Lesson 1: Planning the Crop

Soybeans have been grown for more than 5,000 years and primarily used for food or animal feed. China first introduced them to the United States in 1804. During the 1800s, farmers began using soybeans as cattle feed. Soybeans were used as coffee berries during the Civil War when real coffee was scarce. In 1904 at the Tuskegee Institute in Alabama, George Washington Carver, a Missouri native, began studying the soybean. As a result of his studies, other uses for the soybean were developed such as cosmetics, paints, and wood stains. For a review of the major and alternative uses of soybeans see Unit I, Lesson 1.

By the 1940s, the United States was growing as many as 78 million bushels per year, making soybeans a major export crop. Today, the United States produces more soybeans than any other country. Producers grow more than 2 billion bushels a year; Missouri farmers contribute 177 million bushels to this total.

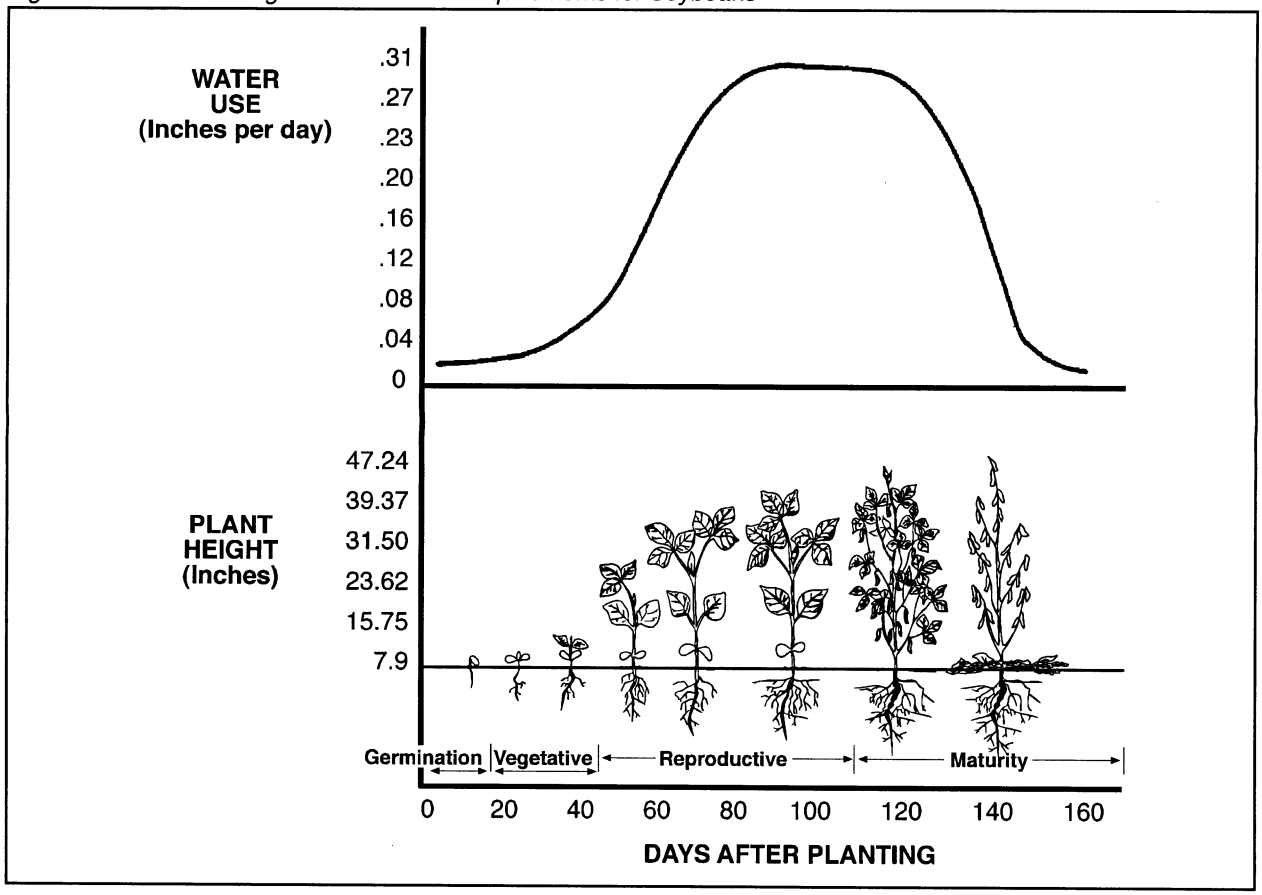
Environmental Conditions Necessary for Soybean Production

The soybean plant is highly responsive to its environment. Growing season, rainfall, topography, and soil type are crucial factors to raising a high-yielding soybean crop. A knowledge and understanding of these factors will help producers make more effective management decisions.

Growing Season

The state's growing season for soybeans averages about 175 days from mid-April (when temperatures rise above 28°F) to the end of October or the first frost. The optimum temperature for soybeans to germinate is 68°F. For the southwest, central, and northern regions of Missouri, these favorable conditions are usually reached between May 1 and June 10. The southeast Delta region reaches this temperature from late April to June 1. Planting later in June can result in yield reductions up to as much as 1 bushel per acre per week. Planting after July 1

Figure 1.1 – Growth Stages and Moisture Requirements for Soybeans



may reduce yields by as much as 3 bushels per acre per week.

Soybeans flower in the maturity stage in response to temperature and photoperiod (day length). To say that soybeans are photoperiod sensitive means they move from the vegetative to the flowering stage in direct response to day length. The key to their flowering mechanisms is the length of darkness during a 24-hour period because most soybean varieties begin flowering after day lengths become shorter. Cooler temperatures and longer day lengths cause delays in flowering, while warm and/or short days hasten flowering and maturity. This day length, or maturity factor, determines what soybean varieties Missouri producers can plant and when they can plant them. (Maturity groups are discussed further in Lesson 2, Selecting a Variety.)

Rainfall

Moisture, whether too much or too little, can affect soybean production. Soybeans require roughly 18 to 22 inches of water during the growing season for good development. Missouri's normal rainfall patterns provide adequate soil moisture during planting, but under normal conditions, soybeans require more than the average rainfall in late June, July, and August. In the fall, Missouri's rainfall normally increases, assisting late-maturing crops. Soybeans may need as much as 2.5 inches of rain per week during the reproductive growth stage. (See Figure 1.1.) This amount varies depending on the variety of seed used and the soil type of the field.

Soybeans are most sensitive to moisture deficiencies during flowering and pod development. A lack of water during these periods can reduce total yield or cause pods to abort. Irrigation relieves stressed soybeans during the middle of the growing season or when exceptionally dry weather occurs. Some southern and central Missouri producers have invested in irrigation systems to increase yields. However, these systems are expensive so producers should weigh potential costs against expected returns. The United Soybean Board reports that continuing research focuses on developing genetically altered soybeans resistant to drought and flooding to address soybean moisture problems. The United Soybean Board is a leading source for soybean data and marketing expertise, soy-related health news, and support soy product research and development.

Topography

The drainage of a field is another environmental condition that plays an important role in soybean production. Waterlogged soils can delay planting dates by delaying tillage and keeping down soil temperatures. They also create perfect environments for fungi and bacteria to grow that can lead to plant diseases. Nitrogen fixation and nutrient uptake may also be reduced. These problems can result in reduced yields. Poor drainage often occurs in fine-textured flatland soils with hardpans or claypans and unfortunately many of the soils in Missouri are of this type. Tillage methods and terracing systems can help prevent or remove excess water. To review these methods and systems see Unit III, Lessons 5 and 6.

Soil Type

Although soybeans are grown in various soil types throughout much of Missouri, the optimum soil type is a well-drained silty clay loam. This soil type has adequate water-holding capacity and releases water to the plants as needed. Soybeans can be grown in sandy clay or heavy clay soils when conditions are right, neither too wet or too dry. Due to moisture needs, they are better adapted for production in clay soils than either corn or cotton. Missouri counties with traditionally high yields have either silty clay loam soils or the producers are making up for less than adequate soil by utilizing current technology and making sound decisions.

Evaluating Field History

One factor to consider when evaluating a field's history is the previous crop grown in the field. Soybeans develop better when planted behind grass-type crops, such as corn or grains. These crops generally leave behind nutrients that can be utilized by soybeans and reduce the need for fertilizers. Considering the previous crop during planning can determine what type of fertilizers may be needed for the new crop.

Knowing the most recent type of tillage and/or planting method used can assist in projecting what pest problems need to be addressed. Soil should be tested if there is a concern about the possibility of a soybean cyst nematode (SCN) problem. This is the most destructive soybean pest in Missouri and can cause severe yield loss. A more thorough

discussion of SCN can be found in Lesson 2 of this unit.

In addition, knowing the previous tillage and/or planting method can determine what method(s) should be used for the new crop. An example of this is a field where only conventional tillage has been used and a producer chooses to use a minimum till or no-till method to reduce soil compaction. This should increase germination and crop yield. Another example is the use of no-till on land that has been in the Conservation Reserve Program (CRP) for 10 years. This program was designed to move highly erodible land out of continuous farming until it could become more stable. Therefore it is only beneficial to producers and the environment if this land is returned to production under a no-till method. This will maintain soil, water, and wildlife improvements.

Fertilizer Requirements for Soybeans

A soil test should be taken before planting to determine nutrient levels and soil pH. Soybeans typically do not respond well to directly applied fertilizer. They develop better on the nutrients left from the previous crop.

Soybeans are less tolerant of soil acidity than the other major row crops and require low soil acidity for nodulation, nitrogen fixation, and plant growth to take place. Soybeans generally develop better in soils with a pH of 6.2 - 7.0. Acidic subsoil (pH 4.0 - 6.0) must have the surface limed in order to maintain good yields. Liming a soil in this range can increase soybean yields by 15%. (Example: If soybean yields averaged 40 bushels per acre, this would mean an increase of about 6 bushels per acre.) Liming helps to release other nonbase plant nutrients and makes these nutrients more available to plants. After the nutrients have been used by plants, they have to be replenished by fertilization if a high productive level is to be maintained.

The three most important nutrients for soybeans, as for most crops, are the primary macronutrients nitrogen, phosphorus, and potassium. The secondary macronutrients and micronutrients are generally sufficient in most Missouri soils and are therefore not a problem in soybean production. For a better illustration of their importance, Table 1.1 shows the nutrients removed from the soil by a 50-bushel soybean yield. Information identifying specific needs or concerns of each of these nutrients follows.

Nitrogen

The soybean is a legume, which means it can extract an adequate supply of nitrogen from the atmosphere under normal conditions. Applying nitrogen fertilizer is generally not profitable. Research shows that if fertilizer is applied during planting, it delays nodulation and actually reduces the available nitrogen even further. However, small amounts of nitrogen can be applied at planting in sandy or cold soils to help stimulate plant growth until nodulation and nitrogen fixation begin.

Table 1.1 – Nutrients Removed by a 50-Bushel Soybean Yield

Nitrogen (N)	160 lb.
Phosphorus (P_2O_5)	40 lb.
Potassium (K_2O)	70 lb.
Calcium (Ca)	75 lb.
Magnesium (Mg)	32 lb.
Sulfur (S)	25 lb.
Zinc (Zn)	0.2 lb.
Iron (Fe)	1.7 lb.
Manganese (Mn)	0.6 lb.
Copper (Cu)	0.1 lb.
Boron (B)	0.1 lb.
Molybdenum (Mo)	0.01 lb.

