Farm Science

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International Harvester Company
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Contents

Introductory

"FARM SCIENCE" has been compiled for the particular purpose of assisting American agriculturists in the work of farm management. With this end in view the highest authorities in their respective fields of research were asked to prepare special articles setting forth the results of extended experiments involving every important operation on the farm. The subjects treated cover a wide range of thought, and deal with every branch and phase of modern agriculture.

Marvelous as have been the achievements in other fields of human activity, the greatest forward strides in the United States have been made in agriculture. Particularly was this true during the last half century. The primitive implements and methods of pre-historic times were retained through the centuries of man's strenuous struggle to master the forces of nature. From the reaping hook and cradle to the modern self-binder is a far cry, but it has all been accomplished within the memory of men now living. As recently as 1845 the United States did not produce enough breadstuffs to supply the needs of home consumption. Now this country, with a population increased many fold, is the largest exporter of breadstuffs and other food products, the yield from American farms rivaling the production of all Europe.

The wonderful progress made in modern American agriculture is due in large part to our unlimited agricultural resources, and to the intelligence of the American farmer who has been materially assisted in his work by the inventors who recognized the necessity of improved methods on the farm, and have supplied machines and implements to lighten labor and transform drudgery into a pleasurable pastime.

If a careful perusal of "Farm Science" suggests any method of improving the quality or yield of crops, any method of making the dairy more profitable, or any method of securing larger results with less work, the purpose of this book will have been fulfilled.

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A MODERN HAY MAKING SCENE.

Alfalfa Culture in America

EARLY HISTORY—DISTRIBUTION AND ADAPTATION—PROFITABLENESS OF ALFALFA.

By Jos. E. Wing

WHERE it Came from.—So many centuries ago that history does not record, the alfalfa plant was adopted into the family of mankind. It was grown long before the days of the Romans, and fed to the saddle horses of the desert. It was in esteem during Roman times, and old Roman books on agriculture tell how to sow it and how to till it and how to nourish it; and how, when it is grown, it "is good for all manner of famished beasts whatever." Doubtless the chariot horses that Ben Hur drove were fed on alfalfa hay. From that day to this it has been a plant held in high esteem wherever the best agriculture has been practised, especially in dry and warm climates where irrigation is practised.

Introduction into America.—The introduction of alfalfa into America proceeded from two sources. The English settlers in Virginia and the Atlantic colonists brought it with them, and at one time many years ago it was in repute, under the name of "lucerne," in New York, parts of New England and Virginia. It was recognized as having remarkable value, yet as acting strangely under cultivation, responding finely for one man, refusing to grow for another, growing beautifully in one field, refusing to grow in an adjacent one. It failed to make much seed, and eventually its culture died out almost entirely in the Atlantic region.

Introduction to the Pacific Coast Region.—The Spanish people brought alfalfa to Chili, Mexico, Peru and in a small way to southern California. It thrived in the dry, warm valleys in soils rich in mineral elements and well watered by irrigation. Its influence was unfelt in the United States until the settlement of California. The earlier settler sought only gold, but soon there appeared another class who sought by tillage of the soil to gain wealth by feeding the gold hunters. Thus there grew up a sort of pioneer farming in California. One of the earlier stockmen there, Henry Miller, killed cattle in San Francisco. In order to have always at hand a supply of available beef steaks, he bought land in the San Joaquin valley, and tried to grow forage crops there. In 1873 he began to make serious attempts to grow alfalfa, importing the seed from Chili. It was a plant that many voyagers from eastern America had noticed growing luxuriantly on the plains of South America. Henry Miller succeeded in making his alfalfa grow. He fed it to cattle, and with the profits bought more land to sow more alfalfa. When the writer some years ago visited the ranches of Lux and Miller he found feeding there on green alfalfa more than a hundred thousand cattle, with very many sheep. Thus had the alfalfa plant heaped up wealth for these far sighted ranchers! Doubtless there were other men experimenting with alfalfa growing in California as early as this or perhaps earlier, but Henry Miller is perhaps the first man to exploit the plant on a large scale.

From California the plant spread eastward to Utah, to Colorado, to Idaho and Montana, to Kansas, Nebraska and, later, to Ohio, Illinois, Indiana, Wisconsin, New York; and now in these blessed days of prosperity it has gone to nearly every State in the Union, is grown in Canada, in Alberta, and many of the islands of the sea.

Alfalfa Growing in its Infancy.—And yet, with all its spread, alfalfa growing has only just begun in the Eastern States. One farmer in ten in favored regions is growing it, and he is growing only half or maybe a tenth of what he will some day. The other nine farmers will learn—they must—or else be crowded out by their more favored competitors. It was held for a long time that alfalfa growing must be confined to certain climatic belts. Now it is known that it thrives, so far as climate is concerned, almost equally well from the Atlantic to the Pacific, from the Lakes to the Gulf. Certainly, it gives more crops in warm climates where it has a longer growing season, but any part of America, saving the high mountain plateaus, is warm enough for two crops a year.

Later it was thought that only certain soils would grow alfalfa. Now it is known that while it prefers rich, loose limestone soils, it will grow luxuriantly on strong, stiff, limestone clays, once they are made dry with tiles and fed with manure. It grows on sand, when the sand is made rich. It grows away from limestone, when the land has been sweetened with lime. In truth there is hardly a class of soils in the Union that is not now growing alfalfa, under enthusiastic culturists, who persist in giving the conditions that it needs and deserves.

Soils Best Suited to Alfalfa.—While it is true that alfalfa may be grown by devoted enthusiasts anywhere, yet it has affinity for certain types of soils, and is most easily grown thereon. These soils are deep, pervious to air and water, well stored with mineral elements, and somewhat alkaline in their nature. Thus alfalfa revels in the arid West, when water is supplied, because there has never been any leaching of mineral fertility, and the land is very rich in potash, phosphorus and lime. This alkalinity favors the growth and development of the bacteria that grow upon alfalfa rootlets and make the plants thrive. In the more eastern sections, along the Missouri river, there are great areas of a peculiar whitish soil called the Loess deposits. These soils are the result of wind deposit, made many centuries ago when the land was desert. On these very deep and fairly fertile Loess soils alfalfa revels, its roots penetrating to very great depths, sometimes as far as thirty feet.

Yet farther to the eastward are the prairies of Iowa and Illinois, black with stored humus and rich in plant food. On these prairies alfalfa does not naturally succeed very well. This is owing in part to a lack of drainage; in some instances, through the decay of too much vegetable matter, there is acidity in these black soils. In many other cases there is some difficulty in establishing bacterial energy, and the reason for that is unknown. However, the remedy has been found to be applications of barn yard manure, which works like magic on these black prairie soils, and when coupled with tile underdraining, where it is needed, alfalfa is found to grow with remarkable vigor and profit on the black corn soils of Iowa and Illinois. The reader if he dwells in this land should consult the bulletins of the Iowa and Illinois Experiment Stations for help to make his alfalfa surely grow.

Soils on which it is Difficult to Grow Alfalfa.—It is more difficult to grow alfalfa on some soils than others, and on some of them it is not wise to make the attempt. First, any soil that is not more than two and one-half feet above the water line is too shallow for continual alfalfa growth. It needs a depth of at least three feet to water, and if the distance is even greater all the better. In laying tile underdrains for a foundation to an alfalfa field seek, then, to get the level of the water line down at least three or four feet.

On peaty soils with little clay or sound earth within them it is not often that alfalfa will thrive. There are some exceptions to this rule, though they are not well understood.

On nearly barren sands it is doubtful if it is worth while trying to establish alfalfa fields. They must be continually fed in order to produce this forage, so rich in mineral elements, and it must be remembered that these mineral elements must come from the soil.

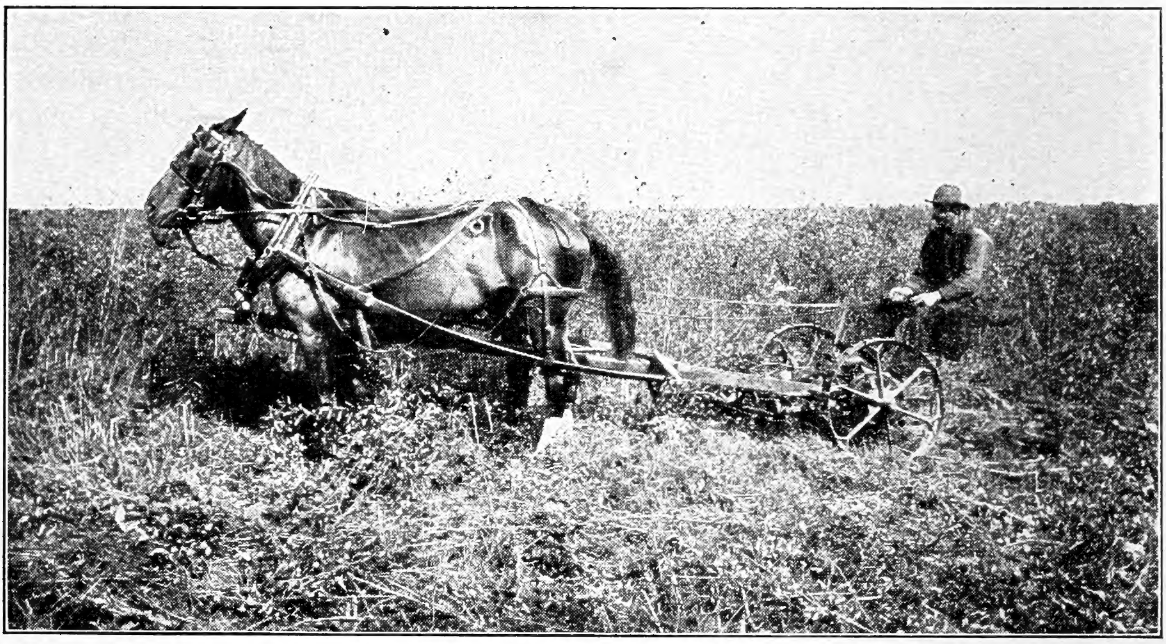
Clays.—While the most luxuriant growth of alfalfa is usually from a porous soil, a loam or gravelly alluvium, yet clays drained and stored with vegetable matter are producing some of the best growths of alfalfa in the United States. This is especially true of strong, tough limestone clays that, when in their natural state, hold water "like a jug," but when underdrained and well manured become more open and pervious to both air and moisture. On such clays alfalfa revels, and when plowed up and other crops are planted on the land it is astonishing to see with what vigor they grow, revealing plainly the very great benefit that the alfalfa has been to the soil, both by adding nitrogen through the decay of its leaves and roots, and by bringing up mineral matters from the subsoil, and by decaying and leaving air and water passages through the clay, always before too dense to permit these helpful agents to work their will. And when alfalfa is sown again upon these clays after one or two years of grain or hoed crops, manure being scattered over the land in the interval, it is found that the alfalfa responds wonderfully and yields better than it did after its first seeding.

Advantages of the Alfalfa Crop.—What, briefly, are the advantages of the alfalfa plant over other forage crops? First, that it roots so deep in the soil. It is safe to say that alfalfa roots penetrate as deep as there is any soil. If the soil is three feet deep, the roots will penetrate three feet. If the soil is ten feet deep, the roots will go down ten feet. And if the soil is thirty feet deep, the roots will go down thirty feet. Thus the whole soil is in use.

The Whole Season.—Next remember that the plant uses the whole of the growing season, and it is the one crop that the farmer grows that does this. It is very hardy and does not much mind cold. As soon in Spring as the sun has slightly warmed the earth the alfalfa is up and is growing. It does not mind light frosts, but keeps right on growing. Soon after the corn is planted the alfalfa is ready to cut, by the first of June in most of the region of the

Corn Belt, earlier in the South, and not much later anywhere. Thus the soil has yielded one crop almost before the corn plant has begun to take hold at all.

Next consider what happens when you cut off that first cutting. It should be taken away as soon as little buds appear on the lower part of the stems, showing that a new growth is ready to start up. At this time the plant will be partly in bloom and the leaves dropping from the larger stems. Then is the time to cut it down and make it into hay. And the hay making must proceed rapidly, for soon after this first crop is laid low these buds start into action, and in about fifteen minutes after the mover has passed over the field there is a second crop under way. This makes it needful to get the crop off the field promptly and let the next one come on. In thirty days from the time it is cut there stands a second crop ready for the mower. And after that in thirty-five or forty days there is yet a third crop ready. And if it is taken off on time there is the fourth cutting. Much of the yield of these later cuttings depends of course upon the presence of moisture in the soil, but it is sure that the alfalfa will use all of the moisture from rainfall, and



CHAMPION MOWER IN ALFALFA FIELD.

if irrigation is possible it will use a very large amount of irrigation water. Thus it uses to the best advantage all of the soil, all of the season from early Spring till late Fall, and all of the soil moisture. Of no other crop can this be said.

Value of the Resultant Crop.—The best of all is that the forage that the alfalfa plant produces is the richest and most palatable that the farmer can grow. The alfalfa plant, cut at the right time and rightly cured, is very rich in protein. What is protein? It is what makes the red flesh and red blood of the animal. It is what makes nerve and brain and vital process. Alfalfa is rich in bone. It is the best feed for the baby on the farm, for the baby colt, the baby calf, the baby lamb, pig and chick. It is good for the baby because the baby must have protein to build his little body. And as it is best for the baby so it is best for the baby's mother. It makes her full of milk and restores her tissues. It builds the unborn young within her, and after its birth it fills her with milk to make the baby grow.

For Working Horses.—There is no one thing so good as alfalfa for the working horse. It builds his wasting muscles, it keeps him strong and healthy. He needs much less grain when he can have alfalfa hay. And he is fuller of life and spirit than when fed upon any other hay. It is only necessary to remember that this hay should be fairly mature when it is cut, and well cured so that it shall not be mouldy or musty. There ought to be no dust on alfalfa hay. There are no hairs upon alfalfa stems and leaves as there are on clover leaves; therefore alfalfa hay has no tendency to bestow "heaves" upon horses. For old and hard worked horses in thin flesh alfalfa has great restorative powers. For driving horses it should be fed in moderate amounts, else it will make them fat and soft. Even working teams may be fed too large amounts of alfalfa hay. It should be steadily borne in mind that early cut and well cured alfalfa hay is nearly as rich, pound for pound, as wheat bran, so that to feed too great an amount of it is not merely wasteful, but puts an undue strain upon the excretory organs to eliminate the unnecessary food substance from the tissues. The over feeding of alfalfa hay to horses has in some localities caused the use of it

MC CORMICK MOWERS IN WESTERN FIELD OF ALFALFA.

to become unpopular, and to raise an outcry against it. To offset that it may be said that the writer has fed no other hay to his horses, both working teams and driving horses with mares and foals, for many years, and has yet to observe the first instance of evil result, save that the driving horses when not used regularly become soft and easily sweated.

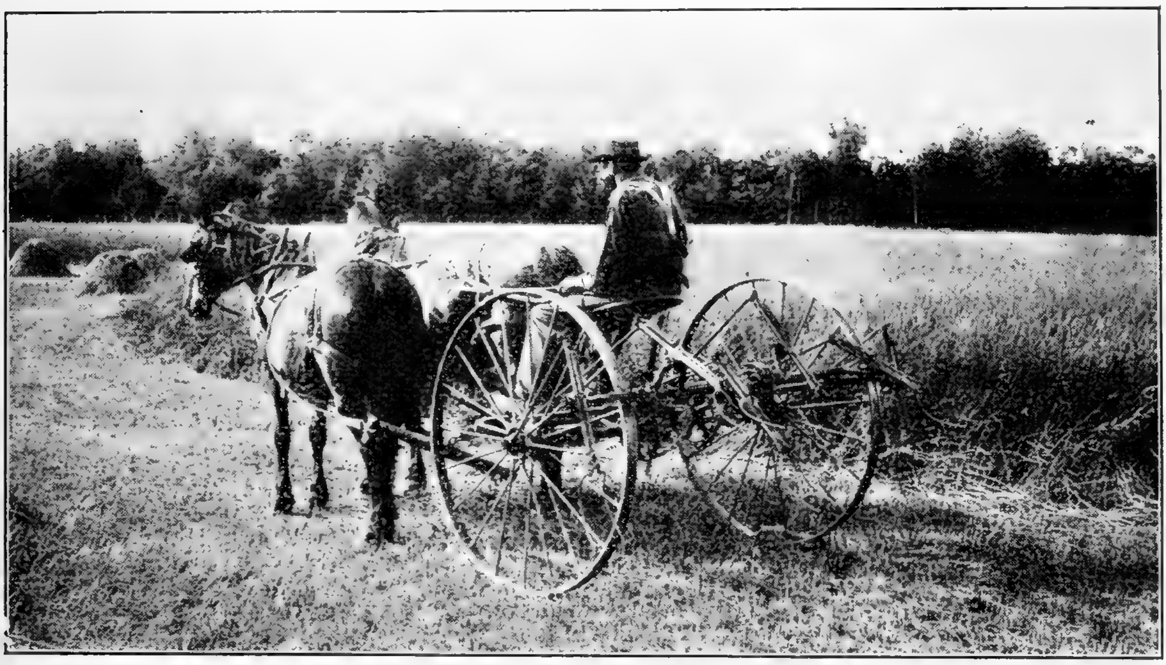
For Mares and Foals.—There is nothing else so good for the mare, while she is carrying her unborn colt, as to run on an alfalfa pasture, and eat alfalfa hay in Winter. Her colt comes strong and well developed, and after it has come she is full of milk for it. Then if she is in the alfalfa meadow the colt early learns to nip the delicious herbage, and thus takes in additional nourishment at the time when he is best able to make use of it. It makes his bones grow and covers them with good firm muscle, it hastens his development greatly, it adds to his beauty and spirit and usefulness. The best thoroughbreds in the United States often come from the alfalfa meadows of California, and the breeders of race horses in

Kentucky are beginning to add alfalfa to the bill of fare of their petted darlings. The great Percherons of France eat alfalfa with the bloom on it when they are lusty foals in their native land. The horse breeder wherever he is should at all times endeavor to call to his aid this crop that is par excellence, the one best suited to his use. While there is some danger in grazing alfalfa with sheep or cows, there is none whatever in grazing it with horses, and thus not only the best but the cheapest possible development may be secured.

Alfalfa for the Dairy Herd.—Calves grown on alfalfa develop rapidly and are ready to become mothers earlier than when developed on other foods. Pregnant cows fed alfalfa come in strong and well nourished, bearing full udders. Milking cows fed alfalfa hay as part of their ration give milk as with no other possible combination. Not to go into figures or tables of percentages, suffice it to say that alfalfa leaves are a little richer in protein than wheat bran, that alfalfa stems, cut early and nicely cured, are nearly as digestible as wheat bran, and nearly as palatable. Thus alfalfa may well take the place of a large part of the grain ration, and may be made to form nearly the whole of the needed protein. Thus not only is the ration very greatly cheapened, but the animals give far greater returns than when they do not have alfalfa hay. On most farms in the Corn Belt there is a decided scarcity of foods rich in protein. Corn itself is deficient, and there can not be fed enough corn to cows to make them give their greatest amount of milk, whereas if the attempt is made disaster results because the excess of fat forming food consumed leads to disorders of digestion or makes the cow too fat herself to be long a profitable dairy animal. Furthermore, the corn fodder and stover, the timothy hay and blue grass, the oat straw, sorghum, silage, nearly the whole list of common farm crops that can be grown for the dairy, are deficient in protein, so that alfalfa has for the dairy farmer a very great value, coming as it does to balance up these other more fattening and heat making provenders. This is not mere theory, but a fact most abundantly proven by experience in the West, in the Middle States and later in the heart of the best dairying section, through New York, Pennsylvania and New England, where some of the farmers are producing their own alfalfa, and others are securing it from their more fortunate brothers of the West. The writer has himself sent alfalfa hay to a gentleman milking one of the best herds of Guernseys in America, animals fed as well as science and skill could devise, and had word afterward that the addition of alfalfa hay to their ration made an increase in milk yield of twenty per cent!

Alfalfa and Silage the Cheapest Dairy Ration.—With good alfalfa hay and good sweet corn silage, made from corn that has been allowed to mature well before being harvested, the cheapest and best milk yields are secured. With this ration there is indeed very little need of any other grain. That great dairy authority, ex-Governor Hoard, has found in practice that with this combination, and as little as four or five pounds daily of grain, not only has he had the maximum returns in milk and cream, but he has seen the dairy herd maintained in remarkable health and vigor. It is time the farmer should break away from the bonds that bind him to the miller and the dealer in food supplies, and learn to produce on his own farm nearly all that his animals need, including that most precious and costly thing of all, the protein content of his animals' ration.

Alfalfa for Sheep.—With lambs selling for $7.00 to $8.00 per head, and wool soaring, men begin to ask what sort of foods best agree with sheep. The answer is, if there is one thing that alfalfa is especially suited to, it is to the flock. Sheep love alfalfa above all other forage, and for a good reason. It is the one thing best suited to their needs. They, more than other animals, need a ration rich in protein. The growing lamb needs it to build his muscles, blood, brain, nerves and bone. The pregnant or nursing ewe needs it to replenish her system fast drained by the demands of her offspring. The ram needs it to keep up his vigor. The wool bearing sheep, and all breeds bear some wool, need alfalfa because it has in it the peculiar elements that make for growth of good, healthy, strong fibered wool. And thus all sheep crave and love alfalfa hay. Think for a moment what it means for an animal to like a food. Liking in the animal world is not whim or



INTERNATIONAL HAY TEDDER.

caprice. Man is the one animal, save a worm, that chews tobacco, the only animal that drinks whiskey. All animals crave things that are good for them. Why do they hunger for fitting foods? Because the very cells of their bodies are calling to be built, and thus instinct tells them that tough grasses nourish feebly if at all, that tender, rich alfalfa leaves and stems have in them substances that when assimilated go directly to build the eager body cells, to reinforce the muscles and strengthen the bones and link together the nerves. It is a fact that sheep once accustomed to a diet of alfalfa will scorn prairie hay and turn from good red clover; they seek that which nourishes best and digests most easily, therefore that tastes best to them.

The Pregnant Ewe.—The pregnant ewe needs alfalfa to make grow within her that highly organized body made up mostly of protein compounds, her unborn lamb. She needs it to repair the waste in her own body. She needs it to store her udder with milk against the time of coming of feeble baby head bunting unsteadily against her and seeking nourishment. With alfalfa in abundance she comes in strong, her baby lamb is strong, her milk flow assured. There is need that she should have not quite as much alfalfa as she would consume, else she might overdo the matter, and the lamb be born too large for safe delivery. She should have exercise and a liberal supply of fresh air. Then her safe lambing is assured.

The Milking Ewe.—After the lamb is born there is no longer any need to stint the ewe in the amount of alfalfa she is fed; her own instinct will tell her how much. And it should be of the earliest cuttings, and nicely cured with the leaves all on. With this alfalfa very little grain indeed will be needed to make her give liberally of milk before grass comes. And after the first green grass of Spring comes it is fine if she can have her regular ration of alfalfa hay to supplement the grass, prevent scours and make her keep strong and in good flesh. Of course her little lamb will eat alfalfa hay from the time it is three days old, the tender leaves first, the stems later on, and there should be a special rack for

INTERNATIONAL BULL RAKE AND STACKER IN OPERATION.

it where the ewes can not come to disturb. With alfalfa hay and a little corn added, soaking both in mothers' milk, the baby lambs will soon attain a beautiful baby maturity that will enable their owners to sell them for many, many shekels of the coin of the realm.

Alfalfa for Feeding Lambs.—For fattening lambs born on the great ranges and kept there till weaning time in the Fall, nothing can take the place of alfalfa hay, if the greatest facility coupled with the largest profits are sought. The lamb feeding business has grown to magnificent proportions in Colorado, where the abundant streams coursing down from the giant snow capped Rockies spread their life giving waters over the fertile plains. There alfalfa is at its best estate, and nothing else is quite so profitable, saving perhaps the crops that naturally follow on alfalfa sod—sugar beets, melons or truck. Enormous amounts of alfalfa hay are stacked up on these plains where the long dry Summers favor hay making operations very greatly, and when Winter comes the lambs are bought and placed in feed lots, and fed till

Spring on alfalfa hay with a little Nebraska or Kansas corn or native barley or wheat. These lambs often come from the ranges half starved, having perhaps endured long drives and been held in corrals and shipping pens until they are little more than bones strung on end, but after they have eaten alfalfa hay for a time they become strong once more and ready to make good use of corn. So well do these lambs thrive on alfalfa hay and grain that it is most difficult for men deprived of these feeds to compete with them in fattening lambs. In Ohio and other Eastern States there is now a good deal of alfalfa feeding to western range lambs in Winter.

Alfalfa Fed Beef Cattle.—What has been said of the mare and of the ewe applies as well to the beef cow. If she has a sufficiency of alfalfa hay in Winter she needs no grain at all. After her calf comes she may have a little grain, and she and the calf all the alfalfa they care to take, which given conditions are sure to go on as well as man can arrange. Her calf should be developed largely on alfalfa. It may eat alfalfa hay every day of its life, may be soiled with alfalfa during the growing season, may possibly be grazed on alfalfa pasture, though by far the better way is to cut the alfalfa and bring it to the calf. By this manner of feeding good flesh is produced and stature assured. It is too common among breeders of beef cattle in the Corn Belt to confine their animals to rations composed mainly of corn and grass, neither having in them enough protein, thus there is a steady loss in size, in "scale," the animals soon become fat, undersized, "bunty" and "bunchy." The difficulty is that you have been asking impossibilities of the animal, asking it to make bricks without straw, or to build without bricks at all. Therefore breeders of pedigreed cattle find it necessary to have frequent recourse to Canadian and English herds to maintain the character of their own. In these other lands less corn and more clovers and other foods rich in protein are fed than in our own. There is blood in a turnip. There is blood and form and breeding in alfalfa, a plant that gives character to whatever it becomes. Therefore let the breeder of beef cattle see to it that alfalfa is one of his chief reliances.

Alfalfa for Feeding Steers.—Fattening cattle might be thought to be an exception to the rule heretofore insisted upon; they are desired to be fattened as rapidly as possible, why, therefore, need they be fed any foods rich in protein? Why not feed them in the old fashioned way with corn alone, to quickly cover their ribs, and then let them go forward to market?

The theory sounds well, but does not work well in practice. These animals find waste going on in their own systems. Digestive processes require muscular action, and there is need to repair muscular tissue. Nerve force is to be maintained. Then, after all, when these animals come to the feed lot they seldom have an adequate frame of lean tissue on which to build the fat. Moreover, the modern trade demands lean flesh intermixed with fat, not fat laid on in masses. And, finally, digestion goes on better when there is fed a variety of foods containing both fats and muscle builders. So theory backs up practice, and that tells always that steers fatten quicker and cheaper and better when they have all the alfalfa hay that they want in connection with their corn. It is astonishing how much the cost of fattening these cattle may be reduced if they are bought young and fed plentifully on good alfalfa hay, and only moderately with corn. And when this beef goes to the killer he finds it by far the most profitable. There is no doubt of the great place that alfalfa should fill in the cattle feeders' business. And the younger the cattle, the truer they are "babies," the better it pays to feed them alfalfa hay.

Alfalfa for Pigs.—The problem of maintaining brood sows in complete health in Winter time is a serious one in the Corn Belt. They are voracious and must be fed. If fed sufficient corn to satisfy them they become too fat and have weak litters of pigs, or so unwieldy that they destroy their own offspring through their very great clumsiness. If they are deprived of sufficient corn to do this and given no other food, they do not keep in health, since it is Nature's way to have the stomachs and digestive tracts of the sow distended with bulky food. Therefore unless this is done there is set up within her an unnatural craving that ends in causing her to eat her pigs at farrowing time. Now if she is fed a liberal allowance of alfalfa hay she finds in it nearly all the nourishment that she needs, she finds her alimentary canal distended comfortably, she is satisfied with same, and she brings into the world a fine litter of pigs, and has milk for them. She has use of her natural instincts and seldom destroys her pigs, either by accident or intent. It is wise to allow to her an ear or two of corn each day in addition to what early cut alfalfa hay she will consume.

If it is Summer time and she can have the run of the alfalfa field she will thrive with very little grain in addition until the pigs come. After that time it will pay to feed her a little more grain. The sucking pigs will soon learn to nip the tender leaves and stems, and that will add greatly to their thrift and growth. It pays largely, however, to feed corn in addition to alfalfa pasture to shotes. It is not necessary to feed so much as when they do not have access to alfalfa, about half the usual amount of grain will cause a fine, thrifty growth. At the close of their life period it is well to give whatever amount of corn they will eat up clean. In this manner is made the cheapest and best possible pork. Fed in this way an acre of alfalfa pastured with hogs has made a clear profit in one year of as much as $25.00.

