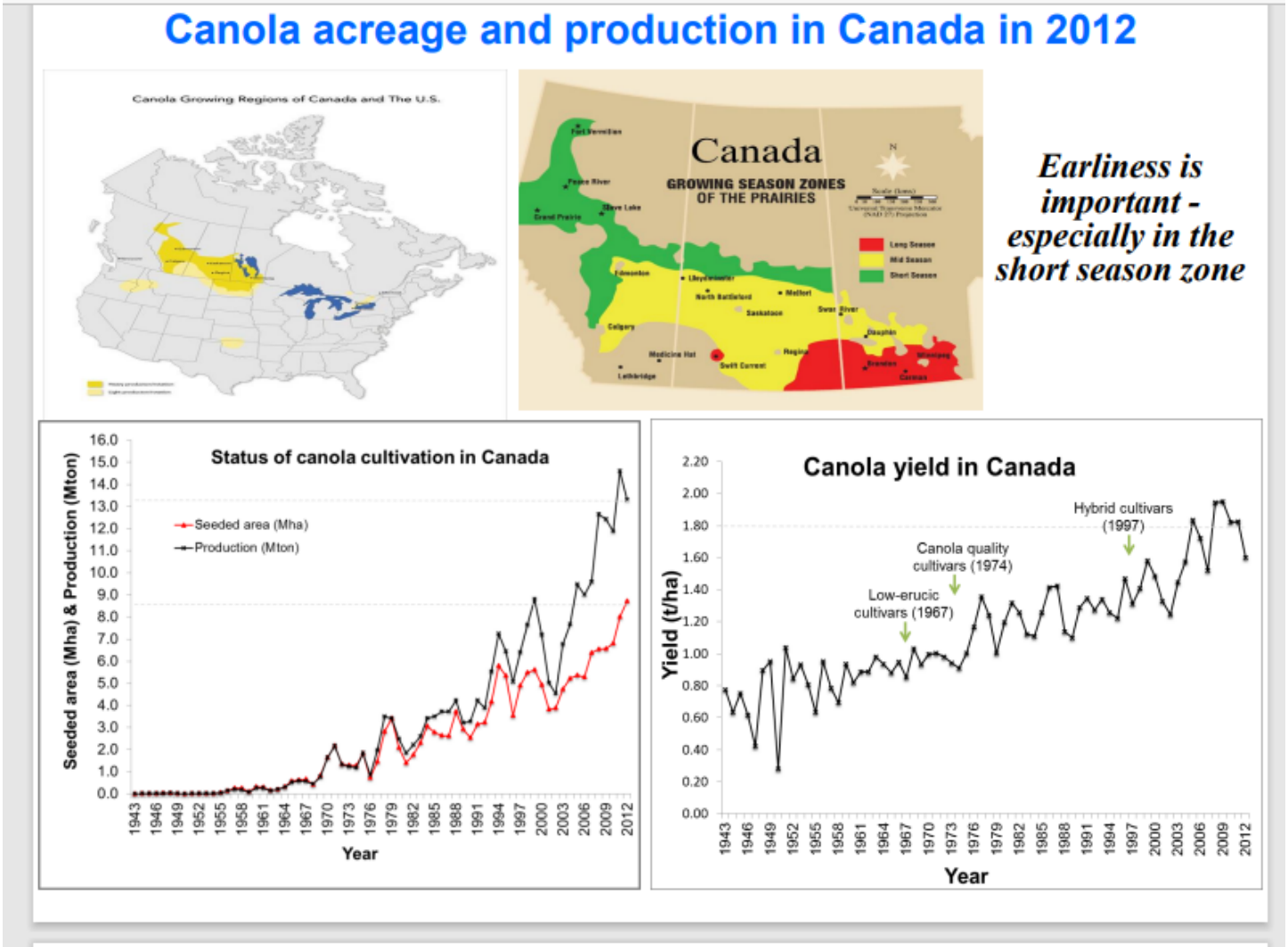
Year	Oil type 'Era'	W. Canada seeded ha., '000s	Average yield kg/ha	Brassica napus cultivar (Breeder institution)	Yield index	Brassica campestris cultivar	Yield index	Low erucic acid oil ?	Low glucosinolate meal?
1943	Rapeseed	1.3	770	'Argentine'	100	'Polish'	100	No	No
1944	Rapeseed	4.3	630						
1946	Rapeseed	9.4	600						
1948	Rapeseed	32.0	900						
1950	Rapeseed	0.2	280						
1952	Rapeseed	7.4	840						
1954	Rapeseed			Golden (AAFC)	101			No	No
1955	Rapeseed	55.2	635						
1958	Rapeseed					Arlo (Swedish)	101	No	No
1960	Rapeseed	305.2	820						
1961	Rapeseed			Nugget (Arg. selection)	100			No	No
1963	Rapeseed			Tanka (UofM)	105			No	No
1964	Rapeseed					Echo (AAFC)	112	No	No
1965	Rapeseed	574	880						
1966	Rapeseed			Target (UofM)	110			No	No
1968	Transition			Oro (AAFC)	106			Yes	No
1969	Transition					Polar (UofM)		No	No
1970	Transition	1,620	1,000	Turret (UofM)	113			No	No
1971	Transition			Zephyr (AAFC)	106	Span (AAFC)	107	Yes	No
1973	Transition			Midas (AAFC)	115	Torch (AAFC)	111	Yes	No
1974	Canola			**Tower (UofM)**	**106**			**Yes**	**Yes**
1975	Canola	1,580	1,000						
1977	Canola			Regent (UofM)	110	Candle (AAFC)	101	Yes	Yes
1978	Canola			Altex (UofA)	112			Yes	Yes
1979	Canola	3,280	1,015						
1980	Canola	2,100	1,200						
1981	Canola			Andor (UofA)	117	Tobin (AAFC)	108	Yes	Yes
1982	Canola	1,720	1,265	Westar (AAFC)	124			Yes	Yes
1984	Canola	2,820	1,100						
1988	Canola	5,354	1,131	Alto (UofA)	124			Yes	Yes
1992	Canola					Eclipse (UofA D)	na	Yes	Yes
1993	Canola					Eldorado (UA D)	na	Yes	Yes
1995	Canola			Quantum (UofA St)	na			Yes	Yes
1999	Canola			Q-2 (UofA St)	na			Yes	Yes
2000	Canola			Hi-Q (UofA St)	na			Yes	Yes
2001	Canola			Conquest RR (UofA St)	na			Yes	Yes
2002	Canola			Kelsey RR (UofA St)	na			Yes	Yes
2007	Canola	6,328	1,489	Clearfield C (UofA R)	na			Yes	Yes
2020	Canola	8,345	2,250						

