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Sugar Beets

IN DIVERSIFIED
IRRIGATION FARMING



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Sugar Beets in Diversified Irrigation Farming

LIONEL HARRIS AND J. C. SWINBANK¹

HIGH CROP YIELDS NECESSARY

Irrigation farming is an intensive type of agriculture, and production costs are higher than those for dry-land farming. Basic production costs—seed, fertilizer, seedbed preparation, cultivation, and harvesting—are the same whether yields are high or low. The irrigation farmer has the additional expense of establishing and maintaining ditches and distributing water over his fields. Chances of making a profit are good only when high yields can be produced.

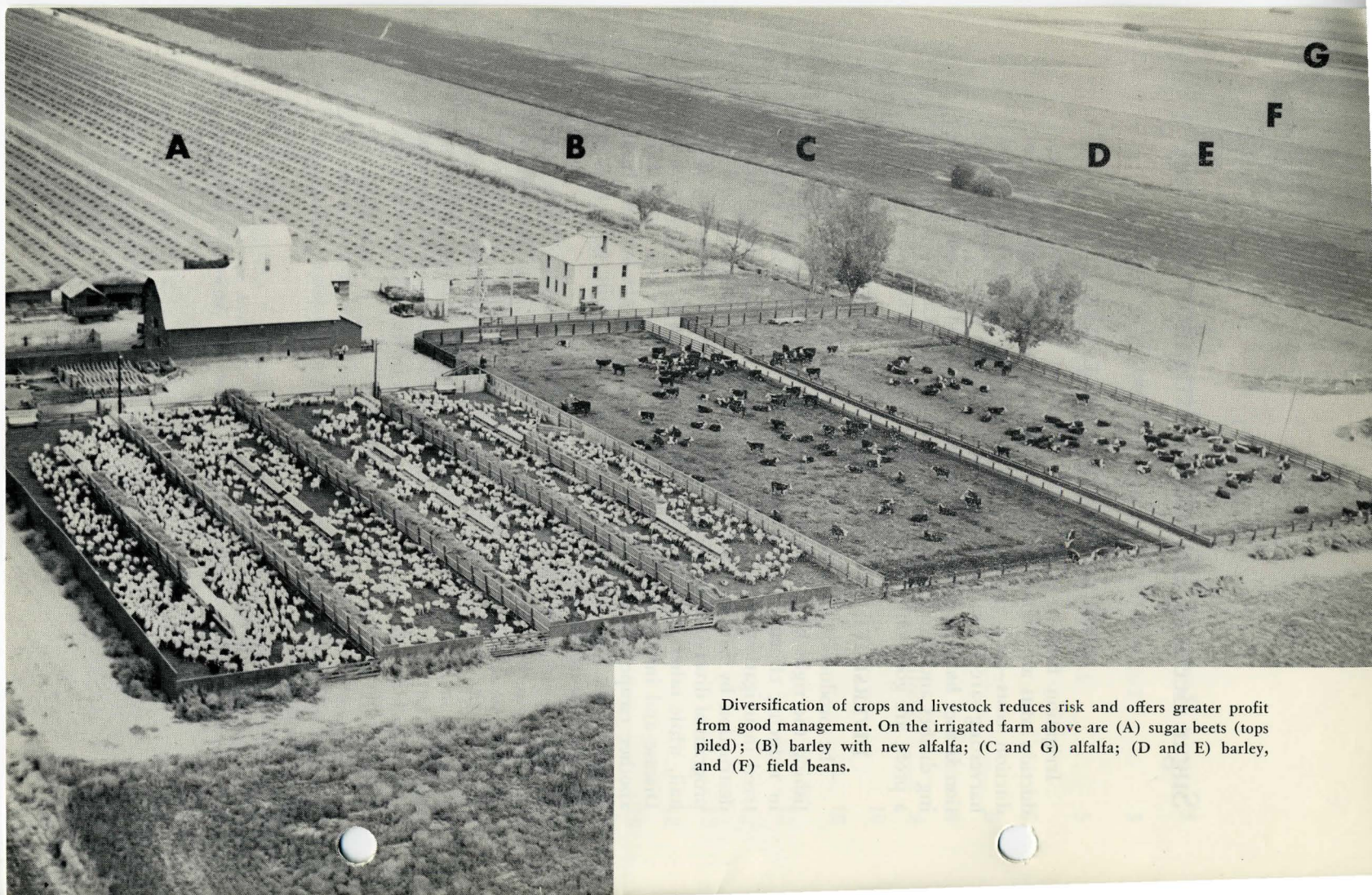
DIVERSIFIED FARMING PROGRAM IMPORTANT

The production of several different crops is important in establishing the right kind of crop rotations, and is of great importance in reducing climatic, disease, insect, and economic hazards encountered in irrigation farming. For example, in the Plains Region crop destruction by hail frequently causes great economic losses. Under a program of diversified farming some crops may be entirely destroyed by hail, while others recover and produce some returns for the farmer. Disease and insects may at times practically destroy one crop while another escapes damage. Under some conditions the returns from certain crops may not cover production costs, while good returns are received from other crops.

