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Canola: An Emerging Oilseed Crop

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INTRODUCTION

Oilseed rape (*Brassica* and related species, Brassicaceae) is now the second largest oilseed crop in the world providing 13% of the world's supply. The world's commerce is largely supplied by two species, *Brassica napus* L. and *B. rapa* L. Both species contain both spring and winter forms that are distinguished by vernalization requirement. Seeds of these species commonly contain 40% or more oil and produce meals with 35 to 40% protein.

The term "canola" is a registered trademark of the Canadian Canola Association and refers to cultivars of oilseed rape that produce seed oils with less than 2% erucic acid (22:1) and meals with less than 30 µmol of aliphatic glucosinolates per gram. The development and subsequent release of the first canola-quality cultivars by plant breeding programs in Canada during the 1970s created a new, high-value oil and protein crop that has gained tremendous acceptance worldwide.

The fatty acid composition of the oil is genetically controlled and has been successfully manipulated to produce products specifically tailored for end use. Commodity canola oil today contains only traces of erucic acid, 5% to 8% saturated fats, 60% to 65% monosaturated fats, and 30% to 35% polyunsaturated fats. Canola oil is widely used as a cooking oil, salad oil, and in making margarine. It is appealing to health-conscious consumers because it has the lowest saturated fat content of all major edible vegetable oils.

The term "industrial rapeseed" does not have any regulatory basis but generally refers to oilseed rape cultivars that produce oils with 45% or more erucic acid and seed meals that are either high or low in glucosinolates. Cultivars with these characteristics are used primarily for non-edible purposes such as lubricants and hydraulic fluids.

The term "specialty canola" most often refers to canola-quality cultivars with improved oil profiles for use in high temperature or continuous frying. Specialty canola cultivars normally produce oils that contain less than 4% linolenic acid (18:3) and/or greater than 70% oleic acid (18:1). Oils from these cultivars have greater temperature stability and improved shelf life.

ORIGIN AND TAXONOMY

Brassica crops are among the oldest cultivated plants known to humans with written records dating back to ca. 1500 BCE (Prakash 1980) and archaeological evidence of its importance dating back to 5000 BCE (Yan 1990). *Brassica rapa* seems to have had the widest distribution historically. At least 2000 years ago it was distributed from northern Europe to China and Korea, with a primary center of diversity in the Himalayan region (Hedge 1976). *Brassica napus* is believed to have developed in the Mediterranean area where the wild forms of its ancestral species were sympatric. It is possible that *B. napus* arose in cultivation, since no wild forms are known. Production of oilseed *B. napus* probably started in Europe during the middle ages where its oil was used as a lamp oil.

In addition to *B. napus* L. and *B. rapa* L., *Brassica* includes cultivated species *B. carinata* Braun, *B. nigra* Koch, and *B. oleracea* L. The four most widely cultivated species *B. juncea*, *B. napus*, *B. oleracea*, and *B. rapa* are all highly polymorphic and include oilseed crops, root crops, and vegetables crops such as Chinese cabbage, broccoli, and Brussels sprouts. The relation-

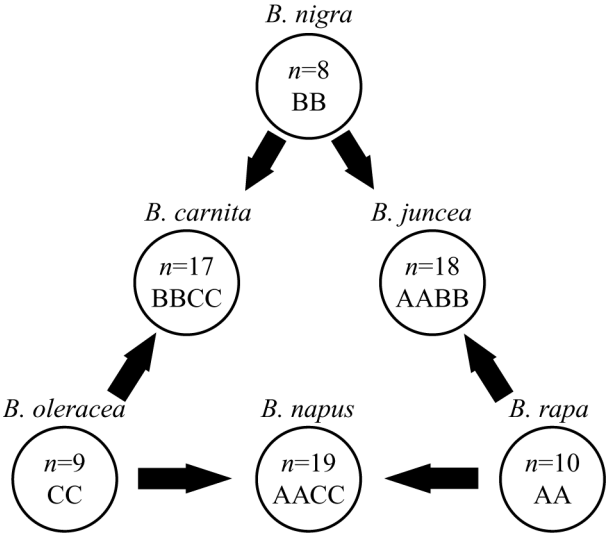

Fig. 1. The "Triangle of U" representing the genomic relationships among *Brassica* species.