* From Alto description (Kondra, Dehenhardt and Campbell 1991 Can. J. Sci. 71: 523-524 where Alto yield shown = Westar)
1982 – 2020 Production statistics drawn from Statistics Canada and Canola Council of Canada; na = Data unavailable; UofA = Univ. Alberta (Kondra et al); UofA St = Univ. Alberta (Stringam et al); UofA R = Univ. Alberta (Rahman et al); UofA D = Degenhardt, Stringam + Kondra); UofM = Univ. Manitoba (Stefansson et al); AAFC = Agriculture and Agri-Food Canada; RR = Roundup Ready © herbicide resistant; C = Clearfield herbicide resistant;

The most significant variety registration in the history of the Rapeseed / Canola transition occurred in 1974, with the University of Manitoba joint release by Stefansson and Kondra of the variety Tower, the very first 'double low' *Brassica napus* variety ever released anywhere. There have been very few reports or recognition of Professor Kondra's vital role in the three Eras of the march from Rapeseed to the 'double low' Canola, nor recognition of his research achievements in that journey, nor subsequently. Professor Kondra had started his rapeseed / canola journey in 1959 as a summer student technician with Stefansson at the University of Manitoba and completed postgraduate studies and a PostDoctoral Fellowship there, as well as a PhD in Saskatoon, where he worked with Downey at the University of Saskatchewan. His role in that journey, and subsequent successes breeding additional canola varieties at the University of Alberta is set out in Section (B). After the introduction of Tower the per acre yields and acreage of subsequent 'double low' varieties both increased very dramatically (Figure 1, next page). A 2020 Report for the Canadian Canola Council showed that the Canola crop impact on the Canadian economy was at that time worth $29.9 b/year, 60% through canola farming, with up to 207,000 fulltime equivalent jobs related to the canola industry.

Figure 1 Canola acreage and production in Canada in 2012
Graphics sources: 2022, Dr. Habibur Rahman, University of Alberta canola breeder

Note re Canola Yield in Canada (below): By 2012 95% of canola acreage was planted with high yielding hybrid varieties



Section (B): Zenon Kondra resets the bar with the first 'double low' Canola variety, and then higher Canola yields

The chronology of Kondra's journey with rapeseed research provides an excellent example of how modern research and 'breakthroughs' require the convergence of much prior work from many different scientists working in different laboratories on different things. This happens through networking and deliberate planning, and access to appropriate facilities and materials, often with a dose of serendipity and good luck thrown in for good measure. Many scientific breakthroughs occur that way, and the history of canola is no exception.

The erucic acid challenge:

Professor Kondra was actively involved in Canola development throughout all three 'Eras' described in Table 1, and in the pivotal oilseed grain quality programs underway both in Manitoba and Saskatoon. In 1960 and 1961 he spent the last two summers of his first degree program, a BSc (Agriculture) at the University of Manitoba, working in Dr. Stefansson's rapeseed breeding program, learning all the basic field-plot, greenhouse work, crossing and laboratory skills necessary for his future career in rapeseed breeding. He also created the materials for his subsequent MSc at the Plant Science Department, Manitoba, completed there in 1964, entitled 'The inheritance of erucic, eicosenoic and other fatty acid components of rapeseed oil (*Brassica napus* L.)'. From Dr. Hougen (Plant Science Professor of organic chemistry, Manitoba) he learned the gas chromatography skills needed to measure erucic acid, a new technique described in 1961 by Dr. Burton Craig, who had developed it at the National Research Council of Canada, Prairie Regional Laboratory in Saskatoon. Kondra was active in the Manitoba program when Stefansson, Hougen and Downey (1981) published an important but brief note describing the first identification of rape plants with erucic acid levels in the seed low enough to use in breeding a rapeseed oil product suitable for human consumption. They had identified 'a few erucic acid free' plants in a bulk seed-lot of the European forage rape *Brassica napus* variety 'Liho' obtained from Limburger Hof, Germany. These were the 'low erucic acid' plants used by Kondra in his MSc genetic studies about the genetic control of that trait, the prerequisite for any breeding program that targeted its incorporation. (As a reminder of the value of scientific networking and the incalculable value of access to highly skilled technical assistants, the Stefansson et al paper not only acknowledges the assistance for this work from Craig at NRC/PRL in Saskatoon, but also that of a Mrs. V. Bodo, laboratory assistant).

The glucosinolate challenge:

By 1966 Stefansson had released two more 'Rapeseed Era' *Brassica napus* varieties, Tanka (1963) and Target (1966). They had much improved agronomic characteristics and average yields 4 – 9% higher than previous *Brassica napus* varieties but did not have either of the 'double low' traits. While this work was continuing Kondra followed his goal to learn about how to improve the meal quality of rapeseed by variety breeding, which could add a great deal to the farm-gate value of rapeseed sales, and in the processing industry. He spent the 1964 – 1967 period at the University of Saskatchewan where he completed his PhD entitled 'Some environmental effects on and genetics of the isothiocyanate and oxazolidinethione content of seed meal of *Brassica napus* L. and *B. campestris* L.'. The chemistry is complex but, described just briefly here, the compounds that Kondra studied can be measured as an estimate of the level of glucosinolates in the high protein meal left over after rapeseed grain has been crushed to collect the oil. Glucosinolates are anti-nutrient factors which can cause feed intake reduction in mammals, iodine deficiency and organ decay (such as in the liver, kidney and thyroid gland). Oilseed meal that has lower amounts is of much higher value in animal feed.