Many prudent irrigation farmers diversify their operations still further by feeding livestock, through which they can market some of the crops produced and also develop a supply of manure on their own farms. Still further diversification may be desirable and can be brought about by maintaining several different kinds of livestock, including dairy cattle, hogs, lambs, and feeder cattle. If returns from one class of livestock are low, the farmer is protected by the possibility of good returns from some other livestock operation.

Too much diversification, involving several sets of equipment or many small projects, may lead to inefficient use of labor, capital, and management.

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Diversification of crops and livestock reduces risk and offers greater profit from good management. On the irrigated farm above are (A) sugar beets (tops piled); (B) barley with new alfalfa; (C and G) alfalfa; (D and E) barley, and (F) field beans.

SUGAR BEETS IN THE DIVERSIFIED PROGRAM

In a diversified system of farming under irrigation, the production of sugar beets is worthy of careful consideration. The sugar beet crop responds to good culture and fertilization practices, and returns high yields. It is seldom completely destroyed by hail. In fact, the sugar beet crop usually makes a remarkable recovery after hailstorms. As a result of improved varieties and control methods, the sugar beet plant is seldom destroyed completely by diseases or insects. Sugar beets also provide high quality livestock feeds, including beet tops, molasses, and dried pulp. These by-products provide a basis for livestock feeding, which diversifies and strengthens the entire farming business.

Sugar is a combination of carbon, hydrogen, and oxygen. These elements are obtained by the sugar beet plant from carbon dioxide in the air and from water in the soil. The twelve other nutrient elements required by the plant and obtained from the soil occur in the beet tops, in the beet pulp, and in the beet molasses. When these by-products of the sugar beet are fed to livestock and the manure is plowed under, a large proportion of the nutrient elements previously taken from the soil is returned.

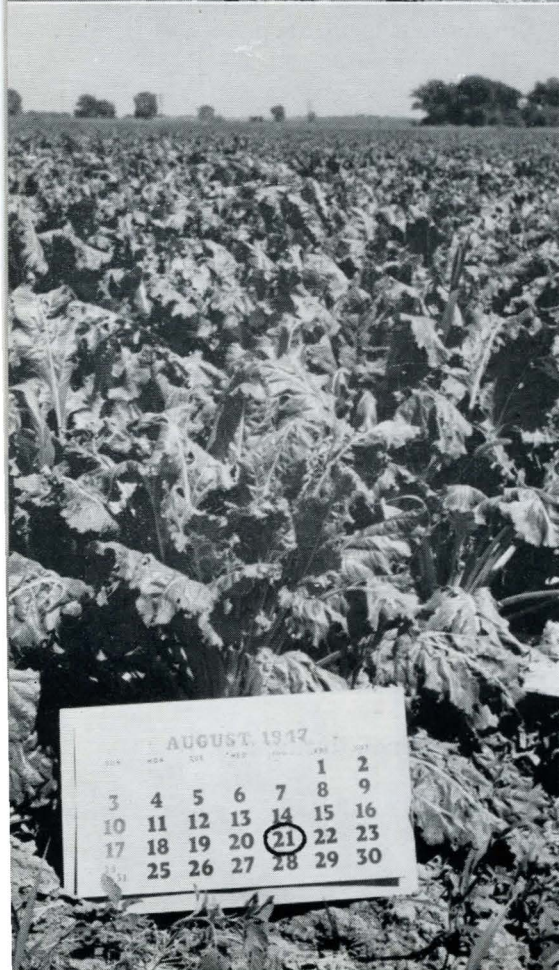
MAINTAINING HIGH SOIL PRODUCTIVITY

Importance of Knowing the Fertility of the Soil

To produce maximum crop yields a farmer should have an extensive knowledge of the productivity of each field or area on his farm. Experiments indicate that the combined use of legumes, farm manure, and commercial fertilizers will produce the highest possible yields. A well planned and systematic crop rotation program, together with years of experience, will greatly aid farmers in adopting the most satisfactory and economical fertilization practices for each crop and for each field or area.

Maintaining soil fertility through crop rotations and fertilizers. Extensive crop rotation experiments, which included sugar beets, were conducted at the Scotts Bluff Experiment Station from 1912 to 1949. Sugar beets responded favorably to applications of farm manure and to the use of legume crops in the rotations. The use of farm manure in nonlegume rotations increased the yield of sugar beets approximately 10 tons per acre as compared with rotations which did not include manure. The use of manure in rotations which included legumes increased the yield of sugar beets approximately 4 tons per acre.

Despite these responses to manure and legumes, during a 30-year



Sugar beets are a valuable crop in diversified irrigation farming. They are seldom destroyed by hail, insects or diseases. In addition to being a hardy crop, sugar beets fit into rotations, produce high yields and a dependable cash income, and supply valuable feed for livestock.

