Crop Profile for Dry Beans

I - Generalities

Authored by Mark Goodwin, Pulse Canada, February 2003.
Crop – Dry beans (including white and coloured) Phaseolus vulgaris
Regions – Alberta, Manitoba, southern Ontario. Small areas of Quebec and Saskatchewan

Short history and use

The crop is used primarily for human consumption and is a protein source for people in many countries around the world. World demand for dry beans is increasing. Recognized as a superb source of vegetable protein for human consumption, dry beans are an excellent low-fat source of complex carbohydrates, fiber, folate, potassium and B vitamins. (1)

Approximately 20 million tons of dry beans are produced yearly with a market value of 10 billion US dollars. Small farms in Mexico, Brazil, Central America, and Africa, account for about 80 percent of the world's annual production (1)

The crop has been grown continuously in southern Ontario since the 1940's. In the 1980's the crop began an acreage expansion in western Canada, primarily in Manitoba and the irrigated areas of Alberta (1).

Beans are adaptable to various growing situations. Their symbiotic relationship with nitrogen-fixing bacteria can help improve marginal soils.

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II – General commodity information

A- Production

In 2002, bean acreage and production hit record levels estimated at 218,000 hectares and 413,000 tonnes. Approximately 290,000 tonnes are destined for the export market. Production in 2002 is estimated to be 44% white beans, and 66% coloured beans. Canadian bean exports have more than doubled in the last ten years, and with higher quality varieties and new market classes being developed, are expected to grow in the future. (See Table 1 Appendix 1- Source Pulse Canada)

Dry beans are grown in southern Ontario, Manitoba and southern Alberta, with a small amount of production in Quebec and Saskatchewan. The following tables outline the production of both coloured and white beans.

Average yields are given in Table 3. Average yield of white and coloured beans are given separately in Tables 4 and 5. *Sources for Tables 1 through 5 - Pulse Canada data 2003*.

Table 1 - Canadian Pulse Production in tonnes

Year	Bean, white	Bean, coloured	Beans, Total
1991-1992	113,400	22,700	136,100
1992-1993	53,100	20,100	73,200
1993-1994	77,800	53,100	130,900
1994-1995	84,800	85,800	170,600
1995-1996	116,100	86,900	203,000
1996-1997	61,200	71,800	133,000
1997-1998	78,100	85,500	163,600
1998-1999	64,800	124,400	189,200
1999-2000	142,700	151,300	294,000
2000-2001	109,800	158,400	268,200
2001-2002	109,700	160,500	270,200

Table 2 - Canadian Harvest Area for Pulses (ha)

Year	Bean, white	Bean, coloured	Beans, Total
1991-1992	61,200	29,100	90,300
1992-1993	47,100	16,600	63,700
1993-1994	47,100	33,900	81,000
1994-1995	43,000	36,500	79,500
1995-1996	61,700	43,200	104,900
1996-1997	41,300	42,300	83,600
1997-1998	45,900	43,600	89,500
1998-1999	35,800	59,700	95,500
1999-2000	76,400	77,600	154,000
2000-2001	71,600	92,900	164,500
2001-2002	68,800	93,300	162,100

Table 3 - Basic Dry Bean Production Information by Region (2001)

Regions	Average Yield (t/ha)	Area Grown (ha)	Yield (t)	% of Canadian Production (t)
Quebec	2.01	8,400	16,900	6%
Ontario	1.35	46,200	62,600	23%
Manitoba	1.69	80,200	135,400	50%
Saskatchewan	1.70	5,000	8,500	3%
Alberta	2.10	22,300	46,800	17%
Canada	**1.67**	**162,100**	**270,200**	

Table 4 - Basic Production Information for White Beans by Region (2001)

Regions	Average Yield (t/ha)	Area Grown (ha)	Yield (t)	% of Canadian Prodn (t)	Cash Value (CDN)*	Yearly Production Costs (CDN)**
Quebec	2.00	2,500	5,000	5%	$ 2,880,000	$ 1,750,000
Ontario	1.38	24,100	33,200	30%	$ 19,123,200	$ 16,870,000
Manitoba	1.69	42,200	71,500	65%	$ 41,184,000	$ 29,540,000
Saskatchewan						
Alberta						
Canada	**1.59**	**68,800**	**109,700**		**$ 63,187,200**	**$ 48,160,000**

* 5-year average price of $0.28/lb or $576/ton

** Average total cost of $700/ha (includes inputs, equipment, interest, crop insurance, etc)

Table 5 - Basic Production Information for Coloured Beans by Region (2001)

Regions	Average Yield (t/ha)	Area Grown (ha)	Yield (t)	% of Canadian Prodn (t)	Cash Value (CDN)*	Yearly Production Costs (CDN)**
Quebec	2.02	5,900	11,900	7%	$ 6,854,400	$ 4,867,500
Ontario	1.33	22,100	29,400	18%	$ 16,934,400	$ 18,232,500
Manitoba	1.68	38,000	63,900	40%	$ 36,806,400	$ 31,350,000
Saskatchewan	1.70	5,000	8,500	5%	$ 4,896,000	$ 4,125,000
Alberta	2.10	22,300	46,800	29%	$ 26,956,800	$ 18,397,500
Canada	**1.72**	**93,300**	**160,500**		**$ 92,448,000**	**$ 76,972,500**

* 5-year average price of $0.28/lb or $576/ton

** Average total cost of $825/ha (includes inputs, equipment, interest, crop insurance, etc)

B – Quality

The Canadian Grain Commission established the official Grade Standards for dry bean grading. Grading factors ('pick') such as damaged or heated seeds, frozen seeds, immature beans, dirt tagged/stained seeds, foreign material, disease, seed uniformity, color and the presence of off-types are all considered when establishing a grade (3).

It should be noted that most bean processors establish their own grading criteria independent of CGC guidelines. Most buyers will purchase based on presented sample or set their own quality standards (4).

C- Market Diversity

Dry bean production in Canada can be classified into either white bean or coloured bean production. Both classes are grown in southern Ontario and southern Manitoba. Alberta grows coloured beans. A small bean industry also exists in Quebec and Saskatchewan (1).

Dry beans come in many different colours, sizes and shapes. Different markets have different cultural tastes and demand different sizes and colour. Some types of dry beans (both white and coloured) are depicted in the pictogram below (1).

Canadian research and development is developing novel processing methods and new products for bean-based foods. Quick-cooking and specialty products for niche markets are developing new opportunities for Canadian beans(1). Photos of bean types follow (2)

Great Northern

Other Names: Large White

Seeds/100g: 280-330

Black Turtle

Other Names: Black Bean, Preto

Seeds/100g: 500-550

Pink

Seeds/100g: 330-400

Dark Red Kidney

Seeds/100g: 150-200

Pinto

Seeds/100g: 260-300

White Kidney

Other Names: Alubia

Seeds/100g: 150-200

Light Red Kidney

Seeds/100g: 170-220

Dutch Brown

Seeds/100g: 210-300

Small Red

Other Names: Red Mexican

Seeds/100g: 275-330

White Pea

Other Names: Navy, Alubias Chica

Seeds/100g: 450-525

Cranberry

Other Names: Romano, Speckled Sugar

Seeds/100g: 145-225

D – Market Status

Canada exports beans all over the world, but the major importers of Canadian dry beans are the US (39%), UK (13%), Italy (5.3%) and Spain (4.8%), based on 2001 exports (1). Appendix A contains a full listing of the leading 50 countries that import Canadian dry beans. The tables below were provided by Pulse Canada.

Note that export by region figures is not available.

Table 6 - Supply and Demand Figures

	Thousand Metric Tonnes						
Crop Year	**Production**	**Imports (b)**	**Total Supply**	**Exports (b)**	**Total Domestic Use (d)**	**Ending Stocks**	**Average Price (e) $/t**
1991-1992	136	12	163	110	28	25	300
1992-1993	73	16	114	81	29	4	435
1993-1994	131	15	150	110	36	4	600
1994-1995	171	12	187	129	44	14	700
1995-1996	203	19	236	173	43	20	585
1996-1997	133	26	179	124	46	9	605
1997-1998	164	20	193	127	51	15	485
1998-1999	198	69	273	193	55	25	655
1999-2000	294	41	360	260	60	40	500
2000-2001	268	40	348	227	71	50	465
*2001-2002**	279	42	371	275	76	20	725
*2002-2003**	355	20	395	275	85	35	515-545

Source-Pulse Canada data 2003

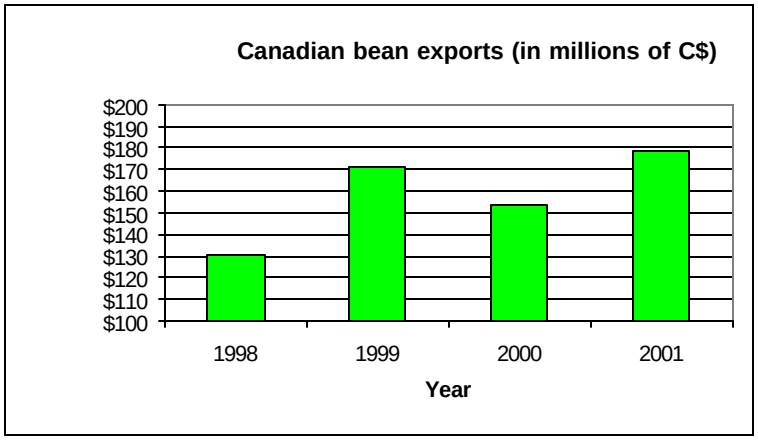

Figure 1. Dry bean exports by year. Source-Pulse Canada data 2003

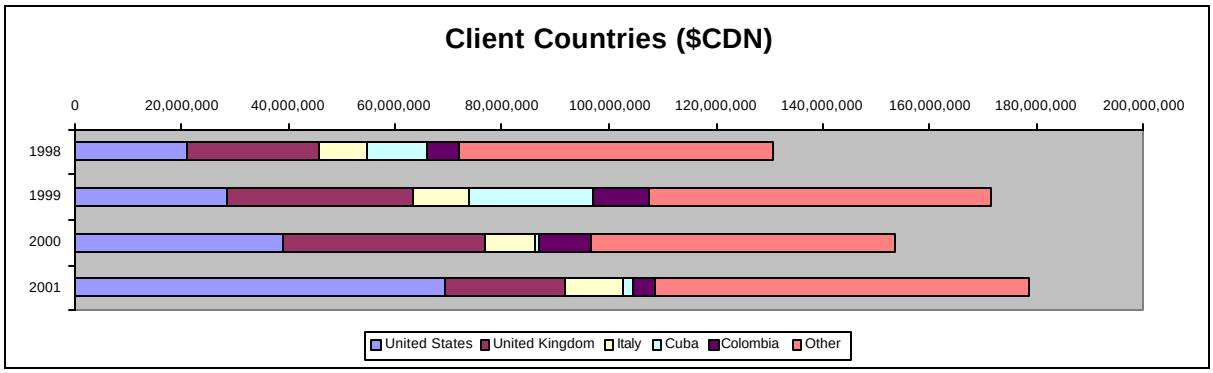

Figure 2. Dry bean exports by market. Source-Pulse Canada data 2003

These exports have steadily climbed since 1991, achieving a 440 percent increase in dollar amount exported to 2002 (1).

