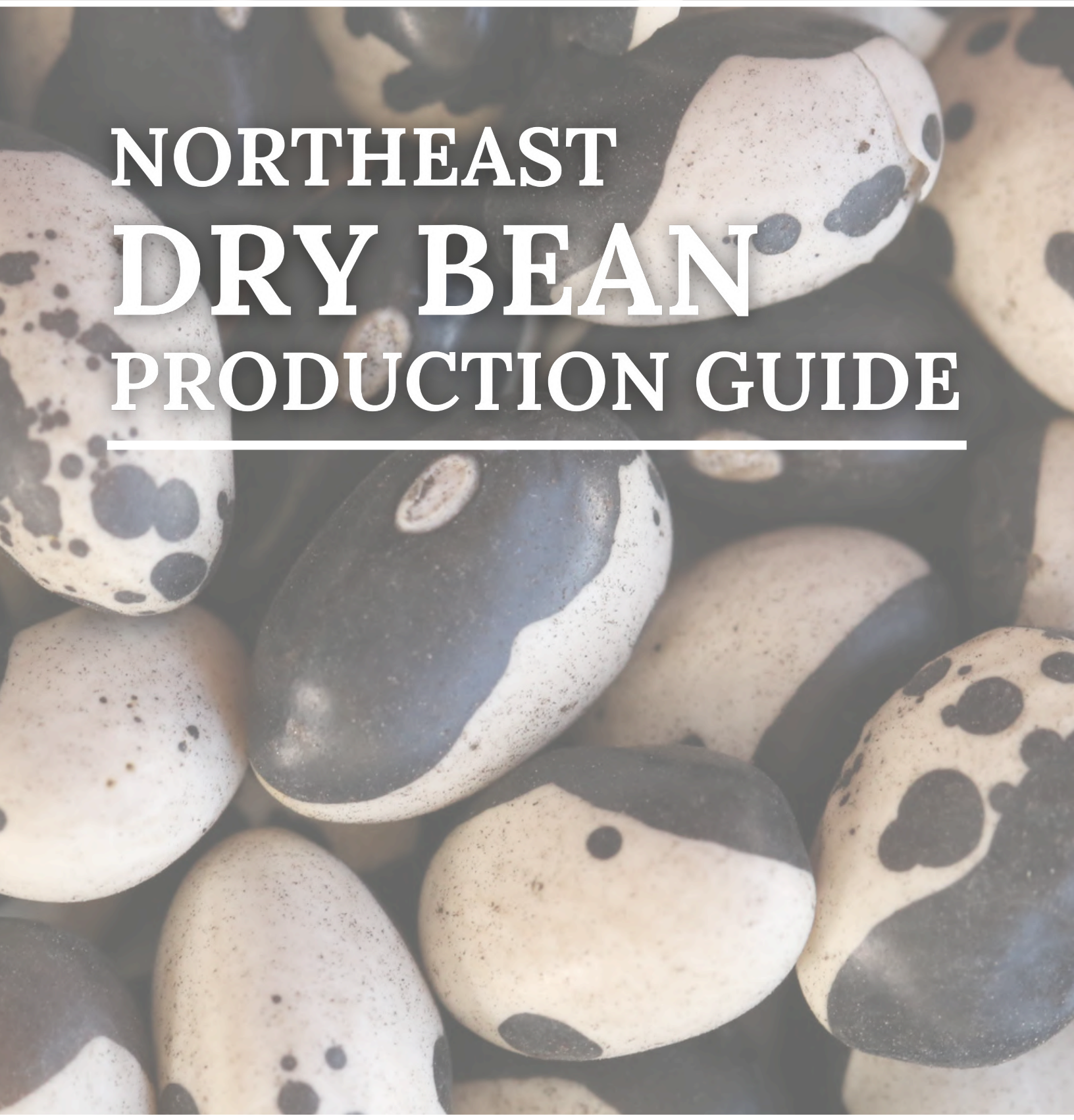


NORTHEAST DRY BEAN PRODUCTION GUIDE

Dr. Heather Darby, UVM Extension Agronomist and Soil Specialist
Erica Cummings, UVM Extension Crop and Soil Specialist
Ivy Krezinski, UVM Research Specialist
Kristen Loria, Cornell University Extension Support Specialist

SARE Sustainable Agriculture Research & Education

USDA

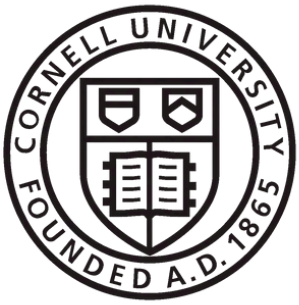
University of Vermont Extension
College of Agriculture and Life Sciences

Cornell University Founded A.D. 1865

University of Vermont

Extension

College of Agriculture and Life Sciences



This guide was produced with funding from Northeast SARE, project ONE15-234 project LNE22-444.

Northeast Dry Bean Production Guide

Dr. Heather Darby, UVM Extension Agronomist and Soil Specialist
Erica Cummings, UVM Extension Crop and Soil Coordinator
Ivy Krezinski, UVM Extension Research Specialist
Kristen Loria, Cornell University Support Specialist

Visit UVM Extension Northwest Crops and Soils Program on our website:
https://www.uvm.edu/extension/nwcrops

Or find us on our social channels

This guide was produced by staff at the
University of Vermont Extension Northwest Crops and Soils Program
in collaboration with Cornell Cooperative Extension

Table of Contents

Introduction

Dry beans (*Phaseolus spp*.) have been a tradition to both grow and consume in the Northeast. Beans originated in the Americas, and in the northeast Native American communities introduced English settlers to this important staple. Dry beans come in a wide variety of shapes, colors, and sizes (Figure 1). Jacob's Cattle, European Soldier, Black Turtle, and Yellow Eye beans are the most commonly grown varieties in the Northeast. The edible field bean is considered a grain legume crop that is well-suited for our climate, but requires good soil quality and diverse crop rotations. Beans are a staple food for much of the world due to their high protein content (generally 22% to 24%) and other desirable nutritional properties being high in vitamin B1, iron, phosphorus, and zinc. They can serve as a great addition to a grain rotation and are a highly marketable crop.

