Beans (Dry)

VEGETABLE CROPS PRODUCTION GUIDE FOR NOVA SCOITA

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1.0 INTRODUCTION

Dry beans (*Phaseolus vulgaris)* are a member of the Fabaceae family (formerly Leguminosae). Dry beans differ from snap beans in that the seed is harvested after it ripens and dries. There are over 200 different types of beans originating in various parts of Central America which have been cultivated for over 7000 years. Today, dry beans are mainly grown for human consumption.

Bean flowers are self pollinated. Flowers appear simultaneously and pods tend to mature together, which is an advantage for mechanical harvesting. Commercial dry bean cultivars are mainly "bush types".

The major types of dry beans are based primarily on physical appearance of the seed:
Black (Black Turtle)
Kidney (light red, dark red and white)
Navy, pea or white (small seed)
Pinto (medium seed size)
Great Northern (large white)
Cranberry (large seed)
White Marrow (large seed)
Yellow-eye (large seed)
Heirloom ("Jacob's Cattle", "Soldier Bean")

Dry Beans are adapted to both temperate and tropical areas where there is frost free period greater than 50 days and soils are warm enough to allow seed germination. Dry beans can be grown in all parts of Nova Scotia; however, beans are sensitive to frost. Spring frost will delay maturity and increase disease, while fall frost will affect seed quality thru discolouration of seed coat and seed hull degradation. Bean plants are killed at temperatures of -1 to -2ºC. The minimum temperature for seed germination is 15ºC, and the maximum is 35ºC. The optimum germination temperature is 20^0C. Seed rot is a problem at lower soil temperatures and is further aggravated by wet soils. Best crop growth occurs at 18 to 23ºC with a minimum of 10ºC and a maximum of 32ºC. Temperatures above 32ºC and below 10ºC will cause poor pod set. Beans do well under warm conditions and date of maturity can be reliably estimated using degree days above 5ºC.

Beans should be planted in high organic matter, well drained soils with good aeration. A range of soil textures are suitable to the crop, but sandy loams are best for early crops and loams for later production. Heavy clay loam soils are not recommended. Avoid fields prone to compaction and crusting, as well; avoid growing on steep slopes since the crop does not offer much protection against soil erosion. Soil nitrogen levels should be low such that excessive vegetative growth is not encouraged. Heavy soils can produce good bean yields as long as rainfall is not excessive so as to cause drowning out of the crop. Also, harvest may be more difficult than from sandy soils under wet fall conditions.

Dry beans reach maturity in early to late September (100 to 120 days from seeding). Plant vigor, earliness, yields and seed quality vary dramatically with the cultivar.

2.0 CROP ESTABLISHMENT

2.1 SEED TREATMENT

Chemical seed treatments should be used to protect seeds from maggots, wireworms and seed decay organisms. Seed treatment should not be done more than 3 months before sowing. Refer to the AgraPoint Guide to Pest Management for a listing of pesticides and their application methods.

Purity of seed is needed to ensure uniformity of maturity at harvest time. It is important to select well developed, mature, uniform seed of sound vitality. Germination and seedling vigor may be affected by the overall quality and age of the seed. Poor seed quality can be expressed in reduced germination, poor seedling vigor and abnormalities of the seedlings. Diseased seed will produce diseased plants which may infect the entire crop. Bean seed should be germination tested.

2.2 SEEDING/PLANTING

Seeding should be delayed until the danger of cold weather and frost is past and the soil has warmed to 10ºC. Wet, cool weather will delay germination, causing decay of seeds and increasing injury to seedlings by maggots and root rot organisms. Beans with a dark colored seed coat are generally hardy and will germinate better under cold soil conditions, than seed with a light coloured seed coat. Beans should be handled gently as cracked seed coats and cotyledons decreases germination and seedling vigor. Generally in Nova Scotia, beans are seeded from middle of May until early June.

Spacing for beans vary depending on the method of harvest and the type of bean grown. Generally, bush beans are seeded 2.5-5cm deep, 7-10 cm apart and in rows 38-80 cm apart. Conventional tillage practices are being used.

In heavier soils, seeds should be seeded no deeper than 2.5 cm, while in sandy soils up to 5 cm is preferable. Sow as shallow as soil moisture levels permit. Planting in wet soil must be avoided because crusting of the soil and seed rot may occur reducing germination and vigor. However, planting into moist soil is preferred over planting into dry soil and then irrigating. The risk of soil crusting and chilling injury to seed increase greatly with irrigation.