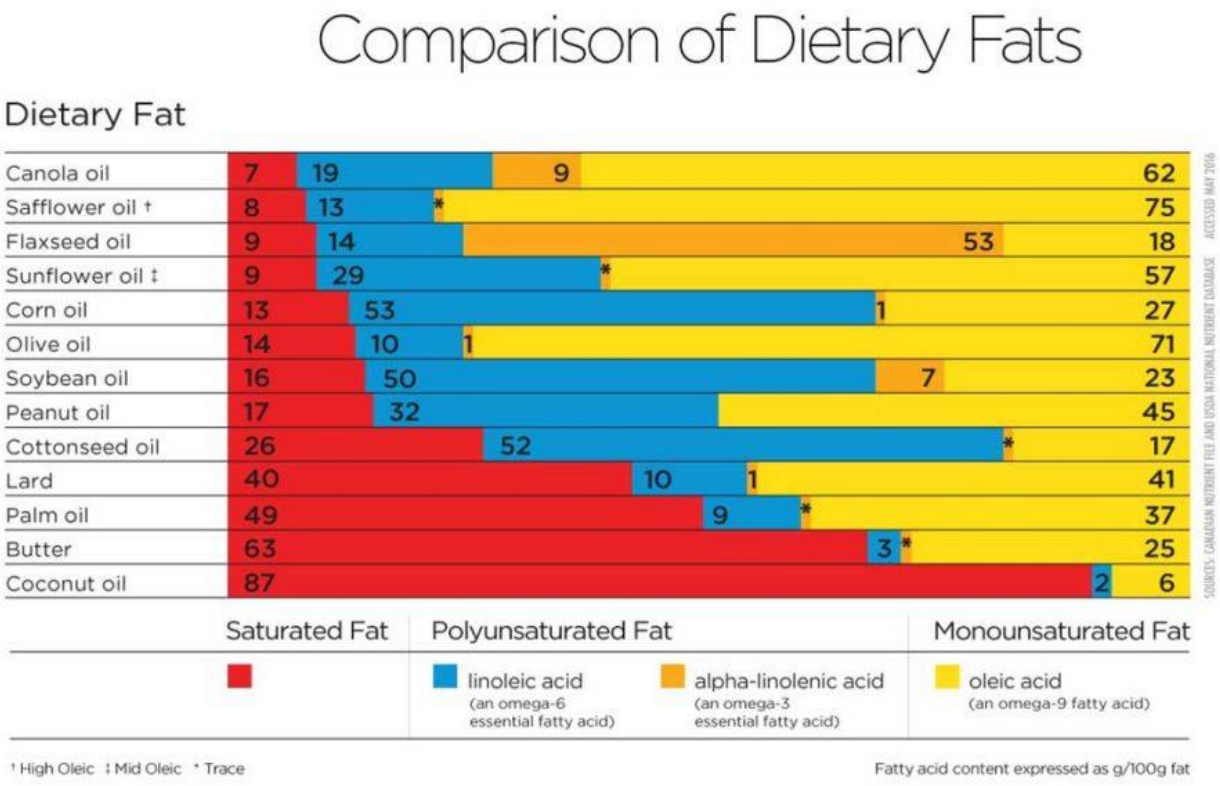
Research about how to genetically breed low glucosinolate levels into rapeseed had started in 1964, and Downey and Harvey (1963) had just devised the 'half-seed' method for assaying rapeseed seed quality. As reported by Kondra (1985) low glucosinolate content was discovered in the variety Bronowski (*Brassica napus*) in 1967 by Dr. J. Krzymanski, during his visit to the Agriculture Canada Research Station in Saskatoon, where he was a visiting scientist. Whilst all of these developments converging in Saskatoon enabled Kondra to carry out his own PhD studies about how glucosinolate levels varied according to the environment, it also later allowed Stefansson and Kondra to carry out the transfer of the low glucosinolate trait from Bronowski into what became their new 'double low' *Brassica* napus rapeseed variety. This was released as Tower by the University of Manitoba in 1974. Prior to that Kondra had managed the variety development that led up to its entry into the Cooperative trials, had already completed his PostDoctoral work with Stefansson at the

University of Manitoba, and had accepted the position of Assistant Professor of Oilseed and Special Crops at the Plant Science Department, University of Alberta, where he started in 1969.

Compared to other sources of dietary fats, the human nutritional benefits of Canola oil because of the lower levels of saturated fats show up clearly in Figure 2, following. Canadian Canola is low in erucic acid and other saturated fats, and from a human health perspective is superior to other sources of dietary fats.

Source retrieved 22/2/2022: https://canadianfoodfocus.org/canadian-food-stories/the-great-canadian-story-of-canola/

Figure 2



The challenge of the initially poorer agronomics of the 'double low' varieties: Kondra raises the yield bar

The first varieties with 'low erucic acid' or 'double low' quality in both species suffered from poor agronomic characteristics, such as lowered yield, late maturity, poor straw strength and a tendency for pod shattering, compared to the early 'rapeseed' varieties. As a result, the existing breeding programs in Winnipeg and Saskatoon focused on solving those productivity problems. On his arrival at the University of Alberta in 1969 Kondra also focused on those traits but also sought to increase yields in varieties that would be better suited to the shorter growing seasons found in central and Northern Alberta, and the entire Parkland zone throughout the Prairies. In 1978 he released Altex, the first of his higher yielding *Brassica napus* varieties, better adapted to a very large area of potential canola production in W. Canada. Altex was a very successful variety for many years, setting the new yield standard for the new 'double low' varieties, until the Agriculture Canada variety Westar took over substantial areas of production, and raised the target yield bar yet again (Table 1). Other new varieties that Kondra released, Andor and Alto, also helped to raise the yield bar for growers prior to Westar, a very important step in the start period for this new crop. The genetics of the other species (*Brassica rapa*) is more complex than for *Brassica napus* which makes it harder to create the 'double low' type, but two varieties of *Brassica rapa* derived from Kondra's program were also released after he retired, Eclipse and Eldorado (Table 1), which were more suitable for areas with very short seasons.

