Lesson 1: Economic Importance of Crops

The strength and independence of the U.S. is in part the result of the efforts and accomplishments of the American farmer. Efficient production in the U.S. enables people to work in other occupations while a small proportion of workers devote their efforts to producing food. The production of food has been and will continue to be of primary importance. Agriculture in the U.S. and the world will continue to be a key point of concern when nations discuss economics and world trade.

Major Crops of Missouri

The diverse geography of Missouri provides a wide range of opportunities for agricultural use. The land, soil type, climate, and available water promote the diversity of agriculture throughout the state. Because of the uniqueness of Missouri land and natural resources, the state is able to produce a variety of crops. Major crops produced in Missouri are soybeans, corn, wheat, cotton, rice, hay, grain sorghum, fescue seed, and lespedeza.

Missouri and the Nation

The production of agricultural products plays a key role in the economy of the state of Missouri. Each year, Missouri agriculture generates over $15 billion in marketing. Because of the state's agricultural diversity, Missouri is able to export many agricultural products to other countries.

Many other states in the U.S. also produce crops for export overseas. However, according to the Missouri Field Office of the USDA's National Agricultural Statistics Service, Missouri ranks among the top 10 states in the production of several crops:

- 2nd in hay production (excluding alfalfa)
- 4th in hay production (all)
- 4th in rice
- 5th in grain sorghum
- 7th in soybeans
- 8th in corn for grain
- 9th in cotton
- 9th in cottonseed
- 9th in winter wheat
- 10th in tobacco
- 10th in watermelon

Major World Crops

The U.S. is the top producer and exporter of agricultural products in the world. Other countries have increased crop production levels so they can provide more food and participate in world trade. Major crops are grouped by their use: cereal grains, oilseeds, sugar, and fiber crops. The major crops in these categories are listed below:

1. Cereal grains – wheat, barley, oats, rye, corn, sorghum, rice
2. Oilseeds – cotton, soybeans, peanuts, canola, rapeseed, sunflower, safflower
3. Sugar – sugar beets, sugar cane
4. Fiber crops – cotton, hemp, flax, jute

Which Crops to Grow

Many factors that affect plant growth should be considered when deciding what crops to grow. The U.S. has abundant fertile land (land that is fit for cultivation) and a relatively mild climate. However, there are many factors that affect which crops are grown: land capability and use, climate, resource availability, product demand, and international trade.

<u>Land capability and use</u> refers to what the land is capable of producing within its limitations. Not all land is the same. Many characteristics are different, and when considering land for agricultural use, recognizing limitations is important. Land capability also refers to the most appropriate use of land. Some land, because of its slope or soil type, should be restricted from row crop production. Other land may be less subject to erosion and therefore, may be used for row crop production.

<u>Climate</u> is another factor that must be considered when deciding on which crop to grow. All aspects of climate affect agricultural production and development. Surface and subsoil temperatures are critical to plant and microorganism growth. Some crop plant varieties are adapted to cooler temperatures and shorter growing seasons. However, most crop plants will grow best in an optimum temperature range.

Climate is one factor that limits which crops can be grown. In Missouri, for example, the below-freezing temperatures prevent citrus fruit from being grown.

Resource availability should also be considered in production decisions because of the related production expenses. Successful crop production relies on the availability of various resources and their efficient use. Crop production is unprofitable when the cost of providing water, fertilizer, or transportation to storage or market is too great.

Product demand affects the level of crop production in the U.S. and internationally. Crop production decisions should consider the product demand by industry and consumers. If the demand for the product is low, production may be unwise unless the producer has plans to use the product on the farm (e.g., feed for livestock, production of ethanol). Crop production should focus on high-demand crops. However, one exception would be canola. Canola is grown for its high quality vegetable oil. Corn and soybeans are the most common crops that produce vegetable oil. However, canola is grown because its vegetable oil is lower in saturated fats. Demand for canola has been limited. However, as consumers become more aware of healthful eating, demand is expected to increase.

International trade affects the kind and amount of crops grown. The U.S. is no different than any other nation. When a specific resource is needed by the U.S., trade is negotiated for that resource. For example, the U.S. produces far less minerals than it uses. Many minerals are imported from developing countries. Often these countries do not have the capability to produce enough food. Therefore, they trade their surplus mineral resources for U.S. food crops (e.g., wheat, soybeans, and corn).

International Relationships

Crop production is more complex than simply providing food or fiber to consumers. U.S. crop production has an impact on relationships with other countries. One positive impact is that the production and exportation of crops help to stimulate the U.S. economy. Jobs in export industries are provided by producing, processing, and marketing crops. Another advantage of U.S. crop production is the contribution to the country's trade balance. Agriculture exports more agricultural products than it imports. Crop production can also impact international relationships by building allies and friendships with other countries.

Some developing countries produce agricultural crops and sell them on the world market. For some developing countries, the sale of agricultural products may be their primary source of income. Overproduction of crops may drive the crop price down. Lower prices may significantly reduce the income derived from exported crops. Over-production may also push developing countries out of the market completely. Reduced export trade may be devastating to the economy of a developing country.

Because of limitations in soil quality or water resources, many countries are not able to produce enough food. Export trade may result in a dependency on food imports to feed the population of a developing country. Planning and management are needed to enable developing countries to improve their own agricultural production. Otherwise, developing countries will remain dependent on others for survival.

Effects of Foreign Crop Production on the U.S.

Before the colonies of North America became independent from Europe, agricultural products were traded with Europe and the Caribbean islands. The U.S. is the leading producer and exporter of agricultural products. However, other countries are increasing their food export capabilities. Competition from other countries in the world market is a major concern for agricultural producers in the U.S.

Some countries produce agricultural crops that are not grown in the U.S., such as tea, coffee, and certain fiber crops. Other countries produce crops similar to crops grown in the U.S. Consumer demand for these products keeps the market strong. However, when crop production in the U.S. and foreign countries is high, the supply may exceed the demand. Excessive production leads to large surpluses, which results in lower prices for commodities on the world market. Many foreign countries enjoy lower labor costs in producing and processing agricultural crops. Lower labor costs reduce the cost of production, which allows the products to be sold for a lower price. U.S. products must be priced accordingly to be competitive on the world market.

Crop Production and Society Development

Countries that are able to produce crops efficiently tend to be more developed. Countries that are able to supply the food, shelter, and clothing needs of their people may be in a position to devote resources to pursue other endeavors. Because of the efficient crop production of American farmers, U.S. consumers spend less money on food. Therefore, most families have money available for other uses (e.g., education, housing, and leisure). Additional purchases of goods and services stimulate the need for jobs, which generates more employment. This circular process stimulates the economy of a community, state, or nation.

When crop production is efficient, many countries trade beyond their borders to attain resources. National and international trade creates more jobs and secures additional resources for economic expansion. Through international trade, developing countries can acquire and develop capital to aid in their advancement.

Summary

Because of the diversity of Missouri's land and resources, efficient production of crops is possible. Missouri ranks among the top 10 states in crop production in the U.S. Missouri also contributes to international trade by producing crops that are sold on the world market.

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Lesson 2: Crop Uses (Products and By-Products)

Agricultural crops are commonly used as food for human or animal consumption. Technology and research have also extended crop usage beyond food. This lesson will address the uses of crops as sources of food and industrial products.

Major Uses of Crops

There are over 300,000 species of plants that have been identified. The majority of these plants are not used as food sources. The term "crop" encompasses any plant grown for a specific reason.

Many crops grown in the U.S. or throughout the world are produced for human or animal consumption. Some crops can be grown to feed both humans and animals. Often these crops are fed to livestock such as beef cattle, chickens, sheep, and hogs, which may then be processed for human consumption. Other uses of crops involve the production of various oils for cooking and industrial uses. Another major use of crops is in the production of pharmaceuticals (i.e., medicines).

Other major uses of plants are the production of fibers, sugars, alternative fuels, shelter products, ornamental plants, and stimulants.

Major Crops

Crops can be categorized according to their use. The major categories are: human and animal consumption, oils, pharmaceuticals, fibers, sugars, alternative fuels, shelter, ornamentals, and stimulants.

Crops grown for human and animal consumption: These crops include cereal and grain crops, legumes for seed, fruits, vegetables, nuts, and forages. Cereal grain crops are grasses that are grown for their edible seeds. The U.S. produces seven major grain crops, which are used in the U.S. and/or exported to many other countries. Major grain crops are corn, wheat, barley, oats, rye, rice, sorghum, and soybeans. Less than 10 percent of the corn grown in the U.S. is for human consumption.

Legume plants such as dry beans and peas are important foods in the diet of many Americans and people around the world. They are highly nutritious and relatively inexpensive. Food products made from field beans, field peas, peanuts, cowpeas, and soybeans are found in most grocery stores. Fruits such as apples, peaches, berries, and cherries are grown for human consumption. Vegetables like tomatoes, cucumbers, squash, and potatoes are also grown for human consumption. Pecans, walnuts, etc., are nuts commonly grown for human consumption.

Forage crops are used for animal feeds. Examples of forage crops include tall fescue, clovers, and orchard grass.

Production of various oils: These crops are grown primarily for the oil extracted from the seeds. They are used to produce oils for human consumption and industrial products. People throughout the U.S. are becoming more health conscious and are changing their diets. The use of vegetable oils has grown and is replacing the use of animal fats in cooking. Crops such as soybeans, peanuts, castor beans, corn, and canola produce quality oils for human consumption. Crops such as soybeans, flax, and cotton also produce oils that can be used in industrial products such as paints and stains.

Production of pharmaceuticals: Plants have been used for years to produce medicines. For example, Foxglove is a source for digitalis, which is used today almost exclusively as a heart stimulant and pulse regulator. Plants are grown to produce medicines that can help in controlling malaria and hypertension.

Production of fibers: Cotton, flax, and hemp are examples of fiber crops. They are used to produce materials like textiles or rope. The fibrous plant material in flax is used to produce linen. Flax fiber is also used in the production of paper pulp, binder twine, insulating wallboards, and numerous upholstery products. Besides the fiber portion of the flax plant, the seeds are used to produce linseed oil. Hemp has been used for making rope, twine, sails, tarpaulins, and numerous other products. Cotton is used in manufacturing cloth and thread in addition to the oil that is extracted from the seed.

Production of sugars: Sugar crops are sugar cane and sugar beets. Sugar cane is a member of the grass family. It is valued for the juices contained in the stem. At maturity, the plant's stems contain sucrose or crystallized sugar. Sugar beets supply over 40 percent of the world's sugar. Sugar beet tops are also processed and used for livestock feed. The sugar beet (fleshy taproot) is processed for its high sucrose content.

Production of alternative fuels: Crops that contain starch or sugars can be processed to produce an alcohol product known as ethyl alcohol or ethanol. Alternative fuel from fibrous or woody plants is known as methyl alcohol or methanol. Grains, tubers, and whole plants that contain fibrous materials can be used to produce this fuel. Once these alcohols are produced, they must be distilled before being blended with gasoline to make gasohol. Common crops used to produce alcohol are grain sorghum, wheat, potatoes, sugar beets, sweet sorghum, sugar cane, and corn. Alcohol can also be produced from legume and grass crops.

Production of materials for shelter: Plants used for shelter are predominately trees. Trees grown for lumber products such as dimensional lumber (e.g., 2 x 4s and 2 x 12s), plywoods, and trims can be grown on tree farms. Pines, furs, and hardwoods such as oaks, walnut, cherry, and hickories are used for buildings and furniture.

Production of ornamental plants: Ornamental plants include all plants grown for their beauty. Ornamental plants may be used indoors or outdoors depending on the type of plant. Boston ferns, African violets, impatiens, azaleas, goldenrain trees, flowering crabapple trees, petunias, and lilac are a few examples of ornamental plants.

Production of stimulant crops: Stimulant crops include tea, tobacco, and coffee. Tobacco is primarily grown in the south-eastern U.S. Coffees and teas are grown in South America, India, China, Africa, Japan, and Indonesia.

Products from Corn

Corn is the most widely grown crop in the U.S. Corn can be eaten as corn on the cob (sweet corn), popcorn, cornmeal, or flour. Field corn can be processed to be fed to livestock. Corn can be used to produce vegetable oils, breakfast cereals, refined corn sugar, and starch. Corn can also be processed to make adhesives, dyes, plastics, and alcohol, which is used to make gasohol.

Products from Soybeans

The soybean is another very important agricultural crop. Soybeans can be used as a grain crop or an oilseed crop. Soybeans can be processed into cooking oils, soy flours, shortening, margarines, and soy sauces. Soybean meal is a by-product after the soy-oil has been extracted from the seed. It is used as a protein source in livestock feed.

Soybean oil can be used to make industrial products: printer inks, paints, varnishes, caulking compounds, and linoleum floor coverings. Soybeans and soybean by-products have become very important to the U.S. and many parts of the world. In many parts of the world, soybeans and soybean by-products are used as a protein source in human diets. Tofu (soybean curd) is a soybean product that is gaining in popularity as a food. Many additional products have been developed from soybeans. Many new uses will be discovered in the future.

Determining Plant Use

Humans have been growing plants to eat and to feed livestock for centuries. Human survival is dependent on plants. Although there are over 300,000 types of plants, farmers have cultivated certain plants to mass produce because of the characteristics that these plants possess. Early agricultural producers selected plants by trial and error. The selection criteria related to the plant's usefulness as a human or animal food.

Through the use of modern technology and research, scientists are able to determine the nutritional requirements of humans and animals. They can also identify plants that can best supply these nutritional needs. The nutritive value (protein content, carbohydrate content, oil content, etc.) of plant leaves, stems, roots, or seeds and the plant's palatability (pleasing taste) are important factors in determining plant use.

Plants are used for more than human food or animal feed. The use of plant parts (stems, leaves, roots, and seeds) for specific products other than food is another characteristic that determines plant use. New uses for crop plants have been discovered to meet the needs of a changing world. For example, researchers have found that the seed of the jojoba plant contains about 50 percent oil which, after processing, yields a liquid wax. Jojoba wax can serve as a substitute for furniture polishes or extenders for other waxes.

Many plants have been produced for many years. One such plant is the rubber tree, which provides latex that is processed into rubber for tires and other industrial materials. New crops such as canola are growing in popularity. Canola produces a high quality vegetable oil that provides an alternative source of food and industrial products. Agricultural scientists continue to conduct research on plants to identify new and alternative products.