Closer row spacing will result in increased yields, although, in some fields gray mold and white mold disease losses are greater. Wider row spacing are suggested for fresh market production for either mechanical harvesters or hand pick. Narrow rows should be used for processing beans when proper harvesters are available. No till seeding is being tested.

3.0 CROP MANAGEMENT

3.1 IRRIGATION

Critical moisture time is at flowering stage of crop development. 25mm of water is needed every 7 days and can be supplied by either irrigation or rainfall. Sprinkler irrigation is commonly used in bean production. Dry beans do not tolerate excessive moisture well. High moisture levels favour disease development.

3.2 CULTIVATION

Preplanting soil preparation is necessary for good crop establishment and consequent crop development. Bean roots, although penetrating the soil for up to 1 meter, are located mainly in the top 20 cm of soil. If cultivation is necessary it should be early in the life of the crop, as shallow as possible. It should cease after bloom and never be done when the leaves are wet, because of the danger of disease spread.

3.3 INNOCULATION

The following paragraph from NCSU professor Dr Mary Peet explains a special characteristic of legume crops.

If little or no nitrogen is available in the field, snap beans will nodulate and form symbiotic associations with N-fixing bacteria in the soil even without artificial inoculation. Modern cultivars require fertilizer nitrogen for best performance, however. Plants fixing their own N often get off to a slower start in cool spring weather and are less uniform in bloom time and subsequent number

of days to harvest. Inoculating bean seed with N-fixing bacteria has not been shown to increase yields or even provide nitrogen to snap beans. If not the proper strain, the N-fixing bacterium will be ineffective and possibly parasitic.

In Nova Scotia, inoculation of seed with nitrogen fixing bacteria should be done on "new" fields with the use of a proper innoculant.

3.4 SOIL FERTILITY

Recommendations for supplemental organic matter, fertilizer, lime and manure should be based on a soil test and a Nutrient management plan. In Nova Scotia, soil tests are preformed by the provincial agriculture labs in Truro. To find out more about how to take a soil test, where to send the sample and fees for the tests, visit www.gov.ns.ca/agri or phone (902) 893-4683. Nutrient management plans balance the crop requirements and nutrient availability, with the aim to optimize crop yield and minimize ground water contamination, while improving soil productivity.

Manure

Heavy applications of manure are not recommended for beans as there may be excessive vegetative growth and a higher risk of seedcorn maggot injury.

Lime

Lime should be applied to maintain the soil pH in the range of 6.0 to 6.8.

Nitrogen

Dry beans have a low requirement for nitrogen since it is a legume crop and therefore only require 30-40 kg of actual nitrogen per hectare. It is advised to preplant broadcast apply or band 5 cm below and 5 cm to the side of the seed at planting. Side dressing of nitrogen is only recommended following heavy rains if foliage suggests a nitrogen deficiency. Over applications of nitrogen reduces concentration of maturity and causes excess plant growth. Extra nitrogen may help alleviate yield reductions caused by bean root rots. Nitrogen deficiency symptoms include uniformly pale green or yellow leaves. Growth is stunted, few flowers develop and pods fill poorly.

Phosphorous

A soil test will determine phosphorous requirements. If phosphorous is required, it should be banded at the time of seeding. Phosphorous deficiency often occurs on low pH soils. Initial symptoms are small, dark green upper leaves and older leaves that are brown and die early. Plants are stunted with thin stems and the number of flowers, pods and seeds are reduced.

Potassium

A soil test will determine potassium requirements. If potassium is needed, broadcast and incorporate into the soil prior to planting either as muriate of potash or manure. Banded potash at the higher rate may result in reduced yields. Deficiency symptoms appear as browning of leaf edges.

Sulfur

On sandy soils low in organic matter that has been intensively cropped, soil sulphate levels may be low. Application of gypsum should be considered on these soils. Deficiency symptoms appear as erect new leaflets.

Magnesium

If soil magnesium levels are low, a fertilizer containing magnesium may be used. Foliar sprays may also be used.

Beans are sensitive to magnesium deficiencies, which are fairly common especially on light acid soils where dolomitic limestone has not been applied. To avoid these problems, apply dolomitic

limestone or add magnesium to the fertilizer. If the problem occurs during the season, spray the foliage with Epsom salts (magnesium sulfate). Deficiency symptoms appear as yellowing between leaf veins.