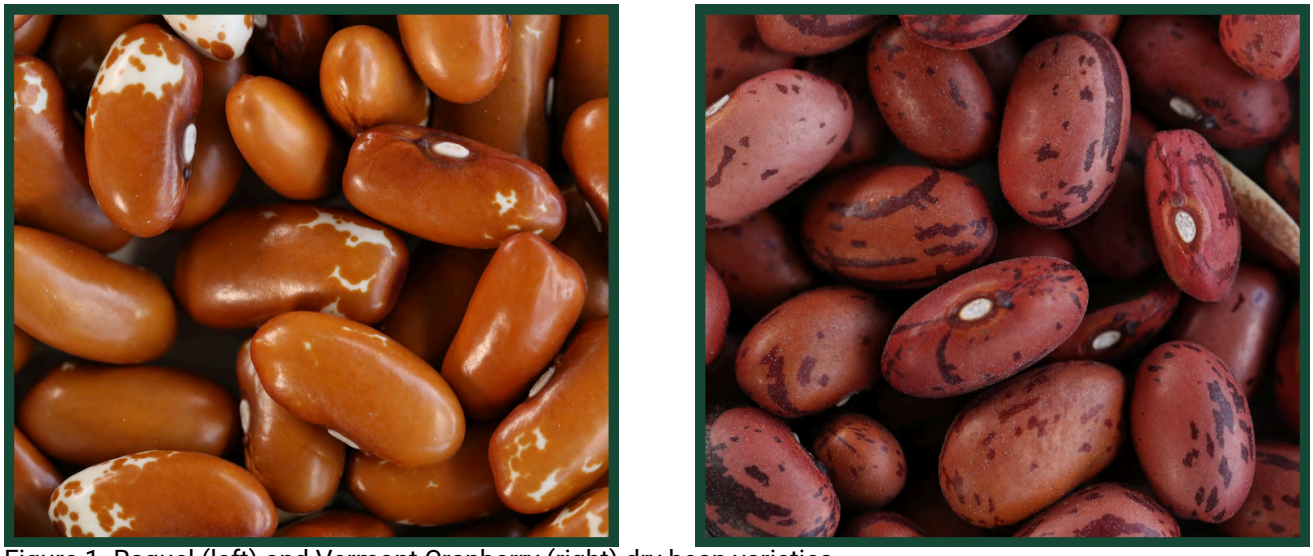


Figure 1. Raquel (left) and Vermont Cranberry (right) dry bean varieties.

Variety Selection

Growers should carefully choose their dry bean varieties based on maturity, growth habit, disease resistance qualities, and market demand. Plant breeders have identified maturity and plant architecture as two of the most important characteristics for maximizing dry bean yields. These two factors should be carefully considered when selecting the varieties you plan to grow on your farm. Other considerations when selecting varieties are the end uses and consumer demand. The growing demand for locally grown food staples like dry beans, along with consumer interest in heirloom or specialty crops, has more growers looking to add them into their rotation.

Dry Bean Market Classes

Dry beans are often organized into market classes by the seed coat color and seed size (Figure 2). Some examples of major market classes are pinto, navy, black, and small red. There is also a large diversity of heirloom or specialty varieties of dry beans that do not fall into a major market class. There are many different varieties of dry beans within each market class. They vary in traits such as yield and disease resistance. Black beans are often considered the easiest to grow commercially and are a good “entry-level” choice for new growers. White-seeded market classes can be more challenging to grow as they are more susceptible to staining. Black beans along with other varieties like navy, small red, pinto, pink, and great northern beans, can be direct harvested using a traditional combine.

Figure 2. Assorted dry beans from the UVM Extension variety trial.

Growth Habit

Growth habit can vary considerably between market classes and varieties. Growers should carefully choose their dry bean varieties, paying close attention to the growth habit. This information may be included in the seed catalog or on a variety profile sheet provided by the seed company or a university dry bean breeding program. There are four main growth habits of dry beans, three of which are grown in U.S field crop production (Table 1, Figure 3). Types I and II tend to mature earlier and their upright growth habit is well adapted for more humid regions like the Midwest and Northeast. Type III varieties mature later and perform better in more arid regions out west. Type IV or pole beans are climbing types and are generally not suitable for field crop production in the Northeast or Midwest, as they require trellising. While dry beans are classified under different growth habit categories, it is not a hard and fast rule. Plant growth habit can change in response to environmental factors such as temperature, soil fertility, or moisture. For example, Type II varieties may become vinier under high nitrogen conditions. Modern breeding efforts have expanded the market classes of dry beans with a sufficiently upright growth habit and pod height to facilitate direct

harvest. For example, many modern pinto and Great Northern varieties exhibit a Type II growth habit.

Table 1. Growth habits of dry beans grown in the U.S.

Type	Common name	Growth habit	Description	Examples
I	Bush bean	Determinate growth	Highly branched with pods set on branches, keeping pods off the ground. Type I varieties often flower early and are ideal for short-season production systems.	Kidney beans
II	Upright short vine	Indeterminate growth	Limited branching with pods that are generally concentrated in the middle of the plant. Strong upright growth habit, and weak vining. Pod set is delayed, occurring on later nodes, in Type II compared to Type I, and results in longer season maturity.	Black and navy beans
III	Vine type		Exhibits a prostrate growth habit, growing along the ground with stems lacking strength to remain erect during pod fill. Pods tend to be concentrated at the base of the plant, resulting in increased likelihood of pod contact with soil surface. Has weak or facultative climbing ability.	Pinto and great northern beans
IV	Pole bean		Climbing type; not suitable for field crop production	

Adapted from Singh, 1982 and Kelly, 2000.

Figure 3. Dry bean growth habit types as first described in Singh, 1982. In order left to right, Type I (determinate bush habit), Type II, and Type III (indeterminate vine habit) (Photo source: J.D. Kelly, 2000)

Sourcing Quality Seed

To achieve desirable plant populations, yields, and quality, it is important to purchase high quality seed with good germination (> 90%) that is free of weed seeds and seed-borne diseases. Buying 'Certified Seed' is your best bet for assuring high quality seed. Certified seed guarantees that the seed meets or exceeds a strict set of quality control standards set forth by the Association of Official Seed Certifying Agencies (AOSCA; https://aosca.org/). All seed must pass field inspection and laboratory testing before it can be sold as

certified seed. In the case of beans, this includes rigid standards for seedborne diseases. Standards vary by certifying agency, but in general dry bean seed must come from a field with less than 2% incidence of following pathogens: anthracnose, bacterial bean blights, wilt, brown spot, bean common mosaic virus, and bean common mosaic necrotic virus. Once seed has been certified, it can be labeled with the official 'blue' certified seed tag (Figure 4). Saving seed from a previous crop is also an option, but for best results, saved seed should be from fields with low weed pressure and free of diseases. Seed-borne pathogens of concern in the Northeast include fungal pathogens like anthracnose (Figure 5), bacterial diseases such as common bacterial blight and halo blight, and Bean Common Mosaic Virus. Unfortunately, there isn't a simple 'do-it-yourself' test you can conduct to determine whether your seed is infected. Plant diagnostic clinics can screen seeds for a variety of diseases. Contact individual diagnostic clinics for instructions on submitting samples and testing services available (see page 5 for clinic information).

Figure 4. Certified seed tag on a bag of dry bean seed (Photo credit: Great Basin Seed.)