Stressful environmental conditions such as wet, very hot and dry conditions, or very acidic soils can cause nitrogen deficiencies. Deficiencies may also occur if *Rhizobium japonicum*, bacterium necessary for nitrogen fixation, is not in adequate supply in the soil. Most soils contain adequate rhizobia if soybeans have been harvested recently. For fields that have been growing other crops for the past 3 or 4 years, the producer should plant soybeans inoculated with the bacterium.

Phosphorus

Soybean plants absorb relatively large amounts of phosphorus throughout the growing season. The greatest demand starts in the late reproductive stages just before the pods begin to form and

continues until about 10 days before the seeds are fully developed. A bushel of soybeans removes approximately 0.8 - 0.9 pound of phosphorus per acre. Recommendations on soil tests are based on building phosphorus levels over 8 years. Higher rates can be applied to current crops and carried over to the next crop. The amount needed varies from field to field based on crop history, seed variety, and soil type. Following soil test recommendations is the safest plan.

Soils deficient in phosphorus reduce the number of nodule bacteria needed for nitrogen fixation and good root development. The symptoms of phosphorus deficiency are a thin, dwarfed stem, lack of luster in the leaves, early defoliation, and poor or nonefficient nodulation.

Potassium

As with phosphorus, soybeans require relatively large amounts of potassium. A bushel of soybeans removes approximately 1.4 pounds of potassium from the soil. Uptake of potassium climbs to a peak during the period of rapid vegetative growth and then slows about the time the beans form. Generally, soybean producers can afford to raise the potassium content of their soils to a high level because it leaches very little (except in sandy soil), it is not used in excess by soybeans, and it is released every year in slowly available forms.

Soybeans grown in potassium-deficient soils have stunted growth with shortened internodes. The edges of leaves are generally scorched or yellow and curl downward, especially in the lower leaves. Severe deficiencies may have brown or black edges on the leaves.

Secondary Nutrients

Calcium, magnesium, and sulfur deficiencies are not as common as deficiencies of the major nutrients. Soybeans as a rule contain more secondary nutrients than other grain crops, except for corn's sulfur content. When limestone is used to adjust soil pH, adequate amounts of calcium and magnesium are provided for most field crops.

If a magnesium deficiency does occur it will begin in the plant's lower leaves and appear as a pale, green color between the leaves' main veins. Sulfur deficiencies become visible with the young leaves and veins appear pale. Plants lacking sulfur are very similar to ones with nitrogen deficiencies; however, these symptoms begin in the upper leaves wheras nitrogen deficiencies are visible in the lower leaves. Missouri has had very few cases of sulfur deficiencies reported except on sandy-textured, low-organic soils.

Micronutrients

Soil maintained at the proper pH level will generally contain adequate amounts of micronutrients for maximum soybean production potential. Only a few isolated river bottom soils in extreme northwest Missouri are affected by iron deficiencies, occurring in soils with a very high pH (7.5 or higher). The symptoms include yellowing of leaves between the veins, with leaves turning almost white in severe cases.

Manganese deficiencies may occur near old lake beds, glacial outwashes, and in peat soil. All of these are sandy soils high in organic matter or heavily textured acidic soils. Symptoms of manganese deficiencies are white or yellow leaves with green veins, a condition known as *Interveinal Chlorosis*.

Molybdenum deficiency occurs in very acid, sandy soils. Legumes need molybdenum for nitrogen fixation so symptoms of this deficiency, indicated by pale green or yellow plants, are actually from a nitrogen shortage.

Soybeans are much less sensitive to zinc deficiency than corn. If corn grows normally on the same soil, a producer can assume the soybeans have an adequate supply. Zinc has been found deficient in graded, severely eroded, or low organic soils. The symptoms of zinc deficiency are stunted plants with interveinal areas of the leaves becoming yellow. From a distance, zinc-deficient areas of a field will appear yellowish-brown.

Summary

First introduced in this country in the 1800s, soybeans have become a major crop for the United States and Missouri. Growing season, rainfall, topography, and soil type are crucial factors to raising a high-yielding soybean crop. Also, knowing the previous crops and tillage and/or planting methods of a field can help the producer plan fertilizer needs, pest management practices,

and current tillage and/or planting methods to be used.

Soybeans respond very well to fertilizer but are less tolerant of soil acidity than the other major row crops. A soil pH of 6.2 - 7.0 is the optimum level. The three most important nutrients for soybeans are the primary macronutrients: nitrogen, phosphorus, and potassium. Fertilizing with secondary macronutrients and micronutrients are generally not needed in Missouri soybean production.

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Lesson 2: Selecting a Variety

Once the local growing conditions have been evaluated (considering the field history and current fertility needs), the producer must select a soybean variety to plant. The variety selected must be adaptable to conditions in the field where it will be grown. High yields are much more likely if the strengths and weaknesses of the selected variety and field are similar. For example, if cool, wet soil is common to the field then an early maturing variety should be selected; if a disease is prevalent, a resistant variety should be grown.

Indeterminate and Determinate Soybean Varieties

Research is ongoing to develop new and improved varieties of soybeans. Crossing two soybean varieties combines desirable characteristics from both parents and selects against undesirable characteristics such as weak stem, shattering, and poor seed quality. These new and improved varieties are created for hardier crops with increased yields that are more adaptable to specific growing regions. They are more resistant to pests and changing environmental conditions (e.g., drought or flooding). As a result of continuing research, Missouri farmers currently have more than 300 soybean varieties from which to choose.

Soybean varieties differ in growth type by being either indeterminate or determinate. The indeterminate plant continues to grow along with flowering and podding stages. With the determinate variety, the main stem stops growing when flowering begins. Indeterminate soybeans frequently double in height after the first flowers appear. These varieties are commonly grown in northern Missouri and some have been developed into early-maturing varieties to use with southern double cropping.

Determinate varieties are shorter and have recently been modified into two classes that combine characteristics of indeterminate varieties, semi-dwarf and semi-determinate. Semi-dwarf varieties are true determinates and are only about half the height of normal varieties. Semi-determinate varieties have a shorter flowering period and grow 6 to 10 inches less than other determinate varieties. After flowering, only a small amount of vegetative growth occurs. Both types are more lodging resistant due to their shortened height and may have a higher yield than taller determinate types in highly productive areas.

Information on soybean varieties can be obtained from other producers, seed dealers, University and extension variety trials, or the producer's own strip trials. The University of Missouri conducts annual performance evaluations on new varieties at more than 10 locations throughout the state. Yield results and soybean quality differ from location to location, however, and producers should choose varieties based on trials in their area.

Factors to Consider When Selecting a Variety

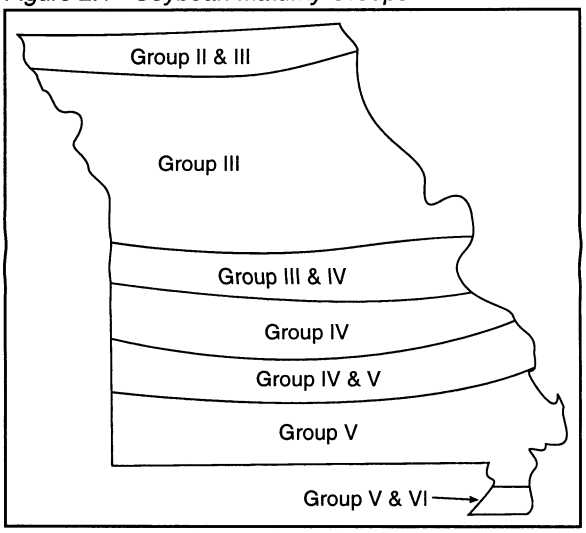
New soybean varieties from public and private sources are abundant. Yields have been steadily increasing due to genetic improvement, though not on all varieties. It is important for a producer to consider the following five factors when selecting a variety: (1) maturity; (2) standability; (3) pest resistance; (4) additional considerations - double cropping, shatter resistance, seed cost, seed quality, availability of seed and marketability of GMO crops, and intended use of the crop; and (5) yield.

Maturity

Soybean varieties are adapted to full-season growth in narrow bands from Canada to the tropics. This means that varieties are classified by their ability to mature and be harvested within the available growing season of a particular location. Varieties are specifically matched to the seasons by their reaction to the photoperiod (day length). All soybean varieties are classified within 13 maturity groups, 5 of which are successfully grown in Missouri. (See Figure 2.1.) The most predominantly grown variety in northern and central Missouri is maturity Group III. Some late-season Group II varieties are also grown in the extreme northern counties. Maturity Group IV varieties are adaptable to central Missouri and are grown throughout the south along with Group V. Group V extends into the Missouri Bootheel, with Group VI varieties also planted in the southernmost counties of Dunklin and Pemiscot. In rare instances, Group I varieties can also be planted in extreme northern Missouri counties.

When choosing a soybean maturity level, a producer should determine if a full-, early-, mid- or

Figure 2.1 - Soybean Maturity Groups



late-season variety is needed. Full-season varieties are generally more productive, but there are advantages and disadvantages to each of these depending on location and cropping system used. For example, in central and southern Missouri, mid- to full-season varieties will normally mature and be harvested in time to plant small grains. Producers who plan to rotate to winter wheat after the soybean crop will want to use an early maturing variety to avoid a delay in planting wheat. Likewise, if the soybean harvest is often delayed by wet weather, an early-season variety should be selected. Late-maturing varieties tend to flower longer and grow taller, which makes them more competitive with weeds and better producers on poorer soils. However, when soil fertility and moisture are high, these varieties may have excessive growth and lodge. These are just a few examples to illustrate why a producer must choose maturity levels that are suitable to their specific location and cropping system.

Standability

A variety must remain erect throughout a growing season to obtain maximum yields. Lodging before maturity can decrease yields 20 to 30%. Although the characteristics of lodging can be controlled genetically, the environment can alter this trait. High soil fertility, narrow row spacing, high plant population, and irrigation can increase lodging. As producers strive for high yields, use of semi-dwarf varieties can reduce lodging by controlling the height and width of individual plants.

Pest Resistance

The soybean has many pests - insects, weeds, disease, and nematodes - some of which are difficult to recognize. Many diseases go unnoticed but may reduce soybean yields as much as 15%. Scientists are working to breed varieties that can resist diseases, nematodes, and nutrient problems, but few insect-resistant varieties have been developed.

Two diseases that many varieties are resistance to are *Phytophthora* root rot and soybean cyst nematode (SCN). Although *Phytophthora* is less serious in Missouri than other states, it can still occur throughout the growing season on poorly drained soils. Nematodes, especially soybean cyst nematodes, are a serious problem in much of Missouri because of their ability to go undetected. Whenever a resistant and susceptible variety of equal yield potentials is available, the producer should select the most resistant variety. County extension centers and reputable seed dealers generally have information about pest-resistant varieties.

Additional Considerations

Other important considerations when selecting a variety include double cropping, shatter resistance, seed cost, seed quality, use of herbicide-resistant varieties, and intended use of the crop.

