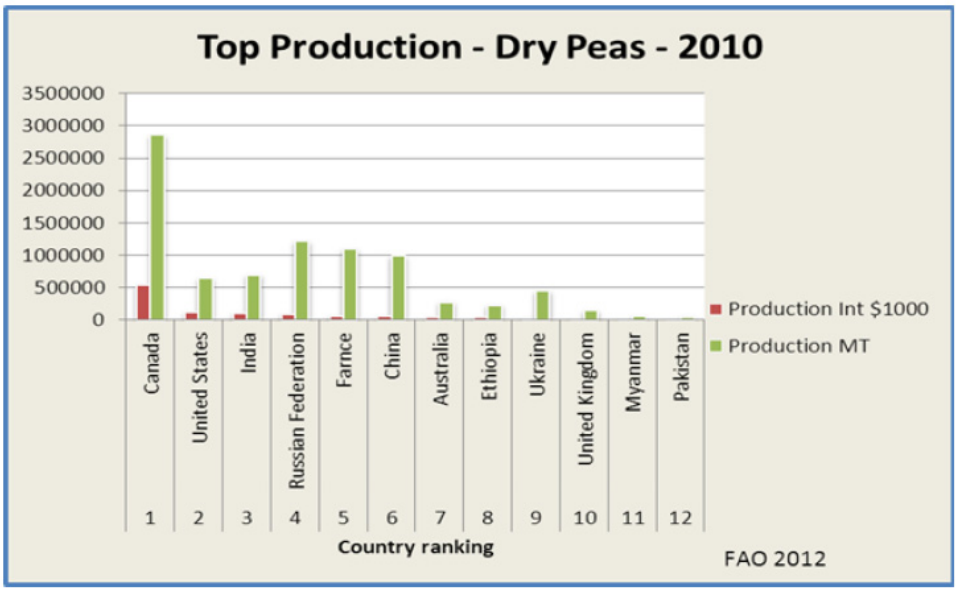
Dry Pea

Introduction

Dry Pea (Pisum sativum L.) is a pulse crop and a member of the family Leguminacea. It was among the first crops cultivated and was domesticated about 9,000 BC in the Fertile Crescent near the Tigris and Euphrates rivers in present-day southern Turkey and northern Syria. It is a cool season crop and is widely grown in the cooler temperate zones of the world. Pea is grown on about six to eight million hectares (ha) annually and total production ranges from 10 to 12 million tonnes per year. The leading pea producing countries are: Canada, United States, India, Russia, France and China (see Figure 1).



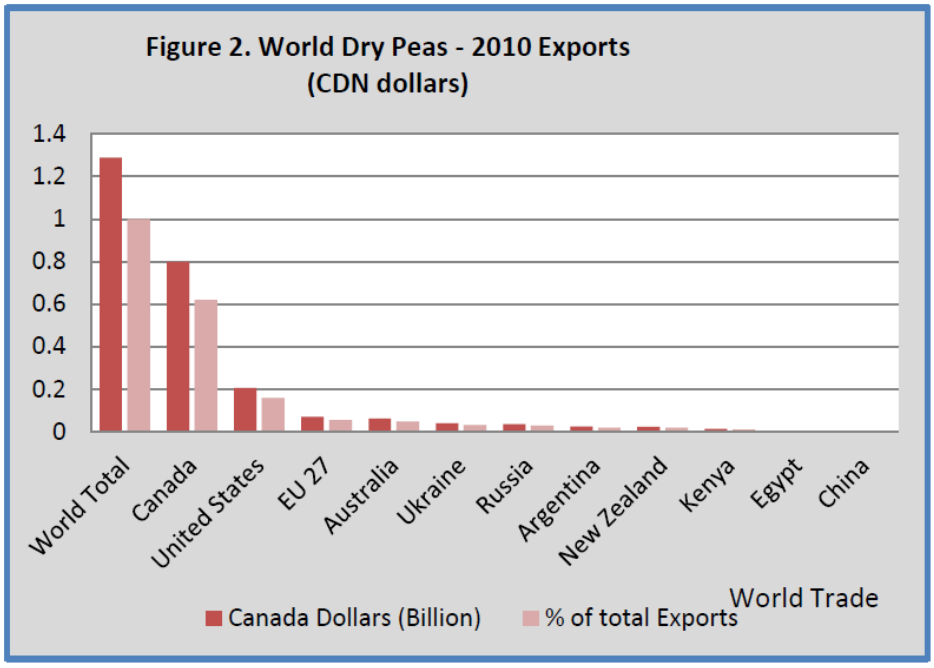
Pea was an important crop in Canada at the turn of the century, with Ontario averaging 288,000 ha for the 20 year period 1883 to 1902. However, by 1980 only 50,000 ha of the crop was grown in Canada, primarily in the three Prairie provinces.

Pea was grown on almost one million ha (2.4 million acres) in Saskatchewan in 2010 and 600,000 ha (1.5 million acres) in 2011, indicating a significant change in cropping practices from the 300 ha reported in 1967. Pea has been a leading alternative crop as farmers move to diversify crop production in Saskatchewan. Both yellow and green cotyledon pea cultivars are grown, with an average of approximately 80 per cent of production in yellow cotyledon types. Most varieties have white flowers and the semi- leafless growth habit. Some niche-market types with coloured flowers and normal-leaf growth habit are also grown.