Grain to Feed with Alfalfa.—Corn is the best single grain to be fed in connection with alfalfa. Corn is rich in fat and low in protein. Alfalfa is very rich in protein and somewhat low in fat. These two should not be separated where flesh is desired. They most admirably supplement each other. Either for the fattening lamb, pig, calf or steer the ration of corn and alfalfa is an ideal one, for they very nearly balance each other, and both can be produced on the farm, and both are adapted to most parts of the United States and much of Canada.

After corn, however, come barley and oats and wheat, valuable to supplement alfalfa, though of the three barley is best, being richer in fat making elements. Very good lambs are made with alfalfa and barley or alfalfa and wheat or alfalfa and oats, or with a mixture of them all together. Yet when corn is available at nearly the same price it is very much to be preferred.

Alfalfa for Poultry.—The alfalfa field is a rich storehouse for the poultry keeper. In Summer time fowls forage far and wide, eating the tender alfalfa leaves, rich in protein, and finding insects. In Winter time fowls will consume great amounts of alfalfa leaves and the fine stems. Sometimes alfalfa is ground into meal for poultry and swine. This is well, though when it is in large supply it is not necessary to do this, as it is cheaper to waste a part of the stems than to grind them into meal. Fowls given all the alfalfa that they desire are more healthy and lay many more eggs than without it.

What Alfalfa Does for the Soil.—Supposing that all that has been said is true, as the reader may well believe, there must arise within his mind a doubt as to whether there can be any further cataloguing of the virtues of the alfalfa plant. Has it not been exhausted in its virtues by now? By no means! One of the very best of its gifts to man is yet to be related—alfalfa enriches soils. It is a clover, and enriches soils in the same manner that all clovers do by the growth upon its roots of bacteria, that have the power to fix nitrogen from the air. By this means it wonderfully improves

INTERNATIONAL REAR HITCH SWEEP RAKE IN THE FIELD.

soils. Then by its very deep roots it feeds upon the lower depths of the soil and draws up the stores of fertility that may be down there. After alfalfa has grown upon a field for two, three, four, six or more years, when that field is broken it will be found to have been enriched beyond what was ever known of it before. Whatsoever is planted upon that land will yield wonderfully, and again when it is laid down to alfalfa that will in turn grow better than it did before. That is perhaps because of the inoculation that has taken place and that enables one to get a perfect stand of alfalfa sooner, and because the decay of the long roots has opened up the subsoil and made it more readily permeable.

How Alfalfa Hay May Build Soils.—The amount of fertilizing material that will come from an acre of first class alfalfa is equal to what would be bought in the bag for $60.00. Now if the owner of a depleted soil can get one small field established in alfalfa, and will save the hay and feed it with care, saving all of the manure and putting it out upon another tract, he can thus enrich this sufficiently to make it grow alfalfa. Now let him have the two fields producing alfalfa, and using the hay again and saving the manure he is ready to enrich the third field. And thus gradually he may extend the area of his alfalfa land until some day, if that man has faith and keeps on, some day he may sweep the poverty altogether off his farm and find it redeemed, glorious in beauty in Summer time and yielding him a steady and very great profit. This may not be so well understood by readers who, living in the arid West, find all of their land ready to take alfalfa, but in the older clays of the rainy East little land is naturally now in condition to take the seed until it has been first enriched.

How to Start an Alfalfa Field.—Naturally the ways of sowing alfalfa vary with the location and climates. In the arid West it is a simple matter. The land is usually plowed in Winter or early Spring, worked down to a good seedbed and the seed sown alone in middle Spring time. It is irrigated occasionally according to the nature of the soil, and crops are often taken from it the same year, though it is not at its best until the third year, but it will yield very heavy crops the second year. In some countries it is a practice to sow a light seeding of oats with the alfalfa, in other regions this will not do since the oats will lodge or bed down and smother the slender alfalfa plants. In general the better practice in the arid region is to sow the alfalfa alone.

The amount of seed to the acre varies between four and thirty pounds. The smaller amount of seed is sometimes sown when seed is desired from it, as it seeds better not to be thick. There are 14,448,000 seeds in a bushel of alfalfa seed. Therefore to sow half a bushel to the acre would put 166 seeds to the square foot. To sow fifteen pounds would put on eighty-three seeds. Seeing that this is true, it is evident that it is more essential to have good seed and good distribution of the seed than to use a great amount of seed. About twelve to sixteen plants to the square foot are all that will ever stand, and on rich, deep soils they will not long endure even that much crowding.

Clipping the Young Alfalfa.—Weeds often come up to crowd the young alfalfa. To destroy these weeds clip the field with the mower, setting it to run as close to the ground as possible. There may come a yellowish rust that attacks the leaves. To destroy this clip close with the mower. Therefore when preparing land for alfalfa see to it that the field is left as smooth as practicable, so that the mower may run over it in security. This trouble of the leaf rust will not be so much in evidence in Western lands as in the lands east of the Mississippi river.

Pasturing on Young Alfalfa Seedings.—It is not well to allow any animals to graze upon a young alfalfa meadow. They will likely do far more damage than the good they will get will pay for. When it is time for the alfalfa to be clipped take the mower to it, and if there is enough stuff on the ground to be worth while rake it up and take it away. After the first season pasturing may be resorted to if it is thought desirable, and little bad result will be seen if the field is not over stocked.

Seeding Alfalfa in the Middle West.—In the region from the Mississippi river to the western limit of the rain belt alfalfa thrives well, but more care is needed to get stands than in the arid region proper. Spring sowings are usual, without a nurse crop. A better plan is to plow the land early in Spring or during the Winter, and to work it up with disk or harrow as soon as the growing season has started weed life, and thereafter to harrow it after every rain until some time in late May or June, when the seed may be sown with confidence that it will not be choked with weeds, and that there will be enough moisture stored in the soil to carry it triumphantly through the hot Summer. The essential thing in this plan is, however, to be certain to harrow thoroughly after every rain, not only to destroy germinating weeds, but to conserve all of the moisture. When the seed is sown it should be sown if possible with a drill, about one and one-half or two inches deep. Earlier in the season it is not necessary to sow it so deep. The depth that alfalfa seed may be sown varies according to the soil, but in most of this region the soils are black, loose and loamy.

Field Seeding in Iowa.—A method that has given very fine results for the past few years has been practised in Iowa; it is the sowing after a crop of wheat or oats in mid-Summer. To accomplish this the crop of wheat or oats is removed as early as possible and at once the land is plowed. Each day what is plowed

INTERNATIONAL SIDE HITCH SWEEP RAKE AT WORK.

is prepared with care to permit the escape of as little moisture as possible. Then alfalfa seed is sown alone. It needs no clipping that year, goes safely through the Winter and the next year gives three large crops of hay. The advantage of this method is that there is no loss of land and no trouble with weeds or fox tail grass, the great pest of alfalfa growers in the Corn Belt. Should the late Summer prove unusually dry this method might not be successful, and in case it is to be sown on clay that naturally freezes and thaws often during the Winter and heaves badly, the young alfalfa roots might not be strong enough to resist. Thus far, however, it has given excellent results at the Iowa Experiment Station and is being adopted in other parts of that State. It is probably a system adapted to Illinois conditions, especially in the northern part.

Need of Manure in Iowa and Illinois.—The soils of this region are black and quite rich. And yet for many years they refused to grow profitable crops of alfalfa. It was found to be very difficult to grow alfalfa upon them. When it did grow it seemed often to be without nodules upon the roots, and therefore devoid of bacteria. A few years ago it was discovered that when stable manure was spread upon that seemingly fat, black land, alfalfa was easily established upon it, and inoculation came naturally and abundantly. Now on all the soils of this region well enough drained alfalfa may be very profitably grown if care is taken first to liberally distribute over the fields stable or yard manure, working it into the soil to create there the ferment or yeast needed in that soil to start the bacterial life, and after it is once established it will endure profitably for a number of years, how long it is not yet possible to say.

Need of Drainage in Illinois and Parts of Iowa and Minnesota.—There is a serious need in much of the black soil of this Corn Belt of more complete drainage than it has at present, before it is really fit for alfalfa culture. Men growing only corn, or corn and oats and timothy hay, have not usually a vivid conception of how wet their lands are during a good part of the year. In Illinois very much of the draining that has been done has been done superficially, with tiles too close to the surface. These should be deepened so that none of them is at a less depth than thirty-six inches, and if they can be put down forty-eight inches all the better. Then there are needed other drains between the ones now in use. When this is done and some manure made use of there is no doubt that very fine alfalfa fields can be maintained in Illinois.

Comparison of Corn and Alfalfa.—It is hard for a farmer in the heart of the Corn Belt to consider seriously the demands of any other crop, yet if he will study alfalfa a little he will see that he is accepting no inferior plant when he puts it in place of some of his corn fields. Alfalfa will make on good land in that region a total yield during the season of from four to eight tons per acre. Taking six tons as a standard, and calling the hay worth $8.00 per ton, there is thus derived from that acre a gross revenue of $48.00. To equal that amount the field must yield 120 bushels of corn which must sell at 40 cents per bushel. Or, put it according to the amount of available and digestible carbohydrates and protein produced by these crops, the alfalfa will yield fully three times as much protein as the corn and double the carbohydrates, too! Furthermore, the alfalfa is not depleting the soil, while corn is a robber crop.

Alfalfa Seeding in the Eastern Regions.—East of Illinois begin the clays, gravels and loams that extend through Indiana, Ohio, New York, Pennsylvania and the sister States. Few indeed of these soils are ready for alfalfa in their natural state, yet all of them will yield it most profitably when made fit for it. The requirements of alfalfa in these States are simple. It needs, first, to have the land drained, if it is not naturally dry. It requires that the land be sweet. In parts of Indiana, Northern Ohio, in some of Pennsylvania and New York there are acid soils. These must first be sweetened with lime before they will grow good alfalfa. The third requirement is that these soils be stored with organic matter, with humus. That means that they must be spread over with stable manure. After these three conditions have been met there is nothing but a little knowledge of the plant necessary to make it thrive admirably. The farm on which the writer lives grows now annually about 350 tons of alfalfa hay, though ten years ago little of its area was adapted to alfalfa at all. Tile underdrains and manure have made its growth possible, and it has proven very profitable.

Sowing Alfalfa on Eastern Clay Soils.—The best method of sowing seems to be to break the land, after having thoroughly well manured and drained it, and plant one year to corn, keeping the corn clean of weeds and fox tail grass. The next year it should be again plowed as early in Winter or Spring as it can be and deeper than ever before. After danger of hard freezing is over, say in late April, the seed is sown upon a nicely pulverized seed-bed, at the rate of from ten to fifteen pounds per acre. At the same time a bushel of beardless Spring barley is sown for a nurse crop. Oats are not admissible, since they usually on this well manured land lodge and destroy the young seeding beneath. The barley is taken off when ripe for grain and the young alfalfa is clipped at the same time. It may need one or two subsequent clippings, and it may not. The safe rule is to let it alone as long as it continues to grow thriftily. When it rusts and stops growing, or when fox tail grass or weeds crowd it, it should be mowed off close. The object of the barley is to discourage that marauder, fox tail grass, which it does quite effectually. Thus you will gain also the crop of barley for the use of the land. It is not usual to get much alfalfa the first year of sowing. If any of the clippings make hay enough to be worth raking off save them. Keep all animals off the field the first season.

Never Allow Animals to Tread on Alfalfa Fields in Winter.—It is sure death to the crowns to be tramped upon in cold weather, especially in the Eastern States. Neither should wagons ever pass over the meadows in Winter.

Making Alfalfa Hay.—The time to cut alfalfa is when it has begun to bloom, the lower leaves have begun to turn yellow and drop off, and buds are starting out from the base of the stems. Cut then, for it has in it the greatest amount of nutrients. Allowed to stand longer the stems become woody, some of the leaves are lost, and the hay is not so palatable, nutritious nor digestible. If cut too soon before the buds have set on the stems, sometimes the succeeding crop is seriously injured, for what reason is not yet known.

Rush the Hay Making.—If possible all of one crop should be cut down within a week, seeing that it is all ready at one time. Thus the hay is secured in best condition and the following crop is benefited by being given the space in which to grow. Wide cut mowers are convenient things in the alfalfa field. After the hay is laid down the haymakers should keep close watch, and as soon as it shows signs of drying and before the leaves will fall from the stems, it should be raked into small windrows and permitted to cure in part in the windrow, or in the cock, according to where you are and what sort of climate you must work in. Alfalfa dried in the swath loses many of the leaves when raked.

Side Delivery Hay Rakes.—These machines work well in alfalfa meadows, since they leave the hay loose, in good condition for drying. In Eastern meadows, under showery conditions, the hay is best cocked up in small cocks while it is yet tough. Such cocks will turn rain well and may be afterward opened out on a sunny day, or they may become dry without opening. Then, too, hay caps may be used on the cocks to advantage.

The Test of Sufficient Dryness.—Take a wisp of the hay, choosing a damp part of it, and twist it violently into a rope. If no moisture can be made to exude from the stems the hay may be put into the mow or stack, especially if many tons are to be put together. If only a ton or two will be put into a small mow it should be well dried before putting away, since it is more apt to mould and become dusty than when much is piled together.

Plowing Alfalfa Sod.—Alfalfa sod is very hard to plow; with indifferent tools impossible. It can be done with comfort, but it requires, first, a good team of three strong horses; next, a plow, preferably a walking plow, in good repair, with a very sharp share. Next, it needs a sober and Christian hearted man. And it is a great aid to carry a file, and frequently file to a knife edge the cutting edge of the share. A little V shaped wing running horizontally out from the landside under the edge of the uncut land about three inches is a great help, since it makes the plow run steadily and renders the next furrow far easier to turn.

Some of the alfalfa roots will not be cut off, and they will live over, doing no harm in the succeeding crop. All that are cut off will probably die, and there is no danger of alfalfa spreading beyond the original limits of its field.

Alfalfa makes little seed in rainy regions. It seeds best in the dry parts of Kansas, Nebraska and westward. Usually the first crop is allowed to make seed. It is easily threshed, and in favorable seasons yields heavily, from one to fifteen bushels per acre being reported. The only seed worth much is the common alfalfa, but it is wise not to get seed from a latitude south of you.

Inoculation.—Alfalfa will not thrive without the right bacteria upon the roots. Nor will milk sour without the bacteria of souring being present. And yet milk sours, and yet women folks do not add bacteria, knowingly, to their milk. Nevertheless milk will sour more rapidly if a little sour milk is added to the sweet at milking time. So alfalfa will surely become inoculated by natural processes if grown on fit soil, but it will the sooner become inoculated if earth from an old field is dried in the shed and pulverized and sown broadcast over the field and harrowed in. There are also cultures available that are used to inoculate the seed. They are sometimes of use. They often fail to be of use, through some defect in the method. It is not worth while to bother with cultures. It is worth while when sowing alfalfa on land that has never had it before to use soil from either an old alfalfa field or a sweet clover (mellilotus) patch. The bacteria that live on mellilotus are the same that live upon alfalfa.

Do not sow either alfalfa or bacteria upon soils not a fit home for bacteria. That means that the land should be dry, sweet and stored with vegetable matter.

Some Other Things About Alfalfa.—Bees love the blooms, especially in the western lands. Alfalfa honey is prime. Alfalfa covers the land with perennial beauty. It makes work for many laborers to gather the harvests and to feed the hay. It causes new homes to spring up, puts paint on school houses and sends little urchins trudging along country lanes with full dinner pails and smiling faces. It is one of God's richest gifts to man.

Joseph E. Wing,
Mechanicsburg, Ohio.

Modern Corn Culture

SELECTING AND STORING SEED—PREPARING THE GROUND—CULTIVATION OF THE PLANT.

By Prof. P. G. Holden

ONE of the best plans is to begin this spring by selecting fifty or one hundred of the very best ears in your seed corn, while you are making the test of germination. These ears should then be butted and tipped and each ear shelled by itself and carefully studied. The kernels should have a bright, cheerful appearance, be full and plump at the tips and have a large clear germ, otherwise they should be discarded. It is very important that this choice seed corn be planted at the time of the first planting, putting it on the south or west side of the field, unless there is danger that it would become mixed from some neighbor's corn near by. In this case, it may be put on the other side of the field.

The important thing is to get it in early and, if possible, on fall plowed ground. This will allow the corn to become thoroughly matured early next fall. The great importance of this can not be over-estimated. It is the late maturing corn that is caught by the freezes, as there is not sufficient time for it to dry out.

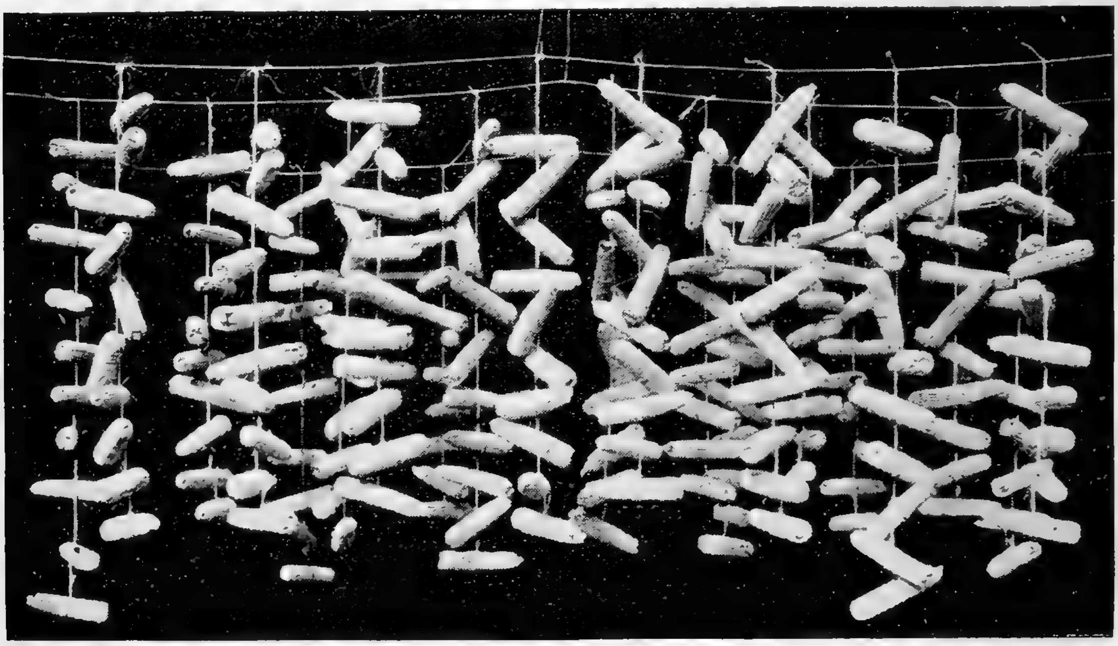
All the seed corn for the next crop should be selected from this patch which was planted from the very best ears. It is a very common practice to select the occasional good ears found throughout the husking season. There are three important reasons why this should not be done. In the first place, we are more likely to neglect the work until too late, when we find ourselves without good seed for the next year. Again, we often begin harvesting from the poorest parts of our fields first for early feeding, as this corn is more likely to be soft and will not crib well. It should also be remembered that the occasional good ears which are harvested throughout the husking season have necessarily been fertilized to a greater or less extent by pollen from the scrub stalks and those which are perhaps barren. In other words, we have simply selected a good female, but know nothing of the character of the male stalk from which the pollen came that fertilized the kernels.

On the other hand, if our seed is all selected from the seed patch planted only from the very best ears, we are much more certain of good parents on both sides. It is a good practice and one followed by many corn growers to go through this seed patch of three or four acres planted from this fifty or sixty best ears of corn, after it has been "laid by" and before the tassels appear, and to cut out all the weak and sickly stalks and those that are too tall and late or too short and early and in this way to prevent them from producing pollen to fertilize the kernels of other ears.

One of the most serious dangers from depending on the occasional good ear found throughout the corn husking season is that many of the fields being late and the corn immature, the husks will prevent the corn from drying out properly. As a consequence, it is frozen before it is husked or, at least, before it has had time to dry out after husking. Again, we often begin harvesting our poorest fields first and delay saving seed until we come to our "best fields."

If every ear of corn that is to be used for seed in Iowa next year could be harvested this fall not later than October 10th, and hung up where it would dry out thoroughly before the bitter cold freezes of November, it would add millions of dollars to the wealth of the State.

Let us go into the best and earliest planted fields, and select well matured ears from the most vigorous stalks, strip off their husks and hang in the attic at once where the circulation of air is good and protection is afforded from the cold freezing weather of November and December. In the 228,000 Iowa farms an average of about 40 acres is devoted to the growing of corn, and while six bushels of



good seed is sufficient to plant this, let us abundantly provide ourselves and save two or three times this amount, as some pests may call on us to replant, or our neighbor may need some seed. Remember, it takes only about a dozen ears to plant an acre. Each ear should have special care.

The above cut illustrates one of the best and safest methods of storing seed corn. Ten or twelve ears are tied in a string and hung on some wires supported by other wires from the rafters.

The twenty-one strings of seed corn shown in the cut require a space less than six feet long by twenty inches wide, and yet this amount of seed will plant more than fifteen acres.

The advantages of this method of storing are:

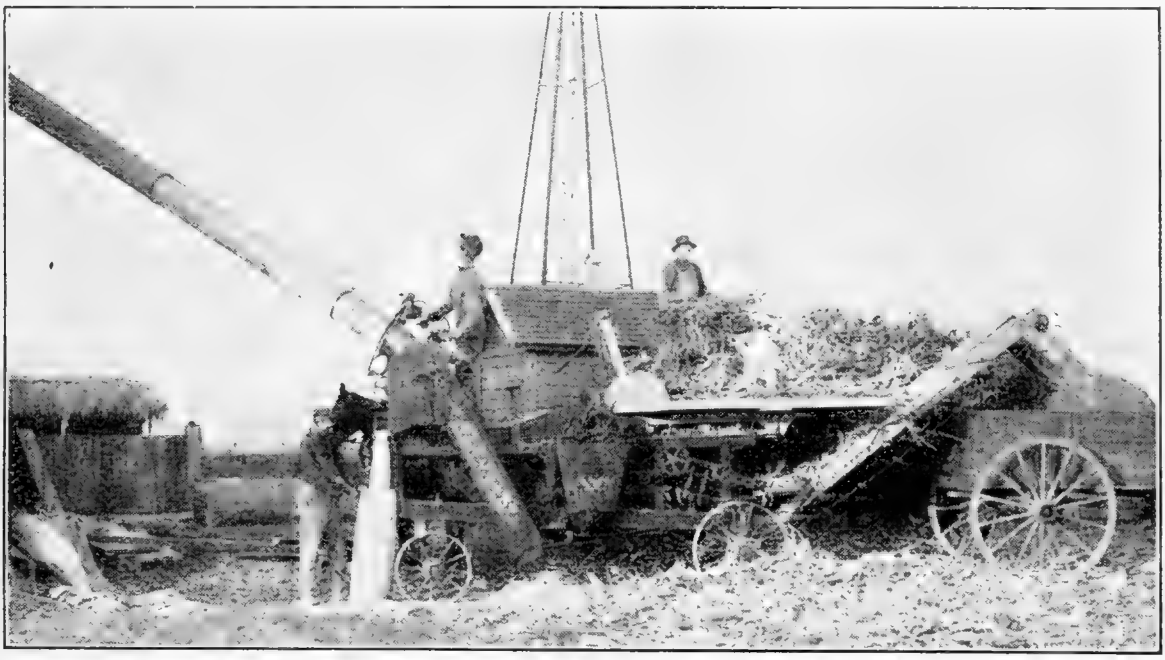
First, that it gives better protection from mice than where it is spread on the floor or corded in piles or put in racks.

Second, it gives better circulation of air which allows the corn to dry out quickly and thoroughly, thus protecting it from molding and sprouting and from being frozen while it is sappy.

The greatest enemy to good seed corn is hard freezing while it still contains moisture, consequently there is more danger from late harvesting than from too early harvesting. However, it is not a good plan to harvest the seed in September while the corn is immature, as it is more difficult to preserve, and will be chaffy and will give weaker plants than corn which has been allowed to mature fully on the stalk.

Place for Storing Seed.—Taking all things into consideration probably there is no better place to store seed corn than in the attic. In the nearly 5,000 samples of seed corn sent to the college for testing during the last two years, those preserved in the attic generally gave the strongest germination and also the highest percentage. The experiments conducted at the college, where seed was stored in more than forty different ways, also show that the attic is one of the very best places for seed corn.

The second best place seems to be the cellar and especially the furnace room. There are several objections to the average cellar. It is liable to be too damp. The corn must be well dried before



PLANO HUSKER AND SHREDDER IN OPERATION.

being placed in the cellar and it must not be corded up or put in piles but hung up.

There is more danger from mice and generally there is less room, but it has one great advantage in that it protects the corn from the hard freezes. Seed that is hung in the barn or under an open shed generally comes through the winter in fair condition provided it was harvested and hung up during the early part of October. Yet the experience of the last two years shows that much of the seed stored in this way was either killed or greatly weakened. During the warm damp spells the seed gathered moisture and was injured by the freezes that followed.

It is quite generally supposed that if the seed sprouts in the spring it is all right. As a matter of fact, much of it has often been so weakened that it will not grow, especially if the ground is cold or the seed is planted too deep, or if it does grow it gives only weak stalks "fooling around all summer doing nothing."

Bad seed has cost Iowa this year not less than sixty or seventy million bushels of corn. This is placing it at a very low estimate. Few people realize how great is this loss to the state each year.

We can not afford to be careless with our seed corn. It means too much. Poor seed means a poor stand; not only is a part of our field idle, but we must cultivate the missing hills and the one stalk hills and the poor worthless stalks, and we receive nothing in return.

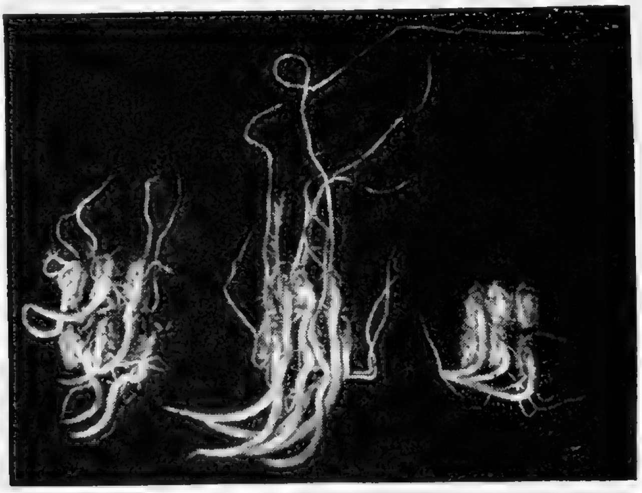
Thousands of people this year in Iowa worked more than a third of every day on ground that produced nothing. Do not depend for seed on the occasional good ear. The corn will be injured by freezing before it is husked, or before it has had time to become dry after husking.

Do not store seed corn in barrels or boxes. It will gather moisture, as we say, and mold or freeze. Do not store over the laundry nor over the stable. Do not put immature or freshly gathered seed corn in a warm room on the floor or in piles. It will either sprout or mold or both. It should be hung up *at once,* and the windows opened to allow the freest circulation of air.

Do not depend on the crib for seed corn.

The importance of selecting fifty or sixty of the choicest ears and planting them on one side of our earliest planted field can not be too strongly emphasized. Out of this seed patch the seed for next year's crop should be selected not later than October 20th, and hung up at once where it can dry out thoroughly before any severe freeze.

Let us have a time and a definite plan for harvesting and storing our seed corn. One day devoted to the seed corn at the proper time may be worth more to us than an entire month of hard work next summer put on a poor stand of corn.



NO. 3. NO. 2. NO. 1.

No. 1 shows a character of growth that is more dangerous than the absolutely dead kernels. This ear should not be planted. Three kernels will fail to grow and three show such weak germination that it is unsafe to trust them. They have failed to start root sprouts.

No. 2 shows a strong growth, indicating strong vitality. Only 60% of the kernels that have been sent to us from more than 3,000 Iowa corn growers during the last season show such vitality as illustrated in No. 2.