Of considerable threat to this export business is the status of European Union Directive 414/91, wherein 320-plus pesticides are to be withdrawn from the market in the EU. The EU itself is a key importer of Canadian beans. But additionally, smaller countries have in the past followed EU regulatory decisions. Thus as the products are withdrawn there will be some concern if bean pesticide maximum residue limits are affected (1).

III – Non-Pest Oriented Cultural Practices

A – Crop Rotation

Manitoba (4)

The recommended crop rotation for Manitoba is dry beans once every three years. The majority of producers will follow this rotation, usually having beans following a cereal (i.e. cereal-dry beans-cereal). Some producers with potatoes in their rotation will have beans follow the potatoes, and use the built up nutrients in the soil from the potato crop as their fertilizer source. The rationale behind the three-year rotation is to reduce disease pressure, as well as manage any volunteer bean issues if growing different types of beans. Volunteer beans will commonly be seen in the first two seasons following a bean crop. If a producer grows navy beans one year, and then a different type of bean (i.e. pinto) two years later, they may have a volunteer navy bean problem, which could downgrade the sample. Some volunteer crops in beans are easier to control with in-crop chemical treatment than others (i.e. flax, canola and peas are hard to control).

Some producers will push the recommended rotation to grow beans every other year, with the major influence for this decision being market related (bean prices are good and/or other crop prices are poor). A very small amount of producers will grow beans back-to-back for a couple years, but this is quite rare, and not recommended.

Ontario(7)
The recommended crop rotation for Ontario is dry beans once every four or five years. Producers also need to keep in mind that soybean and dry beans share a lot of diseases and insects, and need to plan accordingly when growing these crops. A typical rotation usually consists of corn-dry beans-winter wheat-soybeans-corn. Some producers will grow dry beans once every three years, or even once every second year, but this is quite rare.

Alberta (5)
The recommended crop rotation for Alberta is dry beans once every three to four years, and usually consists of dry beans-cereal-sugar beets. Producers pay close attention to what crop has been grown the year before, and how easy any volunteers of that crop will be to control in their dry beans. They also need to be aware of other host crops that share diseases with dry beans (such as canola and sunflowers, who share white mould/sclerotinia).

B – Types and Varieties

There are two basic types of dry edible beans, determinate (bush) or indeterminate (vining or trailing). Cultivars may be classified according to plant types. For example, navy beans may be either of the bush or vining type. In the determinate type, stem elongation ceases when the terminal flower racemes of the main stem or lateral branches have developed. On indeterminate types, flowering and pod filling will continue simultaneously or alternately as long as temperature and moisture permits growth to occur (4).

In addition to the distinction between determinate and indeterminate plant types, plant growth habits have been identified. These growth types are rated on a scale from 1-9, with a 1 being upright/bush type and a 9 being vine type. These growth habits have become useful in identification and classification of new bean cultivars.
The major classes of beans grown are: Navy (also referred to as white or white pea beans); Pinto; Kidney (light red, dark red and white) and Cranberry; Black (sometimes referred to as Black Turtle), Small Red (also referred to as Small Mexican Red), Brown, Pink and Great Northern, etc) (1)

Manitoba
The following table shows the most recent reported area, by bean class, for Manitoba, along with the most popular variety. Navy beans have the best disease resistance to white mould (a major disease for Manitoba). (8)

Table 7. Manitoba Crop Insurance Corporation 2002 Reported Hectares- Source – Manitoba Crop Insurance Corporation data, Portage la Prairie MB 2003

Dry Edible Beans	Ave. Plant Growth Type**	2002 Hectares		2001 Hectares	% Increase	2002 Main Variety (% Share)
Navy (White Pea)	3-5	56,286		42,817	31%	Envoy (71%)
Pinto	7-8	31,926		22,395	43%	AC Pintoba (55%)
Kidney & Cranberry	1-2	7,667		6,288	22%	
Red Kidney			5,293	4,480	18%	ROG 802 (46%)
Cranberry			2,288	1,675	37%	Messina (48%)
White Kidney			87	134	-35%	GTS 401 (65%)
Other		30,573		17,756	72%	
Black	2-4		21,844	11,871	84%	AC Harblack (93%)
Small Red	4-6		3,075	1,963	57%	Cajun (50%)
Brown	4-6		642	240	167%	Berna (100%)
Pink	5-7		2,257	750	201%	ROG 312 (95%)
Great Northern	5-7		2,754	2,933	-6%	Mattehorn (60%)
Other			6	0		
Total Hectares		126,452		89,256	42%	

* Manitoba Crop Insurance Corporation (MCIC) estimates that over 90% of the acreage grown is reported, and thus represented here. ** 1=upright/bush type; 9=vine type

It should be noted that only around 50% of the bean areas are grown from certified seed in Manitoba, although those numbers are increasing as producers knowledge of the benefits of certified seed increases. Some of these benefits are proper seed treatment, decreased risk of disease and quality of seed (ie. max. allowable cracked seed coats, etc).(4)

Ontario

The following table shows the most recent reported bean area, by bean class, for Ontario. It should be noted that white bean area has fluctuated dramatically over the last few years (from 36,500 ha in 1995, to 10,300 ha in 1998, back up to 27,200 ha in 1999), while Manitoba production of white beans rose from 9,600 ha in 1995, to 29,400 ha in 1999. Ontario has been producing dry beans for around 50 years, and has well-established production practices, and high use of certified seed (approximately 90%). Ontario also has the highest incidence of disease and

insect pressure, due partly to the years of dry beans in their rotation but also potentially because of environmental conditions (7,9).

Table 8
Ontario 2002 Hectares (Projected)

Dry Edible Beans	Ave. Plant Growth Type**	2002 Hectares		2001 Hectares	% Increase	2002 Main Variety(ies)
Navy (White Pea)	3-5	**40,500**		**23,490**	**72%**	OAC Thunder, AC Trident, AC Mast
Pinto	7-8					
Kidney & Cranberry	1-2	**14,256**		**12,393**	**15%**	
Dark Red Kidney			5,468	4,253	29%	Montcalm
Light Red Kidney			2,430	2,430	0%	California Early, AC Elks
Cranberry			5,873	5,468	7%	SVM Tailored Cran
White Kidney			486	243	100%	no predominent variety
Other		**5,265**		**2,957**	**78%**	
Black	2-4		3,240	2,025	60%	no predominent variety
Small Red	4-6					
Brown	4-6					
Pink	5-7					
Great Northern	5-7					
Other			2,025	932	117%	
Total Hectares		**60,021**		**38,840**	**55%**	

* Based on Ontario White Bean Producers Marketing Board projections
** 1=upright/bush type; 9=vine type

Source – Ontario White Bean Association

Alberta

The following table shows the most recent reported bean area, by bean class, for Alberta. Dry beans are produced on irrigated land in southern Alberta. (5)

Table 9. Bean type and variety information for Alberta
Agricore United's 2002 Alberta Contracted Hectares

Dry Edible Beans	Ave. Plant Growth Type**	2002 Hectares		2001 Hectares	% Increase	2002 Main Variety (% Share)
Navy (White Pea)	3-5				-	
Pinto	7-8	**10,530**		**9,720**	**8%**	Orthello
Kidney & Cranberry	1-2					
Red Kidney						
Cranberry						
White Kidney						
Other		**10,571**		**11,097**	**-5%**	
Black			243	162	50%	no predominent variety
Small Red	2-4		2,835	2,430	17%	483
Brown	4-6					
Pink	4-6		1,013	810	25%	Viva
Great Northern	5-7		6,480	7,695	-16%	1140, CDC Crocus
Other	5-7					
Total Hectares		**21,101**		**20,817**	**1%**	

* Agricore United estimates that they contract 90% of the acreage grown, and thus represented here
** 1=upright/bush type; 9=vine type

Source – Agricore United, Taber AB

C – Crop Establishment

(i) Seeding

Manitoba (4)

Manitoba has both row-cropped and solid-seeded bean production, although the majority (75%) is row-cropped. The row-cropped beans are grown on farms with other row-crops in their rotation (such as corn or potatoes), where the solid-seeded acres tend to be grown in areas or on farms that seed mostly cereals & oilseeds.

Typically, a producer will leave standing straw from the previous to trap snow over winter and decrease erosion. A pre-emergent herbicide is commonly used in the spring to control grasses and broadleaf weeds. Growers will then cultivate the field to incorporate the pre-emergent herbicide, as well as to blacken the soil and warm up the seed bed. Cultivating is also important since dry beans tend to have non-aggressive roots, that are ineffective in penetrating hard soils, reducing yields substantially.

Around 70% of the navy and black bean area, and virtually all the other bean area (pinto, kidney, cranberry, etc), are row-crop seeded (22-36" row spacing). The seeding rate for row-crops is roughly around 170,000 plants/ha. The crop is seeded with a row-crop planter, and then usually cultivated between the rows at least twice throughout the growing season.

The other 30% of the navy and black bean area is grown mostly in the western areas of Manitoba, and are solid seeded with conventional seeding equipment (ie. air seeder, press drill). The seeding rate for solid seeded crops is roughly around 250,000 plants/ha. It is also very important in a solid seeded stand to have an even seed bed, with little to no stones, in order to decrease the amount of earth tag when harvesting. The bean plant pod lays virtually flat on the ground at harvest. Some producers will roll their fields immediately after seeding to even out the seedbed.