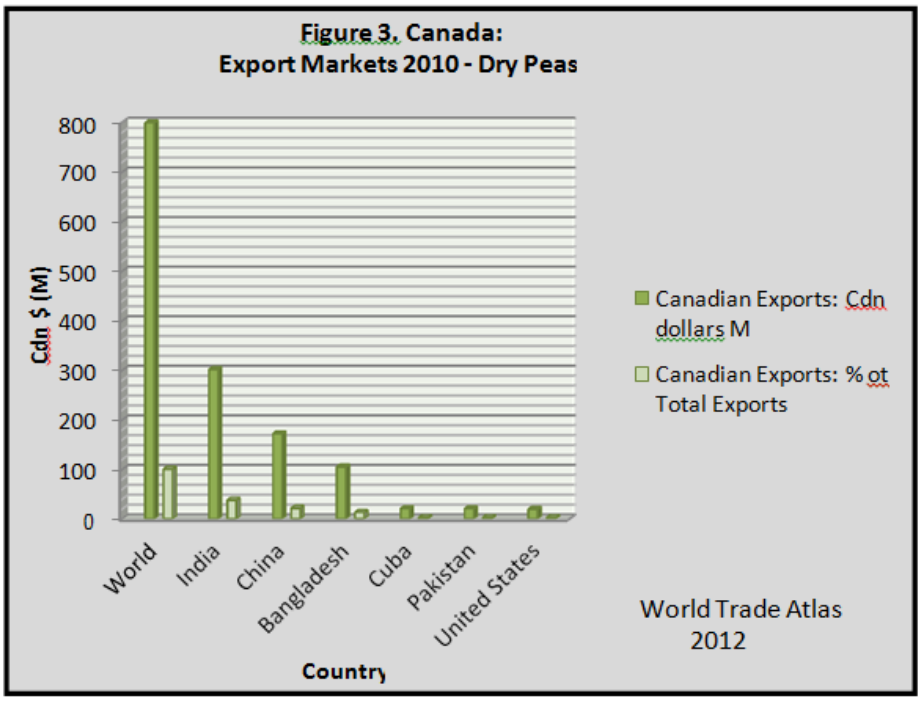
The 10-year average pea yield in Saskatchewan is approximately two tonnes/ha (32 bu/ac). Many pea producers in Saskatchewan expect their pea crops to produce yields equal to or greater than their wheat crops. The bushel weight for dry pea is 60 lb. The Saskatchewan Agriculture publication, Specialty Crop Report, provides annually updated statistical information on pea production.

Market Opportunities

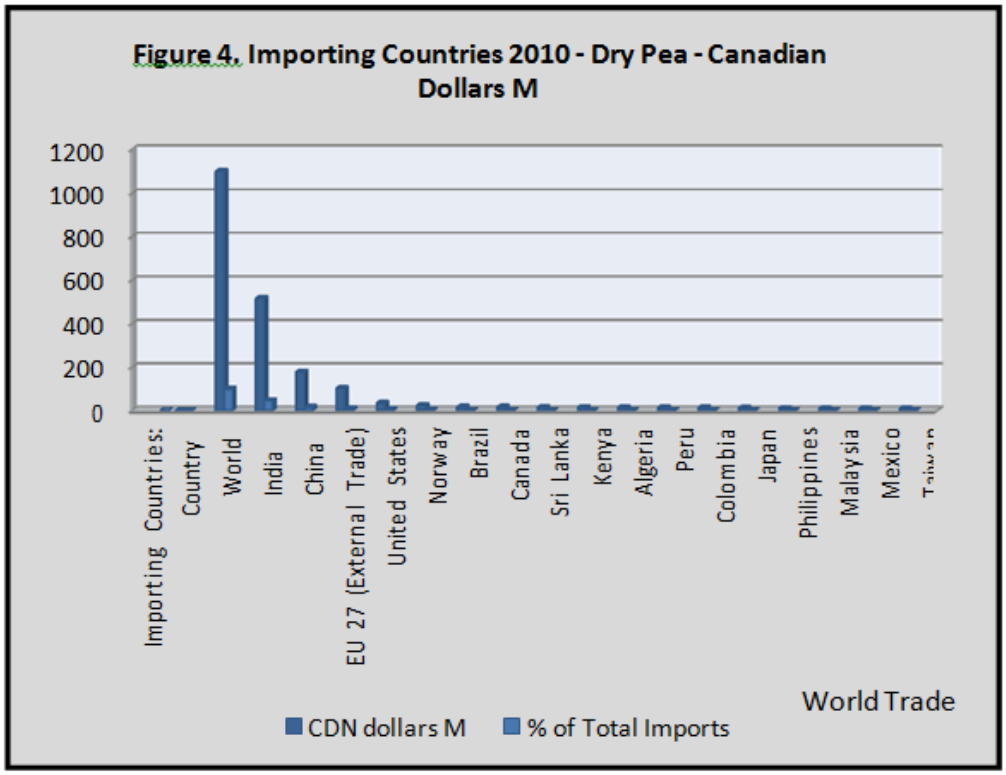
In 2010, world pea exports were 1.29 billion dollars. The main exporting countries are: Canada, United States, European Union 27, Australia, and Ukraine (see Figure 2).



Canadian exports were close to $800 million in 2010. The top markets were India, China, Bangladesh, Cuba, Pakistan and the United States (see Figure 3).



In 2010, world pea imports reached over $1 billion dollars. The main importing countries are: India, China, EU27, Norway, Brazil, Canada and Sri Lanka (see figure 4).



Pea is used for human food and livestock feed. For many years, the European Union has been a consistent importer of pea for use as livestock feed, primarily for swine. Canadian exporters have relied on this market, sometimes shipping more than 700,000 tonnes of feed pea to Europe. The domestic market for feed pea was very important. Most of the pea production in western Canada now enters food markets because of strong demand from India, China and many others. Now peas are generally too expensive for feed. Exceptions are high value feeds like pet food or aquaculture.

Many companies purchase pea for human consumption or other uses and some offer production contracts to growers. For a list of pea marketing companies, refer to the Ministry publication, *Saskatchewan Special Crop Marketing Company Listing*.

Nutritional Characteristics

Table 1

Unique Attributes and Nutritional Advantages	Whole Yellow Peas	Whole Green Peas
	Nutritional Information*	Nutritional Information*
High in fiber (~20%)	Per 100 g dry	Per 100 g dry
High in protein (~2 x higher than cereals)	Amount % Daily Value	Amount % Daily Value
Low fat (~2 %)	Fat 1.2 g 2%	Fat 1.4 g 2%
High in minerals and vitamins	Carbohydrates 64.4 g 22%	Carbohydrates 64.8 g 22%
Gluten-free	Total Fiber 14.7 g 59%	Total Fiber 16.3 g 65%
Low glycemic index	Insoluble Fiber 13.1 g	Insoluble Fiber 14.6 g
Low allergenicity	Soluble Fiber 1.57 g	Soluble Fiber 1.71 g
Non-GMO	Sucrose 2.6 g	Sucrose 3.0 g
Environmental benefits	Protein 23.3 g	Protein 23.3 g
	Calcium 81 mg 8%	Calcium 74.4 mg 7%
	Iron 6 mg 33%	Iron 5.9 mg 33%
	Potassium 1230 35%	Potassium 1080 mg 31%
	Vitamin C 0.55 mg 1%	Vitamin C 0.55 mg 1%
	Thiamin 0.51 mg 34%	Thiamin 0.51 mg 34%
	Riboflavin 0.18 mg 11%	Riboflavin 0.18 mg 11%
	Niacin 1.55 mg 8%	Niacin 1.55 mg 8%
	Vitamin B6 0.05 mg 3%	Vitamin B6 0.05 mg 3%
	Folate 33.8 mcg 9%	Folate 35.5 mcg 9%