No. 3 shows weak vitality. If planted under favorable conditions these kernels might do fairly well, but if planted under unfavorable conditions, they would probably fail to grow or would give weak stalks. Twenty-one per cent of the seed corn received for testing showed a similar strength. Nineteen per cent was no better than No. 1.

Another objection is the fact that the strong ears would be more or less fertilized by the pollen from the undesirable stalks.

Poor Stand of Corn.—A "poor stand" of corn is responsible more than anything else for the low average yield in the central west. The ground may be rich, the preparation good, and the corn may receive the best of cultivation, but if the stand is poor the yield will be correspondingly poor.

Careful counts of the number of stalks to the hill were made last year in more than a thousand different corn fields and it would be safe to say that there was not to exceed sixty-six per cent. of a perfect stand on an average and in some cases it fell as low as forty per cent. This means that the state devoted nearly 9,000,000 acres to corn, and produced only a 6,000,000 acre crop, or, to put

CORN SHOCKER CUTTING AND GATHERING THE SHOCK.

it in another way, with a perfect stand the present average yield of thirty-two bushels would be increased to fifty bushels to the acre or an increase to the state of 153,000,000 bushels. This does not take into consideration the increased yield made possible through the use of improved varieties, better-bred seed, elimination of barren stalks by means of breeding, better methods of cultivation, etc.

The real seriousness of the situation will be more apparent from the following counts illustrating the stand in the poorer, medium and better fields of Iowa. The following figures illustrate the number of stalks to the hill in the poorer fields: 2 2 2 0 3 2 0 1 3 0 1 1 1 3 1 1 0 2 3 0 1 2 1 0 0 2 1 3. Each of the first three hills had two stalks, the fourth hill was missing and the next had three stalks, etc.

That the results might be as accurate as possible, counts similar to the above were made in three places in each field. The hills were taken just as they came in the row and generally crosswise to the way the corn was planted. The field above represents only fifty-two per cent. of a stand of corn. Twenty-five per cent.

of the hills were missing. Thirty-five per cent. had one stalk, twenty-five per cent. had two stalks and twenty per cent. had three stalks to the hill. If the poor stand was largely due to seed of low vitality, which is generally true in case of very poor stands, then the same influence which killed a part of the seed must also have greatly weakened that which did grow and as, a consequence, the yield is even much less than what is represented by the stand.

The above represents what is found in hundreds of corn fields everywhere in Iowa. Many fields were found in which the stand was as low as forty per cent. The following will illustrate very closely the average stand in the state: 2 3 1 2 1 0 1 1 3 3 1 3 1 2 2 2 3 0 3 1 2 0 2 1 2. On the average soil of the state this would represent about sixty-five per cent. of a stand of corn. Twelve per cent of the hills were missing, twenty-eight per cent. of the hills had one stalk, thirty-two per cent. of the hills had two stalks, and twenty-eight per cent. of the hills had three stalks. The fol-

OSBORNE CORN BINDER IN OPERATION.

lowing represents the stand in some of the very best fields in the state: 3 4 3 2 1 3 3 3 3 2 3 3 3 3 2 3 3 3 3 3 3 3 3 3. In this field, there were no hills missing, four hills had one stalk, twelve had two stalks, seventy-six had three stalks, and eight hills had four stalks.

This represents not less than ninety-five to ninety-six per cent. of a perfect stand.

If we go into our fields at husking time and make a study of the stand of corn, we shall be convinced of the serious losses to ourselves and to the state each year from a poor stand of corn.

Variety Test of Corn.—Last spring, the Agricultural Department obtained seed from more than ninety different sources. The corn was all collected from farmers living within a radius of ten miles from Ames. In order to obtain samples of corn actually planted, the farmers were visited and the corn was taken either directly from the planter boxes in the field or from the sacks from which the seed corn was being planted.

The samples were planted by hand, three kernels to the hill, and the experiment was repeated three times and treated alike in every respect, throughout the season.

The following table gives the yield to the acre of the six highest yielding samples and also of the six lowest yielding samples:

Six Highest Yielding Samples	Bushels to the Acre
Sample No. 59	80.5
Sample No. 58	80.0
Sample No. 66	78.5
Sample No. 71	77.0
Sample No. 138	75.0
Sample No. 68	75.0
Average	77.5

Six Lowest Yielding Samples	Bushels to the Acre
Sample No. 44	31.5
Sample No. 132	33.5
Sample No. 36	34.5
Sample No. 32	36.6
Sample No. 29	37.5
Sample No. 33	40.0
Average	35.6

Note particularly the wide range in yield from 80.5 bushels to the acre to 31.5 bushels of a difference of 49 bushels. The average yield of the six highest samples was 77.5 bushels, while the average of the six lowest yielding samples was 35.6 bushels, or a difference of 41.9 bushels per acre.

This great difference in yield was due largely to the difference in vitality of the seed, as in every case the low yielding samples had given a poor stand. It strongly emphasizes the great importance of knowing that the seed to be planted will give a good, strong, vigorous germination.

Testing Each Ear of Corn.—There is, perhaps, no one thing which will do so much to increase the yield of corn on every farm as the testing of each ear to be used for seed. This should be done before the rush of spring work begins or it is likely to be neglected.

The importance of discarding ears that refuse to grow or show a weak germination is apparent when we realize that one ear will plant one-fourteenth to one-sixteenth of an acre.

The most practical way for testing the germination of each ear is by using a germination box. This is a simple affair and can be made by any one in an hour's time. Any box about six inches deep and 2 x 3 feet in area may be used. Fill the box about half full of moist sand, earth, or saw-dust, well pressed down, so that it will leave a smooth, even surface. In case saw-dust is used it should be put in a gunny sack and set in a tub of warm water for half an hour so that it will be thoroughly moistened before using.

Take a white cloth about the size of the box, rule it off, checkerboard fashion, one and a half inches each way. Number the checks

1, 2, 3, and so on and place it over the saw-dust and tack to the box at the corners and edges.

Lay out the ears to be tested, side by side on the floor. Remove one kernel from near the butt, middle and tip of the ear. Turn the ear over and remove three kernels from the opposite

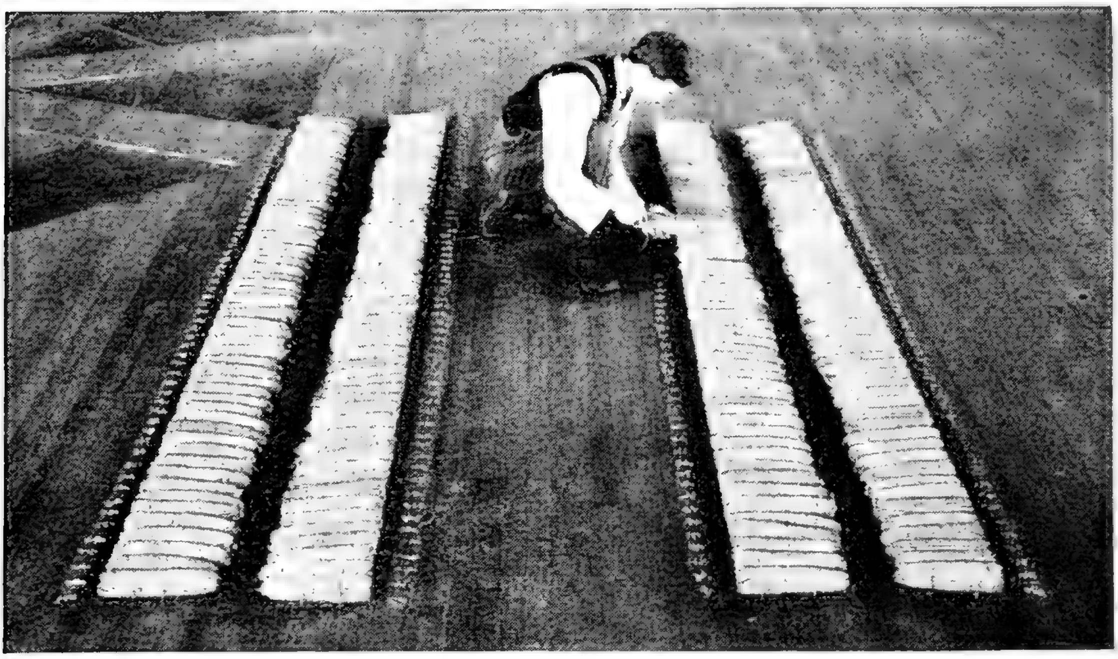


FIG. 1.—REMOVING THE KERNELS.

side, in like manner, making six kernels in all, thus obtaining a sample from the entire ear. Place the six kernels at the end of the ear from which they were taken. Use care that the kernels do not get mixed with the kernels from the ear next to it. After the kernels are removed, boards may be laid over the rows of

FIG. 2.—PUTTING THE KERNELS IN THE GERMINATION BOX.

corn to keep them in place until the germination is known. (See Figure 3).

Place the kernels from ear of corn No. 1 in square No. 1 of the germination box; from ear No. 2 in square No. 2, and so on with all of the ears. Then place over this a cloth considerably larger than the box. Cover with about two inches of moist sand, earth or saw-dust and keep in a warm place where it will not freeze. The sitting-room will perhaps be the most suitable place.

The kernels will germinate in four to six days. Then remove the cover carefully to avoid misplacing the kernels in the square, (a piece of thin cloth placed over the kernels before the covering is put on, will prevent the kernels from sticking to the upper cover). Examine the kernels in the germinating box; for example, the kernels in squares No. 1, 11 and 20 (see Figure 3), have failed to grow and some of the kernels in square 2, 3, 4, 9, 12, and 15 have refused to grow or show weak germination. The corresponding ears should be rejected. The ears showing weak germination should be treated the same as worthless ears.

The kernels are placed on the floor opposite the ear from which they were taken. Before removing the kernels from the ears, it is a good plan to drive nails at each end of the rows of corn to hold the ears in place.

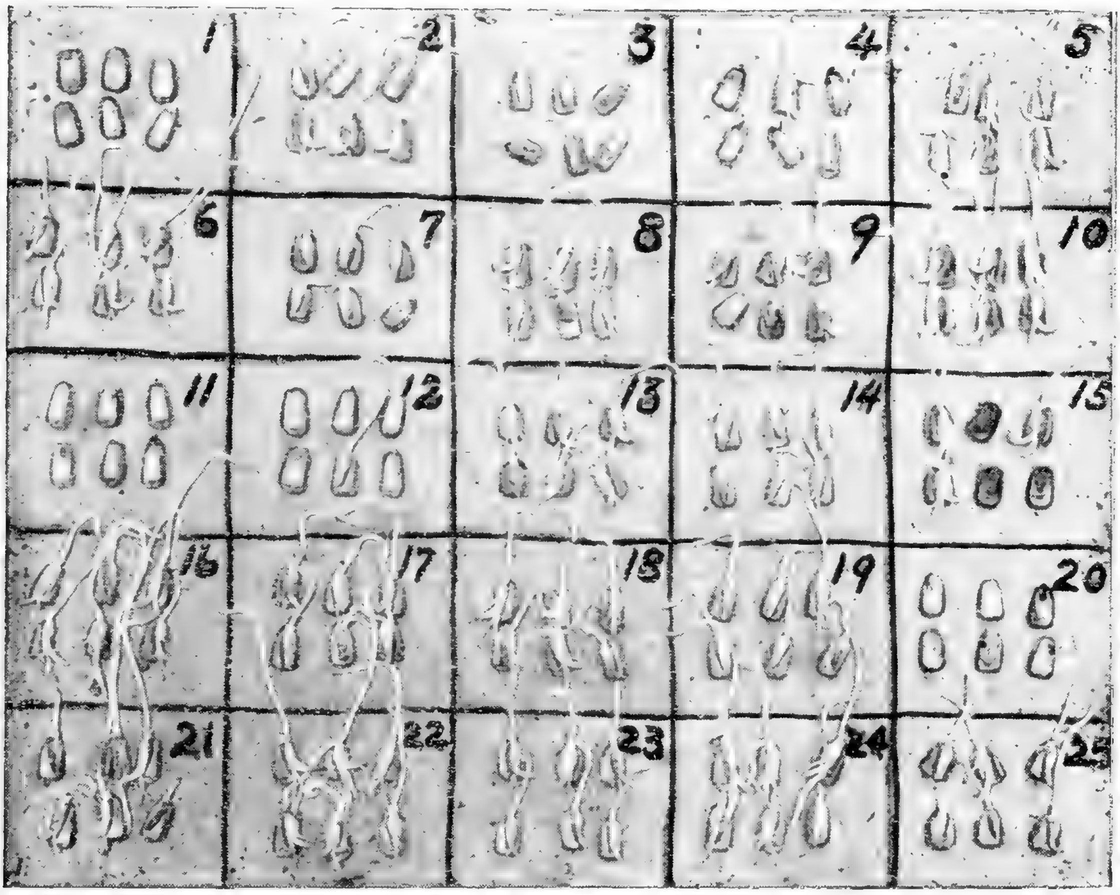


FIG. 3.—SEEDS IN GERMINATION BOX.

Germination Box.—Figure 2 shows the operation of putting the kernels in the germination box; placing those from ear No. 1 in block No. 1; from ear No. 2 in block No. 2, etc.

The germination box is filled about half full of thoroughly moistened saw-dust. A cloth ruled off into blocks or squares is then placed on the saw-dust and fastened at the corners and edges by tacks to hold it in place.

To prevent the ears from being disturbed while the test is being made, it is a good plan to place a heavy board or plank over each of the rows of ears.

Preparing Seed Corn for the Planter.—After the germination test, the next step is preparing the corn for the planter. First by removing the mixed kernels. In yellow varieties it can be done better before shelling and in white varieties after shelling, as the mixed kernnels often do not show in white corn until the corn has been shelled; second, by butting and tipping the ears of corn to insure the planter's dropping the correct number of kernels in each hill.

To be certain of getting the drop adjusted properly, twenty or thirty ears should be shelled separately and put into grades of large, medium and small kernels. The planter may then be tried with each grade and the proper plates may be selected for each grade. If the proper plates are not at hand, then those nearest may be calibrated to do the work desired.

This is very essential and it should be done before the rush of spring work begins. A small outlay for additional plates or a new planter may mean the difference between a good crop and a poor one. The planter must do the work properly. After the planter is tested and it is known what grades are needed, the seed corn should be carefully shelled, put into sacks and properly labeled.

The planter can be adjusted to drop the different grades in uniform manner if the grades are kept separate and the proper planter plate used for each grade, but if these different sized kernels are mixed and dropped miscellaneously it will be impossible to obtain a uniform number of stalks per hill.

We cannot afford to neglect this important work. If every farmer in the state would test every ear of his seed corn in the way described above the yield would be wonderfully increased.

No other time will be so profitable to the farmer as that spent in testing the vitality of his seed and in grading it to insure the planter's dropping the proper number of kernels in each hill. It is possible for every one to do this work. It will cost nothing but the time.

Every farmer should realize the importance of testing every ear of his seed corn before spring work begins. No possible loss can come from it and it will insure a good stand of corn which is absolutely essential, if the best results are to be obtained from the year's hard work. One day spent in March on the seed corn, may be worth more than a month of hard work in the field, later. Without good seed, the after labor is of little avail. Nothing is more depressing or discouraging than a poor stand of corn. If the seed is carefully tested and only good seed planted no risks are run, except those made necessary to every one from the conditions of the weather, etc., which can not be controlled. It is during the bad seasons, when conditions are unfavorable that we most need corn of vigorous germination.

Product of a Single Hill.—Fig. 15 illustrates what is too often seen in a single hill—a good ear, a poor ear and a nubbin. We have seen this so often that we never stop to think what it means. Why do not all these stalks bear ears like No. 1? Being in the same hill, the conditions of soil, climate and moisture must have been exactly the same. One could not have received more thorough cultivation than another. From the time the corn was dropped there was no good reason why Nos. 2 and 3 should not be as good as No. 1. Why, then, is there this wide variation?

Can we do anything to bring Nos. 2 and 3 up to the standard set by No. 1?

We can. The difference in yield of these three ears was not due to differences in soil, climate or cultivation. The difference lay behind all this—it lay in the character of the parents planted.

If we could locate all the stalks in the field which spring from the brothers of the kernel that produced No. 2 we should find that the great majority of them were ears, on an average, as good as it is. The same thing would hold true in the case of the parents of Nos. 3 and 1. This would lead us to the conclusion that the difference in these three ears is due to the difference in the producing power of their parents.

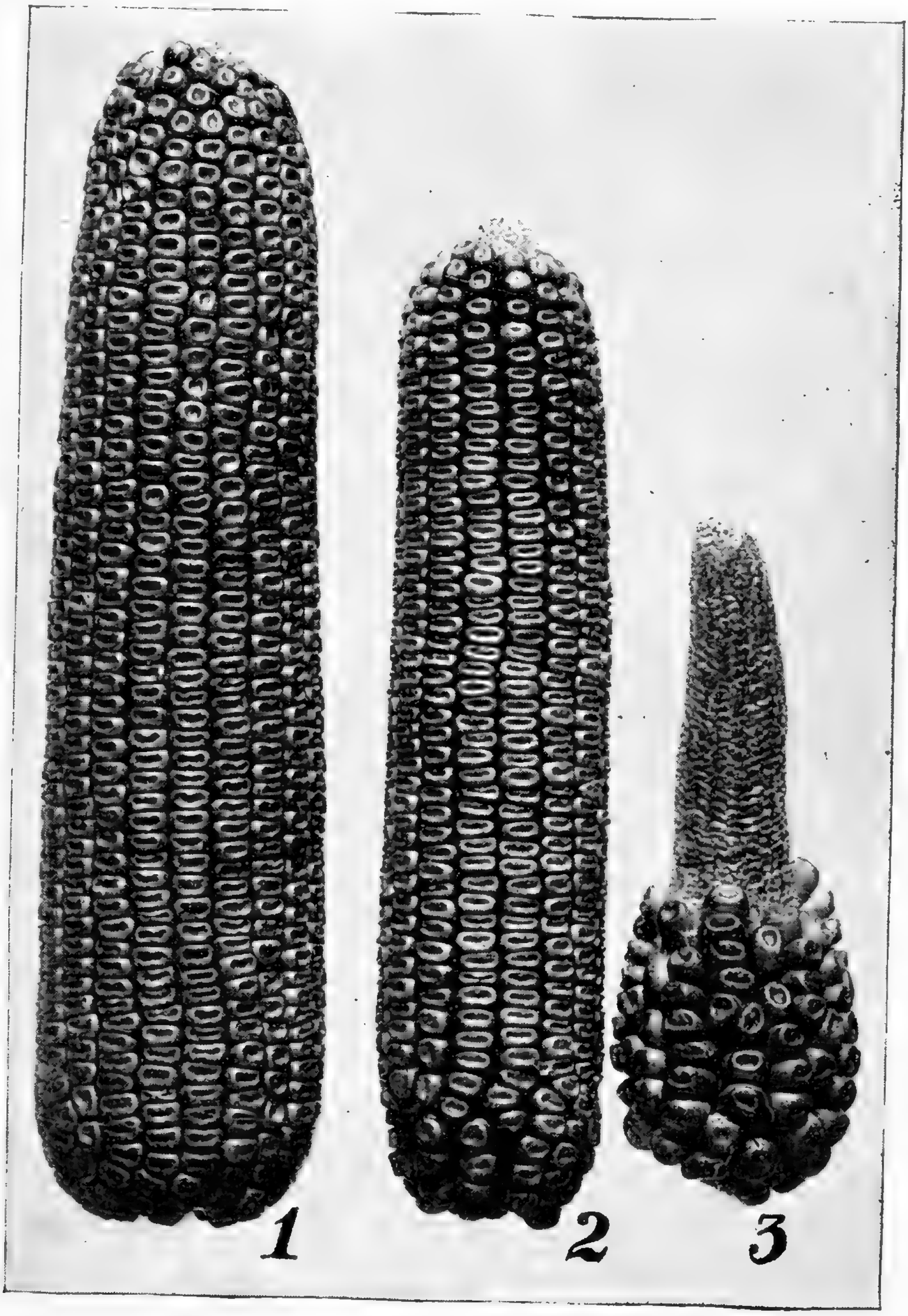


FIG. 15.—PRODUCT OF A SINGLE HILL.

In our study of individual ears we saw the wide variation in the yield which different ears produced. We saw that while one ear yielded 90 bushels to the acre, another ear beside it, under exactly the same conditions, produced only thirty-six bushels. Some ears produced twelve times as many barren stalks as others and the same held true with the broken stalks.

Now if we can select the one which produces the small ear, the one which produces the nubbins, we shall have gone a long way toward materially increasing our yield. For it is evident that this wide variation is due to the difference in the producing power of these two ears. In this work of selection the ear may be taken as the unit. While there is something in the individuality of each kernel, we are sure of getting good corn and a large increase in the number of good ears to the hill if we study our seed ears carefully and plant only the best. Fourteen ears on an average will plant an acre, therefore, if we put in one ear that produces a great many nubbins and barren stalks we greatly reduce our yield on that acre.

Barren Stalks. — Out of the five stalks in these two hills only one produced a good ear. Note how weak and sickly the non-productive stalks are compared with the productive one. Barrenness is one of the greatest sources of loss in corn growing. To the farmer who grows corn for the grain alone these barren stalks are worse than a complete loss. They not only deprive the productive stalks of food, moisture and light, but they produce pollen which fertilizes the silks of the good stalks and so reduces the vigor and future producing power of many of the good ears. Nubbins are simply a mild form of barrenness.

This subject of barren stalks is very closely related to that of "The Product of a Single Hill." (See Fig. 15.)

This cut gives an illustration of the class of stalks which produce the nubbins, or what is worse, nothing at all. The unproductive stalks in these two hills have hundreds of brothers scattered here and there throughout the field wherever the kernels from the ear that produced them were planted. Some of these brothers of course bore something, but a large per cent of the plants that came from that ear would be about like four of those in this cut—worse than nothing.

On the other hand the stalks bearing the good ear would have hundreds of brothers throughout the field, which came from the same good ear as itself, bearing—not nubbins or nothing at all as these others are doing—but strong, vigorous stalks producing in turn, a large percentage of good vigorous ears.

This question resolves itself into one of getting rid of these unprofitable ears and of planting only vigorous ear-producing seed. On an average one stalk in every seven produces nothing because of barrenness. One acre in every seven planted to corn is worse than wasted because of these unproductive stalks. Yet a little time and care in selecting our seed corn—not a dollar in outlay is required—will materially lessen this enormous loss. We can not pay too much attention to the careful selection of our seed corn.

The kernels in the top row in Fig. 29 are taken from ear No. 2 shown on the following page, fig. 31, and those in the bottom row are taken from ear No. 1.

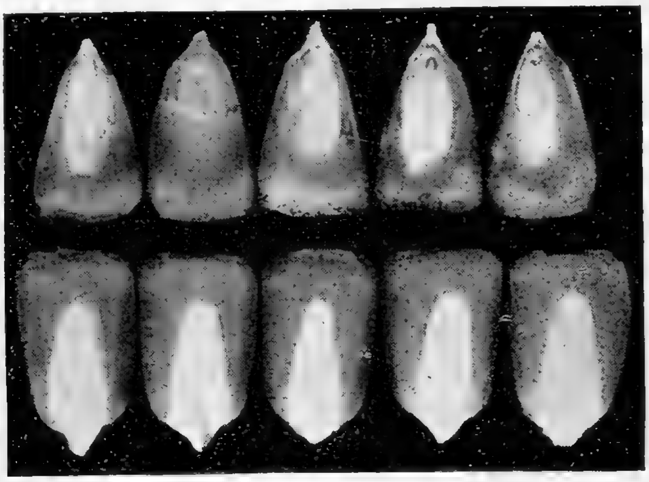


FIG. 29.

The lower row of kernels in fig. 30 is from ear No. 1, fig. 31 shown on the following page, and the kernels in the upper row are from ear No. 2. . Judging from outward appearances of the ear, little or no difference in their values could be discovered. The ears from which these two rows were taken were almost

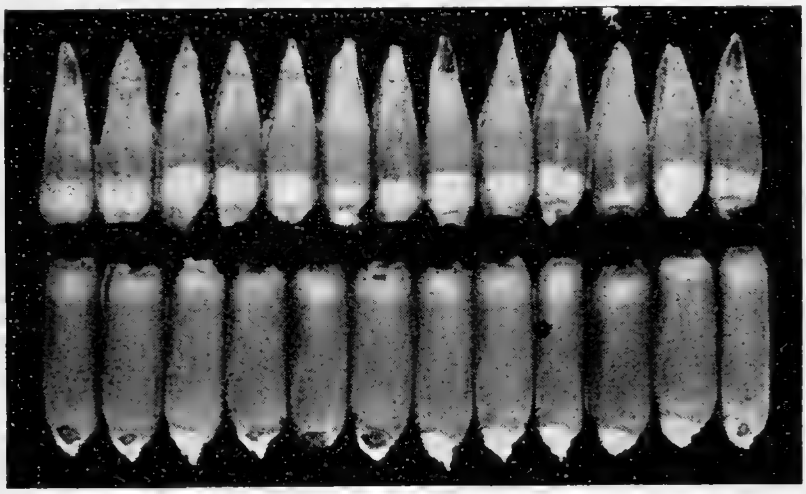


FIG. 30.

exactly of the same size, yet ear No. 1 (see Fig. 31) weighed 16 per cent more than ear No. 2 and shelled out 20½ per cent more corn than ear No. 2. Ear No. 2 is not only very much poorer in feeding value than No. 1 but has a much lower vitality and would give a weaker plant.

It is very important that the tips of the kernels—the portion next to the cob—should be full and plump so that there is no space between the kernels down near the cob. In selecting our seed corn it is important that we should do more than look at the ears; we must study the kernels.

Ear No. 2 shows space between the kernels next to the cob. Ear 1 is especially strong, showing good constitution.

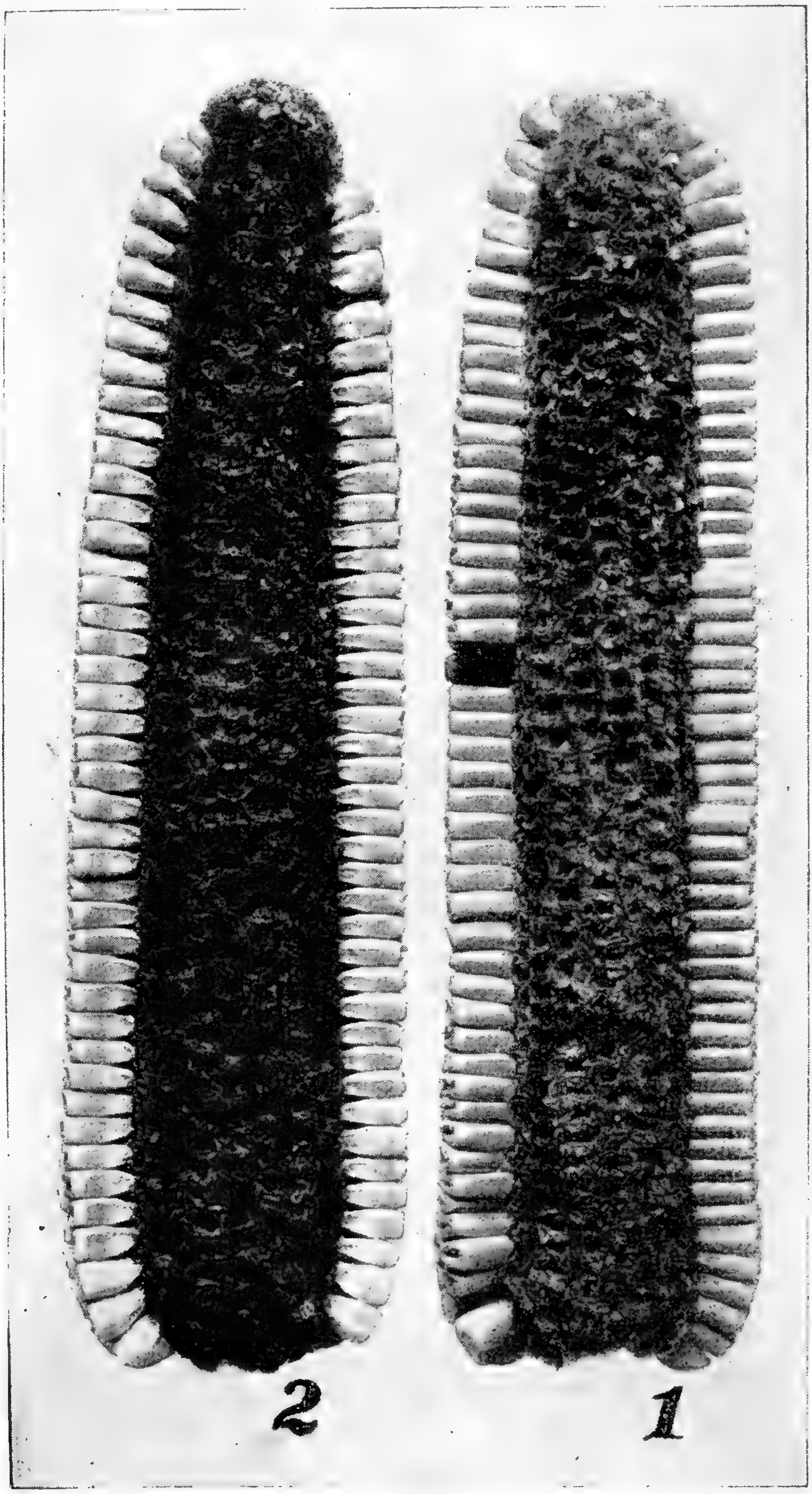


FIG. 31.