Figure 5. Navy beans infected with anthracnose (photo credit: Madison Whyte, Michigan State University).

Sourcing certified heirloom dry bean seed in quantities greater than a pound has proven to be a challenge. Much of the heirloom bean seed we have found thus far has not been 'Certified Seed'—rather it has been saved seed from growers or from businesses selling beans for food. There are companies that carry larger quantities of heirloom varieties, especially improved varieties (i.e. UC Tiger's Eye, an improved version of Tiger's Eye developed by breeders at the University of California, Davis). See the Additional Resources section for more information on seed companies.

Cornell Plant Disease Diagnostic Clinic
Ithaca, NY
(607) 255-7860
https://plantclinic.cornell.edu/index.html

UVM Plant Diagnostic Clinic
Burlington, VT
(802) 656-0493
https://www.uvm.edu/extension/plant-diagnostic-clinic

Dry bean seeds are easily damaged and therefore, seed quality is relatively short-lived. It is not advisable to purchase seed known to be over three years old. If the germination rate is not listed on the seed tag, there is no seed tag, or if the seed is older than a year, a germination test should be conducted prior to planting the seed. A simple germination test can easily be conducted on your own or at a commercial laboratory (Figure 6). It is recommended to test each bean variety in duplicate. Start by soaking two paper towels in water and spreading twenty seeds over one half of it, then fold the other half over the seeds. Fold and roll it up like a burrito, place it in a clear plastic bag or airtight container to keep it from drying out, and store in the dark. Once daily, open up each germination test to see if any seeds have germinated; remove any sprouted seed from the test. Add more water if paper towels dry out, making sure the tests remain damp but not dripping wet.

The germination test should be kept at room temperature (18-21°C or 64-69°F). Most seeds like to be warm as too cool of temperatures (below 60°F) will delay or prevent germination. Continue to check daily until you have concluded that all the viable seeds have germinated. If you haven't seen a new sprout for 7 days, the test is probably complete. Dry beans will generally germinate in three to four days. Count how many seeds are left to calculate percent germination. For example, if you had 2 seeds left out of the original 20, then the germination rate would be 90% (20 – 2 = 18; 18÷20 = 0.90).

If you did the tests in duplicate, average the two tests to get the germination rate. Seeding rates should be adjusted to compensate for seed with low germination rates. For example, if you have seed with a 90% germination rate and want to plant at 100,000 seeds per acre, to adjust your seeding rate you divide the seeding rate by the decimal equivalent of your percent germination (100,000÷0.90= 111,111 seeds per acre). Planting seed with a germination rate below 80% is not advisable.

Also, if germination is slow in lab conditions, this may be an indication of seed with low vigor and may not perform well in field conditions. Plant diagnostic laboratories usually offer plant vigor assessments in addition to germination tests.

Calculating Germination Rate

Dry beans will generally germinate in three to four days. Count how many seeds have germinated to calculate percent germination.

$$\frac{\#\ seeds\ to\ germinate}{total\ \#\ seeds} * 100 = germination\ rate$$

$$\frac{18}{20} = 0.90 * 100 = 90\%\ germination$$

If you did the tests in duplicate, average the two tests to get the germination rate. Seeding rates should be adjusted to compensate for seed with low germination rates.

For example, if you have seed with a 90% germination rate and want to plant at 100,000 seeds per acre, to adjust your seeding rate you divide the seeding rate by the decimal equivalent of your percent germination.

$$\frac{Target\ seeding\ rate}{germination} = Adjusted\ seeding\ rate$$

$$\frac{100,000}{0.90} = 111,\ 111\ seeds\ per\ acre$$

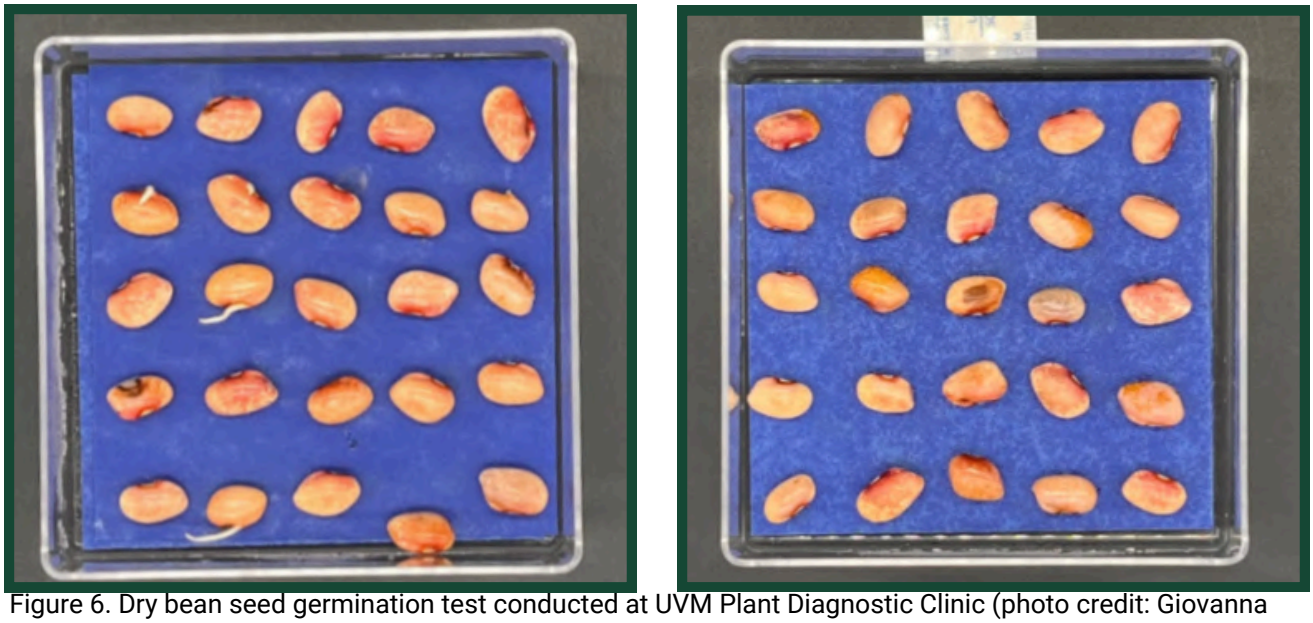


Figure 6. Dry bean seed germination test conducted at UVM Plant Diagnostic Clinic (photo credit: Giovanna Sassi, University of Vermont).

Production and Management

Soil and Fertility

Dry beans prefer a well-drained soil with relatively good fertility. Avoid planting dry beans in a field that floods easily, is heavily compacted, or regularly develops a thick crust. As with any crop, before selecting fields in which to plant dry beans, it is advisable to test the soil for basic soil nutrients. The soil test report generated will provide information on the field's current fertility levels (including pH) and recommendations for amendments that may be added to improve soil fertility specifically for dry beans. Information on how to properly take and submit a soil test may be found at the following locations.