The long-term University of Alberta canola breeding program funding challenge:

Achieving the breeding success with Altex and his other varieties did not come easily to Kondra's program as funds, facilities and resources had to be created completely from scratch when he arrived in Edmonton, as none were yet in place. Unlike the canola programs in Winnipeg and Saskatoon which respectively received continuous long-term core Provincial and Federal funding, the Kondra breeding program never received any long-term stable core funding from any source, Provincial, Federal or private. It was always dependent on a continuous succession of short-term competitive grants to maintain its staffing and operational needs. The University of Alberta did provide one full-time technician in the early years and startup equipment funds for field operations and the quality laboratory but was usually severely underfunded compared to the real needs both in the field and in the laboratory. Despite these limitations Kondra was able to stay on the leading edge of the technologies needed in a modern canola breeding program. Briggs recalls almost weekly visits to Kondra's laboratory by the major manufacturers of gas liquid chromatography equipment, seeking sales of their latest technology that would be useful for better measuring canola quality. Much of the success in Kondra's program was due to the expert technical skills of individual technicians that he was able to attract to the program. Significant research contributions were made by Mike Bolan and Duncan Campbell (quality laboratory), Delbert Degenhardt (MSc student, field technician and then accredited canola breeder), Phil Thomas (fieldwork and breeding), Dr. Mohan Thiagarajah (PostDoctoral Fellow) and various graduate students. While working with Kondra, Dr. Thiagarajah worked out many of the microspore culture 'fast track' doubled haploidy techniques that were then successfully used for developing most of Dr. Stringam's later varieties bred at the University of Alberta, for which Mohan was acknowledged as a co-breeder. The technology and history of the use of this very efficient new method in canola breeding was reviewed in detail by Rahman, M. and de Jimenez, M. M. (2016).

In order to gain some additional funds returning to their wheat and canola breeding programs from successful varieties, Briggs and Kondra negotiated new policy at the University of Alberta which allowed Royalties to be charged on commercial seed sales of University varieties. At that time Plant Varieties did not fall under the Patents Act of Canada, so existing patent law could not be used for that purpose. Their approach was completely new to Western Canada for these crops, whereby the University of Alberta would seek bids from Seed Companies to take on the seed increase and marketing of new varieties, in exchange for a levy on the price of all commercial Pedigreed Seed sold, to be returned to the University for use by the breeding program. This new policy for the commercialization of new University varieties was very much criticized by the W. Canadian variety development and research community because it very slightly raised the cost of seed for growers. It remarkably quickly became the norm with the rapid privatization of canola breeding that soon occurred, especially as adoption of the 'double low' quality standard by the canola industry led to 95% of the canola acreage being planted from pedigreed seed on which a Royalty could be levied. For Kondra's program this still did not generate sufficient funds with which to maintain his breeding program, but it certainly helped. All the criticism that was received by the

University of Alberta about this policy became moot when in 1990 Federal Plant Breeder's Rights (PBR) legislation was enabled by the Canadian Food inspection Agency 'which provides legal protection to plant breeders of seed use for new plant varieties for up to ….20 years'. As a result of its new policies the University of Alberta later received multi-millions in royalties from subsequent canola variety releases from the program, that continued long after Kondra retired in 1988, even far exceeding the total of all other patent royalty income from all other Faculties at the University of Alberta. As soon as PBR legislation was approved the charging of Royalties on seed sales became a normal practice for all canola breeding programs in W. Canada.

Following Kondra's retirement in 1988 the Canola Council of Canada (CCC) expressed dismay as they had heard that this very effective University of Alberta breeding program of Kondra's would be closed down and that the breeding position would also be cancelled due to University budget cuts. Briggs, the newly appointed Chair of the Plant Science Department, was summoned to the CCC AGM in Vancouver to explain why this was happening. They were very surprised to hear from him that there was no intent to close the position at all, and that continuation of the breeding program was certainly not only the preferred outcome, but the expected one. They were also advised in no uncertain terms that this could only happen if the University of Alberta received some significant new funding sources to both retain the academin canola research position and to provide some level of continuing core funding for the program. Fortunately for all parties, and especially for the canola industry, a solution to the funding dilemma was found. Agriculture and Agri-Food Canada came forward with a proposal to relocate and fund the position of one of their staff members, Dr. Gary Stringam, to be appointed as a permanent staff member at the University of Alberta. Stringam was a senior plant researcher and had prior experience breeding canola in Saskatoon. A vital third party, the Alberta Wheat Pool, also came forward and offered to merge their own canola breeding program with that of the University of Alberta and to provide substantial operating funds for the program continuation. The needs of all three parties were all met in the final Tripartite Canola Breeding agreement that was signed, and this arrangement remained in place until Dr. Stringam's retirement in 2003. By the 2020's the canola industry has been able to create new trans-institutional longer term funding programs such as the collaborative 'Canola AgriScience Clusters' which provide much more stability for longer term funding of research especially at Universities. These funds more adequately meet the needs than in the past, and are collectively provided from seed companies, government, industry and seed sales and production checkoffs. Researchers can now spend more of their time on collaborative, multi-institutional research, rather than on chasing collections of smaller often elusive competitive grants, 'a required University of Alberta academic plant breeder task from bygone years' (Briggs, 2022 personal observation).