(See kernels from these two ears in Figs. 29 and 30 on preceding page.)

Different Types of Kernels.—Nos. 1, 2 and 3 are illustrations of kernels with poor, weak, germs. Note how small and shrunken the germs are compared with No. 6 and No. 7.

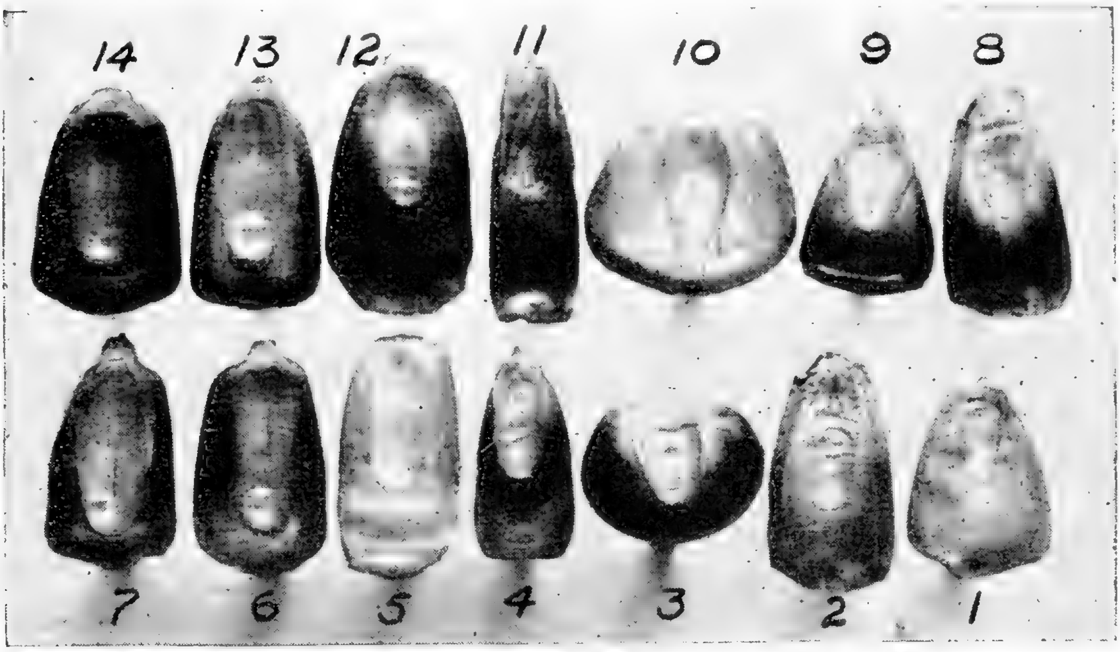


FIG. 32.

Nos. 8 and 9 are somewhat better, but the poor shape of their kernels, coupled with their small germs, make them very undesirable kernels.

Pointed kernels such as these do not give room for good development of germ. In addition to being pointed these kernels are very thin at the tips, and so are weaker than they appear. Kernels of this shape frequently break off in shelling, especially if immature.

No. 2 has a shrunken, blistered germ owing to its immaturity but it is of a better form than 1, 8 or 9. Cobs bearing such kernels give a very low percentage of corn to cob as the wedge-like shape of the kernels does not allow them to fit closely.

Nos. 3 and 10 are types of very broad, shallow kernels such as are grown in the north where the season is short and where deep kernels could not mature.

DEERING CORN BINDER.

Kernels 5 and 12 have germs rather under the medium size but are particularly weak at the crown. They do not carry their width up well like 13 and 14. They are thin at the crown giving a chaffy appearance to the ear.

Of the remaining four No. 14 is the best, followed by 6, 13 and 7 in the order named. No. 14 is a practically good kernel. It is of the broadly wedged type, carries its width well down to the tip, has good depth and good width. It possesses a large, plump, cheerful germ. The appearance of the whole kernel indicates strength and vitality.

Fig. 33 shows kernels having large and small germs, taken from different ears of corn. The left hand kernels in all pairs come from ears with low feeding value and should be discarded for seed purposes, while the right hand kernels with large germs come from ears with a high per cent of oil and protein.

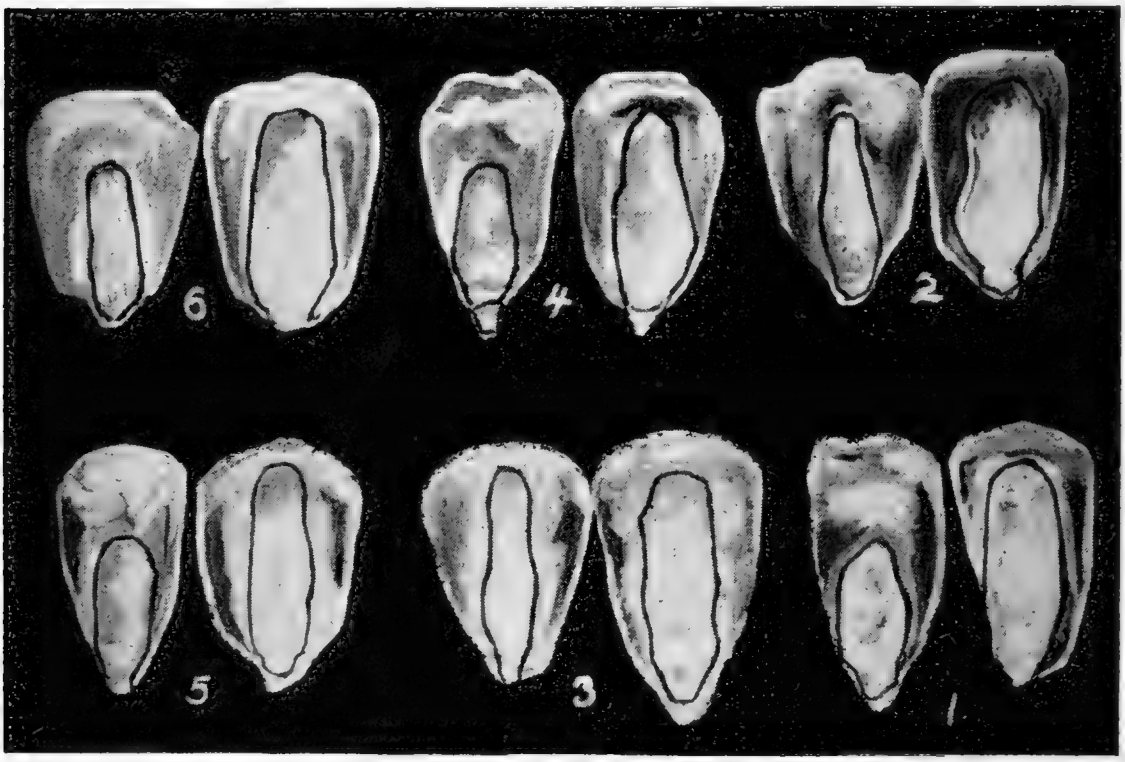


FIG. 33.

Cultural Methods.—There is no one best method suited to all parts nor to the different soils of a given part, nor even to the different fields of the same farm. Frequently two very different methods may give equally good results.

There are no "iron clad" rules which can be followed blindly in the growing of corn any more than in any other farm work. Have good ground, do the work on time and do it thoroughly, should be the object of every corn grower.

Importance of Good Ground.—Nothing can make up for poor ground. Too many are trying to grow corn on "worn out" ground that has produced corn and oats for years.

I met a man at an institute in Illinois who said, in all seriousness that he was satisfied that the seasons were less favorable for growing corn than they used to be, as he could get no such crops as he formerly raised. It developed that he had grown corn for 17 years in succession on the same piece of ground. No wonder that "the seasons were becoming less favorable."

Let us remember that it was only a few years ago that the land of the Central West was broken from the virgin sod and because we have been able to crop the ground continuously in the past is no assurance that it can be done in the future.

The fact is that the time is near at hand when we must pay greater attention to the fertility of our soil, to the conserving and restoring of the elements of plant food or we shall soon be compelled to pay out millions of dollars each year for these elements in the form of commercial fertilizers, as is now done in the East.

The tremendous importance attached to this question can not be appreciated by those who have had no experience in using commercial fertilizers in the older settled parts of our country.

What is needed is more clover, better use of the barn yard manure and less of the continuous cropping with corn and oats.

Depth to Plow.—What is known as deep plowing is generally not advisable in the corn belt, although the loose soils and bottom lands may be plowed much deeper than the black prairie soils with less danger of bad results.

M'CORMICK CORN BINDER.

There is seldom any advantage in plowing more than six inches deep either in spring or fall. If ground is to be plowed deeper than formerly it should be done in the fall. On heavy soils, the bad effects of too deep plowing is often apparent for several years.

Too Deep Planting.—Too deep planting is especially bad when the seed is weak and the spring is cold and backward. When the ground is not well prepared or is very mellow, there is danger of putting the seed down four or five inches, when two would be better. Especial care should be taken in case of early planting when the ground is still cold.

I know of several cases last spring where the same seed planted in two different fields, gave a good stand in one case and a very poor stand in the other. Investigation showed that the poor stands were due to too deep planting. Corn is generally planted deeper than we think. The planter wheels frequently sink into the ground two or more inches and the corn is covered another two inches.

The planter tracks are then filled by harrowing and the corn is often more than four inches deep. We often watch the planter carefully for a few rounds when we start the planter and then pay no more attention to the depth of the planting. The soil is generally mellower as we get away from the head land and consequently the corn is planted deeper than we supposed.

Cultivation.—It is not possible at this time to go much into details, and of course, methods will vary greatly with local conditions, but there are a few things of importance often overlooked.

Many think that there is nothing more to do after the corn is planted for two weeks until it is up and large enough for the "first cultivation."

There are others who believe in harrowing and even in cultivation before the corn is up, but on account of the pressure of work, neglect it. Where ground is left in this manner for two weeks, and often longer, it becomes foul with weeds, which take up moisture and plant food and make it difficult to work the corn.

MILWAUKEE CORN BINDER.

The ground is packed by the rains and baked by the sun until it becomes hard and dry; that is "out of condition."

It is especially important in the case of corn that it should not be stunted when young, as it never fully recovers, even under the most favorable conditions. We should keep a good, mellow, lively tilth until the corn shades the ground, preventing the rain and sun from beating upon it, making it hard, dry and mealy.

The time to kill weeds is before they come up and before they have deprived the corn of moisture and nourishment.

Where it is possible to do so, it is a good plan to cultivate the corn once before it comes up, following the cultivator with the harrow. If the piece is small so that the cultivation can be finished before the corn breaks through the surface, it is well enough to wait until the field is all cultivated and then cross it with the harrow instead of following closely behind the cultivator. However, in case of large fields, it is best to follow the cultivator with the harrow.

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Best Methods in Seeding

PREPARATION OF SEED BED—SELECTION OF SEED SOIL CONDITIONS, VARIETIES, ETC.

By Waldo F. Brown

WHY Wheat is One of the Leading Crops. In many respects wheat seems to be the most important crop the farmers grow. Its importance is due to the following facts:

1st. It is a crop which always commands the cash, and is always in demand. In speaking of the value of other crops or of investments, it is a common expression with farmers that "it is as good as old wheat in the mill."

2nd. It divides the work so that a single team can do much more on a farm where wheat and corn are grown in about equal proportion than where corn is the sole or principal crop.

3rd. It can be successfully grown on rolling lands, which, if continuously cultivated in corn, would soon be ruined by washing.

4th. It gives an opportunity to rotate with clover, which, while occupying the land and furnishing plant-food for successive crops, is almost an essential crop in any good rotation.

5th. It can be easily stored. There is little risk of injury from dampness, and almost no loss from shrinkage, and at the usual prices, a team can take to market several times as many dollars worth of wheat as of corn.

6th. Probably no farm crop grown gives such certain and large returns for manure as this, and at the same time, under proper treatment, leaves the land in good condition for a succeeding crop.

7th. It furnishes the farmer a large bulk of straw, which can be utilized for food, bedding, shelter, and as an absorbent for liquids which would, without it, on many farms, be wasted.

8th. As wheat is exported to a large extent, and can be held for one or more years if desired, it is less subject to fluctuations in price than many other farm products, and is not so likely to be depressed by an unusually heavy crop.

Flourishes in Many Kinds of Soils.—Wheat flourishes on a great variety of soils, the essential conditions being good natural or artificial drainage, and a supply of available plant food. A limestone clay under favorable conditions is probably one of the safest soils for this crop, but it is grown with success on soils of various textures and degrees of fertility.

Drainage Necessary for Good Crops.—There is no crop which is more benefited by drainage than this. In fact it is scarcely wise to attempt the cultivation of wheat on a soil that is not drained either naturally or artificially, as a perfect crop can be grown on such land only in exceptionally favorable seasons.

If the surface soil is filled with water during the winter and spring, the freezing and thawing will heave out the young plants, and if water remains upon the surface the result will be more disastrous.

Where the surroundings or the circumstances of the farmer are such as to make underdrainage impracticable, very good crops may often be obtained by plowing in narrow lands and opening out the dead furrows, making provision for a clear outlet so that water will never stand in these furrows.

It will be sufficient for this purpose that the furrows be opened without rounding the lands. The latter practice, by giving a greater depth of surface in the middle of the land, is liable to cause the crop to mature unevenly.

Outlet Needed at Every Low Place.—An outlet should be opened with the plow at every low place in the field, so as to prevent the water from standing on any part of it. Of course, these open furrows across a wheat field are objectionable, and interfere with the convenient use of machinery. But they are less objectionable than the loss of a crop from excess of water.

As soon as thorough underdrainage can be accomplished, these open furrows may be dispensed with. I have seen heavy crops of wheat harvested on the flat lands.

Preparation of the Seed-Bed.—I believe that the increased yield of wheat during the last few years is due more to the care and intelligence in the matter of preparing the seed-bed than to any other cause.

One important point is early plowing, and this applies especially to the clay lands of which I have spoken as particularly adapted to wheat. Our farmers have found that wheat does best on a seed-bed that is compacted, with two or three inches of mellow soil at the surface, and that this can be obtained best after the land has been plowed for some time, and has been settled by rains.

I have often had an opportunity to notice the difference in results between early and late plowing, where a farmer began plowing a field in July, and stopped when the ground become hard, and was unable to finish until late in September. In such instances I have seen in the same field a difference of ten bushels or more to the acre in favor of the part which was plowed early.

Crop Proves that "Tillage is Manure."—The farmer is not liable to make a mistake in putting too much work on his wheat land in the way of mellowing and compacting. The best yield I ever obtained was on a field that I harrowed, rolled, and dragged six times between breaking and seeding.

I fully believe in the truth of the maxim, "Tillage is manure," and that a soil which is kept mellow and fine for six weeks or two months during the heat of summer, becomes vitalized and enriched so as to give the young plant a thrifty start.

It is of importance in all the work of preparing the seed-bed for wheat, so to arrange that the work can be done at the best time. During the heat of summer we usually have after each rain one or two cool, cloudy days. This is the time when the teams should be kept at work early and late. The land is moist and turns up easily, and a team will do twelve or even fourteen hours of work with less strain and worry than they will in eight hours a day a week later, when the ground has become dry and the mercury is up in the nineties.

Pulverize When Ground Crumbles at Touch.—It is the same with the work of pulverizing. There are times when one day's work will accomplish more than three a little later.

There is a time after each rain when the ground will crumble at a touch, and the farmer can go on his fields then with a harrow that will take a wide sweep, and leave it in a condition to be benefited by sun and air, and that will check the evaporation of moisture so that the land will not soon become dry and hard.

If, however, he neglects this a few days until a crust forms, it will be impossible to get it in good order till another rain falls.

Roll Wheat Land as Soon as Plowed.—My advice in preparing wheat land in the summer is to roll as soon as plowed.

At the first plowing after a rain it will do to plow a day or sometimes two days before rolling. But as the weather gets hot, and the land begins to dry, roll each half day.

Under some circumstances it will pay to unhitch from plow and hitch to the roller as soon as sufficient number of furrows are

WIDE CUT BINDER AT WORK.

plowed to make a round for the latter. I think that any farmer who will give this plan a fair test will never abandon it.

It is wonderful what power of retaining moisture a fine soil has. A field that is at once made fine and compact with the roller will be put in excellent condition for seeding by a shower which would make no impression on a field that had been left rough and cloddy.

I think there can be no beneficial chemical action in the soil without moisture, and the field which is allowed to be baked and hard for some weeks previously to seeding time, loses the cheapest and best source of fertility which is at the command of the farmer.

Take Strip for Test in Pulverizing.—If any of my readers think I am giving undue prominence to this matter of pulverizing, I would recommend that they test it on a strip in the field, and continue the experiment for a series of years, that they may hit both dry and wet summers. I am sure the experiment will result in convincing them that thorough preparation of the seed-bed is one of the most important points connected with the crop.

There are seasons when it is impossible, on account of dry weather, to plow early for wheat and when the plowing must be done just before sowing, I would recommend that it be shallow,—about four inches, not more than five. A deep, loose seed-bed holds too much water, and if we can not have our land settled and compact it is best to plow only what we can thoroughly pulverize.

I think that three inches of soil made fine and mellow, resting on hard unplowed land, is better than eight inches thoroughly fined. The seed is also liable to be covered too deeply on the loose land.

How Compact Seed-bed Secret was Learned.—The farmers learned early in the forties the importance of a compact seed-bed. In those days we plowed our land, turning on the plowed ground instead of "back-furrowing" as we now do and turning on the unplowed ground; and we found that always the strip of land some ten or twelve feet wide, on which the horses turned, gave a stronger growth and thriftier plant than that sown on the loose, plowed ground. Farmers noticing this, as a general result soon learned that the wheat plant required a compact seed-bed with a loose surface.

Avoid Plowing Clover Under Late.—Another thing which must be avoided is the plowing under late in the season of a heavy growth of weeds or clover. During the war a man of my acquaintance, named Jones, who was a contractor, made a fortune in Government work.

Probably thinking that any one could farm, he invested in three choice farms in my neighborhood. For two of them he got no tenant the first year. These farms were all in clover but he did not even pasture it. He allowed the clover to grow up and fall down, and the second crop to grow through.

He found a tenant in September, after the land ought to have been plowed and compacted, and turned under this great mass of clover.

I was riding past the farm with a neighbor, and noticing how thoroughly the clover was turned under he said to me, "What a tremendous crop of wheat that farm will yield next year."

I replied, "I predict that his wheat will not be worth cutting."

When he asked me why, I said, "It will freeze out. He has plowed under this mass of green foliage so late in the season that it will not be decomposed and compacted before cold weather, and will hold water enough to kill his wheat."

The next season, as I passed the field I saw my prediction had been fully verified, as his wheat was a failure.

Too Much Clover—Too Few Feathers.—Mr. Jones made a mistake which was the reverse of the Irishman who heard that feathers made a very comfortable bed, and who caught a goose, pulled out a handful of feathers, put them on an oak plank and lay down on them for the night. But he was unable to sleep, and after tossing on the hard board until morning, he got up and said, "Bejabbers! if a handful of feathers is that hard, what would a whole bed be? I will never sleep on feathers agin."

Mr. Jones had heard that clover was a fertilizer, but unlike Pat he used an overdose of it and lost his crop.

Remove Clover by Burning or Mowing.—This calls up another point,—What shall we do when we have been unable to plow, and our field, late in the season, is covered with a dense growth of weeds or clover?

I answer, it must be removed, and there are two methods by which it can be done. One is by burning, if the growth is dry enough. The other is by mowing, and drawing it off, stacking it for use, and then plowing shallow and compacting it.

The heaviest crop of wheat grown in northern Ohio several years ago was on a ten acre field, which made five hundred bushels (fifty bushels to the acre).

The owner of the field had sown it in Mammoth Clover the previous year to plow under to enrich the land, but found with his team and plow it was utterly impossible to do it. After working half a day he gave it up, and, as the clover was dry and lodged, he touched a match to it and burned the field over, resulting in the yield named above.

A Mistake of My Own in Corn and Stubble.—Soon after I began farming I concluded to try the experiment of plowing my corn-stubble under instead of making a mellow surface and seeding as had been my practice.

I cut off the corn, made the shock-rows as far apart as possible, cut down the butts so that they were turned under completely out of sight, and I thought as I looked at it that I had never seen a better seed-bed, perfectly mellow, with nothing on the surface to interfere with the use of the drill. I congratulated myself that I had a chance for a record-breaking crop. But as I had allowed the plow to run seven or eight inches deep, I had committed the blunder of making a deep, loose seed-bed, and my wheat froze out and was not worth cutting.

Good Crop Over Burned Wheat Stubble.—My own experience in burning off wheat-stubble was exceedingly satisfactory. I grew a crop on my father's farm, when I was of age. The season was good, and the average yield more than thirty bushels to the acre.

As it was cut with the cradle, (the harvesting machine not having come into general use), the stubble was in many places nearly three feet high. The grain was so thick we could not carry it round to the swath with the cradle except by cutting as high as possible.

I put the same field in wheat the following fall, and finding that I could not possibly plow under the stubble, I fired it. On a large part of the field the stubble burned off clean, but on the higher clay land where the stubble was short it only half burned, running out a tongue of fire here and there, leaving strips of stubble between.

It was plowed and put into as good condition as possible, and sown. The wheat came up very much sooner and stronger on the part where the stubble had burned, and showed until winter set in a marked increase of growth over that where the stubble had been plowed under.

Fire an Effective Cutworm Destroyer.—A few years later I burned off a stubble field in the spring that I was plowing for corn. I had plowed an acre or two before firing the stubble, and then applied the match because I could not turn it under properly, and learned another fact with regard to firing, which was that it destroyed the cutworms entirely. The acre or two that had been plowed early was nearly eaten up by cutworms, while not a single hill was touched on the part that had been burned over.

Compacting More Important in Prairie Land.—The reader will understand that all my experience in growing wheat has been on clay upland soil, and my instruction about making the seed-bed compact would be of still greater importance on the loose prairie or bottom soil. While in Nebraska some years ago, I found soil of the part I visited so loose that the wind blew the wheat out by the roots, and winter wheat could hardly be raised at all on this account.

I think this condition could have been avoided by pasturing the land, so that the tramping of the cattle would compact it, then preparing the seed-bed with a harrow, making only a shallow seed-bed, just enough to cover the grain.

This compacting of the soil enables the grain to root in the hard ground, and thus to escape the perils of winter freezing and the blowing winds of the prairies. For while the compact seed-bed has proved to be the proper thing and exceedingly important on clay upland, it is much more so on loose prairie or bottom lands.

Importance of Selecting Clean Seed Wheat.—Too little attention is given by farmers generally to the selection of their seed wheat.

On many farms wheat is sown year after year which contains a large per cent of rye, chess or cockle and in which there seems to be an admixture of different varieties, the latter may be no disadvantage and some farmers prefer to sow mixed seed, thinking it produces better than a single variety. But there is little excuse for sowing seed that is foul.

One of the best ways in which the farmer can remedy this matter is by setting apart a certain plot, it may be an acre more or less on which to grow stock seed. All our seedsmen select stock seed for their own planting and in this way keep up the quality of all their products.

It is well to inspect your wheat fields thoroughly before deciding whether your varieties are satisfactory. If not, take a day and drive through your neighborhood and examine the wheat grown and from the best engage a small quantity of stock seed. It is a well established fact that wheat should not have too radical a change of climate or soil.

Learn Everything to be Known About Variety.—When you select the seed to begin this experiment question the grower and learn all you can about the variety. Whether it stands up well. As to its time of ripening and ability to endure wet weather after harvest. Weight of grain and plumpness. Liability to shatter when over-ripe. Some kinds will shatter badly when others would not waste at all.

Probably a two bushel sack full will be enough seed for this experiment as if it does not do well the less the better, and if it proves all right this amount will grow enough seed for a large field another year.

When you have found a variety that suits you, sow an experimental plot each year until you have eliminated everything that is not satisfactory from your seed and have established the variety that suits you.

Some would prefer paying high prices to advertisers of wheat rather than go to this trouble but I believe for seed to grow on your own soil you can establish a variety yourself that will be of more value to you.

When you sow this selected seed the second year go over your plot from which you are intending to save your seed wheat for the ensuing year and pull out all objectionable mixtures. If your variety is bald cut out all bearded heads and remove all cockle, chess, rye or anything that will injure your seed.

How Shall the Wheat be Sown?—No money is better spent on the farm than in the purchase of the *best* Wheat Drill on the market. There is no question that the advantages of the use of the drill are many and paramount.

First, it puts the wheat in so that it all comes up, the seed being distributed evenly. The depth of covering can be regulated by the use of the drill, and long experience has shown that shallow covering gives the strongest growth of plant.

I give here a table showing the result of experiments made by the Agricultural College at Lansing, Mich., which emphasizes the advantage of shallow covering.

I would recommend from one inch to one and one-half. In the table given the first column shows the depth of planting, the second the time that elapsed between planting and the appearance of the plant above the soil, and the third the proportion of the seed that grew.

Depth.	Time in coming up.	Proportion of seed that grew.
½ inch	11 days	⅞
1 "	12 "	all
2 "	18 "	⅞
3 "	20 "	¾
4 "	21 "	½
5 "	22 "	⅜
6 "	23 "	⅛

Plant Weakened by Deep Sowing.—It was also noticeable that the plants from the deep-sown wheat were weak and lacked vigor, they had rooted at the bottom, and later put out a new set of roots near the surface, and the stem below rotted off, leaving the plants to start a new growth from the second set of roots, which of course made it later, and weakened the plants. This would not have been the case with wheat drilled at the proper depth.

Small Ridges Between Rows Hold the Snow.—Another, and perhaps the greatest advantage of all in drilling, is that the ground is left in small ridges between the wheat-rows, and these hold the snow so that often a light snow will protect the plant in the furrows, and during the freezing and thawing of mild days the earth is continually crumbling down around the roots of the wheat sown in the depression between the drills.

Some farmers have practiced dragging the land after the wheat was sown with the drill, but in doing this they lose the advantage of the drilling as above mentioned.

All rolling and harrowing should be done before the wheat is sown.

How Much Seed Shall We Sow to the Acre?—I conducted a series of experiments with Fultz wheat many years ago, this variety having a small grain, and I reached the conclusion then that one bushel of seed to the acre was sufficient to produce a heavy crop.

One year I sowed two acres adjoining with this wheat, using a bushel of seed on the first acre and one-half bushel only on the second. When it came up the lighter seeding looked thin on the ground, but as the ground was in excellent order, and the wheat sown early, before fall no difference could be detected between the two. The two acres produced seventy bushels from one hundred and three shocks, fifty-one of which grew on one acre and fifty-two on the other.

From this and other experiments I settled the question for myself, that on my soil, and with this variety of wheat, one bushel of seed to the acre was ample.

After reading the experiments which have been carried on for many years at our Station, however, I modify this conclusion as the Station publishes from year to year that it finds very nearly two bushels to the acre gives the maximum yield. Knowing, as I do, how careful and accurate these experiments are, I am obliged to give up my theory of light seeding, although during the period of my experiments I averaged with the best wheat-growers of the neighborhood, who sowed from one or two pecks more of seed to the acre than I did.

What Varieties of Wheat Shall We Sow?—Every year new varieties of wheat are advertised, about the yield of which marvelous stories are told. Often men are led to invest in a large amount to sow their entire crop with the new and high-priced varieties. This I believe always to be a mistake.