UVM Agricultural and Environmental Testing Laboratory
Burlington, VT
(802) 656-3030
AgTesting@uvm.edu
https://www.uvm.edu/extension/agricultural-and-environmental-testing-lab

Dairy One Soil Laboratory
Ithaca, NY
(800) 344-2697
soil@dairyone.com
https://dairyone.com/services/soil-laboratory/about-soil-laboratory/

Dry beans grow best in near neutral soil, with a pH around 7.0. More acidic soils will require the addition of limestone, preferably dolomitic lime, to raise the pH. However, dry beans are sensitive to soil zinc levels, especially in soils where the pH is above 7.0. To amend soil zinc levels, add 10 lbs per acre of zinc sulfate into your starter fertilizer. Broadcasting zinc onto fields is not recommended but foliar applications may be used if applied when the plants are young, before flowering. Depending on your soil test results, nitrogen, phosphorus, and potassium (N-P-K) may need to be applied.

Dry beans are legumes, so they produce their own nitrogen through a symbiotic relationship with the bacteria *rhizobium phaseolus*. Unfortunately, the relationship is not very strong and applying a small amount of nitrogen fertilizer to the bean crop can increase yields. Trials in North Dakota have shown yield responses with up to 40 lbs of nitrogen fertilizer per acre. Remember, it is important to account for nitrogen credits from past year manure, compost, or cover crop applications. Excessive nitrogen can cause vining growth habit, increased lodging, and increased incidence of diseases such as white mold, due to reduced airflow in the crop canopy. Beans are sensitive to salt injury and ammonia burn; therefore, fertilizer should be band applied and separated from the seed by 2 to 3 inches. Over-applying chemical fertilizers or manure may also cause excessive vegetative growth and increase the

chemical fertilizers or manure may also cause excessive vegetative growth and increase the risk of disease. Care should be taken in proper soil testing and crediting past year soil amendments.

Seeding Rates

Seed size and established plant populations vary significantly among dry bean market classes. Dry beans come in a variety of different sizes (Table 2). Since there aren't as many seeds per pound in a large bean variety (e.g., kidney) as there are in a smaller variety (e.g., black), it takes more seed of a larger bean variety to get the same plant population as a smaller bean variety. Therefore, it is important to calibrate your planter properly for the type of bean being planted. Beans can be planted with a corn planter fitted with bean cups appropriate for the seed size or using a corn planter with different size seed plates. You may need to adjust the settings depending on the variety and germination rate. Most seeding rate recommendations for dry beans are around 100,000 seeds per acre for conventional production systems. In organic production, the seeding rate should be increased by 20% to account for reduced emergence due to seed disease or predation. As a general rule, adjust the planter to seed at about 60 lbs per acre; this should produce about 7 seeds per foot. This rate can be adjusted up to about 70-75 lbs acre for larger seeds (kidney) or reduced to 45-55 lbs acre for smaller seeds (blacks and navy).

Table 2. Seeds per pound for dry bean market classes.

Market class	Seeds per pound
Black	2,100-2,500
Cranberry	900-1,000
Great Northern	1,300-1,600
Kidney	800-1,000
Navy	2,200-2,400
Pink	1,300-1,600
Pinto	1,200-1,600
Small Red	1,300-2,000

Adapted from Kandel and Endres, 2019.

Planting

Dry beans are generally planted in late May to mid June, once soil temperatures are reliably 60°F or higher. Beans can easily be injured or killed by frost, so it is best to delay planting until any chance of frost has passed. Most dry bean varieties need 90 to 100 days to mature. If beans are planted late (mid to late June) you run the risk of the plants not reaching maturity before a fall frost arrives. It is important to find varieties that are adapted for the short growing season of the Northeast. Before planting, seeds should be inoculated with the bacteria *Rhizobium phaseoli* for optimal nitrogen fixation.

Beans are usually planted about 1½ to 2½ inches deep and in 30-inch rows. Some growers plant in narrower rows to suppress weed growth, but this can increase the likelihood of disease and make cultivation and harvesting more challenging. Dry beans need sufficient moisture to germinate due to the large seed size and thick seed coat. Dry soils at planting will result in delayed germination and could potentially lead to reduced stands. If there is adequate soil moisture at planting, a shallow planting depth (~1½ inches) will be sufficient,

but if soil conditions are dry, be sure to plant dry beans deeper (~2½ inches). Be sure to avoid excessively wet or water-logged soils. Cold and wet conditions after planting can cause delayed germination and seeds can even rot before emergence. Beans will emerge most rapidly when soil temperatures are 65 degrees Fahrenheit or above. Rapid, uniform emergence is important to optimize uniformity of plant maturity at harvest and reduce weed competition. Soil crusting due to heavy precipitation can reduce or delay seedling emergence; this can be addressed via tine weeding or rotary hoeing prior to emergence.

Some dry bean varieties, including most kidney and cranberry beans, are photoperiod sensitive, while others, including most black, pinto and navy beans, are not. For photoperiod sensitive varieties, flowering is triggered by day length, while in non-photoperiod sensitive varieties, flowering is triggered by days after planting. All dry bean varieties are self-pollinating though occasional outcrossing may occur, especially where pollinator populations are higher. Indeterminate varieties of dry beans will continue to expend energy in vegetative development for several weeks after they flower. Most dry bean growth will occur when temperatures are between 65°F and 75°F. During extended periods of cold (below 46°F) or hot (above 95°F) weather, beans may shed blossoms and developing pods. Dry beans require adequate moisture as they bloom and develop pods so dry conditions during this period can decrease yield. Beans cannot tolerate prolonged water-logged soils so adequate drainage is a necessary consideration when selecting fields for production (Figure 7).

Figure 7. Standing water in a dry bean field following several heavy rain events (left). Crop damage due to standing water and saturated soils (right).

Dry Bean Pest Management

Weed Control

Weeds may develop quickly in beans due to relatively poor competitiveness compared to other row crops, with slow or no closure of the crop canopy. Because of this, a grower should select a field with lower weed pressure or have a rigorous weed management regime to minimize yield loss. Weeds can also harbor diseases that will affect the dry bean crop. False-seed bedding prior to planting can reduce early weed competition. Pre-emergent weed control can also be accomplished after planting with either a tine-weeder or a rotary hoe, depending on the weather and soil conditions and amount of plant residue in the field. Do not cultivate when the beans are starting to emerge (in “crookneck” stage) (Figure 8) as bean seedlings are vulnerable to damage at this stage. Small seedings can also be damaged by overly aggressive tine weeding or rotary hoeing, so careful adjustments should be made. To minimize disease spread, beans should not be cultivated when leaves are wet. Cultivation can be undertaken when plants are between 2 and 3 inches tall until they are sufficiently large to risk damage. The timing will vary by variety; for indeterminate or vining/trailing varieties, extra care should be taken to avoid cultivation once plants have started to send out vines. Vines can get caught on equipment and cause serious damage to the bean plants. Late season weed control is crucial to facilitating successful harvest, especially for indirect harvest methods. There are pre and post emergence herbicides available for weed control in dry beans. Since many of the herbicides have rotation restrictions, selection needs to be planned around other crops in the rotation.