***References: 1)** Wang and Daun, 2004. J Sci Food Agric 84: 1021-1029; **2)** Centre for Agri-Industrial Technology and Alberta Agriculture, Food and Rural Development. 2005. Development of a Compositional Database for Alberta Pulse Crops; **3)** Wang, 2004. The Chemical Composition and Nutritive Value of Canadian Pulses. www.pulsecanada.com; **4)** Wang, 2005. Quality of Western Canadian pulse crops-2005. Canadian Grain Commission, www.grainscanada.gc.ca; Daily Values obtained from Health Canada. **5)** Canada Grain Commission, 2008. Data not published.

(adapted from Pulse Canada's, "Canadian Dry Peas")

Adaptation

Pea has a relatively shallow root system. It is best adapted to the moist Dark Brown and Black soil zones; however, it is relatively drought resistant and can be productive in most years in the Brown soil zone. Pulse crop adaptation trials conducted at seven locations in Saskatchewan and funded by the Canada-Saskatchewan Agriculture Innovation Fund (AFIF) showed pea to be the most widely adapted pulse crop across the agro-ecological zones in Saskatchewan.

Planting pea on cold, poorly drained soils should be avoided, as it favours the development of seedling diseases and root rots. Pea does not tolerate water-saturated or salt affected soils. Well drained, clay loam soils are ideal for pea production. Pea can tolerate some hot weather or drought stress during flowering but yields may be reduced.

Rotational Considerations

Pea production is most often successful when grown in rotation with cereals such as barley, spring or durum wheat. Research carried out at the Semiarid Prairie Agricultural Research Centre at Swift Current, Saskatchewan, indicates pea roots reach a depth of approximately 0.75 to 1m, compared to 1.5 to 2m for wheat. In stubble conditions, pea is able to efficiently use soil moisture when the top metre of the soil profile has been recharged by fall or spring rains. Soil moisture below the depth of 1m remains in reserve for the following crop. In crop rotation tests, spring wheat and durum wheat grown on pea stubble produced higher yields and a higher protein percentage compared to wheat grown on wheat stubble.

Research indicates that planting pea into standing cereal stubble helps protect the soil from erosion and provides shelter for newly emerging seedlings. Leaving cereal straw in clumps or piles in the field increases the risk of injury to newly emerged pea seedlings due to late spring frosts. Spreading the straw and chaff evenly in the field helps to prevent spring frost injury and avoids mechanical problems such as air-seeder plugging or header plugging of harvest equipment.

A major benefit of rotating pea with cereal crops is the interruption of pest cycles. Most cereal diseases do not affect pulse crops. Soil-borne root rots in continuous cereal systems may cause average yield losses up to 10 per cent. Grasshoppers do not thrive in pea crops and pea is not a host for wheat midge or wheat-stem sawfly.

Pea is susceptible to mycosphaerella blight (ascochyta) and sclerotinia (see Disease Control), and careful consideration must be given to crop rotation to avoid these diseases. Where mycosphaerella blight is a problem, pea should not be grown more often than one in three years in the same field. In areas where sclerotinia is a problem, avoid seeding susceptible broadleaf crops (canola, mustard, sunflower, hemp, chickpea, bean, pea, lentil) more often than one in four years in the same field.

Highly fertile soils, such as fields with high levels of available nitrogen, may produce excess vegetative growth at the expense of seed production.

Pea is a poor competitor with weeds so selection of a clean field is important. Perennial weeds such as Canada thistle and sow thistle should be controlled in the years prior to pea production. Pea is susceptible to the soil residues of some herbicides used in previous years. It is important to record herbicide use each year and to avoid seeding pea in fields where these residual herbicides have been used. Post harvest or fall application of herbicides containing dicamba such as RUSTLER®, BANVEL / ORACLE, high rates of 2,4-D; and spring application of 2,4-D at low rates used for winter annual control may also cause damage. The Ministry publication, *Guide to Crop Protection,* contains more information about herbicides and their soil residual properties.

Irrigation

Pea can be successfully grown under irrigation. Early maturing, short-vined varieties are best suited to this type of production. Agronomy of irrigated pea is similar to dry land production. Yields can be much higher than dry land production; however, special attention must be paid to prevent losses due to disease and lodging. The Canada-Saskatchewan Irrigation Diversification Centre (CSIDC) at Outlook, Saskatchewan, compares pea varieties under irrigation conditions and provides recommendations for the proper production of irrigated pea.

Inoculation

Pea inoculated with the appropriate strain of *Rhizobium* bacteria is able to fix a large portion of its nitrogen requirement from air in the soil. For this to occur, the seed or the soil surrounding the seed must be inoculated. The rhizobia enter the root hairs and induce nodule formation. The plant provides energy for the bacteria living inside the nodules and, in return, the rhizobia convert atmospheric nitrogen into plant-useable forms. Maximum benefit is derived if the supply of available soil nitrogen is low and the soil moisture and temperature levels are adequate for normal seedling development from the time of seeding until seedlings are well established.

The *Rhizobium* bacteria die if they are exposed to stress such as high temperature, drying winds or direct sunlight. Therefore, both inoculant products and inoculated seed should be treated with care and every effort must be made to plant the inoculated seed into moist soil as soon as possible after treatment.

Inoculants are sensitive to granular fertilizer, so banding fertilizer to the side (or to the side and below the seed) is preferred. Inoculants are also sensitive to some seed-applied fungicides (see Disease Control). When using a combination of fungicide and inoculant, apply the fungicide to the seed first, allow it to dry, and apply the inoculant immediately prior to seeding. Granular inoculants are less affected by dry seedbeds and seed-applied fungicides than other forms of inoculants.