Ontario (7)

Ontario has both narrow (20" or less) and wide (30-36") row-crops, as well as solid-seeded dry bean production. Generally, producers will work the field at least once before planting, although around 15% of producers are minimum or no-till, seeding directly into standing stubble (usually corn stubble). No-till producers, will typically use a chemical burn-down product, such as glyphosate, before seeding. Some of the other producers will use a pre-emergent herbicide before seeding, although the usage of these isn't as common as in Manitoba.

Around 80% of the white and black beans are row-cropped (65% being narrow row-cropped, with 15% being wide row-cropped). The other 20% are solid-seeded. For the other classes of beans grown, virtually all (90%) are row-cropped in a wide row.

Alberta (5)

Alberta grows all their dry beans on irrigated land in southern Alberta, and virtually all (95%) is planted in row-crops with 22" spacing. Most producers have, or have had, sugar beets in their rotation, so they own all the row-crop equipment already. In the spring, a pre-emergent herbicide is commonly used (90%) to control grasses and broadleaf weeds. They will normally cultivate the field to incorporate the pre-emergent herbicide before seeding.

(ii) Fertilization

Manitoba (4)
Most bean acres require nitrogen (N), phosphorous (P), potassium (K) and sulphur (S) to maximize production. Even though beans are legumes, the use of inoculants is not recommended. The vast majority of producers will apply their NPK fertilizer before seeding, either in the spring, or the fall before. The method of application will depend on each producers operation (ie. broadcasting, knifing into the ground, etc). General fertilizer recommendations for field beans are 100-250 kg/ha of N (less for row-crops, summer-fallow land or land with manure applied), 75-100 lb/ha of P, 75-150 kg/ha of K and 50 lb/ha of S. Dry beans will respond positively to zinc where the nutrient is deficient. If it is used, it is normally applied at 25-37 kg/ha in the spring with the NPKS, or 5-8 kg/ha as an in-crop foliar application (usually combined with an existing fungicide pass).

Ontario (7)
Ontario follows very similar fertilization practices as Manitoba.

Alberta (5)
Alberta also follows similar fertilization practices to Manitoba, although growers in that province are also starting to apply their nitrogen through pivot irrigation, rather than before seeding. This practice is becoming more common, with around 30% of the bean area treated this way. Although not common, some growers also add micronutrient foliar feeding along with their fungicide applications (at 50% bloom, and then early pod fill).

D – Specialized Production Systems

Not applicable.

E – Crop Cycle/Growth Stages

The crop is grown as a spring seeded annual. It reaches flowering in mid-summer and is harvested in August/September. (4)

Row-cropped beans may be sprayed through the growing season with a herbicide if the weed population warrants it, although the pre-emergent herbicide application plus the between row cultivation can both work together to minimize this occurrence. The crop will typically be sprayed twice with a fungicide, where warranted by disease pressure.(4,5,7)

Virtually all the solid seeded fields will be sprayed throughout the growing season at least once with a herbicide to control weed growth. The crop may also be sprayed up to twice with a fungicide, where warranted by disease pressure. (4,5,7)

F – Utilization of Plant Growth Regulators

None.

G – Harvest Practices

Manitoba (4)
Most row-cropped beans are undercut at harvest, which slices the roots off and lays the plant down on the ground. The beans will then be windrowed into a swath, which shakes off some of the dirt and helps to cushion the beans during harvest (The more product going through the combine at once at harvest, the more of a cushion to the beans). When the beans dry-down to 18-20% moisture, the grower will bring in a conventional combine to pick up the swath and harvest the crop. Typically the combine has slight modifications to minimize the risk of cracking the seed, which could downgrade the product, thus decreasing the value.

On lighter soils, a producer may have the option of pulling the beans (pulls whole root system out and lays the plant onto the ground), and then windrowing and combining. This isn't a very common practice in Manitoba. A small number of producers (15%) may just swath their row-crops where the field is flat and even and they won't pick up a lot of dirt during swathing. This has potential to give a better quality sample with Navy beans and black beans than if they were undercut.

For a solid seeded crop, around 40-50% of producers will use some form of chemical desiccation (either diquat or a glyphosate burn-off), depending on the growing season. The crop is most commonly swathed and then combined, although some producers will use a straight cut flex-header on their combine, allowing them to combine the standing crop. But not all producers can justify the additional cost of a flex-header for their combine.

Ontario(7)
Most white and black beans are straight cut with a flex-header on the combine. The other wide row-cropped beans are mostly pulled, and then windrowed and combined. Around 60-75% of producers will use some sort of chemical pre-harvest/desiccant (most use a glyphosate pre-harvest product, with around 25% using a true desiccant such as diquat.

Alberta (5)
Almost all (90%) of the row-cropped dry beans are undercut into a paired row and then combined, with the remaining 10% being pulled, windrowed and then combined. Agricore United (the processor that contracts the majority of the dry bean acres) strongly recommends against a pre-harvest/desiccant application, and most producers abide by this recommendation.(5)

H - Post-harvest Practices

Dry beans have a thin seed coat and need to be handled gently to minimize damage to the seed. Small hairline cracks to the seed coat will discount the product, as these small cracks will widen when processed making the beans unappealing to the canner (5).

Improper moisture content at harvest can also be an issue. Beans are often stored and traded at 17 per cent seed moisture content, but are considered dry at 16 per cent. Drying beans below seed moisture content of 16 per cent makes the seed coat more fragile and susceptible to cracking or splitting when handled. Beans can also be discounted if they are too dry (<15 per cent seed moisture content) (6). Foreign material can also lead to dockage. Corn and pea seed can be difficult to separate and are especially a problem (7).

Manitoba (4)

A significant amount of the crop is delivered straight from the field to the contracted processor without ever being stored on the producer's farm. This is mostly due to the fact that a lot of the crop is forward contracted, so the producer has already signed a contract with the processor before the crop is even planted. (6)

The small quantity of beans that is stored on farm needs to be stored in hopper bottom bins, preferably with aeration. Most bean producers will use a conveyor to get the beans into the bin, versus the typical grain auger, as a conveyor will minimize the risk of cracking the seed coat. Some producers will also have bean ladders in their bin. To minimize the damage beans receive when dropped into the top of the bin. Beans will roll down the angled ladders to the bottom of the bin, protecting them from damage. Some producers will choose to store their beans in a shed with a concrete floor, and load/unload their beans with a front-end loader.(6)

There are very few producers who will clean their own beans. Producers planning to use their own beans for seed (rather than purchasing certified seed), typically will take them to a professional seed cleaner who has the proper equipment to handle the beans while minimizing the risk of damaging the seed coat. (6)

Ontario (7)

Post-harvest practices in Ontario are very similar to Manitoba, with around 80-90% of the dry beans area coming directly off the field to the processor, without any on-farm storage. Producers who do have on-farm storage will have some modifications to minimize damage, including hopper bottom bins with aeration and bean ladders, and belt conveyors to move the bins into/out of the bins.

Since virtually all the area In Ontario is seeded with purchased certified seed, producers will not be involved with on-farm cleaning.

Alberta (5)

Virtually all the dry beans are delivered straight off the combine into the Agricore United processing plant, with no on-farm storage or handling.

I- Worker availability/activity

The crop is largely grown by owner operator/growers and is highly mechanized.

J. Pruning and nutrient management

Pruning not applicable. Fertility is discussed under 'Crop Establishment'.

IV – Production Problems

A-Introduction

There is a lack of efficient control methods for broadleaf weed control in dry beans. There is also a need for a reduced risk product for white mould control and bacterial bean blight. Resistance problems include ACCase resistant wild oats, ACCase resistant Setaria species and ALS inhibitor resistant broadleaf weeds.(4, 5, 7) A list of priority needs is included in *'Section V. Critical Needs'*. Significance of these limitations is discussed specifically under each pest in Sections C, D, E.

Integrated pest management information is available from provincial government extension services, with locations throughout rural communities. There is no specific research being conducted at universities that centre specifically on pulses. This field is researched in an uncoordinated way at universities, federal research stations (on an ad hoc basis) by growers associations.

Safety issues relate chiefly to occupational exposure as the grower or hired assistance applies pesticides. The highest level of exposure occurs during mixing of the concentrate. Specific recommendations relating to safety equipment used are given on specific labels.

There are no figures available on specific intensity of use of pesticides that may be detrimental to beneficial insects but in general, all insecticides are commonly used in the crop have the potential for harming beneficial predators (e.g. lacewings, lady beetles).

Many of the issues related to management of bean production problems stem from the fact that this crop often does not receive the amount of research attention is required. The diversity of classes and varieties within the crop creates a wide range of management practices.

There are no genetically modified market classes of this crop. There are no quarantine issues associated with this crop.

B – Non-pest Problems

i) Summary

A list of priority areas is found in *Section V Critical Needs*. There is one main category of priority need in dry beans. That need relates to weather and more specifically to the need to have varieties that match the seasonal requirement of the area in Canada growing season. (4,7,5)

Most of the non-pest problems are common to in all growing regions of Canada. Since the crop is not tolerant to frost, one of the highest priorities with dry bean production is assuring a minimum risk of frost damage in the spring or fall. (4,7,5)

The second most critical factor that affects crop potential relates to seed quality and source. The seed itself needs to be of the highest quality. In order to germinate quickly, and produce a strong, healthy plant, the seed must have been produced with minimum disease pressure, and must be treated with an appropriate seed treatment to control disease (and maybe insect pressure, depending on the area grown). It also needs to be handled properly when put into the ground, to make sure that the growing point is not damaged, and the seed hull is not cracked. (4)

Some other factors that will influence a crop's potential are (i) the amount of rainfall it receives during the growing season (especially any excessive rainfall, or extended periods of high moisture), (ii) the pH level of the field (beans will not tolerate salinity of 8.0 pH or greater), and (iii) the amount of exposure to airborne pollution (can cause a situation commonly referred to as bronzing). (4)

ii) Key Factors

- Frost – Beans do not tolerate frost well at any time throughout the growing season. Producers can minimize spring frost risk by planting into a warm seed bed (pre-seeding cultivation), choosing shorter season varieties, and putting off seeding as long as possible. If the crop is set back by frost, there is an increased risk of disease, as well a likelihood of delayed maturity. In Ontario, the growing season is long enough that if a crop has enough damage from a spring frost, a producer may be able to reseed the crop. (7) However, in Manitoba and Southern Alberta this usually isn't an option, since the growing season is not long enough. (4,5) A fall frost will greatly affect the quality of the seed (discoloration of seed coat and seed hull degradation). If there is significant damage from frost, it will downgrade the crop by increasing the pick, which will negatively affect the price a producer receives. Any frost on a crop within the first week of swathing/undercutting/desiccating will have some effect on quality of the beans, depending on the moisture content and the amount of frost. (4,5,7)
- Quality of the Seed – The quality of the seed that goes into the ground is very important when trying to maximize production. The seed itself needs to be from a good seed source, with 16-18% moisture, low amounts of cracked seed, has been grown under minimum disease pressure, and is treated with a seed treatment for disease (and potentially an insecticide). Producers need to be careful when handling the seed before putting it into the ground, so they do not damage the growing point, or crack the seed hull (thus increasing

the risk of disease). If improperly handled, a damaged seed can cause what is referred to as a baldhead, which will germinate but not produce a strong, healthy plant. (5,6)