Figure 8. Bean emerging during “crookneck” stage.

Diseases

Dry beans are susceptible to various root rots including *Rhizoctonia, Fusarium*, and. *Pythium* —all can cause seedling death and reduce yields. In addition, several bacterial leaf diseases including Bacterial Bean Blight, Bacterial Brown Spot, and Halo Blight are common (Figures 9 and 10). Bacterial diseases can be challenging to identify, but samples of diseased plant tissue can be sent to your local plant diagnostic clinic for identification (see page 5). Bacterial diseases are often spread by insect pests so diligent scouting and control of all pests is critical to disease management. To break the cycle of disease transmission, it is best to grow dry beans in rotation with other crops, especially cereals. It is commonly recommended to grow dry beans every 3 to 4 years, to prevent a buildup of pathogens.

Fungal pathogens include *Sclerotinia* white mold (Figure 11), and Anthracnose (*Colletotrichum lindemuthianum*). Anthracnose (Figure 12) begins with discoloration as red spots on leaves that develops into lesions. As lesions develop, leaf veins turned reddish-dark brown and spread through the leaf. The fungus then spreads to the pods, causing black lesions. Mature circular lesions on pods are surrounded by reddish-brown to black borders with a grayish black interior that exuded pink masses of spores. Anthracnose can wipe out entire fields of beans and is spread primarily by planting infected seed.

Figure 9. Bean leaf infected with Bacterial Bean Blight.

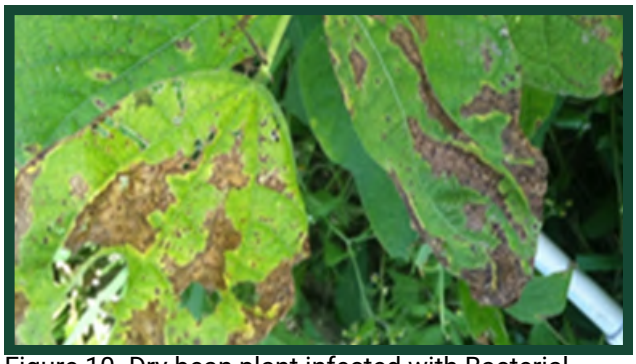


Figure 10. Dry bean plant infected with Bacterial Brown Spot.

Figure 11. White mold on dry bean plant.

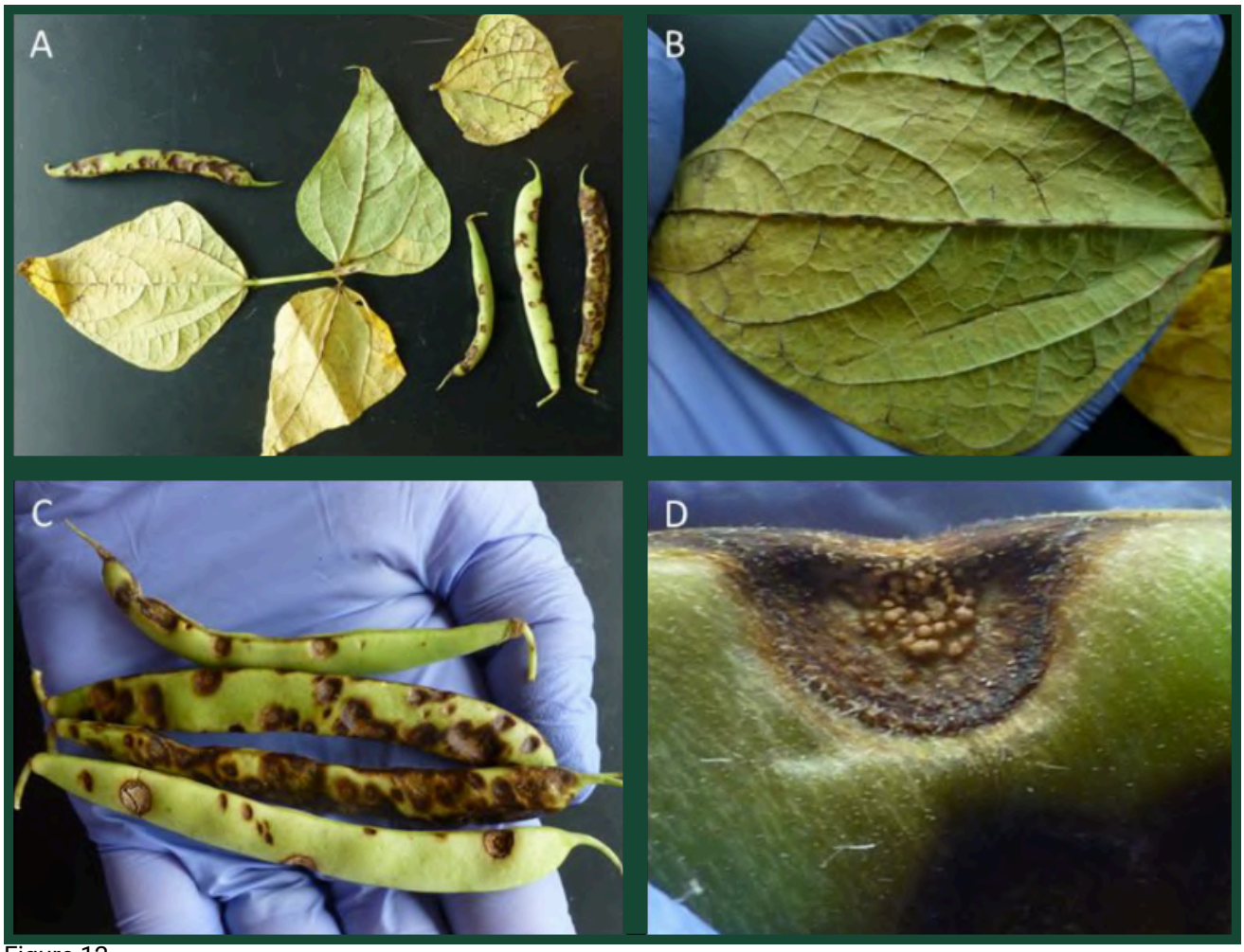


Figure 12.
A. Typical symptoms of bean Anthracnose collected from an infected field. **B.** Leaf underside with dark lesions along veins. **C.** Circular pod lesions with gray-black centers. **D.** Distinctive interior of the lesion exuding tan to pink/salmon masses of spores.