The conditions of soil may be very different on your land from that which produced the big crops. It is better to sow a small amount and test it one or two years before changing to a new variety. In doing this I would limit the new variety to a single sack. If this proves valuable you will save enough from it to sow a large acreage the second year. If it makes a failure, it is too much rather than too little.

It will require more than one year to test all the qualities of a new variety of wheat. An illustration of this in my own experience was that I bought two bushels of Clawson wheat several years ago, it being recommended as a wonderful yielder. I noticed that it came up in about four days less time than the Fultz, and grew rapidly, so that the ground was soon green and covered with wheat. I was greatly pleased with it until the ensuing harvest, when a long period of wet weather prevailed. Before long my Clawson was growing green in the shock, while the Fulz wheat did not sprout at all. If the wet weather had lasted a few days longer my crop would have been greatly damaged. I dropped the Clawson from my list. This shows that a single season is not sufficient to test a new variety of wheat, as there is more than yield to be taken into account.

Time of Sowing and Enemies of the Wheat Crop.—My experience shows me that there are several causes for a poor crop or failure. These are the Hessian fly, rust, and the conditions of temperature and rainfall. There may be other causes, as hail, but this is always local, and usually extends over only a few farms.

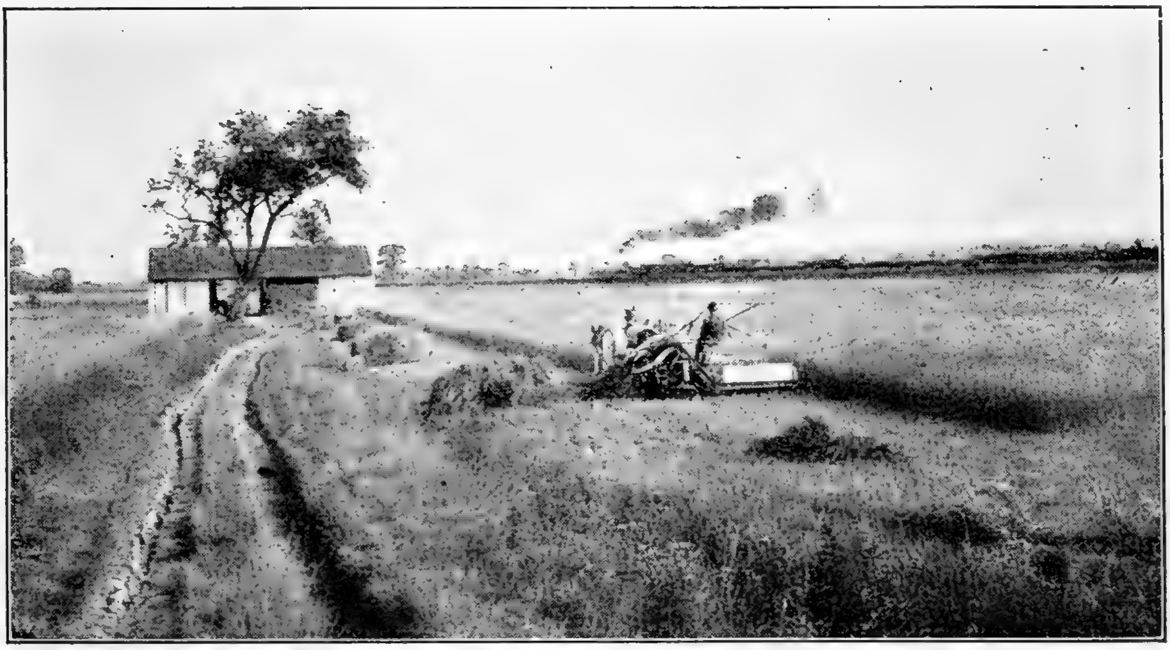
Taking up the question of the Hessian fly, it often destroys or greatly injures the wheat over a large territory, yet I believe that intelligence will enable us largely to prevent loss from it.

Some of our experiment stations have published maps of their States, divided off, and recommend a particular time of sowing to avoid the fly. These are based on the history of the work of the fly for many years, the time it puts in its work, and when the work on the young plant ceases.

These I have not found, however, a safe guide, as other questions come in to complicate the matter. For example the questions both of temperature and rainfall affect the work of this insect. In trying to avoid loss from the fly, one may meet with a greater one from questions which are not considered in recommending a certain time of sowing, and which are to a great extent entirely beyond the control of the farmer.

Weather a Very Uncertain Factor.—The trouble is here, that no man can foretell the weather for even a week ahead, and the seasons vary so greatly, that what would be successful in one year would prove fatal in another.

For example, one fall we had a drought which lasted during



M'CORMICK SELF BINDER.

the entire fall, with only two showers during the month of September.

Those whose land had been pulverized well, and who sowed immediately after the first shower, had a good stand and fine growth of wheat, the second shower coming about a week later, continuing the growth. But those whose land was not in condition to receive the seed then, failed to get a good growth, and their wheat went into winter with no protection from the growing crop and made a very light crop for the ensuing year.

The next fall we had a sufficient rainfall, but cold weather came on early in October, and the growth was very small and weak.

I have often had wheat that seemed to be so full of fly that it was likely to be ruined, but which made more than an average crop. I recall a few years ago when our farmers' club met in May on a good wheat farm, that the members went out and examined the wheat fields, and found the fly very prevalent through all the wheat growing on the farm. But the crop was far above the average.

Importance of Good Growth in the Fall.—One of the most important things connected with the fall wheat crop is that it shall make a good growth in the fall to protect the roots, and prevent winter-killing.

In trying to avoid the fly by late sowing, if the fall proves unfavorable for growth we fail to get a vigorous plant and a growth of blades to protect the roots. As temperature is entirely beyond the control of man, he always runs a risk with his wheat crop in planting late, though it may produce the best results.

I recall a few years ago that I sowed the eighth day of October a field of wheat. The whole month of October gave a high temperature and sufficient rainfall, and I had a magnificent growth and a yield of thirty bushels to the acre. My own experience teaches me that I would rather take the risk of the fly, and sow my wheat not later than the 20th of September, than to postpone the seeding until into October in order to avoid the fly.

Trapping Fly by Rye Strip Around Field.—At our Farmers' Institute held recently, a wheat-grower recommended the seeding with rye, the latter part of August or first of September, a few rods wide surrounding the wheat field. He said that the fly would deposit all its eggs in this, and then it could be plowed under in the spring for potatoes. He is a large potato-raiser, and as an additional advantage he found that potatoes never were scabby planted in land where a heavy growth of rye had been plowed under.

This seems to me, if true (and I do not dispute it), a very important fact in connection with the destructive work of the fly, and the saving of the wheat, with the added advantage of clean, saleable potatoes and a heavy yield.

Let us remember that the fly will destroy the wheat if it is of weak, feeble growth, when by early sowing, thorough preparation of the seed-bed, and an application of fertilizer, we may raise a very profitable crop of wheat in spite of it.

The Seeding of Spring Grains.—In the seeding of spring grains, I think it of first importance to sow as early as possible. Occasionally there is a season when oats sown in April yield a maximum crop. But as a rule, the nearer the first of March we can come to sowing in this latitude, the heavier the yield will be, and the better the quality of the grain.

In this connection I will say that formerly I had great trouble in getting a stand of clover with spring grain, but it was not because the seed did not germinate and start well; the plant was so shaded as to become spindling, and was often killed by the hot sun soon after harvest.

In those days I sowed oats broadcast. For the last ten years, however, I have followed the rule of drilling always, and have had no difficulty in getting a good stand of clover.

I find also that fertilizing the oats not only increases the crop, but also adds to the vitality and vigor of the clover. In cutting the oats the sickle should be raised, as if cut close to the ground it takes off all the foliage and leaves only the bare stems, which are likely to be killed by the summer heat. Clover that has been sowed on drilled grain grows much stronger, as it is little shaded until it has become well rooted.

My success with the grasses is much better when sown in the fall, and careful experience has shown that if sown without a the first year, therefore I have adopted this plan of seeding the grasses. I will have something to say about the legumes, their value and needs, in observations on fertility and fertilizing.

The Utilization of By-Products.—This age is noted for utilizing what was formerly wasted.

The by-products of the beef pay all the expense of slaughtering and packing, and leave a handsome profit beside.

The by-products of wheat are straw and chaff, and any one who will estimate the amount of loss from the wasteful management of these things will be astonished at the result—and they are two products of the farm that are more generally wasted than any other.

There are still localities where the wheat is threshed in the field nurse-crop they will make a large yield and profitable crop of hay year after year, and the straw is left on the ground slowly to decay. Not only is it absolutely lost, as far as any valuable service is concerned, but it often covers a large area of land which cannot

OSBORNE SELF BINDER IN THE FIELD.

be cultivated until the straw is either removed by slow decay, and spread for manure, or burned on the field.

There are large neighborhoods where the practice is universal of threshing and not even stacking the straw, but leaving it spread out over one-eighth to one-quarter of an acre each year, adding to the loss of the straw the loss of the use of the land on which it lies.

How Straw May be Made Profitable.—Perhaps the majority of farmers do not know that the average weight of the chaff and straw that will produce one hundred bushels of wheat (which weighs 3 tons) is 6 tons. So that you can estimate the number of tons of your straw and chaff from knowing how many bushels of wheat have been produced.

I wish to suggest how this straw can be made profitable. If you will refer to a work on Agricultural Chemistry, you will find that straw contains much valuable food, but that it is an unpalatable ration, so that fed by itself it is of little value.

I remember in my younger days when cattle were often wintered on straw alone, to which they helped themselves from the stack from fall until spring. It was common then for cattle to become so poor that if they got down they would have to be helped up, and many of them would die from starvation.

A careful study of this question leads me to believe that on a farm where a large amount of wheat is grown, it is not necessary to feed any hay to the stock, or at least very little. But the farmer should utilize his straw, and to do this he must add the elements of food that are deficient, so that the straw will become more nearly a balanced ration than it is when fed alone.

Brine Will Make Straw Palatable.—The straw lacks two things: it lacks palatability, and also the nutritious elements of food which would enable the animals to digest and assimilate it almost or quite as well as good hay.

I have long believed that a ration can be constructed largely of straw, and made both palatable and nutritious, so that animals fed on it will come through almost if not quite as well as if fed on good hay.

To make the straw ration palatable, it is only necessary to sprinkle it with brine daily when put into the racks. If the brine is made strong, the sprinkling can be light; if weaker, more can be given. This also I believe from long experience adds to the digestibility of it.

As a dairy-man I know that the dairy cow that receives a moderate ration of salt every day is seldom off her feed, and cleans up her ration and digests it much better than if salt is not given in some form.

Nitrogenous Food Adds to Digestibility.—In addition to this, the digestibility of the ration is largely increased by adding some highly nitrogenous food. I have figured out from my own experience that cattle that receive sixty pounds each of straw daily, and in addition, oil meal and bran for the grain ration, will come out in the spring as well as cattle that are fed on the best of hay.

On many farms twenty horses and grown cattle are wintered yearly, and, if fed entirely on hay for their rough feed, about forty tons will be consumed by them between fall and spring. When hay will sell, as it frequently does, at from $10 to $12 per ton, a large saving can be made by substituting the straw ration with such mixture as will properly balance it. Forty tons of hay if sold will make a large addition to the income, and your straw that is not consumed will be reduced to rich manure, as it absorbs all the liquid, and can be applied to the wheat and grass fields, largely increasing their yield and profit.

When to Manure and Fertilize for Wheat.—To begin with, I am a believer in keeping manure under cover; but if thrown under cover and left loose, it soon heats, drives off the nitrogen, and burns so that it is of little value, and very difficult to spread evenly. The best way to manage manure is to clean out the stalls daily, and distribute the manure evenly in a covered shed, keeping on it dehorned cattle.

The reason I say "dehorned" cattle is this that when dehorned they will all crowd into the manure shed and tramp it thoroughly while if not dehorned a few of the leaders will keep the rest out and they will not only suffer from exposure but the manure will not be put into as good condition for spreading.

Then an experiment which has been largely carried out at the Ohio Experiment Station shows that it adds greatly to the value of this manure if each day it is sprinkled with ground phosphate which has not been treated with acid but is put on in the stalls or in the manure shed every day at the rate of about one pound to the animal. The natural acid in the manure causes this to decompose, and the phosphorous to become available.

When treated in this way the amount of manure to the acre may be largely reduced and yet better results obtained from it than if the manure were taken directly from the stable or barnyard and spread.

An application of eight tons to the acre of this manure gives excellent results, especially if it can be applied with the manure-spreader, which will disintegrate it and spread it evenly all over the surface.

By the use of this a large increase in the yield of wheat and other crops is made.

I prefer drawing out manure for wheat after harvest and spreading on the plowed land. This will avoid any tramping of the land to injure it or pack it by wagoning over it too much in places as at this season of the year it dries out and packs solidly very soon and the manure will be much more available for the young plants than if plowed under deeply.

The Use of Commercial Fertilizers.—It seems to me that this article would be incomplete without something about the use of commercial fertilizers. Like many other innovations the use of commercial fertilizers had to fight its way into favor. Some of our most intelligent farmers scoffed at the idea of a single sack of fertilizer doing any good and denounced it as a humbug and swindle to get the farmer's hard earned dollars from him. It was not until they had visible proof on the farms of their neighbors that they finally began its use.

In Highland County, Ohio, I passed a wheat field half of which had been fertilized the previous year with a single hundred pound sack to the acre of commercial fertilizer. This half averaged thirty-six bushels of wheat to the acre and the other half eighteen, no possible difference between the two except this application of fertilizer.

Test on Piece of Run-down Sorghum Land.—My first experience with commercial fertilizers, something over thirty years ago, was on poor ground. I had put a piece of run-down land in sorghum which made a small growth and light yield. Wishing to make a test plot of it I manured with good stable manure one strip and sowed bone meal broadcast on the remainder of the plot with the exception of a twelve foot strip through the middle. The stable manure made a good showing in the fall as the wheat made growth enough to furnish considerable protection to the roots. In the fall no difference could be seen between the plot on which bone meal had been used and the untreated strip.

I was unusually late in going to sow clover on it in the spring, as I did not apply the seed until April. To my astonishment when I got within twenty or thirty rods of the field I could see a dark green color and a rank growth on the fertilized strip which was a gratifying sight.

At harvest time the unmanured strip was very poor the growth being a foot shorter than that fertilized with the bone meal and heads only an inch long while the plot treated with bone meal had large well filled heads and plump grain and made about twelve bushels to the acre while that unfertilized was not worth cutting.

Keeping in mind the fact that this was very poor land and that wheat seldom does well after sorghum this yield of twelve bushels per acre was good.

I have frequently in passing a field on which commercial fertilizer had been used, seen where the fertilizer drill had run empty a few rods from the end and you could note at a distance of several rods.

Another thing which I have noticed is that when you get the right combination of elements in your fertilizer the wheat on the fertilized plot will ripen a week or more earlier than that which has not been treated. Every farmer knows that early ripened grain gives much better results and is plumper than that which ripens later.

I need not amplify this further for in most localities where fertilizers have been used there is no question about their value. One should study his soil and experiment until he finds what elements give the best results and then use them.

The Use of the Legumes in Farming.—These include not only all the clovers, but cow peas, soja beans, Canada field peas, and some other crops; wonderful advantage in maintaining fertility and increasing the yield of crops has been thus obtained.

The first piece of wheat I sowed when I began farming for myself was a seven acre field, on one-half of which I sowed clover. In the fall the yield of clover was so light, the season not having been favorable, that I did not think it would pay to leave it, and so plowed the entire field for wheat again.

I do not think there would have been 500 pounds on an acre if it had been pulled up root and branch and weighed green. But within two weeks after I had sowed the wheat, standing at the side of the field you could see to a foot where the clover had been plowed under. The wheat came up quicker and stronger, and started into better growth.

I then laid down this rule, which I have observed ever since, that no man can afford to allow any ground in small grain to go without clover. The legumes are the cheapest of all fertilizers, and the greatest possible help in maintaining fertility. In another place I have told of the methods to be used to get a good stand of clover on spring grain by drilling the grain instead of broadcasting it.

WALDO F. BROWN,
Oxford, Ohio.

Small Grain Growing

MAGNITUDE OF THE INDUSTRY—DEVELOPMENT OF NEW VARIETIES—VARIETAL DIFFERENCES, ETC.

By Willet M. Hayes

SEVEN Farinaceous Small Grains. — Excluding corn, the big king of the cereals, we have seven farinaceous grains which for the purpose of this article we shall call the *small grains*.

These with their respective values for 1899, as shown by the Twelfth Census, are: Wheat, $370,000,000; Oats, $217,000,000; Barley, $42,000,000; Rye, $12,000,000; Rice, $8,000,000; Buckwheat, $6,000,000; while for the millets or non-saccharine sorghums, the value was not determined.

As shown by the figures for the crop of 1905 published in December by the United States Department of Agriculture the values of these crops had grown, respectively, to the following: Wheat, $518,000,000; Oats, $277,000,000; Barley, $55,000,000; Rye, $17,000,000; Rice, $12,000,000; Buckwheat, $8,500,000.

Wheat the Golden Queen of the Harvests.—Men are enchanted with the sowing of wheat seeds, with harvesting the golden fields of grain, with the hum of the great threshing machine, with the movement of the great cars and ships laden with the trillions of berries, with the burring of the mighty mills, with the mysteries of the bake oven, and with the never cloying pleasures of white bread covered with June-yellow butter.

If a grain of wheat could tell the story of its brothers, sisters, father, mother, uncles and aunts, and its other relatives near and remote, it would equal any fairy tale.

One kind of berry would tell of its origin in England, another in France, another in Germany, and perchance another in Russia; each with its forbears back in some remote neighborhood, or may be in still another country, with possibly a legend as to its unknown wild parentage.

Until in recent decades the history of the varieties of wheat, and of the other cereals is not of record. No doubt selection by man in more or less of a blundering way has gone on for many centuries. Hybridizing, by natural agencies, also may have occasionally occurred often enough to aid materially in making new varieties, by blending the good qualities of two or more parent kinds.

Few Varieties in World's Great Wheat Crop.—At present there are thousands of varieties of wheat, most of which have been originated in recent years by wheat breeders working with more or less of system. But the world's great crop of wheat is nearly all produced by a few dozen varieties.

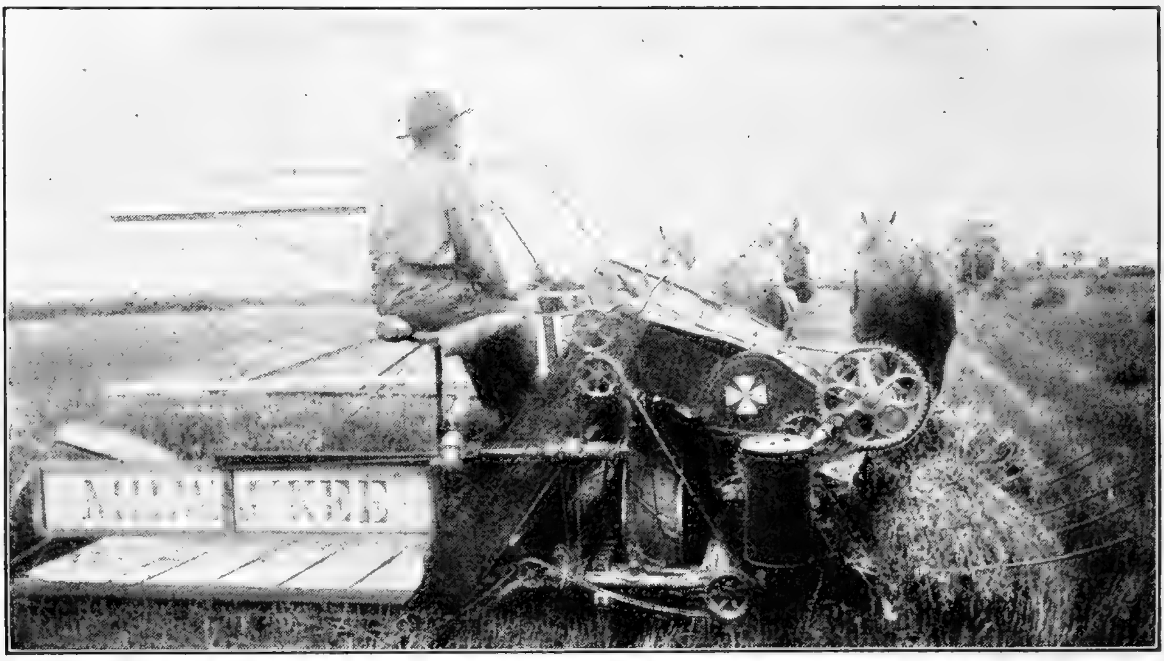
The fingers of both hands would enumerate the main varieties in this country, each of which spreads over not more than several states.

In Europe likewise there is a group of several varieties of wheat which make the bulk of the crop. And it is so with the other cereals, there is a relatively small number of dominating varieties.

Though the recent great activity in breeding wheat is originating thousands, if not tens of thousands of new selected and new hybrid wheats, this work is done with such care that only the relatively few best will escape the hands of the experiment station or other trained breeders.

Small Yield in America a National Disgrace.—That American wheat yields an average of less than fifteen bushels per acre is a national disgrace which can be cured by using two means:

The betterment of the soil conditions under which the crop may yield more.



MILWAUKEE SELF BINDER IN OPERATION.

The improvement of the yielding power of the varieties planted.

Since the improvement of the fields may be discussed at once for all six of the small grains, that will be taken up first, and the breeding of each crop will be dealt with more in detail under the respective species.

Our national average yield of wheat should be increased from fifteen to twenty-five bushels per acre. By better preparation of the land five bushels of this increase can be gained and by wheat breeding the other five bushels.

More Careful Crop Rotation to Pay the Cost.—The five bushels gain from better organized field and farm management will probably cost three dollars annually; and this must be paid by the grower in a more carefully managed scheme of crop rotation, in fertilizers and in cleaner and better intercultural tillage of the hoed crops with which the wheat alternates in the rotation.

The five bushels from breeding and good seed will not cost ten cents an acre, and of this the national and state governments will pay part for breeding work on experiment farms. The farmer's part in obtaining seed of the new varieties and in raising, caring for and preparing his seed will not be appreciably greater than now

Place of Grains in the Rotation.—Wheat and other small grains are somewhat sensitive to the condition in which the previous crop left the soil. They do not thrive well after a crop of small grain. In many cases they will yield twenty or thirty per cent more after a hoed crop, as corn or potatoes, or after a crop of grass, clover or alfalfa than after a small grain crop.

Though these grains are benefited by a direct application of either barn or commercial fertilizer on poor soils, they are often injured by the application of barn manure on rich soils.

Generally barnyard manure will give more final returns by the acre to the farm if applied to a previous cultivated crop as corn, or even to the grass crop, in rotation; the wheat, oats, barley or other grain thus receive the residual effect.

Barnyard manure often overdoes the small grain crop by causing it to grow heavy in the straw and to lodge and produce light, shrunken grain though it helps without injuring the other crops mentioned.

Some of the Best Plans of Rotation.—A good five-year rotation for grain in some of the states of the Middle Northwest is first year, small grain; second and third years, meadow and pasture of grasses and clovers seeded the first year with the grain; fourth year, small grain; fifth year, corn, applying the manure before the corn crop; then, beginning the second five-year period, repeat the rotation.

A four-year rotation found useful on some farms is as follows: first year, small grain; second year, red clover; third year, small grain; fourth year, corn: and repeat.

A three-year rotation as follows gives splendid conditions for the wheat or other small grain: First year, small grain; second year, red clover; third year, corn: and repeat.

Small grain and corn in a two-year rotation place the land in good condition for each crop of grain.

In the South cotton and cowpeas can take the place of the corn and clover in a four, three, or two-year rotation; and in many cases the cowpeas may follow the winter wheat, making two crops in one year, thus shortening the rotation by gaining one year in the four or three-year rotation.

By following some such method of natural farming the leguminous crops help to add nitrogen and organic substance to the soil surface of weeds and will provide the rather well compacted furrow slice needed to cause the small grain plant to stool well and to thrive throughout its growth.

Other Crops Benefited by Rotation Scheme.—That the rotation scheme is not all to favor the small grain crop may be shown in case of the five-year rotation first named.

The wheat, by serving as a nurse crop among which the newly seeded grass and clover may pass their first unproductive season without cost, prepares the land for the two crops of grass. The grass crops by cleaning, resting and enriching the soil prepare the land for a good crop of small grain the fourth year. The second crop of small grain which may often be followed with a crop of rye or turnips sown in spring to make pasturage among the grain stubble in autumn, furnishes conditions under which the manure may be hauled out and plowed under in fall, winter or spring in preparation for the corn crop. The corn grown the fifth year reduces the manure from too great activity, clears the surface soil and compacts the furrow slice so that it is in nearly ideal conditions under which the small grain may be put in with shoe or hoe drill or broadcast and disked in or covered with other suitable implement, and the second series of fine yearly crops started out in good condition.

Chemical Fertilizer Tests Not Expensive.—But it is not expensive to make trials of chemical fertilizers on a given farm, or on a given soil type. Thus a farmer, or a group of co-operating farmers can easily test their soils.

Corn is a splendid crop to use in the North, and corn or cotton in the South. The plots may be marked and the marks preserved for a year so that the residual effect on the following crop of grain may be observed, provided the effect is marked.

In making the trial with corn the following general plan may be pursued: Apply to plots three or more rows wide and ten or more rods long, on land where uniform plots may be obtained with alternating check plots not manured between, such amounts of nitrogenous, phosphoric and potash fertilizers and lime as may be advised by the agriculturist of your state experiment station; and follow his instructions as to time and manner of application also.

When the corn or cotton is ripe harvest the fertilized plots and the check plots separately and measure or weigh so as to determine whether the fertilizer gave any additional yield. It is wise to have one or two alley rows between each two plots, because corn roots reach over across the row, often extending five feet from the hill.

If these preliminary trials show that the soil is weak along any one line of plant food, or needs time to correct acidity, the experiments should be continued along that line to determine how much fertilizers to use and to which crop in the rotation to apply them.

Allotment of Land to United States Crops.—This country has about a billion acres in farms, half of which is improved land and half unimproved.

Of the 500,000,000 acres of improved land corn covers about 100,000,000 acres and the small cereals a similar amount, while cotton covers a third as much as corn, and grass lands for hay and summer forage cover two-thirds as much as corn.

There is probably nearly 200,000,000 acres in grass, and a total of 300,000,000 acres in all other fields, orchard and garden crops.

Thus of the 500,000,000 improved acres we have 200,000,000 acres in pasture grasses, 100,000,000 in corn, 100,000,000 in small cereals, 100,000,000 acres in hay, summer forage, potatoes, beans and other minor field crops and the more intensified crops of the orchard and garden.

Cereals from Canada to the Gulf.—Cereal growing extends from the Canadian partition fence down nearly to the Gulf of Mexico, and from Maine to California, and our Dominion brethren grow wheat some distance northward in their broad estate, especially in the expansive plains west and northwest of Winnipeg.

In the Euroasiatic Continent there is a similar band of small cereal areas which extends from far north in the Scandinavian Peninsula and in Northern Russia down past the Holy Land and even into elevated regions in India.

There is a temperate zonal strip in the southern hemisphere also, where the cereal band crosses Southern South America, Southern Africa, and Southern Australasia and including many islands.

Where it Pays Best to Raise Cereals.—On what part of Uncle Sam's estate does the cultivation of the small cereals most naturally belong? Only a small part of the wheat, oats and barley should be grown below Mason and Dixon's line, because the yield is not sufficiently large to justify it in comparison with values produced by crops of cotton, corn, rice, cowpeas and garden and orchard crops.

PLANO BINDER AT WORK.

Above that line and well toward the Canadian border winter wheat yields moderate value to the acre. It here holds a splendid place in the rotation, because it follows corn so well, requires labor at a time of year when other crops are not suffering and serves as a nurse crop for clover and grass seeds planted to make a crop the following year.

Along the northern border and over in Canada spring wheat takes the place of the winter wheat, though its average value to the acre is even lower.

Oats do not thrive well so far south as does winter wheat, not having been as yet bred for hot summer weather, but some will be grown nearly to the Gulf; and the barley zone is still further north than the oats.

Rye sown in the autumn is hardy to the northern counties of the United States and thrives south to Mason and Dixon's line. The millets and nonsaccharine sorghums are grown well to the north and kaffir corn has an especial usefulness on the droughty plains where it produces grain with light rainfall.

