LEADERS' GUIDE

UNIVERSITY OF MINNESOTA
INSTITUTE OF AGRICULTURE
ST. PAUL 1

4-H M-106

4-H AGRONOMY (CROPS AND SOILS) PROJECT *

INTRODUCTION

There is no field in agriculture that has shown more change in the last two decades than crop production. However, the rate of change has not been as rapid with all crops, or in all sections of the state. Individual practices in the production of a given crop have made greater advance than others.

As you review the objectives of the Agronomy (Crops and Soils) Project you will see a change in emphasis over the old project. Several studies indicate that each year a smaller percentage of our farm youth return to the farm because of the mechanization and automation coming to the farm. This does not mean, however, that farm youth cannot stay in agriculture, for the professional and non-professional opportunities in agriculture open a vast horizon for young people who are well trained.

As volunteer and professional workers, we have an opportunity to guide these young people into the channels which make best use of their talents. Through this 4-H project, we have an opportunity to challenge our youth not only in crop production but to encourage them to observe the growing things about them. It is hoped that experience gained in this project will open the "door of opportunity" to crop members and serve them well in adult life whether they be on the farm, in a related field of agriculture, or away from agriculture completely.

This is the leaders' guide

The material presented here is developed for you, the volunteer leader. So that you can be of greatest help to the individual project member you should become familiar with the material. No attempt has been made to cover the entire field of crop production, since many good textbooks are available for this purpose; rather the handbook includes material which you can readily use with the 4-H member in guiding him successfully through several years of crops and soils experience.

Graded approach to crop practice units

Because of the range in age for beginning and ending membership in 4-H, the crop practice units have been arranged based on age. This is a suggested approach and should not be followed too strictly for some younger members will have the ability to develop faster than the outline may indicate. Let us strive to always challenge the member and help him to advance as rapidly as he is able, rather than stifle initiative by keeping him within the arbitrary age limits suggested for each unit.

* This handbook was prepared by Extension Specialists in Agronomy and Soils to aid you in giving project, record, or demonstration help. Notice that there are both helps for things to do as well as suggestions for items to make. Work done in the home may be divided into five units.

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HISTORY OF CROP PRODUCTION

The story of crop production is the story of man and civilization. When man discovered that he could plant seeds of wild fruits and grains, and harvest these, he was able to stay in one place long enough to develop a community. The world's great civilizations began along major rivers where the soils could be tilled more easily, where an abundant supply of water was available, and where the soil was often renewed each year by floods.

History also tells us of the struggle man has had in crop production, the pestilence of disease and insects, rampaging flood waters, extreme drouth, soil erosion, and many other natural factors which have hampered crop production. In addition, man has accelerated some problems such as soil erosion by wind and water, reduced water supplies, and lower fertility by continued use which has added to the natural problems.

So all through history, man has looked for better ways of growing and storing his crops. We are a long way from solving all the problems today, but we do know more about plants and how they function; their dependence on adequate moisture and nutrients; their resistance or susceptilbility to disease and insects; their reaction to environment; and because of this knowledge, we can set out to make changes which result in more efficient crop production.

Minnesota — A leading crop state

The production of crops for livestock and cash is an important enterprise on Minnesota farms. We have a great diversity in crops grown. About one-tenth of all the corn and soybeans produced in the United States are grown in Minnesota. Minnesota ranks high nationally in the production of small grains and forage crops. Thirty percent of Minnesota farm income comes directly from the cash sale of crops.

The major market for Minnesota crops is livestock fed on Minnesota farms. The dollar value of livestock feeds, transformed into livestock products, accounts for an additional 50 percent of cash income to Minnesota farmers.

It can be said then that crop production in Minnesota is "Big Business." It provides for 30 percent of the cash income directly and 50 percent indirectly, for a total of 80 percent of Minnesota farm income. For this reason alone, our young people should be encouraged to study and learn all they can about present practices in growing and storing crops. With this knowledge and experience we believe that some of them will lead the way in the development and/or practice of new production techniques that will maintain the high position of Minnesota in crop and livestock production. But the most important goal is development of our young people into valuable assets of the state and national community.