High available soil nitrogen levels (over 55 kg N/ha) inhibit nitrogen fixation since the pea plant will preferentially use the soil nitrogen rather than fix nitrogen. *Rhizobium* bacteria can live in the soil for a number of years. However the most efficient nitrogen-fixing bacteria may not be among those that survive. For this reason, most experienced pea producers use an inoculant on their pea crop every year.

The Saskatchewan Agriculture publication, *Inoculation of Pulse Crops*, provides more detailed information on the use of nitrogen-fixing inoculants.

Fertilization

Nitrogen - Soil testing is a good investment. A properly conducted soil test can provide an excellent guideline for pea fertility requirements. Nitrogen is necessary for high pea yields, but generally nitrogen fertilizer application is not required. When properly inoculated with an appropriate Rhizobium inoculant, pea can derive up to 80 per cent or more of its nitrogen through nitrogen fixation. The remaining nitrogen comes from what is available in the soil at seeding, plus nitrogen that is released (mineralized) from the soil during the growing season.

Nodule formation and subsequent nitrogen fixation are very sensitive to external nitrogen sources, including fertilizer and available soil nitrogen. As the supply of nitrogen available from soil and fertilizer increases, the amount of nitrogen fixed decreases. When the combined levels of soil and fertilizer nitrogen exceed 28-40 kg/ha (25-35 lbs/ac), any additional nitrogen will delay the onset of nodules and reduce nodulation and nitrogen fixation. Combined soil and fertilizer nitrogen levels greater than 55 kg/ha (50 lbs/ac) can prevent nodulation and nitrogen fixation.

It can take three to four weeks after planting before nodules are fully functioning. Early plant growth may be poor in soils with nitrogen levels less than 11 kg/ha (10 lb/ac), and plants may appear yellow prior to the onset of active nitrogen fixation due to a nitrogen deficiency. This early deficiency can be corrected by adding low levels of starter nitrogen at seeding. Although high levels of starter nitrogen may appear to help the crop overcome a nitrogen deficiency during early crop growth stages, final seed yields may not increase. Monoammonium phosphate (ex. 12-51-0) provides the small amount of nitrogen needed for early plant growth and, depending on the soil test, may provide the starter nitrogen required. The Saskatchewan Agriculture publication, Inoculation of Pulse Crops, provides information on what to do if the crop fails to fix nitrogen through inoculation.

Phosphorus - Pea has a relatively high requirement for phosphorus. Phosphorus is needed to promote the development of extensive root systems and vigorous seedlings. Encouraging vigorous root growth is an important step in promoting good nodule development. Phosphorus also plays an important role in the nitrogen fixation process. Pea planted on soils testing low in available phosphorus or under cool or wet conditions may respond dramatically to phosphorus fertilizer. As with cereals, yield responses are not always achieved when applying phosphorus in the form of phosphate fertilizers; however, a pea crop may benefit from increased frost tolerance, resistance to disease, improved nitrogen fixation and drought tolerance.

The maximum safe rate of actual phosphate applied with the seed is 17 kg/ha (15 lb/ac) in a 2.5 cm (1 in) spread and 15-18 cm (6-7 in) row spacing under good to excellent moisture conditions. Rates of seed-placed phosphate fertilizer must be reduced if the seed bed has less than ideal moisture conditions. Higher rates of phosphate fertilizer placed in the seed row with narrow openers like discs or knives can damage the emerging seedling and reduce the stand. If higher phosphate rates are required, banding the fertilizer away from the seed (sideband or to the side and below) or the use of the product Jumpstart® should be considered. If sidebanding, sideband all the phosphate fertilizer, especially when using narrow openers.

Sulphur - A 40 bu/ac pea crop requires about the same amount of sulphur as a 40 bu/ac wheat crop, which is approximately 9-11 kg/ha (8-10 lb/ac). Soils testing low in available sulphur should have this deficiency corrected with ammonium sulphate, which contains sulphur in a plant-available form. Most research indicates no yield response to the addition of sulphate- sulphur fertilizer except in fields testing very low in sulphur. The Saskatchewan Agriculture publication, Sulphur Fertilization in Crop Production, contains more details for correcting sulphur deficiencies.

Potassium - Pea has a high demand for potassium, and is about 135-165 kg/ha (123-150 lb/ac) K_2O for a 50 bu/ac crop. Fields low in potassium should be corrected based on soil test recommendations. Banding potassium fertilizer is effective. For more information, see the Saskatchewan Agriculture publication, Potassium Fertilization in Crop Production.

The Ministry publication, Guidelines for Safe Rates of Fertilizer Applied with the Seed, provides more information about fertilization of pea.

Seeding

The use of high quality seed is important for successful pea production. Seed-borne diseases such as mycosphaerella blight can reduce seedling vigour and lead to yield and quality losses. Do not use seed from a pea crop that had a pre-harvest application of glyphosate as uneven germination and poor seedling vigour may occur. Early fall frost may also damage pea seed and reduce vigour. It is important to have pea seed tested for germination, purity and disease levels by an accredited seed test laboratory.

Pea seed is highly susceptible to mechanical damage during harvest, handling and seeding operations. Dry seed (14 per cent moisture or less) is brittle and can easily crack or split, leading to reduced germination. Moisturizing the seed with water before seeding can reduce mechanical injury. Information on moisturizing the seed can be obtained from the Prairie Agricultural Machinery Institute (PAMI) factsheet, *Moisturizing Pulses to Reduce Damage*.

A firm, weed-free seed bed on well-drained soil is best for pea production. Stony fields should be avoided or rolled after seeding to bury loose stones and to smooth soil ridges that may cause harvest problems (see Land Rolling). Excessive soil packing should be avoided, especially in heavy or wet soils prone to crusting.

The recommended seeding depth for pea is 3-8 cm (1-3 in). It is critical that seeds are placed into moist soil.

The target plant population for pea is 85 plants/m^2 (8/ft^2). Crop stands of 85 plants/m² provide better competition against weeds and will result in higher yields. Surveys of commercial pea crops in Saskatchewan reveal that this target population is rarely achieved. Thinner stands with uniform plant-to-plant spacing are capable of producing high yields provided that weed control is excellent. Crop stands of greater-than-recommended density may increase the risk of foliar disease infection, especially in wetter areas.