The field above was hailed on June 19, but the beet crop made a remarkable recovery in the following two months. The photograph at the left shows the same field on August 21.

period, yields of sugar beets declined in all rotations except those where farm manure was applied once in two years at the rate of 12 tons per acre in a two-year rotation of beets and potatoes. In most instances the applications of manure were insufficient to maintain high yields. The production of alfalfa or sweetclover as green manure crops in a rotation maintained the yield of sugar beets and other crops at a much higher level than where legumes were not grown, but still did not prevent a decline in yield over a 30-year period.

Nitrogen was maintained at higher levels in the soil where legumes were included in the cropping system or when manure was applied than where neither practice was followed. However, the nitrogen level of the virgin soil was maintained only where both practices were followed in the cropping system.



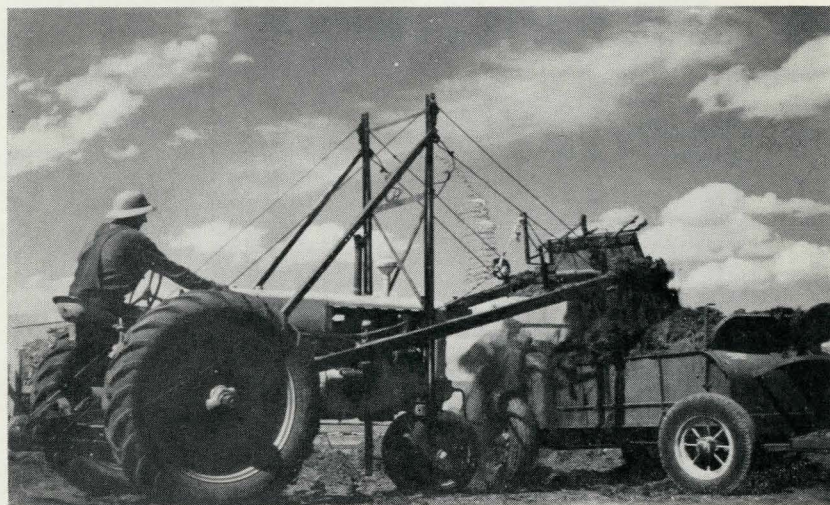
The grower should determine the fertility of each of his fields. Soil tests will help.

There was a definite decline in phosphorus level of the soil where legumes were included in the cropping systems. Manure applications tended to reduce the decline in phosphorus level of the soil due to the growing of legumes. Only when 12 tons of manure were applied each two years in a nonlegume rotation was the phosphorus level of the soil maintained.

During the eight-year period 1942-1949 applications of commercial nitrogen and phosphorus fertilizers were compared with applications of farm manure for the production of sugar beets and other crops in rotations. An attempt was made to apply the same amount of nitrogen and phosphorus in commercial fertilizer as was derived from a given application of farm manure. During the eight-year period the commercial fertilizer treatments of phosphorus and nitrogen produced the same or slightly higher yields of beets than did corresponding applications of farm manure.

Correcting deficiencies in soil fertility with fertilizers. Deficiencies in soil fertility should be corrected as one of the first steps in producing any crop. The amount and kind of commercial fertilizer or manure to use depends upon the general location of the farm, soil type, and past cropping and fertilizing practices.

Nitrogen fertilizer is likely to be needed for optimum sugar beet production in the North Platte Valley where little attention has been



Barnyard manure supplies all the necessary elements for crop growth, but is not well balanced. It is a good source of nitrogen but is low in phosphorus. In most cases, manure should be supplemented with phosphate fertilizer.



For maximum yields, manure and legumes should be supplemented with commercial fertilizers. The effect of superphosphate (plowed under in the spring) is shown on the right. The check strip on the left had no application of phosphate.

given to the use of legumes and manure. Sandy soils are more likely to be deficient in nitrogen and phosphorus than heavier soils. Phosphorus is more likely to be deficient in limy soils than in nonlimy soils.

Nitrogen may be applied satisfactorily as ammonium sulfate, ammonium nitrate, ammonium chloride, urea, anhydrous ammonia, and solutions of any of these. In tests at the Scotts Bluff Experiment Station yields of sugar beets were the same under the influence of equal rates of nitrogen applied as ammonium nitrate and anhydrous ammonia.

The amount of available nitrogen in the soil affects the sugar content of sugar beets. Excessive available nitrogen tends to reduce sugar content. In some areas, and in some types of farming, this fact needs careful consideration by the farmer in his use of nitrogen fertilizer. In the experiments at the Scotts Bluff Station the application of manure to sugar beets in a rotation had very little effect on the sugar content of the beets; legumes in the rotation increased top growth and tended to reduce sugar content. In most instances, however, proper application of nitrogen fertilizer will increase both the yield of beet roots and sugar per acre.

The influence of crop rotations and fertilizers on the yield and composition of the beet crop is illustrated in the table on page 11.

Nothing is gained by heavy application of phosphorus fertilizer when nitrogen is the limiting factor for growth of sugar beets. During the period 1912 to 1936 a two-year rotation of spring wheat and sugar beets without fertilizer treatment was conducted at the Scotts Bluff Station. By 1936 the yield of sugar beets in the rotation was about 6 tons per acre. The sugar beet plants were small and unthrifty, the tops were light yellow in color, and the plants stopped growth early in the fall. During the period 1937 to 1941 treble superphosphate applied annually at the rate of 300 pounds per acre to the sugar beet crop in this rotation did not change the yield or the general appearance of the beet plants.