Summary

Plant crops have many uses. Human food, animal feed, oils, pharmaceuticals, sugars, beverages, and fibers are produced through the cultivation of plants with specific characteristics. Because of growing world needs, scientists continue to develop new plant products through the use of research and technology.

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Lesson 3: Plant and Seed Identification

Weeds rob crops of sunlight, nutrients, and water, which are needed for proper growth and development of crops. In order to effectively control crop pests such as weeds, proper and early detection is necessary. Unfortunately, weeds are not easy to identify. The ability to identify weed and crop plants and seeds is necessary to effectively manage crop production.

Seed Identification

Seed identification is important for seed selection and weed control. Some seeds vary greatly, while others are very much alike. The five characteristics used in seed identification are size, shape, color, surface markings, and other botanical characteristics. Table 3.1, "Descriptions of Selected Crop Seeds" and Table 3.2, "Descriptions of Selected Weed Seeds," identify the characteristics of common crop and weed seeds.

Weed Classes

Loss of and damage to crops caused by weeds cost American farmers millions of dollars each year. These losses increase production costs and reduce profit. Weeds also serve as hosts to insects and diseases. The presence of weeds in a field can weaken crop plants, making them more susceptible to diseases.

Weeds can also be harmful to animals and people. Certain weeds can cause severe illness and even death when eaten. Steps have been taken to properly identify and classify weeds that pose health problems. The three classifications of weeds are prohibited, noxious, and common.

Prohibited weeds such as Canadian thistle, field bindweed, and Johnson grass are difficult to control because of their growth, length of life, or abundant seed production. Missouri law prohibits the sale of agricultural crop seed that contains prohibited weed seeds.

Giant foxtail, dodder, and quackgrass are examples of noxious weeds that can be controlled, but with difficulty. The presence of noxious weed seeds in agricultural crop seed is restricted in Missouri.

Common weeds like crabgrass, cocklebur, and chickweed are those weeds that are not classified as prohibited or noxious. These weeds are relatively easy to control but interfere with agricultural production by reducing crop yields and increasing production costs.

Plant Identification

Botanical and agronomic characteristics are used to identify crop and weed plants. There are five main characteristics that can be used to identify crop and weed plants. These characteristics include: 1) leaf shape, 2) stem, 3) flower, 4) root, and 5) other characteristics. Table 3.3, "Descriptions of Selected Crop Plants," and Table 3.4, "Descriptions of Selected Weed Plants," present characteristics of crop and weed plants. Additional information on plant life cycle, plant height, and where the plant is most commonly found may also be helpful in plant identification.

Summary

Identification of crop and weed seeds and plants is important for crop production. Proper identification and control of weeds increase profitability. Some weeds are harmful to animal and human health. Weeds are classified as prohibited, noxious, and common.

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1. RP0089: *Annual Broadleaf Weed Seedling Identification*
2. G04850: *Common Names of Weeds in Missouri Field Crops*
3. G04863: *Pasture Weeds (Perennials)*
4. RP0281: *Weeds of the North Central States*

Glossary of Terms Used in Identification

Auricle: Claw-like appendages at the junction of the leaf blade and leaf sheath of grasses.

Awn: A hair-like projection occurring on the lemma of a seed.

Callus: Enlarged base at end of the lemma.

Culm: Stem.

Hilum: The scar at the point of attachment of a seed to the pod.

Lemma: The husk on the back, dorsal side of the grass seed.

Ligule: Membranous, upright structure located on the collar between leaf blade and leaf sheath of grasses.

Palea: The husk on the front, ventricle side of the grass seed.

Palmately trifoliolate: No distinct petiolule bearing central-terminal leaflet.

Pinnately trifoliolate: Central-terminal leaflet borne on a conspicuous petiolule.

Pubescence: Hairiness of leaves.

Rachilla: A small stem to which a grass seed is attached to the branch or stem.

Rhizome: Underground creeping stem.

Stipule: Leaf-like structure from either side of the leaf base.

Stolon: Above ground, horizontal stem.

Table 3.1 – Descriptions of Selected Crop Seeds (Grain, Forage, Legume, Fiber, and Other)

Seed	Botanical Classification	Agronomic Classification	Life Cycle	Size	Shape	Color	Surface Markings	Other Botanical Characteristics
Corn	monocotyledon	cereal grain, feed, food, oil crop	summer annual	varied	semi-round to elongated flat sided	yellow	pronounced wrinkle or dent on top	
Wheat	monocotyledon	cereal grain, food, feed	winter annual or summer annual	3-10 mm long, 3-5 mm wide	oblong to rounded, or fish-backed	brownish to amber	deep crease with rounded cheeks	brush at pistallate extremity
Oats	monocotyledon	cereal grain	annual, winter annual	8-10 mm long, 1.6-3.2 mm wide	spindle shaped	varies from white to yellow gray and red to black	furrowed on one side	covered with moderately long, fine, silky hairs
Rye	monocotyledon	cereal grain, hay, cover crop	annual, winter annual	6-9 mm long	slightly higher than thick	glaze brown, brownish olive, greenish brown, bluish green or yellow	longitudinally channeled	lemma is broad, keeled, terminally awned
Barley	monocotyledon	cereal grain, food, feed	summer or winter annual	10-12 mm long	narrowly ovoid	creamy white, black, red, purple, or blue	irregularly wrinkled	rachilla is a small, long- or short-haired structure lying within the crease
Rice	monocotyledon	cereal grain	summer annual	3.5-8 mm long, 1.3-2.3 mm thick	shaped like a pelican beak	white	enclosed in light to dark yellow lemma and palea	
Soybean	dicotyledon	cereal grain and oil	summer annual	varied	round to ovoid	straw to buff tan colored	hilum colors from buff to black	hulls are brown to tan with hairy surface
Sudangrass	monocotyledon	forage, hay	annual	6 mm long		light gray		
Pearl Millet	monocotyledon	forage, hay, silage	annual	3-4 mm long, 2.25 mm wide	obovoid	yellowish gray	smooth	embryo has a reddish tinge
Kentucky Bluegrass	monocotyledon	forage	perennial	2 mm long	long, narrow	light gray	lemma, showing numerous veins and nerves	lemma somewhat curved around palea
Rape	dicotyledon	forage	biennial	1 1/2-2 mm across	spheroid to irregularly globase	dark reddish brown to purplish black	small hilum evident	
Red Top	monocotyledon	hay, forage	perennial	1 mm long	ovoid	translucent reddish	rough coat	lemma and palea appear much longer than caryopsis

Table 3.1 – Descriptions of Selected Crop Seeds (Grain, Forage, Legume, Fiber, and Other) continued

Seed	Botanical Classification	Agronomic Classification	Life Cycle	Size	Shape	Color	Surface Markings	Other Botanical Characteristics
Orchard Grass	monocotyledon	forage	perennial	5 mm long	boat shaped	straw colored	finely hairy dorsal nerves	hulls dull with short, curved awn
Reed Canary Grass	monocotyledon	forage	perennial	3 mm long	carrot shaped	olive brown	very shiny	paleas sparsley covered with long hairs
Tall Fescue	monocotyledon	forage	perennial	5 mm long	rounded knobbed rachilla with blunt tip	light gray		light purple tinge on the glumes or chaff
Timothy	monocotyledon	forage	perennial	1 mm long	small plump ovoid	light straw	rough surface	caryopsis light brown
Bromegrass	monocotyledon	forage	perennial	11 mm long	long and thin	brownish	chaffy appearance, strongly veined	light papery appearance
Bermuda Grass	monocotyledon	forage	perennial		boat shaped	straw yellow		sharp pointed at apex
Perennial Ryegrass	monocotyledon	forage	perennial	6 mm long	round, knobbed rachilla with blunt tip	light gray	chaffy appearance	awnless rachilla lies flat against seed with broken appearance
Annual Ryegrass	monocotyledon	forage	perennial	6 mm long	round, knobbed rachilla with blunt tip	light gray	chaffy appearance	awn is present
Red Clover	dicotyledon	legume, forage	perennial	2 mm long	heart shaped and rounded	green-yellow, tan to purple	smooth surface and shiny with notched side	hilum located at the end of the seed
White Clover	dicotyledon	legume, forage	perennial	1.2 mm long	very small, heart shaped	light yellow to tan to brown	smooth surface with notched side	hilum located at the end of the seed
Crimson Clover	dicotyledon	legume, forage	winter annual	2.4 mm long	flat, oval	yellow to yellowish-orange	smooth surface	pinkish red on hilum side
Alsike Clover	dicotyledon	legume, forage	perennial	1.5 mm long	round, heart shaped	greenish black to mixed with yellow	smooth surface	hilum on side
Sweet Clover	dicotyledon	legume, forage	biennial or annual	2 mm long	catcher's mitt, flattened ellipsoidal	yellow sweet = speckled goldened yellow, white sweet = golden yellow	slightly notched or lobed with longitudinal furrow	vanilla-like aroma

Table 3.1 – Descriptions of Selected Crop Seeds (Grain, Forage, Legume, Fiber, and Other) continued

Seed	Botanical Classification	Agronomic Classification	Life Cycle	Size	Shape	Color	Surface Markings	Other Botanical Characteristics
Korean Lespedeza	dicotyledon	legume, forage	summer annual	2 mm long	elm leaf shape	hulless or naked seed is black	prominent veins w/smooth surface	hilum is reddish-brown
Sericea Lespedeza	dicotyledon	legume, forage	perennial	2-2.5 mm long, 1.5 mm wide	ovate	light green to light tan, green flecked with purple or brownish-purple	smooth surface	hilum on side of barely, notched end
Common Lespedeza	dicotyledon	legume, forage	annual	2.2 mm long	ovate	naked seed is black to purple-mottled	smooth surface	long prominent sepals
Alfalfa	dicotyledon	legume, forage	perennial	2.4 mm long	kidney bean shaped	yellow to olive-green	longitudinal furrow not parallel to margin	seed coat <u>not</u> shiny, flat on one side
Birdsfoot Trefoil	dicotyledon	legume, forage	perennial	1 mm long	small, plump, fairly thick, irregularly heart-shaped	dark brown to gun metal	semi-smooth surface	shiny seed coat, hilum on edge or side
Hairy Vetch	dicotyledon	legume forage	annual, winter annual	size of buckshot	round	dark gray to black	rough seed coat	oval shaped hilum
Castorbean	dicotyledon	oil	perennial	10 mm long	large tick-shaped	mottled with gray and brown markings or black variations with white	semi-rough surface	hilum or caruncle prominate at end of seed
Cotton	dicotyledon	fiber, oil, feed, food	perennial (annual)		ovate	dark brown covered with grayish fuzz	tough, leathery hull	pointed at attachment end
Tobacco	dicotyledon	drug crop	summer annual	very tiny (sand grain size)	round	dull brown	rough seed coat	when magnified seed shows definite rippling
Flax	dicotyledon	fiber	summer annual, winter annual in warm climate	3.6-5 mm long	pear-shaped, flat	light brown to yellow-mottled greenish yellow to nearly black	smooth and shiny surface	hilum mainly on small end of seed
Sunflower	dicotyledon	feed, silage, oil	summer annual	6-10 mm long	elongated rhomboid achene	black to gray with white streaks	semi-smooth surface and veined	hairy at tip

Table 3.2 – Descriptions of Selected Weed Seeds (Prohibited, Noxious, Common)

Seed	Agronomic Classification	Life Cycle	Size	Shape	Color	Surface Markings	Other Botanical Characteristics
Canadian Thistle	prohibited	perennial	4.5 mm long	slightly tapered	brown	smooth coated	ridge around blossom end
Field Bindweed	prohibited	perennial	3 mm long	long with 1 rounded and 2 flattened sides	dark brownish-gray	rough coated	very irregular seed
Johnson Grass	prohibited	perennial	3 mm long	oval	reddish-brown	marked with fine lines on surface	awn that is easily broken off
Sorghum Almum	prohibited	perennial	2.7 long	oval	reddish-brown		
Buckhorn Plantain	noxious	perennial	small	boat shaped	brown	shiny and smooth	indentation in the middle of one side, sticky when damp
Curled Dock	noxious	perennial	2-2.5 mm long	triangular, sharp-edged	brown	smooth seed coat	3 heart-shaped bracts with smooth edges
Dodders	noxious	annual	size of white clover	round to pear shaped	brown	roughened seed coat	triangular in cross-section
Giant Foxtail	noxious	annual	1.5 mm long	intermediate between green and yellow foxtail	mostly greenish, straw or dark brown	glossy margins of palea	
Hedge Bindweed	noxious	perennial		obovoid-wedge shape	slate colored to black	dull surface color	1 rounded and 2 flattended sides
Leafy Spurge	noxious	perennial		thick oval	light gray or with brownish spots	smooth surface	often yellowish out growth near point of attachment
Ox-eye Daisy	noxious	perennial	1.5 mm long	oval, usually curved with one side straight and other side convex	black with 8 to 10 white to gray ridges	rough surface (ribbed)	long prominent knob-like scar on top
Perennial Peppergrass	noxious	annual or winter annual	1.5-1.8 mm long	slightly oblong	reddish brown	semi-smooth surface	point of attachment at end
Quackgrass	noxious	perennial	8 mm long	oblong and narrow	yellow-brown		lateral bulge is present on back of lemma
Red or Sheep Sorrel	noxious	perennial	1 mm long	3-sided	reddish-brown	dull, rough surface	
Russian Thistle	noxious	annual		conical shaped	gray to yellowish-brown	spirally ridged	
Wild Carrot	noxious	biennial	2.5 mm long	oblong and flat on one side	grayish-brown	4-heavy, long-bristled ridges	
Wild Garlic and Onion	noxious	perennial	often the size of wheat kernels	garlic = flat on one side and obovoid	black to dark brown		
Yellow Star-Thistle	noxious		1/16-1/8 inch long	1 type has pappus bristles – the other doesn't	one type is pale yellow, the other is dark grayish		

Table 3.2 – Descriptions of Selected Weed Seeds (Prohibited, Noxious, Common) continued