Optimum seeding rate depends on the seed size. For example, the medium sized yellow pea variety CDC Mozart has an average seed size of 230 grams per 1,000 seeds. Assuming 95 per cent of seed producing vigorous seedlings and a population of eight plants per square foot, the seeding rate is calculated below:

$$\text{Seeding rate (lb/ac)} = \frac{(\text{population/ft}^2 \times \text{1000 seed wt. g})}{\text{Per cent of plant survival}} \times 10$$

$$\text{Example: CDC Mozart} \qquad \frac{(8 \times 230)}{95} \times 10 = 193 \text{ lb/ac seeding rate}$$

Pea should be seeded as early as possible in the spring (mid-April to mid-May), provided that the average soil temperature at depth of seeding has reached 5°C and the soil is not excessively wet. This means that pea is often the first crop seeded in the spring. Seeding early advances maturity of the crop, reducing the probability of damaging high temperatures during the flowering period. Pea seedlings can withstand some late spring frost. Even if the frost is severe enough to kill the main shoot, regrowth from buds at one of the nodes at or below the soil surface can occur, but with a resulting delay in maturity. Early seeding generally results in higher yields.

The use of a registered fungicide seed treatment (see Disease Control) for the control of seed rot and seedling blight in pea should be considered if seeding into cold wet soils in early and delayed springs, or if the seed has been cracked or peeled. For best results, apply the fungicide first, allow it to dry, and apply the nitrogen fixing inoculant just prior to seeding.

Land Rolling

A land roller can be used in pea fields to provide a smooth and level surface for harvest. Land rolling can be done before or after the crop emerges. Research done by Alberta Agriculture and Forestry indicates that post-emergence land rolling can occur up to the five- node stage without significant yield loss. Land rolling beyond this stage can damage plants, increase the spread of foliar diseases and reduce yields. Best results are obtained if rolling is completed before the pea crop emerges. Rolling should not be done on wet soils or when the crop is damp or stressed by extreme heat, frost or herbicide application. For more information on land rolling pulse crops, consult the Alberta Agriculture and Forestry publication, *Land Rolling Guidelines for Pulse Crops in Western Canada.*

Varieties

Both yellow and green cotyledon pea varieties are grown in Saskatchewan. Most pea varieties have white flowers and are suitable for the human consumption or livestock feed markets. Most commercially produced varieties have the semi-leafless growth habit which has tendrils instead of leaflets. The tendrils of adjacent plants intertwine to provide better support (standability) for the entire canopy. This characteristic can reduce foliar disease development and ease harvest under good growing conditions. The canopy of semi leafless varieties may be less competitive to weeds. It is important to control weeds and establish the recommended plant density for semi leafless types.

Marrowfats are blocky, very large-seeded green cotyledon pea used in the specialty snack food market in Asia. Some production of purple-flowered varieties with coloured seed coats (Maple pea) also exists. Maple pea is used to feed racing pigeons. The Saskatchewan Agriculture publication, *Varieties of Grain Crops*, provides an annually updated list of pea varieties. Variety characteristics of yield, maturity, vine length, seed weight, disease resistance, seed coat breakage, lodging and bleaching are compared.

Weed Control

Pea crops do not compete well against weeds, so good weed control using suitable cultural controls and/or herbicides is essential and often the most important consideration for profitable pea production. An integrated approach to weed control combines preventative and cultural measures (such as the use of clean, healthy seed, crop rotations with diverse agronomic traits and good sanitation practices) with the effective use of selective herbicides.

Weed control in pea begins in the year prior to production. Grow a rotational crop the year prior to pea that provides good competition to weeds and allows for a wide range of weed control options that will not result in carryover of herbicide residues or difficult to control volunteer crops. An application of pre-harvest glyphosate in the previous year's crop, fall herbicide application for winter annuals and selection of a field where weed problems can be controlled culturally or with herbicides registered for use in pea, are important points to note when planning pea production. Avoid areas where perennial weeds such as Canada thistle or sow thistle may be a problem. Clean harvest and seeding equipment to avoid the spread of weed seeds into new fields. Pea is susceptible to the soil residues of some herbicides used in previous years (see Rotational Considerations).

Pea is slow to develop, so early seeding and optimum plant densities are important to enhance weed competition. A pre-emergence burn-off treatment with glyphosate can control early emerging weed seedlings. Rod-weeding 5-7 days after seeding provides excellent weed control without herbicide use and good tolerance to peas seeded 7.5 cm (3in) deep. Tillage 10-12 days prior to seeding helps stimulate weed growth for control with the rod-weeder. Harrowing between seeding and emergence of the pea crop can control newly emerged weed seedlings and remove weeds that escaped previous tillage operations. Harrowing should be avoided during crop emergence and for several days afterwards to permit effective rooting and stand establishment. Post-emergence harrowing has been researched at the Agriculture and Agri- Food Canada Research Station at Scott, Saskatchewan Pea was found to be somewhat tolerant to post emergence harrowing. A higher seeding rate should be used to offset the plant losses due to harrowing. Post-emergent harrowing should be done under warm, dry conditions to improve weed control and to prevent the spread of diseases.

Pea plants are more competitive with annual weeds if they emerge rapidly and cover the soil surface before the weeds emerge. If post-emergence herbicides are used, they should be applied before the pea plant reaches the five-node stage for best coverage and control of weeds with minimal damage to the crop. Crop injury due to late herbicide application is a common problem. With short-stature varieties or in adverse growing conditions, a pea plant can reach the five-node stage and be only 7.5 cm (3 in) tall.

Research conducted at Agriculture and Agri-Food Canada and Agri-Arm Sites in Saskatchewan has demonstrated the importance of early weed removal in pea production. Annual weeds were removed from pea crops at intervals of one, two, three and four weeks after crop emergence. Pea yields declined by 0 per cent after one week, seven per cent after two weeks, 12 per cent after three weeks, and 26 per cent after four weeks.

Thoroughly clean sprayers according to the label directions of the previous herbicide before using the sprayer to apply herbicides in pea, as very small amounts of residue of some herbicides can cause significant crop injury.