Many soybean varieties have similar performance when grown as a double crop or as a full-season crop. Good-performing, full-season varieties are the best when wheat follows soybeans, except in northern counties where wheat should be seeded by the end of October. When soybeans are planted after wheat or small grains in the same growing season, mid-season varieties are usually best. These varieties produce the necessary canopy (leaves) to shade out weeds but still mature fast enough to avoid frost losses. Determinate semi-dwarf varieties should not be used because of their low height and short flowering period. They mature too early and their pods are too close to the soil surface, making harvest difficult and low yielding.

Since soil moisture is the most critical environmental factor, a producer should double crop soybeans immediately after a small grain harvest only when there is sufficient soil moisture to ensure seed germination. Also, the fullest

season variety available should be used that will mature before frost. Seeding rate should be increased by 20% and rows should be narrow if possible. An effort to get good seed-to-soil contact should be made.

Some varieties have a tendency to shatter - pods break open before or during harvest and soybeans are lost. This is common during dry conditions, especially in western Missouri. Most new varieties are shatter resistant. Nonresistant varieties should only be used if they are exceptional in other aspects and an early harvest is expected.

Variety choice can be influenced by seed cost. Generally, a bushel or two of increased yield will cover any increase in seed cost, but a producer should be sure the potential yield difference is high enough to justify the expense. Producers should shop around to find the best price on the highest quality seed of a given variety. Also, keep in mind that smaller seed varieties need fewer pounds of seeds per acre, resulting in reduced cost.

Producers should not take chances on seed quality. There is very little difference in cost per acre of good seed versus poor seed or seed of unknown quality. The purchase of certified seed guarantees varietal purity, germination, and freedom from weed and other crop seeds. If a producer is using saved or bin-run seed, a germination and purity test can be obtained by sending a pint sample to the Seed Control Lab at the Missouri Department of Agriculture in Jefferson City. Several samples can be evaluated free of charge each year if the seed is for personal use.

The availability of herbicide-resistant varieties and marketability of genetically modified organisms (GMO) crops is also a consideration. In the worldwide debate on GMOs, producers are caught in the middle and they should stay current with developments in this market.

Producers should determine the intended use of the crop. Soybeans are developed into very diverse by-products and a producer can focus on planting soybeans for a variety of uses, e.g., edible soybeans, livestock feed, or oil protein.

Yield

The most economical and rewarding factor in selecting a soybean variety is high yields. However, producers should not choose the highest-yielding variety unless it also has other necessary characteristics (maturity, disease resistance, etc.) needed for the specific planting location. By considering other factors along with potential yield data, a producer has a better chance of obtaining consistent and optimum yields.

Yield information, along with lodging, height, maturity, and other characteristics are published in a special report titled *Missouri Crop Performance: Soybean* from the Agricultural Experiment Station. This report is available each January at county extension offices and producers can use it to evaluate varieties. (For a more detailed explanation of the yield information provided on this report refer to the University of Missouri Extension agricultural publication G04412 - *Soybean Variety Selection,* subhead *Yield.*)

For current soybean variety information, producers can access the Agricultural Electronic Bulletin Board (AgEBB) sponsored by the University of Missouri. This is a free computer information site that contains annually updated variety testing results on all major Missouri crops under the category "Crop Performance Testing" along with other valuable agricultural information. The web address is <http://www.ext.missouri.edu/agebb/index.htm>. Private companies can also provide information on soybean varieties suitable for cultivation in Missouri.

Determining Prevalent Diseases

Soybeans were considered a disease-free crop when they were introduced into the United States. That quickly changed and soybean diseases cause Missouri producers more than $100 million annually in losses and even more in wet years. Pathogenic fungi, bacteria, viruses, and nematodes cause soybean diseases. Producers must also recognize that crop injury can occur from improper use of herbicides or from environmental causes (excessive wind, rain, or temperatures) that may be mistaken as a disease.

Diseases are often classified in the following six categories: (1) seedling diseases, (2) root and stem diseases, (3) pod and stem diseases, (4) foliar (leaf) diseases, (5) virus diseases, and (6) nematodes.

Seedling Diseases

Disease	Causes	Symptoms	Control
Pythium Phytophthora Rhizoctonia Fusarium	Fungi acting independently or together. Favor cool, wet soils. Attack seeds before germination, as the seedling emerges, or after it is established.	Dark brown or reddish lesions on the root. Blackened and decayed lesions on the cotyledons. Shriveled cotyledons. Water-soaked primary leaves. Soft stems.	Plant high-quality seeds in warm, well-drained soil. Use fungicide-treated seeds in soils that hold water.

Root and Stem Diseases

Diseases	Causes	Symptoms	Control
Phytophtora Root and Stem Rot	Lives on crop debris in the soil. Attacks plant during periods of high soil moisture. Attacks plant at any growing stage. More prevalent in poorly drained clay soils.	Appear in young plants as a reduction in stand. Lesions on the stems and roots. Yellow leaves. Older leaves become yellow between the veins, wilt and die. Dark brown lesions on lower stems.	Plant-resistant varieties. Improve field drainage. Apply seed treatment that contains metalaxyl.
Fusarium Root Rot	Survive in soil and residues and are present in cultivated soils. Infect seeds, seedlings, roots, and lower stems.	Poor germination, late emergence. Stunted growth. Widespread wilting in young plants in low moisture soils. Older plants survive but wilt during low moisture.	Plant high-quality seeds in warm, well-drained soils. Ridge soil around plant base to promote root development.
Charcoal Rot	Fungus survives in crop residue. Enters roots of seedlings shortly after emergence. No outward symptoms until near harvest.	Wilt prematurely and defoliate under hot dry conditions after flowering. Tiny black specks on the roots.	Fertility program with strong plant growth. Rotate corn or cotton for 2 years to reduce fungus. Avoid high seeding rates.
Southern Blight	Found in clay soils of southern Missouri. Survives from year to year.	Seedling death before or stem rot shortly after emergence. White, cottony growth on lower stem.	Rotate crops less susceptible, such as grasses. Deep plowing.
Sudden Death Syndrome (SDS)	Soil-borne fungus attacking roots soon after emergence. Sporadic occurrence.	Yellow areas between veins that eventually become brown. Young pods and damaged leaves fall off. Upper root and lower stem may contain dark streaks. Root rot usually occurs.	Double cropping. Plant varieties that are resistant to leaf symptoms.

Pod and Stem Diseases

Diseases	Causes	Symptoms	Control
Pod and Stem Blight	Fungus spores developed in the tissues of the pod and stem are spread by the wind. Warm, humid weather helps fungus grow. Increase in severity if harvest is delayed.	Infection begins early but does not appear until plant matures. Small, black fruiting structures appear in linear rows on stems or scattered on pods. Seeds may have white mold growth. Seeds are often dull, cracked, or shriveled.	Plant bright, healthy seeds. Treat seeds and fields with approved fungicides. Plow under crop residue. Rotate crops.
Stern Canker	Usually affects plants intermittently rather than whole field.	Brown, slightly sunken lesions on leaf petioles or at the base of branches. Lesions or cankers eventually surround stem, choking the plant. Leaves remain attached to dead plants.	Plant disease-free seed. Use fungicide seed treatment prior to planting. Rotate with crops such as grain sorghum, cotton, or forages. Plant resistant varieties.
Anthracnose	First fungus infects plants at all ages. Second fungus only affects older plants. Spores infect healthy plants.	Produce reddish or dark brown areas on stems or pods. Later form into black structures resembling pin cushions with black spines that are difficult to see. May not show visible signs until weather conditions are more favorable for fungi growth.	Plant healthy fungicide-treated seeds. Apply foliar fungicides as needed. Rotate with nonhost crops.

Foliar (Leaf) Diseases

Diseases	Causes	Symptoms	Control
Brown Spot	Fungus hibernates in the tissues of fallen leaves and stems. Spores are spread to leaves and plants during warm, moist weather.	Small red-brown, angular spots on young leaves. Use crop rotation. Heavily infected leaves turn yellow, wither, and drop off.	Plant healthy, disease-free seeds. Treat seeds and fields with approved fungicides. No resistant varieties currently available.

Foliar (Leaf) Diseases

Diseases	Causes	Symptoms	Control
Downy Mildew	Fungus hibernates in infected leaf residues and survives on infected seeds. Prevalent during wet seasons, seldom causes severe damage.	Yellow-green areas on upper leaf surfaces. Spots later become enlarged and grayish-brown to dark brown with yellow-green margins. Grayish mold develops on underside of leaves with severe infections causing premature defoliation (leaf drop). Can spread to pods and infect the seed.	Plant healthy, disease-free seeds treated with a fungicide. Rotate crops. No varieties resistant to all but a few are moderately resistant.
Bacterial Blight	Survives in crop residue above soil surface and in seeds. Spread to seedlings during wet or rainy weather. Most severe during cool, moist weather.	Small, angular, yellow spots with water-soaked centers appearing on lower leaves. Spots turn dark, reddish-brown to black and surrounded with yellow halos. Centers of older lesions drop out or tear away leaving a ragged and shredded leaf. Often seen during midsummer and may appear about a week after a severe storm.	Plant healthy disease-free seeds. Rotate crops. Dry, hot weather often stops the spread of the disease.

Virus Diseases

Diseases	Causes	Symptoms	Control
Soybean Mosaic	Most common virus. Spread by seeds and from plant to plant by feeding aphids.	Stunted plants with crinkled and mottled leaves. Vary depending on the variety. Vary by the strain of the virus.	Plant disease-free seeds. Practice good weed control.
Bean Pod Mottle	Spread by the bean leaf beetle, farm machinery, wind-carried sand or soil, and infected seed.	Yellow-green mottling of young leaves during cool weather. Reduced pod formation if soybeans are water-stressed.	Use insecticides. Rotate crops with nonlegumes. Remove infected plants when first noticed. Plant disease-free seed.

Virus Diseases

Diseases	Causes	Symptoms	Control
Bud Blight	Wide range of hosts that serve as carriers. Transmission is by thrips and other insects. Tends to be sporadic. Highly susceptible areas include fields adjacent to fence rows with legumes and old stands of forage legumes. Infections usually begin on the outer edges of a field following insect patterns.	Vary depending on the time of infection. Before flowering: Terminal buds will turn brown, curve downward, and turn dry and brittle. Rusty flecking often develops on young leaves. Stems are discolored at the nodes. Plants are stunted. Produce little or no seed. During flowering: Small, undeveloped pods. Pods have dark blotches and poorly filled. Plants remain green after normal plants have matured.	Spray broadleaf weeds in nearby fields. Avoid planting next to other legumes. Plant a buffer strip of a nonhost crop between the fields.