Seed	Agronomic Classification	Life Cycle	Size	Shape	Color	Surface Markings	Other Botanical Characteristics
Hemp	noxious	annual	3 mm long	oval	mottled brown to green	semi-smooth surface	
Barnyard Grass	common	annual	3-4 mm long	oval	tan to brown	longitudinal ridges	awned and awnless
Cheat	common	winter annual, annual	10-15 mm long	oblong and flat with one end wider	tan to brown		large lemma with a long awn
Chickweed	common	winter annual, annual	very small seed	somewhat heart shaped but nearly rounded	dull reddish-brown	roughened by curved rows of minute tubercules	
Cocklebur	common	annual	1.3 mm long	slender with pointed tips	dark brown	ridged surface	
Corn Cockle	common	winter annual	3 mm long	triangular	black	covered with rows of sharp tubercles	
Crabgrass	common	annual	2.4 mm long	small canoe shaped	green to greenish purple	semi-smooth surface	pointed lemma
Dandelion	common	perennial	4.5 mm long	elongated with slender tip	tannish	rough coated and ridged	tip bears a tuft of hairs
Fall Panicum	common	annual	1.5 mm long	oblong but semi-flat	yellow	smooth surface	readily separated from hull when ripe
Foxtail (green)	common	annual	1.5-2 mm long	ovate to narrowly ovate	dark blotched upon a ight straw background	longitudinally striate or weakly cross-wrinkled	
Foxtail (yellow)	common	annual	1.5-2 mm long	broadly oval	mostly yellowish but some dark brown	lemma, coarsely wrinkled	
Horse-nettle	common	perennial	1.5 mm long	obovate	glossy yellow to orange	faintly roughened by low curving ridges	
Jimson Weed	common	annual		kidney shaped flattened	dark brown to black	irregular and pitted	
Lamb's Quarters	common	annual	1.5 mm long	disk-shaped	black	small niche in the edge	may be enclosed by a grayish hull
Milkweed (climbing)	common	perennial		flattened, oval	brown	rough coat	tuft of silky, white hairs at tip
Milkweed (common)	common	perennial		flat, oval	brown	rough coat	tuft of silky, white hairs at tip

Table 3.2 – Descriptions of Selected Weed Seeds (Prohibited, Noxious, Common) continued

Seed	Agronomic Classification	Life Cycle	Size	Shape	Color	Surface Markings	Other Botanical Characteristics
Morning-glory	common	annuals and perennials	various sizes	round with 2 flattened sides or round, flattened and fringed with hairs	dark gray or black		
Musk Thistle	common	biennial	4.5 mm long	long, curved	glossy yellowish-brown	rough and ridged	
Mustard (wild)	common	annual, winter annual	1.5 mm long	round	black, bluish or brown	smooth and hard surface	
Nutgrass (Yellow Nutsedge)	common	perennial	1.6 mm long	3 angled-small with blunt ends	yellowish-brown		
Plantain (bracted)	common	annual, winter annual	3 mm long	boat shaped with groove across oval side of seed	dull light brown	2 white scars in indentation on inner surface	
Pigweed (smooth)	common	annual	1.0-1.2 mm long	ovate, lens shaped and notched at narrow end	shiny black		
Ragweed (giant)	common	annual	.6-1.3 cm long	shaped like long kings crown with 5 to 10 spikes at top	gray to brown	rough surface	
Shepard's Purse	common	annual, winter annual	1 mm long	small and oblong	yellowish	distinct longi-tudinal furrows on each side	
Smartweed, Pennsylvania	common	annual	3 mm long	circular flat at least one surface concave	reddish-brown to black		usually stays in husk
Spiny Sida (prickly sida)	common	annual	1.6 mm long	3 angled egg-shaped	dull dark reddish-brown	rough odd shaped	
Velvet Leaf	common	annual	3 mm long	flattened notched	grayish-brown	rough surface	
Wild Buckwheat	common	annual	3 mm long	3-sided	black to brown		often covered with a rough dull brown hull

Table 3.3 – Descriptions of Selected Crop Plants (Grain, Forage, Legume, Fiber)

Plant	Botanical Classification	Agronomic Classification	Life Cycle	Plant Height	Leaves	Stem (culm)	Flower (inflorescence)	Root
Corn	monocotyledon	feed, food, oil crop	summer annual	varies depending on variety grown	thin, flat, expanded blade with a midrib and smaller veins with pronounced ligules	alternating nodes and internodes average 100 inches in length and 1 1/4 inches in diameter	functional staminate flowers in the tassle, functional pistallate flower in the silks	seminal and adventitious
Wheat	monocotyledon	cereal grain, food, feed	winter annual or summer annual	range from 1-4 feet in height depending on cultivar	composed of sheath, blade, ligule and auricle	culm – hollow jointed cylinder constituting 3-6 nodes and internodes	spike type, typically a single spikelet per node, 3-4 florets per spikelet	seminal and coronal, tillers are common
Oats	monocotyledon	cereal grain	annual, winter annual	range slightly less than 2 feet to 5 feet depending on cultivar	solitary sessile leaves in two ranks	culm-series of nodes and internodes that alternate solitary sessile leaves	panicle consists of a main axis terminating in a single multiflorous spikelet	fibrous, seedling and permanent
Rye	monocotyledon	cereal grain, hay, cover crop	annual, winter annual	typically more than 5 feet tall, some up to 6 feet tall	coarser and more bluish in color than those of wheat	larger and longer than those of wheat	spike type inflores-cence like wheat except with 3 florets per spikelet	seminal and coronal with some tillers
Barley	monocotyledon	cereal grain, food, feed	summer or winter annual	range from 1-4 feet depending on cultivar	presence of large auricles and absence of prominent ligule	culm is hollow jointed cylinder	spike type like wheat with 3 spikelets per rachis node with single florets	seminal and coronal, tillers are common
Rice	monocotyledon	cereal grain	summer annual	2-6 feet tall	long, thin, narrow, coarse, and ribbed	erect culms that are hollow and consist of nodes that vary in number	loose, freely branched, panicle-type inflores-cence, each floret has six stamens and two, long styles	shallow root system, tillers under poor growing conditions
Soybean	dicotyledon	cereal grain, oil, forage	summer annual	2-4 feet tall	trifoliate and pubescent	erect, very bushy and branched	small purple and white borne in axillary racemes	taproot with branches
Sudangrass	monocotyledon	forage, hay	annual	3-5 feet when broadcast, 6-8 feet when grown in rows	soft with numerous open penicles	slender		numerous tillers, rarely any branches and no rootstocks
Pearl Millet	monocotyledon	forage, hay, silage	annual	2-5 m	long, pointed, with finely serrated margins	pithy, erect	thick, cylindrical spikes, 20-50 cm long and 2-4 cm in diameter	free tillering from axillary meristems

Table 3.3 – Descriptions of Selected Crop Plants (Grain, Forage, Legume, Fiber) continued

Plant	Botanical Classification	Agronomic Classification	Life Cycle	Plant Height	Leaves	Stem (culm)	Flower (inflorescence)	Root
Kentucky Bluegrass	monocotyledon	forage	perennial	varied height depending on use	green and V shaped in cross sections	fine and cylindrical	spreading panicles	creeping underground stems, rhizomes
Rape	dicotyledon	forage	biennial	2-2 1/2 feet tall	mostly glabrous; basel leaves 4-12 inches long	much branching from an erect pithy stem	elongated raceme; light yellow flower 1/4-3/4 inch across	branched taproot
Red Top	monocotyledon	hay, forage	perennial	attain 1 m	flat, sharp pointed with ligules that are .6 cm long and pointed	creeping but mostly upright	panicles are reddish and loosely pyramidal in shape	shallow root stocks, vigorous, 2-6 inches long
Orchard Grass	monocotyledon	forage	perennial	60 cm-2 m	flattened and strongly keeled; ligule membraneous and 3-10 mm long; no auricles	flowering culms that bear few basal leaves	spikelets bear 2-5 florets	fibrous root system but deep tillers are produced
Reed Canary Grass	monocotyledon	forage	perennial	60-240 cm	flattened with sharp point	tall, stout and leafy	semi-dense spikelet panicles of 5-20 cm	has short, scaly rhizomes
Tall Fescue	monocotyledon	forage	perennial	2 feet	numerous shiny, dark green, ribbed, ciliated auricles and collars	erect, stout, smooth	branched panicle head 10-35 cm long	may or may not have short rhizomes, massive root system fibrous
Timothy	monocotyledon	forage	perennial	80-110 cm	flat, elongated	erect culms	dense, cylindrical spikelet inflorescence one flowered	many tillers, shallow but fibrous
Brome-grass	monocotyledon	forage	perennial	5 feet	long, flat with center rib	many erect, stout culms	numerous spikelets, florescence are made up of 5-10 florets	extensive fibrous system
Bermuda Grass	monocotyledon	forage	perennial	mainly a creeping pattern can grow up to 6-12 inches	smooth to slightly hairy, and fairly coarse, ligule is a circle of white hairs	very leafy, short internodes	erect panicles with 5 spikelets	adventitious roots with rhizomes and stolens
Perennial Ryegrass	monocotyledon	forage	perennial	90 cm	ligules up to 2.5 mm long; may or may not have auricles	erect or spreading	straight or slightly curved spikes up to 30 cm, contain 5-40 spikelets	fibrous

Table 3.3 – Descriptions of Selected Crop Plants (Grain, Forage, Legume, Fiber) continued

Plant	Botanical Classification	Agronomic Classification	Life Cycle	Plant Height	Leaves	Stem (culm)	Flower (inflorescence)	Root
Annual Ryegrass	monocotyledon	forage	perennial	120 cm	leaf sheaths are glabrous, ligules up to 4 mm long auricles usually present	erect or spreading	straight or curved up to 30 cm in length, each spike up to 40 spikelets	fibrous
Red Clover	dicotyledon	legume, forage	perennial	30-90 cm	usually 3 oblong leaflets, generally hairy	numerous leafy, rising from crown	flowers on heads (compact clusters), heads usually consist of 125 rose-colored flowers	taproot system with many secondary branches
White Clover	dicotyledon	legume, forage	perennial	30-90 cm	long-petioled, trifoliate usually marked with white V	fleshy stem with short internodes	usually white, occa-sionally pinkish on an almost globose head	has stolons with a primary root with adventitious roots
Crimson Clover	dicotyledon	legume, forage	winter annual	30-90 cm	3 leaflets broadly obovate at tip, narrow at base and hairy	fleshy, stout stems with short inter-nodes	bright crimson red color, conical flower head	central taproot with many fibrous roots
Alsike Clover	dicotyledon	legume, forage	perennial	under favorable conditions 2.5-5 feet	3 leaflets on a main axis	smooth, leaf, erect	vary from white to almost rose	tap root and secondary roots
Sweet Clover	dicotyledon	legume, forage	biennial or annual	may reach 2.8 m	trifoliate leaves that are toothed around margins	erect stems that vary from 3-6 feet tall	yellow or white flowers	deep tap root
Korean Lespedeza	dicotyledon	legume, forage	summer annual	30 inches	larger, coarser with prominent stipules	hairy	born in clusters at tips of branches (petalous)	extensive but relatively shallow
Sericea Lespedeza	dicotyledon	legume, forage	perennial	.5-1 m	long and narrow, indented at end	coarse, hard stems, hairy	purple or yellow petalous and apetalous	deep taproot
Common Lespedeza	dicotyledon	legume, forage	annual	4-30 inches	narrow leaflets, small stipules	upright with numerous nodes, hairy	small purple	taproot
Alfalfa	dicotyledon	legume, forage	perennial	60-90 cm	pinnately trifoli-olate, alternately on stem	short, that produce other leafy branches	purple or yellow depending on cultivar	creeping rooted and taproot with branches

Table 3.3 – Descriptions of Selected Crop Plants (Grain, Forage, Legume, Fiber) continued

Plant	Botanical Classification	Agronomic Classification	Life Cycle	Plant Height	Leaves	Stem (culm)	Flower (inflorescence)	Root
Birdsfoot Trefoil	dicotyledon	legume, forage	perennial	60-90 cm	compound leaves, alternately attached five leaflets	numerous, fine stems 12-30 inches in height	typical umbrel with 4-8 florets dark yellow to orange	deep taproot that is branched
Hairy Vetch	dicotyledon	legume, forage	annual, winter annual	60-180 cm	pinnate leaflets which have tendrils	stout	white or purple in clusters or raceme	taproot
Castor-bean	dicotyledon	oil	annual or perennial depending on climate grown	3-12 feet for commercial type		coarse	racemes bearing female on upper and male on lower	taproot system with lateral roots
Cotton	dicotyledon	fiber, oil, feed, food	annual in tropics, or short lived perennial	2-5 feet	large, hairy, simple with 3-5 lobes borne on petioles with stipules, palmately veined	woody, stout stems with alter-nate branching	alternate sides of fruiting branch com-plete and perfect, 5 large sepals, 5 petals	deep taproot and widely branching secondary system
Tobacco	dicotyledon	drug crop	summer annual	vary from 4-6 feet	simple, alternate leaves up to 2 feet long and 1 foot wide covered with sticky hairs	erect, stout yet fleshy that termi-nates in a raceme type inflorescence	complete and perfect, calyx of 5 sepals, coralla of 5 petals fused into a floral tube usually pink	generally shallow branched system 2-3 feet depth
Flax	dicotyledon	fiber	summer annual, in warm climates winter annual	ranges 1-4 feet	short, narrow alternate on stem and are sessile	narrow and branch trim the base	white or blue com-plete and perfect, 5 sepals, 5 petals, 5 stamens	poorly branched taproot, 2 feet depth
Sunflower	dicotyledon	feed, silage, oil	summer annual	5-20 feet in height	alternate, ovate	stout, erect, simple, 1-3 inch diameter	6-12 inch diameter, 40-80 golden petals surrounding a brown to nearly black disk	fibrous and branching system

Table 3.4 – Descriptions of Selected Weed Plants (Prohibited, Noxious, Common)