Pre-Harvest Weed Control

A pre-harvest application of glyphosate for the control of perennial weeds is registered for use on pea. This treatment will provide some crop dry down, but this benefit is inconsistent and is unlikely to occur under cool, wet conditions. Apply when the crop has 30 per cent or less grain moisture (75- 80 per cent of pods are tan). Do not apply glyphosate to pea crops destined for planting seed because irregular germination and seedling development can occur.

The Saskatchewan Agriculture publication, *Guide to Crop Protection*, provides information on the herbicides registered for use in pea.

Insect Control

Pea crops have relatively few insect pests of economic importance.

The pea aphid adult is small, about 4 mm (0.15 in) long, light green and long legged. The insect may be wingless or have prominent, translucent wings. Although pea aphids rarely survive winter in Saskatchewan, they may over winter as an egg attached to the stems or leaves of alfalfa or clover. The eggs hatch in early spring and the young aphids feed on the newly emerged alfalfa or clover plants. During May and June, depending on weather and host plant conditions, new generations of these insects develop wings and, with the aid of wind currents, fly to pea fields. The majority of aphids in pea fields are blown in on warm southerly winds from the United States in June or early July. The pea aphid weakens the plant directly by sucking its sap, and in warmer countries, is responsible for transmitting virus diseases. Economic losses can occur if there are more than 10 aphids per plant during the period between formation of the tenth node and the appearance of the first flower. Population estimates should be calculated by averaging the counts taken from at least five separate areas of the field. To avoid a reoccurrence of the problem after spraying, delay application of insecticide until late-flowering. One application per season should give satisfactory control. Pea aphid populations usually begin to decline in mid-to-late August due to drying of the crop, parasitic wasps, diseases and other factors. Numerous insecticides are registered to control aphids on pea. Insecticides with both contact and systemic action can be advantageous.

Cutworms can occasionally attack pea crops. Economic thresholds are approximately two to three cutworms /m2. Fields should be monitored from late-May to late-June. Insecticides that are currently registered for the control of cutworms are listed in the Ministry of Agriculture publication, *Guide to Crop Protection*. Best control is achieved by applying in the evening due to their nocturnal feeding habits.

Grasshoppers can attack pea crops, but the risk is not severe. Damage is most likely to affect seedlings along ditches and road allowances. Although grasshoppers can severely damage pea seedlings, pea is not their preferred food. Often weeds within the crop will be a more preferred food source. Usually, grasshopper infestations of 10/m2 (1/ft2) do not cause economic losses in pea. Insecticide is registered for the control of grasshoppers on pea. The Ministry publishes an annual grasshopper forecast map which indicates the risk of grasshopper outbreaks in each crop district. There are also two fact sheets about grasshoppers in specific environments.

Pea leaf weevil has been expanding its infestation eastward across southern Saskatchewan. The most noticeable sign of damage caused by this insect is the presence of scalloped or notched leaf margins in seedlings. The adult weevil is grey in colour and difficult to observe; therefore, economic thresholds are determined by severity of notches in plants at various points in the field. Usually pea plants will survive this defoliation; however, adult females will lay large numbers of eggs at the base of pea plants. The larvae hatch and burrow into the soil causing more serious damage when they feed on nitrogen fixing nodules on the roots of the plant. Research at Agriculture and Agri-Food Canada (AAFC), Lethbridge, Alberta, suggests the best yield response from insecticides results with a seed treatment. If a foliar application is required,

the current threshold for insecticide application is one notch on the clam leaves per three plants prior to the sixth node stage of crop growth.

For more information about registered insecticides on pea, consult the Saskatchewan Agriculture publication, *Guide to Crop Protection* or the product label.

Disease Control

Pea crops are subject to a number of diseases that can reduce yield and quality. Infection can come from a variety of sources. Seed-borne, soil-borne and residue-borne diseases can be minimized through preventative management. Disease prevention recommendations include:

1. Use of effective crop rotations. Plant pea only once every four years in the same field. Continuous production of broadleaf crops can increase some seedling diseases and sclerotinia.
2. Use of the best seed available. A seed test will indicate the presence of seed-borne diseases.
3. Use of a registered fungicide seed treatment may be warranted, especially if seeding early into cool wet soils.
4. Use varieties with disease resistance, such as powdery mildew resistance.
5. Early seeding.
6. Monitoring of fields for diseases.

Mycosphaerella blight - this fungal disease is also known as ascochyta blight and is the most important disease of pea in Saskatchewan. There are three *Ascochyta* species that infect pea. In Saskatchewan, the most common species is *Ascochyta pinodes*. The sexual stage of this species, which produces air-borne spores is called *Mycosphaerella pinodes*. Infection can be caused by inoculum from infected pea stubble in neighbouring fields. Thus, crop rotation is not a guarantee against infection.

Early symptoms of mycosphaerella blight are small purplish black, irregularly shaped spots on lower leaves, stems and pods. These spots turn brown or black, grow together and spread up the plant. The impact on yield depends on the timing of the initial infection and on weather conditions. If the infection originates within the same field, the disease can develop early and the likelihood of loss is greater. If the initial infection occurs at the base of the plant, footrot (see Figure 4) can occur and the plant may prematurely lodge and die. This disease is favoured by wet conditions. For more information Refer to the Saskatchewan Agriculture factsheet *Ascochyta Blight of Field Pea*.

Figure 4. Mycosphaerella blight causing footrot on pea.

Seed infection is a significant factor in introducing mycosphaerella to an area; however, seed transmission is less significant than transmission from infected pea stubble. No commercial pea varieties are resistant to mycosphaerella blight; however, some varieties are more susceptible than others. See the Saskatchewan Agriculture publication, *Varieties of Grain Crops*, for disease resistance ratings of pea varieties. Various foliar fungicides are registered for the control of mycosphaerella blight in pea and can be found in the Saskatchewan Agriculture publication, *Guide to Crop Protection.*

Powdery mildew (*Erisyphe polygoni*) - Most new varieties of pea commonly grown in Saskatchewan are resistant to powdery mildew and growers are strongly advised to select these. The Saskatchewan Agriculture publication, *Varieties of Grain Crops*, provides a list of pea varieties with resistance to powdery mildew.