Table 1 – National rank of Minnesota in crop and livestock production

Corn	3	Dairy Cows	2
Soybeans	4	Hogs	5
Oats	2	Beef	6
Barley	4	Turkeys	1
Flax	3	Milk Production	2
Hay	5	All livestock and livestock products	4

Minnesota crop production - a brief history

Crop production in Minnesota has seen great shifts in our first century as a state. With use of the tremendous soil resources in the southern and western parts of the state and the favorable climate, Minnesota agriculture has gradually awakened to its potential. The state has come a long way from when the early settlers first learned to handle their soil to the knowledge now gained from experiment stations and practicing farmers. In the earliest years all agriculture was of the subsistence type with most of the crop being grown for livestock feed and home use.

In the decade of the 90's, crop production reached record levels in 6 of the 10 years. By 1899, Minnesota was the leading wheat-producing state with production centered in southern counties. Today, the northwest counties are the areas of wheat production in the state, but we no longer rank high in the national wheat production picture.

Over the years, major shifts were made to corn and soybeans. Soybeans were but a curiosity until the early 1930's. Today we are a national leader in production of this crop which is a principal source of cash income to Minnesota farmers.

The changes in crop production in Minnesota are a result of improved cultural practices such as increased use of commercial fertilizer; weed, disease, and insect control programs; better seed of adapted varieties; higher planting rates; and better equipment to help in all production jobs. In addition, well trained professional people have worked with farmers to keep them up to date, and bring to the farm the results of research in the field and laboratory.

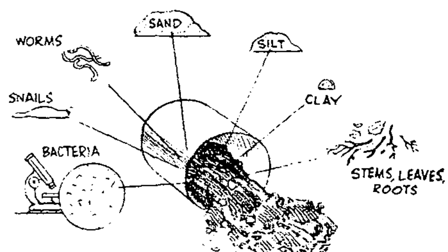
PRINCIPLES OF CROP PRODUCTION

Soils and seed – the basic resources

Before crop production can begin, two major factors must be present under practical conditions. These are soils in which the plants grow and seed from which new plant life develops.

THE SOIL RESOURCE

As the factory is to the manufacturer, so the soil is to the farmer. The soils of a farm represent the potential for crop production. Just as a factory provides the location and the tools for the production of manufactured goods, the soils and atmosphere of a farm provide the raw materials for manufacture of plant materials. From the soil, plants obtain the water and minerals essential for growth. From the air in the soil and above the ground come essential gaseous elements.



A BUCKETFUL of SANDY LOAM SOIL MAY CONTAIN ALL THESE

Many of the possibilities and limitations of crop production are determined by the type of soil. Soils vary widely. Even in Minnesota, surface color may range from dark black to almost white; fineness of particles from plastic clays to coarse gravels; and depth from a thin layer of moss to deep sedimentary deposits.

Moisture-holding capacity, topography, and native fertility are very important in affecting plant growth – and these all change with the type of soil.

As with breeds of cattle, different soils have different names. Over 400 individual soil types have been identified in Minnesota. You may be familiar with some of the more common soils such as Clarion, Fayette, or Fargo. These are names which were given to the soil when they were first described – Fayette and Clarion are counties in Iowa while Fargo is named after Fargo, North Dakota. Some soils named after Minnesota locations are Nicollet, Isanti, and Menahga.

A particular soil doesn't just "happen" to be there. The characteristics of a soil–texture, color, mineral content–are determined by the forces at work in building or developing a soil. Just as the surface landscape of an area – hills, lakes, and rivers – are determined by the local geology and climate, a particular site in the landscape is affected by the same forces. A soil, therefore, is a natural result of the effect of climate and vegetation on the surface material which may be bed rock or rocks ground fine by glacial action. This soil-forming process continued for a long period to form the soils we see today. The age of Minnesota soils ranges from over 16,000 years in the southeast and southwest to about 10,000 years old in central and the northwest parts of the state. This difference in the age of soil explains why there are many lakes in central and northern Minnesota but none in the southeastern section. Here natural erosion has continued for a sufficient time so that the lakes and bogs have been drained.