Upper: Field Research Stations where Kondra worked 1960-1964 / 1967-1969 — 1969-1988

The Point, Univ. of Manitoba

University of Saskatchewan Field Station

Edmonton Research Station (U of Alberta

Lower: The Co-breeders of the very first Canola Variety 1969-1988

Dr. Zenon Kondra (L) and Professor Baldur Stefansson (R) at the University of Manitoba.
Co-breeders of the first Canadian 'double low' Canola variety, Tower (1974)

Section (C): More University of Alberta canola breeding successes after Kondra and into the 2020's
- the Stringam /Rahman Era

When Dr. Kondra retired in 1988 he left a strong capability in place for future canola breeding efforts at the University of Alberta. This included a very substantial genetic resource, all the generations and germplasm accessions of his ongoing breeding program, up-to-date physical resources and equipment for fieldwork (including a custom-built Plant Sciences field station completed in 1983 on the South campus), and fully equipped laboratory, greenhouse and growth cabinet facilities in the new AgForestry Faculty building also completed in 1983. The addition of the Alberta Wheat Pool as a partner expanded the genetic resource base considerably, and also brought to the table expanded budget, field testing resources, staffing and seed industry and marketing connections. This was a very great contrast to what little resource was available for canola research at Kondra's 'startup' date in 1969. This was a substantial platform for Dr. Stringam to immediately put to use on his arrival in 1988. Of equal or perhaps greater value was the continuation of a number of experienced plant breeding staff from Kondra's program especially Delbert Degenhardt, plus Dr. Mohan Thiagarajah and his locally developed and emerging protocol for doubled haploid canola breeding in *Brassica napus*. The latter method was subsequently used extensively during Stringam's variety development work and contributed significantly to its ongoing successes.

About Professor Stringam's research and new Canola varieties from the University of Alberta:

Although Stringam also worked on *Brassica juncea* research and breeding, his paramount success was made in *Brassica napus*, with the release of five high yielding varieties between 1995 and 2002, when he retired (Table 1). The first of these varieties was the canola variety Quantum which was the first variety resistant to the severe canola disease named Blackleg, which would have otherwise completely decimated the canola crop across the Prairies. Blackleg was first discovered in fields in E. Central Saskatchewan, but then spread throughout the western Prairies to become a major concern. The details about Stringam's work experience and University program have already been widely documented (Bryson, 2015) and are described at length on the Canadian Canola Council website. His Quantum variety incorporated a gene for blackleg resistance that Stringam obtained from an Australian variety named Maluka. Kondra's legacy of improved canola quality germplasm played an extremely important part in the breeding of Quantum, as his variety Alto was the variety of choice into which Stringam transferred the blackleg resistance. To the author's knowledge Kondra has never received any recognition for that critical germplasm contribution that then allowed Quantum "to save the entire Canadian canola industry from a potential production level collapse due to blackleg disease", as the industry described it.

Quantum also set a new bar for high yield potential and suitable adaptation to a majority of the Prairie production area. Its' immediate widespread production generated considerable Royalties for the University of Alberta program, that in turn allowed program breeding objectives and staffing to be further expanded. It also allowed for an interim escape from the previous patterns of year to year program funding challenges, exactly as envisaged by the University seed checkoff policies initiated by Briggs and Kondra in the 1980's.

Two more Stringam varieties higher yielding than Quantum followed relatively quickly, Q-2 (1999) and Hi-Q (2000), followed by release of two herbicide resistant varieties. This latter response was due to new weed control technologies in the crop and grower demand for this type of canola, also paralleling a rapid increase in private seed company canola breeding following the introduction of Plant Breeder's Rights in 1990. The two herbicide resistant varieties released were both Roundup Ready © and were named Conquest (2001) and Kelsey (2002).

Consistent with his Professorial position, Dr. Stringam carried out much of his research with the help of graduate students in a wide diversity of areas. They included traditional and molecular genetics of important traits such as yield potential and other agronomic characteristics and resistance to an array of canola diseases, resistance to seedling insects and maggots, sourcing of useful genes from related and unrelated species, herbicide resistance, and breeding methods (including doubled haploidy, and the use of molecular markers as an assist in genetic selection.

Most of the Stringam basic research projects also involved extensive inter-institutional and private sector participation in research networks which have continued on very effectively into the subsequent Professor Rahman 'Era'. This was also a time when private seed companies were now also becoming very active centers in canola breeding, and where in recent years over 95% of the varieties in production are hybrid varieties (Rahman, 2021). As an example of that trend the 2019 Alberta Cereal and Oilseeds Variety Description table, that describes all varieties available to farmers, listed 26 recommended varieties, all of which are herbicide resistant (2 for Clearfield, 7 for Liberty Link and 17 for Roundup Ready), all registered and distributed by nine different seed companies, the result of almost complete privatization of canola breeding effort and outcomes in W. Canada by the 2020's.

About Professor Rahman's canola breeding background and his research at the University of Alberta:

Dr. Habibur Rahman joined the University of Alberta canola research program with a stellar prior background of practical variety breeding in canola. The notes presented here are drawn from a detailed review written about his career (Kanters, 2018) that started with his BSc and MSc at Bangladesh Agricultural University, followed by a PhD in Plant Breeding and Genetics at the Royal Veterinary and Agricultural University (current name Copenhagen University). After that, between 1989 and 2003, he was senior canola breeder with the Danish seed company Danisco Seed, where he solely or jointly released 47 spring and winter *Brassica napus* varieties. One of these was the variety Aviso which at one time captures 33% of the commercial winter canola acreage in France, and was blackleg resistant, the same breeding challenge that Stringam had recently cracked in Canada. On arrival in Edmonton Rahman already had experience with molecular genetics approaches to breeding, as well as the doubled haploid breeding method and goals applied to disease resistance, oil and protein quality, hybrid variety creation, and for the improvement of agronomic production traits.