In later experiments in this rotation, large yield increases were obtained by the use of nitrogen fertilizer. These results demonstrate the importance of applying the right kinds and amounts of commercial fertilizers. The farmer should have a thorough knowledge of the soil fertility needs in each of his fields.

With the development of commercial fertilizers that have different physical properties, new techniques and applicators are required to apply them to the soil and crop. When anhydrous ammonia and fertilizer solutions are used, metering devices are needed to insure accurate amounts.

Controlling soil erosion to maintain fertility. Soil washing and blowing may be serious in irrigated fields. Since more fertility is often lost through erosion than is removed in harvested crops, erosion control is essential for maintaining top yields.

Water erosion is caused largely by improper handling of irrigation water. Wind erosion results when the land is left unprotected during winter and early spring. It can be controlled by growing cover crops and by using crop residues and manure to protect the land surface.

Cattle grazing a brome-grass-alfalfa pasture. Legumes in the crop rotation can be utilized for pasture or green manure and are essential in maintaining soil fertility.



Average yields of edible beet top silage, sugar beets, and gross sugar in different types of rotations at the Scotts Bluff Experiment Station, 1942-1947.

Number of rotations	Type of rotation and treatment	Mean yield		Edible silage per ton of beets	Moisture in tops at harvest	Sugar in beets	Gross sugar per acre
		Edible beet top silage	Sugar beets				
		tons/a.	tons/a.	lbs.	%	%	lbs./a.
II	2 Untreated nonlegume rotations	2.14	6.1	702	64.9	18.1	2235
	4 Untreated legume rotations	5.51	11.8	940	71.4	16.0	3783
	4 Manure in nonlegume rotations	5.37	14.3	751	70.8	17.5	5020
	4 Phosphorus and nitrogen in nonlegume rotations	4.97	14.6	677	70.3	17.4	5079
	3 Manure in legume (alfalfa) rotations	8.43	16.5	1024	75.9	14.8	4908
	3 Phosphorus and nitrogen in legume (alfalfa) rotations	7.38	15.3	966	74.1	15.6	4818
	2 Manure in legume (sweetclover) rotations	6.15	13.4	919	71.2	16.6	4460
	2 Phosphorus and nitrogen in legume (sweetclover) rotations	7.24	14.6	991	76.2	14.8	4313

Crop Rotations Important in Controlling Disease

Recent studies of the presence and development of the root knot nematode disease in sugar beets at the Scotts Bluff Station indicate that crop rotations have been important in reducing the damage from this disease. In 1933 and 1934 a survey showed that root knot nematodes were present in sugar beets in the short rotations, but none was observed in sugar beets grown in rotations four or more years in length. In 1946, or after a period of 35 years, the disease was present in beets to a limited extent in the four- and six-year rotations. The use of farm manure or commercial fertilizer in the two-year rotations reduced the damage from the root knot nematode disease.

Root rot diseases have also been more prevalent in the short rotations.

CULTURAL PRACTICES

Preparing the Seedbed

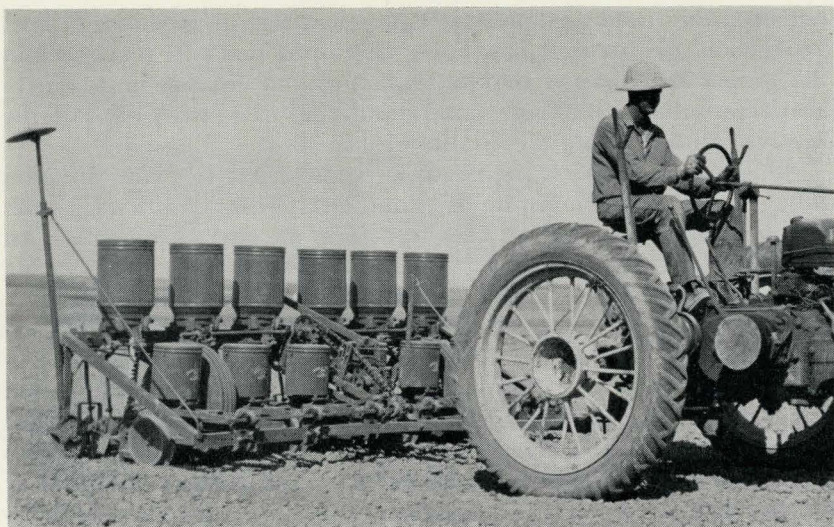
Sugar beet seed should be planted in a firm, moist seedbed. Fall preparation is recommended on heavy soils—in fact, all soils excepting light sandy soils, sandy loams, and alkali soils. Obviously, soils which tend to pulverize or blow must be worked in the spring close to planting time.

Plowing is a useful practice for incorporating manure or crop residues into the soil. In the spring after the soil has been plowed, it is packed with a subsurface packer or disk and then smoothed with the leveler and harrow. Leveling the ground makes planting, cultivation, and irrigation easier.