Type of native vegetation has a marked influence on soil type. Hardwood and evergreen trees and grass prairie were the main types in Minnesota as settlers moved in. Rainfall and temperature largely determined where these types grew; evergreens in the northeast with cool humid conditions, and prairie in the drier west and south. Hardwood trees mixed with evergreens formed a belt between these two types. As you travel the state today, you can see the effect of this native vegetation as light colored soils low in humus developed under trees; and dark, deep soils rich in humus or organic matter developed wherever prairie grasses grew.

Virtually all of the soils in this state originate from what is called glacial parent material. There are four major kinds of glacial deposits:

1. Glacial till - Deposited by the ice itself, this consists of a mixture of fine and coarse particles. These deposits cover most of the state and account for most of the productive soils.

2. Windblown deposits - This medium, fine silty material is called loess. It covers all or part of seven counties in the southeast and parts of three counties in the southwest. Soils are productive but erosive due to the texture and slopes.

3. Outwash - These are deposits laid down by fast moving melt waters of the glaciers. This water carried away the fine silts and clays leaving a sandy parent material. These areas are usually close to rivers and occur in extensive areas in the north central part of the state.

4. Lake-laid deposits - This deposit is a result of material settling out of quiet water which means the very fine clay is on the surface of the resulting soil. There were large glacial lakes in Minnesota such as Lake Agasiz and Lake Duluth. The level silty clay soils of the Red River Valley are a product of this parent material.

A close look at soil

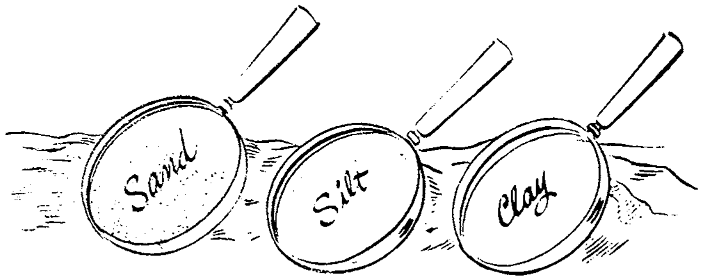
Many of the differences in soils described in the previous section are not apparent until you look below the surface. A close look at the upper 3 or 4 feet of soils shows changes with depth in color and structure (arrangement of particles) and sometimes texture (size of particles). These changes are the result of plant remains near the surface and the leaching effect of water. The surface dark layer or horizon is mainly small particles of rock but contains enough organic matter or humus to darken the color. This also makes the soil easy to work compared to a subsoil with no humus.

Below the surface horizon is a horizon intermediate in characteristics from that of the surface and the fresh parent material.

Parent material comprises the lower layer of the soil profile and consists of rock fragments from which the upper horizons were formed. Take a good look at the soil below the surface as this material to a large extent determines the crop production possibilities.

The texture of the soil

We have talked about some of the important characteristics of soil such as color, structure, and texture. Of these, texture is the most important. By texture we mean the fineness or coarseness of the soil particles. The normal range in size of soil particles is divided into three catagories: the coarse large particles are called sand; the intermediate, silt; and the very fine particles, clay. Clay particles can only be seen with a microscope. To illustrate the small size, it would take 12,000 clay particles to measure an inch in length. Soil texture then is the proportion of sand, silt, and clay in a soil.



Sand is gritty; silt is floury; clay is sticky when wet.

Following are the most important soil texture classes:

Silty clay—very fine, sticky when wet.

Clay loam—contains some sand but is primarily silt and clay.

Silt loam—this texture contains above 70-percent silt and is very desirable for agricultural use.

Loam—contains about equal proportions of sand, silt, and clay. When the soil is wet the sand particles can be felt.

Sandy loam—sandy in nature as they contain more than 50-percent sand.

Organic matter in our soils

Organic matter is one of the important components of good soil. The original supply of organic matter developed from vegetation and contributed to the growth of additional plant material and soil organisms by releasing essential nutrients as the tissue decayed. Because root systems are more abundant near the surface and stems and leaves are added at the surface, "topsoil" tends to have a darker color and contain more organic matter than layers deeper in the soil.

Soils vary in amount of organic matter present. The dark soils in southern and western Minnesota may contain as much as 160 tons of organic matter per acre. In the more sandy soils of northern and eastern Minnesota, an acre may contain only 90 tons or less.