- Seed Treatment – An appropriate seed treatment is integral for dry beans. One of the most popular seed treatments in Canada is a mix of diazinon, captan and thiophanate methyl (6% diazinon, 18% captan, 14% thiophanate-methyl). This product will help control seedling blight, seed rot and seed-borne anthracnose (if seed is not severely infected with anthracnose). (4,5,7) It will also help control root maggots. Captan is another seed treatment that is used (30% captan), and is common on seed imported from the US. This will help control seedling blight and seed rot. One of the major issues in Canada is the limited amount of seed treatments that are available for use in Canada. In the US, producers have been using streptomycin. Canadian producers have been allowed to import streptomycin treated seed from the U.S. under special permit from PMRA in the past. As of 2003, this practice will no longer be permitted. (1)
- Excessive Rainfall – Dry beans do not tolerate excessive rainfall well, especially if it results in standing water. A row-crop will recover quicker from excessive rainfall, since the producer can cultivate between the rows to get rid of some of that moisture. High amounts of moisture also provide ideal conditions for disease growth, especially in solid seeded stands, or with indeterminate varieties (vining growth types), since they will have a thicker canopy that will trap the moisture for longer periods. (4)
- Alkalinity/salinity – Beans do not tolerate alkaline or saline fields very well.(5)
- Bronzing – Bronzing is an issue for Ontario producers. (7) Bronzing is reddish-brown flecking of the leaves, which is caused by airborne pollution. This pollution can cause the tissue of the leaf to die, which is seen by the reddish-brown discoloration. While this is quite visually apparent, and disturbing, most dry bean crops can handle up to 30-40% defoliation (either by bronzing, or even insect damage) before it will start to effect yield. This is quite common in areas of Ontario with high amounts of airborne pollution. The only way of minimizing this is choosing an appropriate variety, since there seems to be some variety specificity.(7)

C – Plant Pathogens/Diseases

i. Summary

A complete list of priority needs is given under *Section V – Critical Needs*. Disease is the biggest production problem dry bean growers face in Canada. There is a lack control measures that are efficient and reduced risk. These are discussed by specific pest organism in subsections (ii) and (iv) below. Specific priority needs are discussed in *V. Critical Industry Needs*.

Some diseases are seed-borne (such as anthracnose and bacterial blight), and can be minimized by the use of a proper seed treatment, and the use of disease free seed. (4,5,7) Certified seed is highly recommended. (5) Other disease problems over-winter in the soil (such as root rot, rust and white mould/sclerotinia), and have various other commonly grown host crops which help increase the risk of disease in a field. Producers have commonly used preventative practices, which help decrease the risk of disease (ie. using certified seed, growing varieties/classes of beans which are more disease resistant, increasing the airflow under the canopy to make less than

ideal conditions for the disease to flourish, and adhering to a proper rotation), but if weather conditions are ideal for the disease, it can flourish despite all the producer's best efforts.(5,7)

In these instances, reactive measures are necessary.

ii. Key Factors by Pathogen

- Anthracnose (*Colletotrichum lindemuthianum*) (10, 11)

  Host Crops - Dry beans, Fababeans
  Biology - The fungus that causes anthracnose is seed- and stubble-borne. Temperatures of 13–26º C with an optimum of 17º C favor production of spores and initial infection. Relative humidity above 92% and free moisture also favors infection. Frequent showers, especially when accompanied by driving winds can bring on epidemics.

- Bacterial Blight , Common Blight (*Xanthomonas campestris pv. phaseoli*), Halo Blight (*Pseudomonas syringae pv. phaseolicola*), Brown spot (*Pseudomonas syringae pv. Syringae) (10,12)*

  Host Crops - Dry beans
  Biology - Hail, blowing sand, or wind whipping, followed by rain, often trigger bacterial blights. Bacterial blights are also spread if bean rows are cultivated while leaves are wet. Halo blight may occur any time during the cropping season. Typical symptoms are small brown spots that are surrounded by a light-green or yellow halo. The halo ranges from dime-size to the size of a quarter. A toxin produced by the halo blight bacterium causes the halo. This toxin is produced when the temperatures are less than 21º C for at least part of the day. In hot weather, halo blight will resemble bacterial brown spot. Bacterial blight lesions can also occur on pods. Both diseases are carried on the seed and can be spread from plant to plant by rain, hail, irrigation, or wind. In the soil, blight can survive in old diseased plants for a year or longer.

- Root Rot (*Fusarium solani, Rhizoctonia solani* and *Pythium species*) (10,12,7)

  Host Crops - Dry beans, sunflowers
  Biology – The fungi causing root rot are soil borne. Root rotting fungi can attack any part of the root system and even the lower portion of the stem at the soil line. When young seedlings are infected with root rot, they usually die. Infected plants may appear yellowed and stunted. Root rot pathogens are also responsible for seed decay and seedling blight in beans.

- Rust (*Uromyces phaseoli*) (10,12)

  Host Crops - Dry beans
  Biology – Symptoms first appear as white, slightly raised spots on the lower surfaces of leaves. Small red blisters are then formed on leaves, stems and pods. The lower leaves are the most severely infected. Heavy leaf loss is common. Occasionally, rust will

appear on pods but rust on bean stems is rare. Wind, people, and implements spread the disease

- White Mould/Sclerotinia (*Sclerotinia sclerotiorum*) (10,12)

Host Crops - Dry beans, field peas, canola, sunflowers, lentils, mustard, and potatoes
Biology - The fungus overwinters as hard black bodies or sclerotia in crop debris and in the soil. The disease cycle begins with the germination of the sclerotia to produce small, mushroom-like structures. Warm (15-25º C), wet weather, 1-2 weeks before flowering, coupled with a thick bean canopy favor the development of this disease. Once the "mushrooms" have matured, each of them can release up to 2 million spores over a 5-10 day period. These spores germinate and infect bean plants, aided by a dead food source (usually the bean blossoms or pedals). The disease develops most rapidly at temperatures of 20-25º C. The fungus can spread from the dead blossoms to adjacent flowers, stems, leaves, and pods within 2-3 days. The sclerotia formed may persist in the harvested pods and seed, fall to the soil, or remain in the crop residue.

iii. Pest Assessment

❖ Monitoring

Note that monitoring of the crop occurs on a weekly to semi weekly basis, with the initial rounds of scouting occurring to deal with weeds that are germinating. By mid- to late-July, efforts focus on disease monitoring. Most growers do their own scouting or will use the services of the dealer who sells them their crop protection chemicals. Monitoring of seed quality is undertaken by some key bean contractors (i.e. Agricore United).

❖ Forecasting

No pest forecasting systems are in use in wide scale in any of the dry bean areas.

❖ Use of thresholds

Economic thresholds are not developed for pests in this crop in any of the regions.

There are 'rules of thumb' that are followed. Beans are sprayed for anthracnose if the disease shows on foliage up to podding time. Beyond this, there is insufficient work done in this area. As another example, beans are sprayed for white mould if the bean field has at least an average yield potential, if white mould is a common problem in the area, and if weather has been wet for 1-2 weeks before flowering. There is also a

diagnostic test that can be done which measures the spore load on petals before they fall, but this is very labor intensive and not commonly used.

❖ **Use of advisory services**

The higher value of dry beans has led to a small number of independent consultants who advise growers on pest problems. The bulk of the dry bean growers rely on industry partners such as dealers or seed processors for information and advice on pest assessments.

iv. Pest Management

Preventive Measures

- Cultural practices
  - ❖ Growing beans no more frequently than one year in four is a major cultural pest control technique.

  - ❖ Anthracnose –. Use certified seed or seed with a low disease rating (preferably seed with an anthracnose DOME rating of 3 or less), include varieties that have more resistance to the common races of anthracnose. Adhere to proper rotations (beans no more than once every 3 or 4 years).

  - ❖ Bacterial blights – Use certified seed or seed with a low disease rating (preferably seed with a bacterial blight DOME rating of 3 or less). Include varieties that have more resistance. More determinate plants, with an upright/bush type growth pattern will have more resistance since these plants receives more airflow. Decrease the seeding rate (to provide adequate airflow). Do not over-irrigate. Turn under affected plant debris as soon as possible (to allow enough time for it to disintegrate over winter). If disease is present do not cultivate or pass through the crop when leaves are wet (to decrease spreading of the disease). Adhere to proper rotations (beans no more than once every 3 or 4 years).

  - ➢ Root rot – Producers should be sure to seed into a warm, slightly moist, well drained seed bed, at proper depths to ensure quick emergence. Use a seed treatment such as DCT (6% diazinon, 18% captan, 14% thiophanate-methyl. Include varieties which have more resistance. Do not over irrigate. Use higher rates of nitrogen (helps root system regrow if stressed by disease). Adhere to proper rotations (host crops no more than once every 3 or 4 years).
  - ➢ Rust - Most of the commonly grown dry bean cultivars are susceptible to one or more races of the rust fungus. The earlier the rust is evident, the higher the impact on yield. Include varieties which have more resistance, classes of beans which are more resistant, decreases the seeding rate, do not over irrigate, prompt crop destruction after harvest (if this is not done, rust can continue to develop and serve as a major source of inoculum), and adhere to proper rotations.

- Sclerotinia stem rot is a common disease with other host crops so proper rotations with these crops are the best preventative measure. Include varieties which have more resistance, classes of beans which are more resistant, decreasing the seeding rate, do not over irrigate but rather irrigate 8-12 hours after fungicide application (to increase effectiveness of fungicide), and adhere to proper rotations.

- Quarantine measures
  - None applicable.