On Rahman's arrival in Edmonton the very serious disease clubroot had recently been found for the first time by University of Alberta Professors 'JP' Tewari and Strelkov in commercial fields not far North of Edmonton, and the need for varieties with resistance to this disease was deemed very urgent. Both Tewari and Strelkov were Professors in the same Faculty of ALES Department as Professor Rahman (AFNS), so collaborative research on this threatening disease quickly ramped up, to better understand its biology and the genetics of rapeseed germplasm that might offer resistance to it. Using a combination of 'conventional' and molecular marker methods to achieve it, (described in the Kanters article) Rahman soon developed Canola quality lines that had single or double gene resistance to clubroot. This has proven to be a very hard disease for which to create canola plants with durable resistance and as of 2022 many recommended Canadian canola varieties still do not yet have lasting resistance. The University of Alberta canola research program still retains the goal of releasing new varieties, usually through linkages with private companies, but also recognizes that private seed companies have now substantially taken over that primary role for the Western Prairies. In recognition of this the University program has been able to expand its complementary basic research efforts in areas less easily carried out by industry. These include breeding methods research (especially for using novel molecular breeding techniques), clubroot and blackleg research, increasing the genetic diversity obtainable from winter canola and wide crosses, heterosis achievement to further improve the yields potential of hybrid varieties, the breeding of earliness of flowering and maturity without yield penalty, yellow seed color, and improvements in seed oil, meal protein content and other grain qualities (Kanters 2018). Of significance to canola growers, during his time at the University of Alberta Professor Rahman has already released seven canola varieties with special emphasis on herbicide resistance and he has gained novel successes in breeding resistance to the newest threat to canola, clubroot disease. Improved resistance to Sclerotinia stem rot continues to be sought, and Verticillium stripe has now emerged as the next disease that can cause major damage to the canola crops of the 2020's.

A summary of all eighteen varieties released that involved Kondra, Stringam or Rahman by 2022 is shown at the end of this article, and this work is continuing under Professor Rahman's direction. To view more information about Professor Rahman's program readers can visit the following URL:

https://apps.ualberta.ca/directory/person/hrahman/

Section (C): Postscript from Briggs, about the Canadian canola story and the University of Alberta role

Briggs, the sole author of this 'TALE of ALES #8, is a retired Professor Emeritus of Cereal Breeding and Agronomy of the Faculty of ALES, was also past Chair of the Departments of Plant Science and, later, Agricultural, Food and Nutritional Science in the Faculty. Although he never worked on the canola crop he is an enthusiastic supporter of the outstanding canola breeding achievements over the 53 years now elapsed by 2022 since Kondra was hired to start this program. In his opinion the University Agricultural Faculties should never stop reminding the agricultural community and the public at large about the poast multi-billion dollar contribution to the economy that can be attributed to astute Faculty of ALES staffing decisions, including those have related to the creation and continual improvement of the canola crop. Until this article only parts of the Kondra and University of Alberta canola story have been recorded, limited to fragmentary reporting of only the 'big canola outcomes', mostly those at other institutions. It was the intent of this article to record these canola developments in just one document, but with a specific focus on the long overlooked 'Kondra effect' on W. Canadian canola breeding programs and variety releases. With respect, Briggs suggests this full story needed to be told more fully, bringing to the fore that Professor Kondra was himself actually one of the founders (Fathers) of this crop, a reality virtually unknown in the agricultural community. This author also draws special attention here to three areas of achievement by the University of Alberta program for which both Dr. Kondra and the Faculty of ALES were responsible.

- The Faculty of ALES choice to hire Dr. Kondra to start the University rapeseed program in 1969, even before the very first canola quality variety Tower was even released in 1974 by the University of Manitoba, for which he was a co-breeder. Being a breeder of Tower was a pivotal achievement for which he has been barely recognized in any of the major historical accounts about the Canadian canola crop and in most, not at all. Over the years Kondra also built up the germplasm base, program staff, facilities and institutional networks from which subsequent University of Alberta canola program leaders benefited greatly, going forward. In Edmonton he also quickly reset the yield bar for what could be achieved, starting with the release of the widely adapted variety Altex, which farmers widely adopted and grew for many years as this new crop became established. Kondra was also the MSc program supervisor and then career-long mentor for Mr. Phil Thomas who became the leading Consultant and Extension Specialist in Alberta and W. Canada for 'all things canola', and who personally wrote the Canola Growers Manual, still used in an updated form by all canola growers in W. Canada.

- It surprised this author very much that Dr. Kondra has received almost no special recognition for this legacy of major contributions to the development of the canola crop and the personnel who work with it throughout W. Canada, neither provincially nor nationally. The author did discover that Zenon was awarded the Agradex International Award for Plant Breeding for Animal Nutrition. He received that award at the Canadian Feed Industry Association Annual Conference in Calgary, Alberta in June, 1978. Until his research for this story even this author was unaware that there were actually three founders of the canola crop, not just two. One of them was, indeed, Zenon Kondra with his research at the University of Manitoba, clearly a notable alumnus from that campus based on his continual achievements breeding improved varieties of canola. There has also been no attention even drawn to the use of Kondra's own variety Alto as the parent into which blaclekg resistance was first transferred, nor any estimate of the actual value of Alto in initially solving the early blackleg threat, previously described.

- Continuing excellent choices at the University of Alberta to hire Dr. Stringam and then Dr. Rahman as the replacement canola breeding Professors over time, who each arrived with major credentials and extensive prior rapeseed breeding experience. They both brought about the release of some extremely significant varieties for W. Canadian canola growers, particularly around control of blackleg and clubroot disease threats to the entire canola crop kind. Their particular stories have already been very justifiably told and recognized in many places. Additionally, their contributions to basic research discoveries, continuing after those by Kondra, and the application of the newest breeding technologies, were always at the forefront of their discipline. The seed industry and farming community likely best recognize the University of Alberta variety releases as the best visible outcomes from its' canola program but they rarely get to see that whole list in one place, as presented here, in what this

author believes to be a fitting conclusion to this script. The University of Manitoba can certainly claim credit for the roots of the varieties in this list, based on its role in developing the very first canola variety Tower, and from the subsequent and outstanding career outcomes enabled by one of its very significant Alumni, Professor Zenon Kondra, retired.

Breeder program source	Variety names and notes
Stefansson/Kondra	Tower (Registered by the UofM, Kondra co-breeder) The first Canola variety.
Kondra	Altex, Andor, Alto
Kondra	Eclipse, Eldorado (Jointly registered with Degenhardt after Kondra retired)
Stringam	Quantum, Q-2, Hi-Q
Stringam	Conquest, Kelsey (Both Roundup Ready © varieties)
Rahman	UA AlfaGold, UA BountyGold, UA CountyGold (Imidazoline herbicide resistant)
Rahman/DL Seeds	1918 (Glyphosate herb. tolerant)
NAG/Rahman	PV580GC, PV585GC (Both Glyphosate herb. tolerant + stacked clubroot Resist.)