Cultivation and cropping reduce the organic matter in soils

Under cropping soils have lost up to half of the original organic matter. A North Dakota study at Mandan showed the effect of 30 years of cropping on the organic matter content of the soil.

Table 2 - The 30-year effect of different cropping systems on the organic matter content of the soil.

Cropping System	Percent of Organic Matter Lost
Continuous small grain	19
Rotation of summerfallow and small grain	28
Rotation of summerfallow and corn	40
20 tons of manure on the fallow on a 4-year rotation of fallow small grain, corn, small grain	7

The loss of organic matter affects soils in several ways. Organic matter contains plant food elements including nitrogen and phosphorous. The organic matter serves as a storehouse of these elements. When soil is cultivated the decay of organic matter is hastened; this releases more of the plant food elements for crop use, but it reduces the supply in the storehouse. Cultivation acts much like opening the draft on the furnace; the fuel burns faster, more heat is given off, but more fuel must be added to keep the fire alive.

Another effect is that clay soils become tighter. They do not soak up water as quickly, they tend to be more cloddy when cultivated, and more rain water runs off causing more soil erosion. Sandy soils become less firm, and they blow more easily.

Poor Tilth

Good Tilth

Organic matter and soil management

It is not practical to try to maintain organic matter at original levels. In fact, studies have shown that with rotations with a large amount of sod crops, total organic matter gradually decreases.

However, it is important to get as much fresh organic material into the soil as possible each year. More important than the total organic matter level is that we have some material that is actively decomposing in the soil. This provides the desirable effect on soil tilth and water intake which we want. This can be done with all crops provided the unharvested residues are plowed down. It is also necessary to control water and wind erosion with appropriate practices to keep the more fertile topsoil in place.

There is a great deal more that could be written about soils; but if we have some understanding of the formation process and the role of organic matter, we can better understand the need for good soil management practices which include proper use of commercial fertilizer.

Plant nutrition

It is possible that even before Minnesota soils were farmed they varied widely in the amount and kind of mineral nutrients available to plants. It is now known that even on our best soils, one or more of the essential nutrient elements were originally present in short supply. In the early years farmers did not apply fertilizer to correct nutrient deficiencies either because:

(a) they did not recognize that the deficiency existed <u>or</u>
(b) fertilizers were not generally available.

During the period that Minnesota soils have been farmed large nutrient losses have occured through:

(a) Erosion: Each year water and wind remove millions of tons of topsoil containing great quantities of plant food.

(b) Leaching: Water seeps through the soil carrying plant nutrients to depths that roots cannot reach. On some soils leaching losses are severe.

(c) Crop removal: Selling crops off the farm removes large quantities of plant nutrients from the soil.

As Minnesota farmers further intensified crop production practices it was soon evident that if they were to produce high-yielding, high quality, and profitable crops, it would be necessary to "feed their crops from the bag."

Fertilizers contain certain of the essential nutrients needed for plant growth. Even with adequate moisture, sunlight, temperature, and good seed, the farmer cannot expect profitable crop production if he does not adquately feed the crop.

Nitrogen, phosphorous, potassium, magnesium, calcium, and sulfur are used by plants in large amounts. The first three elements are called "major" nutrients; the latter three are referred to as "secondary" elements. Boron, manganese, copper, zinc, iron, molybdenum, and chlorine are used in small amounts. They are referred to as "trace" elements. All these nutrients are essential and a shortage of any of the "major," "secondary," or "trace" elements results in poor plant growth.

Nitrogen, phosphorous, and potassium are the plant food elements most often needed in large amounts for good plant growth. These nutrients can be bought in fertilizer, either alone or in mixtures of two or all three. In some cases certain of the other "essential" elements will also be included in these fertilizers.

The law requires that each bag of fertilizer be labeled to show the percent of nitrogen, phosphate, and potash contained. The order of the nutrients is always printed the same so that a 6-12-24 grade of fertilizer, for example, means 6-percent nitrogen, 8-percent phosphate, and 24-percent potash. A bag of 33-0-0 contains 33-percent nitrogen but no phosphate or potash and is commonly called "ammonium nitrate."

Each of the elements has a specific role in the growth of the plant. Nitrogen is needed for leaf, stem, and seed growth. A plant with a shortage of nitrogen is usually pale green in color.