Weed Plant	Classification	Life Cycle	Plant Height	Leaves	Stem	Flower	Root	Found
Canadian Thistle	prohibited	perennial	2-5 feet	crinkled edges and spiny margins	grooved, slightly hairy	male and female on different plants, usually numerous and compact, 1.9 cm or less diameter	extend several feet down and horizontally	in all crops
Field Bindweed	prohibited	perennial	2-7 feet	ovate with spreading basal lobes	smooth, slender, twining or spreading over ground	white or pink, funnel-shaped 2.5 cm across, single in the axis of the leaves	extensive down 20-30 feet	in and able to spread in all noncultivated areas and under most cropping systems
Johnson Grass	prohibited	perennial	1.5-6 feet	alternate, simple, smooth, 6-20 inches long, 1/2-1 1/2 inches wide	erect, stout	panicles – large, purplish, hairy	freely branching, fibrous, rhizomes, stout, creeping	especially on rich soil, corn, soybeans
Sorghum Almum	prohibited	perennial						
Buckhorn Plantain	noxious	perennial	4-12 inches	ground level in a basal rosette, hairy 2-10 inches long, 1/4-1 inch wide, 3-5 prominate lengthwise veins	erect, leafless, 4-12 inches long, terminating with flower spike	numerous, petals in short cylindrical spikes at ends of stem	mostly fibrous	lawns, meadows, pastures, waste places
Curled Dock	noxious	perennial	1-4 feet	alternate mostly basal, smooth, 6-12 inches long lanceolae with wavy curled edges, short petiole	smooth, erect, single or in groups from root crown	dense clusters on branches at tip of stem without petals, small, greenish to reddish brown	large yellow, somewhat taproot	pastures, roadsides, new hay fields
Dodders	noxious	annual	vine like, para-sitic, twining around other plants	absent or reduced to small bracts	stringlike, smooth, yellow or orange, branching extensively	numerous, small white, 5 lobes in clusters	small fibrous system	in clovers, alfalfa, and lespedeza
Giant Foxtail	noxious	annual	3-7 feet	covered with short hairs on upper surface	tall, weak	panicle, dense, 3-8 inches, 3-6 bristles per spikelet	fibrous, branching	in cultivated crops
Hedge Bindweed	noxious	perennial	vine like plant that twines round other plants	large, alternate, usually sharp pointed at tip	smooth, 3-10 feet long twining or trailing on ground	large, 1 1/2-2 inches across, white or pinkish	extensive but relatively shallow	in cultivated fields, fence rows, and waste areas

Table 3.4 – Descriptions of Selected Weed Plants (Prohibited, Noxious, Common) continued

Weed Plant	Classification	Life Cycle	Plant Height	Leaves	Stem	Flower	Root	Found
Leafy Spurge	noxious	perennial	1-2 feet	alternate on stems narrowly strap shaped, 1/4 inch wide, usually drooping	erect, smoothly branched at top with milky juice	small, greenish-yellow, petals fused into cup-like structure heart-like floral bracts	deep, woody, spreading	in pastures, waste areas, along roadsides in cultivated fields
Ox-eye Daisy	noxious	perennial	1-3 feet	alternate, simple, usually conspicuously lobed, near plant base	smooth, seldom branched	occuring singly at the ends of the stems 1-2 inches diameter; ray flowers – white; disk flowers – yellow	fibrous	in old pastures, especially those low in fertility
Perennial Peppergrass	noxious	annual or winter annual	6-24 inches	alternate, covered with soft hair, arrow shaped	hoary-pubescent or rarely, hairless	white or greenish, 4 petals in rather dense racemes at plant top	short, straight, taproot	in winter wheat, first year meadows, and waste land
Quackgrass	noxious	perennial	1 1/2-3 feet	have auricles, ligule 1/32 inch long, hairy lower sheaths, upper smooth	smooth culms and 3-6 joints	3-7 short-awned florets in a spikelet	extensive rhizomes	in pastures, and open waste lands, most cropped area
Red or Sheep Sorrell	noxious	perennial	6-18 inches	arrow-shaped 1-3 inches long, thick, smooth, acid to taste	slender, upright, branched at top	yellow to red on raceme near plant top, male and female on different plants	extensive but rather shallow	in pastures, meadows, sometimes lawns
Russian Thistle	noxious	annual	1-3 feet	cylindrical or awl-shaped, young are soft; later leaves are short, stiff, prickle pointed	young plant – soft and succulant, mature plant – stiff and woody	numerous, small, without petals, axillary on upper branches	taproot	in spring grain and legume seedings
Wild Carrot	noxious	biennial	1-3 feet	alternate, finely pinnnately divided, hairy – smells like carrots	erect, hairy, stout and branched at top	small, with 5 white petals in umbrels at branch ends	fleshy taproot	in meadows, pastures, road-sides, not in cultivated fields
Wild Garlic	noxious	perennial	1-3 feet	slender, hollow, nearly round attached to lower stem	tall, smooth, waxy	greenish-white, small on short stems above aerial bublets	fibrous from bulb	in grain fields, pastures
Wild Onion	noxious	perennial	1-2 feet	flat not hollow at base of plant stem	tall, smooth	clusters of small flowers	fibrous from bulb	in grain fields, pastures
Yellow Star-Thistle	noxious							

Table 3.4 – Descriptions of Selected Weed Plants (Prohibited, Noxious, Common) continued

Weed Plant	Classification	Life Cycle	Plant Height	Leaves	Stem	Flower	Root	Found
Hemp	noxious	annual	2-10 feet	palmately divided, 5-9 hairy leaflets with notched edges	coarse, somewhat grooved, rough, and hairy	male and female on separate plants	branched taproot	along ditches, fences, road-sides, waste land
Barnyard Grass	common	annual	1-4 feet	both sheath and blades, smooth, light green, 3/8-5/8 inch wide	thick, coarse, mostly erect, smooth branches	panicle bearing several compact side branches green or purplish color	fibrous but shallow	in most cropped areas
Cheat	common	winter annual, annual	12-24 inches	smooth and slightly hairy	erect with few internodes	panicle spikelets on shorter upright stalks	branching and fibrous	grain fields, meadows and waste land
Chickweed	common	winter annual, annual	4-12 inches	small, opposite, simple, broadly ovate, pointed tips, smooth; petioles have hair on one side	branched, creeping	small white 5 deeply notched petals	flibrous and shallow	lawns, gardens, alfalfa
Cocklebur	common	annual	2-4 feet	alternate, simple, triangular	erect, normally bushy	separate, small male and female together in clusters	taproot, woody, stout	cultivated land, poor pastures
Corn Cockle	common	winter annual	2-3 feet	opposite, slender, hairy joined at base	rough, hairy, erect, swollen at joints	large, purple with narrow, green sepals	taproot, shallow	cultivated land
Crabgrass	common	annual	up to 3 feet long	somewhat hairy 1/4-1/3 inch wide with leaf sheaths	stout, smooth, rooting at joints	3-10 segments in whorls at top of stem	spreading, fibrous	lawns, gardens, fields
Dandelion	common	perennial	6-8 inches	simple, variously lobed, 3-10 inches long, milky juice	never elongates but produces a rosette of leaves	1-2 inches in diameter of yellow ray flowers	thick, fleshy with branches	lawns, meadows, gardens
Fall Panicum	common	annual	20-50 inches	smooth, hairy, sheaths heavy short, loose, often purplish	smooth, spreading, often partly, flat on the ground lower nodes swollen	panicle compact spikelets	fibrous roots	in gardens, cultivated fields
Foxtail (green)	common	annual	1-3 feet	hairless	erect	dense 1-3 inches long erect near tip	fibrous roots	all places except woods
Foxtail (yellow)	common	annual	1-2 feet	flat, often with spiral twist, long hairs on upper	erect	dense, erect, spikelets, 5 or more bristles	fibrous roots	all places except woods
Horse-nettle	common	perennial	1-4 feet	alternate, oblong, wavy edged and prickly	simple branched, hairy and prickly	white or bluish, 5-lobed, 1 inch across in clusters	creeping rootstocks	fields, gardens, sandy soils

Table 3.4 – Descriptions of Selected Weed Plants (Prohibited, Noxious, Common) continued

Weed Plant	Classification	Life Cycle	Plant Height	Leaves	Stem	Flower	Root	Found
Jimson Weed	common	annual	2-4 feet	alternate, large, coarse, smooth, ovate, toothed edges, rank odor	smooth, thick, erect, branching	large funnel-shaped white to pinkish 2-5 inches long, egg shaped	thick, shallow, branched	in cultivated crops, old feedlots
Lamb's Quarters	common	annual	3-4 feet	alternate 1-3 inches long, smooth, white, mealy-coated	tall, smooth, grooved, often red, green striating	small, green, without petals at branch ends in axils of leaves	short, branched taproot	in cultivated crops
Milkweed (climbing)	common	perennial	climbing, length varies	smooth, heart shaped pointed, long petioles in pairs at nodes	smooth, slender, twining, without milky juice	small, whitish clusters on stalks from the axils of the leaves	spreading root system	fence rows cultivated fields
Milkweed (common)	common	perennial	2-5 feet	opposite, oblong, rounded, 4-8 inches long prominent veins	stout, erect, covered with short hairs, with milky juice	sweet-smelling pink to white, ball-like clusters at stem tips	thick root stock	pastures, cultivated fields
Morning-glory	common	annuals and perennials	twining plant 2-10 feet long	alternate, heart shaped, 2-6 inches long, smooth with long petioles	trailing, twining, woody	funnel shaped 2-3 inches diameter, white with dark purple center	yellowish white, enlarging greatly	cultivated fields, fences, roadsides
Musk Thistle	common	biennial	3-6 feet	alternate, coarsely toothed	erect spiny wings lower portion branched	heads as much as 2 inches across, drooping, purple to lavender	large thick root stock	pastures, meadows, roadsides
Mustard (wild)	common	annual, winter annual	2-3 feet	lower are irregular lobed, toothed with petioles and bristly hairs	erect, branched, near top bristly hairs	4 yellow petals in clusters at branch ends	branching fibrous	grain fields
Nutgrass (Yellow Nutsedge)	common	perennial	1-2 feet	3-ranked, narrow, grasslike, basal	erect, triangular, yellow-green	yellowish-brown, small narrow spikelets on umbrel-like florescence	fibrous	pastures, cultivated fields
Plantain (bracted)	common	annual, winter annual	6-18 inches	long, loose, hairy, basal	erect, simple, leafless, hairy, terminating in flower spike	numerous, petals in axils of long bracts in spikes	thick root with small branches	meadows, pastures
Pigweed (smooth)	common	annual	up to 8 feet	dull green, 6 inches, ovate to lanceolate	branching freely if not crowded	green, small, slender, panicle like spikes	taproot	cultivated fields, yards, fence rows
Ragweed (common)	common	annual	1-4 feet	nearly smooth, deeply cut into a number of lobes, alternate	rough, hairy, branched	two kinds: male 1-pollen producing, 2-seed producing	shallow rooted	old pastures, roadsides

Table 3.4 – Descriptions of Selected Weed Plants (Prohibited, Noxious, Common) continued

Weed Plant	Classification	Life Cycle	Plant Height	Leaves	Stem	Flower	Root	Found
Shepard's Purse	common	annual, winter annual	1-1 1/2 feet tall	in rosette at base; coarsely lobed	erect covered with gray hairs	small, white, 4 petaled	branched taproot	non-cultivated areas
Smartweed, Pennsylvania	common	annual	1-4 feet	smooth, pointed, alternate 2-6 inches long	smooth, swollen at nodes	bright pink or rose, 5 parted in a short spike	thick branched root	cultivated ground
Spiny Sida (prickly sida)	common	annual	1-2 feet	alternate, simple, oblong, toothed edges	erect, branching, hairy	5 pale-yellow petals, solitary or clustered in axils of leaves	taproot slender, branching	cultivated fields, gardens
Velvet Leaf	common	annual	6-8 feet	large, heart shaped, altenate, petioled, hairy, velvety	smooth, covered with short velvety hairs	3/4 inch diameter, 5 yellow petals	taproot well developed	in soybeans and corn fields
Wild Buckwheat	common	annual	vine-like varying length	alternate, heart shaped, pointed with smooth edges	smooth, slender, branched at base	small, greenish-white clusters in leaf axis	taproot and branched	non-cultivated areas and cropping areas

Lesson 4: Certified Seed and Variety Selection

Quality crops begin with quality seed. This may sound like a simple statement, but it is not. The process of providing quality seed involves an entire area of agricultural expertise in agricultural research. Agricultural researchers have devoted considerable time and effort to provide dependable, quality seed to farmers. This seed is known as certified seed. This lesson will discuss the characteristics of certified seed, the classes of seed certification, benefits of using certified seed, and factors to consider when selecting a crop variety.

Quality Seed Characteristics

Careful consideration should be given to selecting crop seed. Quality crops possess specific characteristics as do quality seed. Using quality seed improves crop yields an estimated 10 to 20 percent over crops produced from poor seed.

When purchasing seed, farmers should select seed from a good variety. A good variety would be one that has the reputation of producing a quality crop. Good germination is another desirable characteristic. Seeds that fail to germinate are worthless. Other characteristics of quality seed are proper size and development; uniformity in size and shape; absence of seed-borne diseases and insects; absence of prohibited, noxious, and other weed seeds; absence of mixtures with other crop seeds and other varieties; and absence of inert materials.

Seed Certification

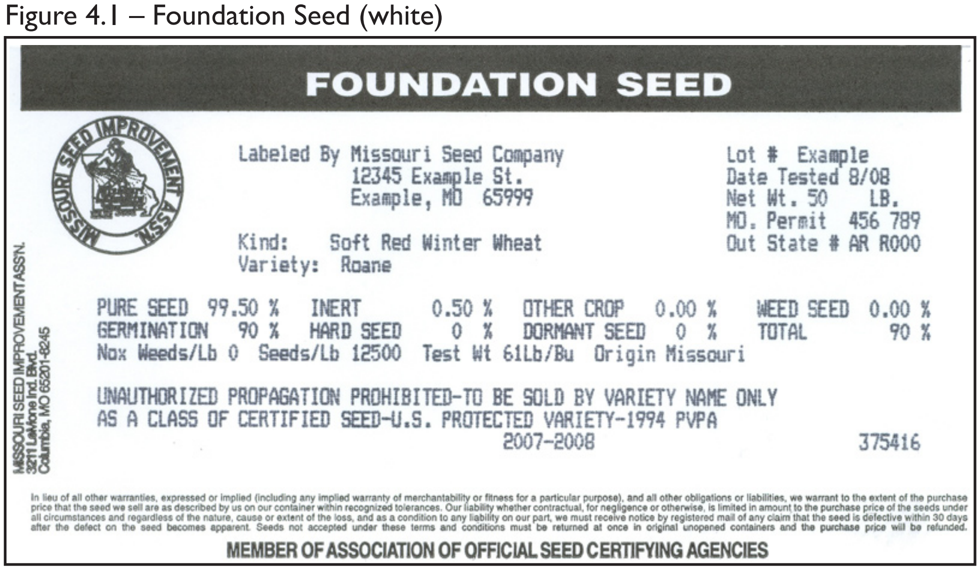
The main objective of seed certification is to monitor the seed production process to ensure that genetic purity is maintained. Agencies that certify seed work with agricultural experiment stations, agronomists, and experienced growers under strict guidelines to produce pure seed varieties.