After the ground has been leveled or floated, a harrow will elevate small clods to the surface and provide protection against wind erosion. In preparing the seedbed, avoid unnecessary operations which only increase the expense and result in excessive packing. Too much packing of heavy soils may have an undesirable effect on the soil structure.

Seeding

Time of seeding. In the North Platte Valley length of growing season may limit the yield of sugar beets. Weather conditions in the spring have a bearing on planting date but, in general, early planting (during the first half of April) is desirable. In tests at the Scotts Bluff Station early planting and irrigation for emergence have produced large yield increases in some years. In other years these practices have reduced yields because of frost damage to the sugar beet seedlings. Under any condition, the sugar beet grower should plan to take advantage of all the growing season available.



Timely and careful planting, immediately after seedbed preparation, is important. Six-row planters make it possible to plant quickly, thus conserving soil moisture and allowing beet seed to germinate ahead of weed seeds. Early planting helps the farmer take advantage of the full growing season.

Sugar beet breeders are well on the way to producing cold-resistant beets. Already some varieties of sugar beets have been developed that will withstand temperatures as low as 18 degrees in the spring. Further gains in frost resistance are in the making.

Rate of seeding. Sugar beet seed is now segmented by breaking the multiple-germ seed ball into segments that contain approximately 50 per cent single-germ units. This segmented seed is planted at the rate of 5 to 6 pounds per acre, as compared with the former practice of planting 20 pounds of whole seed per acre. Precision planters are being developed to use less seed and yet give a good stand which may be thinned mechanically. Planting must be done slowly enough to insure uniform dropping of the seed and good seed coverage.

Plant breeders are developing a single-germ beet seed equal to the commercial varieties in tonnage, sugar content, and disease resistance. This may be accomplished within the next five years.

Depth of seeding. Sugar beet seed is usually planted 1 to 1½ inches deep. Earlier plantings are usually made at a depth of 1 inch and later plantings at a depth of 1½ inches. The seed should never be planted deeper than 1½ inches.

Equipment for seeding. The best possible stands of beets are required to insure maximum yields. Although planting equipment has

not been improved as rapidly as equipment for other phases of beet production, planters are now being developed that will place seed at the proper spacing and depth. This improved equipment will help growers to obtain uniformly good stands and will justify the expense involved in improving the quality of beet seed.

Once the seedbed is prepared, it is important to plant the crop promptly before the moisture dries out. Delay also permits weed seeds to germinate ahead of the beet seed. For these reasons there is an increasing use of six-row beet planters which are capable of operating accurately at higher speeds.

Skillful operation of the drill is important in obtaining a good stand. Pressure wheels should be properly adjusted for the soil conditions prevailing. Development of crusts on the soil after the seed has been planted sometimes makes it difficult for the beets to come up. Crusts can be broken by rolling or cultivating. Several devices have been developed recently to break crusts formed above sugar beet seedlings. Soil crusts are usually not so great a problem on early-planted sugar beets as on late plantings.

Blocking and Thinning

Seedbed preparation, date of planting, rate of seeding, and irrigation to get the crop up all have a bearing on whether beets can be thinned mechanically.

Sugar beets have traditionally been blocked and thinned by hand during the four- to eight-leaf stage. A delay in thinning until the 10- or 12-leaf stage usually results in lower yields. Sugar beet plants should be spaced 10 to 12 inches apart in rows 20 inches apart. During recent years rows have been spaced 22 to 24 inches apart to make mechanical harvesting easier. In these wider rows beets should be spaced closer in the row to avoid loss in yield. Uniformity of stand is important in producing maximum yields.

Complete mechanical thinning of sugar beets is now an assured success and makes timely thinning possible. In 1952 beet growers in western Nebraska thinned more than 4,000 acres of sugar beets with machines at a saving of approximately \$10 per acre over that of hand labor for the season. Beet growers are adopting the practice of mechanical thinning more rapidly than they adopted mechanical harvesting.

The machine used for thinning beets is a rugged four- or six-row type that travels down the row. Each row of beets is thinned by a revolving cutter head equipped with eight to sixteen blades that rotate at right angles to the row. With a single six-row machine it is possible to cover a 40-acre field in one day. The usual practice is



Thinning beets the old way (above) is tiring work—slow and expensive. Delays in thinning usually result in reduced yields. Modern machines (below) make complete, mechanical thinning possible. Cheaper and more efficient than hand thinning, the new method also makes it easier to do the job “on time.”

to delay using the machine until the beets are well rooted and are $1\frac{1}{2}$ to 2 inches high. If more than 100 to 120 beets per 100 feet of row remain after thinning, a second operation with the machine is used to reduce the stand further. The machine gives an in-the-row cultivation that eliminates weeds and excess beets, and thereby conserves moisture and soil fertility.



Chemical weed sprays are proving a boon to sugar beet growers for the control of wild oats, volunteer grain, and shallow-rooted grasses. The plot at the right was treated with IPC which was disked in ahead of beet planting. Untreated plot at left.