Phosphorous is used by plants to develop strong roots, form blooms and seeds, and to help use the nitrogen. When a plant lacks phosphorous it will be stunted with purplish leaves, and will have slow growth and delayed ripening.

Potassium improves the quality of the fruit and seed of plants. It gives disease resistance and strong stalks. When corn, for example, does not have enough potassium, the leaf margins turn brown.

THE SEED RESOURCE

Nearly all plants begin from seeds, but some can produce new plants without seeds being planted each year. A typical seed is made up of two major parts. The first is the embryo or germ. The new seedling plant develops from the embryo.

The second part is for food storage. This is called the endosperm in grasses, and cotyledon in legumes. Just as we need food from the time we are born, so does the young seedling plant from the time it germinates. Nature provides for a supply of food until the young seedling can obtain food from the soil.

Crop plant families

The two major crop plant families are the grasses and legumes. Many wild forms of these families were important in developing the organic matter of our soils. About 80 percent of the food we eat comes from grasses and legumes.

Breakfast cereal is made from some member of the grass family; either oats, wheat, corn, rye, or rice. Milk, eggs, and meat come indirectly from alfalfa, cereal grains, and soybeans.

Legumes produce nodules on their root system from the activity of certain soil bacteria (Rhizobium spp.) on the minute root hairs. Because of this relationship, legumes take free nitrogen from the air and "fix" it, storing the nitrogen in the nodules. The bacteria and legume plants use this nitrogen for food. However, when the plant dies or is plowed under, the nitrogen still present in the nodules can be used by following crops.

Grasses do not have the function of "fixing" nitrogen, but can benefit when grown in combination with legumes as is common in forage seedlings.

Growth habits of plants

All plants can be divided into two major groups based on their growth habit. One group is called annuals, the other biennial and perennial. Annuals all start from seed and will produce a new crop of seed within the year. The plant withers and dies, but the seed remains to start new plants the next year.

The second group is made up of biennial or perennial plants. Plants in this group live for 2 or more years, and generally do not produce seed until the second year after they are planted. For example: If you plant alfalfa this year, it will develop seedling plants that live over the winter. Next spring crown buds near the soil surface start to grow and new shoots develop on the plant. If you do not cut these plants they will flower and produce seed.

Many biennial and perennial plants reproduce from vegetative plant parts such as underground stems (rhizomes) and above ground prostrate stems (stolons). These plants then are not completely dependent on seed production for survival. The fact that they live over for several years makes them useful for livestock feeding and soil and moisture conservation.

Root system development

When a seed germinates, the first part to develop is the root. Once the root is established, the young plant can get food from the soil. Grasses have a more branching root system while legumes usually have a tap root which penetrates deep into the soil. Under drought conditions the legumes are usually less affected than grasses, as the tap root can obtain moisture and nutrients from deeper zones in the soil. Perennial grasses, however, usually survive drought periods, even though growth may be slowed down.

Seed development

We have seen that most plants begin from seeds. Have you ever wondered where seeds come from? All plants have flowers which contain the reproductive organs. Have you ever seen the flowers on grass?

In some plants like wheat, oats, and barley, the flowers are self-fertilized, Here the pollen from the male part fertilizes the ovary or female part within the same flower on the same plant. Fertilization is needed to develop a seed.

In other plants, cross-fertilization or pollination is the method for developing seed. In corn, rye, and most of the forage grasses, the pollen is spread from one plant to another by the wind. If fertilization takes place a new seed will develop.

Some cross-pollinated plants need help from insects, such as the honeybee. In alfalfa and clovers, the reproductive parts are held tightly within the flower. In order for pollen to shed, the flower must be opened. When a bee visits the flower for nectar, he "trips" the flower, and pollen is spread all over him. As he goes from one blossom to another in search of nectar, some of the pollen is left behind. Again, if the pollen grain gets to the ovary, fertilization takes place and new seed develops.

Seed quality

Because the seed planted is so vital to successful crop production it is important that the highest quality seed obtainable be used for planting. This applies both to purchased seed and home-grown seed.