Reactive Measures

- Anthracnose – Headline has been recently registered for anthracnose control in dry beans. Seed treatments can also be effective. (E.g. a mix of diazinon, captan and thiophanate methyl (6% diazinon, 18% captan, 14% thiophanate-methyl). This will only be effective if seed is not severely infected),

- Bacterial diseases - Some producers will apply blue stone (copper sulphate) or other copper-based fungicides in-crop, but this is a preventive measure, and the treatment must be applied on an on-going basis (every 5-7 days if moisture conditions persist). For most coloured bean growers the treatment of choice has been streptomycin as a seed treatment (imported seed only). This importation permission is being withdrawn by PMRA. There is no seed treatment for use in Canada that will control bacterial blight, but a copper Sulphate/Vitaflo 280® registration is pending.

- Root rot – No reactive measures available.

- Rust - Headline® is a recent registration that may be used for control of this disease.

- Sclerotinia – Ronilan® can be used for this disease but there are some concerns with regards to exports to the U.S. of bean seed from crop that has been treated with this product. This is applied at early to mid-bloom, with a second pass 7-14 days later if disease persists, or weather conditions are favorable for disease development.

Discussion by region

- Manitoba (4,10)
  - Anthracnose – This is a common seed-borne disease, and the disease is present in 40-60% of the seeded area (although the area with a severe enough infection to cause yield/quality loss is closer to 20-30%). Producers are very interested in a newly registered in-crop fungicide (Headline®), which will be available for the first time in the 2003/2004 growing season.

- Bacterial Blight –Depending on the year, 50-70% of the seeded area has some disease present (see AAFC Bacterial Blight Incidence Survey in Appendix B). Some producers will use a copper based in-crop fungicide product, but this is not very common.
- Root Rot – While this disease isn't very common now, it is increasing in Manitoba. As more beans are being grown year-after-year and the amount of disease in the soil is increasing. Around 10-20% of the seed area can be affected.
- Rust – Depending on the year, 20-30% of the seeded area can be affected. Headline® (a new fungicide) will be available for the first time in the 2003/2004 growing season.
- White Mould (*Sclerotinia*) – Most common disease in Manitoba. Depending on the year, 60-80% of the seeded area is affected. Around 90% of affected area will be sprayed every year with an in-crop chemical control product (Benlate® in the past and currently, Ronilan®).

- Ontario (7)
  - Anthracnose –With over 90% of the fields using certified seed (sourced from disease free fields and/or growing areas) there are very few fields with this problem.
  - Bacterial Blight – Again, with virtually all the fields using disease free certified seed, this generally isn't a problem. Even if conditions are ideal, there may be 5% of the fields affected. Bacterial seed treatments/foliar sprays of copper products can be used for this disease.
  - Root Rot – Will vary greatly based on the growing season, but is one of the most common diseases in Ontario.
  - White Mould (*Sclerotinia*) – Affected area has been pretty sporadic lately, but if given ideal growing conditions this increases. If growing conditions are ideal for the disease, most producers will apply an in-crop chemical control product (usually Ronilan), assuming there is a crop there to protect.
- Alberta (5,12)
  - Bacterial Blight – Depending on the year, 50-70% of the seeded area is affected (see AAFC Bacterial Blight Incidence Survey in Appendix A), although much less actually suffer yield losses (appx 10-20%).
  - Root Rot (*Rhizoctonia)* – can be a small problem in Alberta, especially if the grower follows a host crop such as sugar beets with beans. If it has been a problem in the area, some producers will try and seed later, and a little shallower to get the crop out of the ground quicker.
  - White Mould (*Sclerotinia*) – Most common disease in Alberta, with virtually all seeded area infected. Virtually all acres are sprayed with a split application fungicide (usually Ronilan®).
  - Unique Bacterial Problem – Alberta has some occurrences of an as-of-yet unidentified bacterial problem. During late plant development (when seed pods are starting to fill), these bacteria will infect a seemingly healthy crop and the plant will shut down prematurely before the pods fill completely. This seems to hit hardest on Great Northern beans (more indeterminate, vining/trailing varieties). Scientists are still studying this disease. Some producers have used a copper based in-crop product, which seems to control it to some extent.

Table 10. Summary information on disease levels in dry beans.

Region	Disease	% ha infected	% ha treated	Yield loss (%)	Yield loss ($)	Avg % efficacy of products	Problem priority level
All	Anthracnose	40 to 60	40 to 60	20	$50-100	90	1 (E)
All	Bacterial blight	49 to 100	50 to 70	0 to 30	$0 to 150	60	1 (Re)
All	Root rot	10 to 50	100	0 to 20	$0 to 100	90	1 (Re, H)
Manitoba	Rust	20 to 30	0	0 to 20	$0 to 100	90	2
All	White mould	Varies (ON). 60 to 100 (MB,AB)	0 to 100	0 to 30	$0 to 100	80	1 (E)
Alberta	Bacterial wilt	Unknown	0	Unknown	Unknown	Unknown	1 (E)

Sources used – 4,5,6,7

A survey conducted by Stratus follows. This gives the intensity and usage of current pest control tools in dry beans as reported by growers. The survey was conducted in western Canada only and no data was available for Ontario. Seed treatments are presented and then fungicide usage

Table 11. Seed treatments in dry beans

	Total Market			By Province in 2002			By Soil Zone in 2002 [2]		
	2001	2002	Chg	AB/BC	SK	MB	Black	Dark Brown	Brown
Base Size	49	19		3	6	10	16	1	2
% of Growers Using	69.4%	56.4%	-13.0						
Seeded Acres (000's) [1]	305	388	27.3%	60	13	315	356	11	22
Application Intensity (%)	77.7%	80.4%	2.7		7.1	98.8	87.7		
Acres Treated	237	312	31.7%		1	311	312		
Diseases		172				172	172		
Insects									
Both		1			1		1		
Don't Know		139				139	139		
Expenditures ($000's)	$711	$1,532	115.5%		$1	$1,531	$1,532		
Average Cost ($/acre)	$3.00	$4.91	63.6%		$0.75	$4.92	$4.91		

Sources used – Stratus Survey (13)

Foliar fungicide use in dry beans

	Total Market			By Province in 2002			By Soil Zone in 2002 [2]		
	2001	2002	Chg	AB/BC	SK	MB	Black	Dark Brown	Brown
Base Size	49	63		12	3	48	50		13
Using Fungicides (%)	59.2	56.7	-2.6	91.7		50.0	47.5		84.6
Seeded Acres [1]	305	388	27.3%	60	13	315	323		65
Application Intensity (%)	68.0	38.0	-30.0	84.7		30.7	29.9		78.2
Application Acres (000's)	207	148	-28.8%	51		97	97		51
Botrytis	36	33	-6.5%	16		18	18		16
Sclerotinia	160	117	-27.1%	35		82	82		35
Expenditures ($000)	$5,118	$3,887	-24.0%	$1,514		$2,374	$2,374		$1,514
Average Cost ($/acre)	$24.67	$26.34	6.7%	$29.79		$24.52	$24.52		$29.79

[1] Statistics Canada - June Estimate of Principal Field Crop Areas

[2] Post-emergent grass/broadleaf products are reported under both "post-emergent grass" and "post-emergent broadleaf" categories

[3] Seeded acres by soil zone based on distribution of acres reported in survey sample

Sources used – Stratus Survey (13)

D – Weeds

i. Summary

Specific priority needs are addressed in *Section V. Critical Industry Needs.*

Field beans are not competitive and severe yield losses will occur even from low weed pressure. Some weeds, such as perennial weeds (i.e. Canada thistle, sow thistle and quack grass) can not be chemically controlled in-crop, so high pressure of these weeds will influence whether or not dry beans are grown on a field. Other weeds are harder to control in-crop (such as wild buckwheat and volunteer canola/flax/peas) so producers must take into account the amount of these weeds in a field when planning their rotation. Weeds may also harbour diseases that can be transmitted to the crop. Green weeds, or high moisture weed seeds (ie. berries, etc) present at harvest can reduce crop quality through staining of the beans.(4,5)

Another major weed issue dry bean producers have to consider is past use of herbicides and their residual in the soil. Dry beans are very sensitive to residual from several commonly used herbicides, and should not be seeded into a field that has had that herbicide applied for the last 1-2 years. Examples of some of these restrictions (14), and the amount of months after application before you can grow beans, are:

- Accord® (quinclorac; 24 months)
- Ally® (metsulfuron methyl; 48 months)
- Amber ® (triasulfuron; 48 months)
- Assert® (imazamethabenz; 24-36 months)
- Attain/Trophy® (fluroxypyr; 22 months)
- Banvel II ® – high rate (dicamba; 12 months)
- Curtail M® /Eclipse® /Prevail® /FlaxMax® /Lontrel® /Prestige® (clopyralid; 22 months)
- Everest ® (flucarbazone-sodium; 24 months)
- Muster ® (ethametsulfuron-methyl; 22 months)
- Prepass® (florasulam; 12 months)
- Pursuit/Odyssey ® (imazethapyr; 12 months)
- Reflex® (fomesafen; 12 months)
- Tordon® (picloram acid; 60 months)
- Unity ® (bromoxynil and triasulfuron; 12 months)

ii. Key Factors by Weed or Group of Weeds

- **Broadleaf Weeds (4,5,7)**
  - Commonly Found Weed Species in Dry Bean Producing Areas – Wild buckwheat (Polygonum convolvulus), ragweed, nightshade, redroot pigweed, lamb's-quarters. No specific survey numbers are available with respect to actual infestation levels. Nightshade is an annual weed that can cause yield reductions, but is particularly troublesome because of its high moisture berries, at harvest. If these berries go through the combine with the beans, they can cause seed coat staining, as well as increased dirt tagging. Nightshade also flourishes without the benefit of direct sunlight, so a dry bean canopy provides little competition against the weed's mid and late-season development.
  - Biology – These broadleaf weeds are annual weeds, which can cause yield losses if not controlled early.
  - Percent of Hectares Affected – 60% in Alberta and Ontario, 45% in Manitoba.
  - Percent of Hectares Treated – 100%
  - Potential Crop Damage – Up to 70% yield loss if high weed pressure.
- **Grassy Weeds(4,5,7)**
  - Commonly Found Weed Species in Bean Producing Areas – Barnyardgrass, Green foxtail (Setaria viridis) in Manitoba, wild mustard, wild oats (Avena fatua L.). No specific survey numbers are available with respect to actual infestation levels.
  - Biology – These grassy weeds are annual weeds, which can cause yield losses if not controlled early.
  - Percent of Hectares Affected – 60%
  - Percent of Hectares Treated – 100%
  - Potential Crop Damage – Up to 50% yield loss if high weed pressure.
- **Perennials(4,5,7)**
  - Commonly Found Weed Species in Bean Producing Areas – Canada thistle (Cirsium arvense), sow thistle (Sonchus arvensis), quack grass (Elytrigia repens)
  - Biology – Perennial weeds tend to have extensive creeping rootstock, which frequently produces shoots that will then produce a new plant. They also tend to readily regenerate through either seed germination, or root fragments (normally they can regenerate from as

little as an inch of root fragment). Most of the perennial weed seeds will germinate within a year, but some may remain viable in the soil for up to twenty years or more. Due to their perennial nature, they are hard to control since the entire plant including rootstock must be killed in order to prevent re-growth. Control of these perennial weeds should be done in the year previous to bean production.