Infection of susceptible pea varieties usually begins about mid-to-late-July. Pea crops seeded in early spring have often progressed past the stage of economic impact because pods and seeds are already formed before the disease appears. Delayed seeding of susceptible varieties increases the risk of an economic impact.

Powdery mildew thrives under warm, dry, daytime conditions with nights that are cool enough to cause dew formation. Rain showers actually disrupt the spread of powdery mildew.

Symptoms include the development of white powdery spots on lower leaves and stems which can quickly spread to the entire plant. Severely affected crops are covered in a white mat of powdery spores and may appear to have a bluish or silvery sheen. The underside of infected leaves turns yellow below the powdery infection. The disease can reduce yield, delay maturity and reduce uptake of desiccants.

For most fungicides the recommended application should take place at the onset of symptoms.

Sclerotinia stem rot (*Sclerotinia sclerotiorum*) - This disease attacks many broadleaf crops, but is most severe on sunflower, dry bean and canola. It over winters as sclerotia,small, black resting bodies in the soil, apart from the host. Sclerotia may remain viable for three to five years.

Infection can take place in two ways. Firstly, when in close contact with the pea root, sclerotia may germinate and cause infection at the base of the plant. Secondly, under a dense plant canopy, sclerotia will germinate and develop tiny mushroom like structures that produce spores. These spores colonize dead plant material such as fallen flower petals or hail damaged leaves. Spores can be scattered by the wind, so planting pea next to previously infected fields can assist in spreading the disease.

Once infection has occurred, it can spread very quickly by plant to plant contact, especially when there is moisture under a heavy crop canopy. If infection occurs late in the growing season, there may be little effect on yield; however, the buildup of sclerotia in a field may have a negative impact on later broadleaf crops. There are no fungicides registered for the control of sclerotinia in pea. Refer to the Saskatchewan Agriculture publication *Sclerotinia Infection in Field Crops* for more information on this disease.

Root Rot - Root rotting fungi (*Pythium, Rhizoctonia, Botrytis*, Aphanomyces and *Fusarium* species) can attack any part of the root system up to a short distance above the soil surface. Young seedlings infected with root rot appear yellow and stunted and often die. Numerous products are registered for seed treatment in pea. See the Saskatchewan Agriculture publication *Guide to Crop Protection* for more information.

Seed treatments offer protection to the developing seedling, especially under cool, wet conditions when emergence may be delayed. Seed treatments can reduce the viability of nitrogen-fixing *Rhizobium* inoculants. Fungicide seed treatments should be applied, allowed to dry, and then the inoculant should be applied just prior to seeding. Granular inoculant is not typically affected by fungicides.

Crop rotation can also prevent the build-up of soil-borne fungal organisms. Continuous production of broadleaf crops in the same field can lead to a build-up of root rot and seedling rot diseases. If *Aphanomyces* is isolated in the soil, crop rotations uaing pea may have to be extended to six years.

Bacterial blight (*Psuedomonas syringae pv. pisi*) - Infections of this disease are not common in Saskatchewan. It is primarily seed-borne, so obtaining seed free of bacterial blight is important. The bacteria can also over winter on crop residues, so crop rotation is an important method of controlling this disease. Symptoms start as small, water soaked spots on leaves, stems and pods. During wet weather, creamy white ooze may appear on the spots. When this material dries, the spots become dark brown and may appear shiny. When held up to the light, these leaf spots appear translucent. The bacteria are spread by rain-splash. Hail or other physical injury to the plant may favour infection.

Other Diseases - Other fungal disease of minor importance include sclerotinia stem rot, root rot, bacterial blight, downy mildew (see Figure 5), anthracnose, septoria blight and rust. Virus-like diseases can also occur in pea. With the exception of one disease,pea seed borne mosaic virus (PSbMV),they are spread by aphids.

For more information on disease of pea refer to *Diseases of Field Crops in Canada* available from the University Extension Press, University of Saskatchewan at (306) 966-5565.

Frost Injury

As peas mature from the bottom of the plant toward the top, frost injury may be much greater on plant tops. Seeds near the ground may have little frost damage and care should be taken to focus harvest efforts on these seeds.

During early pod fill a frost can cause discoloration and deformation of seeds. Frost damaged pods and seeds will be water soaked and no longer firm as they start to "leak". Heavily damaged pods will have a rubbery wilted appearance. Pea pods with medium frost injury will show a white patch-work effect a few days following the frost (see Figure 6).

Figure 6. Frosted Pea Pods.

Pea crops should be monitored after a frost to determine the level of injury to the pods and seeds. If the majority of the seeds are not damaged, harvest should continue as planned. If the great majority of pods and seeds are damaged, consider harvesting the crop for feed keeping in mind the risk of nitrates. If a medium level of frost has occurred, monitor the crop for possible pod breakage and consider swathing if pods appear to be splitting open.

Harvesting

Great care should be taken when harvesting pea for human consumption. Pea samples that contain excessive amounts of foreign material or cracked, peeled or discoloured seeds are suitable only for the feed market. Soil stuck to the seed is called earth tag and is a common factor in down-grading dry pea. Earth tag may occur during combining, when moisture from weeds or heavy dew causes soil or dust to stick to the seed.

Pea crops should be monitored closely to determine the proper stage for harvest. Generally, plants mature from the bottom up. Crops are nearing maturity when the bottom 30 per cent of pods are ripe, the middle 40 per cent of pods and vines are yellow-coloured, and the upper 30 per cent of pods are turning yellow. This is the proper stage for crops to be swathed or desiccated.

The most important grading factor for the human market in green cotyledon pea is seed colour. The maximum allowable bleach level for green pea destined for human consumption is two per

cent. Green varieties are susceptible to bleaching as they near maturity. Bleaching of seed is caused by high humidity, bright sunshine and warm temperatures. For this reason, extra care should be taken to harvest green pea varieties as soon as possible.

Pea may be swathed prior to full maturity or straight combined at full maturity. The swather or straight-cut header should be equipped with vine lifters (pick up guards) and/or a pick up reel to ease the harvest of lodged or tangled crops. The swather can also be used to cut the crop at full maturity. The combine should follow immediately behind the swather, as even moderate winds can damage pea swaths.