Weeding and Cultivating

Cultivation controls weeds and provides furrows for irrigation. Weeds compete for both water and plant nutrients and should be eliminated by proper cultivation and supplemental hand work. Shallow cultivation is desirable to avoid cutting the roots.

Tractor-mounted cultivators make for faster and more precise cultivation of crops, particularly with respect to closeness to the row and, in some cases, in-the-row cultivation to remove weeds and mulch the plants.

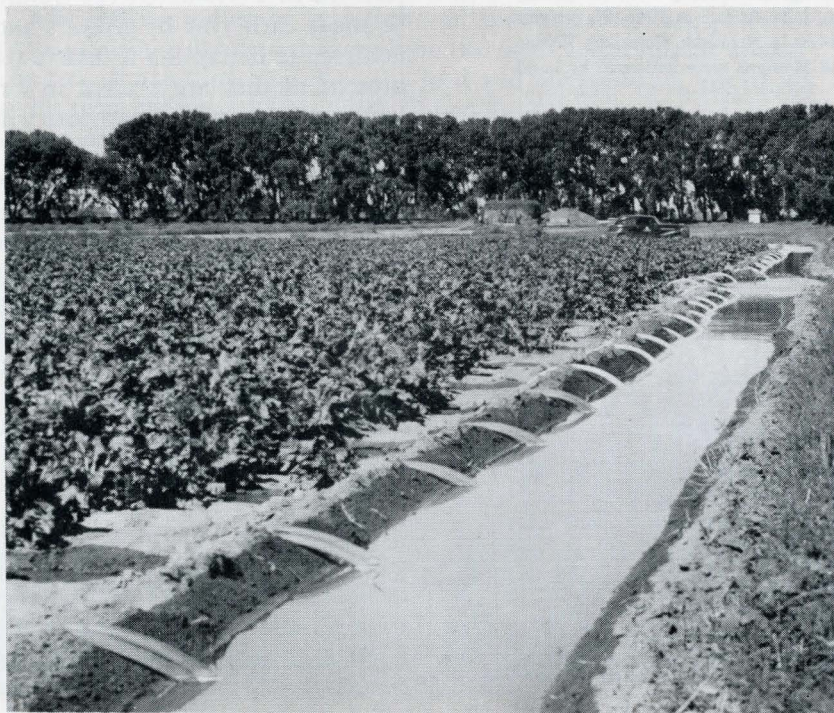
Chemical control of weeds is still in its infancy, but experiments during the past two years promise great possibilities for its future success on a mass basis. The most promising characteristics of the various chemicals are their selectivity and economy for controlling weeds and grasses in the row. Wild oats and volunteer grain have been almost completely controlled by the use of IPC applied at the rate of 3 to 5 pounds per acre and disked in to a depth of 3 inches immediately before planting. IPC does not control shallow-rooted grasses, however. Where ample spring rainfall is received, excellent control of shallow-rooted grasses has been obtained by the application of sodium TCA, which is sprayed on the soil at the rate of 5 to 8 pounds per acre just before the beets come up. Where rainfall is inadequate to carry the chemical TCA down into the soil, irrigation for germination will supply the needed moisture.

Irrigating

For maximum yields irrigation water should be applied often enough to maintain constant, vigorous and thrifty plant growth. The soil should never be allowed to dry so much that plants wilt excessively. Late irrigations delay maturity and reduce the sugar content of beets, and should be applied only when necessary to facilitate harvest operations.

For efficient use of irrigation water, the depth to which the moisture penetrates should be as uniform as possible throughout the field. If rows are too long the upper part of the field is overwatered before the lower part is adequately irrigated. As a general rule it is desirable to keep the rows short. Cross ditches can be used to shorten the runs. Experimentation and frequent use of a soil auger will indicate the best length of run for each field. The furrow stream must be small enough so that there will be no soil erosion.

A good crop of sugar beets will remove about 30 inches of water from the soil. This includes both the water added by irrigation and



Timely irrigations to maintain constant, vigorous and thrifty plant growth are essential for maximum yields. Good water control saves irrigation water and soil.



Harvesting beets the old way. Hand topping, piling, and loading were slow, back-breaking jobs. At late as 1946, 91 per cent of the beets in Nebraska, Colorado, Wyoming, and Montana were harvested by hand.



Harvesting machines now lift, top, and load the beets in one operation. Most beets were machine-harvested in 1952.

natural precipitation. Experiments have shown that the sugar beet plant takes about 65 per cent of the total water used from the top foot of soil and 85 per cent from the top 2 feet of soil. Soil moisture to a depth of 6 feet may be utilized.

Controlling Insects

The beet webworm is the most serious insect pest of sugar beets in Nebraska. Occasionally webworms develop so rapidly that severe defoliation may result before growers are aware that they are present. Grasshoppers, pale-banded flea beetles, root aphids and certain kinds of leafhoppers occasionally injure beets. Periodic checks should be made each year by growers and fieldmen to determine if insects are present. If they are present in serious numbers, control measures will be required.