- Percent of Hectares Affected – 15 to 35%
- Percent of Hectares Treated – 100%
- Potential Crop Damage – Up to 50% yield loss if high weed pressure.

- **Volunteer Crops (4,5,7)**
  - Problem Volunteer Crops in Beans – Canola, cereals, corn.
  - Biology – Volunteer crops are annual weeds, which can cause yield losses if not controlled early.
  - Percent of Hectares Affected – 10%
  - Percent of Hectares Treated – 10%
  - Potential Crop Damage – Up to 30% yield loss if high weed pressure.

Special note on Herbicide resistant weeds

- Resistant weeds are starting to become more of a problem in some areas, since the amount of in-crop chemical control products registered for dry beans is limited. Some examples of problem herbicide resistant weeds are kochia (*Kochia scoparia*) resistant to group 2 herbicides, and green/yellow foxtail is resistant to group 1 & 3 herbicides.

i. Pest Assessment (2,3,7)

- **Monitoring**
  - It is best to begin monitoring for weeds immediately after seeding to minimize duration of competition.
- **Forecasting**
  - No formal models available.
- **Use of Thresholds**
  - None available.
- **Availability of IPM and/or ICM Programs**
  - Best control measures are keeping fields clean in years outside of bean production.

ii. Pest Management (2, 3, 7)

Preventive Measures

- Cultural practices
  - Seed into fields with low weed pressure, since there are limited chemical control measures available.
  - Volunteers – The best practice is to have a cereal the year prior to the bean crop since these are easier to control. Managing the harvesting operation so that a minimum of seed is thrown out the back of the combine will minimize the problem in the following year.
- Quarantine measures

- None applicable.

Reactive Measures

- **Chemical control**
  - Annual weeds can be partially controlled with a pre-seeding burn off with a glyphosate product.
  - Broadleaf weeds – Chemical in-crop control measures are available such as Pursuit® (imazethapyr; for Pinto, Pink and Red classes only) or Poast Ultra ®(sethoxydim), Select® (clethodim), Assure II ®(quizalofop). Reflex® (fomesafen) may be used in Manitoba and Ontario for broadleaf weed control.
  - In Ontario, the bulk of acres are treated with imidazilinone herbicides such as Pursuit® or Odyssey®. Chief products used in the Alberta region are Basagran® as a post-emergence treatment, with Edge® as an underlying preplant incorporated herbicide. In Manitoba, Pursuit® can be used on pink and red beans.
  - Grassy weeds – An application of Poast Ultra® (sethoxydim), or a similar product, can give good control of grassy weeds.
  - Perennial & volunteer weeds – There are no control measures available for thistle species. Quackgrass and volunteer crops can be controlled using Poast® or Assure II®
- Biological control and biopesticides – None currently available.

  - product such as Edge® (ethafluralin).
  - Pest Management Methods (reactive measures) – Chemical in-crop control measures are available such as Pursuit ®(imazethapyr; for Pinto, Pink and Red classes only) or Basagran® (bentazon). (5,7)
  - Basagran® (bentazon) tank-mixed with Reflex® (fomesafen) (only registered for the Red River Valley in Manitoba).

i. Weed Assessment by Province

- Manitoba(4)
  - Some of the major weed problems in Manitoba (in order of importance) are perennial weeds, wild buckwheat, grassy weeds, and herbicide resistant weeds.

- Ontario (7)
  - Some of the major weed problems in Ontario (in order of importance) are redroot pigweed, lamb's quarters, and green/yellow foxtail. Perennials don't tend to be as much of a problem as in western Canada, although they are more of a concern to minimum tillage producers. Another weed that is unique to Ontario is poke weed *(Phytolacca americana*), which has red berries similar to nightshade that can stain the dry beans. Ontario also has some issues with herbicide tolerant weeds (broadleafs tolerant to pursuit), and contamination with volunteer corn, especially GMO corn.
- Alberta (5)
  - Some of the major weed problems in Alberta (in order of importance) are perennial weeds, nightshade, volunteer crops, and herbicide resistant weeds.

Table 11. Weed problems by area (4,5,7)

Region	Disease	% ha infected	% ha treated	Yield loss (%)	Yield loss ($)	Avg % efficacy of products	Problem priority level
Ontario	Ragweed, nightshade, lamb's-quarters, pigweed	>75	>75	20	$50-100	70	1 (E)
All	Annual broadleaf weeds	100	100	0 to 30	$0 to 150	80	1 (E)
Alberta, Ontario	Nightshade	10 to 30	10 to 30	0 to 20	$0 to 100	80	1 (E)

Use and intensity of herbicides by group are reported in the following table. These are sourced from Stratus and the data was collected through direct interviews with growers. No data was available for Ontario.

Table 12. Herbicide use in dry beans (13)

(000's of acres)	Total Market	Provinces			Soil Zones [3]		
		AB/BC	SK	MB	Black	Dark Brown	Brown
Base Size	63	12	3	48	50		13
Seeded Acres [1]	388	60	13	315	323		65
Use Intensity (%)	96.6%	100.0%	62.8%	97.4%	97.5%		92.3%
Base Acres Treated	375	60	8	307	315		60
Application Intensity (%)	265.1%	181.0%	130.2%	286.8%	284.7%		167.1%
Fall Market	19.3%	13.1%	52.3%	19.0%	20.7%		12.1%
Spring - Preseed Market	79.3%	39.7%	10.5%	89.8%	87.9%		36.7%
Spring - Post Market	166.5%	128.2%	67.4%	178.0%	176.2%		118.3%
Application Acres	1,029	109	17	903	921		109
Fall Market	75	8	7	60	67		8
Spring - Preseed Market	308	24	1	283	284		24
Spring - Post Market	647	77	9	561	570		77
Product Application Acres [2]							
Dinitroanilines	257	30		227	227		30
Glyphosate	79	2	8	69	77		2

Post-emergent Grass	214	25	8	181	189	25
Post-emergent Broadleaf	465	57	8	400	408	57
Total Market Value ($000's)	$14,258	$1,754	$187	$12,317	$12,504	$1,754
Fall Market	$1,033	$105	$56	$872	$928	$105
Spring - Preseed Market	$3,812	$410	$9	$3,393	$3,402	$410
Spring - Post Market	$9,413	$1,239	$121	$8,053	$8,174	$1,239

Source – Stratus survey - 2002

E – Insects and Mites

i. Summary

Specific priority needs are addressed in *Section V. Critical Industry Needs.*

Generally, insects are not a major problem in dry beans. The largest amount of insect pressure comes when the plant is first germinating (from pests such as cutworms, seed corn maggot, and wireworms), but this is usually only found in pockets and generally not a major problem. While Ontario has an in-season pest in the potato leafhopper, the other two provinces find little to no insect pressure in-season, and will very rarely apply an in-crop insecticide.

ii. Key Factors by Pest (Including Pest Management Strategies)

This section is discussed in two parts. The first part covers biology and control and the second part discusses pest problems by region.

- Cutworms (4,5,7)
  - Host Crops - The red-backed cutworm feeds on practically all field crops, vegetables, and home garden plants. It is best known for its' feeding on cereals, flax, sugar beets, canola, and mustard. The army cutworm feeds on the foliage of wheat, oats, barley, mustard, flax, alfalfa, sweetclover, field peas, cabbage, sugar beets, corn, oats, potatoes, various weeds (notably stinkweed) and grasses. Almost any crop, present during the early spring, could be a potential host.
  - Biology – There are many different species of cutworms, but the most common ones are the red-backed cutworm (*Euxoa ochrogaster (guenee*)) and the army cutworm *(Euxoa auxiliaris* (*Grote*)). Cutworm moths may lay several hundred eggs on their host plants. After the eggs hatch, the larvae feed on the host plants. They moult several times, eventually reaching about 5 cm (2 in.) in length. The larvae tunnel into the soil to form earthen cells where they pupate. The new moths emerge, exiting through the soil using the old larval tunnels. Some species overwinter as eggs (e.g., the red-backed cutworm); others, as larvae or pupae. Still others do not overwinter in the Prairies but rather reinvade annually from the USA, aided by southerly winds. Most of our pest species have only 1 or 2 generations per year.
  - Economic Threshold – None available.
  - Pest Management Methods (preventive measures) – No effective preventative measures, since it has so many host crops. No registered seed treatments for cutworms.

- Pest Management Methods (reactive measures) – No effective in-crop chemical control measures available.