In our cool, moist climate, practices that are critical to managing the multitude of diseases that impact dry beans include:

- Planting clean seed
- Improving air flow
- Rotating crops

Weed management is especially important to improve air flow and assist with keeping the bean plant canopy as dry as possible. A dry canopy can help minimize the infection of disease. Spores from many of the fungal diseases can survive in the soil for 3 to 5 years, waiting for their host plant and/or ideal conditions.

Crop rotation is also crucial in minimizing disease presence during bean production. Dry beans should not be grown in the same field for more than 3 to 4 years. Small grains are

well-suited to rotations with beans because they are not susceptible to the same diseases as beans. Conversely, crops like sunflower, canola, and soybeans should be spaced properly between dry bean plantings.

Insect Pests

Early season pests can be an issue, especially if beans are planted in adverse conditions that slow germination rates. Seedcorn maggots can burrow into the seed killing or stunting the growth of the plant. Seedcorn maggots are most prevalent when there are wet, cold springs and on high organic-matter soils with tillage. Wireworms can also be an issue and generally outbreaks can occur in beans that follow a long-term sod crop.

Figure 13. Potato Leafhopper nymph and adult.

Figure 14. Potato leafhopper damage “hopper burn”.

Potato Leafhopper (*Empoasca fabae*) are another prominent pest of dry beans in the Northeast. Adult females overwinter in southern states and are carried northward on spring wind currents. The migratory nature of this native pest makes its arrival time and population size unpredictable. Potato leafhoppers are light green, wedge shaped insects that can be found scuttling on the underside of leaves (Figure 13). Depending on spring arrival time and temperature, growers have witnessed 2 to 4 generations per season in the Northeast. Potato leafhoppers feed with piercing-sucking mouthparts on host plant's vascular tissue. This restricts phloem and eventual xylem flow to the rest of the leaf resulting in leaf edge yellowing and curling, called "hopper burn" (Figure 14). As this pest weakens the plant, it becomes more vulnerable to disease.

Insecticide options are limited for organic growers but products with azadirachtin or pyrethrin as active ingredients are effective against potato leafhopper. For conventional management, products with active ingredients beta-cyfluthrin or imidacloprid may be used for potato leafhopper control.

Mexican bean beetle (*Epilachna varivestis*) is an extremely damaging pest to beans in parts of New York State and therefore is an emerging pest of concern for dry beans in Vermont. The Mexican bean beetle adults and larvae feed on the leaves of all types of beans. Severe infestations that result in widespread defoliation will cause reductions in crop yields (Figure 15). The adult beetles overwinter in leaf litter and sheltered vegetation and emerge in mid to late spring once temperatures have warmed up. Small clusters of yellow eggs are laid on the underside of leaves, and larvae start feeding on the leaves once they have hatched. The adults are orange or yellow with black spots. The beetle feeds along the underside of the leaves, leaving only the leaf veins, resulting in a lacy or skeletonized appearance.

Figure 15. Foliar damage caused by Mexican bean beetle (left) (photo: Whitney Cranshaw, Colorado State University, Bugwood.org). Multiple life stages of the Mexican bean beetle (right)(photo: Clemson University - USDA Cooperative Extension Slide Series , Bugwood.org).

Releases of the parasitic wasp species *Pediobius foveolatus* can be an effective control strategy to reduce population levels of Mexican Bean Beetle, but especially for heavy infestations, multiple years of treatment may be necessary. More information and sourcing of *P. foveolatus* can be found at the New Jersey Department of Agriculture's Phillip Alampi Beneficial Insect Laboratory.

Insecticides for both conventional and organic production are also available that have some efficacy against Mexican Bean Beetle. As with Integrated Pest Management (IPM) programs in other crops, frequent monitoring for pests is recommended. Scouting the undersides of three leaves per plant in each variety is recommended weekly. As always, pesticides used must be registered for use on dry beans in your state. Read and follow pesticide labels carefully. Certified organic producers should ensure products are allowed by checking with their organic certifier before they apply any product.

More information about dry bean pests can be found in the Northeast Dry Bean Pest Guide, available at: https://www.uvm.edu/sites/default/files/Northwest-Crops-and-SoilsProgram/Articles_and_Factsheets/NEDryBeanPestGuideApril2020.pdf

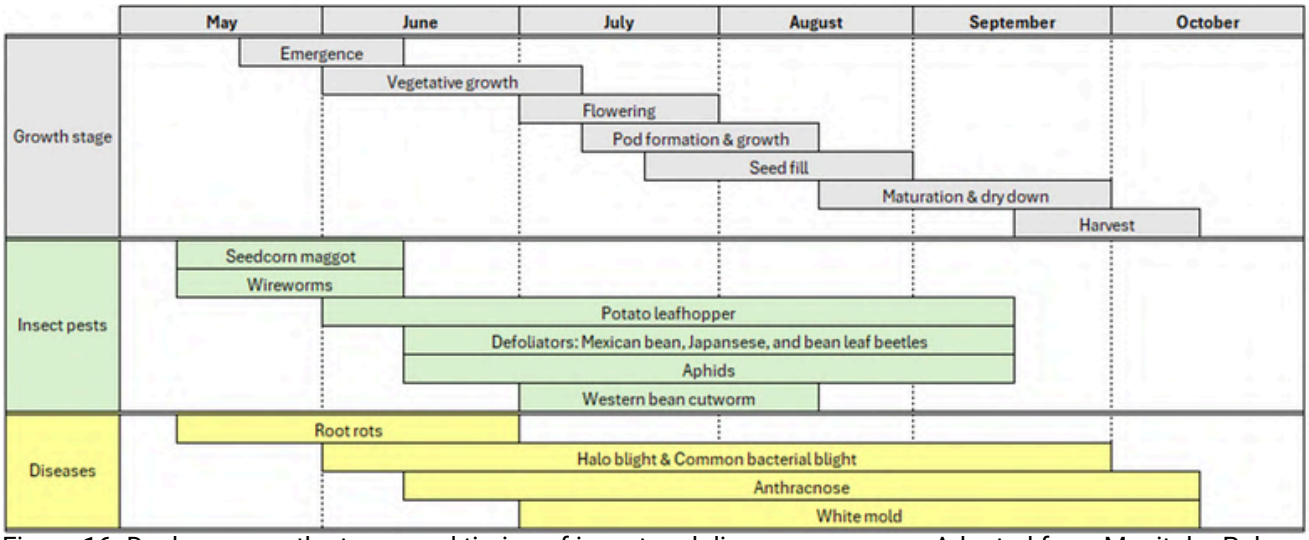


Figure 16. Dry bean growth stages and timing of insect and disease pressures. Adapted from Manitoba Pulse & Soybean Growers Dry Bean Insect and Disease Scouting Calendar (2019) and NYS IMP Scouting Calendars (n.d.).