Micronutrients

Boron
Beans are sensitive to excessive residue of boron especially on soils with a pH lower than 6. Do not grow after boron has been applied to a crop, such as Cole Crops, celery or rutabagas. Boron toxicity causes yellowing and necrosis of the margins of older leaves and of the primary leaves shortly after emergence. Boron deficiency symptoms include intervienal chlorosis on middle aged leaves.

Zinc
Zinc deficiencies may be a problem in fields that are intensively cropped, with low organic matter, high pH and not receiving applications of manure. Symptoms of zinc deficiency appear as interveinal chlorosis, deformed stunted and small young leaves and leaves rolled upwards with wavy margins. Older leaves develop dead tissue in and between the veins.

Manganese
Manganese deficiency is a problem when the pH is over 6.8. One or two foliar sprays of Manganese sulphate may be required to correct this problem. Soil application is not recommended because of the large amounts of manganese required. Manganese deficiency symptoms include interveinal chlorosis and fine speckling of younger leaves. The leaves may also appear bumpy and brown lesions appear on cotyledons.

High salts
High salts will cause the leaves to shrivel and desiccate. Beans do not tolerate alkaline or saline fields well.

3.5 CROP ROTATION
There are many benefits to crop rotation including the suppression of diseases, insects and weeds. In addition, crop rotation improves soil fertility because it is allowed to replenish naturally and soil structure improves because of the alternating between deep rooted and fibrous rooted crops.

Crops within a family tend to be susceptible to the same pests, therefore rotation of non susceptible crops (or groups) for several years allow all plant material to decompose and pest cycles to become broken. Without the presence of susceptible plant material, the number of disease and insect organisms will begin to diminish.

Crop rotation aids in weed control because the growth habit of each crop differs, which causes a decrease in a weeds ability to compete for space. Also, tillage practices and timing are different for dissimilar crops resulting in a decrease in the weeds ability to permanently establish. Another benefit of crop rotation for weed management purposes is with certain crops, there is a better chance at controlling different weeds. For example, in a broadleaf crop, grass control will be easier because of the use of grass killing herbicides and visa versa.

To create a crop rotation schedule, there are several things to be considered including types of vegetables grown, size of root system, size of planting rows, amount of fertility required for the crop and how much organic matter is left in the soil by the crop. Start designing the crop rotation by making a list of all vegetables to be grown and group them together by botanical relationship

(e.g. *brassicaceae, solanaceae, alliaceae*). Each year, change the location of the entire group within the field. This way, the same crop group will not be planted on the same piece of land two years in a row. Secondly consider the size of the root system of the crop to be grown. Deep rooted plants will help to break up the soil, while shallow rooted crops will not. Thirdly, consider the size of the plant rows. Wide rows will allow for more weed seeds to germinate, but on the other hand, tillage equipment may be able to go through them with more ease than in narrow rows. The fourth consideration should be given to whether or not the crop to be planted is a heavy feeder. A heavy feeder will deplete the soil of nutrients quicker than a non heavy feeder. The final consideration for a crop rotation is whether or not the crop will leave a lot of organic matter in the soil. Leaving organic matter behind is beneficial for replenishing the soil of nutrients lost to the crop while it was growing.

A long rotation of more than five years is better than a short rotation of two years. Also, ask yourself the following questions when putting together a rotation: Is the rotation profitable? Are the yields sustainable? Does it make use of nitrogen produced by an earlier crop? Are herbicide residues left?

A long rotation of more than five years is better than a short rotation of two years.
Due to diseases such as white mold, often found in lettuce, carrot and potato crops and insect pest (refer to the pest management section of this guide) it is best to plant beans every 3-5 years. Beans have an intermediate root depth that will aid in improving soil structure and aeration. Beans have large seeds that do not require a finely manicured seed bed; therefore previous crop residues would be tolerated. Green manure crops and wheat or cereal crops before hand are beneficial to beans. Also, beans should not follow Cole crops, celery or rutabagas, which may have had a lot of boron applied.

4.0 PESTS AND PEST MANAGEMENT

Effective management of any pest requires the use of multiple pest control techniques. Integrated Pest management (IPM) is a system that integrates Managerial, Cultural, Physical, Biological and Chemical control techniques to manage pests. A key to IPM is understanding what pests are in your crop, through scouting and adjusting production practices to discourage pests from becoming problems. IPM is a proactive approach to pest management, rather than just a reaction to pests as they occur. For more information on IPM techniques, refer to the AgraPoint Guide to Pest Management.