- Grasshopper (*Acrididae*) (4,5,7)
  - Host Crops – Grain and forage crops
  - Biology – There are several species of grasshoppers that are serious pests of grain and forage crops in Western Canada. Eggs are laid in packet-like bunches 1–5 cm below the surface of the soil. They are mainly deposited in uncultivated ground such as field margins, pasture land and roadsides. They may also be laid in considerable numbers in clover, alfalfa, and stubble fields. There are usually five or six nymphal instars that require about 1-2 months to reach the adult stage. Growth is usually completed in the late summer. A late spring or cool summer may delay development so that nymphs are present through the autumn. Adult feeding can continue until the first heavy frost. The eggs are mainly deposited during August and September, where they overwinter and begin hatching in May through June.
  - Economic Threshold – Grasshopper control is advised whenever 40 or more small nymphs per square meter can be found in adjacent, non-crop areas, or when 24 or more nymphs per square meter can be found within the field. When 20 or more adults per square meter are found in field margins or 6 to 11 adults per square meter are occurring in the crop, treatment would be justified.
  - Pest Management Methods (preventive measures) – No effective preventative measures available.
  - Pest Management Methods (reactive measures) – An in-crop chemical control product such as Cygon (dimethoate) can be used.
- Lygus Bug/Tarnished Plant Bug (*Lygus lineolaris*) (4,5,7)
  - Host Crops – Alfalfa, dry beans, potatoes, soybeans, vegetable crops
  - Biology – Adults emerge in early spring and females lay approximately 5 eggs per day for 10-31 days into the petioles of alfalfa, weeds and vegetables. Eggs hatch in 7-10 days. Nymphs undergo 5 instars or growth stages and develop into adults in 3-4 weeks. The adult overwinters in protected areas such as leaf litter, plant debris and under bark in hedgerows and borders.
  - Economic Threshold - The threshold for basing spray decisions is when an average of one or more lygus bugs can be found per plant at flowering.
  - Pest Management Methods (preventive measures) – Destroy effected plant debris as soon as possible, and adhere to proper rotations with other host crops.
  - Pest Management Methods (reactive measures) – An in-crop chemical control product such as dimethoate can be used.
- **Potato Leaf Hopper (*Empoasca fabae* (Harris))** (4,5,7)
  - Host Crops – Alfalfa, dry beans, potato, soybeans
  - Biology - The potato leafhopper does not overwinter in Canada. Large numbers migrate northward from the Gulf States each spring. The female lives about a month. Each female can deposit 2 or 3 tiny white eggs a day in the stems and large leaf veins of the plant. The tiny nymphs emerge from these eggs in a 7-10 day period. They reach adult stage about two weeks later. The entire life cycle takes about a month, and there are two to three generations each year. Both adults and nymphs suck sap from the veins of the plant.

- Economic Threshold - The threshold for basing spray decisions is when an average of one leafhopper nymph per trifoliate leaf is found.
- Pest Management Methods (preventive measures) – No effective preventative measures available.
- Pest Management Methods (reactive measures) – An in-crop chemical control product such as dimethoate can be used.

- **Seed Corn Maggot *(Delia platura*)** (4,5,7)
  - Host Crops – Corn, vegetables, beans
  - Biology – The seed corn maggot overwinters as pupae in the soil. In early spring, the adults emerge. The flies mate within 2-3 days after emerging and lay eggs in soil with abundant decaying organic matter and/or on seeds or plantlets within these fields. The eggs hatch in 2-4 days in temperatures as low as 10º C. The larvae or maggots develop over a large temperature range (11-33º C). The maggots complete their entire development within the soil by burrowing into seeds or feeding on cotyledons emerging from seeds. Generally, seed corn maggots complete their life cycle within three weeks and have two-three generations in Canada. The first generation causes the most crop damage.
  - Economic Threshold – When conditions are wet and cool, or when planting into high crop residue conditions, seed treatments will provide the best defense against injury.
  - Pest Management Methods (preventive measures) –Early, shallow planting into a warm seedbed is ideal (damage is most severe when delays in germination and emergence occur), watch rotation with other host crops, and use an insecticide/fungicide seed treatment such as a mix of 15% captan, 15% diazinon, 15% lindane. If maggot pressure is extremely high, replanting may be the only option (not usually an option in Manitoba and Alberta due to the shorter growing seasons).
  - Pest Management Methods (reactive measures) – No effective in-crop chemical control measures available.

- **Wireworms (4,5,7)**
  - Host Crops – Prefers annual and perennial grasses, canola, cereals, corn, potatoes, sugar beets, sunflower
  - Biology – Wireworms are larvae of a group of beetles commonly called click beetles. There are almost 400 species of wireworms found across Canada. While most are harmless, several species are serious pests. The larval stage of wireworms requires from two to six years or more to complete. When fully grown, usually in July, the larvae pupate about 5 to 10 cm below the soil surface. Pupation lasts for less than a month; however, adults do not emerge until the following spring. Wireworms often burrow into shoots causing plants to appear stunted, wilt or die
  - Economic Threshold – None available.
  - Pest Management Methods (preventive measures) –Early, shallow planting into a warm seedbed is ideal (damage is most severe when delays in germination and emergence occur), watch rotation with other host crops, and use an insecticide/fungicide seed treatment such as a mix of 15% captan, 15% diazinon, 15% lindane. If larvae pressure is extremely high, replanting may be the only option (not usually an option in Manitoba and Alberta due to the shorter growing seasons).

- Pest Management Methods (reactive measures) – No effective in-crop chemical control measures available.

iii. Insect Assessment by Province

- Manitoba(4)
  - There is no major insect pressure on dry beans in Manitoba. Potato leafhoppers and lygus bugs haven't been a problem as of yet, but are being watched. Seed corn maggot can be a problem if in higher residue soils, with other host crops in the rotation (corn, vegetables).
- Ontario(7)
  - Potato leafhopper is the only common insect, and around 75% of the crops are sprayed, with most having a dual application. Producers are also looking forward to an upcoming systemic seed treatment (hoping for registration in 2004), which will control this pest. Seed corn maggot is seen on a few acres (around 2-3%), but is very sporadic and needs a lot of rotting organic matter to thrive. Wireworms and grasshoppers have been seen in some fields, but are very sporadic.
- Alberta(5)
  - There is no major insect pressure in Alberta. Wireworms, cutworms or root maggots can be found sporadically in some pockets at seeding, especially when the field is coming out of perennial production. Grasshoppers have been known to cause some damage, but only when extremely high pressure in the area, and they have destroyed all other host crops.

F- Other Animal/Vertebrate Pests

No other animal or vertebrate pests are an issue in dry beans.

Table 13. Summary of product use in dry beans

REGIONS	Name ai (Trade name)	Type/ (Pest)[1]	% Area Treated	Typical Rates Kg/ha ai	Timing & Frequency	Cost per ha	% Control	PHI/ REI[3]	*IPM* Compatibility[4]
All	Bentazon(H) (Basagran)	Broadleaf weeds	N/a	1.0	Once at 2 to 6 lf	$25	70 to 90		R+
Ontario	Imazathapyr(H) (Pursuit)	Broadleaf weeds	N/a		Once at 2 to 6 lf	$15	70 to 90		R-
All	Sethoxydim (H)	Grassy weeds	N/a	0.25	Once at 1 to 6 leaf	$25	80		R-
Alberta	Streptomycin(B) Agstrep	Bacterial bean blight	N/a	1g/kg seed	Seed treatment	<$3	60 to 80		Re
All	DCT(ST)	Seedling diseases	N/a		Seed treatment	<$3	60 to 80		Re
All	Fomesafen (H) (Reflex)	Broadleaf weeds	N/a		Once at 2 to 6 leaf stage	$15	80		R+
All	Ethalfluralin (Edge)	Broadleaf weeds	N/a		Preemergent	$15-25	80		R+, Re

Sources – 4,5,6,7,14

Table 14. Summary of information on IPM Techniques in dry beans (4,5,6,7)

Pest type	Method type	Estimated % efficacy	Cost per ha	% Adoption	Comments
Weeds (annual)	Preseeding tillage (C)	30%	$10 +/ha fuel	100	Will control early germinating weeds. Destructive to soil on erosion prone areas
Bacterial diseases and fungi - seed borne	Certified seed use (C).	20 – 30 %	$ 20/ha	100 percent excl. Manitoba….50 % in Manitoba	Will not control disease sources present in soil.
Diseases, weeds and insects	Economic threshold spraying (C)	100 %	$5	<10	Poor adoption due to lack of information.
Weeds	Delayed or early seeding	10%	$0 to $50	<10	Long season beans require seeding based on frost issues and thus seeding time manipulation of pest control is of minimal use.
Diseases	Crop rotation every four years (CR)	60 – 100%	N/a	80%	Most growers adhere to rotation but some will push rotations if economics dictate tighter rotations

Source – 4,5,7

V. Critical industry needs

Bean industry stakeholders at a meeting in Winnipeg in February 2003 developed key priorities. Names of participants are given in Appendix.

Table 14 Critical needs in the dry bean industry

Region	Issue category	Specifics	Solutions
All	Weed control	Lack of alternatives for broadleaf weed control. "Drying up" of herbicide development pipeline due to deflated soybean input market.	Investigate the following; (1) candidate chemistries being developed and (2) biologicals
Manitoba, Alberta,	Disease control	Lack of alternatives in place for bacterial disease control.	Investigate breeding potential. Investigate alternative reduced risk seed treatments.
All	Weed control	Need more streamlined labeling to account for unconventional bean types/classes	Investigate labeling alternatives and language that would not exclude market niche bean varieties from being treated with a herbicide.
All	Diseases	Require reduced risk approach for white mould.	Investigate (1) economic thresholds and (2) reduced risk control strategies such as resistant varieties
Manitoba Ontario	Diseases	Require integrated approach to root rot complex	Investigate (1) alternative seed treatments, (2) resistant varieties and (3) biology of the disease.

.Source – Proceedings of Dry Bean Strategic Pest Management Planning Session (Draft)

VI Actual research areas

The following trials are registered with ICAR and relate to pest management/agronomy research associated with bean production. These do not directly address the critical needs in Section V. Nonetheless they represent a view of what the research community is working on in dry bean pest research.

ICAR ID	Project Title
11110727	Genetic Improvement of Common Bean
11110755	Molecular and Cellular Aspects of Disease Resistance, Plant Development and Crop Quality
11110785	Management and Performance Evaluation of Dry Bean, Oilseed and Forage Crops in Western Ontario
22221613	Special crops regional variety tests
22221614	Field bean varietal tests
33330083	Evaluation of fungicides for control of rhizoctonia and Fusarium root rot of dry bean
33330415	Chemical control and cultivar resistance for anthracnose of dry bean
33330805	Production Practices for Optimum Yield of Type I Upright Pinto Bean Varieties Suitable for the Short Saskatchewan Growing Season
33330806	Control of Common and Halo Bacterial Blight in Dry Bean During Seed Multiplication
86000976	Development of alternative methods for controlling major diseases in Ontario of dry edible and coloured bean for domestic and export markets
88880288	NEMATODE MANAGEMENT WITH ALTERNATIVE PRACTICES TO SOIL FUMIGATION
88880319	Development of high yielding white and coloured bean varieties with improved quality, disease resistance and agronomic characteristics for Ontario production and export markets
88880371	Pulse crop breeding, pathology, and agronomy for western Canada.
91000246	Molecular Interactions Affecting Plant Protein Isolation and Functionality.
94000651	Dry bean production technology development
96000238	Elucidating the Mechanisms Implied in the Partitioning of Nitrogen and Carbon in Dinitrogen-Fixing Rhizobium-legume Symbioses and in Cereals.