Certification programs have four classes of seed: breeder seed, foundation seed, registered seed, and certified seed. For seed to be certified, specific criteria must be met. Criteria for certified seed are: 1) the seed must be grown from registered or certified seed stock; 2) the crops produced must pass an inspection for mixtures, weeds, and diseases in the field; and 3) the harvested crop must attain the standard of perfection set by the seed association.

Each seed class must meet specific requirements for certification. Breeder seed is controlled by the originating plant breeder. Breeder seed is used in the production of foundation seed. Although breeder seed does not require identification tags or labels, foundation seed, registered seed, and certified seed do require labels or tags. Only small quantities of breeder seed are produced by commercial seed companies.

Foundation seed is owned and supervised by the original plant breeder (usually an agricultural experiment station). Foundation seed is the parent line for registered and/or certified classes of seed. Foundation seed requires a white identification tag or label. See Figure 4.1.

Figure 4.1 – Foundation Seed (white)



Registered seed is produced from foundation seed that meets genetic purity and identity guidelines. Registered seed is tagged with a purple identification tag or label. See Figure 4.2. Registered seed may be used to produce certified seed or sold directly to farmers.

Certified seed is produced from foundation or registered seed that meets genetic identity and purity guidelines. Certified seed is tagged with a blue identification tag or label. See Figure 4.3.

The steps in the production of certified seed are diagrammed in Figure 4.4. The arrows indicate where the seed is used. For example, registered seed can be sold for the production of certified seed or for the production of field crops by farmers.

Many states produce seed to be exported to other countries. The Organization for Economic Cooperation and Development (O.E.C.D.) has set forth specific minimum requirements that must be met by the seed producers

Figure 4.2 – Registered Seed (purple)

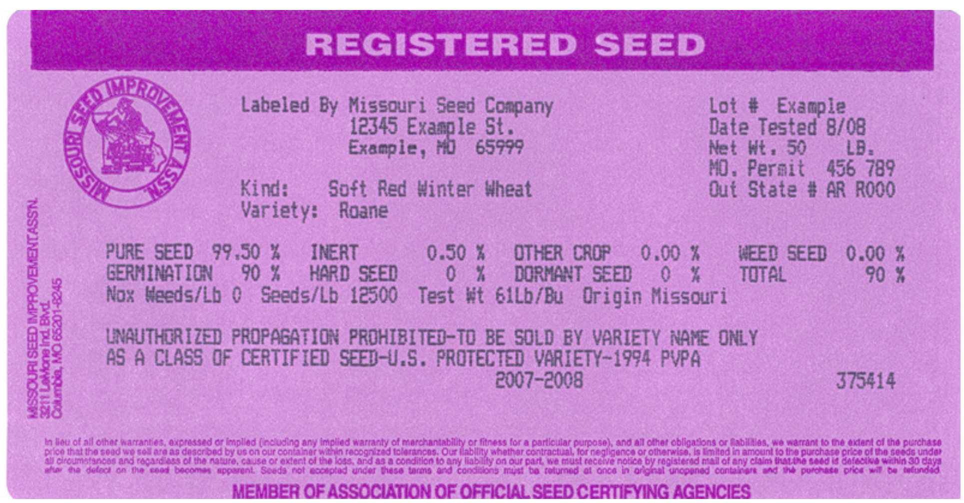


Figure 4.3 – Certified Seed (blue)

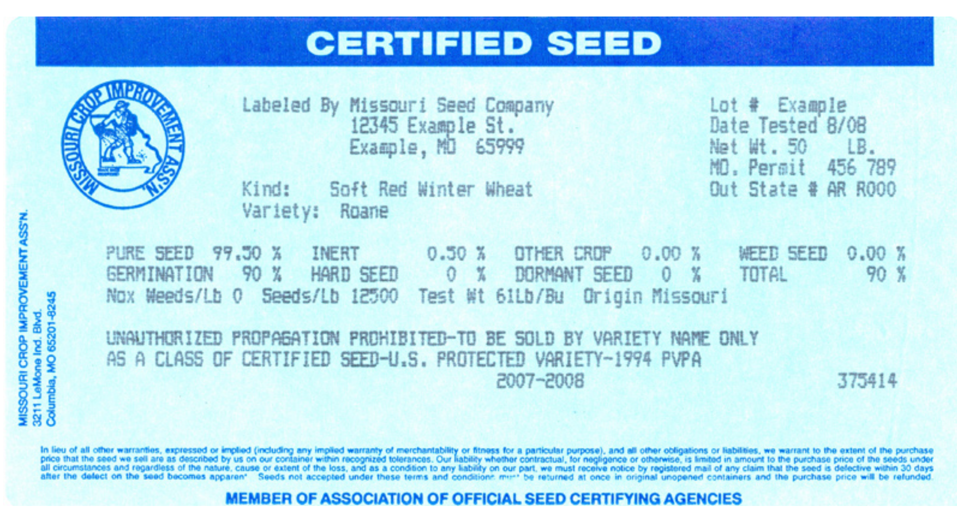
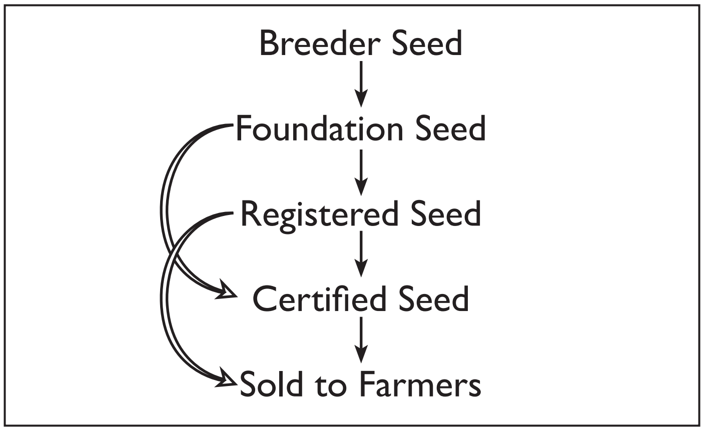


Figure 4.4 – Steps in the Production of Certified Seed



in order to be tagged with an O.E.C.D. tag. The Missouri Seed Improvement Association working with the Missouri Agricultural Experiment Station and the United States Department of Agriculture, Agricultural Research Service, provides the needed information to Missouri seed producers for this certification.

Missouri seed producers presently export seed to Argentina, France, Greece, Italy, Mexico, Portugal, Spain, and Turkey. The tags that are placed on approved seed are black and blue in color with the specific information listed on the tag. See Figure 4.5.

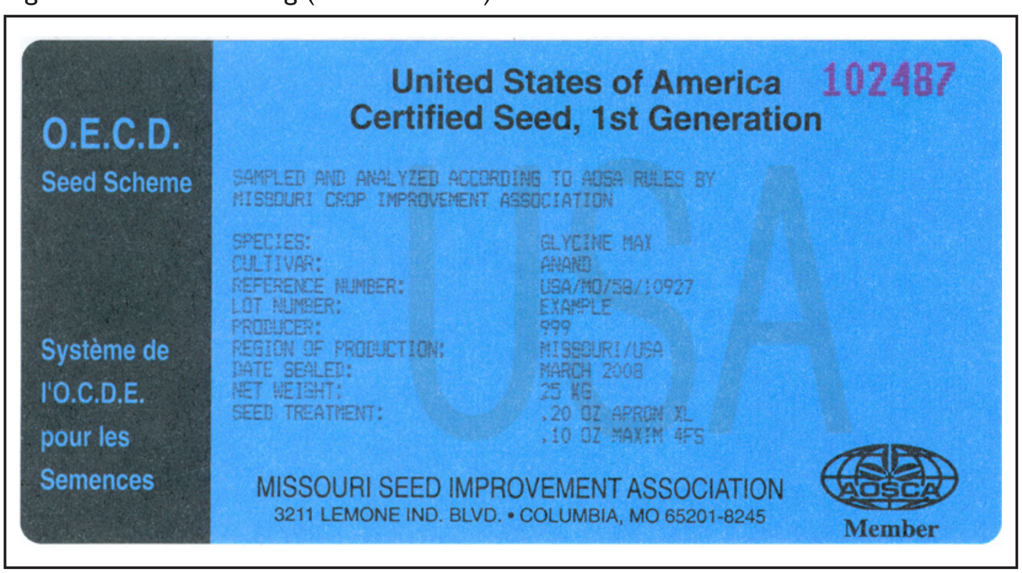
Requirements for Seed Certification

Three requirements must be met before seed can be sold to farmers as "certified" seed. First, the seed must be grown from foundation or registered seed stock. Second, the growing and harvested crop must pass an inspection for mixtures, weeds, and diseases. Lastly, the harvested crop of seed must attain the standard of quality set by the seed association. Seed which fails to meet any of the three requirements cannot be sold as "certified" seed in the state.

Benefits of Certified Seed

Farmers have found that the use of certified seed provides specific benefits. Farmers use certified seed because it is guaranteed to be the variety it is advertised to be. Certified seed guarantees no unexpected varieties. The minimum germination rate is guaranteed as listed on the tag. Therefore, the buyer is assured of the viability of the seed that is purchased. Using certified seed guarantees a high quality seed that is free of weed seeds, disease organisms, and insects. However, the cost of certified seed is often more than uncertified seed.

Figure 4.5 – O.E.C.D. Tag (black and blue)



Crop Variety Selection

Many factors should be considered in selecting a crop variety. The environment is one very important factor. Environmental factors such as growing season length, annual precipitation, and the soil type affect the growth and development of crops. Unfortunately, most environmental factors cannot be controlled.

Seed selection should consider cost of varieties and adaptability to local growing conditions.

When selecting seed, it is helpful to know the characteristics of a crop variety. Certified seed provides this information to the buyer. When selecting a crop variety, consideration should be given to the adaptability of the variety. The ability of the variety to adapt to local soil and environmental conditions is vital.

Another important consideration is the yield potential. Matching the variety with the local growing conditions will help to ensure the crop meets its yield potential. Other considerations are purity of the variety, quality of the crop (e.g., protein content and resistance to lodging), disease and insect resistance, and the crop's maturity date.

Summary

Quality seed should be used to produce a quality crop. Using certified seed assures the purchaser of certain quality and purity standards. Selecting varieties according to the cost, adaptability, yield potential, purity, crop quality, and disease and insect resistance is important. Farmers can reduce risk and produce quality crops through the use of certified seed.

Credits

Chapman, S.R.; L.P. Carter. *Crop Production: Principles and Practices*. San Francisco, CA: W.H. Freeman and Co., 1976.

Missouri Handbook of Seed Certification Standards. The Missouri Seed Improvement Association, n.d.

Lesson 5: Stand Establishment

Producers are interested in receiving the maximum profit from their crops. In order to receive maximum profits, the producer needs to use methods or techniques that will help in establishing a good stand and enhance the crop's yield potential. Establishing a good stand is vital. In this lesson, the purpose of tillage, tillage methods, environmental effects, seeding methods, seeding depth, nutrients needed for stand establishment, and factors that affect seeding rates will be discussed.

Tillage

Tillage (cultivating land) is important in the establishment of a crop stand. Generally, there are three main purposes for tillage: to prepare a suitable seedbed, to eliminate competition from weeds, and to improve the physical condition of the soil. Preparing a suitable seedbed refers to the care taken by the producer to prepare the soil to ensure adequate moisture for germination at the appropriate seeding depth. A suitable seedbed should also maximize the soil contact with the seed for water absorption. Eliminating competition from weeds involves the removal of unwanted plants that would compete for the needed nutrients. The soil's physical condition refers to the soil moisture content, aeration, rate of water infiltration, internal drainage, and water holding capacity. The ideal seedbed would provide the optimum environment so that the seed has the best chance to germinate.

Tillage and the Environment

Soil is a precious natural resource. Since there is a limited supply of soil, alternative growing methods are being researched. One method that is used for small-scale production is hydroponics. Hydroponics is growing plants without soil; their essential nutrients are supplied by liquid fertilizers. However, it would be impossible to produce thousands of acres of crops without soil. Therefore, measures must be taken to protect the soil. Soil erosion by wind and water removes an average of 1.6 billion tons of top soil annually from U.S. farm land. This eroded soil runs off into rivers, lakes, and reservoirs where it contaminates these water sources.

There is a growing concern about the effect of certain tillage methods on the environment. Modern technology and equipment enable farmers to use soil-conserving tillage methods. The traditional tillage method that has been used for many years is known as conventional tillage. Conventional tillage involves the use of a moldboard plow, disk, and harrow to prepare the soil. Conventional tillage leaves the soil surface smooth and relatively free of crop residue. It also requires more trips across the field. This method leaves the soil surface exposed and highly vulnerable to water and wind erosion. Farmers are using more soil-conserving methods of tillage rather than the conventional method.

Minimum tillage is considered a type of conservation tillage. Minimum tillage involves the use of a chisel plow, disk, or other implements (equipment). Minimum tillage maintains crop residues and surface roughness, while still providing adequate weed control and seedbed preparation. Minimum tillage increases soil-to-seed contact while decreasing soil erosion.

No-till is another method of conservation tillage. No-till systems leave all crop residue on the soil surface. The no-till methods involve planting seeds directly into the previous crop's residue without exposing the soil. With no-till, good management is important to ensure control of insects and diseases from the previous crop. No-till nearly eliminates soil erosion because all crop residue is left on the soil surface.

Seeding

Once the seedbed is prepared, the field is ready for planting. Seeding methods commonly used are row, drill, and broadcast. When using the row method, seeds are evenly spaced in parallel rows. Corn, potatoes, cotton, tobacco, soybeans, and sorghum are crops commonly planted in rows far enough apart to allow periodic cultivation between the rows. Machines used for planting seed are referred to as planters.

Another method of seeding is the drill method. Drills place seeds in narrow rows at high population rates. Crops such as clover, alfalfa, wheat, oats, barley, and rye are usually planted by this method. When using the drill method, attachments can be used to place fertilizer at the same time, thus saving time and trips across the field. Planting seed by the drill method reduces the need for mechanical cultivation.