Nematodes

Diseases	Causes	Symptoms	Control
Soybean Cyst Nematode (SCN)	Infection inhibits growth and functioning of the root system. Interferes with nutrient and water uptake. Reduces nodule formation. Affects the amount of available nitrogen.	Occurs without visible symptoms. Leaves may be yellow-green and wilt in midday more than healthy plant leaves. Usually occurs in small to large oval area of a field. Roots will be stunted and appear darker in color. Less nitrogen-fixing nodules. Females may be visible as shiny white or yellow round knots on roots. Mature cysts turn brown and fall off.	Avoid introducing it whenever possible. Work uninfected fields first to avoid spreading in soil. Rotate soybeans with crops that are not hosts. Use and rotate resistant varieties. Maintain good plant health. Weed control. Soil test in the fall to provide ample time to control before next crop.
Root-knot Nematode	Problem in sandy, light textured soils. Worms penetrate roots and feed on them.	Plants are stunted and yellow-green in color. Tendency to wilt under moisture stress during hot, dry weather. Reduced nodules and dark tumors appear on roots.	Plant resistant varieties. Rotate soybeans with grain sorghum and certain forages.

Nematodes are small, worm-shaped animals that move like snakes. Most are so small that they cannot be seen by the naked eye. They are found in water and soil everywhere in the world, feeding on microorganisms, plants, and animals. Most nematodes are beneficial organisms that help decompose organic matter, releasing nutrients for plant uptake. Several types of nematodes feed on soybean roots, but the soybean cyst nematode (SCN) is a plant-parasite and the only one that has been a severe problem in Missouri.

Young SCNs bore their way into the root and grow into either a sac-shaped female or a wormlike male. The females' bodies form a protective covering around their eggs resembling a cyst - where it gets its name. The females continue to swell and eventually break through the root surface. Several hundred young nematodes leave the sac and begin boring into the plant roots. The cycle begins again with each generation lasting up to 3 or 4 weeks depending on soil temperature. Eggs inside cysts can survive winter and other conditions such as floods and droughts. SCN infection inhibits the growth and functioning of the soybean root system, interfering with nutrient and water uptake. It also reduces nodule formation and affects the amount of available nitrogen.

SCN is difficult to identify because damage and yield loss occur without visible symptoms. Even when plants are under stress and SCN is present, symptoms can be mistaken for other problems such as low soil fertility, drought, and root rot. Leaves may be yellow-green and wilt in the midday more than those of healthy plants. SCN usually occurs in small to large oval areas of a field. Roots will be stunted and appear darker in color. They will also have less nitrogen-fixing nodules and females may be visible as shiny white or yellow round knots on roots. Producers should not rely on visual inspection of roots, however, because once cysts have matured they turn brown and fall off. SCN can also attack other legumes such as lespedeza, certain varieties of vetch, garden beans, and some clovers.

Although it can only move a few inches a year in the soil on its own, SCN moves every way that soil moves. It finds its way into bagged seeds through contaminated soil on farm and construction equipment, on workers, on birds, on root crops, in drainage or floodwater, or the wind - virtually by any means that soil particles travel. To control SCN, producers should avoid introducing it whenever possible because it cannot be eradicated from a field once it becomes established. Producers should work uninfected fields first to avoid spreading SCN in soil. Rotating soybeans with crops that are not SCN hosts (see Table 2.2), using and rotating resistant varieties, maintaining good plant health, and weed control are all preferred choices to nematicides. University Extension specialists recommend soil testing during the fall to determine if an infestation is present and to provide ample time to determine control methods to be used before the next crop.

Table 2.2 – SCN Nonhost Crops

Alfalfa	Forage grasses
Barley	Oats
Canola	Rye
Clover (red, white, ladino)	Sorghum
Corn	Tobacco
Cotton	Wheat

Root knot nematode is sometimes a problem in southeast Missouri fields that have sandy, light-textured soils. The worms penetrate roots and feed on them causing tumors that resemble root-rot infection. Female worms can lay up to 1,500 eggs in a root of a plant and the surrounding soil. Unhatched eggs can survive the winter. Plants showing symptoms may be stunted and yellow-green in color with a tendency to wilt under moisture stress during hot, dry weather. Reduced nodules and dark tumors appear on plant roots. Control of this nematode is similar to SCN measures: plant resistant varieties and rotate soybeans with grain sorghum and certain forages.

Summary

Scientists crossbreed different strains and varieties of soybeans to develop new and better varieties every day. Missouri producers currently have over 300 soybean varieties from which to choose. Soybean varieties are classified by two growth types: determinate (the main stem stops growing when flowering begins) and indeterminate (the plant continues to grow along with flowering and podding stages). Determinate varieties have been modified into two classes, semi-dwarf and semi-determinate, that combine characteristics of indeterminate varieties. Variety performance differs by location so producers should choose varieties based on trials in their area.

When selecting a variety there are five characteristics to consider: (1) maturity; (2) standability; (3) pest resistance; (4) additional considerations (double cropping, shatter resistance, seed cost, seed quality); and (5) yield. Of the 13 maturity groups, only 5 are grown in Missouri: Groups II, III, IV, V and VI. When looking at maturity, a producer should also determine if a full-, early-, mid- or late-season variety is needed. Full-season varieties are generally more productive, but there are advantages and disadvantages to each. Lodging before the crop is ready to harvest can decrease yields 20 to 30%, and many diseases that go unnoticed may reduce soybean yields as much as 15%. Scientists are working to breed varieties that can resist diseases, nematodes, and nutrient problems, but few insect-resistant varieties have been developed. All these factors, especially yield, play an important role in variety selection.

Several diseases prevalent in Missouri can drastically affect soybean production. They are generally divided into six different categories: (1) seedling, (2) root and stem, (3) pod and stem, (4) leaf, (5) viruses, and (6) nematodes. Although many of these can reduce yields drastically, the soybean cyst nematode (SCN) is considered one of the most severe disease problems in Missouri. An awareness of these diseases can help producers make decisions about selecting resistant varieties.

Credits

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Lesson 3: Selecting a Tillage and Planting Method

As stated in Unit III, Lesson 5, tillage is the act of moving soil particles or cultivating the land. Moving particles affects soil compaction, water intake, and microbial activity. The choice of tillage methods can limit planting options. The planting method used, or the means by which one places the seed into the ground, also has effects on the soil. Field history of soil erodibility, drainage, and fertility are all factors the producers should consider before selecting a tillage and planting method. Along with these issues, this lesson will discuss recommended seeding rates for producers to achieve optimum yields.

Optional Tillage Methods

Missouri soybean producers basically use four methods of tillage: conventional, minimum, no-till, and remedial. A discussion of the advantages and disadvantages for selecting a specific method follows.

Conventional tillage is any tillage system that attempts to cover crop residue, leaving less than 30% of the surface covered after planting. This method has maintained popularity with soybean producers over many years. Approximately 25% of Missouri farmers continue to use this method. Advantages of this system include (1) machinery is familiar and widely available, (2) system is adaptable to a wide range of soil and crop conditions, (3) it allows the use of cultivation for weed control throughout the growing season, and (4) soils warm faster when soil residues are incorporated into the soil. Disadvantages of conventional tillage are (1) higher fuel and labor costs, (2) greater field traffic that can lead to soil compaction, (3) high risk of erosion, and (4) reduction in organic matter.

Minimium tillage includes two methods: mulch-tillage and ridge-tillage. Use of the mulch-tillage method among Missouri soybean producers has increased over recent years. In this system, soil is disturbed only between harvesting and planting. More than 30% of the soil surface is covered with residue. Advantages of this method include (1) reduced soil erosion, (2) lower fuel and labor costs, and (3) maintaining conventional tillage method advantages. Disadvantages of mulch-till include (1) modifications to equipment required, (2) warming of soil slowed, (3) less effective under wet conditions, and (4) may require a larger tractor. Another minimum tillage system rarely used in Missouri is ridge-till. Seedbeds are raised In this tillage system. Advantages include (1) reduced erosion, (2) lower fuel and labor costs, (3) reduced compaction due to controlled traffic, and (4) weed control due to inter-row cultivation. Disadvantages include (1) inter-row cultivation is required to build ridges, (2) ridges must be level, and (3) wheels of machinery must be modified to avoid damaging ridges.

No-till, the most widely used tillage method among Missouri producers, is the system of planting narrow seedbeds without disturbing the soil. Herbicides are used to control weeds. Advantages include (1) lower cost and (2) greatly reduced erosion. Disadvantages include (1) high residues slow the warming of soils, (2) attachments must be added to equipment, (3) weed control is dependent on herbicides, and (4) high management by the producer is required.

Remedial tillage involves subsoiling and land leveling and is generally not used in Missouri. This system is used only under special conditions. Subsoiling involves loosening soil in severely compacted soils. Land leveling involves leveling off the top layer of soil. The controlled method uses a laser in an attempt to put a consistent slope on a flat field to move surface water. The uncontrolled method scraps the top layer of soil from high areas to fill in low areas. Both methods are very expensive and deplete organic matter.

Optional Planting Methods

Planting methods that can be considered for use by Missouri producers include row cropping, skip row, drilled or solid-seeding, broadcast, and aerial. Row cropping and drilled methods predominate in Missouri because of their consistency in producing good stands.

Row cropping is very popular because of its consistency in producing good stands. Crops are planted in straight rows. Row widths are based on environmental conditions and tillage method used. Row cropping does not require any special equipment; planters and drills used in conventional tillage and minimum tillage methods can be used easily. Convenience and familiarity make this method very favorable throughout Missouri.

Skip row planting is very similar to row cropping. The difference is that rows are left unplanted or skipped between rows. This skipped row is used for maneuvering equipment between rows for cultivating and easier sprayer applications. The width of the skipped row is based on the size of an individual's equipment. Skip rows can also be used in managing soil compaction or field traffic. This method is not typically used for soybeans in Missouri.

Drilled or solid-seeding is the method of using a drill to drive seeds into the ground with narrow spacing 10 inches or less apart. Drilling is primarily associated with no-till but can also be used in conventional or other minimum tillage methods. The wide use of no-till by Missouri producers makes drilled planting methods favorable throughout Missouri. Because of improvements in weed control, producers can use the drilling method to increase yields. Good early season weed control is essential until the canopy develops. Harvest loss is reduced because the combine can be operated closer to the ground. Seed depth control is usually less uniform with drilling equipment than with a conventional planter, resulting in poorer emergence. Use of a seeding rate slightly higher than that recommended for 30-inch rows is necessary.

Broadcasting and aerial are planting methods that distribute seeds uniformly over the surface of the field and are followed by light tillage. These methods require a firm, level seedbed to be effective in establishing a stand. The success rate is lower than when using row planters or drills because seeds are placed at random depths. Therefore, they are not typically used in Missouri for soybeans.

Recommended Seeding Rates

Optimum yields can be obtained with plant populations of 70,000 plants per acre. This would amount to approximately 4 plants per foot of 30-inch rows and 1 plant per foot in drilled rows. Populations less than 70,000 plants per acre may result in yield reductions due to insufficient plant numbers. Plant populations affect other characteristics such as low podding and excessive branching. However, low populations produce better lodging resistance wheras higher populations produce increased lodging. Populations above 150,000 plants per acre may result in yield reductions due to overcrowding. Other characteristics are higher podding, less branching, and increased lodging. Therefore, plant populations vary depending on the characteristics needed by the region. Table 3.1 gives recommendations and adjustments under average conditions.

The seeding rates shown in the table are designed to provide a starting point. Surveys show that many planters actually seed at different rates than suggested by most manufacturers' charts. Also, planters should be checked for proper adjustments. A planter that does not run level will cause uneven placement of seeds. Check the manufacturer's manual for specific adjustments.