The quality factors that should be considered in selecting seed are:

a. The crop and variety and whether it is adapted.

b. Freedom of the seed from other crop seeds as well as weed seeds.

c. Percent germination.

Both state and federal laws are aimed at protecting the seed buyer from getting poor seed when he buys through commercial channels. All seed sold in commerce must carry a tag similar to the one shown. This tag contains the information needed to help decide whether you want to plant this seed on your farm.

KIND OF
SEED ____________ VARIETY* ____________ LOT NO. ____________

PURITY % ________ GERM. % ________ HARD SEED % ________ GERM. DATE ________

WEED SEED % ________ INERT MATTER % ________ OTHER CROP SEED % ________

NOXIOUS WEED SEEDS ____________ NO. PER OZ. OR PER LB. ____________

GROWN IN ____________ (State or foreign country) COUNTY ____________ (Open pollinated corn only)

FOR HYBRID CORN: ZONE ____________ DAYS FOR MATURITY ____________ SINGLE CROSS ( ) DOUBLE CROSS ( ) TRIPLE CROSS ( )

DEALER'S NAME & ADDRESS ________________________

*Variety name is not required but if given must be correct.

When home-grown seed is used, it is a good idea to sample the bin or bags. Send about 1 pint of seed to the State Seed Laboratory for the purity and germination test.

The address is: Minnesota Department of Agriculture
Seed and Weed Section
Botany Building
St. Paul 1, Minnesota

Certified seed is your assurance of varietal purity in addition to high standards for mechanical purity.

CROP PLANTS AND THEIR ENVIRONMENT

Our common crop plants have been much influenced by their environment. Native plants to the Americas were corn, beans, and potatoes, all of which first grew in the region we now call Central America. It is likely that the climate was not as tropical in this region several centuries ago as it is today. However, we know that these three crops are grown in nearly all of the 48 states and parts of Canada indicating adjustment to an environment different from that of the native forms. Not only have extensive breeding programs developed varieties of these crops adapted to different environments within the United States, but these same plants have been introduced into other parts of the world to provide a staple food source.

Just as these plants have moved from America to other parts of the world, so plants from far-off Asia, Africa, Northern Europe, and the Middle East have become important crop plants in this country. Wheat, barley, and flax are believed to have developed in the Middle East. Soybeans were introduced from China, many of our forage grasses came from northern Europe, and our legumes from Europe and Africa. There are scientists who do nothing more than search the world for plants that might be adapted to the environment of some section of the United States.

And so we have countless examples of the way the natural environments of plants have been altered through breeding programs and changing cultural practices. However, everyday cultural practices can alter the growth patterns and yield potentials of the crops we now think of as native to our state and country.

Tillage

From the time man began to till the soil with a stout stick down to the presently used large field cultivators, plows, and disks, men have looked for easier, faster, better ways to till the soil. Many of the methods adopted destroyed the soil through compaction, or left the soil in such condition that it was more subject to erosion by wind and water.

Over the past three or four decades we have made a complete switch in our thinking as to what determines good tillage practices. In the 20's and 30's when many farms still depended on horses for power, plowing was shallow, discing and dragging was sufficient only to smooth the seedbed, and horses compacted the soil only slightly.

With the advent of tractor power, we thought it necessary to disc and drag the land until it was an "ash heap" and then do it once more to be sure. There was power to use and to burn. Of course, each trip over the field meant more compaction, destruction of soil tilth, and extra cost. The former well drained field began to develop trouble spots.

More recently with development of large power equipment we wonder why plowing and discing or dragging can't be done in one operation. We wonder if for some crops there may not be a real advantage to having a loose soil, except where the seed is planted. The term "minimum tillage" has become the byword for progressive soil preparation and yet we did this in the early 1900's without realizing its benefits for we had nothing with which to compare.

And so over a period of 30 to 40 years we have moved away from minimum type tillage, because our horse power dictated this, through an era of intensive tillage which was in many instances destructive. Out of necessity if we are to keep our soils productive, we must return to the concept of minimum tillage. By definition then "minimum tillage" is the practice of tilling the soil with a minimum of trips across the field.

It can have many combinations, such as fall plowing, with discing and dragging done in one trip over the field the following spring. It can be spring plowing, followed by one trip for discing and dragging. It can be only the use of the field cultivator, fall or spring. "Wheel track planting" with some crops can be a part of minimum tillage, but minimum tillage goes beyond this planting method.