Harvesting and Storing

Depending on the variety, dry beans generally take 60 to 90 days to mature in the Northeast. Dry beans are extremely sensitive to frost, and so it is important to have selected a variety that will reach maturity before the first fall frost. A fall frost can negatively impact the quality of the seed, causing discoloration of the seed coat and degradation of the seed hull. Bush varieties (including navy, kidney, and black beans) will mature more evenly and provide for an easier and more consistent harvesting. When most pods have turned yellow-brown (resembling parchment paper), beans are ready to be harvested. Pulling or direct harvesting of beans can be challenging if the crop is weedy, stems remain green or leaves have not dropped from the plant prior to pods drying. Some of these traits are genetic, but weather patterns also play a role. The following bean moisture targets in Table 3 can be used to time your harvest. Targeting these moisture contents ensures that beans are mature and can fully thresh from pods, while minimizing damage to seedcoat. The larger the seed size, the more susceptible a variety is to damage at threshing.

Table 3. Target moisture content for harvest by market class.

Market class/type	Target moisture at harvest
Small-Medium Seeded i.e. Black, Navy, Pinto	18.5-19.0%
Large Seeded i.e. Cranberry, Kidneys, many New England heirlooms	20.5 - 21.0%

Credit: Mark Callan.

Direct Harvest

Direct harvest refers to the simultaneous cutting and threshing of plants with a combine and is typical with black and navy varieties as they are most upright in growth habit, and pods are highest off the ground, minimizing yield loss at the cutter bar (see figure 17). If you are planning to direct harvest a variety, it will typically be an upright indeterminate (Type II) variety. Increasingly, the Type II growth habit is being introduced into pinto and Great Northern market classes, expanding the option for direct harvest to more market classes. However, variety trials in New York and Vermont have indicated that some varieties of pinto demonstrating an upright Type II habit in Western regions may become more prostrate in a Northeastern climate. Direct harvest is preferred by many growers as it does not require specialized bean harvesting equipment, and it is a one-pass operation. However, time should be taken to properly set up the combine to minimize loss and damage to your bean

crop. Consider slowing cylinder RPM and opening concave clearance to minimize damage. Additional technologies such as a flex draper head, air reel, slow-down kit for combine auger will further minimize loss and damage, and can facilitate direct harvest of other market classes such as kidney or cranberry beans by further minimizing loss from low pod set.

In organic production systems, excessive hilling from mechanical cultivation events can also increase yield loss at the combine header, so consider low-profile cultivation sweeps and finger weeders that minimize hilling effect while effectively managing in-row weeds. On the other hand, some Northeast farmers report that some amount of hilling can be helpful at harvest as it allows rocks to roll down the furrow and away from the cutter bar.

Indirect Harvest

Some classes and varieties of beans are typically pulled either with bean knives or rod cutter (or by hand). This may be due to low growth habit with pods close to the soil surface, excessive lodging or vining of plants leading to prostrate growth habit, or weather-related conditions preventing proper dry down to direct harvest.

Figure 17. Pulling kidney beans with a Pickett rod cutter. Peter and Hanna Martens Farm, Penn Yan, NY.

Figure 18. Dry bean combine, Morningstar Farm, Glover, VT.

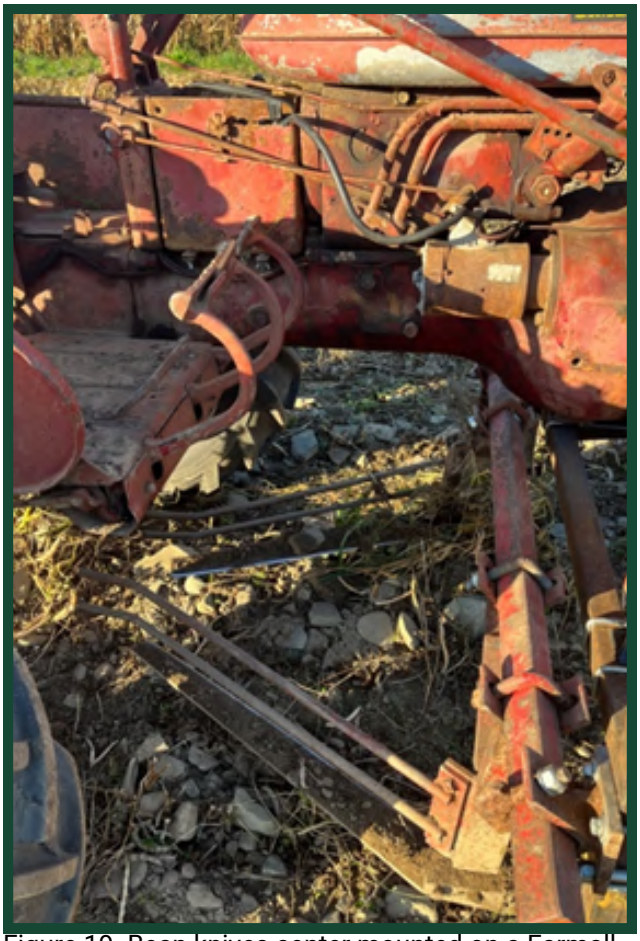


Figure 19. Bean knives center mounted on a Farmall Super A. Lo Rida Farm, Danby NY.

A rod cutter (often referred to as a Pickett One Step, one manufactured model) will uproot or cut bean plants with a rotating bar that runs just under soil surface, with a belt that combines multiple rows of beans into a windrow. Knife pullers followed by a separate tow-behind windrower will accomplish the same goal. Bean pulling should always occur in the morning when a heavy dew reduces shattering. Rod cutters require less adjustment but can reduce performance in rocky or weedy conditions. Bean knives require more adjustment and expertise, but can perform well in adverse conditions. Modern bean knives are typically front-mounted, though center-mounted models were made for many older John Deere and International tractors and can still be found (Figure 19).

After beans are pulled, they can be dried down in the windrow as weather allows, and may be run through again with the windrower or a hay rake to dry further. When beans have reached proper moisture (see Table 3) they can be harvested with a bean combine or conventional combine with pickup head (Figure 18). See Direct Harvest section for further information on combine settings to minimize damage when threshing. Bean combines are typically designed to handle beans more gently than conventional combines. Common manufactures of bean combines available in the Northeast are Bidwell, Bob's and Lilleston models. For small plots, a portable thresher can also be used (Figure 20).


Figure 20. Portable bean thresher, Morningstar Farm, Glover, VT.

Drying and Cleaning the Crop

After harvest, beans should quickly be brought to a safe storage moisture content of 15-16% using forced air bins, portable aerators or a homemade equivalent.