(Notes: NAG = Bred by Nutrien AgSolutions, using Rahman source of clubroot resistance; Resist. = Resistance)

Photo credits: unsplash.com



An impressive University of Alberta canola variety breeding contribution, by any measure !

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Appendix 1

Some background about Professors Kondra and Briggs, longtime University of Manitoba and Alberta colleagues

Professors Briggs and Kondra named in the the essentially autobiographical TALES of ALES shared a great deal in common in their background suitability for academic careers both as Professors and as plant breeders of grain crops. This was especially the case for their contributions towards the creation of two entirely novel kinds of grain crop for use by Western Canadian grain farmers and processors, and in broadening the scope for Canadian agricultural access to novel grain markets. The reader will learn in this Appendix how the educational, research and even the family cultures of these two individuals are remarkably similar, (they note, on reflection, a surprise even to them) despite their upbringing in entirely different national and family cultures. The stories around each of the crops they worked with, and the 'first of their kind' varieties they produced is have many commonalities. Their initial meeting in 1965 was the start of a career-long professional and collegial association, as well as one that also included many common interests far beyond the world of work.

1. About Zenon (Zen) Kondra: A third generation Canadian, from Winnipeg, Manitoba

When Kondra and Briggs first met at the Department of Plant Science at the University of Manitoba in 1965, Kondra had already completed his BSc (Agriculture) and MSc (about rapeseed oil genetics and breeding) at the University of Manitoba. He had followed this up with a PhD (about rapeseed meal quality genetics and breeding) from the University of Saskatchewan where he studied with Dr. Keith Downey. Downey had been Principal Research Scientist at the Agriculture and Agri-Food Canada (AAFC) Research station, Saskatoon since 1958, also working on oilseed breeding, mostly on rapeseed. By 1965 Kondra had returned to the University of Manitoba as a Post-Doctoral fellow to work in Dr. Baldur Stefansson's ongoing rapeseed grain quality breeding program in the Faculty of Agriculture.

Stefansson had been appointed to the University of Manitoba in 1952 and became well-known for his suggestion and breeding efforts to lower the erucic acid content in rapeseed, and to add value to rapeseed meal by lowering the glucosinolate content. Kondra was an ideal addition to his program, having prior experience on both of these objectives. Kondra had already worked as a summer student technician for Stefansson during the previous four years, working to isolate a novel source of low erucic acid in rapeseed oil. In 1967 he also now brought with him hands-on expertise with two important techniques developed in Saskatoon at the National Research Council Laboratories and at AAFC, a 'half-seed' quality testing method, plus the use of novel Gas Liquid Chromatography technologies by which the seed quality could actually be measured. These techniques became the key to all future Canadian successes in developing a new kind of rapeseed variety that could be used for the production of an edible oil, and a non-toxic, high protein meal for feeding animals. In summary, Kondra was completely involved in the key development years as a researcher in both of the Canadian programs of Stefansson and Downey, that together enabled the development and commercialization of the new oilseed crop, first called 'double low' rapeseed, and later called Canola.

Kondra's grandparents had emigrated in 1898 from Hushtin, Western Ukraine, to an uncleared, wilderness homestead near Yorkton, Saskatchewan. One of their sons, Peter, started the family culture of becoming members of academia, with a stellar career as a Professor of Animal Science in the Faculty of Agriculture at the University of Manitoba. Peter Kondra's older son Zenon became a Professor of Plant Science at the University of Alberta in 1969 and retired in 1988, to complete 'Three Generations of University Professors' (Ewanchuk, 2000), Zenon's son Alexander also joined academia with appointments to Acadia University, Nova Scotia and then to Athabasca University, Alberta, where he has been Executive Director of the MBA program for the Faculty of Business. Ewanchuk draws attention to this significant century long Canadian contribution of the Kondra family to academia, a considerable family history and achievement which deserves recognition of itself (Briggs, 2022 Personal observation).

Kondra, as well as Briggs, was in the late 1960's working at the Plant Science Department, University of Manitoba, which was then receiving much international recognition in its establishment of a new man-made cereal crop, Triticale, a

new species created by combining the genetics of rye and wheat. The very first N. American commercial variety of Triticale was registered in Canada in 1969, named 'Rosner' (Shebeski et al 1970) and Triticale was then recognized as an official crop of commerce in Canada. (Triticale breeding programs were subsequently expanded internationally, and commercial production has also expanded to over 40 countries and over 3.8m hectares, to where it is now a preferred food component in some specialty grocery products and specialty breads, and as an animal feed). Because of this success with Triticale there was very much a 'can do' atmosphere around the Plant Science Department in the 1960's where breeding research was seen as a central pillar by which improvements for Canadian producers could be achieved. In retrospect, it was therefore no surprise that two other completely new crops would also soon emerge from this Institution, Canola and Canada Western Extra Strong (CWES) spring wheat.

2. About Keith Briggs: A first generation Canadian from Truro, Cornwall, England

Briggs was born in London, England but was raised in the west country, mostly in Cornwall. Always interested in the sciences and botany in particular he completed his first degree minoring in botany and zoology, graduating in 1964 with Honors in Genetics at Cambridge University, England, at Sidney Sussex College. This was a time when Crick and Watson had recently published their discoveries in Cambridge about how DNA controls inheritance in living organisms, and it was a place where a student could attend seminars by some of the world's leading geneticists.