4.1 WEEDS

There are several effective preplant incorporated, preemergence and postemergence herbicides available for use on beans. Preemergence treatments provide good control of annual broadleaf weeds. When a heavy annual grass infestation is anticipated a preplant incorporated treatment should also be used. Postemergence treatments are available for both grass and broadleaf weed control. The timing of postemergence treatments is critical for the control of some species and control may be poor if applications are not properly timed. Care must be taken to avoid fields where residual herbicides from previous years persist in the soil as crop injury may occur.

No till seeding is being tested using herbicides that are currently registered.

4.2 DISEASES

Anthracnose
Anthracnose is caused by the fungus *Colletotrichum lindemuthianum*. Symptoms on seedlings are dark brown to black lesions on stems and cotyledons. On older plants, signs of anthracnose usually appear on the lower leaf surface along veins which show a red to purplish discoloration. Lesions may also appear on stems causing them to break. On the pods, the disease appears as

small brown specks or rusty brown circular spots. As the spots enlarge, their centers become sunken and turn brown. Under humid conditions, masses of pinkish spores appear on the lesions. Seeds obtained from heavily infected pods show brown colored spots on the seed coat.

Control:
The causal organism over-winters in seed, soil and plant debris. Do not use home-grown seed, only certified disease-free seed. Practice a 3-year crop rotation. Do not cultivate or harvest when plants are wet. Rogue and destroy affected plants. Do not spread bean refuse or manure containing bean refuse on land intended for beans in the next three years. Plant resistant varieties. If chemicals are used, scout fields frequently and apply a compound at first signs of the disease. Refer to the AgraPoint Guide to Pest Management for a listing of fungicides and their application methods.

Common Bacterial Blight
This disease prefers humid conditions and temperatures of 25-30^{0}C and is caused by the bacterium *Xamthomonas campestris.* Initially symptoms include water soaked spots and then irregular shaped, light brown lesions with yellow margins on the leaves. On pods, initial symptoms are circular, greasy gray lesions that eventually turn reddish brown.

Control:
Refer to the Halo Blight control section.

Halo Blight
This disease prefers temperatures of 16-20^{0}C and humid conditions. It is caused by the bacterium *Pseduomonas syringae* and causes small, water-soaked spots on undersides of leaves that develop into numerous, small reddish brown lesions with pale to yellow margins or halos. Reddish brown lesions with white deposits form on the pods.

Control:
Use certified seed, proper crop rotation and cultivation to bury crop residues. Use proper sanitation methods to clean fields, equipment, soil and people because pathogens can over winter. Fungicide sprays are also important. Scout fields frequently and apply fungicide at first sign of disease. Refer to the AgraPoint Guide to Pest Management for a list of fungicides and their application methods.

White Mold (Sclerotinia)
This fungus is caused by *Sclerotinia sclerotiorum*. Dark-green, water soaked lesions develop on the pods, branches or stems during or after flowering. Eventually white, fluffy, cottony growth occurs on blossoms, stems and pods. As the disease progresses, mounds of white mycelium harden and darken to a black colour. These dark black structures become sclerotia, which allow the fungus to over winter. Infection starts on the flowers and spreads from there to the other plant parts. This disease spreads rapidly during flowering, early pod development, during harvest and in storage. Continuous leaf wetness and temperatures of 20-25^{0}C favour development.

Control:
Serious losses result when susceptible crops are grown for several consecutive years, therefore follow a four year rotation and avoid placing beans in a field recently planted in soybeans, canola, beans, lettuce, peas, tomatoes, carrots, parsnips, cucumbers, celery or cabbage. Do not apply excess irrigation. Cultivate and pick when plants are dry. Plow plant refuse down immediately after harvest to prevent development of sclerotia. Do not use manure infected with white mold sclerotia. All sprays must penetrate crop canopy and contact blossom petals for good control. Applications of fungicides must be applied during bloom. Refer to the AgraPoint Guide to Pest Management for a listing of fungicides and their application methods.

Botrytis Gray Mold
This disease is caused by the fungus *Botrytis cineraea* and it develops on dense plant canopies in warm, moist weather. Symptoms include plant tissues (stem, leaves and pods) dying and rotting and then gray masses of fuzz appear.