ships among the cultivated species as presented in Fig. 1 were first clarified by Morinaga (1934) and verified by U (1935). *B. napus* (2*n*=38, AACC), *B. juncea* (2*n*=36, AABB), and *B. carinata* (2*n*=34, BBCC) are amphidiploids species resulting from combining chromosome sets of the low chromosome number species *B. nigra* (2*n*=16, BB), *B. oleracea* (2*n*=18, CC), and *B. rapa* (2*n*=20, AA).

CANOLA IN THE WORLD

Canola (oilseed rape) is now second only to soybean as the most important source of vegetable oil in the world (Table 1). During the past 20 years, this crop has passed peanut, sunflower and, most recently, cottonseed in worldwide production. In 2000–2001, world production of rapeseed/canola totaled 33.86 million tonnes (t) or 13% of oilseeds produced (ERS 2001).

Canola is produced extensively in Europe, Canada, Asia, Australia, and to a more limited extent here in the United States. The world's commerce is largely supplied by two species, *Brassica napus* L. and *B. rapa* L. and to a lesser extent by the mustards, *B. juncea* Coss. (brown mustard) and *Sinapis alba* L. (yellow mustard).

Winter type *B. napus* is the main oilseed rape crop in most of Europe and in parts of China. Spring type *B. napus* is produced in Canada, northern Europe, and China. In Australia and the southeastern United States, where winters are mild enough, spring type *B. napus* can be grown as a fall-planted winter crop.

Spring *B. rapa* occupies a substantial portion of Canadian production and is also grown in northern Europe, China, and India. Spring types of *B. juncea* are dominant in India and are also grown to a limited extent in Canada and Europe for condiment use (Sovero 1993).

CANOLA IN THE UNITED STATES

Oilseed rape has been grown on a limited scale as a crop in the United States since World War II, yet canola is still considered a *new* crop in the United States. Canola is a new crop in the United States in the sense that it has a relatively short history here. Significant domestic markets were not created until GRAS (Generally Recognized as Safe) status was granted by the FDA in 1985, allowing its oil to be used in foods marketed in the US.

In the United States, canola production is dominated by spring type *B. napus* and is grown largely as a spring-planted crop. Major production areas include the Northern Plains and the Pacific Northwest with very limited production in other regions. Winter type *B. napus* can be grown in the Midwest, Great Plains, and Eastern region of the US (Raymer et al. 1990).

Early expectations were that canola would take the United States by storm as this new, improved, and renamed version of rapeseed had done in Canada in the previous decade. Many experts projected three to four million hectares in the US by the turn of the century with broad scale adoption in the Midwest and Southeast.

Canola production in the US has increased dramatically over the last decade increasing from 60,000 ha to more than 650,000 ha in 2001 (NASS 2001) (Table 2). Average yields during the past ten years ranged from 1385 to 1622 kg/ha (NASS 2000) and were typically well above Canadian average yields. Even more

Table 1. World oilseed production, 1993/94 to 2000/01. Source: Foreign Agricultural Service, USDA.

	Production (million t)							
Oilseed	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01[z]
Soybeans	117.83	137.68	124.90	132.22	158.06	159.83	157.69	166.35
Cottonseed	28.94	32.32	35.15	33.61	34.39	32.49	33.05	32.86
Peanuts	24.23	27.37	27.47	28.96	27.29	29.82	29.15	29.55
Sunflower seed	20.60	23.34	25.72	23.80	23.21	26.13	26.39	23.85
Rapeseed/Canola	26.73	30.31	34.44	31.55	33.23	35.92	42.60	38.32
Copra	4.89	5.53	5.13	6.05	5.32	4.32	5.03	5.15
Palm kernel	4.14	4.52	4.87	5.21	5.05	5.62	6.20	6.43
Total	227.36	261.07	257.67	261.40	286.55	294.13	300.10	302.50

[z]Forecast.

encouraging is the growth in US demand for canola oil which has continued to out pace growth in domestic production. Demand for canola oil has grown from virtually zero in 1985, when domestic markets for canola oil were first created here, to almost 1 million t in 2001 (Fig. 2).