The third method is broadcast planting. Broadcast planters scatter the seed in a random pattern across the top of the soil. Broadcast planting is usually the cheapest method and provides faster coverage for erosion control. Airplanes, tractor-pulled seeders, or hand-held seeders can be used for broadcast seeding. Crops that can be seeded using the broadcast method are grasses, legumes, and small grains. Light tillage is usually required to cover the seeds with a thin layer of soil.

Seed Depth and Fertilization

Depth of seed placement is critical for germination and emergence. Crop producers are interested in having the planted seed emerge as soon as possible to allow photosynthesis to begin. Seed depth depends on: soil type, seed size, type of emergence, soil moisture, and soil temperature. As a rule, larger seeds (e.g., corn and beans) are planted deeper than smaller seeds (e.g., wheat and clover). Larger seeds have more stored food for seedlings to utilize during germination and emergence. Once the seeds are planted, fertilization of the crop is important.

To ensure proper stand establishment, crop producers must anticipate which elements are needed to produce a quality crop. Fertilization can be done by either using a general application, a starter application, or a side dressing. In stand establishment, starter fertilizers are most commonly used. Starter fertilizers, also known as "pop-up" fertilizers, give the most effective results. Starter fertilizers may contain only nitrogen. However, a complete fertilizer consisting of nitrogen (N), phosphorus (P), and potassium (K) is needed for stand establishment. Following the application of a starter fertilizer, a top dressing of a complete fertilizer may also be used. Because of the expense, soil test results should be used to determine the correct application rates and nutrients required.

Seeding Rates

There are many factors related to a productive stand. Using good management practices, crop producers can increase their potential yield. Plant populations refers to the number of growing plants in a given area. The density of growing plants directly influences the yield potential. The desired plant population is dependent upon several factors; one of which is the seeding rate.

Seeding rate refers to the amount of seed planted in a given area (per foot, per acre, etc.). Accurate seeding rates are important. Overseeding wastes seed and underseeding reduces yields. By underseeding, the utilization of available light, moisture, and nutrients is inefficient. Overseeding creates excess competition among the plants, thus reducing yield. Optimum seeding rates should be based on the type of crop, use of crop, pure live-seed ratio, seed quality, soil moisture, soil productivity, time of seeding, method of seeding, row width, and expected average rainfall.

The type of crop being planted influences the desired seeding rate. Corn is typically planted at 18,000 to 24,000 seeds per acre, whereas soybeans are typically planted at a 60-pound-per-acre rate. The intended use of the crop is also a factor. Corn for silage is generally planted at a higher plant population than corn to be harvested for grain.

The pure live-seed ratio refers to the ratio of weight of the viable seed of the cultivar (variety within a plant species) being seeded to the total weight of the seed stock, which may include nonviable seeds, weed seeds, and inert matter. If 80 percent of the seed is viable (able to grow) and it is 95 percent pure, the pure live-seed ratio is 76 percent ($0.80 \times 0.95 = 0.76$). If an individual has 100 pounds of seed, there would be 76 pounds of pure live-seed of the desired cultivar to plant. In order to calculate the correct seeding rate from pure live-seed ratios, reference to the cultivar's recommended seeding rate should be made. An example is presented as follows.

A recommended seeding rate based on 100 percent pure live-seed is 6 pounds per acre. This rate is common for small-seeded range grasses. The appropriate seeding rate would be slightly less than 8 pounds per acre based on the following calculations:

$$\frac{\text{rate based on 100\% pure live-seed}}{\text{pure live-seed (ratio)}} = \text{seeding rate}$$

$$= \frac{6}{0.76} = 7.9 \text{ pounds per acre}$$

Seeding rate can also be affected by seed quality. Seed quality is based on germination rate and other factors. If seed quality is low, it is advisable to increase the rate of seeding to ensure a good stand. Seeding time refers to seeding the stand at the appropriate time of the season (i.e., fall or spring). Climatic conditions can reduce stand establishment if planted after the optimum time. Increased seeding rates are suggested when planting before or after optimum planting dates.

Soil productivity and soil moisture also affect the optimum seeding rate. Productive soils may sustain the recommended seeding rates where poor soils may only sustain production at lower seeding rates due to the less fertile soil condition. Excessive soil moisture can retard germination. Most seeds cannot tolerate excessive moisture and may rot. If there is excessive moisture, seeds should be planted at a shallower depth and at a higher seeding rate to promote faster germination and to compensate for loss due to wet conditions.

The method of seeding and row width also affect the seeding rate. Row planting usually involves relatively lower seeding rates than the drill method. Broadcast seeding is used when high seeding rates are desired. As a rule of thumb, as row width narrows, the number of seeds planted can be increased to some degree. Conversely, planting seeds in wide rows should be completed at lower seeding rates.

Summary

Successful stand establishment requires careful planning and consideration of many factors. By choosing the appropriate method of tillage, the seedbed can be prepared in a soil-conserving manner. Selecting the proper seeding method, planting depth, use of fertilizer, and optimum seeding rate can make the difference between an average stand and a productive stand.

Credits

Chapman, S.R.; L.P. Carter. *Crop Production: Principles and Practices*. San Francisco, CA: W.H. Freeman and Co., 1976.

Cooper, E.L. *Agriscience: Fundamentals and Applications*. New York, NY: Delmar Publishers Inc., 1990.

Delorit, R.J.; L.J. Greub; H.L. Ahlgren. *Crop Production*. 5th ed. NJ: Prentice Hall, 1984.

Lesson 6: Managing the Crop

Quality crops are the result of good management. Good crop management decisions involve fertilizer use and application, pest control measures, soil pH and adjustments, tillage, treatment of crop residues, and the proper use of irrigation. Producing quality crops at a profit requires planning and the use of sound management practices.

Elements Needed for Plant Growth

There are 16 nutrient elements that are required for plant growth. Each of the elements performs specific tasks. Carbon, hydrogen, and oxygen are essential in the process of photosynthesis and respiration. They are not generally applied as fertilizer. The other 13 elements are important for many plant functions.

The 13 nutrient elements can be categorized according to the amounts needed by plants. The major elements, commonly called macronutrients, are nitrogen (N), phosphorus (P), and potassium (K). These three nutrients are most commonly applied to crops. Calcium (Ca), magnesium (Mg), and sulfur (S) are considered secondary macronutrients. The other seven mineral elements, known as micronutrients, are boron (B), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo), zinc (Zn), and chlorine (Cl).

Application

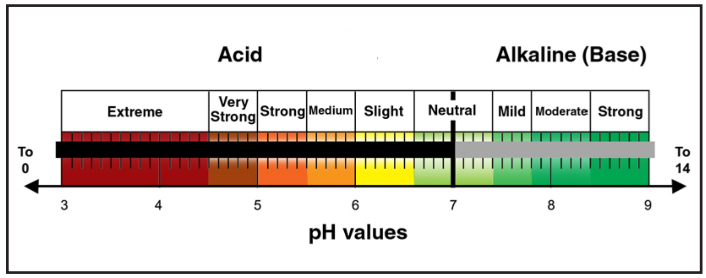
The amount of fertilizer applied should be based on the soil test results. Fertilizers are expensive. Some fertilizers are petroleum-based, and applying them incorrectly can be very costly. After considering the results of a soil test, more effective management decisions can be made regarding soil nutrient needs and applications.

Fertilizer may be applied at the time of planting with a starter fertilizer. Starter fertilizer may consist of nitrogen only or a complete fertilizer containing N, P, and K. Side-dressed fertilizers may be applied after the plant seedlings have emerged and vegetative growth has begun. Top-dressed fertilizers are applied after plants have become established. The amount and application method vary because of cultural practices, soil type, type of crop, and personal preference. Information relating to production of specific crops can be obtained from seed companies. However, soil tests are vital for good management decisions and should be completed well before planting.

Soil pH

Soil pH refers to the degree of acidity or alkalinity of a soil. The pH scale ranges from 0 (maximum acidity) to 14 (maximum alkalinity). At the midpoint of the scale (7), the pH is considered neutral, meaning neither acidic nor alkaline. See Figure 6.1.

Figure 6.1 – pH Scale



Profitable crop production is dependent on soil pH. Most crops grow and produce the best in soils with a pH range of 5.0 to 7.5. Soils with a pH outside the 5.0 to 7.5 range inhibit the absorption of nutrients by growing plants. When planning for crop production, the soil's pH should be tested at least every 3 years. Once the pH is determined, measures can be taken to adjust it to a desirable level.

Altering the pH can be accomplished by applying lime or sulfur depending on the needed change. If the soil is too acidic, application of agricultural lime will raise the pH. The amount of agricultural lime needed varies depending upon the amount of organic matter, soil texture, and current pH level of the soil. The greater the organic matter and clay, the more lime required. More acidic soils also require greater amounts of lime to raise the pH to an acceptable level.

If the soil is excessively alkaline, application of sulfur or aluminum sulfate will lower the pH. In land where production has occurred before, excessive soil alkalinity may be caused by heavy applications of lime or by applying lime to soils with a high pH. Applications of sulfur will lower alkalinity of soils in an average of 3 to 6 months. Applications of aluminum sulfate will change soil alkalinity within 10 to

14 days. When using agricultural lime, sulfur, or aluminum sulfate, care should be taken not to use more than what is needed. The crops to be produced, fertilizers used, and cultivation practices after harvest are factors to consider when attempting to alter a soil's pH.

Crop Residues

After harvesting crops, farmers are faced with the decision of how the plant residues should be handled. Plant residues are the unused parts of the crop that are not harvested (e.g., straw, corn stalks, and soybean hulls). A major component of soil is organic matter. Organic matter is important because it is the basis of soil productivity. Crop residues are often tilled into the soil to increase soil organic matter, which raises the nutrient-holding capacity, water-holding capacity, and physical condition of the soil. Most Missouri soils contain less than 3 percent organic matter, whereas other states like Illinois have 5 percent or more of organic matter. Crop residues can also be left on the surface, which will greatly reduce the amount of soil erosion due to wind and water. Crop residues left on the soil surface reduce the force of the rain and slow the travel of water across the surface. Crop residues help hold the soil particles together, which also reduces erosion by wind.

Pest Control

Farmers lose billions of dollars annually because of crop pests. Crop pests include diseases, weeds, insects, and animals. Crop pests may damage crops by destroying the seed, attacking the live plant, or contaminating the harvested crops. Crop pests may reduce yields, reduce quality, and damage crops in storage. Methods of controlling plant pests involve mechanical, cultural, biological, genetic, and chemical means.

Mechanical control refers to practices that disrupt the pest's environment or the pest itself. Cultivation exposes soil-borne pests to the air and sunlight and controls weed. Mowing, electricity, and traps are also considered mechanical control methods.

Cultural control refers to adapting agricultural production practices to control pests. Pests can be controlled by planting resistant crop varieties, rotating crops, and timing certain operations to break the reproductive cycle of specific pests.

Biological control involves the use of predators or diseases that affect only the pests. Genetic control is done through the development of crop varieties that are resistant to pests.

Chemical control of pests is accomplished through the use of pesticides and other chemicals. Care must be taken not to use excessive dosages because of the increased chance of soil and water pollution due to runoff. Pesticide application should be performed by experienced persons and according to recommended rates.

Irrigation

In many states, the average annual rainfall is not adequate to sustain intensive crop production. There are also years where rainfall in some areas is not sufficient due to drought conditions. When these situations arise, steps may be taken to supply adequate water to the crops.

Irrigation is a technique of supplying water to plants, which has been used for thousands of years in many parts of the world. Although irrigation is not a new technique, some of the methods have greatly improved. Irrigation provides water for crop production through aerial, surface, and subsurface methods.

Aerial irrigation generally refers to the use of sprinkler systems. Aerial irrigation involves the use of permanent or portable pipes. High volume equipment such as center pivot systems are used in the western parts of the U.S., where rainfall is limited.

Surface irrigation moves water directly from the source to an area where the crops are. The surface methods include flood, drip, furrow, and corrugation irrigation. Surface irrigation uses various methods to move the water across the soil surface to the crops.

Summary

Managing a crop involves making decisions related to assessing nutrient needs of crops, fertilizer application, pest control, soil pH, handling crop residues, and irrigation. Each factor can enhance or restrict the crop's potential for high yields. Good crop management considers each of the factors that affect crop growth.

Credits

Chapman, S.R.; L.P. Carter. *Crop Production: Principles and Practices*. San Francisco, CA: W.H. Freeman and Co., 1976.

Cooper, E.L. *Agriscience: Fundamentals and Applications*. Albany, NY: Delmar Publishers Inc., 1990.

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Fridline, C.R. *Field Crop Nutrition.* The Ohio State University: Ohio Agricultural Education Curriculum Materials Service, 1978.

Lesson 7: Harvesting and Storing Grains

Use of proper grain harvesting procedures is necessary to ensure that farmers are able to harvest all of the grain they produce. Harvesting time and methods, storage requirements, and grain drying procedures will be topics of discussion in this lesson.

Harvest Time

Determining the optimum harvest time is critical for profitable grain production. The best time to harvest is when the producer receives the highest yield of the highest quality. Choosing the correct time to harvest can be the difference between profit or loss. Factors that determine the proper time to harvest grain crops can be divided into three categories: plant characteristics, climatic factors, and harvesting methods.

Plant characteristics refer to the plant's stage of maturity, tendency to lodge (bending or breaking plant stems), and tendency to shatter (the loss of grain, or seed, from the inflorescence, or head). Delaying harvest beyond the optimum time decreases yield and increases the possibility of loss due to lodging and shattering.

Climate is also a consideration in harvesting because of the effect it has on mature crops. Rainfall, humidity, wind, and temperature affect crop moisture content. Harvesting crops with a high moisture content may increase storage losses due to molding and overheating. Adverse weather conditions can also damage crops that are ready for harvesting. Also, grain harvesting equipment may not be usable in muddy fields.

The harvesting method used will also influence the optimum harvest time. Windrowing small grain crops may allow for earlier harvesting since the crop moisture is reduced somewhat in the windrow before threshing. Grains dry more quickly in a windrow than as standing crops. Combining standing grain will generally result in harvesting at a higher moisture content than with the windrow harvesting method. However, windrow harvesting may increase losses due to shattering. Optimum harvest times vary with the crop and its anticipated use. Table 7.1 identifies the characteristics that indicate the proper harvest time for common grain crops.