Control:
Avoid damaging the leaves. Good sanitation is important as the disease will live on dead plant material. Incorporating plant debris immediately after harvest will help speed up the decomposition process. Monitor the field frequently and spray at first sign of the disease. Refer to the AgraPoint Guide to Pest Management for a listing of fungicides and their application methods.

Root Rot
Root rot is caused by a complex of several soil borne fungi, *Pythium*, *Rhizoctonia*, *Fusarium* and *Thielaviopsis*. It is present in every soil and nearly all plants have some degree of root rot. *Pythium* causes seed decay and damping off. In older plants, it causes a decrease and discolouration of roots and lesions at the tips of pods. *Rhizoctonia* causes seed decays and damping off. On older plants, it produces reddish brown, sunken lesions on the stem and tap root. *Fusarium* causes long red lesions on stems and roots. *Thielaviopsis* produces dark brown to black lesions on stems and roots.

Control:
In seriously infected fields, long rotations of 6 years or more are necessary. Bean refuse should always be placed in areas where beans will not be grown. Any bean refuse left on the field should be turned under deeply by fall plowing. Plant only on well drained, well fertilized soils. Avoid fields that are known to carry the pathogens. In fields with the disease, it is best to plant shallow and later in the season. Use disease tolerant varieties and certified seed whenever possible. Scout fields frequently and apply fungicides at first sign of disease. Refer to the AgraPoint Guide to Pest Management for a listing of fungicides and their application methods.

Bean Yellow Mosaic Virus (BYMV)
This virus is spread by the following aphids: bean aphid, green peach aphid, potato aphid, cow pea aphid and pea aphid. Symptoms consist of yellow and green mottling on leaves. Pods generally are not affected, but the number of seeds per pod may decrease.

Control:
BYMV will not persist on plant debris, in the soil or on equipment, but it will survive on weed hosts such as sweet clover and red clover, therefore it is best to keep a weed free zone around the field of beans. Avoid fields with a known aphid problem and high populations of perennial weedy legumes. Use disease tolerant varieties and certified seed whenever possible. Scout plants regularly and apply a spray at the first sign of aphids. Refer to the AgraPoint Guide to Pest Management for a listing of insecticides and their application methods.

Bean Common Mosaic Virus (BCMV)
This virus is spread by seed and by aphids, mainly the bean aphid, green peach aphid, potato aphid, cow pea aphid and pea aphid. Symptoms consist of downward cupping along the main vein of each leaf and a green mottling on leaves. Malformed leaves, blistering and green vein-banding may also be present. Generally plants and pods are smaller in size, malformed and mottled in colour.

Control:
Plant certified disease free seed and resistant varieties if available. Scout plants frequently and apply an insecticide when aphids are first noticed. Refer to the AgraPoint Guide to Pest Management for a list of insecticides and their application methods.

4.3 INSECTS

Seedcorn Maggot

Seedcorn maggots (*Delia platura*) are small yellowish-white maggots 6 mm long with a pointed anterior end (head). The adult is a small, 5 mm grayish-brown fly. Maggots feed on seed destroying the embryo and feed on roots, causing poor plant growth. Damaged seed will either not germinate or produce a deformed plant. Seedcorn maggots attack deeply planted seeds. Maggots are usually a problem in direct seeded crops during cool, wet springs when germination is delayed.

Control:
Plant tolerant varieties if available. Biological control options include the fungal disease *Entomophthora muscae* and the nematode *Steinernema carpocapsae*. Plant as shallow as needed in a well prepared seedbed. Early germination is necessary to get good plant stands and prevent injury. Later planted crops are not as susceptible to this pest. Good weather conditions are necessary to completely control the pest. Avoid planting susceptible crops in fields very recently manured because root maggots prefer soil with high organic matter. Chemical seed treatment is essential. Scout fields frequently and apply insecticides at first sign of disease. Refer to the AgraPoint Guide to Pest Management for a listing of insecticides and their application methods.

Two-Spotted Spider Mite (TSSM)
The TSSM (*Tetrahyehus urticae*) is an occasional pest, but when it does occur it can be serious. Leaves become speckled and then turn bronzed or brown. A fine webbing is produced on the underside of the leaves. The mites are microscopic in size, yellow to dark green in colour with two black dorsal spots. Usually this pest only becomes a problem under very hot dry weather conditions.