Seeding

This is another cultural practice that has seen change over the years. It is one of the very important factors in producing a crop. With small grains it was and still is common in some parts of the state to use an "end gate" seeder, with the drag used to cover the seed. However, the grain drill is the more accepted method, and to assure good stands in the drier areas, packing or press wheels have been added.

With row crops some changes have been made, but many are still needed. Row width has been determined more by what was needed for horses to get between the rows than what was needed for the crop. However, research has shown higher yields and profit are possible with narrower rows. The major problem is equipment that will plant, cultivate, and harvest from the narrower rows.

Methods of planting row crops, especially corn, have moved rapidly from check planting to power check and drill planting. This has been made possible by equipment changes, better stalk strength in hybrids, improved weed control through use of herbicides, and substantial evidence of the advantage of higher population in getting the most profitable yields per acre when sufficient fertilizer is used.

With forage crops there has been a slow movement to seeding without companion crops. Where forage seedings are made with a small grain companion crop, "band seeding" has assured better establishment because the small seedlings come quickly into contact with the fertilizer applied in the band.

Another important link in successful crop production is the use of good seeding practices, practices that will result in good stands that can compete with weeds, feed on supplied or natural fertility, and produce a profitable crop.

Harvest and storage

Many farmers do a good job of fitting the land; selecting and planting the seed; caring for the crop by proper fertilization, weed, disease and insect control; but destroy much of their effort when they harvest and store. When the crop is ready to harvest, the success of crop production depends on how much of the crop is finally put into storage for later feeding or sale as a cash crop.

Harvesting the crop

With small grains and other combined crops, part of the crop may be left in the field because of improper combine operation. All too often the combine is set for conditions when the day's operations begin and the grain has higher moisture content. As the day progresses, the grain dries and so the combine should be adjusted to avoid hulling oats; cracking wheat, soybeans, or flax; and skinning and breaking barley. By looking at the grain and straw coming over the tailings gate and off the straw rack you can tell a great deal about field losses in harvesting.

A study in Ohio of soybean harvest showed the following losses:

Table 3 - Effect of harvesting speed upon losses of soybeans by source*

Source of loss	Loss pounds per acre at varying harvest speed MPH		
	2.5	3.2	5.0
Cylinder, rack, and shoe	20	20	21
Shatter	118	111	152
Stubble	38	61	109
Lodged and stalk (pods that do not get into combine)	35	43	67
Total	211	235	349
Harvesting efficiency	90 percent	88 percent	82 percent

* Ohio State University

Farmers report average losses of only 100 pounds, but these were under more varied conditions of time and operation than were the losses in the research study.

Corn harvest may leave from 3 to 20 percent of the corn in the field depending on how stiff stalked the hybrid is, how firmly the ear is attached to the stalk, and how well the picker or sheller has been adjusted. Table 4 shows losses that have occurred in corn harvest with the picker sheller.

Table 4 - Typical losses in corn yield when harvested with a picker sheller at varying moisture percentage

Source of loss		Percent moisture at harvest 30	26	22	18	14
		bushels per acre				
(1)	Pre-harvest ear loss	1	1.5	2.2	3.5	4
(2)	Shelled - lost at snapping rolls	5	4	4	5	7
(3)	Ears - knocked off by picker	3.5	4	4.3	5	5.2
(4)	Kernel - losses in sheller	1	.5	.5	.5	.3
(5)	Total	10.5	10	11	14	16.5

This data indicates that the least loss occurs between 22- and 30-percent moisture. Twenty-seven percent has been about optimum in Minnesota trials.

With forage crops we know that much of the feeding value is lost by delayed cutting, poor drying conditions, raking at too high speeds, or poor adjustment of baler or chopper. The figure below shows the importance of early cutting if we are to get the greatest feeding value from forage crops.

Storing the crop

After the harvest, crop losses still occur in storage. With grain and seed crops it is very important that storage bins be cleaned well in advance of harvest. In addition, grain should be dry, between 14- and 15-percent moisture for storage periods of 1 to 3 months, but below 13-percent for longer periods of storage. Ducts for good air movement should be available in event of grain being too wet as it moves into storage.