VII Available resources

The following institutions conduct work in the field of bean agronomy/pest management.

Institution	Area of expertise
Harrow Station, AAFC, Harrow, ON	Pathology/Agronomy/Breeding
University of Guelph/ Ridgetown College, ON	Entomology, Agronomy, Pathology/ Weeds
Morden Research Station, AAFC, Morden, MB	Pathology/Agronomy
Brandon Research Station, Brandon, MB	Agronomy/Fertility/Pathology/Weeds
Indian Head Research Station, AAFC, Indian Head SK	Agronomy/Weeds
University of Saskatchewan, Saskatoon SK	Breeding/Pathology/Weeds/Agronomy
Brooks Research Station, Alberta Agriculture, Brooks AB	Agronomy/Pathology
Lethbridge Research Station, AAFC, Lethbridge AB	Weeds/Pathology

VI. References

1. Pulse Canada, 12th Floor, Royal Bank Building, Winnipeg, MB
2. Pulse Canada Website www.pulsecanada.com, March 1, 2003.
3. Canadian Special Crops Association. Personal Communication February 18,2001
4. Pulse Specialist with Manitoba Agriculture & Food; Carman, MB
5. Jim Rex, Agricore United, Taber AB
6. Dennis Lange, Agronomist, Parent Seed Farm, St Joseph, MB
7. Chris Gillard, Professor, Ridgetown College
8. Manitoba Crop Insurance Corporation, Portage la Prairie, MB
9. Ontario White Bean Producers Association estimates.
10. Manitoba Agriculture website www.agr.gov.mb.ca
11. Saskatchewan Agriculture website www.agr.gov.sk.ca
12. Alberta Agriculture website www.agr.gov.ab.ca
13. Stratus Agrimarketing Inc, Guelph Ontario
14. Guide to Crop Protection 2002, Published by Manitoba Ag and Food
15. CARC website of ongoing research by commodity http://www.carc-crac.ca/english/index.htm
16. Proceedings of the Dry Bean Strategic Pest Management Planning Session
17. Incidence of bacterial bean blight in farmers fields (1992 to 2001)

The following websites have useful information pertaining to pulse crops.

Markets and general information - www.pulsecanada.com
Production and marketing statistics - www.statcan.ca
Production information - www.gov.mb.ca/pulse/agriculture/crops/pulsecrops
Production information - www.pulse.ab.ca
Production information - www.agric.gov.ab.ca/navigation/crops/pulses/
Production and marketing - www.agr.gov.sk.ca
Quality and grading - : http://www.cgc.ca/main-e.htm

Trademark usage

Appendix A

Dry Bean Exports to All Countries

	Quantity (KGM)		% of Total Exports	
	2000	2001	2000	2001
TOTAL:	**219,250,487**	**252,109,884**		
United States	63,080,498	99,267,793	28.8%	39.4%
United Kingdom	56,302,110	33,216,459	25.7%	13.2%
Italy	12,035,501	13,375,041	5.5%	5.3%
Spain	6,567,779	11,999,849	3.0%	4.8%
Algeria	3,007,158	9,206,986	1.4%	3.7%
Venezuela	2,627,564	8,345,178	1.2%	3.3%
Colombia	14,469,018	7,207,868	6.6%	2.9%
Netherlands	7,691,718	6,313,823	3.5%	2.5%
France	3,213,139	5,546,237	1.5%	2.2%
Mexico	2,529,528	5,222,508	1.2%	2.1%
Greece	2,873,949	4,593,081	1.3%	1.8%
Germany	5,727,184	4,415,501	2.6%	1.8%
Portugal	5,674,615	4,212,263	2.6%	1.7%
Dominican Rep.	1,769,946	3,849,806	0.8%	1.5%
Belgium	2,004,751	3,443,828	0.9%	1.4%
Japan	5,744,915	3,337,098	2.6%	1.3%
Cuba	1,506,054	2,959,613	0.7%	1.2%
Korea, South	1,399,401	2,507,061	0.6%	1.0%
Malaysia	232,751	2,432,592	0.1%	1.0%
Ireland	2,625,157	2,318,742	1.2%	0.9%
Saudi Arabia	2,450,826	2,152,810	1.1%	0.9%
Angola	3,738,128	2,098,284	1.7%	0.8%
Croatia	844,741	1,590,304	0.4%	0.6%
Israel	1,114,855	1,567,259	0.5%	0.6%
New Zealand	2,648,543	1,099,950	1.2%	0.4%
Costa Rica	440,601	1,027,138	0.2%	0.4%
Lebanon	442,257	836,303	0.2%	0.3%
Guatemala	679,921	814,156	0.3%	0.3%
United Arab Emir.	247,509	777,389	0.1%	0.3%
Czech Republic	0	657,106	0.0%	0.3%
Slovenia	824,847	588,690	0.4%	0.2%
Egypt	1,791,020	469,977	0.8%	0.2%
Poland	168,119	464,202	0.1%	0.2%
Slovakia	145,257	428,290	0.1%	0.2%
Sweden	144,033	421,265	0.1%	0.2%
Jordan	84,422	405,232	0.0%	0.2%
Trinidad-Tobago	142,304	324,360	0.1%	0.1%
Switzerland	307,427	298,513	0.1%	0.1%
Australia	209,974	283,753	0.1%	0.1%
Jamaica	426,746	272,157	0.2%	0.1%
Malta	165,832	216,149	0.1%	0.1%
Russia	0	215,369	0.0%	0.1%
Chile	293,630	192,496	0.1%	0.1%
Morocco	587,631	191,701	0.3%	0.1%
Sri Lanka	0	171,190	0.0%	0.1%
Austria	122,520	164,259	0.1%	0.1%
Bosnia'herzegovia	60,452	128,037	0.0%	0.1%
Nicaragua	0	127,915	0.0%	0.1%
El Salvador	0	126,000	0.0%	0.0%
Neth. Antilles	63,958	122,519	0.0%	0.0%
Luxembourg	22,198	105,784	0.0%	0.0%

Appendix B

Incidence of bacterial blight in dry bean surveys conducted in farmers' fields by AAFC (1992-2000)

Reference	Province	Fields surveyed	% Of fields infected
93-1	Manitoba	100	49
94-1	Manitoba	26	50
94-2	Alberta	31	77
95-1	Alberta	37	51
96-1	Alberta	10	100
96-3	Alberta	18	100
96-5	Manitoba	23	74
97-1	Manitoba	18	33
99-1	Alberta	21	66
99-3	Manitoba	34	100
00-1	Alberta	22	77
00-3	Alberta	56	64
01-3	Manitoba	36	78

Appendix C. The following personnel were involved with the setting of the critical needs listed in Part V.

Resource	Organization	Phone number	Email address
Ontario			
Peter Sikkema		519-674-1603	psikkema@ridgetownc.uoguelph.ca
Steve Twynstra	OCB Growers	519-232-4449	stwynstra@gcbc.ca
Brian Hall		519-271-0083	brian.hall@omaf.gov.on.ca
Mike Donnelly		519-461-1055	mdonvan@odyssey.on.ca
Chris Gillard		519-674-1632	CGILLARD@ridgetownc.uoguelph.ca
Soon Park		519-738-2251	parks@agr.gc.ca
Art Schaafsma		519-674-1624	phoned left message for Email address or fax
John Walls	OBPMB	519-652-3566	whitebeans@ontariobeans.on.ca
Derwyn Hodgins	Hensall District Coop	519-262-3002	dhodgins@hdc.on.ca
Manitoba			
Bruce Brolley	MAF	204-745-5667	bbrolley@gov.mb.ca
Murray Froebe	Grower - MPGA	204-745-2868	
Jack Froese	Grower	204-325-7291	jack@valleycable.com
Jim Pallister	Grower	204-274-2323	
Ralph Morrow		204-526-2531	
Francois Catellier		925-3781	director@specialcrops.mb.ca
Danny Penner	MB Grower	204-737-2664	penner@mts.net
Saskatchewan			
B Vandenberg	CDC/U of S	306-966-8786	bert.vandenberg@usask.ca
Ray MacVicar		306-787-4655	RMcVicar@agr.gov.sk.ca
Lana Shaw			lshaw@agr.gov.sk.ca
Alberta			
Jake Schutter	Grower	403 545 6282	hillview@monarch.net
Jan Bennen	Grower - APG	403 654 4326	lucasb@telusplanet.net
Leif Andersen	NEBC	403-545-2227	landersen@agricoreunited.com
Blair Roth	AU	403-382-3405	broth@agricore.com
Daan Lieuaart	APG- Coaldale	403-345-3136	lieuaart@telusplanet.net
Ron Wikkerink	APG-Bow Is.	403-545-2182	RWIKK@shockwave.com
Jim Rex	Agricore United	403-223-2772	jrex@agricoreunited.com
Resources and experts - nonregional			
Rod Macrae	World Wildlife Fund	416-465-1011	rmacrae@ican.net
Judy Shaw	Syngenta	519-837-5328	judy.shaw@syngenta.com
Robert Hornford	BASF	831-6572	hornfor@basf-corp.com
Veldon Sorensen	BAYER	403-723-7454	veldon.sorensen.@bayercropscience.com
Eric McEwen	BAYER		eric.mcewen@bayercropscience.com
TBA	Dupont	?	
Ron Howard	AARC Research	403-362-1328	ron.howard@agric.gov.ab.ca
Jacques Drolet	PMRA -Health Cdn	613-736-3700	jacques_drolet@hc-sc.gc.ca
Ken Campbell	AAFC	613-759-7808	campbellk@agr.gc.ca
Bob Blackshaw	AAFC	403-327-4591	blackshaw@abrsle.agr.ca
Bob Conner	AAFC	204-822-7221	conner@agr.gc.ca
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Jim Chaput	OMAFRA	519-826-3539	jim.chaput@omaf.gov.on.ca
Dave Kaminski	MDA	204-745-5656	dkaminski@gov.mb.ca
Peter MacLeod	Croplife Canada	416-622-9771	macleodp@croplife.ca
Imme Gerke	PMRA	613-736-3794	Imme-Gerke@hc-sc.gc.ca