Control:
Monitor TSSM activity in a field by checking leaves with the aid of a hand lens. Apply a spray if there are four or more mites per leaf or one severely damaged leaf per plant. Refer to the AgraPoint Guide to Pest Management for a listing of insecticides and their application methods. Natural enemies can be used to control TSSM and include: *Phytoseiulus persimillis, Phytoseiulus longipes, Neosiulus californicus and Galandromus occidentalis.*

European corn borer (ECB)
European corn borer (*Ostrinia nubilais*) larvae are gray with rows of brown spots and are 2 cm in length when fully grown. They over- winter in corn stubble, and by July they become nocturnal adult yellowish to reddish brown moths that are 2.5 cm in length. Females lay 20-40 eggs in scale-like masses on the undersides of leaves. The larvae hatch within a week and enter the stems and bean pods. Several pods will be damaged by a single larva before it stops feeding. The European Corn Borer can continue to consume beans after harvest if they make it to the storage bin.

Control:
Plow down corn stubble in the fall. Avoid planting beans in fields that had corn in the previous years or fields adjacent to current corn crops. Biological control options include maintaining high numbers of the following natural predators: predatory lady beetles, minute Pirate bugs, lacewings and fly and wasp parasitoids. Monitor adult ECB moth activity by using blacklight or pheromone traps. If moths are active and the bean is in a vulnerable stage (i.e. pin stage/14 days to harvest to one day before harvest) then the field should be sprayed. Refer to the AgraPoint Guide to Pest Management for a listing of insecticides and their application methods.

Wireworms
There are several wireworm (*Agriotes*) species in Canada, but in Nova Scotia, three species are previlant; *A. lineatus, A. obscurus,* and *A. sputator*.

Early in the spring, adult wireworms (click beetles) lay their eggs around grass roots. The larvae hatch in about a week and, depending on the species, will live for 1 to 5 years in the ground feeding on roots and seeds. Wireworms require 3 or more years to complete their life cycle. Wireworms of all sizes and ages are present in the soil throughout the year as there is always an overlapping of generations. The wireworms, or larvae, are yellow, white or darker shades of brown. Fully developed larvae may be 1.2 to 4 cm long and have a hard, smooth surface. When a larva is mature, it pupates in the fall. It then becomes an adult beetle and waits until spring to emerge. Wireworms are often numerous in land that has been in sod for several years. They are also more abundant in heavy poorly drained soil.

Wireworms are sometimes confused with millipedes. Millipedes have numerous pairs of legs and coil up when disturbed, while wireworms have three pairs of legs near the front of the body and do not coil up.

Control:
Plant treated seed and avoid planting crops highly susceptible to wireworms in a field that has been recently in sod. Refer to the AgraPoint Guide to Pest Management for a listing of insecticides and their application methods. It should be noted that chemical control products may not work on all wireworm species.

Wireworm activity can be monitored in the fall or early spring with the use of bait traps. Place whole carrots 7.5 cm deep in the soil at 10 marked locations in the field for 2-3 days. A count of 0.5-1 wireworm per station indicates a potential problem.

4.4 PHYSIOLOGICAL DISORDERS

Bronzing
Bronzing is caused by high levels of atmospheric ozone associated with air pollution. It occurs following the initiation of flowering and after the older leaves become fully mature. Pods as well as the upper surface of the leaves become covered with reddish-brown spots and the plants age prematurely, eventually with death of leaf tissue. However, most dry bean crops can handle 30-40% defoliation before yield is affected.

Control:
Plant resistant cultivars.

5.0 HARVESTING AND HANDLING

Start harvesting when seeds are at 18% moisture, which is when some pods are brown and the majority are yellow and dry. Low seed moisture can result in mechanical injury (split seed coats) so use extreme caution. Special drying techniques using heated and/or unheated air have been developed. It is imperative that plants have reached physiological maturity before being harvested. Unevenness of maturity can lead to problems of shattering or abrasion, discolouration or disease of immature beans. Delaying harvest too long after maturity will cause sprouted or blemished seed, darkened seeds and shattering.

As plants approach maturity, a rainfall following a dry spell may initiate new growth and flowering on plants, which causes problems at harvest. Mature seed will become contaminated with immature seed and green plant material can stain the seed coat during harvest. To avoid these

problems, crop desiccants can be used to dry down green vegetative growth from the crop and surrounding weeds.