For specific conditions, using the table, increase the seeding rate per acre according to the following guidelines:

5% for each rotary hoeing planned
10 - 15% for very early or very late planting
10 - 15% for short season varieties

Table 3.1 - Recommended Seeding Rates

Row Width (inches)	Approximate Lb/Acre*	Seeds to Plant Per Ft. of Row	Seeds/Acre	Expected Plants Per Ft. of Row**	Expected Plants Per Acre**
40	40	9	118,000	5.4 - 6.3	71 - 83,000
30	50	8.5	148,000	5.1 - 6.0	89 - 104,000
20	60	7	183,000	4.2 - 4.9	110 - 128,000
10	70	4	209,000	2.4 - 2.8	125 - 147,000
7	80	3	224,000	1.8 - 2.1	134 - 157,000

* Assuming 3,000 seeds per pound.
** Assuming from 60 to 70% emergence of planted seed, based on 80% germination seed and average to good conditions for establishment. If higher germination seed is used, planting rates may be reduced accordingly.

20% + for short season varieties planted very early or very late
35% for semi-dwarf determinate and semi-determinate varieties
10% for cold soils
50% for broadcasting
10% for no-till
10% for rough seedbeds
10% for thin line varieties
10% if a flexible or floating cutter bar or combine is not used or rough combing conditions are expected

Decrease the seeding rate per acre by:

5 - 10% if in the Bootheel
5% if lodging has been a problem
5% if planting under ideal conditions in rows
5% if using high-quality seed (higher than 85% germination)

Summary

Tillage systems used in Missouri soybean production are conventional, minimum, and no-till. The most widely used of these systems is no-till. Planting methods available to soybean producers in Missouri include row cropping, drilled or solid-seeding, skip row, broadcast, and aerial. Row cropping and drilled or solid-seeding are both very popular because of their consistency in producing good stands. Skiprow is similar to row cropping with the difference that rows are left unplanted or skipped between rows. Broadcasting and aerial seeding distribute seeds randomly across a field and are rarely used in Missouri. Optimum yields can be reached with plant populations of 70,000 plants per acre. Populations less than 70,000 may result in yield reductions due to insufficient plant numbers. Populations above 150,000 plants per acre may result in yield reductions due to overcrowding.

Credits

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Lesson 4: Selecting a Weed Control Program

Previous lessons have discussed the importance of evaluating local growing conditions when planning the crop, selecting a variety, and choosing a tillage and planting method. Choosing a weed control program that will reduce crop losses due to weeds will have an economic impact on the producer.

Factors That Determine a Weed Control Program

Weeds compete with soybeans for moisture, nutrients, and sunlight. Controlling weeds is one of the most important steps in successful soybean production. Statistics show that crop producers lose about 1 pound of soybean dry matter for each pound of weed produced on an area of land.

Good weed control requires early planning and good execution. This may involve mechanical or chemical control measures or a combination of the two. One or more herbicides are applied to most of the soybeans grown in the United States. Specific herbicides and rates will not be recommended in this lesson because the recommended chemicals, rates, and methods of application vary across the state and are likely to change through the years.

Weeds are responsible for as much as 15% of the annual losses in the state, thereby making a weed control program very important. Before choosing a weed control program there are several factors to consider.

- Knowledge of the annual recurrence of weeds in the field
- Knowledge of what type of weed control program was used previously in the field
- Crop rotations used and planned for the field - Continuous soybeans present more weed control challenges than if planted in a grass rotation.
- The variety of seed to be planted (herbicide-resistant varieties)
- Seed planting method - Narrower rows form a canopy earlier and shade out late season weed germination.
- Planting date - Delayed planting will allow early emerging weeds to be eliminated with tillage or a burn down herbicide before planting.
- Environmental conditions - Is the field close to a stream that is susceptible to runoff?

Start by scouting the fields after the crop is planted. Inventory the weed situation field by field and draw a map showing problem locations. This should be done within 2 weeks after the crop emerges. Include noncropped land such as fence rows, grass waterways, and drainage ditches. It is beneficial to include differences in soil types and textures, soil organic matter, and the pH on the weed map. These factors react differently with many soil-applied herbicides.

Weed Problems Specific to Soybeans

Proper weed identification is required to formulate the most effective herbicide program for each soybean field. Improper herbicide selection will result in poor weed control, which causes lower soybean yields. This often leads to another costly herbicide application for "salvage" weed control.

Broadleaf weeds, annual grasses, and perennial weeds plague Missouri farmers. Table 4.1 provides a list of common weeds that cause problems with soybeans in Missouri.

Table 4.1 - Common Weeds Occurring in Soybeans

Broadleaf Weeds	Annual Grasses and Perennial Weeds
Buckwheat, wild	Barnyardgrass
Cocklebur, common	Bindweed, field
Jimsonweed	Bindweed, hedge
Morningglory, ivyleaf	Cane, wild
Morningglory, pitted	Crabgrass, large
Lamb's quarters, common	Foxtail, giant
Mustard, wild	Foxtail, green
Nightshade, black	Foxtail, yellow
Pigweed	Hemp, dogbane
Ragweed, common	Horsenettle
Ragweed, giant	Johnsongrass
Smartweed, Pennsylvania	Milkweed
Sunflower, wild	Nutsedge, yellow
Velvetleaf	Panicum, fall
	Proso millet, wild

Weed Pressure's Effect on Yield

The toll on soybean yield may be heavy when there are uncontrolled weed problems. Many weeds emerge with soybeans as they germinate and increase in height at about the same rate as the crop. For this reason, and also because weeds are killed most easily in the early growth stages, early season control is most important. If weeds are controlled within 2 to 4 weeks after soybeans emerge, little damage is done to the yield. The longer the weed problem continues, the greater the yield reduction. Table 4.2 indicates how the yield of soybeans might be affected by the density and length of competition from a specific number of cocklebur plants per foot of row. When one cocklebur plant per foot of soybean row is left in the stand for the entire growing season, it can result in about 61% of yield reduction.

Table 4.2 - Effect of Cocklebur Density and Length of Competition on Soybean Yields

	Weeks That Cocklebuns Were Left Uncontrolled				
Density of Cocklebuns	4	6	10	12	Full season
	% reduction in soybean yield				
1 per 10 feet of row	2	5	10	13	13
1 per 5 feet of row	4	10	21	26	26
1 per 2.5 feet of row	5	14	31	39	40
1 per foot of row	10	15	38	60	61
3 per foot of row	10	36	60	80	80

Source: University of Arkansas

Table 4.3 shows the effect of foxtail weeds left in the soybean stand. If the stand was weed free, there was a yield of 30 bushels per acre. When the foxtail was left until the soybean plants were mature, the yield dropped to 12 bushels per acre.

The amount of damage caused by weed pressure varies depending on the growth stage of the soybean. If early weeds are controlled and a uniform stand of soybeans is allowed to become established, plants completely shade the ground and damage from weeds is minimized.

Weed Control Options

There is no simple cure for weed control in soybeans. There are a variety of possible approaches to weed control: cultivation, herbicide application, and herbicide tolerant system.

Table 4.3 - Effect of Removing Foxtail from Soybeans

Soybean Height When Foxtail Was Removed	**Average Yield**
Inches	Bushels per Acre
Weed-free check	30
8	30
12	30
16	29
22	29
Left until beans were mature	12

Source: University of Illinois

Cultivation involves removing weeds from rows manually or mechanically. There are several advantages to using cultivation as weed control. It is environmentally safer and more economic than chemical use, depending on acreage and amount of weed growth. The disadvantages are low effectiveness on weeds growing directly in the row, grass weeds, and increased cost of labor and fuel, particularly if cultivation needs to be repeated. Cultivation is also dependent on timing and severity of the problem.

The second method of weed control is the use of herbicides. This involves applying chemicals to fields or plants to either prevent or destroy weed growth. An advantage to this method is controlling weeds throughout the whole field with no need to reapply the chemical during the growing season. The roots are killed, slowing or preventing new growth. Disadvantages to using herbicides are the toxic effects on the environment, the cost of the chemicals, and the chance of plant injury. Chemical companies are working toward developing new herbicides that are environmentally safe and more affordable.

A third method of controlling weeds is the herbicide-tolerant system. This requires planting herbicide-resistant varieties. The advantages of this system are less trips across the field and reduced cultivation costs. There are several disadvantages of the herbicide-tolerant system: lack of residual control during the growing season, damage can occur to the plant if the herbicide is applied incorrectly, and no spraying can occur after the V-6 stage.

Summary

Weeds are responsible for as much as 15% of the annual losses in Missouri, thereby making a weed control program very important. When selecting a weed control program there are several factors to consider: (1) knowledge of annual reoccurrence of weeds, (2) knowledge of past herbicide treatments if any, (3) crop rotations used and planned, (4) variety of seed to be planted, (5) how the seed is to be planted, (6) planting date, and (7) environmental conditions. Each of these factors plays an important part in how the type of weed program will perform. A large number of broadleaf, perennial, and annual grasses cause problems for Missouri producers. Competition from weeds accounts for 30 to 80% of yield reductions and increases input cost of soybean production. Although there is no simple method to control weeds, methods fall into two categories: cultivation and herbicide control. Effectiveness of each depends on environmental conditions in the area.

Credits

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Lesson 5: Scouting and Maintaining the Crop

Evaluation of the soybean crop during the growing season, referred to as scouting, is one of the most important activities producers perform during the season. Scouting is the only way to determine when it is appropriate to begin management practices such as irrigation, IPM (integrated pest management), and herbicide practices.

Scouting the Growing Crop

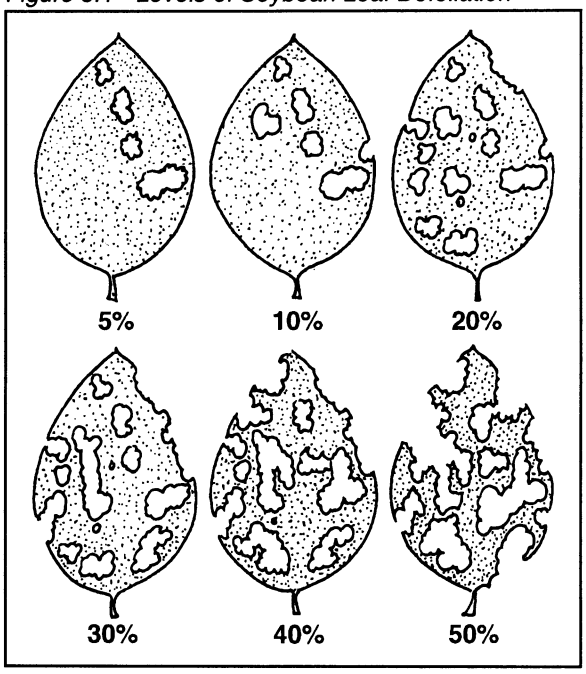
There are several reasons for crop producers to scout their fields on a regular basis. These reasons include evaluating the stand for replanting (as discussed below), checking for insect and disease presence and/or damage, evaluating plant nutrition practices and outcomes, checking weed presence, evaluating herbicide and insecticide effectiveness, moisture availability, and crop readiness for harvest.