Briggs gained a particular interest in the chromosomal genetics of plants from one of his Cambridge Professors (Dr. John Henderson) and in population genetics and selection theories from the internationally famous Professor John Thoday, a pioneer of the research in that area. These interests proved to be a strong base for his later career area. Briggs describes himself as having main interests in the applied sciences, so was quickly drawn towards further studies in agriculture and in plant breeding. To this end he completed a Diploma in Agricultural Science at Cambridge University in 1965, during which program he spent considerable time at the UK Plant Breeding Station located at Trumpington, close to Cambridge, gaining theoretical and practical field experience about how to breed cereal varieties. The special feature of this experience was that the instructors there were all the very best cereal breeders in the UK, including Dr. Ralph Riley (later knighted in the UK for his accomplishments as a plant researcher and cereal breeder). Briggs reports that he felt very privileged to have gained this 'on-the-job' experience from these globally recognized plant breeders, including interactions with many other leading cereal breeders who were there at that time (Drs. Francis Lupton, Dr. Colin Law and Dr. John Bingham, plus Dr. Dick Metcalfe (an Agriculture Canada, Winnipeg barley breeder / Post Doctoral Fellow visitor to Cambridge in 1964). This inspired Briggs to continue with further studies that would lead to qualifications to be a plant breeder.

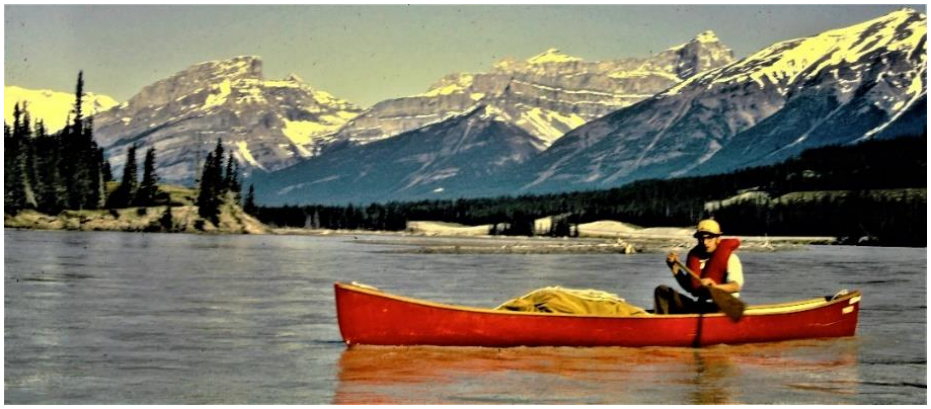
After an interview with a senior staff member from the University of Manitoba at the 10th International Botany Congress in Edinburgh in 1964 Briggs was later accepted for a MSc program in plant breeding at the Department of Plant Science, University of Manitoba, starting in 1965. His supervisor was the Dean of the Faculty of Agriculture, Leonard Shebeski, and the project was to study breeding methods for the improvement of yield and grain quality in Canadian spring wheats. The nature of the work soon allowed the MSc program to be directly upgraded to a PhD program which was completed in 1969. Briggs then moved to the Plant Science Department at the University of Alberta to be Assistant Professor in Cereal Crops, Genetics and Agronomy with a research emphasis on the breeding of varieties of wheat and barley adapted to Northern Alberta conditions. A direct product from the Briggs PhD Thesis work in Manitoba was his plant selection of the new wheat variety later registered by the University of Manitoba as 'Glenlea', the subject matter of TALES of ALES #7.

Unlike Zenon Kondra, Keith Briggs did not come from a family with any prior activity in academia, nor had any prior members of his family ever attended University or ever worked at one. At that time in the UK Briggs would have been described as from an urban middle-class family. Constituting but a very soft version of the major Kondra family heritage in academia, Keith's older brother Dr. Colin Briggs did become a Professor of Pharmacy at the University of Manitoba. Also, Keith's son Tony completed his MBA in the Business School at the University of British Columbia, followed by a PhD and other graduate studies in Boston, at MIT and the Questron School of Business at Boston University, plus employment and academic associations at Harvard University. Tony became an Executive Professor at the School of

Business, University of Alberta (Director of Innovation and Entrepreneurship, and Technology Commercialization Centre). However, there are no further family members forseen to enter the Professoriate in the near future. All this family related information has no direct relationship to the 'new crop' stories told in the TALES, but it does confirm how a family environment that is friendly and supportive to academic careers can run through the generations. Keith Briggs was appointed in 1969 as Assistant Professor of cereal breeding, genetics and agronomy in the Department of Plant Science, University of Alberta at the same time as Dr. Kondra, and retired in 1999 after 30 years in the Professoriate.

3. Kondra and Briggs common and uncommon interests beyond the Workplace

By 2023 Kondra and Briggs have been work and leisure-time associates for 58 years since 1965, and in the early days of their Professorships spent much time travelling Alberta together, to determine the specific needs of growers for varieties of oilseeds and cereals suitable for the very variable agricultural ecozones of the Province. As a bonus from these extensive agronomic research travels they not only learned which were the best Chinese restaurants from the South to the North of rural Alberta, but also both enjoyed camping and the outdoors, and photography along the way. Another common leisure-time interest of both was navigating some of the river routes throughout the Rocky Mountains and Foothills in multi-day trips, Briggs in his home-built kayak and Kondra in his canoe, shown below on the N. Saskatchewan River.



Zenon tackles the North Saskatchewan river
Too much work is never good for you, but river trips through the Rockies definitely are!

Keith tackles the North Saskatchewan river with his home-built kayak

Keith goes sailing on Lake Wabamun

Zenon (on the left) lands a big one!

As shown in the photos above, there were also a few major differences in their other outdoor interests. Kondra was an avid fisherman which he combined with canoe/camping in frequent expeditions to remote lakes in Saskatchewan and elsewhere (with other keen fishermen, since Briggs was not a fan of fishing). By contrast, Briggs was a keen small sailboat racer, a sport he enjoyed in England in his teens, and spent many of his summer weekends racing at Edmonton Yacht Club and Wabamun Sailing Club west of Edmonton. His greatest success was winning the International Canadian Contender Nationals Regatta held at Pigeon Lake in 1974. Kondra was more a fan of small boats that you could use for fishing, propelled by paddle, oars or motor! In the winter months the Kondra / Briggs duo also took a number of self-help evening courses together that could make them 'more handy' at home. They learned enough in the 'Home electrical wiring' and 'Basic welding' courses to decide that such activities should usually be left to the professionals. Briggs and Kondra were also fans of cross-country skiing in the Rocky Mountains. Science.