There are two methods to harvest dry beans; direct or pulled and windrow. Direct harvesting is carried out with rotary combines or combines with flexible cutter bars. Generally combines used for soybeans will also work for dry beans. If using the second method, than beans are pulled in the morning, when pods are damp and tough thereby lessening shatter. Vines are windrowed for subsequent pickup and threshing with a specialized bean combine; the time between pulling and combining should be minimized to avoid discoloration.

Seed damage at harvest is related to low seed moisture

Beans are harvested from mid September to late October. They are dried and then marketed on a year round basis. Most beans produced in Nova Scotia are of the large seeded type. These find markets at roadside stands and are also delivered to wholesalers.

5.1 STORAGE AND CONDITIONING

If beans are not sold at harvest they can be stored at 15-16% moisture content in an elevator or granary. Careful handling of seed is a must! High moisture seed must be dried slowly so the skin is not wrinkled or damaged. If there is a lot of foreign material in the beans, then natural heating must be prevented by aeration. Store beans at 5°C during the winter.

6.0 BIBLIOGRAPHY

Atlantic Provinces Agricultural Services Coordinating Committee. Beans (Snap) Vegetable Crops Production Guide for the Atlantic Provinces. September 1997.
www.nsac.ns.ca/lib/apascc/acv/production/beanssnp.htm

Agriculture and Agri-Food Canada. Crop Profile for Dry Bean In Canada.
www.agr.gc.ca/env/pest/pub/pdf/dbean-haricots_e.pdf. February 2005.

BBC Radio 4. Gardeners' Question Time – Fact sheets. August 2001.
www.bbc.co.uk/radio4/gqt/fsheets/12_08_01/fsheetsq8.shtml

Government of Manitoba. Beans (Snap).
www.gov.mb.ca/agriculture/crops/vegtablecrops/pdf/bmz00s02p.pdf

Howard, Ronald, J. Allan Garland and W. Lloyd Seaman. Diseases and Pests of Vegetable Crops in Canada.1994.

Innvista.com. Crop Rotation. www.innvista.com/health/foods/rotation.htm

Johnny's Selected Seeds Catalogue. Beans. 2006. Pages 5-7.

New York State IPM Program. Beans – Dry and Snap. May 2006.
www.nysaes.cornell.edu/recommends/13beans.html

North Carolina State University. Vegetable Crop Irrigation. August 1997.
www.ces.ncsu.edu/depts/hort/hil/hil-33-e.html

NDSU Fact sheet. Crop Rotations for Increased Productivity. January 1998.
www.ag.ndsu.edu/pubs/plantsci/crops/eb48-1.htm

North Carolina State University. Pole Bean Production. May 2005. www.ces.ncsu.edu/depts/hort/hil/hil-3-a.html

North Carolina State University. Beans – Sustainable Practices for Vegetable Production in the South. October 2001. www.cals.ncsu.edu/sustainable/peet/profiles/c08bbean.html

Ohio State University. Beans: Snap, Dry and Lima. http://ohioonline.osu.edu/b672/pdf/Beans.pdf

OMAFRA. Vegetable Production Recommendations 2006-2007.

OMAFRA. Beans – Fertility. February 2006. www.omafra.gov.on.ca/english/crops/pub363/9-fert-beans.htm

OMAFRA Fact sheet: Horticultural Crops-Vegetables. August 2005. www.omafra.gov.on.ca/english/environment/hort/veg.htm

Oregon State University. Snap Beans – Green, Romano, Yellow Wax. August 2004. http://oregonstate.edu/Dept/NWREC/snapbean.html

Purdue University Centre for New Crops and Plants Products. Bean. www.hort.purdue.edu/newcrop/Crops/BeanCommon.html

Purdue University. Bean, (Common-dry), Field Bean. www.hort.purdue.edu/newcrop/Crops/BeanCommonDry.html

Purdue University & Jefferson Institute. Alternative Crop Guide: Dry Edible Beans. A high value alternative legume. www.hort.purdue.edu/newcrop/articles/ji-beans.html

Royal Horticultural Society. RHS Help and Advice: Crop Rotation. www.rhs.org.uk/advice/profiles1200/crop_rotation.asp

Stokes Seeds Catalogue. Beans 2006. Pages 5 & 6.

UC Davis, Vegetable Research and Information Centre. Beans. http://vric.ucdavis.edu/veginfo/commodity/garden/crops/beans.pdf