The storage bin should be checked for holes that allow rodents and birds access to the storage. Grain contamination is one of the major discount factors in marketing grain and in cases of grain intended for human food it can result in refusal for that purpose. After the grain is in storage it should be checked each week to be sure that it is not heating or being infested by insects or rodents.

The type of storage for forage crops can affect feeding value. Hay stored in the field in small, poorly built stacks results in high losses. If the hay was too wet going into storage, it will heat and not only destroy feeding value, but possibly even burn the barn. Some farmers use a system of drying partially field-cured hay in the barn by moving unheated air through the haymows with a large fan and suitable air ducts.

Silage stored in airtight silos will lose little of its feeding value if put up at the right moisture content. Even when stored in trench or bunker silos, losses can be kept to a minimum by good packing and capping with moist plant material or plastic sheets.

There are many references covering storage which you will find helpful listed under references on page 16.

WEEDS AND THEIR CONTROL

Weeds reportedly exact 3.5 billion dollars from United States farm income. This cost is from reduced crop yields and increased production costs.

Weeds are also a major problem to successful crop production on Minnesota farms. This problem is not hopeless, however, and can be solved if people become interested enough. To become interested, they must first know weeds, and secondly know how to control them.

Weeds cost money in the following ways:

1. Weeds compete with crop plants for water, plant nutrients, and sunlight. Crops may have to be cut before they are mature if weeds are too troublesome.

2. Weeds add work and expense to harvesting.

3. Weeds add expense to preparing crops for market.

4. Weeds reduce market value of crops.

5. Poisonous weeds can kill livestock or leave them in an unthrifty, unprofitable condition.

6. Weeds can taint milk and other livestock products.

7. Weeds may cause irritation to man and involve medical cost for relief.

8. Weeds may be hosts for plant diseases and insects which spread to crop plants.

9. Hundreds of dollars are spent yearly on each farm to control or eradicate weeds.

10. Weeds reduce the value of farm property when serious weeds are present.

There are four major methods for control of weeds. They are as follows:

1. Prevention

2. Crop rotation and cropping practice

3. Cultivation

4. Herbicides

Prevention is the most important but often most neglected method of weed control. If the farmer is particular about the quality of seed he plants, many troublesome weeds will never get a chance to start. The state and federal seed laws offer protection from planting poor quality seed by having standards set for maximum weed seed content for seed sold in commerce. When home-grown seed is used it should be carefully cleaned and germination determined before planting.

Drill box surveys carried out in Minnesota indicate that the quality of planting stock on many Minnesota farms is very low. One sample picked up in the survey contained 180 Canada thistle per pound. The seed containing this pest was putting back 13,000 seeds per acre. Other examples with other culled seeds show that some planting stock is not suited for seed.

Crop rotations and cropping practices

These are excellent ways of controlling weeds. Pasture and hay crops cut two or three times each year can prevent seed formation and weaken weed plants. Cultivated crops may provide better control of some weeds than others. Most weed seeds if ensiled will be completely killed after the first 2 to 4 weeks in the silo.

Cultivation

Cultivation may be the best way of controlling large areas of perennial weeds. Quackgrass and Canada thistle, and most annual type weeds are often best controlled by timely cultivation.

Herbicides are a useful supplement to the control methods above. However, present chemicals will not do the complete control job above.

It is important that label instructions be followed carefully to avoid crop injury and problems from harmful residues. Also avoid personal injury by following directions for handling.

References

It is difficult to be all-inclusive in a handbook of this type. Rather, some high points have been covered that should make you more familiar with the various phases of crop production. A group of references are suggested for further reading, and with this source you should be able to guide 4-H Agronomy project members through a successful program.

Principles of Field Crop Production. Martin and Leonard, MacMillan Co., New York

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1958	Land
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Bulletins:

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Soybeans for Minnesota, Ext. Bul. 134.
Maturity Ratings for Corn Hybrids in Minnesota, Misc. Report No. 20.
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Folders:

Weed Control in Field Crops, Ext. Folder 212.
Grass Silage, Ext. Folder 181.
More Profits From Malting Barley, Ext. Folder 68.