Although the current area planted to canola in the United States of 650,000 ha falls far short of those original projections, these production levels still verify that canola is the greatest new crop success in the United States since the development of soybean as an oilseed.

Unfortunately, the success of canola in the US is limited to only one region, the Northern Plains. Of 650,000 ha of canola produced in 2001 in the US, 556,000 ha or 87% of the US production were grown in North Dakota and most of those within a hundred kilometers of the Canadian border (Table 3). One could view virtually all of the US canola production simply as an extension of Canadian production since it is largely supported by Canadian infrastructure, Canadian varieties, and Canadian markets.

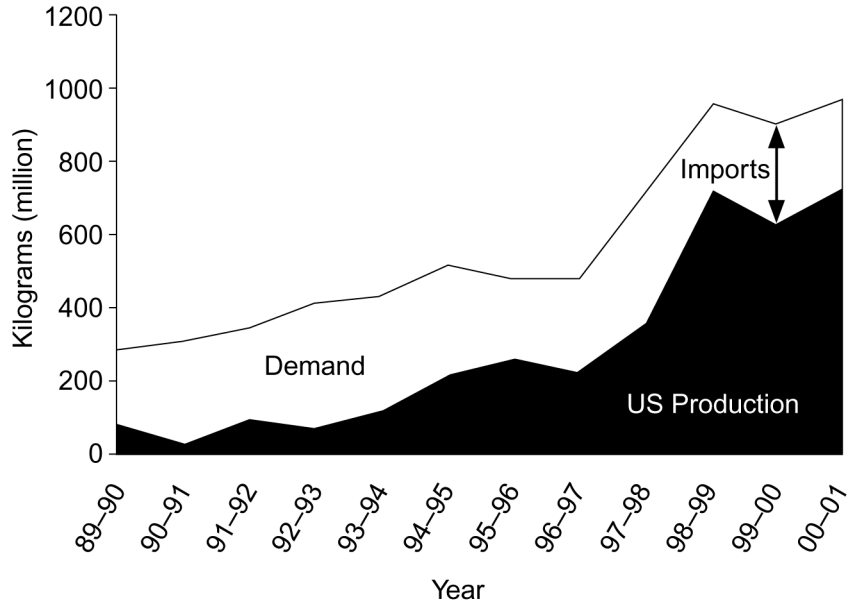

Fig. 2. United States demand and production of canola oil from 1989–1990 to 2000–2001.

Table 2. Canola area planted and harvested, yield, and production, United States, 1991–2000.

Year	Area (ha)		Yield (kg/ha)	Production (t)
	Planted	Harvested		
1991	62,727	59,489	1456	86,681
1992	97,126	45,325	1440	65,334
1993	80,533	75,677	1512	114,509
1994	143,260	137,595	1474	202,954
1995	180,492	173,612	1431	248,770
1996	148,521	140,427	1551	217,960
1997	271,547	255,359	1385	354,122
1998	451,229	435,446	1622	706,603
1999	435,446	422,496	1463	618,552
2000	608,249	590,443	--	--

Table 3. Distribution of US canola production 2001.

State	Production area	
	ha	% of total
North Dakota	566,562	87
Minnesota	40,469	6
Other states[z]	44,920	7

[z]Other states: AL, AZ, CA, GA, ID, IN, KS, MI, MT, MT, KY, OR, PA, SC, SD, and WA.

Factors Limiting Growth

It is true that several other production regions in the United States have demonstrated good potential for canola production, but they have experienced very little growth over the past fifteen years. Most other regions in the US are still struggling to develop or sustain viable canola industries. Introducing canola anywhere but in the Northern Plains has been largely unsuccessful due to the host of problems that are all too familiar to those of us who work routinely with new crops. Absence of local markets, unavailability of locally adapted varieties, lack of registered crop protection chemicals, reluctance of farmers to adopt a new crop, various production challenges, absence of infrastructure, meager research funds, limited crushing capacity, and strong world competition combined with no incentives for domestic production have each played a role in stifling commercialization efforts in one or more regions.