A desiccant can be applied to pea to kill green weeds and speed the dry-down of the crop. This treatment does not mature the crop, but can eliminate the need for swathing and dry-down green weeds and crop material which interfere with harvesting. Desiccation will reduce the risk of bleaching in green pea varieties by shortening the time the crop is left in the field.

For example, REGLONE DESICCANT® is a registered desiccant for ground or aerial application on pea. REGLONE DESICCANT® should be applied to pea crops when bottom pods are ripe and dry and seeds are detached from the pods. Avoid spray drift onto adjacent crops and tree rows. Germination of seed is not affected. See the Saskatchewan Agriculture publication, *Guide to Crop Protection*, for more information about the use of desiccants.

Straight cutting pea is a common harvest method due to the widespread use of land rollers, development of flex-headers and the introduction of varieties with improved standability. The crop is permitted to completely ripen and harvested at approximately 18 to 20 per cent seed moisture with the combine equipped with a flex-header. An alternative method involves the use of a Rake-Up® or modified Sund® pick up at full maturity. These pick ups have a positive motion that breaks the brittle, ripe vines off at the soil surface, eliminating the need to swath.

Mature pea pods can shatter their seeds very easily when dry, thus care must be taken to reduce shattering during swathing or straight combining. Shattering can be reduced by harvesting during the humid part of the day, and by reducing the reel or pick-up speed to keep the action against the crop to a minimum.

Pea should be combined at 18 to 20 per cent seed moisture content to reduce the risk of seed cracking or peeling. Low combine cylinder or rotor speeds are required to reduce seed cracking. Speeds of 300 to 600 rpm are normally used, depending on the moisture content of the pea sample. An initial concave setting of 0.6-1.5cm (0.25-0.6 in) clearance at the front and 1.2cm (0.5 in) at the rear is recommended. Combine and grain augers should be operated full and at low speeds to reduce cracking and splitting seeds.

There is an increased risk of combine fires when harvesting pea especially if the crop has suffered a serious infection of powdery mildew.

Post-Harvest Pea Residue Management

Pea and other pulse crops extend and diversify crop rotations, increase nitrogen availability, improve soil tilth and contribute to soil organic matter. Pea residue breaks down more rapidly than the residues of many other crops, such as wheat or canola, providing nutrients to subsequent crops.

Pea residue must be handled properly to reduce seeding problems in the following year. If the straw is being used for livestock feed, it should be removed soon after combining to retain feed quality. If not, pea straw should be chopped and evenly spread during harvest. Bunched and piled pea straw can cause extensive plugging of seeding equipment in the following spring. Some producers report that the use of heavy harrows can spread pea residue before seeding.

Direct seeding equipment with narrow openers and good trash clearance can seed directly into pea residue, provided that the straw has been chopped and evenly spread during the previous harvest.

Storage and Handling

Samples containing green weed seeds and other high moisture materials should be cleaned as soon as possible to prevent heating. There are many special crop processing companies in Saskatchewan that clean, bag and handle pea, making it suitable for domestic and export markets.

Moisture levels up to 16 per cent and temperatures below 15°C are considered safe for pea. The use of aeration fans to reduce moisture and temperature levels will improve storage.

If supplemental heat drying is necessary, air temperatures should not exceed 45°C to preserve germination, and the sample should not be dried more than four to five percentage points per pass through the dryer. Temperatures up to 70°C should only be used for drying feed pea.

Pea seed often respires or "goes through a sweat" after it is placed in storage. Extra care should be taken to monitor the grain inside the bin for moisture build-up or spoilage. Aeration fans can be used to cool the grain in the fall and warm it in the spring to reduce moisture condensation in the bin. Pea seed is more susceptible to cracking and peeling if handled at temperatures below 20°C.

The Canadian Grain Commission (CGC) sets standards for grading pea in Canada. For more information on pea grading standards, contact your grain buyer or the CGC office in your area. The CGC website address is: http://grainscanada.gc.ca/main-e.htm

Economics of Production

The Saskatchewan Agriculture publication, *Crop Planning Guide*, includes estimates on projected costs of production and expected returns of various pea market classes in Saskatchewan.

Marketing

A list of pea brokers and buyers is available in the Saskatchewan Agriculture publication, *Saskatchewan Special Crop Marketing Company Listing.*

Additional Sources of Information

Saskatchewan Agriculture website: www.agriculture.gov.sk.ca

Agriculture Knowledge Centre: 1 (866) 457-2377

Inoculation of Pulse Crops, Saskatchewan Agriculture

Guide to Crop Protection, Saskatchewan Agriculture

Guidelines for safe rates of fertilizer applied with seed, Saskatchewan Agriculture

Principles and Practices of Crop Rotation, Saskatchewan Agriculture

Soil Improvement with Legumes, Saskatchewan Agriculture

Sulphur Fertilization in Crop Production, Saskatchewan Agriculture

Potassium Fertilization in Crop Production, Saskatchewan Agriculture

Varieties of Grain Crops for Saskatchewan, Saskatchewan Agriculture

Crop Planning Guide, Saskatchewan Agriculture

Saskatchewan Special Crop Marketing Company Listing, Saskatchewan Agriculture

Specialty Crop Report, Saskatchewan Agriculture

Ascochyta Blight in Pulse Crops, Saskatchewan Agriculture

Crop Varieties for Irrigation, Canada-Saskatchewan Irrigation Diversification Centre at Outlook, SK. (306) 867-5400

Pulse Production, Saskatchewan Pulse Growers, Saskatoon, SK. (306) 668-5556 website: www.saskpulse.com/

Diseases of Field Crops in Canada available from the University Extension Press, University of Saskatchewan: phone 306 966-5565.

Moisturizing Pulses to Reduce Damage, Prairie Agricultural Machinery Institute, Humboldt, SK phone (800) 567-7264

Alberta Agriculture and Forestry website: http://www.agric.gov.ab.ca/Land Rolling Guidelines for Pulse Crops in Western Canada Pulse Crops in Alberta

Pulse Canada, Winnipeg, MB (204 925-4450) website: http://www.pulsecanada.com/

Manitoba Agriculture, Food and Rural Initiatives

website: www.gov.mb.ca/agriculture/crops/pulsecrops/bhe01s00.html