Soybean growers are most concerned about how much yield or seed quality loss will result from the presence of pest insects. Loss of yield or seed quality will result only when the amount of injury exceeds the tolerance of the plant. This is known as the "injury threshold" of the plant. Defoliation is the most common and visible form of chewing insect damage to soybeans. Growers tend to overestimate defoliation. Defoliation damage can be estimated by removing 10 to 20 leaflets from the middle and upper portion of plants from several areas in the field. Compare these to the illustrations in Figure 5.1, average the percentage of defoliation, and the mean will reflect the level of damage for the field.

Herbicide and insecticide effectiveness may also be evaluated when scouting or surveying the field. If one or more of these problems still exist or become present, contact the chemical representative for adjustments and/or recommendations before proceeding. If additional weeds are a problem, this may be corrected early by a tillage method such as rotary hoeing.

Moisture management during the growing season can significantly affect soybean productivity. Soybeans require about 18 to 22 inches of water for good development and maturation. The objective of good moisture management is to provide water to the roots when needed by the plant to produce the most economical soybean yields. If the soils are overly wet, drainage practices may need to be employed. This may include tile drainage, tillage, or surface drainage. Ridge planting is another consideration before planting on traditionally wet fields. If moisture is deficient and a water source is available such as with a river, reservoir, or a deep well, irrigation may be a consideration. Without the optimum amount of moisture, the soybean plant may be stressed and maximum yield not obtained.

Figure 5.1 - Levels of Soybean Leaf Defoliation



Replanting Decisions

Deciding whether to replant is by far the most difficult decision to make when producing soybeans. This decision requires the producer to make an unemotional analysis of the field. In making this decision there are a few steps that should be followed. If crop insurance covers the damage, consult an insurance agent before taking action. When all of a stand is lost, it is realistic to replant if adequate growing season remains for beans to mature.

The first step is to determine the cause of damage. Causes can be the result of poor seed quality; planting too deep or too shallow; herbicide injury; insect or disease problems; cold, wet soils; hot, dry soils; or soil crusting.

Second, assess the damage by evaluating the stand density. If the stand loss is random or erratic, a stand count should be taken. If 40% (30% in southern Missouri) or less of the recommended stand remains, and it has been 3 weeks or less since the first planting date, it is probably economical to replant. A computer program (AG0031) at University Extension Centers is available for more assistance on replant decisions.

To estimate the amount of live plant populations remaining, count the number of live plants in the appropriate areas. For row planting, the easiest length of row in which to count plants is one equal to 1/1000th of an acre. For example, for 30-inch row width, use a row length of 17 feet, 5 inches; 20-inch row width, use 26 feet, 2 inches; and 15-inch row width, use 34 feet, 10 inches. (Refer to Table 3.1 in Lesson 3 of this unit, Recommended Seeding Rates, to determine expected plants per foot of row.)

The hula hoop method can help determine plant populations in drilled soybeans. Place a circular measuring device, such as a hula hoop, on the ground and count the number of plants contained within the circle. Refer to Table 5.1 for determining drilled soybean populations using the hula hoop method. Wait several days to determine if regrowth in these areas is possible. Do not count plants that have a potential for recovery. Again, if 40% or less of the stand remain, and it has been 3 weeks or less since planting, it may be necessary to replant.

Table 5.1 - Hula Hoop Method

	Inside Diameter of Hula Hoop				
# of Plants	30"	32"	34"	36"	38"
	Plants (1,000s) Per Acre				
4	35	31	28	25	22
6	53	47	41	37	33
8	71	62	55	49	44
10	89	78	69	62	55
12	107	94	83	74	66
14	124	109	97	86	77
16	142	125	110	99	89

After stand density has been established, yield potential must be predicted. Be sure not to overestimate normal yields for the area of the state. The entire field must be observed for amount of weed pressure, extent of plant defoliation, and large gaps in the stands. Refer to Table 5.2 for estimated yield potential of soybeans at various populations. Keep in mind that soybeans are most affected by weather conditions in July and August. When determining yield potential, assume normal weather patterns. Refer to Table 5.3 for effect of planting date on yield of soybeans.

Table 5.2 - Soybean Yield as % of Normal

Population	**30" Rows**	**7" Rows**
160,000	100	100
120,000	100	100
80,000	100	96
60,000	94	92
40,000	88	87
20,000	79	77
10,000	64	58

Table 5.3 - Effect of Planting Date on Soybean Yield

Planting Date	**Yield as % of "Normal"**
May 10	100
May 20	100
May 30	94
June 10	88
June 20	78
June 30	70
July 10	Not recommended in northern Missouri

Once the yield has been predicted, determine income by multiplying yield potential and predicted market price at harvest. Even if predicted replanting yield is greater than that of the damaged field, the cost of replanting may still be more than the additional replant yield.

There are cases when replanting is not the best option. When only parts of a stand are lost, the decision to replant is more difficult. If a total loss is suffered, it may be more profitable to file a crop insurance claim. A producer who double-crops may not have enough time for replanting. In such a case, filing an insurance claim may be the best option. Once the estimated yield and predicted market price are determined, a decision can be made about insurance.

Costs to consider when determining replanting cost are (1) the cost of the seed, (2) fuel and machinery costs, (3) additional pesticides and herbicides, (3) labor, (4) interest on loans, and (5) increased cost associated with late harvesting, such as increased dryer costs.

Decisions about Weed Removal

The decisions a soybean producer makes prior to planting will determine the method of weed removal. Cultural methods such as deep plowing in the fall or early spring will reduce most perennial weed problems. Producing soybeans in wide rows (greater than 20 inches) using conventional tillage methods allows for cultivation of weeds between the rows. However, grasses are not easily controlled by cultivation. Cultivation is also ineffective for controlling weeds growing directly in the row. Cultivator sweeps should be set to run as shallow as possible (1 to 2 inches).

Greater reliance is usually placed on herbicides for weed control in drilled soybeans because postemergence cultivation is more limited. A timely rotary hoeing early in the season can be effective. If rotary hoeing is used properly, less than 5 to 10% of a well-established soybean stand should be destroyed. Drilled or broadcast beans are also more competitive with weeds because of a more uniform crop distribution that forms a canopy earlier in the season.

Herbicides are the primary method of weed control in soybean production. Many new herbicides have been introduced in the last few years. However, no single herbicide is capable of controlling all of the common weed problems encountered in Missouri soybean fields. Many of the new herbicides are more species specific in activity than previous herbicides. A more complete treatment of weed control options and herbicide combinations is provided in the *Weed Control Guide for Missouri Field Crops* (MP575), which is updated annually and available at any county extension office.

Scouting for Insects

Soybeans are inhabited by many kinds of insects. Most do not pose a threat to profitable soybean production. A few kinds, however, can reduce yields significantly if their numbers are high. Scout fields regularly to stay abreast of insect infestations. Typically, insect problems are low early in the season, until late July or early August. From that time until the plants mature, soybeans may be invaded by large numbers of foliage feeders or pod feeders.

Thesholds have been established for most major insect pests and for several minor pests. Insecticides should be applied only when pest levels reach economic thresholds. Producers should become familiar with the threshold values for the major soybean pests in their area. A local University Extension Center will have current information available for producers.

Some of the more common soybean insects are the bean leaf beetle, stink bugs, corn earworm, and grasshoppers.

Bean leaf beetles overwinter under debris. They attack germinating soybeans by chewing on cotyledons, underground stems, and first sets of true leaves. Adults are about 1/4 inch long and vary in coloration (red, orange, tan, or gray) and markings (dots, strips, or both). All adults possess a black triangle at the base of their forewings. There are two generations per year in Missouri. As soon as soybean seedlings emerge, it is important to scout fields weekly for bean leaf beetle infestations. Scouting procedures are targeted at the adult stage because sampling for the larvae is expensive, labor intensive, and time-consuming.

Stink bugs overwinter as adults underneath leaf litter, tree bark, and other materials in areas not used for crops. Both the nymphal and adult stages attack primarily the seeds and pods of soybean plants. They also feed on plant stems, foliage, and blooms. Feeding punctures can be identified by the presence of small brown or black spots. In Missouri, insecticide treatments are recommended when adults or later-instar nymphs reach at least one insect per foot of row as soybean pods begin to fill with seeds.

Corn earworm larvae may attack soybean foliage and pods, especially in southern counties. Newly hatched larvae feed on terminal foliage for a few days before moving down to small pods and eventually to larger pods. Pod injury is most severe on mid-season and late-planted beans during late August and early September. There are three generations annually, but the last generation is the one most likely to damage soybeans.

Grasshoppers, both nymphs and adults of several species, may feed on soybean leaves and pods, especially during a dry summer. Damage is usually confined to rows adjacent to fences, ditch banks, and grassland. Grasshoppers overwinter as eggs in the soil, mate during May and June, and the partially grown to mature hoppers begin to move into crops during July and August when surrounding vegetation becomes scarce and matures.

Apply insecticides only when pest numbers reach or exceed threshold levels. Economic thresholds are always changing to include stage of development of the crop, stage of development of pest(s), weather, yield potential, market price of commodity, and cost of pesticide and its application.

Summary

Scouting the growing crop is a crucial step for the producer. Factors such as insect pest damage, weed and disease damage, and moisture availability help producers know when to implement management practices. If the crop is damaged, decisions regarding replanting need to be made. The cause of the damage needs to be determined and the damage needs to be assessed to determine if replanting is the best option. Cost factors for replanting will determine if yield potential can be increased. Methods of weed removal will be determined prior to planting resulting in either herbicide applications or cultural methods. Scouting for insect infestations should occur on a regular basis with economic thresholds determined for pesticide applications.

Credits

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Lesson 6: Harvesting the Crop

Harvest management is an important part of turning high-yielding soybeans into profit. Harvesting and storing the crop are the final steps that will determine if a producer will be profitable. This lesson will address challenges producers face and methods to reduce losses during harvesting and storage.

When to Harvest

Choosing the most favorable harvest time can be the difference between profit and loss for a producer. The factors that determine when to harvest soybeans are the maturity level and the climatic conditions. Harvesting should begin when the beans are mature, the leaves have fallen off the plant, and the stalks and pods are golden brown. Soybeans mature based on the variety; some are short-season varieties and some are long-season varieties. On average, they will mature 50 to 80 days after full bloom.

A determining factor in the maturity level of the soybean is the moisture content. A newly formed soybean seed contains nearly 90% moisture. The moisture content continues to decline throughout the growth and development of the soybean. At harvest, the ideal moisture level should be 13% or lower if short-term storage is used. For long-term storage, the moisture content should be 11 or 12%. Complete the harvest as quickly as possible after beans first reach combine maturity.

Climatic conditions affect the moisture levels of the soybean. Soybeans are hygroscopic, meaning they give up and reabsorb moisture more easily than other crops. Harvesting at moisture levels that are too low can cause high shattering losses. Shattering can be reduced when the relative humidity of the air is high. Avoid harvesting during hot, dry afternoons when pods and beans tend to be brittle. Early mornings or early evening hours when the dew is high will provide adequate moisture to reduce shatter. Typical moisture changes can vary from 16% at night to 9 to 10% during the hot, dry part of the days. Beans should be covered or stored immediately after harvest to reduce reabsorption of moisture from the air. Typically producers will wait until after the first frost to reduce problems with green weeds. Weeds can become tangled in the combine and cause drying problems when stored. The mature soybean normally remains highly viable after exposure to below-freezing temperatures.