Great Advance in Rice Growing in America.—Rice on the other hand has a distinctly southern habitat and is local. The rice area recently has mainly moved from the Atlantic Coast States to Louisiana and Texas and its area has greatly extended. Its method of cultivation too has radically changed, and it has now come under America's broad plan of farming by machinery. Rice has been made more plentiful and cheaper. Broader acres, machinery, better varieties and better knowledge of methods of cultivation have revolutionized rice growing in the last five years.

Flax is not one of the cereals, but as it is grown at the same place in the rotation, requires the same preparation of the soil and affects the land in much the same way as do the small cereals, its cultivation may be discussed with theirs.

It is certain that economic factors have determined the present distribution of the small cereals.

In North Dakota, for example, wheat, oats, flax, barley and millet seed pay better than corn; therefore the farmers are constrained to grow as large an acreage of these money crops as is consistent with keeping their lands free of weeds, in good mechanical condition for grain, strong in fertility and otherwise in condition for good crops of these grains.

Alternation With Fallow in Semi-arid West.—Out in the Western semi-arid regions, instead of rotating the grains with corn and grasses they alternate them with the bare fallow, thus to keep down weeds, to secure good mechanical preparation of the furrow slice, but especially to conserve the water of the alternate year so as to supply the growing crop with the surplus water of two years instead of one.

The frequent droughts, too, make frequent seeding to clovers and grasses uncertain, so that the plan in these western, northwestern parts is to grow grain for some years continuously and then to seed to grass for some years, possibly injecting one crop of corn in among the crops of grain.

Thus a rotation is arranged as follows: First and second years grain; third, fourth and fifth years grass and clover; sixth and seventh years grain; eighth year corn; then repeat by eight-year rotation period.

Stock Feed More Profitable in Iowa.—In Iowa, on the other hand where corn, mainly fed to live stock, and pastures of clover and grasses, yield more value to the acre, the grains are being crowded down to a limited area.

There these crops are often chosen because of the need of a nurse crop to produce during the year of seeding the timothy and clover sown for hay or pasture following seasons. And though wheat and flax do not average as much value to the acre as corn and oats, barley and rye do not produce as much feed value to the acre as corn or grass; and though all these small grain crops deplete the soil more than crops of corn or grass yet in limited areas they round out the farm management plan.

If we can sell more live stock products, even at prices recently prevailing, Iowa and surrounding States can afford still further to reduce the acreage of these soil consuming, weed increasing crops, unless prices for these commodities increase. The world needs the amount of cereals now grown, but other countries where labor is not so dear are willing to produce them at a rather low price to the acre and to the worker.

Only better varieties for each and all of the many localities, better preparation of soil by rotation, good cultivation and cheap effective fertilization will make it practicable to retain our present acreage.

Handicap in Competition With Live Stock.—Live stock and the crops they require are a paying proposition with which grains for sale must compete. They have two great handicaps, they bring in less money and they leave the soil impoverished instead of richer.

As a matter of practical business most of the small grains in American agriculture are produced in connection with live stock products. By alternating them with the crops fed to live stock the land is prepared for the grains; often at the expense of the future crops for live stocks.

From Illinois eastward and southward commercial fertilizers are gradually coming into extensive use, placing the production of these crops on the same basis as that on which grains are grown in much of Europe. And the use of commercial fertilizers for this purpose will of necessity gradually extend westward and to other regions where the lands are now new.

The world will not rapidly change the proportionate amounts of cereal and live stock products it demands, and these, the one competing with the other, will each regulate the price of the other.

The great cities which consume the surplus of these products keep bowling along in their growth and in their ever-increasing ability per capita to purchase meat as well as bread.

The world's most rapid expansion of acreages of grain and live stock production was passed during the earlier years of railway and steamship transportation when the body of the world's great continental prairies was upturned with the plow.

The next expansion of production will no doubt be largely due to the better farm methods and the better breeds and varieties which the bounding growth of agricultural science is ready to bring forth.

Every Farmer Should Plan His Campaign.—Every farmer should work out his own farm scheme, map it out on paper where he can project it forward ten years or more under a definite rotation system.

When the ten years is up, the record of yields for each year placed in ten annual farm maps will enable him to average the several crops and determine what each yielded to the acre.

Before that time his state experiment station will probably have given him items of average cost so that he can calculate the average cost to the acre of each kind of crop.

By balancing accounts he will be able to tell what was the net profit or loss of each kind of grain grown and of each kind of crop fed to live stock. His neighbors also will have begun more of system and many of their figures will serve to guide his future operations.

Let the farmer block out his farm scheme, submit it to farmer friends for criticism, and finally send copies to the professor of agriculture in his state agricultural college, who may be able to give advice as to kind of crops in the rotation; as to the plan of rotation; also as to the preparation and fertilization of the soil.

Farm Management Developed as Science.—The agriculturists of the state experiment stations and of the National Department of Agriculture are seriously taking up the matter of farm management, and as far as their time permits they are ready to give advice.

They need a specific, intelligent statement of your problem and your point of view, that they may the better understand how to investigate farm management in all its manifold bearings.

There has already begun to appear writings on farm reorganization and management from a number of men who ere long will be regarded as masters along this line of scientific instruction and advice.

The experiment stations and the U. S. Department of Agriculture have begun to accumulate a valuable body of knowledge along this line and teachers are beginning to reduce to pedagogic form a system of teaching farm management to be comparable with teaching other lines of engineering and business organization.

The Various Soils Best Suited to Cereals.—The cereals are suited to a wide range of soils. On light sandy, leachy or drouthy soils these crops usually make a crop of good quality but poor in quantity.

The new durum wheat and Kaffir corn are adapted to the drouthy regions of the semi-arid plains; durums well to the north, and Kaffir from Nebraska southward in this "plains region."

There are few soils too heavy or wet for the small cereals, and rice grows in soils kept flooded so much of the time that few weeds can encumber the soil.

Like most crops, these grains are best suited by soils which are a happy medium in texture from being made up of coarse and fine materials combined, as where the great glacier, crucible-like, has left its mixture of sand and clay to the northward of the Ohio and Missouri Rivers.

Sods Adaptable to the Cereal Crops.—As was stated earlier, these crops like to follow corn, potatoes, or other hoed crops, and the grasses, as on sods of timothy, clover, or timothy and clover sown together.

The sod of the long-standing blue grass pasture, or of the long-established alfalfa meadow also suits these crops; though if the soil is naturally rich and the season unduly wet these crops are liable to overgrow in stems and leaves on rich land, and falling down, or even continuing too late their mere vegetative growth, make grain of poor quality and not large in quantity.

Flax is less liable to be overfed, while the varieties of oats as yet available for most localities are peculiarly liable to lodge and to be overdone with much plant food.

Why the cereals do not yield nearly as well following cereals as after alternating crops mentioned, is not fully understood.

It is known that a specific bacterial disease of flax gets in the soil and destroys the flax by the disease called flax wilt.

Crops Believed to Leave Poison in Soil.—It is believed that some of these crops leave in the soil substances which are toxic or poisonous to the same plants grown the next year, and that this is one of the reasons why the yield is so low when one of these crops follow itself, or even follows one of the other small grains instead of following corn, grass or clover.

It is observed by all that these crops allow weeds to ripen and the furrow slice to become full of weed seeds; especially if the stubble is allowed to stand unplowed for weeks after the grain has been harvested from over the weeds theretofore suppressed.

Flax grown for seed is the worst sinner along this line, because its leaves do not form a dense covering, allowing the weeds free growth, and because it is often so late in the ripening that many weeds have an opportunity to mature before the flax is harvested.

Winter rye and winter wheat generally ripen before many of the annual weeds have had time to ripen; and oats, barley, buckwheat and millet often grow so dense and so rapidly that the weeds which start to grow are smothered out.

Grain Stubble Should be Plowed at Once.—It is very important that grain stubble in which no grass seeds have been sown, be plowed or even disked, or better, plowed shallow at once after the grain is harvested.

This prevents most of the weeds from ripening and the land can be plowed again later in the autumn, or if corn, potatoes or other cultivated crop is to be planted there, plowing may be done in the spring. This plan often serves well to provide a place into which the winter's crop of barnyard manure may be plowed under.

In the South a crop of crimson clover sowed with the cereal and allowed to develop among the stubble may be plowed under in the autumn or the next spring; or a crop of cow peas may be sown after the grain is harvested in June.

Feeding Legumes to Stock Best Plan.—These leguminous crops are valuable as green manure on account of the nitrogen and the humus-making organic matter they contain. But where they can be harvested, fed to live stock and half of these substances can be returned to the soil as manure dropped in the field or carted from the barns, that is generally the best plan.

Where the crop is carted from the field, nearly half the nitrogen and humus-making materials are left in the roots and in the bottoms of the stems and in the leaves and other portions of the plants not obtained in gathering the green forage or the field-dried fodder.

The live stock secure sufficient toll from the crop to pay for more than the one-fourth of the total manurial value finally lost. Besides, feeding out a crop of forage makes live stock necessary, and there is another compensation in the grain which must be usually fed with the roughage, thus keeping also on the farm more of the manurial value of the grains raised on the farm or purchased.

Live stock are great agencies for building up and conserving soil fertility. When "the pig roots off the mortgage," he has also rooted greater value into the soil saved from the money lender; and the cow has well-nigh usurped the "golden hoof of the sheep" in many states because "she ships out in the form of golden butter sunshine for dollars," leaving practically all the fertility contained in her food to be returned to the soil.

Preparation of the Grain Crops' Seed Bed.—These grain crops are generally good feeders, but they want to feed near the surface as well as deeper down. They can send their water-finding roots four or even six feet deep.

But they know that the richest part of the soil is the furrow slice and they want that in the best possible condition to feed in. In most climates they like to have the furrow slice a year old, so that its lower half has had a year in which to become compact and well-knit together.

They like to have only the upper part of the furrow slice loose to easily take in falling rain and to serve as a dust blanket or dirt mulch to retard its wasting by evaporation from the surface of the ground. Fall-plowed land is as a rule, therefore, better than spring-plowed land. Corn and potato fields often leave the soil in excellent condition for these grains. This is true of fields in which the surface was stirred several times to the depth of two or three inches the previous year. Thus the lower part of the furrow slice is allowed to become compact, its upper part is kept mellow and many weed seeds are brought into the sprouting zone the resulting plants from which are at once destroyed.

Here the grain is generally best planted without plowing; cultivating the land only to cover the seeds at a uniform depth of one to two inches.

Cases of Advantage in Replowing in Spring.—On very heavy lands far to the north in rare cases it is best to replow the land in the spring to prevent its becoming too dense.

In some climatic conditions in the dry plains regions plowing in the spring gives better yields than fall plowing. There the evaporation into the dry atmosphere is so rapid, and the supply of soil moisture is so meager that the whole depth of the furrow slice is needed to retard the loss of evaporation of water from the surface of the ground.

The plants can better give up having their roots in the lower half of the furrow slice and feed in the subsoil than do with less water. These soils are rich in plant food to great depth and the conservation of water instead of the conservation of plant food is the prime necessity.

Seed Bed Should be Fine and Smooth.—The immediate preparation of the seed bed should be such as to have it fine and smooth, that the seeds may be placed at a moderate depth, one to two inches for flax and millet and one and one-half to three inches for the other grains.

Under dry, late, warm conditions the deeper depths should be approached, and under cool, early, wet conditions the shallower planting should be made.

The best time for seeding must be worked out for each locality. Sometimes unusual conditions control, as where it is necessary to plant winter wheat late in the autumn so that it may escape the Hessian fly. As a rule, spring wheat should be sown very early, oats a little later, barley still later, millet not till corn planting time, while flax and buckwheat have a wide range from the time danger of frost is well passed till in June.

Planting at Uniform Depth in Moist Soil.—The planting should be done in such manner that the seeds are placed at a uniform depth in moist soil from which they may at once absorb the necessary moisture to induce germination and to provide a water contact between rootlets and soil particles through which plant food may at once go from soil into root and plant.

There has been great improvement in machinery for seeding small grains. The hoe drill, and especially the disc drill and the shoe drill, place the seeds in the moist bottom of a freshly made furrow and allow the soil to at once fall back as a covering.

Following with a Scotch harrow or other drag to complete the covering is often an aid to uniform germination and to care of plantlets in escaping from the seed bed.

Conditions Determine Amount of Seed.—The amount of seed varies greatly with the openness or closeness of texture of the soil, and its fertility; also with the temperature and rainfall, and with the earliness or lateness of planting.

When conditions as dense, moist, cool soil prevail for a long period, inducing the grains to stool well, less seed will be necessary. On the other hand, an open, drouthy infertile soil, warm weather and a short stooling season, will make necessary for a larger amount of seed for a full stand of plants.

Some of these conditions are in conflict, as the inability of a soil poor in fertility to support a heavy crop.

The amount of seed best to use in each agricultural district for each crop, each kind of soil and each time of seeding must be determined by formal experiments or by wide practical experience by farmers in that district.

Since the farmer cannot predict with certainty what the weather is to be following a given date of seeding, he must take into consideration all other available facts and use his best judgment; not departing too widely from what is known to be the best average amount of seed to be used.

Some General Rules as to Amount of Seed.—About one-sixth less seed is needed when the drill is used to place the seeds at a uniform depth than when they are broadcast and placed at different depths by cultivating them in. Only the average extremes in amount of seed to sow are given here, because local requirements differ so widely.

They may be stated as follows: Wheat, five to eight pecks; oats, eight to ten pecks; barley, seven to nine pecks; rye, seven to nine pecks; millet, two to three pecks; flax, for seed, two to three pecks; buckwheat, two to three pecks.

As a rule little more can be done for the growing crop of closely drilled or broadcast grain than to pull out by hand large weeds or such weeds as wild mustard, the seeds of which ripen with the ripening grain and reseed the field.

In some foreign countries women and children are employed to pull out the weeds and even to hoe between the narrow drill rows when the plants are several inches high. We are glad that our country has such high rates of wages that this is impracticable; and that our farming is on a broad basis of machine farming under which our farmers and farm laborers can get good and just remuneration for their work.

Shocking an Art to be Taught by Example.—Modern farm machinery has blocked out a rapid, easy and effective way of handling the small grains. These crops are practically all bound in bundles by the self binder, and the bundles are bunched ready for the shocker, who is the only man who needs to touch the bundles with his hands.

Shocking is an art that is easily taught by example, but not so easily described on paper. Different arrangements of the bundles suit different purposes. For wet grain, or for quick drying, that the grain may early go to the stack, barn or threshing machine, "two by two" shocks are often best. Sometimes these should be set closely, and under other conditions they should be set open so as to give to the air the freest possible circulation.

A simple round shock is made by placing four bundles in the middle and then placing around them a circular row of compactly placed bundles, each slanting toward the center. These bundles should be firmly set on the ground and unless rapid drying is needed each successive bundle should be set compactly against its fellow so that the wind may not get a hold and tear the shock to pieces. Generally two bundles with both butts and heads broken over should be used to set into and lap over the shock so as to serve as shingles in shedding water, and so placed that they will withstand wind pressure.

Fighting Dampness and Weevil from Grain.—As American farmers accumulate wealth they build great barns, if not sufficient for all their hay and unthreshed grain, at least to store the neat grain until such time as good prices or needs of the bank account warrant its being taken to market. Only where the newly-threshed grain is damp is there usually need of extra precautions in storing grain. Then some means of drying must be employed. Large barn floors on which the grain is spread and turned with shovels twice or oftener daily, to avoid heating, and to induce drying, is often the most available method.

In rare cases grain weevils need to be fought. Then the bisulphide of carbon treatment can be effectively used, and your experiment station or your Uncle Sam's Agricultural Department will send a bulletin for the asking.

It may be applied directly to the infested grain or seed without injury to its edible or germinative qualities by spraying or pouring, but the most effective manner of its application in moderately tight bins, or other receptacles, consists in evaporating the liquid in shallow dishes or pans or on bits of cloth or cotton waste distributed about on the surface of the infested grain.

Insects Killed by Evaporation of Liquid.—The liquid rapidly volatilizes and being heavier than air descends and permeates the mass of grain killing all insects and other vermin present.

The bisulphide is usually evaporated in vessels containing one-fourth or one-half pounds each, and is applied at the rate of a pound and a half to the ton of grain. In more open bins a larger quantity is used. For smaller masses of grain or other material an ounce is evaporated to every 100 pounds of infested matter.

The grain is generally subjected to the bisulphide treatment for twenty-four hours, but may be exposed much longer without harmful results. Since this chemical is inflammable all lights and matches should be kept away from it.

The time will surely come when grain will be sold for the cleaned grain and then all the farmers will be induced to keep the weed seeds and other foreign matter to be fed to live stock on the farm where they were raised.

SELF BINDER IN SERVICE.

During recent years great improvement have been made in grain cleaning machinery, both in the threshing separator and in the barn farming mill. With one of the modern mills which is both efficient and rapid, the grain can be recleaned before sale at no great cost of labor. As a matter of fact, many threshing separators in good hands put only clean grain into the farmers' granaries.

The Most Profitable Marketing of Small Grains.—It pays to market some small grains "on hoof"; that is, feed them to live stock; but the larger part must go to feed the men and horses of the cities, and to make linseed oil and other non-food products.

As a rule, farmers market their grains as soon as convenient after they are garnered, as most of the commercial crops of these grains are produced in the north temperate zone. This puts the bulk of these commodities on the market in our northern autumn and early winter.

Since the purchasing agencies are better organized than the original sellers, the producers, it is believed that this tends to placing the farmers under some disadvantage as to price. The ability to prognosticate prices has been successfully developed by comparatively few farmers, while many who make of trade a business have developed peculiar ability along this line.

Scientific investigations are being made of the marketing of farm products; and in some cases growers have met combinations of buyers with combinations of sellers. This brings barter and sale to a more equal basis, often with only a single representative, or better with a committee, on either side. The deal is then on a broad basis and all the facts may be available to both sides.

Effect of Reports and Organization.—The development of government reports of crops, of stocks on hand and in transit, and of demand, and the organization of buyers and sellers offers a most interesting phase for study in our rural economics.

The world is becoming more co-operative, even more sensibly socialistic, using that word in its true sense, than it has yet recognized. Farming is to be the one great industry where individualism is conserved for the business and family life, and where only those things where co-operation is necessary, and best, are given over as public or co-operative functions.

Individualism under co-operative organization was made possible by our farmstead scheme, where "the farm business and the family form a unit" calculated for the best production of men and women.

Progress in Breeding the Small Cereals.—That the American farmers are ere long to have varieties of grain which yield ten or even twenty-five per cent more than those now in use is certain.

The introduction of the best old or newly bred varieties, varieties from foreign countries, and from state to state; and the improvement by breeding the varieties of each state suiting them to each and every agricultural district, are proved methods, capable of adding one to three dollars to the acre to the value of our 100,000,000 acres of small cereals.

These possible hundreds of millions of increased crops annually, at a cost of much less than ten millions, is finally interesting the national and state governments, as well as seed firms, also a large number of private breeders of field crops.

The introduction of durum or macaroni wheats to the semi-arid lands of the great West has made possible tens of millions of added crop, and the cost has been very slight. These durum varieties are now serving as bases on which plant breeders at various experiment stations are building better varieties by the art of selective breeding, and by breeding by hybridization followed by selection.

Notable Increase by Spring Wheat Breeding.—Some of the spring wheats have already been bred so as to yield fifteen and eighteen per cent more grain on millions of acres upon which rapidly spreading varieties from the Minnesota Experiment Station are now grown.

The United States Department of Agriculture is co-operating with a number of state experiment stations and new selected and new hybrid pure-bred varieties of each of the small grains are being originated by the tens of thousands.

On one experiment farm alone 2,000 new hybrid winter wheats have been originated. It is believed that at least a few of these new sorts will be as hardy as rye and will extend the winter wheat zone to the Manitoba boundary, thus greatly increasing the yield.

Continuous Snow Makes Large Crops.—When the winters are such that snow covers the ground during the winter season winter wheats yield thirty to fifty per cent more than do spring varieties. The combined autumn and spring cool periods greatly extend the stooling period, and besides, winter wheats, by ripening earlier, escape much of the bad effects of the hot, dry summer weather and much of the ravages of insects, and especially of wheat rust.

A new variety of flax, named Primost, has also been supplied to the farmers under co-operative work of the U. S. Department of Agriculture, and the Minnesota Experiment Station which yielded 15 bushels to the acre, as compared with 11.9 bushels of common flax grown under the same conditions. This gain of 3.1 bushels per acre or of 26 per cent is worth $3.50 an acre. The breeding of this new variety did not cost more than one thousand dollars.

Other new varieties of each species of the small grains, which are now incubating on various experiment farms, will rapidly come forward and all farmers should be ready to buy as each new and thoroughly tested and authenticated variety is brought forward by these public institutions.

Scientific Methods of Breeding Cereals.—The methods of breeding the cereals are being worked out in a most scientific and effective manner.

The best varieties are obtained. From each of these a large number of seeds, say 10,000, are planted the first year, one seed in a hill to give each plant the same room as each other plant.

There are chosen a large number, say 500, which appear to be splendid bearers of grains. The seeds are shelled out from each plant and weighed and further selection is made, of say, 100 best plants.

The second year 150 seeds from each of these 100 mother plants are planted in a little plat. By means of a machine devised for the purpose, the seeds are planted in hills, say four or five inches apart each way, one seed in a hill.

Average Yield of the Progeny is Obtained.—When these breeding plats are ripe the plants are counted and harvested and each little bundle is run through a specially designed miniature threshing machine. The weight of the grain from each plat is divided by the number of plants which grew to maturity, thus giving the average yield of the progeny of each mother plant.

Seeds are chosen from ten of the best plants and the third and again the fourth year a similar nursery plat is planted from each of the 100 varieties. The average yield of the progeny of each of the 100 mother plants gives their relative breeding power and the few, say five, of those producing crops of greatest value, are elected to be tested in field trials.

The fifth, and sometimes the sixth year's, are consumed in increasing so as to have sufficient seed for a field plat. The sixth year the five new varieties are grown beside the parent kinds and beside other valuable introduced or new varieties.

These field trials are repeated the seventh and eighth years. Any which are specially promising may be placed with other experimenters during these last years for confirmatory tests and to determine the larger area in which the new kind is especially valuable.

Class of Pure-Bred Seed Growers Needed.—For rapidly distributing the many valuable new forthcoming varieties of field crops, that they may quickly replace poorer kinds, and that they may be kept pure from diseases and clean of weed seeds, there needs to be developed a class of pure-bred seed growers, as we have now growers of pure-bred live stock.

In some states the experiment stations select the men to whom they will sell at a good price their valuable new creations, that every county and every neighborhood may have the seeds grown for them near home and at a fair though profitable price.

In some cases these growers of pure-bred seeds have formed state seed growers' associations. This plan of distribution of new varieties helps to give to growers of valuable seeds that added profit which originated by experiment stations induces them carefully to produce and market the needed large amounts of each valuable new kind of seeds so that all will grow them instead of the old-fashioned poor yielding kinds. It is both an honor and a profit to be a grower of pure-bred seeds, and this plan is profitable to the mass of farmers who need the good seeds.

American grain growing is looking up because it is fast becoming a part of general farming, because the fields are becoming better prepared for grain, and because science is making vast improvements in machinery, in methods of cultivation and in transportation and especially in the inherited power of the varieties of grain themselves.

WILLET M. HAYS,
Assistant Secretary of Agriculture,
Washington, D. C.

Profitable Hay Making

THE SEEDING—THE GROWING CROP—BEST METHODS OF CURING HAY.

By Prof. Thomas Shaw

THE corn crop of the United States stands first in the popular estimate. This estimate is based on the fact that the corn crop far exceeds, in direct cash value, any other single crop grown in the United States. In 1905 the farm value of the corn crop was $1,116,696,-738. Wheat ranks second with a farm value of $578,372,727. The hay crop is a close third with a farm value of $515,959,784.

That corn is king among farm crops, to use a popular phrase, would be apparent from the above figures. But it is only apparent. The grass crop is the most important crop that the United States produces, and it will continue to be so through all time. That such is the fact may readily be shown. Let it be observed:

1. That the estimated value of the grass crop included only hay, while it is undoubtedly true that the pasture crop is more valuable by a large margin than the hay crop, because of the immense area in pasture. Add these values, and the cash value of the grass crop will exceed that of the corn.

2. The corn crop has cost much more to produce it than the hay crop, hence the net profit from growing the hay would approximate much more nearly the net profit from growing corn, than the maximum value of the former does that of the latter.

3. The full value of the hay to the farmer is not shown by its commercial value in the matured form. While the grasses have been growing into arable farms where rotation is practised, they have been storing the ground with their roots, which along with the stubbles, furnish humus when the meadows are broken up, for the growing of other crops. Those leguminous in character always in addition, leave the ground richer than they found it in nitrogen, and nitrogen is the costly element of fertility.

The indirect value of the hay crop to the farmer can not be stated in figures. But it would not be extravagant to say, that all things considered, it would not be much less than the market value of the hay.

In the absence of grass, the humus supply in the land can not so well be maintained in any other way, which means that without it, land can not be kept for a considerable term of years in a proper mechanical condition. Without the grass crop, weeds can not be so readily kept under control, nor can the diseases that affect grain crops be so readily kept at bay. In its absence, some soils blow and others are carried away by the action of water, which may fall in the form of rain or snow. In its absence, live stock can not be maintained on the farm without undue expense, and consequently in its absence mixed farming will be impossible. Beyond all question, grass is king among the crops of the farm in the United States and so it will continue to be.

Meadow in the Rotation.—In the absence of the grass crop, true rotation is not possible in the sense of resting and renovating land, without undue expense. To change from one cereal crop to another in the rotation does not rest or renovate land unless the cereal grown is a legume. Growing these crops in alternation has some advantages over growing only one in unchanging succession, especially when one of these, as corn for instance, is made a cleaning crop, but all of these except the pea crop draw upon practically the same elements of fertility in the land.

The frequency with which the hay crop should be introduced into the rotation depends upon conditions such as relate to soil, climate, the character of the hay crop grown and the object for which it is grown.

Where the soil conditions are such that in conjunction with the climatic conditions, a stand of grass can be reckoned in with much

OSBORNE MOWER IN MEADOW.

certainty, the introduction of the grass crop should be quite frequent in the rotation. The aim should be, as a rule, to grow not more than three crops of grain between the grass crops. In this way the land may be adequately supplied with humus. With great propriety the grass crop may precede such crops as corn and potatoes, and if the sod has been manured with farmyard manure before plowing it, the conditions are just to that extent improved. Under the conditions named, the plan is good which cuts two crops of mixed hay, followed by one season of pasturing. This in time is followed by a cultivated crop, and after the cultivated crop, two crops of cereals.

Wherever the rainfall is large and the temperature warm, it would be better to aim to grow only two crops of cereals between the grass crops, because of the quick decay of humus. But where the rainfall is light and the atmosphere of a character which retards the decay of humus, as in the northwestern states, in many instances four crops of grain may come between the grass crops without too quickly depleting the land of the humus supply.

If the hay crop grown should be a legume, as for instance red clover, then the most profitable rotation is clover cut twice in one season, a cultivated crop as corn or potatoes the next season, and a cereal crop seeded to clover the third season. Such a rotation is unrivaled for the maintenance of maximum production in crops.

But there may be instances when it is not desirable to rotate hay crops. Certain soils have special adaptation to growing hay, and they may be so situated that hay crops grown upon them are more remunerative than other crops; such are reclaimed tide lands by the sea, and in some instances river bottom sands subject or not subject to overflow.

In some cases hay is so dear relatively that it is more profitable to keep the land growing hay for successive years when once a good stand has been obtained. The production in the crop is then maintained by applying artificial fertilizers. In other instances good crops may be grown for a long term of years without fertilizers, as when certain marsh lands have been reclaimed, and in yet other instances a certain hay crop may have adaptation to certain soils, so

DEERING MOWER PASSING AN OBSTRUCTION.

high, that it may produce many successive crops of hay without injury to the land, such as the alfalfa crop.