Table 7.1 – Characteristics of Proper Harvest Time

Crop	Percent Moisture	Plant Maturity Stage	Physical Plant Signs for Harvest	Method Used to Harvest
Wheat	below 14%	a little past hard-dough stage	majority of kernels shell out when rubbed betwen hands	direct combine
Oats	no more than 13-14%	hard-dough or 2-3 days later	when the straw shows no greenness and the heads have turned a dull white	direct combine or windrow-pickup combine
Barley	below 14%	hard-dough stage	when heads have turned golden yellow but straw may be slightly green	direct combine or windrow-pickup combine
Corn (grain)	15.5%	50-60 days after pollination	kernels are nearly all well glazed and dent corns, well-dented husks and bottom leaves dry, upper leaves 1/4 to 1/2 green	direct combine
Corn Sillage	65-70% (for plant)		kernels well glazed, and husks begin to turn yellow although most leaves are green	field chopped

Grading Grains

In 1916, the U.S. Grain Grading Act was passed, requiring that all grain shipped to or from the U.S. be inspected and graded. Specific procedures for sampling grains were established. Grain samples were used to assign a class and grade for marketing purposes.

Factors used in federal grain grading are: class, test weight per bushel, percentage of damaged grain, percentage of foreign materials, and percentage of other classes. Class refers to the varieties that exist in each type of grain crop. For example, wheat consists of seven classes. These classes are hard red spring wheat, durum wheat, red durum wheat, hard red winter wheat, soft red winter wheat, white wheat, and mixed wheat. Some classes may have subclasses. Grain crops may have from one to several classes. For example, flaxseed has only one class whereas wheat has seven classes.

Determining the classification is part of the grain grading process. The weight of a grain sample is used in estimating the moisture content and percentage of dry matter. Percentage of damaged seed (grain) is estimated as a percentage of the sample and then extrapolated to the whole shipment. Percentage of foreign material refers to weed seeds, weed plant parts, insect parts, or any material other than the seed. The percentage of other classes includes any other class of grain that is found in the shipment. All of these factors are considered when determining the grade of a grain sample. The market price for grain is based upon the grade classification of a representative sample of grain.

Grain Quality Factors

Factors that determine grain quality are purity of crop and variety, percentage of weeds and other mixtures, and percentage of diseased and damaged kernels. Each of these factors influences the quality of a grain sample.

Methods of Harvesting

Methods of harvesting vary with the type of crop. Methods most commonly used are direct combine method and windrow-pickup combine method. The direct combine method utilizes combines with interchangeable gathering units (heads) depending on the crop. The direct combine method involves cutting and threshing (the separation of grain from the rest of the plant material) the standing grain in the same operation. With direct combining, the threshed grain can be held in a hopper on the combine.

The windrow-pickup combine method places the cut, but unthreshed crop in rows for field drying. After the grain has dried in the windrows, it is gathered by a combine equipped with a pickup attachment. After the threshed grain is accumulated in a hopper, it is then loaded into grain trucks for transportation.

Improperly Stored Grain

Much of the profit potential from grain production can be lost due to improper storage. Economic loss during storage may be caused by high moisture content, heat damage, rotting, improper drying, foreign material, and insect and rodent infestation. Mold can be a problem if grains are harvested and stored when the moisture content is too high. If moisture content is too high, the grain will heat up, encouraging rotting and spoilage. Foreign material in the grain such as weed seeds, plant parts, and insect parts can encourage grain spoilage. If adequate storage is not provided, insects and rodents can infest the grain and reduce the quality by contamination.

Maintaining Crop Quality

Maintaining crop quality can be accomplished using good management practices. The primary goal of a grain storage facility is to retain the quality of stored grain. Several steps can be taken to maintain crop quality: harvesting grain at the proper moisture content, properly constructing and maintaining storage bins, protecting against pests, providing proper ventilation, protecting from fire and wind damage, and inspecting the grain frequently.

Harvesting grain at the proper moisture content is vital for good storage. The maximum moisture content for various grains follows: shelled corn grain, 13 percent; hard red spring wheat, 13 percent; soft red winter wheat, 12.5 percent; hard red winter wheat, 12 percent; and soybeans, 13 percent.

Properly constructed and maintained storage facilities reduce grain spoilage. Cleaning and disinfecting facilities between storage seasons discourages entry by pests. Providing proper ventilation also decreases the possibility of grain deterioration. Frequent inspections are also recommended to prevent losses due to unexpected problems.

The facility should provide protection against fire and wind damage. Other factors to consider would be the convenience to fill, empty, and inspect. The facility should be structurally sound and able to withstand lateral pressure when full. For example, there are approximately 300 pounds of lateral pressure per square foot on the bottom wall of a 2,000-bushel round bin that is 16 feet in diameter by 12 feet deep. All of these factors should be considered when deciding on a storage facility.

Drying Grain

The ability to dry harvested grain in storage provides many advantages to grain producers. Early harvesting may be necessary to avoid weather conditions that would contribute to excessive harvest losses. Market prices, which may be higher early during the harvest time, decrease as the harvest season progresses. Artificial drying can help reduce losses from molds, heat damage, and spoilage due to high moisture content. Drying grains in storage to the proper moisture content helps to maintain crop quality. The methods of drying grain crops are drying with unheated air, drying with heated air, and drying in the field.

Unheated air may be used to dry harvested grain that contains no more than 15 percent moisture. Unheated air must have a relative humidity of 70-75 percent or less to decrease the grain moisture content. During the final drying stages, unheated air must contain less than 50-60 percent humidity to reduce the grain moisture content to 13 percent. Bins for drying must be equipped with perforated ducts or false floors to allow the air to be forced through all parts of the bin by a ventilating fan.

Advantages of drying with unheated air include lower expense for energy, less fire hazards, lower initial equipment costs, little management and supervision, and less chance of overdrying. Disadvantages arise because the unheated air uses outside air which is affected by natural weather conditions. Unheated air systems are not effective in cold, damp conditions. Other disadvantages are slower drying rates, more drying time required, and greater possibility of damage from mold due to prolonged drying times.

Drying with heated air is accomplished by heating the air with natural gas or petroleum fuels and forcing the heated air throughout the storage bin. The heat from each gallon of fuel will evaporate 50 to 85 pounds of water from the grain if direct heat drying is used. If indirect heating is used, 35 to 60 pounds of water can be removed.

The advantages of using heated air are increased ability to dry the wettest grain, no dependency on weather conditions, shorter and faster drying times, and high drying capacity. The disadvantages of using heated air drying are higher initial cost, higher fuel expense, some fire hazard, potential to overdry grain (thus reducing quality), and requires more careful management and supervision.

In field drying, the crop is allowed to dry to the appropriate moisture content while standing or after cutting, conditioning, and windrowing. The standing crop is harvested with the appropriate combine head attachment. Windrowed crops can be picked up once they reach the correct moisture content using a combine windrow-pickup attachment.

Summary

Successful on-farm grain processing involves proper harvesting and storage. Producing and marketing grain of high quality is a result of good management decisions. Decisions that consider proper harvesting times, harvesting methods, and storage methods that maintain grain quality, are important in the overall grain production process.

Credits

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Lesson 8: Harvesting and Storing Forages

There are more acres in the U.S. used for the production of forage and pasture crops than for any other agricultural purpose. Forages are crop plants that are grown or produced for animal feed. Production of forages takes place on more than 475 million acres of pasture or range land in the U.S. An additional 60 million acres are used for intensive hay production. Missouri is the second leading state in the nation in hay production (excluding alfalfa). Missouri produces an estimated 5.8 million tons of hay each year.

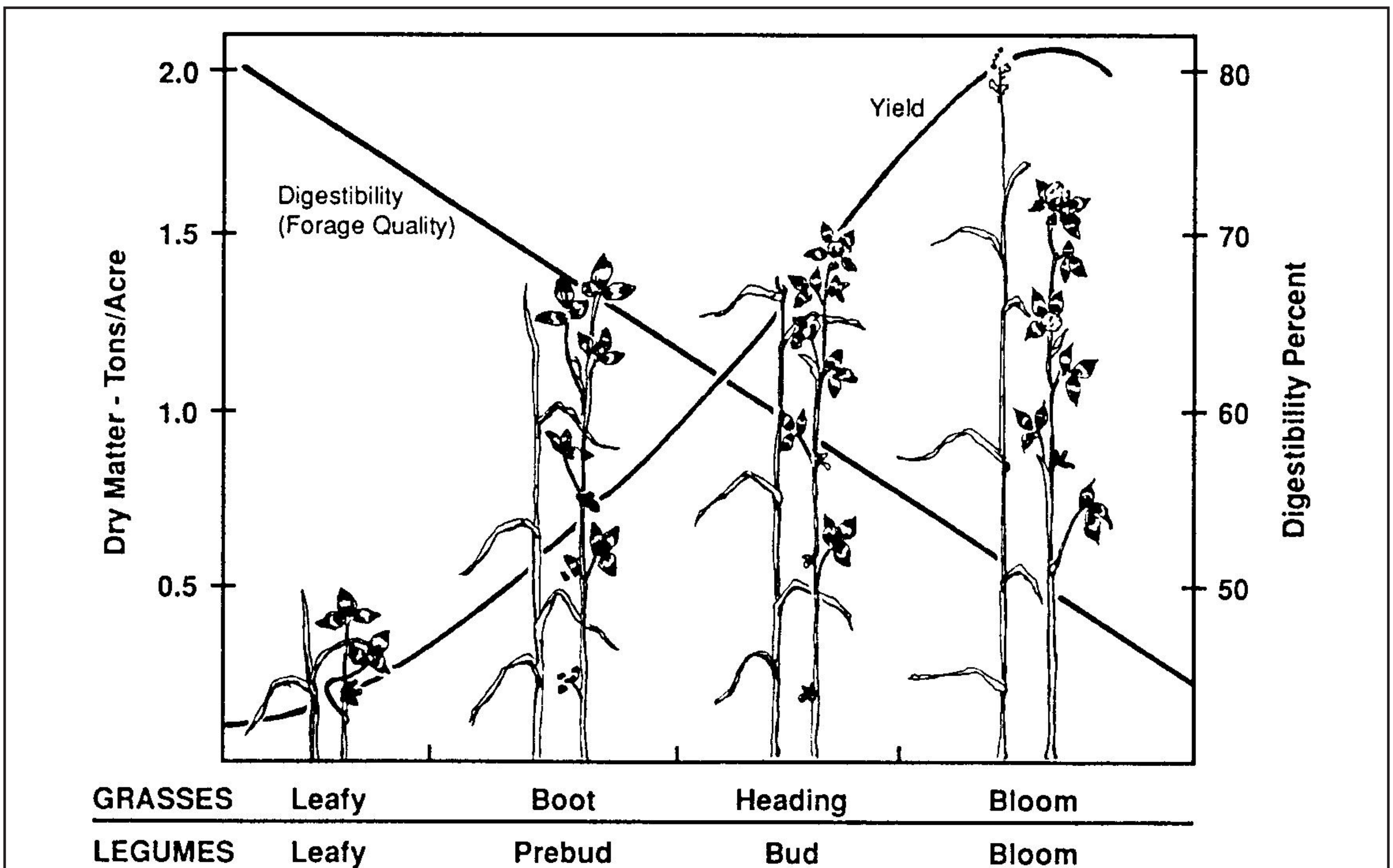
Many factors are involved in harvesting and storing forages. Supplying quality forages for livestock feed requires forage producers to make decisions regarding when to harvest, which harvesting method to use, and how to store forages to maintain quality. The term harvesting includes direct grazing, cutting for dry or high moisture systems, and baling.

Determining Harvest Time

Quality forage crops originate from quality seed. However, forage quality can be reduced if cutting and baling are done improperly or if weather conditions are not favorable. The nutrient content and palatability (taste) of forages are important; therefore, harvesting must occur at the optimum time.

Forage nutrient value is at its highest level at an early growth stage; however, yield would be low at that time. A balance must be reached between nutrient content and yield when considering the best time to harvest forages. Refer to Figure 8.1. Cutting early will reduce yield but produce the highest quality. Cutting later increases yield but reduces quality. If cutting is delayed, leaf drop and lodging (plant falling over on the ground) may become problems. The optimum time to harvest forages depends on the plant species. Refer to Table 8.1.

Figure 8.1 – Yield and Quality in Forages



Optimum time for baling forages is equally important to ensure quality. Baling too early when the forage is wet may cause mold and heat damage. Delaying baling past the optimum time may result in leaf shattering and a reduction in forage quality. Measures must be taken to estimate the optimum time to bale in order to avoid these problems. Figure 8.1 shows yield and quality at different growth stages of forage grasses and legumes.

Weather conditions should also be considered. Forage cutting can be hindered and forage quality reduced by undesirable weather conditions. Cutting hay before or during rain is detrimental to the nutrient quality of the forage. Rain will leach out nutrients from cut forage.

Determining Forage Quality

Forages can be consumed by livestock through pasture grazing or in the form of hay, haylage, or silage. Hay includes the entire vegetative part of a forage crop dried for feed. Haylage is cut forage stored in airtight systems at a higher moisture content. Silage is a forage crop preserved in a succulent state that ferments and is used for feed. Forage quality is important in order to supply nutrients to livestock.

The quality of forages affects milk production levels in dairy cattle and rate of gain in livestock. Care must be taken to provide quality forages. Factors that determine forage quality can be assessed by physical appraisal or chemical analyses.

Physical appraisal is the most common method used. It uses sight, smell, and touch when determining the quality of a forage. The three main characteristics that determine the quality of hay are visual appearance, color, and odor. Good quality hay should consist of a leafy forage that is not dominated by coarse large stems. Quality forages should also be free of foreign material.

Color can be used to judge whether or not the forage has been damaged or improperly dried. The appropriate color

Table 8.1 – Hay Types and Optimum Time to Cut

Type of Hay	Optimum Time for Harvest
1. Alfalfa	first flower to 1/10 bloom
2. Alsike clover	1/2 to full bloom
3. Birdsfoot trefoil	1/10 bloom
4. Cowpeas	when first pods have started to ripen
5. Corn silage	harvest when kernels are fully dented and glazed
6. Crimson clover	1/2 bloom
7. Fescue	boot to early heading
8. Ladino clover	full bloom
9. Lespedeza	early bloom
10. Medium red clover	1/4 to 1/2 bloom
11. Small grains	boot stage to early dough
12. Soybeans	when beans in the pod are half developed
13. Sweet clover	when first blossoms appear
14. Bromegrass	early bloom (anthesis)
15. Orchard grass	fully headed but before bloom
16. Reed canary grass	when first heads appear
17. Timothy	early bloom (anthesis)

of quality hay should be a bright green. The odor of hay should be pleasant. A musty or moldy smell would indicate damage due to excessive moisture or heat damage.