Much of the same equipment used to clean a food-grade wheat crop may be used for dry beans. First, a a rotary cleaner can be used as a a first pass out of the wagon before drying and initial storage. Next, a grain cleaner (also known as a screen cleaner or fanning mill) is used with two or more screens to remove any objects larger or smaller than your bean crop, or of a different shape. Next, many bean growers or processors utilize a gravity table and destoner to further remove low quality beans (having a lower density) or stones (having a higher density) out of the crop. Lastly an optical sorter, or on a smaller scale, a conveyor grading table, can be used to remove any stained beans or other undesirables not successfully removed by size and density sorting.

Beans not suitable for human consumption can be roasted and incorporated into livestock rations, but prices are significantly reduced. Beans should be conditioned using low or ambient temperature and dried to a moisture level of 15-16%, then stored in bins that are inaccessible to rodents, insects, contamination, and temperature extremes. Storing dry beans at low temperatures (35 to 55°F) will discourage mold growth and maintain quality.

Resources

University of Vermont Northwest Crops and Soils Program, Dry bean research:
https://www.uvm.edu/extension/nwcrops/research-results

East-Central Organic Dry Bean Collaborative (ECOBEAN):
https://blogs.cornell.edu/ecobean/

Dry Bean Growth Staging Guide (2017), Manitoba Pulse & Soybean Growers, available at:
https://www.manitobapulse.ca/2017/10/dry-bean-growth-staging-guide/

Hensall Co-op's Edible Bean School, educational video series, available at:
https://hensallco-op.ca/Edible-Bean-School.htm

Manitoba Pulse & Soybean Growers, Dry Bean Production resources, available at:
https://www.manitobapulse.ca/production/dry-bean-production/

Michigan State University Extension, Dry Bean resources, available at:
https://www.canr.msu.edu/dry-beans/index

North Dakota State University, Dry Edible Bean resources, available at:
https://www.ndsu.edu/agriculture/ag-hub/ag-topics/crop-production/crops/dry-edible-bean

Northeast Dry Bean Pest Guide (updated 2020), available at:
https://www.uvm.edu/sites/default/files/Northwest-Crops-and-Soils-Program/Articles_and_Factsheets/NEDryBeanPestGuideApril2020.pdf

Saskatchewan Pulse Growers, Growing Pulses Production resources, available at:
https://saskpulse.com/growing-pulses/production-resources/

Seed Sources

The following companies sell dry bean seed in quantities **more than 25 lbs.** Information is subject to change and seed companies should be contacted about seed availability.

ADM Seedwest Edible Bean Seeds
(800) 637-5843
www.seedwest.com

Central Bean Company Inc.
Quincy, WA
(509) 787-1544
www.centralbean.com

Gentec, Inc.
Twin Falls, ID
(208) 734-6604
www.gentecseeds.com

Kelley Bean Company
Scottsbluff, NE
(308) 635-6438
www.kelleybean.com

Treasure Valley Seed Co.
(208) 733-3110
www.tvseed.com

The following companies sell dry bean seed in quantities **less than 25 lbs.** Information is subject to change and seed companies should be contacted about seed availability.

Adaptive Seeds
Sweet Home, OR
www.adaptiveseeds.com

Fedco Seeds
Clinton, ME
www.fedcoseeds.com

Baker Creek Heirloom Seeds
Mansfield, MO
www.rareseeds.com

Hudson Valley Seed Co
Accord, NY
www.hudsonvalleyseed.com

References

Bhakta, M. S., Gezan, S. A., Michelangeli, J. A. C., Carvalho, M., et. al. (2017). A predictive model for time-to-flowering in the common bean based on QTL and environmental variables. *G3 (Bethesda)*, 7 (12), 3901-3912. DOI: http://DOI: http://doi.org/10.1534/g3.117.300229.

CALS. (2024). *Field Crops* IPM. [online] Available at: https://cals.cornell.edu/new-york-state-integrated-pest-management/outreach-education/ipm-areas/field-crops-ipm [Accessed 12 Dec. 2024].

Copeland, L.O., Hesterman, O.B., Pierce, F.J. and Tesar, M.B. (n.d.). *Seeding Practices for Michigan Crops.* Michigan State University Cooperative Extension Service.

Government of Canada, P.S. and P.C. (n.d.). *Information archivée dans le Web.* [online] publications.gc.ca. Available at: https://publications.gc.ca/collections/collection_2009/agr/A118-10-4-2005E.pdf.

Hardman, L.L., Oplinger, E.S., Schulte, E.E., Doll, J.D. and Worf, G.L. (1990). *Fieldbean*. [online] Alternative Field Crops Manual. Available at: https://www.hort.purdue.edu/newcrop/afcm/fieldbean.html [Accessed 12 Dec. 2024].

Kandel, H., NDSU Extension Service and Northarvest Bean Growers Association (2013). *Dry bean production guide*. Fargo, N.D.: NDSU Extension Service.

Kelly, J.D. (2001). Remaking bean plant architecture for efficient production. *Advances in agronomy*, pp.109–143. DOI: https://doi.org/10.1016/s0065-2113(01)71013-9.

Lazor, J. (2013). *The organic grain grower : small-scale, holistic grain production for the home and market producer*. White River Junction, Vt.: Chelsea Green Pub.

Lee, B., Telford, L., Joanne Thiessen Martens, Wallace, J. and Canadian Organic Growers (2017). *Organic field crop handbook.* Editor: Ottawa, Ontario: Canadian Organic Growers, Inc.

Logsdon, G. (2009). *Small-scale grain raising.* White River Junction, Vt.: Chelsea Green Pub.

Manitoba Pulse & Soybean Growers. (2019). *Dry Bean Insect and Disease Scouting Calendar.* [online] Available at: https://www.manitobapulse.ca/2019/12/dry-bean-insect-and-disease-scouting-calendar/ [Accessed 12 Dec. 2024].

Meronuck, R. A.; Hardman, L. L.. (1981). Edible Bean Disease and Disorder Identification. Retrieved from the University Digital Conservancy, https://hdl.handle.net/11299/205408.

Robertson, L. S.. (1978). *Dry bean production: principles and practices.* East Lansing, Mich.: Cooperative Extension Service, Michigan State University.

Schwartz, H. F., Steadman, J R., Hall, R., and Forster, R. L. (eds). 2005. Compendium of Bean Diseases, second edition. The American Phytopathological Society, St. Paul, MN.

Singh, S. P. (1982). A key for identification of different growth habits of *Phaeseolus vulgaris L. Annu. Rept. Bean Improv. Coop.* 25, 92-94.

This guide was produced by staff at the University of Vermont Extension Northwest Crops and Soils Program in collaboration with Cornell Cooperative Extension.

Find more resources like this on our website at at https://www.uvm.edu/extension/nwcrops.

SARE Sustainable Agriculture Research & Education

USDA

University of Vermont Extension

College of Agriculture and Life Sciences

Cornell University Founded A.D. 1865