Mixed Grasses for Hay.—Some grasses grow best alone. This may arise from inability to cope with other grasses, as in the case of alfalfa, hence, except under peculiarly favorable conditions, the aim is to grow alfalfa alone. Or it may arise from the great aggressive character of these grasses, which enables them soon to crowd out other grasses. Such are Johnson grass grown in the south, Bermuda grass also grown there, Kentucky blue grass which grows over almost the entire United States save in the semi-arid west, quack grass which is widely scattered over farms in the northern central and eastern states, and which persists in growing where it is not desired. Johnson grass and quack grass yield well, but both are so persistent in their growth that they should never be sown. Bermuda and Kentucky blue grass have far higher relative adaptation for pasture than for hay, hence they should only be sown or planted for pasture.

The three grasses, timothy, Russian brome, and western rye grass or slender wheat grass, as it is sometimes called, may be grown with other grasses, but for certain reasons, are very frequently sown alone.

Timothy is the most valuable of all grasses. It stands shipping best. It has highest adaption to the needs of horses, partly on ac-

FOLLOWING THE MOWER.

count of its composition, and partly because of its freedom from dust. For these reasons it is very frequently grown alone.

Russian brome grass is frequently sown alone in the Dakotas and the northwestern provinces of Canada, because of its high relative adaption to the conditions found there. For a similar reason western rye grass is sown alone in the same areas, and more particularly where the conditions are driest in the same.

More commonly, however, hay is sown in mixtures. The following are among the chief reasons for sowing it thus:

1. Larger yields are obtained.

2. Usually such hay has a wider adaption for feeding than is possessed by any other variety.

3. It is frequently more easily cured than if grown alone. Experience has shown that in growing plants in certain combinations, larger yields may be obtained than when they are grown singly. This is owing to the fact, doubtless, that in mixtures they more completely occupy the soil, and to the further fact, that each draws most heavily on its own proper food elements in the soil, hence more plant food is appropriated by the combination than could be appropriated by any singly plant. Because of the difference in the analyses of plants thus grown together, they have a wider adaptation than if grown alone. Timothy, for instance, has high adaptation for horses, but low adaptation for sheep. Clover has high adaptation for sheep and unless when entirely free from dust, low adaptation for horses; whereas, a mixture of clover and timothy answers well for almost every kind of feeding to the domestic animals of the farm.

The prejudice to a limited amount of bright, well cured clover in timothy fed to horses, is not well founded. When clover is grown alone it is sometimes difficult to cure. When grown along with such grasses as timothy or orchard grass, it cures more quickly and easily, since the curing, or rather the keeping qualities of the clover is favorably influenced by admixture with grasses which cure thus quickly.

The most common mixture of grasses is medium red clover and timothy. These are peculiarly adapted to produce hay most desired on the farm. They grow well together on the same land. The timothy helps to sustain the clover and the clover improves the character of the hay for feeding, and when it dies the dead roots nourish the timothy. In such a mixture clover will predominate the first season of harvesting the crop for hay, and timothy the next year.

This mixture has high adaption for all the northern states and several of the provinces of Canada, also for certain areas west of the Rocky Mountains and in the irrigated valleys of the Rockies. In these areas the yields may be improved upon by sowing timothy medium, mammoth, and Alsike clover in combination.

In the Central States, with Kansas as a center, orchard grass, meadow fescue and Russian brome grass may figure largely in the grasses of the meadow.

In the upland areas of the northern plateaus of the western mountains, orchard grass, meadow fescue, Russian brome and tall oat grass have given satisfaction. And in the south, one of the best combinations is orchard grass, tall oat grass, and in some instances timothy.

The Legumes as Hay Crops.—Leguminous crops are those that produce their seeds in sacs or pods. They are all possessed of the power to draw nitrogen from the air in the process of growth and to store it in the soil, where it is accessible to crops that immediately follow. This power to appropriate nitrogen not in the soil is doubt-

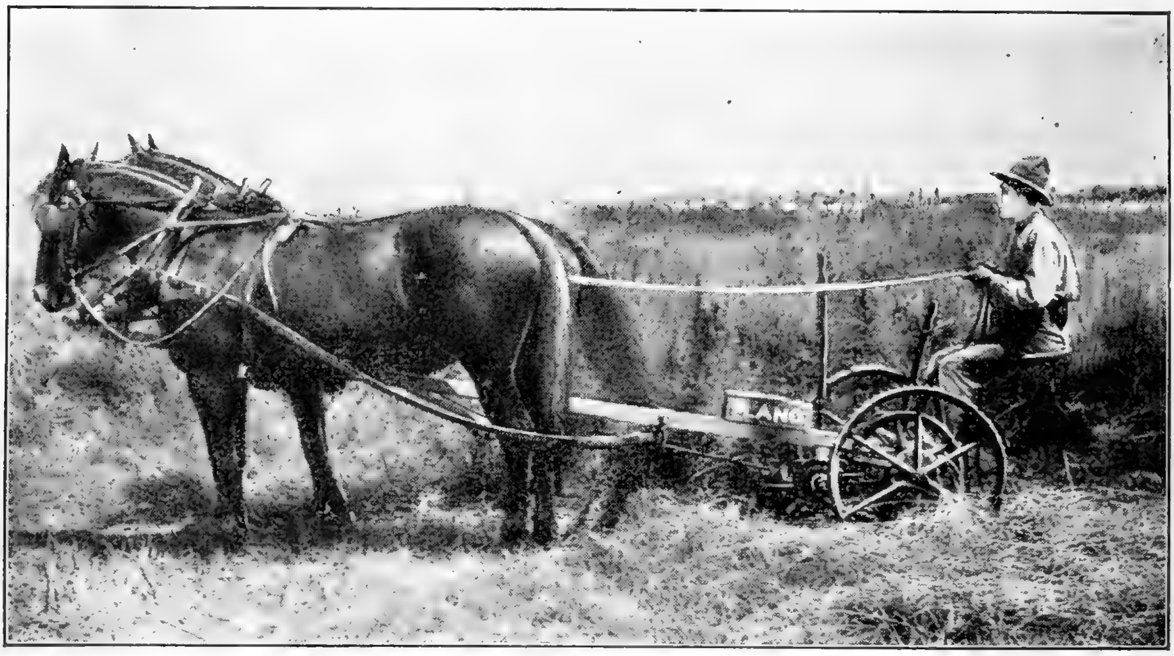
MILWAUKEE IN CLOVER FIELD.

less one reason why legumes are so rich in protein. Protein is the element in foods which is chiefly used in making muscle and milk, for other than legumes are largely used in the production of heat and energy. Unless these foods are fed in due balance animals can not be so cheaply grown, so perfectly grown, or so well maintained.

Three reasons will always exist for the growing of legumes. The first is that they must be grown if foods are to be fed in balance. The second is that nature unaided does not furnish them in anything like the same abundance as it furnishes many of the grasses proper. The third is because of the great service they render in the enrichment of the land. Of so much account are they in the animal and vegetable world that it behooves the farmer to give special attention to their abundant growth in the rotation.

Young animals, especially, must be abundantly supplied with muscle-making material. This explains why the clovers furnish more suitable food for them than the grasses proper. Likewise cows and other animals which provide milk can not do so in the absence of liberal supplies of protein. This explains why good clover hay is better adapted for milk production than good corn stover. There is, of course, some protein in grasses and coarse fodder, but there is not enough to supply the needs of the classes of animals named. It must be supplied from some other source, and there is no source of supply so cheap ordinarily as that which furnishes protein by growing it on the farm.

Nature does not furnish foods, nitrogenous in character, with anything like the same abundance that it does foods that are car-



SERVICE IN A SOUTHERN FIELD.

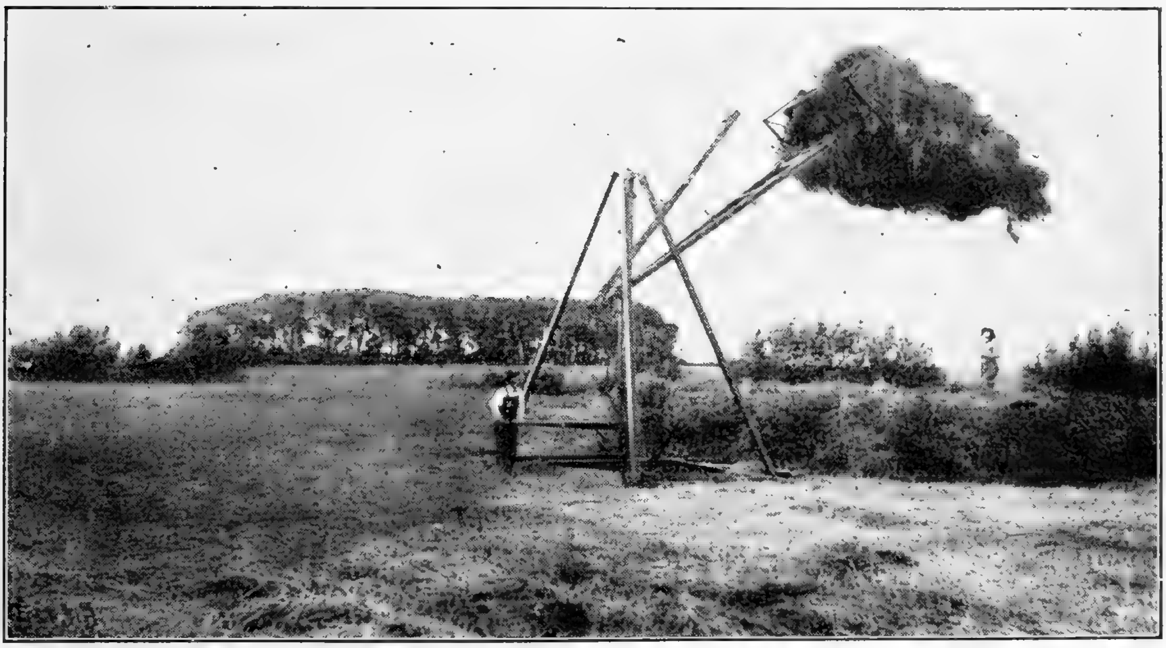
bonaceous. All the grasses, many of which take possession of the soil unaided as it were, are relatively low in protein as compared with legumes. Nature covered the original prairies with grasses not legumes. When the forest is cut away, blue grass comes in and possesses the soil. Nature never covers the land with legumes. The nearest approach to such a covering is found in the more or less abundant growth of wild pea vines scattered amid the native grasses, and particularly on lands more or less covered with brush in the American and Canadian northwest.

All the grains which grow in the north are non-leguminous, except peas, vetches and beans, and the same is true of those of the south except cow peas, soy beans and velvet beans.

The only leguminous root crops, strictly speaking, that furnishes food for live stock is the peanut. All the coarse fodders, as corn, sorghum and the non-saccharine sorghums are non-leguminous. True, flax in the north and cotton-seed meal in the south are relatively rich in protein. So are the by-products of wheat, as bran and shorts, but none of these is a legume. Where live stock is to be kept, therefore, the need is imperative for growing a sufficiency of protein, and in no way can it be more cheaply furnished than by growing legumes, and more especially in the form of hay.

But the great service that legumes render to the soil furnishes an important reason for growing them freely. Red clover grown on soil will furnish a crop of hay and also of seed in one season, and will leave the ground richer in nitrogen than when the crop was sown. Peas, vetches, cow peas and soy beans may be allowed to mature and the vines and seed may both be removed and yet the land will be richer in nitrogen than it was previously. Should alfalfa, clovers, and the other legumes mentioned be fed on the land, it will be at once apparent that the process will exert a favorable influence in building up the soil. Of course, when these crops are sold, it may be necessary to supply the soil with additional phosphoric acid and potash.

Soils for Producing Hay Crops.—The question of soil adaption in growing hay is one of great significance. A grass or



INTERNATIONAL HAY STACKER DISCHARGING LOAD.

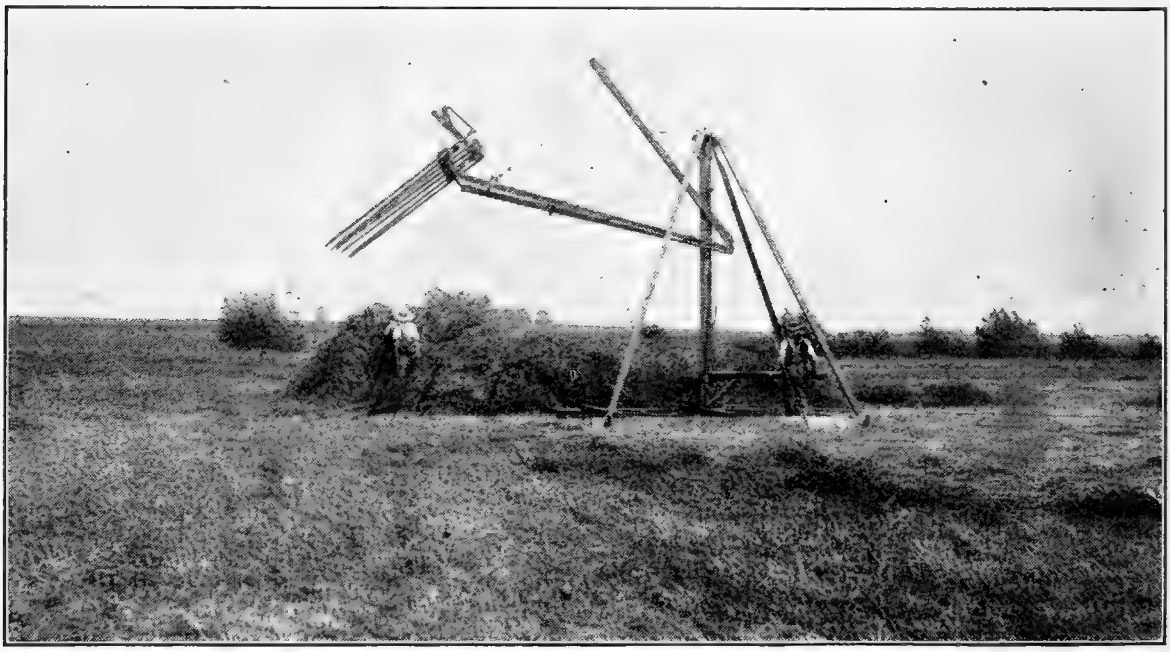
clover that may flourish well on one kind of soil may utterly fail on another. Climate adaption is also important, but that has already been touched upon when referring to the areas in which these various hay crops are found at their best.

The highest adaption for alfalfa is found in the volcanic ash soils of the west. These are more or less sandy in character and if they are underlaid with sheet water within a few feet of the surface, the adaption is further increased. Next to these come clay loam soils of mild texture and underlaid with clay not dense in character. Wet and marshy lands are quite unsuitable. On many soils alfalfa will not succeed well until inoculated with the bacteria essential to its growth. This is most easily done by sowing 200 to 300 pounds of earth over the land that has been obtained from a field in which alfalfa is growing vigorously.

Medium red clover has soil adaption a good deal similar to that of alfalfa, but it will flourish in a shallower soil, as it feeds less deeply, and also in a soil with watery saturation which comes nearer to the surface. Red clover is almost certain to grow well on soils that will produce hard wood timber, and usually without inoculation. It generally grows well also on the average prairie soil where the climate conditions are suitable, but these may in some instances require inoculation with soil taken from a field in which red clover has recently been grown, or is growing in the same when the soil is obtained for such a use.

Alsike clover has high adaption for humus soils. It will succeed well in situations that would be entirely too low for red clover of either variety, for mammoth clover has much the same adaption as medium red clover. It is because of this adaption for humus soils that alsike clover is so well adapted for being grown with timothy, as well as because the two mature at the same time. But alsike clover will also grow well on soils with much less clay in them, although the yields from these will not equal the yields from humus soils.

Timothy, like alsike clover, has highest adaption for humus soils, providing these are possessed of a considerable clay content and more particularly when they are underlaid with clay. Timothy will also grow well on sandy and clay loams, particularly the latter,



INTERNATIONAL HAY STACKER WITH LOAD DISCHARGED.

when an ample supply of moisture is present. But neither timothy nor alsike clover is well adapted to light lands low in fertility, and especially where the conditions are dry.

Red top grows naturally in low lands, that is, it grows at its best in these, even when composed of peaty muck. In such marshes as have grown wire grass before they were drained, red top will usually possess the soils when the waters have been removed. But red top will also grow well on uplands reasonably moist, as shown by its behavior in New England when grown in conjunction with timothy, and in several of the states of the South, in which it is a factor of considerable importance in growing hay.

Orchard grass will grow in a fairly wide range of soil. It has been mostly grown on certain of the loamy clays of New England, the stiffer soils of Indiana, the reddish clays of Tennessee and other states of the south, and in the sandy loam soil of Idaho and the adjoining states. Orchard grass calls for soils naturally moist, but not wet.

Russian brome grass will grow in soils that would be too dry for timothy or orchard grass, but it does not grow nearly as well relatively on dry as on moist soils. It has high adaption for the soils of western and especially northwestern prairies and in many localities it gives yields considerably ahead of those obtained from timothy, and produces hay of equal feeding value, ton for ton, but not nearly so well adapted for selling in the open market.

Western rye grass grows well on average prairie soils. It will grow better on sandy soils under dry conditions than almost any other kind of grass. It will flourish under conditions that would be too dry even for Russian brome, but of course it will give better yields where the soils are not so open and the land is more moist. The hay is more woody than that of timothy and brome grass.

Tall oat grass is adapted to a considerable variety of soils, ranging from light sandy loams to clays of considerable density, but it finds most congenial conditions in loam soils. This grass has higher adaption to the central and far western states, and to areas south rather than north from these.

Meadow fescue would seem to have nearly the same adaption as tall oat grass, but it is slower in taking a firm hold upon the soil and is correspondingly more enduring. It has been grown with much satisfaction for hay and for seed in Nebraska and Idaho. Peas and vetches require a moist but not a wet soil. It should also be more or less clayey in texture. The conditions suitable for medium red clover are also usually suitable, at least in a fair degree, for growing Canada field peas and common vetches. The cow pea and sand vetch will grow well under conditions less favorable to growth, as where the soil is sandy and relatively low in fertility.

The soils adapted to growing grains for hay are virtually the same as those for growing them for the grain, but with the difference that when grown for hay grain production is not so important relatively as when grain is the principal object sought, and straw or rather hay production, that is the production of stem, and leaves, is relatively more important. Because of this, these crops may be sown on lower soils and richer in vegetable matter than would be suitable for growing them at their best for grain production.

Sorghum and Kafir corn may be successfully grown for hay on any kind of soil that will produce Indian corn in good form, that is, they may be successful on any good sandy or clay loam soil where the climate is suitable. In almost every state in the Union the climate is suitable for growing some variety of sorghum into hay, but Kafir corn requires conditions somewhat warmer. The central Mississippi states have highest adaptation to growing such hay.

Sowing Grasses and Grains for Hay.—No matter what the grass or grain may be that is sown, it should always be the aim to sow on soil clean, mellow on and near the surface, moist and firm. These conditions may usually be attained by the proper preparation of the land previously. They are most readily secured when crops for hay are sown after those that have been cultivated the previous season, as for instance crops of corn, sorghum grown for sirup, Kafir corn grown for grain, or potatoes on field roots. The cultivation given to those crops furnishes all the requisite conditions named above where such cultivation has been ample. Usually the preparation that should follow such crops consist of disking and harrowing rather than plowing and harrowing, but of course to this there are even many exceptions.

The best time for sowing many of the grasses is the early autumn, but they also may be sown in the early spring. When thus sown they are not so well able to endure dry weather the summer following. In all Northern areas these may be sown in the spring and the same is true of alfalfa. But in all southern areas these may be sown in the autumn.

Alfalfa is best sown in the early autumn. As a rule south of parallel 40 degrees. When sown northward in the spring, it should not be sown so early as the clovers. As these are more hardy than alfalfa, the aim should be to sow them very early.

In moist climates grasses and clovers may be sown any time from early spring to early autumn. The aim should be not to sow cereal mixtures, as small grains, early sorghum and Kafir corn, until the arrival of settled warm weather and the same is true of cow peas and millet.

Millet in several varieties is frequently grown for hay. It yields abundantly on prairie and slough soils, because of their richness in vegetable matter, and since it will mature a crop in 60 to 80 days from the time of sowing, it is often sown to provide hay when there is likely to be a shortage. But the hay though palatable and nutritious, for certain reasons should be fed in connection with other fodder.

All of these hay plants should be sown broadcast or on the broadcast plan. They may be sown by hand or by machinery. Both the grasses and clovers may be sown by hand-machines, strapped to the body and turned with a crank, by a distributor wheeled over the ground like a barrow, or by an attachment to the grain drill. Usually when mixtures of grass seed are sown they are mixed and sown together. But this way may not always be possible, as when large or small seeds are sown together. They do not feed out evenly in such instances, hence it may be necessary to sow them separately. Timothy, all the clover seeds and alfalfa grow well together. All grains or grain mixtures may be best sown with the grain drill. The same is true of sorghum, Kafir corn and even millet, though all these may also be broadcast.

Whether the grasses and clovers should be sown with or without a nurse crop will depend largely on climatic conditions. A nurse crop is of course a crop along with which these crops are sown and in many instances at the same time. Usually the grass and clover seed thus sown grow without doing any harm or any serious harm to the grain crop along with which they are sown until the later are harvested. In some instances, however, the nurse crop overshade the ground to the extent of smothering the young grass or clover plants. In other instances, they smother them by lodging, and in yet other instances, they so weaken them by drawing on the moisture in the soil, that the young plants perish after the nurse crop has been harvested. But usually the plan is good which sows them with a nurse crop.

Alfalfa is oftener sown alone than the other grass and clover seeds, as under some conditions, the plants are benefited by being cut off two or three times with the mower during the first summer.

SIDE DELIVERY RAKE IN TIMOTHY

The best nurse crop is probably barley, as it does not grow so tall as other grains and it occupies the ground for a shorter period. Next to barley probably is speltz, for similar reasons. Then comes rye which does not stool so much as other grains and it is harvested earlier, thus letting in sunlight and ceasing at an early period to draw moisture from the soil. After rye is wheat, of both the winter and spring varieties. After wheat comes oats, lowest in adaptation because of the abundance of the stooling and the large amount of the leaf growth. But oats answer well for a nurse crop when they are grown thinly and cut for hay at the heading out stage.

In some instances grass and clover crops are sown along with certain cereals which are pastured off rather than reaped. Where soils are over porous, and the climate is dry, the plan works well, as in western areas which border on the semi-arid region. The treading of animals helps to make the land firm. The grazing removes shade too dense and leaves more moisture for the young plants. Such grazing may consist of any of the small cereals, or better, of two or more of them combined. Grass seeds may thus be sown with rape grazed down, or with the flax which is to be harvested.

The depth for sowing grass and clover seed will depend much on soil and climatic conditions. On loam soils where the weather is moist, much of the season, grass and clover seed will not of necessity require other covering than that given to them by allowing them to fall before the grain drill tubes, or rolling the ground when they are sown by hand.

In other instances, as where the conditions are dry they will be benefited by a stroke of the harrow in addition. This should always be given when they are sown in the spring along with winter rye or wheat, but under some conditions it may not be practicable to do this. Where soils are so light and spongy as to stick much beneath the tread, it may be wise sometimes to sow the grass seeds along with the nurse crop and to feed them along with it through the grain tubes.

Sorghum and Kafir corn and also millet, should be buried from one or two inches deep according to the soil and its condition at the time of sowing.

The amounts of seed to sow will vary with soil and climatic conditions and the character of the hay sought. Thick sowing increases fineness and thin sowing coarseness. Some instances the conditions are so dry that thin sowing is imperative to give each plant enough moisture.

Should the clovers be sown alone the amounts suited to average conditions would be: alfalfa eighteen pounds per acre, medium red or mammoth clover twelve pounds, and alsike clover five or six pounds. The average amount of timothy or red top to sow alone would be nine pounds. When timothy is sown with one or more clovers, the average amounts may be fixed at, timothy six pounds and clover or the clovers at eight pounds in all. This last is the great standard hay crop.

Should orchard grass, meadow fescue, tall oat grass, Russian brome, or Western rye grass be sown alone, the average amount of seed may be fixed at fifteen pounds an acre, and when two or three of them are sown together, proportionate amounts are sown. It is of course to be understood that in all instances these amounts relate to the growing of hay. For pasture it may be necessary to sow more seed.

When timothy, red top and alsike clover are sown to provide permanent meadow, the respective average amounts of seed may be set down at six, six and three pounds of each respectively.

When oats are sown for hay, the average amount of seed sown may be fixed at three bushels per acre. Wheat and barley if grown without irrigation should not be sown in greater quantity than say one and one-half to two bushels an acre. Cow peas are usually sown alone for hay at the rate of about one bushel per acre. Oats and peas are commonly sown at the rate of two and one-half bushels per acre, of which the proportion of peas will vary from one to one and one-quarter bushels according to the soil adaption. When vetches are sown with other grain, the whole amount sown may be put at two and one-half bushels, of which one bushel or more is vetches. Except where the conditions are very dry about two bushels of seed is sown per acre in order to make the hay

A WESTERN CLOVER PATCH.

fine and about one bushel of millet seed. When grains are sown in mixtures and pastured, from two and one-half to three bushels are sown and the usual amount of grass and clover seeds.

Harvesting Hay.—It is exceedingly important that hay should be harvested at the proper season. If cut too early there is a great loss of nutrients through loss in bulk and weight. If cut at too advanced a stage, there is serious loss in palatability, and also in digestible nutrients. The loss from undue delay in cutting is least from crops that produce only one cutting in the season, and greatest from those that produce more than one. Alfalfa and medium red clover are of the last named class, hence delay in cutting one crop is followed be serious shrinkage in the next crop in addition to the loss in feeding value in the crop thus cut at too advanced a period.

The best stage at which to cut alfalfa is when it is coming into bloom, when probably not more than one third of the blooms are opened. All the clovers are at their best for cutting when approaching or at full bloom. They will then have some heads, not many, beginning to tint brown. If cut sooner than the period named alfalfa and red clover will be hard to cure, if cut later there is likely to be a serious loss of leaves in the curing process, and leaves are the most nutritious and palatable portion of these foods.

Timothy is at its best for cutting when in the later stage of bloom, that is, when the bloom still lingers upon say one third or one fourth of the top of the head. If cut when in full bloom the adherent blossoms make the hay somewhat dusty when cured. Red top should be cut when in bloom, and the same is true of Russian brome. The orchard grass, meadow fescue, tall oat grass and western rye grass are better cut in the early stage of bloom than later as they quickly become woody and so lose rapidly in palatability. This is particularly true of orchard grass and western rye grass.

When hay crops are grown in combination, that is when clovers and grasses are grown together there will be no difficulty in determining the time at which they should be cut when they mature at the same time. Happily this is true of mammoth and alsike clover, timothy and red top. The best time for cutting these clovers will also be the best time for cutting timothy and red top which grows with them. But should medium red clover and timothy be grown together the difference in the time of maturing is from two to three weeks, according to the season. The safe rule to follow is to cut at the best time for making clover hay when the clover hay predominates, as it usually does the first year, and the best time for making timothy hay when timothy predominates, as it usually does the second year.

The best stage at which to cut wheat, oats and barley for hay, is when the grain is in the dough stage, or a little earlier with wheat and barley, as when it has reached the milk stage. This will be indicated by yellow appearance in the stems for a few inches up from ground. In the case of oats there will appear a slight tint of yellow on some of the heads when ready to harvest.

When grains are sown in combination, as in the case of peas, vetches and other grains, they should be cut when the bulk of the grain in the dominate crop is reaching the dough stage.

Cow peas are ready to harvest for hay when a considerable sprinkling of the pods have begun to mature. Sorghum and Kafir corn should be allowed to reach maturity, or nearly so, as then they contain a much larger amount of food nutrients than at an earlier period. But they should in all instances be cut before frost. Millet is at its best for hay when the crop begins to assume a yellow tint. Cut earlier it will be lacking in bulk, but later it will shed seeds freely.

The implements for cutting hay are the mower and the binder. The implements for curing are the tedder and the horse-rake. The implements for storing are the wagon, hay loader, hay sweep or bull rake, the horse fork, the sling and the stacker. The binder is only used for cutting grains for hay alone or mixed, sorghum, Kafir corn and millet. But in some instances these are also cut with the mower. When cut with the binder the sheaves should be small and rather loosely bound to prevent them from moulding underneath the band in the airing process.

Alfalfa and clover are cured by the same method in climates possessed of normal rainfall. When cut with the mower the hay lies on the ground until it is ready for being raked. This can be told by the ease with which it can be raked cleanly into windrows. When too green for being drawn together, bunches of the hay will

SIDE DELIVERY RAKE AND HAY LOADER AT WORK.

fall back from the ends of the rake and it will draw heavily. The drying will be greatly facilitated by running the tedder over the field once or twice within a few hours of the cutting of the crop, or at least the same day when the hay is cut early in the day. If kept unraked until browned with the sun, the loss of leaves and of palatability is considerable, especially in the case of alfalfa.