Preventing Harvest Losses

There are two categories of soybean harvest loss. Soybeans lost during the maturation process are called preharvest losses. Losses that occur during the harvesting process are called harvest loss.

Preharvest Loss

Preharvest loss is loss that occurs before harvesting and is influenced by the soybean variety, weather, and timeliness of harvest. Preharvest loss is caused by lodging of plants and shattering of pods. To hold shattering to a minimum, plant shatter-resistant varieties. Beans that fall to the ground cannot be harvested. Harvest the bean as soon as the moisture is low enough. Starting early is important because the moisture content declines rapidly when the humidity is low. On average, total crop yield loss is 0.25% before harvesting begins.

Harvest Loss

Harvest loss during the harvesting process cannot be completely avoided but it can be reduced to an acceptable level. The most common causes of harvest loss are shatter loss at the combine header, stubble loss, lodged or loose stalk loss, cylinder loss, and separation loss.

Shatter loss at the combine header occurs when the header is operated improperly or when the crop tends to shatter easily. The soybeans are shelled in front of the combine and do not pass through the header. Shatter losses increase with crop dryness and a properly adjusted combine header will help to reduce losses. Adjustments to the combine header need to be made according to the guidelines in the operator's manual for that specific combine. Typically the reel speed is too fast or positioned too far forward. The forward speed of the combine and the reel speed need to be in proper proportions according to manual guidelines. On average, the reel speed should be 25% faster than ground speed.

Stubble loss occurs when pods are left on the stalk because they were missed by the cutter bar and not gathered into the combine. A cutter bar set too high will miss the lowest pods. This problem can be reduced by keeping the seedbed level when

cultivating and by operating the cutter bar as close to the ground as possible.

Lodged or loose stalk loss occurs when beans are left in the pods on downed stalks or those that are cut but do not pass through the combine. A pickup reel with pickup guards on the cutter bar will reduce these losses. In addition, the combine should be in top condition, the knife sharp, and the correct reel height used.

Cylinder loss occurs when beans are left in the pods after passing through the combine. This is a result of harvesting when the moisture content is too high and incorrect cylinder-concave settings. Cylinder speed should be set according to the operator manual. The settings may vary depending on moisture levels.

Separation loss occurs when loose beans pass out of the combine. This loss can be reduced with the correct blower and sieve settings. Set cleaning sieves and wind according to the operator manual.

Tips for Keeping Combine Losses Low

- Keep equipment in good working order.
- Keep the seedbed level.
- Operate the cutter bar as close to the ground as possible.
- Use a ground speed of 2.8 to 3.0 miles per hour.
- Use a reel speed about 25% faster than ground speed.
- Reel axle should be 6 to 12 inches ahead of the cutter bar.
- A six-bat reel will give more uniform feeding than a four-bat reel.
- Complete the harvest as quickly as possible after beans reach 13% moisture content.
- Cylinder speed and clearance should be set according to owner manual guidelines.

Harvesting Soybeans for Seed

Recent trends find producers returning to the practice of harvesting soybeans for reseeding. Soybeans genetically altered have not allowed producers to hold back seeds for future crops because of patents on the original product.

Soybeans that are being harvested for use as planting seed require special attention. The following list from the University of Missouri Extension publication G04410 provides guidelines for producing high-quality, good-germinating seed.

- Give special attention to genetic purity, freedom from weed seeds, and overall quality of the seed planted. Certified seed growers must use foundation or registered seed. Producers of noncertified seed can ensure varietal purity by planting certified seed.
- Plant seed fields on land that was not planted in soybeans the previous year unless the same variety was planted.
- Avoid early planting. Although yields may be higher, the quality of seed produced from early plantings is often poorer.
- Make every effort to control weeds. One or more cultivations are usually necessary even with good results from chemical weed control.
- Start harvest as soon as the bean reaches 13% moisture. Harvest as much of the crop as possible at 12% moisture or above to avoid cracked seed coats and splits. Stagger planting dates of the same variety so that they mature at different times.
- If heavy pathogen infection is predicted, consider using foliar-applied fungicides during the reproductive stages.
- Pay special attention to combine adjustments, keeping cylinder speed as low as possible while still doing a good job of threshing.
- Avoid harvesting during hot, dry afternoons when pods and beans tend to be brittle. Nights and mornings are the best time to harvest.
- When moving beans from the combine to storage and handling and conveying them while cleaning, drop the beans as few times and as short a distance as possible to reduce seed coat cracks.
- Avoid using auger elevators; they increase seed damage.

Storage Options

Soybean storage options are very similar to corn storage. Grain bins located on the farm can be used as well as local grain elevators. These local elevators store and condition the soybeans before selling and shipping them to a soybean processor or export elevator. Some areas may have grain buying stations or processing plants nearby that may purchase soybeans directly from the producer. Grain may also be transported by truck to a regional transport facility such as a railroad or river terminal to market or store harvested soybeans.

Storage Problems

Soybeans have a high oil content and absorb moisture from the air more easily than most other crops. High temperatures and humidity can lead to mold growth. Therefore, it is very important that beans are dried and humidity levels kept at equilibrium. Equilibrium describes the ratio between a relative humidity and the moisture content in soybeans. Drying can be achieved either with high temperature driers or with natural air. There are many types of driers available and each should be analyzed to determine the potential for causing cracks in the soybeans.

Storage bins should not be overloaded. Excessive depths of wet grain will increase drying costs and delay harvests. It is not good practice to add new grain on top of old grain in storage.

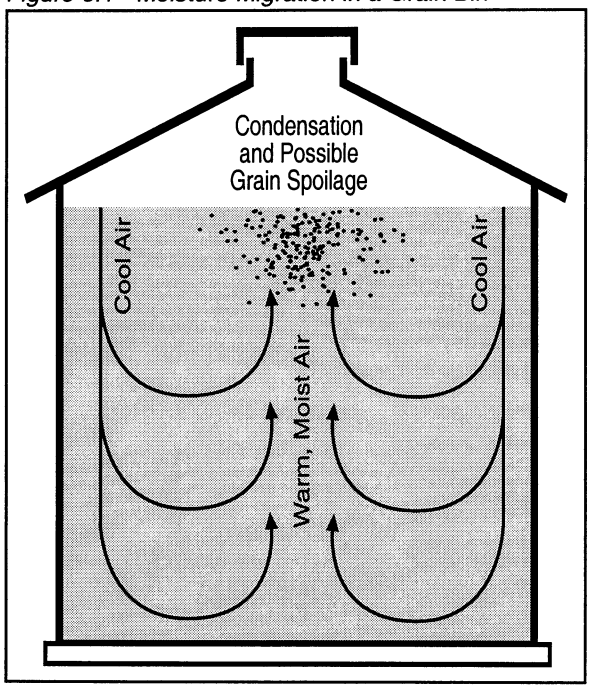
Avoid an accumulation of trash, such as weeds, in the soybeans. Trash will affect drying. Uneven moisture gradients in the trash and the soybeans can result in hot spots during later storage.

Insects are generally not a problem in soybeans if stored for less than 1 year. Special precautions should be taken if storage is going to be longer than one year.

Maintaining Crop Quality During Storage

Whether the soybeans are being stored for a short time or for longer periods, the temperature and moisture levels must be controlled. As outside temperatures decline, the soybeans cool near the surface and outside walls of a storage bin. The soybeans remain warm in the interior mass. Cool air moves down the inside walls, forcing warm air upward. When the warm air reaches the cool surface, condensation occurs. Figure 6.1 shows moisture movement through the grain bin.

Figure 6.1 - Moisture Migration in a Grain Bin



One of the most typical ways to control moisture in soybeans is by aeration. Aeration is a mechanical ventilation of grain in storage. The primary objectives of aeration are to (1) keep the soybeans at a seasonally cool temperature, within 10 degrees of the average monthly ambient air temperature and to (2) maintain a relatively uniform temperature within the soybean mass, preferably no more than a 10-degree difference from one part of the bin to another. Aeration prevents condensation that forms from warm, moist air by cooling the interior mass of soybeans.

Soybean mass temperature needs to be controlled throughout the year. Run the fan continuously if grain is above 16% moisture. Do not turn off the fan when it rains or there is bad weather. Beans should be cooled to 40°F in the fall and warmed to 60°F in the early spring. There should be no more than 15 degrees difference between the beans in storage and the average outdoor temperature. When warming beans in the spring, start fans for cooling when the outdoor temperatures are about 10 degrees warmer than grain temperatures. Forcing air warmer than 10 degrees above grain temperatures can cause moisture condensation within the grain mass. This condensed moisture can cause beans to go out of condition later.

Summary

The maturity level and climatic conditions determine when soybeans should be harvested. The moisture content determines the maturity level of the soybean. Soybeans should be at a 13% moisture level or lower at harvest. Climatic conditions also affect harvest time. Soybeans are hygroscopic and give up and reabsorb moisture easily. Harvesting after the first frost will typically provide ideal conditions.

Preharvest loss is caused by lodging of plants and shattering of pods before harvest. Shatter-resistant varieties should be planted and the bean should be harvested as soon as the moisture level is low enough.

Loss during harvest is caused by shatter loss at the combine header, stubble loss, lodged or loose stalk loss, cylinder loss, and separation loss. To reduce combine losses, keep the equipment in good working order and keep the seedbed level. The cutter bar should be close to the ground with a combine ground speed of 3.0 miles per hour. The reel speed should be 25% faster than ground speed with the reel axle 6 to 12 inches ahead of the cutter bar. Combine settings should be set according to the owner manual guidelines.

Proper storage of soybeans is very important because of their ability to absorb moisture easily. Beans need to be dried and humidity levels should be kept at equilibrium. One of the most typical ways to control moisture is by aeration. If condensed moisture is not controlled properly, it can cause the seed coat to crack or cause the beans to go out of condition later.

Credits

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Managing Grain for Year-Round Storage (AE-90). Cooperative Extension Service, Purdue University, West Lafayette, Indiana. 1997.

Measuring and Reducing Soybean Harvesting Losses (G01280). University Extension, Columbia, MO: University of Missouri-Columbia. 1993.

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Lesson 7: Marketing the Crop

This unit discusses the process of producing soybeans for selling the crop. There are a number of marketing options available to producers. Crop prices are closely tied to national and world prices by a network of marketing tools. To be profitable, the producer must determine when to sell or store soybeans and understand how the quality of the grain affects the price. Soybean checkoff funds contributed by the producer enable soybean products to be marketed worldwide.

Marketing Options

There are many options available to producers when marketing their soybean crop. The most common methods are to sell for cash at harvest, store at harvest and sell for cash later, use forward pricing in the futures market, use delayed pricing, use grain pooling agreements, or a combination of these methods.

Probably the simplest method of marketing to practice and to understand would be the marketing option of selling the grain at harvest. This involves transporting the grain from the combine directly to the grain elevator, selling the grain upon delivery at that day's cash market price, and receiving payment from the elevator.

Some crop producers have storage facilities available to dry and store the grain when harvested and sell on the cash market later. This may be done if the cash market is unseasonably low at the time of harvest with the expectation and forecast of increased prices in the near future. The producer could transport the soybeans to the grain elevator when the cash price is expected to rise to a level of greatest profit.