In recent years great strides have been made in the use of new and effective insecticides in powder or liquid form. By the use of either high-pressure or low-pressure power ground sprayers or of airplanes these insecticides may be applied to large areas in a short time and before the pests can materially damage the crop.

Harvesting

Most sugar beets are now harvested mechanically. The difficulty of obtaining enough hand laborers forced rapid mechanization of the harvesting of sugar beets. It is estimated that 91 per cent of the crop was hand harvested in 1946 whereas 90 per cent was mechanically

harvested in 1952. There is evidence that beet harvesting machines will be improved for better field performance, for greater durability, and perhaps for lower initial and operating costs.

Difficulties in recovering tops with early mechanical harvesters are rapidly being overcome by improvements in the machines and farmers' methods of conserving them.

BEET BY-PRODUCTS FOR LIVESTOCK

Beet tops, beet-top silage, molasses, and dried beet pulp are all used successfully in feeding livestock. Sugar beet tops fed to livestock, with the livestock manure returned to the fields, are considered to be worth three times as much as they are when "beaten off" and plowed under as green manure.

Field-cocked beet tops are readily eaten by cattle. For fattening cattle, the tops should be fed with legume or other roughages and with concentrates to obtain best results. It is considered good practice to give cattle free access to ground limestone and salt when they are being fed on beet tops, or to feed about 2 ounces of ground limestone per 100 pounds of tops.

The feeding values of beet tops and beet-top silage are probably comparable on a dry-matter basis if the two feeds are of similar quality. The cost of handling and using the feed and the probable loss of nutrients from the time the beets are topped until the tops are fed should be considered in determining whether or not to ensile them.

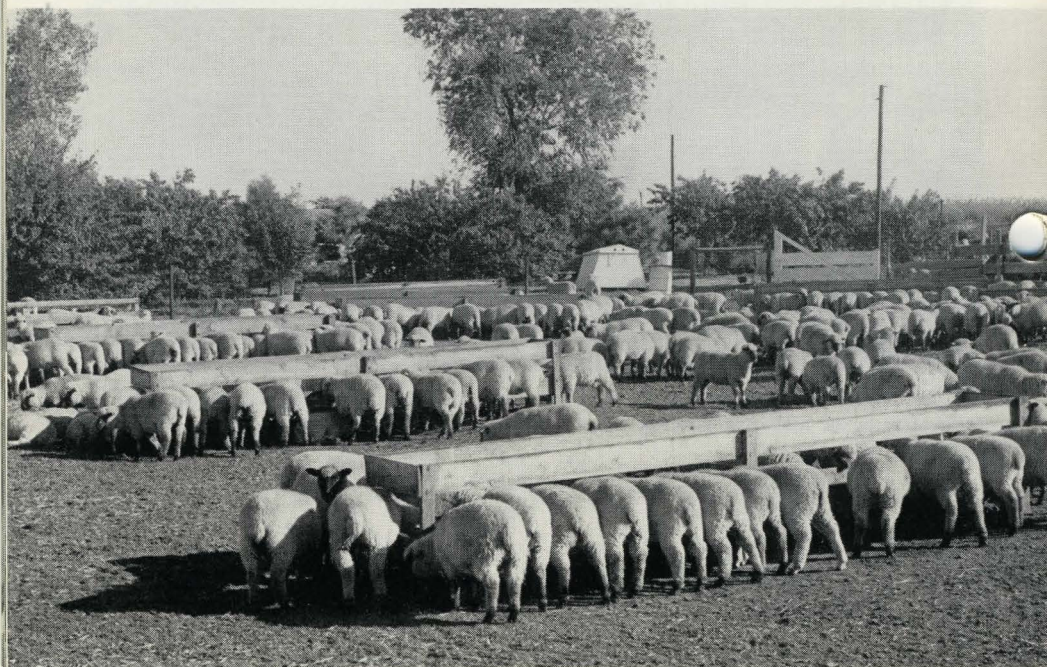


The feeding values of beet top silage and cured tops are comparable on a dry matter basis. More of the feed is saved when tops are ensiled in a trench or stack.

Three types of beet molasses are available for livestock feeding. These are (1) non-Steffens or foreign molasses, (2) Steffens molasses, and (3) Johnstown "B" molasses, which result from different processes. There is little difference in nutritive value between the first two products, which are similar to cane molasses in sugar content. The third product, Johnstown "B" molasses, is a saccharate filtrate relatively low in sugar but high in protein and mineral matter. For cattle, not more than 4 pounds daily of non-Steffens or Steffens molasses or 2 pounds of Johnstown "B" molasses per 1000 pounds of live weight is recommended. It usually is considered that 100 pounds of beet molasses will replace about 75 pounds of the grains ordinarily used in fattening cattle in the beet producing sections.

Dried beet pulp may satisfactorily replace as much as half of the corn in cattle fattening rations. In three trials with yearling steers at the North Platte Experiment Station, a mixture of equal parts by weight of ground shelled corn and dried beet pulp proved to be fully as good as ground shelled corn alone or a mixture of two-thirds corn and one-third dried beet pulp, when judged by rate of gain, economy of gain, selling price, or carcass yield and grade. The steers were fed for an average of about seven and one-half months and made average daily gains of 2.2 pounds per head. Somewhat different rations were used in the three trials, but all included protein supplements, silage, and other carbonaceous roughages. In two of the three trials alfalfa hay also was fed.