Chemical analyses are used when knowledge of the precise nutrient content of a forage is important. Scientists use chemical analyses to determine the levels of crude protein in a forage sample. Such information is needed to prepare a balanced feed ration that provides maximum animal performance. Digestibility is estimated by chemically analyzing the fiber content in the forage. Digestibility relates to the ability of animals to digest the forage. Chemical analyses are also used to determine the lignin content of forages.

When to Harvest Forages

Refer to Table 8.1, "Hay Types and Optimum Time to Cut," for information. Note that the optimum harvest time occurs before the crop reaches physical maturity.

Methods of Harvest

When harvesting forages, the use of the forage influences the best method of harvest. Forages to be used for grazing must be managed to provide feed for the number of animals which will be grazing the field. Grazing too many animals on a pasture can damage the forage crop stand and lead to soil erosion. Pastures managed properly by rotation grazing increases forage production and protects the soil.

Dry hay harvesting systems involve cutting the forage, drying it in the field (curing), and packaging it for transportation and storage. Methods used to package forage crops vary, depending on how the crop is to be used or stored. Common methods of packaging are conventional square or round bales, large round bales, large rectangular bales, portable haystacks, and field cubes. Each method uses different equipment and results in products of various weights and sizes. The preferred packaging method is dependent on the needs of the producer.

There are several steps in the hay harvesting process. The first step involves cutting the forage at the optimum time. After cutting, the forage can either be left in the swath (cut path) or raked into rows (windrows). Cutting can also be done by using a mower-conditioner. Mower-conditioners cut the forage, crimp or crush the stems, then windrow it to dry. Conditioning forages speeds up the drying process. Once the forage is dried to the desired moisture level, it is then baled, stacked, or cubed for storage. Chemical additives can be used to reduce drying time and the formation of molds.

High moisture systems involve cutting forages at higher moisture levels (40-75%) and storing them in airtight silos, bunkers, or bags. When forages are cut for silage, they should contain approximately 60-75 percent moisture content. Haylage is stored at 40-60 percent moisture content in an oxygen-free atmosphere. High-moisture silage is generally harvested with a mechanical chopper. The chopper cuts the standing forage crop into short lengths and blows it into a truck or wagon that is trailing behind the chopper. The freshly chopped forage is then taken to a silo and stored until needed for feed. Wilted silage or haylage is allowed to dry to proper moisture before storage.

Specialized forage processing machinery can be used to produce cubes or pellets. Stationary cubers force ground forages through extrusion dies to form cubes. Stationary cubing requires expensive machinery and much labor.

Pelleting machines produce pellets that vary in length. Pelleting machines use ground forages. Pellets are used for small animal feeds such as rabbits, sheep, and poultry. Alfalfa is a common forage used for pellets and is a primary protein source in mixed feeds.

Forage Deterioration

Forage deterioration can be caused by improper cutting, improper baling, improper harvesting methods, and improper storage. Early baling can cause forage deterioration due to high moisture content. Mold and heat damage will occur, causing deterioration. Mold and heat damage reduce the quality and palatability of forages.

Improper storage can also cause forage deterioration. Facilities that do not protect forage crops from heat damage, weather, or pests increase deterioration of stored forages. Deterioration of forages can be a costly problem. Steps should be taken to prevent forage deterioration.

There are four main steps that should be taken to reduce forage deterioration. First, to ensure quality forage, the crop must be harvested at the optimum time. Second, the appropriate harvesting method should be used to help maintain feed value. Conditioning cut forages can reduce drying time and limit field damage from pests or adverse weather. Methods that reduce the loss of leaves from the plant should be used since leaves contain most of the nutrient value of forage crops. If leaves are lost through drop or shattering, forage quality is reduced. Harvesting forages at the proper moisture content will help to maintain forage quality during storage. Maintaining proper storage facilities is the fourth important step to prevent forage deterioration.

Storage Requirements

The effort, time, and expense required to produce a quality forage crop can be wasted if it is improperly stored. The basic requirements for storing dry hay are to provide protection from weather, insects, animals, and birds and to provide adequate ventilation. For silage and haylage, protection from weather, insects, animals, and birds must be provided. However, silage and haylage require air-tight facilities because of the fermenting action which occurs during storage. Silage and haylage storage facilities should also provide for convenient filling, emptying, monitoring, and cleaning.

Improving Field Drying

Forage crops, when cut in the field for hay, should contain 15-20 percent moisture for baling. Methods used for field drying are swath drying, windrow drying, crushing or conditioning, and chemical additives.

In swath drying, the forage is left in the path it was originally cut to sun dry. Once dry, the swath is raked into windrows to be picked up and baled. Windrow drying involves cutting the forage and raking it into rows, allowing it to dry in the rows before baling. Both techniques are commonly used. Swath drying can cause bleaching of the forage if not done properly. Bleaching reduces the quality of the forage and causes the forage to lose much of its green color.

Crushing or conditioning is also a method used for field drying. The forage is cut by a conditioning machine that either crushes or crimps the stems to speed up the drying process. Conditioners place the crimped forage in windrows. Since a shorter field drying time is required, the chance of bleaching or damage from other sources is reduced. Chemical additives such as calcium carbonate can speed up the drying time and reduce nutrient losses from overexposure to sunlight. Other chemicals such as organic acids (i.e., propionic acid) can be used to prevent molding, thus permitting the forage to be baled at a higher moisture level.

Summary

Forages provide vital nutrients to many species of livestock. Millions of acres in the U.S. are devoted to the production of forages. Forages may be produced on pastures, on range lands, or in intensive hay crop production. Producing quality forages such as hay, silage, and haylage requires good management practices. Proper cutting time, baling time, harvesting methods, and adequate storage are important factors to consider in producing quality forages.

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Lesson 9: Controlling Crop Pests

Crop pests destroy billions of dollars of crop plants each year. Pests also spoil billions of dollars of stored crops each year. Controlling crop pests is a major field of study in agricultural research. Methods and practices have been developed that reduce the damage caused by pests. This lesson will present common methods of crop pest control.

Pests

Most consumers consider the term pest to mean an insect. However, to crop producers, the word pest takes on an expanded meaning. Pests that affect plant growth may include weeds, insects, and plant diseases. Plant pests are organisms that inhibit or prevent plant growth.

It is a good crop management practice to prevent plant pest damage before it starts. However, in some situations, it is necessary to reduce the effect of plant pests after some damage has begun. Methods of control vary, depending on the type of pest.

Weed Control

Control methods for weeds include hand, mechanical, chemical, and biological methods. Hand methods involve pulling weeds out by hand or hoeing weeds out with hand tools, which is extremely effective. However, this method cannot be done on a large scale. Mechanical methods are similar to the hand method, except it is completed using tractors and cultivation equipment.

Chemical methods involve the use of chemicals to control plant pests. Herbicides are used to control weeds with minimum damage to crop plants. Selective herbicides are designed to destroy specific plants based on how crops and weeds absorb and break down chemicals. Selective herbicides may be used to control broadleaf weeds (e.g., cocklebur, mustard) that are growing among grasses (e.g., corn, oats). The amount of herbicide used must be closely monitored to avoid injury to crop plants.

Biological methods are also used to control weeds. Biological control is growing in popularity because of the concern for the environment. In nature, there are specific insects, weeds, and diseases that inhibit the growth of other insects, weeds, and diseases. Researchers in this area continue to discover means by which biological control can be used to control pests in crops.

Insect Control

Insects vary in the way they damage crop plants. Some insects chew on plant parts. Others suck the juices or bore into the plant. Because of these differences, methods of control must also vary. Methods used to control insects include genetic, cultural, biological, and chemical practices.

Genetic control involves the development of cultivars (variety within a species) of crops that are resistant to common insects. One example is the wheat stem sawfly. The wheat stem sawfly attacks the hollow stem of wheat. Crop researchers discovered that wheat varieties with solid stems were not attacked by the sawfly. Plant scientists have manipulated the genetic makeup of hollow stem wheat varieties by incorporating genes that produce a solid stem. From this work, a wheat variety was developed that has the good characteristics of hollow stem wheat combined with the solid stem. Therefore, the sawfly does not attack this new variety. This genetic method to control the wheat stem sawfly has proved to be successful.

Cultural control methods involve the modification of production practices. Examples of cultural control include crop rotation to break the reproductive life cycle of insects or adjusting planting and harvesting dates to break the life cycle of insects.

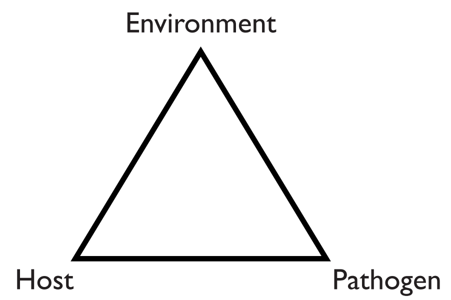
Biological control may use predator insects to inhibit plant damaging insects. Genetically sterile, mutant insects may be released to spread through the population of harmful insects and reduce their reproductive potential. Other biological controls involve releasing a disease into an insect population which in turn infects other insects. Such biological control methods must be carefully monitored to prevent the introduced insects from becoming pests.

Chemical control involves the planned use of insecticides to combat insects in crop plants. Insecticides are applied in the form of sprays, dusts, and gases. Chemical methods of insect control must be closely monitored to protect the environment and human health.

Disease Control

Crop yields can be reduced due to plant diseases. Plants are subject to many diseases. In order for a disease to start, three conditions must be present: a suitable environment, a viral pathogen (organisms which produce disease), and a susceptible host. This relationship of three factors is referred to as the disease triangle. See Figure 9.1.

Figure 9.1 – Disease Triangle



Plant diseases are usually caused by fungi (plural for fungus). Fungi do not contain chlorophyll. Because fungi have no chlorophyll, they depend on green plants for food. Damage to plants by fungi can involve the entire plant or localized areas. Methods of controlling fungi are genetic, cultural, chemical, and isolation.

Pesticide Safety

There is wide concern in the U.S. for the environment and human health. The use of chemicals in crop production is under scrutiny. In 1988, over 820 million pounds of pesticides were used in the U.S. Over 6 billion dollars were spent on chemicals to control insects, weeds, and diseases. Considering the volume of use, individuals applying pesticides should be trained to use them properly.

Care must be taken when working with pesticides. Safety procedures should be followed when handling and applying pesticides. Some general safety rules are as follows:

1. The applicator should be trained in pesticide application.
2. Carefully read and follow pesticide label directions.
3. Understand toxicity ratings, signal words, and symbols.
4. Wear appropriate protective clothing and use protective equipment.
5. Store pesticides properly.

Toxicity ratings, signal words, and symbols should be read and understood. These ratings are based on LD50 (lethal dose) and LC50 (lethal concentration) values. The LD50 and LC50 ratings refer to the amount of chemical that is required to cause death in 50 percent of a test population of laboratory animals. The lower the LD50 value, the more toxic the pesticide. Word labels such as “DANGER–POISON,” “WARNING,” and “CAUTION” relate to the relative hazard of the pesticide to the handler.

Using special protective equipment and clothing when handling pesticides is very important. The human body can absorb some pesticides very quickly. Pesticide absorption through the skin is known as dermal absorption. For protection, the following safety equipment should be worn when using pesticides: clear face shield, goggles, rubber gloves, respirator, boots, wide-brimmed hat, rubber apron, and lightweight coveralls.

Proper storage of pesticides is critical to minimize the risk of accidental poisoning. Improperly stored pesticides are a safety hazard. Storage areas should be well-ventilated, locked, fireproof, and properly marked. Each pesticide should be stored separately and on different shelves. Do not place pesticides in unmarked jars or soda bottles. Keep labels in good condition, on the original container, and keep records of pesticide applications.

Environmental concerns about the use of pesticides have brought about many changes. Awareness of the risk to human health and the environment has prompted the Environmental Protection Agency (EPA) to restrict the use of some chemicals. Use of pesticides on food products must follow strict guidelines to limit chemical residues. Most pesticides are expensive, and improper application can be very costly. Because of the concern for safe food, care should be taken to use pesticides safely.

Integrated Pest Management

Integrated pest management (IPM) is a technique of controlling pests using multiple pest control practices. IPM is used in agriculture by establishing levels of "acceptable" and "not acceptable" pest infestation in a crop (economic thresholds). Once these economic threshold levels have been established, they are used to determine the need for pest control treatment. Below the economic threshold, control measures cost more than the economic loss caused by the pest. Above the economic threshold, the loss caused by the pest exceeds the cost of controlling the pest.

IPM strategies focus on key pests and their biological characteristics, including weaknesses, crop biology, and the relationship between a crop and its ecosystem. Techniques of manipulating ecosystems by introducing pest-resistant cultivars and the establishment of economic thresholds have been very successful. Using crop scouts, data can be collected to match the method of control with the particular pest, crop, and ecosystem.

IPM involves the use of a variety of regulatory control techniques. Regulatory control measures are designed to prohibit the spread of pests into uninfested areas. Regulatory control includes the use and enforcement of quarantine or isolation techniques. IPM researchers are working toward the development of disease-resistant cultivars for commercial use. Other control techniques used in IPM are biological, cultural, physical, mechanical, and chemical control. IPM is effective in controlling crop pests. By conducting research on pests, crops, and their relationship with the ecosystem, greater control can be achieved.

Summary

Controlling crop pests involves controlling weeds, insects, and diseases. Control can be achieved by means of hand and mechanical methods as well as genetic, cultural, biological, and chemical methods. Chemical control has become the most common method of controlling pests. However, it has become the most controversial because of the potential hazards to human health and the environment. Safety is very important when using chemicals.

Another technique used in crop pest control is the integrated pest management (IPM) system. IPM utilizes professionals in entomology, pathology, agronomy, and horticulture. These experts collect research data on pests, crops, and their relationship to the ecosystem. IPM works to control crop pests by combining multiple control techniques.

Credits

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