Probably the most common constraint is the formidable "chicken or egg" dilemma caused by the large initial production level that is required for profitable commercialization. Local crushers often require 20,000 ha or more of production in order to justify handling and switching facilities over to crush and market oil and meal. Without markets, growers have no incentive to grow the crop. In fact, several successful years of production back to back are necessary to build grower confidence and production of the crop to the size necessary to establish profitable and reliable local markets.

Factors Improving the Potential for Future Growth

Fortunately, some of the many barriers that stifled early commercialization efforts in the US have now come down. The "Freedom to Farm" philosophy reflected in the last farm bill removed many cropping restrictions and made it possible for producers to incorporate new crops, such as canola, into their production systems. Coverage of canola crops by Federal Crop Insurance, inclusion of canola and related oilseeds in the Commodity Loan Program at a favorable loan rate, registration of a host of new crop protection chemicals (Table 4), and the development of better adapted cultivars by publicly-funded regional breeding programs should greatly improve the chances of successful commercialization of canola in other regions of the US over the next 10 to 20 years.

The fifteen-year history of canola in the United States documents a harsh reality. The introduction of a new crop is a long-term undertaking, especially if attempted in the absence of a coordinated national policy that encourages and supports new crops research and development programs.

Table 4. US registered crop protection tools for canola.

Herbicides	Insecticides	Fungicides	Seed treatments
Assure II	Capture	Quadris	Allegiance FL, fungicide
Poast	ethyl parathion	Ronilan	Thiram, fungicide
Treflan	methyl parathion		Gaucho - insecticide
Liberty			Helix/Helix Xtra = insecticide/fungicide
Roundup			
Muster			
Select 2 EC			
Prism			
Beyond			
Sonalan (Tolerance only, Sec. 3 label expected soon)			

REFERENCES

Economic Research Service (ERS). 2001. Oil crops situation and outlook. OCS-2000, Oct. 2001. ERS, USDA. p. 66.

Hedge, I.C. 1976. A systematic and geographical survey of the world cruciferae. p. 1–45. In: J.G. Vaughn, A.J. MacLeod, and B.M.G. Jones (eds.), The biology and chemistry of Cruciferae. Academic Press, New York.

Morinaga, T. 1934. Interspecific hybridization in *Brassica*. The cytology of F_1 hybrids of *B. juncea* and *B. nigra*. Cytologia 6:62–67.

National Agricultural Statistics Service (NASS). 2000. Acreage. Agr. Stat. Board, NASS, USDA. Jun. 2000. p. 33.

National Agricultural Statistics Service (NASS). 2001. Acreage. Agr. Stat. Board, NASS, USDA. Jun. 2001. p. 17.

Prakash, S. 1980. Cruciferous oilseeds in India. p. 151–163. In: S. Tsunoda, K. Hinata, and C. Gomez-Campo (eds.), *Brassica* crops and wild allies. Biology and breeding. Japan Scient. Soc. Press, Tokyo.

Raymer, P.L., D.L. Auld, and K.A. Mahler. 1990. Agronomy of canola in the United States. p. 25–35. In: F. Shahidi (ed.), Canola and rapeseed: Production, chemistry, nutrition, and processing technology. Van Nostrand Rhienhold, New York.

Sovero, M. 1993. Rapeseed, a new oilseed crop for the United States. p. 302–307. In: J. Janick and J.E. Simon (eds.), New crops. Wiley, New York.

U, N. 1935. Genome analysis in *Brassica* with special reference to the experimental formation of *Brassica napus* and peculiar mode of fertilization. Japan. J. Bot. 7:389–452.

Yan, Z. 1990. Overview of rapeseed production and research in China. Proc. Int. Canola Conf. Potash and Phosphate Institute, Atlanta. p. 29–35.