Lambs on good beet top silage, grain, protein and alfalfa hay average 0.36 to 0.44 pound gain per day in feeding tests.





Beet tops, pulp and molasses produce low-cost gains on fattening cattle.

Beet pulp and beet molasses are low in phosphorus content. When they are fed heavily, steamed bone meal or other phosphorus supplement should be included in the rations.

In lamb feeding tests over a number of years, beet top silage has been equal or superior to good corn silage. Lambs have consumed the beet top silage at rates of 4 to 5 pounds per head daily without ill effects. Lambs on good beet top silage rations have made daily gains averaging 0.36 to 0.44 pound. In most cases a limited amount of alfalfa hay has been of great value when fed with beet top silage, grain, and protein. Dehydrated alfalfa has been an exceptionally good supplement for beet top silage rations. In rations for fattening lambs, dry beet pulp is almost equal to corn when it replaces one-third to one-half of this grain.

Because of its bulk and nutritive qualities, dry beet pulp is an exceptionally good feed for dairy cattle.

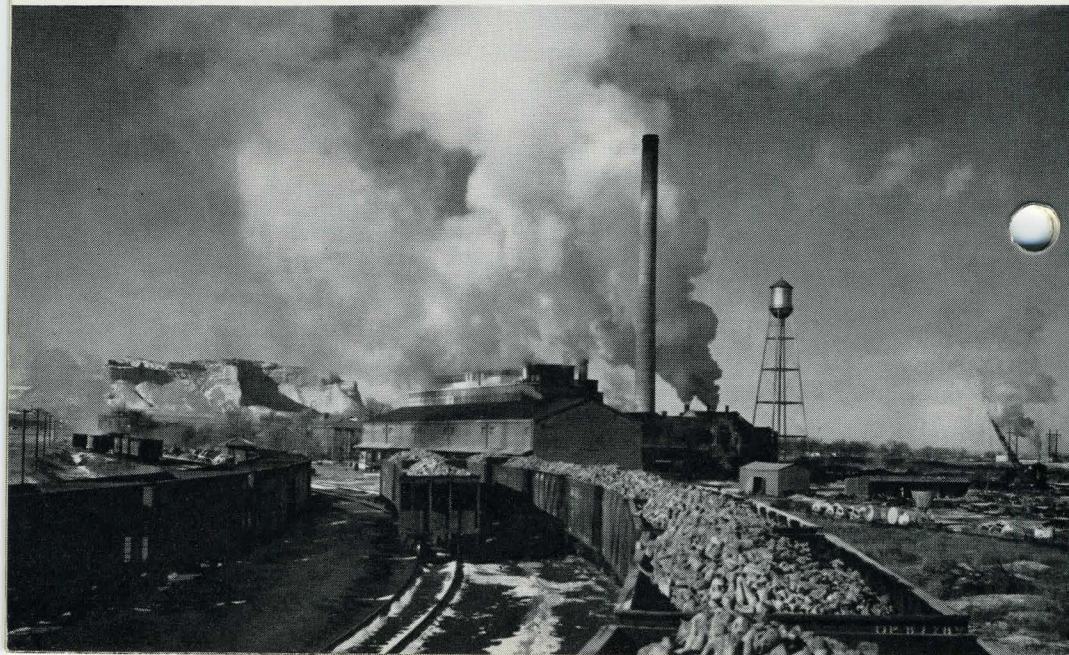
IMPORTANCE OF SUGAR BEETS TO THE COMMUNITY

Sugar beets are an important cash crop in most of the irrigated areas of Nebraska and other states in the Northern Great Plains. When supplemented by other crops grown in good rotations, and by the feeding of livestock, sugar beets provide high acre income and occupy a position of importance in the economy of the irrigated areas in this region.

The Bureau of Reclamation and privately owned irrigation companies have reported in recent years that the average gross return per acre of sugar beets is over \$100 more than the average acre return from all other crops grown in their projects. The cost of production must of course be considered in arriving at net returns from any crop. A relatively stable market for sugar beets is assured, thus reducing the market risks which all farmers encounter.

Progressive industries are an asset to any city or town and extend favorable economic influence into the surrounding rural areas. In its close association with agriculture, the sugar beet industry provides desirable industrial diversification to the community. As an example, the processing expenditures of one sugar company for a recent year amounted to \$70 for each acre of beets harvested. Of this amount, \$48 was used for factory payrolls, and \$22 was spent for real estate and personal taxes, local freight, and local purchases of materials and supplies. A program of well-rounded, diversified farming, closely associated with a progressive, responsible industry means increasing values for farm land and city property; better roads, churches, schools, and hospitals; improved market, service, and shopping centers; and greater social, cultural, and business opportunities for those who live in the community and surrounding rural areas.

Diversified irrigation farming and allied industry join in developing a prosperous community.



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