Another option for producers is to use forward pricing in the futures market. Forward contracts can be established between grain elevators or on the futures market. The futures market adds a time dimension to the pricing process and helps smooth out price changes due to short harvest or bumper crops, shifts in government markets, and changes in foreign markets. Forward pricing is established in advance, sometimes as much as 12 months or more, and locks prices in place. The disadvantage is uncertainty of market prices that may rise above the price that was locked in. There is also a chance that a loss in yield or quality may occur.

To offset the risk associated with forward contracting on the futures market, producers use hedging. Hedging is using the futures market as a temporary substitute for a cash purchase or sale to be made at some later date. Hedging is a way of reducing some risk of holding investments.

The simplest but most expensive method is to use an alternative called put or call option contract. The put option gives the buyer the right, but not the obligation, to sell the commodity. The call option gives the buyer the right, but not the obligation, to buy the commodity. Option markets are like buying insurance against falling prices. If the market falls, a put option protects the producer. However if the market rises then a put option is worthless and a loss is suffered. A call option is more of a gamble. It requires the market to rise to be valuable. Used correctly both can offset risk and give the producer a profit. Before attempting to use the futures market, producers should seek the help of marketing specialists to gain a better understanding.

Delayed pricing, or cash contracts, is another option producers have available. Price is delayed until the delivery of the product. This delay allows the buyer to inspect the product and pay according to the quality after arrival. That reduces some risk involved with transporting.

Another marketing alternative would be to participate in a grain pooling agreement with other producers. This involves joining other soybean producers in an agreement to combine their harvest. This increases the volume of grain to such a size that would lend itself to bargain directly with a soybean exporter for the highest price per bushel.

Another option would be to use a combination of the above methods. A producer might sell some grain at harvest, store some and sell on the cash market during the winter, and also have some grain sold through a futures marketing option. This method of marketing would spread the risk associated with a marketing option over several marketing alternatives.

The federal government also offers price support programs that offer producers a loan in return for pledging some of their grain crop as loan collateral. Rather than repaying the loan,

producers can choose to default on the loan, keeping the loan money and forfeiting ownership of the grain to the government. If market prices were below the loan rate, producers will benefit from defaulting on the loan.

Determining When to Sell or Store Soybeans

The marketing of soybeans is a complicated issue. When to sell or store the grain is a decision a producer must make after becoming more informed of the soybean pricing structure. The primary pricing structure includes two segments: (1) the supply, demand, and governmental programs that affect and shape the pricing behavior of the market and (2) the market forces themselves that change and direct pricing behavior. The former is known as "price determination" and the latter as "price discovery."

There are many factors that interact over time to alter the supply and demand of soybeans, causing variations in price relationships between markets. A major decline of 2 to 3 million metric tons in Brazil's soybean crop can often result in a significant increase in U.S. export markets for soybeans and soybean products. This will ultimately increase soybean prices. Price is the hub of the system for the produce, regardless of whether soybeans are sold in the domestic or foreign markets.

Proper use and analysis of market information and a knowledge of the marketing options by the producer are the keys to increased profits. A successful producer will also become aware of the marketing information services offered through the media and with tools such as marketing newsletters. The decision concerning when to store or sell can only be made by the producer after becoming experienced with these factors.

Grain Quality

Soybeans are marketed on the basis of federally established classes and grades. Two classes of soybeans include Yellow soybeans and Mixed soybeans. There are five grades of soybeans: 1, 2, 3, 4, and "Sample grade." Price discounts or deductions from gross weight are imposed on soybeans that violate grading factors.

Yellow soybeans have yellow or green seed coats with cross sections of yellow or yellow tinge. Not more than 10.0% of other colors may be included with class Yellow soybeans. Mixed soybeans are those soybeans that do not meet the requirements of the class Yellow soybean.

The grade of a soybean is determined by several standards: the amount of damaged kernels due to heat or other means, amount of foreign material, amount of splits, and amount of soybeans of other colors. Table 7.1 shows the current standards for soybeans as set forth by the U.S. Department of Agriculture.

Table 7.1 - Soybean Grading Factors

	Grades U.S. Nos.			
Grading Factors	1	2	3	4
	Minimum pound limits			
TEST WEIGHT (lb./bu.)	56.0	54.0	52.0	49.0
	Maximum percent limits			
DAMAGED KERNELS				
Heat (part of total)	0.2	0.5	1.0	3.0
Total	2.0	3.0	5.0	8.0
FOREIGN MATERIAL	1.0	2.0	3.0	5.0
SPLITS	10.0	20.0	30.0	40.0
SOYBEANS OF OTHER COLORS*	1.0	2.0	5.0	10.0
	Maximum count limits			
OTHER MATERIALS				
Animal filth	9	9	9	9
Castor beans	1	1	1	1
Crotalaria seeds	2	2	2	2
Glass	0	0	0	0
Stones**	3	3	3	3
Unknown foreign substance	3	3	3	3
Total***	10	10	10	10

* Disregard for Mixed soybeans.
** In addition to the maximum count limit, stones must exceed 0.1% of the sample weight.
*** Includes any combination of animal filth, castor beans, crotalaria seeds, glass, stones, and unknown foreign substances. The weight of stones is not applicable for total other material.

U.S. Sample grade are soybeans that (a) do not meet the requirements for U.S. Nos. 1, 2, 3, or 4;

or (b) have a musty, sour, or commercially objectionable foreign odor (except garlic odor); or (c) are heating or otherwise of distinctly low quality.

Checkoff Dollars

Every producer who sells soybean crops participates in the national checkoff program. The checkoff dollars occur when the crop is first sold and is charged at a rate of 0.5% of the market price per bushel. Half of all checkoff funds remain in the state where the fund is collected and used as directed by producer-controlled boards. The other half of the checkoff funds are forwarded to the United Soybean Board (USB). The USB uses the funds on a national level to fund marketing and research projects designed to improve the demand for U.S. soybeans, both at home and overseas.

There are four main program areas where the national checkoff funds are used. International marketing works with other countries to increase soy exports. Domestic marketing focuses on increasing the demand for soy from food industry and industrial use. Production conducts research to look at ways to reduce production costs by the soybean producer. The New Uses area researches and develops new ways to use soy such as in wood adhesives, paints and coatings, lubricants, and solvents.

Summary

Common methods of marketing soybeans include selling for cash at harvest, storing at harvest and selling for cash later, use forward pricing in the futures market, delayed pricing, grain pooling agreements, or a combination of these methods. A producer must become informed about the soybean pricing structure to decide when to sell or store grain. Grain quality is based on classes and grades established by federal standards. Price discounts and deductions from gross weight are imposed on soybeans that violate grading factors. Checkoff funds are used to market and research soybeans to increase the demand both domestically and in foreign markets.

Credits

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United States Standards for Soybeans - Subpart J. U.S. Department of Agriculture. <http://www.usda.gov:80/gipsa/stru/reg/standard/soybean.htm> 28 Oct. 1999.

Lesson 8: Figuring Crop Costs

Raising a high-quality, high-yielding crop is the goal of every producer. Making a profit on that crop regardless of the quality is even more important to producers. Keeping good records is the best way for producers to plan and measure profitability. This lesson will address the costs associated with soybean production and how these costs are used to measure profitability. The total profit can only be figured after considering the variable costs, the fixed costs, and the labor costs of producing the crop.

Variable Costs

Variable costs are also spoken of as "operating costs." Variable costs per acre are those costs that vary with the level of production each year. These costs include seed, fertilizer, chemicals, machinery repairs, fuel, interest, and miscellaneous out-of-pocket costs. If the producer has a goal of increasing the production of soybeans from 40 bushels per acre to 60 bushels, the variable costs will also have to increase. More seed, fertilizer, and chemicals will need to be purchased. These costs represent about 38 to 40% of the total costs to produce an acre of soybeans. According to the Missouri Management Information Record (MIR) program, the average variable costs for an acre of soybeans in 1985 was $76.50. In 1997, the MIR program showed an average of $131.31 to produce an acre of soybeans. Variable costs have obviously increased over the years. The cost of seed, fertilizer, chemicals, along with machinery repairs have greatly increased.

Fixed Costs

Fixed costs are also known as "ownership" costs. Fixed costs are those costs that do not vary with the level of production each year. This includes depreciation and interest on machinery, interest, and taxes on land and other real estate, and possible labor costs. If a soybean producer decided to increase efforts to produce a higher yield, these costs would remain the same. These costs (including labor) represent about 62% of the total costs of producing an acre of soybeans. In 1985, the average fixed costs were $124.00 per acre. In 1997 these costs were $110.94 per acre. Producers have obviously reduced fixed costs in the last 12 years. Spreading the fixed costs per acre over more bushels by attaining higher yields offers the greatest opportunity for reducing per bushel costs and enhancing profits.

Table 8.1 shows average Missouri crop costs based on 1997 MIR summarized by University of Missouri Extension.

Table 8.1 - Missouri Average Crop Costs

Average Variable/Operating Costs /Acre	
Seed	$16.81
Fertilizer and Lime	7.00
Chemicals and Materials	33.00
Machinery Fuel, Oil, and Repair	23.00
Machinery Hire and Services	5.50
Average Labor Cost/Acre	22.00
Taxes and Insurance	3.00
Miscellaneous	9.00
Operating Interest	12.00
Total Operating Cost/Acre	$131.31
Average Fixed/Ownership Costs /Acre	
Machinery Depreciation and Interest	$28.44
Land Costs, Taxes, and Interest	82.50
Total Fixed/Ownership Costs/Acre	$110.94

Calculation of Cost Per Acre

Profitability of a crop is determined by looking at the cost of growing that crop less the returns received from sales. To calculate costs, first determine the total variable costs and the total fixed cost. Together these make up the total cost of production. Subtract total cost of production from total returns to calculate the return above variable cost.

Total (operating) variable cost
\+ Total (ownership) fixed cost
Total cost of production

Total returns
\- Total fixed cost
Return above variable cost (return on investment)

Acceptable Return on Investment

Unfortunately, crop producers are faced with decisions concerning levels of profitability each year of production. What is an acceptable return on their investment to produce a crop of soybeans? What factors must be considered to determine if their returns are worth their investment of labor and capital?

Producers must consider if the return is adequate for their labor. They must be able to make a living for themselves and their families. Returns to labor will determine their lifestyle and the quality of how their families will be able to live. The return to labor will be the result of subtracting the total costs of production (fixed and variable) from the total returns.

Producers must consider if the returns will allow expansion of the operation. Will it be enough to purchase larger and newer equipment to produce the soybean crop? Does the producer want to add or expand storage facilities?

There are several variables that must be considered to determine if the crop producers' profits are at an acceptable level. The final decision may involve consulting someone who knows the producers' finances, such as the banker or agricultural loan agent, but the ultimate decision should be made by the producers.

Summary

Variable costs are costs that change with the level of production each year. These costs include seed, fertilizer, fuel, and operating interest. Fixed costs do not vary with the level of production. Examples include depreciation on machinery, taxes, and interest on the land and equipment. Producers use the calculations of these costs to measure profitability and to plan and budget for the next year.

Credits

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