As soon as raked the hay should be put up in cocks, not wide, but reasonably high to complete the curing. In the cocks the hay sweats and usually requires two days to complete the curing. It is then drawn and stored. In showery weather it is a great advantage to have the cocks covered with caps of rain-proof cloth, weighted at the corners and kept over from year to year. In such weather it may be necessary to open out the cocks a few hours before drawing the hay.

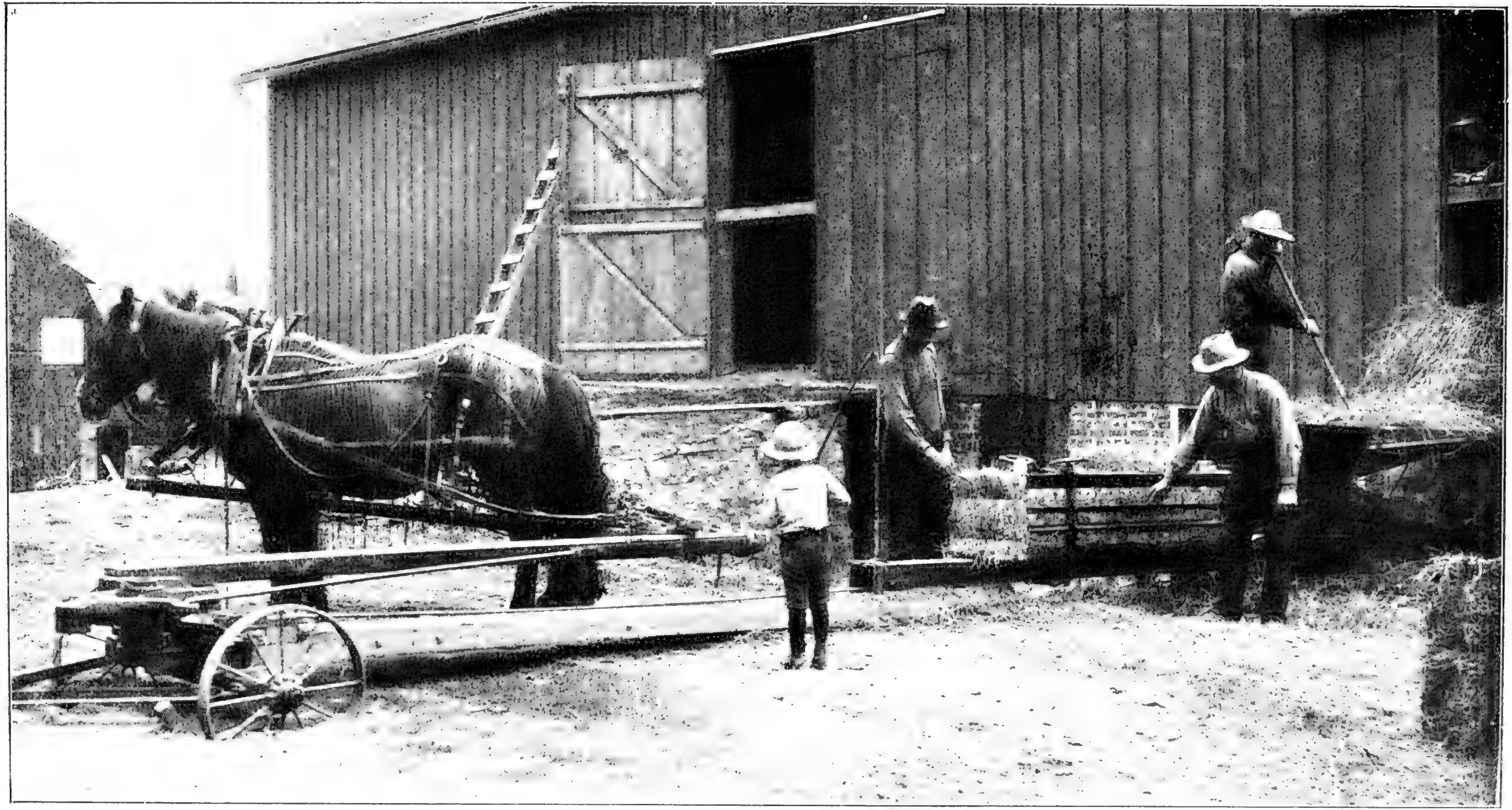
This method of curing makes excellent hay but is costly when hay is made on a larger scale. Because of this, clover is sometimes cured in the swath and windrow, and the same is the common method of curing alfalfa in dry areas. The plan answers well with clover well sprinkled with timothy when the weather is good. It can then be loaded with the hay loader. Cow peas are cured in much the same way as clover, but they are even more difficult to cure in good form.

The grasses proper are more commonly cured in the swath and windrow than in the cock. They cure much more quickly than the clovers and alfalfa, and are much less injured by rain. When put up in cock they also turn or shed rain much better than the clovers. With the aid of the tedder it has been found possible to cut some of these in the morning and to store them the same day. Usually in good weather they may be cut one day and stored the next.

When grains grown alone or in mixtures are cut with the mower, they are harvested in the same way, substantially as grasses, but may take somewhat longer to cure. The tedder should also be used on these with more caution lest the hay should be soiled with earth. When cut with the binder they are most quickly cured in long shocks in which the sheaves are set up in pairs, in locations where they are not liable to be thrown down by the winds.

When sorghum and Kafir corn are cut with the binder, after the sheaves have lain a day or two to dry the butts, they are stood up in round shocks, as these frequently stand for weeks and even months. These shocks are tied near the head with a band. When cut with the mower the crop may lie on the ground from two to four or five days where it fell. It is then raked and put up into large cocks and fed from these as desired. It does not readily mould in these, nor does it take injury easily from rain. Millet is cured in best form like clover, but is more commonly cured like the grasses.

Feeding Hay on the Farm.—Of course, the question as to whether hay shall be fed to live stock on the farm or sold, must be determined by the conditions. These are such as touch the relative market value of hay and meat, the needs of the live stock on the farm and its condition as to fertility. There are instances when it is justifiable and commendable to sell hay. The revenue of some farms runs in great part or entirely from the sale of hay and this is not incompatible with the maintenance of fertility. Everything depends upon the way in which the work is done.



PREPARING HAY FOR THE MARKET.

It is difficult under any American conditions to get more than $10 to $12 a ton for hay—however, it may be fed. On the other hand, the conditions are seldom or ever present when the grower can afford to deliver hay in the market at much less than $7 or $8 a ton. An exception is found in alfalfa areas in the western mountain valleys, where hay is sold at $3 to $4 a ton in the stack, to men who graze cattle and sheep on the adjacent ranges.

Thus much is clear, it never pays the farmer to let his stock go backward for the sake of selling hay at a high price. The policy is also mistaken which sells hay from a farm much in need of fertility unless the price is such that it will justify selling the hay and buying the needed fertility in the form of commercial fertilizers.

When hay is fed to live stock, the resultant product in meat, wool, milk or labor, is only a part of the farmer's return. He has also the fertility obtained from feeding it. It is common to estimate that the fertility offsets the cost of labor from feeding the hay. Usually it is worth much more than such labor.

It should be observed also that hay composed of legumes is usually much more valuable for feeding than non-leguminous hay, and the resultant fertility is also much greater. On the other hand non-leguminous hay, as timothy and red top, is most in demand in the markets and brings the highest price. If therefore hay is to be sold from the farm, let it be hay that is non-leguminous in character. Such hay ships much better than the other, since it breaks less while being handled. For some kinds of hay there is virtually no market off the farm and probably it is well that it is so, as they can be utilized so well on the farm. Such are sorghum and Kafir corn hay.

Usually it pays better to feed hay on the farm than to sell it. Where it does the farmer should aim so to stock his farm that the animals on the same will consume it all. The great truth that should ever be remembered, is that the relation between abundant stock-keeping and high values of land and profits from it, is of the closest possible kind.

PROF. THOS. SHAW,
St. Anthony, Minn.

Up-to-date Dairying

THE DAIRY FARM—FEED AND CARE OF THE COWS—USE OF THE CREAM SEPARATOR.

By CLINTON D. SMITH

GOOD Clean Flavor Most Desired in Butter.—A man is judged by his ideals and his success by his approach to them.

The dairyman has his ideals made for him by the tastes and whims of the consumers of his products. They are not of his making, but he must conform to them. When the wealthy city resident goes out to buy something to spread on his bread, he aims for the grocery which will furnish him butter of good flavor, according to his idea of flavor, of good yellow color, salted just right and with a texture characteristic of butter, with water and salt mingled with the butterfat in such quantities and in such distribution as to appear as shining points in the surface of the broken sample. In other words the purchaser of the best butter wants, above everything else, a good clean flavor. Next he values most the body, texture, the grain, next to that possibly the color and finally the salt. Unconsciously he makes up the score card like this, counting 100 as perfect for the butter as a whole and counting perfection on each particular point the number set opposite in the card:

BUTTER SCORE CARD.

Flavor	45	points
Body	25	"
Color	15	"
Salt	10	"
Package	5	"
Total	100	

Discriminating Buyer Smells Carefully.—The discriminating buyer will smell the butter carefully to note whether there are odors hanging about it which he does not like and which the sensitive tongue of his wife or daughter will note with disgust when they come to eat it.

He will find photographed in the butter all the separate stages in its manufacture from the cow to the consumer. If the cow has been improperly fed, on food with strong odors, the ghosts of those vegetable aromas will be there.

If the udder has been unclean and the milker has allowed dirt to fall into the milk, the unpleasant essences of that unmentionable filth will attend to give a bad flavor to an otherwise perfect product.

If the utensils have not been properly washed, the bacteria developed in the seams of pails, pans and strainers will have left their multitudinous descendants to plague the butter seller.

If the cream has been improperly handled, if it has been allowed to stand in the can for hot days lengthened out into a week, until it is rancid, moldy and rotten, the bad elements thus created have not taken unto themselves wings and flown away.

They are there yet and off goes a dozen points on the score of flavor. If the buttermaker has not known how to make and control his "starter," the evils introduced in the prior history of the cream are intensified instead of reduced and the buyer has them in new and enlarged editions.

Illustrated History of the Dairy.—The butter is an illustrated history of the dairy and factory whence it came, an album with accurate photographs of men, cows and surroundings, of processes, of daily sins and dairy vices, a condensation of praise or blame for all men who have been interested in its making.

Do not think for a moment that the discriminating buyer is a crank. He is nothing of the kind. He simply knows what he wants and intends to take nothing else. He wants butter well made from absolutely clean materials and knows that if there has been neglect anywhere it will show itself in the flavor, hence he trains his nose and tongue to recognize the peculiar trends of flavor that indicate dirt and carelessness and rejects all samples having them.

Naturally the color, salt, package and even the texture of the butter are factors within the control of the buttermaker, of the man who takes the cream from the hands of the farmer and manufactures it into butter. With them we have little to do, but with the flavor we have much to do, because the flavor is largely made by the men who keep the cows and it is with these men that we are to talk in this part of this booklet.

Few Learn to Pick Good Butter from Poor.—The quantity of butter made, as well as its quality, is of prime importance to the dairymen, but the quantity is easily measured by the scales while few among the thousands of cow keepers have ever learned to pick out good butter from poor or to know why this package should sell for ten cents per pound more than that.

The butter that my wife makes may be good enough for me to eat but it is not good enough for me to sell if it be not so made that it ought to bring and will bring the highest market price.

At the very outset of his career, the dairyman ought to learn to score butter, using a score card like the one above, until his practiced eye and nose will unerringly lead him to right judgment when a sample of butter is submitted to him for criticism. Butter judging is not guess work, it is an art at which the milk producers ought to become adept.

Largest Quantity of Butter at Minimum Cost.—The utmost measure of the dairyman's success, if he is going into the keeping of cows for the production of butter, is the largest quantity of the best butter, produced at least cost and sold at the highest price. A good many superlatives, it is true, but we are after the utmost limit of profit and should not content ourselves with less. Let us look at these superlatives, one by one.

The largest quantity of butter produced at least cost means good sized herds of good cows, wisely fed. It is the function of the cow to eat what grows on the farm. The farm may not be run altogether for her special benefit, but she is there to convert what the fields produce into milk.

What feeds shall be bought to go with what the farm produces will depend not upon her physiological wants but upon the economics involved. The farm ought to produce about all she will need to do her best work at least cost.

Private Customers or the Creamery.—When it comes to selling the butter for the best price and making butter that will bring the best price, there are two roads before us and which shall be chosen depends on circumstances.

If we have within the circle of our acquaintances, wealthy people in some city who know what good butter is and are willing and able to pay for it a price that is satisfactory, then the thing to do is to sell to private customers.

Without these advantages, it is better far to sell to a creamery equipped with the latest and best buttermaking devices operated by an expert, trained in the dairy schools, capable of turning out a uniformly good package of butter every day and able also to sell it in the best market at the highest price.

The factors, then, in profitable buttermaking are the feed, the cow, the milk, the cream and the factory. Let us consider them in that order.

Corn and Clover Essential Crops.—In all Northern United States there are at least two crops which every dairyman ought to raise. A third is appearing on the scene, probably to remain as a most important addition to our list, but with future yet uncertain. The two main crops ought to be corn and clover. Alfalfa is the new baby, likely to grow into a giant but possibly to succumb a little later on to adverse winters and too harsh summers.

The Possibilities of the Corn Crop.—Corn is grown because it produces a greater amount of feed per acre and per dollar put into it than any other crop. It does if it is wisely grown, and does not if it is fooled with.

Every wise dairyman who wants to produce milk at least cost looks after his seed corn in the fall. He has an ideal in his mind and selects his seed toward that ideal.

To produce corn at low cost the seed must be right, must be selected early, must be well dried before hard freezing and tested for germination in the early spring. It must be planted in a regular rotation, in soil well manured with cow manure hauled to the field during the winter as fast as made and spread as fast as hauled, to be plowed under in the early spring. This obtains thorough admixture of the manure with the soil and also a chance to kill the weeds with the harrow before the corn is planted.

Silage Safe Food for Dairy Cows.—When harvested the corn is put naturally in a silo, perhaps of wood, perhaps of cement. There it is kept in succulent and palatable condition ready for the cow at any time in the next year or two years or even later. Silage is a safe feed for dairy cows, giving no bad flavor to the milk or to the butter.

It is, probably, the cheapest source of starch and sugar and similar compounds that the American dairyman possesses.

Silos can be built at small cost to the ton capacity and the silage can be stored at slight expense. The silo is therefore coming more and more into use. Remember the rules and do not build too big. Do not build too small. Build just right.

In determining the size of the silo horizontally, remember that for winter feeding the silo should contain eight square feet of horizontal area to the cow. Thus if the herd is to include twenty cows, the silo should have eight times twenty or one hundred and sixty square feet of horizontal surface. If the silo is to be round, it would need to be not far from fourteen feet in diameter to contain this number of square feet.

In the same way the diameter of the silo to meet the requirements of a herd of any size can be determined. Remember simply the eight square feet surface and multiply by the number of cows.

As to height, remember that you will need to feed down an inch and a half a day. The winter feeding will need to be continued for fully a hundred and eighty days each winter and the silo ought to provide for it. This means that the packed silage ought to be fully twenty-four feet deep. To make provision for settling, the silo must therefore be fully thirty feet deep.

Soiling the Herd and the Summer Silo.—On high priced land it can hardly pay to pasture the cows as they do not get enough feed to the acre to pay the interest on the cost of the land and besides the same area will yield four or five times as much feed in the shape of corn that it will in the shape of pasture.

Resort has been had to feeding the cows green crops through the summer. Rye has been sown in August for early spring feed, and a poor enough feed it is too. Alfalfa, clover, oats and peas, mammoth clover, millet, sweet corn and field corn have followed each other through the season in the ration of the dairy cow on many farms.

This method of keeping the cows from pasture and feeding a succession of suitable crops is called soiling. It pays well enough when the weather is all right but is inconvenient, to say the least, when rainy days follow each other in quick succession.

The summer silo offers the best solution of the summer feeding of non-pastured cows. Build the summer silo of less diameter than the winter silo for the herd of the given size. Allow only six square feet of horizontal surface to the cow in the summer silo and feed down two inches per day instead of one and a half. Even then it is not easy so to fill the silo and care for it that the silage will not tend to spoil down faster than the cows eat it in the hot days of July and August.

Why Clover Should be Grown on Dairy Farms.—The economical dairyman will rely upon his silage as the basis of the ration of his cows. With the silage he will feed clover hay. The clover is the one crop on the farm that yields a good crop of forage and at the same time leaves the ground richer for having grown it. Experiments have shown that in the roots of medium red clover, when yielding a harvest of a ton and a half of dry hay to the acre, there was as much plant food per acre as would be found in possibly eight or even ten good loads of barnyard manure.

This plant food comes partly from the air and partly from the lower depths of the soil out of the reach of the cereals and is stored in the surface eight or nine inches of the soil for the most part, there to decay, when the field is plowed, and to give up the plant food for the next crop, slowly, just as that crop will want it.

The Chemist and the Ration of the Cow.—Clover fits into the ration with silage most perfectly. It is rich in the very elements in which silage is poor.

The chemists call that class of elements in the ration of the cow that corresponds to the red muscle of lean meat, to the white of eggs and to the cheesy part of cheese in the ration of men, protein. That word is now so common that we need not define it.

The sugar and starch and similar compounds they call carbohydrates, which is also a word in too common use among dairymen to need definition here.

Chemists and cows have worked together over most of the foods in use in American dairies and the results of their work has been compiled into tables. These tables give the amount of digestible protein in one column and of digestible carbohydrates and fat in another, while in the third they give the ration between the protein on the one hand and the carbohydrate and fat on the other.

All of these points are important because a well nourished cow, turning out twenty or thirty pounds of milk a day containing a pound of fat needs a good supply of protein for the support of her body and for the cheese in the milk and a large amount of carbohydrates and fat to keep her warm and to supply part at least of the materials out of which the fat of the butter is made.

Good Feeding Must Be Continuous.—The cow has no creative function and must take in at the mouth all that she sends out through the udder. She must be well and even highly fed if she is to yield a profitable mess of milk. Moreover the good feeding must be continuous through the season as it is hard to bring a cow to her full mess where she has shrunk in her yield. It means good pasture in summer, and good feeding in warm and comfortable quarters, sunny and well ventilated, in the winter.

The above standard ration of 2.06 pounds of protein a day with fully 14 pounds of carbohydrates and fat ought to be kept in mind and the feeds mixed in such proportions as to give these amounts daily to each cow

The nutritive ration will then be one to seven or perhaps as low as one to six. These tables and rules are to aid in guiding the experienced feeder. They can never take the place of experience.

Richness of Milk in Fat Remains the Same.—Experiments and observations at several experiment stations have shown that the richness of milk in fat remains about the same with a given cow from her first calf on through her life. Changes in feed affect only temporarily and then to no great degree.

A cow gives richer milk when she is almost through milking for the year and is rapidly drying up than when she is fresh. But none of the changes in feed or other conditions can fundamentally modify the composition of the milk. This means that if you want a cow to supply the family with rich milk, you must buy a Jersey or Guernsey, breeds which have inherited from generations of rich milkers the ability to yield milk rich in fat. If you want yellow milk, buy a Guernsey. If you want a large quantity of milk, buy a Holstein. The milk will not be as rich as would be the milk of the Channel Island cattle but it will be rich enough for family use and the quantity will be large if the cow be a good one of the breed.

If a fairly large mess of good milk is wanted the Ayrshire ought not to be forgotten, the breed that has made Scotland famous.

Breed Does Not Guarantee a Payer.—The fact that a cow belongs to a given breed however, does not make her a paying member of the farmer's herd. All cows should be carefully tested before admitting them to the herd. Their milk should be weighed daily for some time and samples taken for the Babcock test. If it is found that the amount of fat secreted by the cow be insufficient to

CHAIN DRIVE CREAM HARVESTER "DAIRYMAID."

pay a good profit over the cost of her feed she ought not to be kept. Her form will come out all right if she is a good milker. Test that matter the first thing whether she is a member of the herd or whether she is offered for you to buy.

Importance of Test for Tuberculosis.—Next the cow proposed for the herd should be tested with tuberculin. If she reacts, she undoubtedly has tuberculosis and her milk ought not to be used either for consumption as milk or for manufacture into butter or cheese. There are altogether too many deaths now from consumption to allow any avenue through which additional infection may enter, to remain open. The public has a right to demand that all dairy herds should be tested for this dread disease.

Good feed will do much to make a herd not well selected yield paying quantities of milk. At one of the Government Experiment

Stations, a herd of twenty-nine cows was gathered together with no selection at all, taking practically all cows offered, yet good feed continuously fed produced a yield of over 6,000 pounds of milk to the cow per year and over 300 pounds of butter.

Had the same amount of feed been given a herd of selected cows, the results would have been still more surprising. From a given weight of feed, one cow in a certain stable made 370 pounds of butter in a year while her stable mate yielded but 250.

It is not all in the feed therefore. If profit is to be expected the scales and the tester must select out the cows that have the proper capacity.

The advantage of pure-bred stock lies in the fact that the good qualities of the cows are much more likely to be transmitted to the offspring than they are when the breeding is mixed. A pure-bred sire should be used for the same reason.

The Four C's of the Dairy Business.—The four C's of the dairy business are Cows, Comfort, Cleanliness and Cold. The matter of cleanliness is suggested the moment we think of milk and milking.

Whole volumes have been written about the necessity of everything being clean about milk because that fluid is so impressionable not alone to tastes imparted to it by filth in solid and liquid forms but to odors as well, coming into it through the air.

Cleanliness begins therefore in the stable and is continued through the entire history of the milk.

The Stable.—The stables themselves must be so built that the air is changed frequently, that is, it must be well ventilated. At the same time it must be warm to afford the cow comfort. This means that the side walks and the overhead must be tight and frost proof with the air admitted through channels provided for the purpose and the foul odors carried off through ducts leading to the roof and above.

The old idea that cracks should be left unbattened in the sides has been done away with in modern stables and a system has been introduced by which the changes of air are accomplished without sharp currents to give the animals colds, yet with sufficient rapidity to keep the air of the stable wholesome and free from bad smells.

Sunlight the Great Destroyer of Germs.—Sunlight is furnished free by nature to preserve the health of all animal life. It is the germ destroyer. It is necessary to admit the sunlight freely to all parts of the stable. For this reason, the ridgepole of the barn ought to run north and south to admit the sunlight on the east side of the barn in the forenoon and on the west side in the afternoon.

Big round or square barns with the cows huddled together in masses are bad. So are basement barns if the sunlight is excluded by the earth on one side or possibly on two.

The barn ought to be long and narrow, not more than two rows of cows being accommodated. These cows may face in toward a central feeding alley or they may face outward leaving a broad passageway in the middle through which a wagon may be driven for the manure which is hauled directly to the field and spread from the wagon, thus never being handled more than once. Or the manure spreader itself may be driven through the barn in the morning after milking and receive the manure as it is shovelled from the gutters.

Manure Taken Out By Suspended Cars.—If the cows face toward a central feeding alley, the manure may be taken out of the stable by means of suspended cars, hanging from a steel track above the gutters and so arranged as to empty automatically on the manure wagon or spreader stationed near the stable door.

Of the two methods of arranging the cows it is difficult to decide which ought to be preferred. Where are cows face in there are no obstructions to the entry of the sunlight which may be allowed to flood the whole floor where the cattle stand. If the cow fasteners and mangers are thrust up toward the windows they stop the sunlight in great part and the floors on which the cows stand are kept in perpetual shade.

The floor should be of cement, not troweled smooth but left somewhat rough that it may not be slippery when wet. Such a floor is somewhat more expensive at first cost than wooden floors but its permanent character and the fact that it may be kept clean and free from odors is enough in itself to decide every dairyman in its favor.

The milk must be kept pure. This means floors that can be scrubbed and that will dry out, not wooden floors but cement.

Clean Milkers and Clean Milking.—The stable should be provided with brushes readily attached to the milking stools or accompanying them. The milkers should be encouraged to use these brushes before milking and if such milkers are naturally cleanly, they should also be encouraged to dampen the udders before beginning to milk.

If the milkers are not naturally orderly, systematic and cleanly, discharge them and either get clean milkers or quit the business. It is impossible to make a filthy man clean by any set of rules or by any amount of possible supervision. "Though thou shouldest bray a fool in a mortar among wheat with a pestle, yet will not his foolishness depart from him."

The milk is received in pails washed in this way. They are first rinsed off in tepid water; then washed in water too hot for the hand and containing some cleansing powder or sal soda, the washing being done by brushes rather than cloths. They are then rinsed with boiling water and steamed if possible, otherwise taken from the rinsing water, the loose drops shaken off and allowed to dry without wiping.

The milk is strained through two or three thicknesses of cheese cloth which pieces are washed and scalded or boiled between successive hours of milking.

After straining, the milk is either aerated, cooled and sent to the factory or it is run through the separator at home.

Use of Hand Separator.—The hand separator bids fair to revolutionize the dairy industry. By the use of this labor and butter saver, the farmer can take practically all of the fat from the milk and can do it at the time of milking while the milk is warm. The skimmilk is then ready for the calves or pigs.

Who then shall buy a separator? He that has four or more cows and wants to make all the butter possible from them at least cost.

Why shall he buy? Because the amount of fat a separator saves over the cold deep setting will not only pay the interest on the first cost of the machine but will actually pay for the machine in a few years, if the number of cows is large enough to warrant. Because, too, the skimmilk is not taken into the house at all but is fed warm to the young stock.

Again, if the cream is delivered to a creamery to be made into butter, the milk does not have to be hauled to the factory and back again. It is kept separate, uncontaminated with skimmilk from other sources and is fed before souring.

SEPARATING BY HAND WITH CHAIN DRIVE CREAM HARVESTER "DAIRYMAID."

An examination of the records of pigs officially condemned as tuberculous at the Chicago stock yards shows that the great bulk of tuberculous pigs come from the dairy districts and undoubtedly get the disease from drinking unpasteurized skimmilk returned from the factory. By separating the milk at home the cow owner avoids this source of infection for his young stock.

What Sort of Separator Shall Cow Owner Buy?—The one that will skim the largest amount of milk the cleanest in a given time with the least force to run it. Separators vary widely in capacity. Some of the hand machines will separate only 250 pounds an hour while others will run through fully eight hundred pounds.

Other things being equal the larger machines are the more economical.

Separating milk is a slow job at best. It takes from one to two hours a day and this multiplied by the number of days in the year grows to a very perceptible share of the working time of the season.

Again it takes no longer to wash and care for a large machine than a small one. Finally no one should intend to remain a dairyman with two or three cows. His ambition ought to be to increase the size of his herd until he is carrying all the cows his farm can support. The large machine will not have to be exchanged when the number of cows increases. The separator should have capacity, skim clean, be durable, simple in construction, easily cleaned and easy of separation.

Separators Location is Important.—The care of the separator is not a hard problem if the location is right, the foundation good and the essentials in the way of accessories are convenient.

One thing required is pure air. A cow stable will not do because the air cannot be kept pure and, although it is handy to have the separator right there so you can pour the milk from the pail into which it is drawn, through a strainer at the top of the separator can, still such a practice is rightly forbidden in the stable itself. The separator must be placed where the air is always pure.

The room where the separator is must be free from dust, hence the woodshed is forbidden unless a part of it be partitioned off and well floored so that it can be kept clean and sweet.

The floor of the separator room had better be made of concrete since milk is bound to be slopped over at some time and must be washed up with abundance of water. This demands a tight sound floor and good drainage. A cement floor is slippery and cold but it can be kept much sweeter than a wooden floor.

The room must be arranged to exclude flies. The separator must be kept spotlessly clean and this cannot be done in a room to which flies are admitted. Screens to windows and doors are necessary, with an occasional use of insect powder to kill off such flies as steal in with the milkers.

The room ought to be where it can be kept cool and yet where the sunlight can have free range to kill off bacteria.

It is not to be understood that the separator is to be set off into a world of its own where nothing but pure milk enters and only angels can attend it. It is quite possible to build a room as an integral part of the barn itself, or as a part of the house, where all the requirements are fully met. Pure air, kept pure, free from dust and fairly cool with sunlight are the essentials.

Separator Foundation Should be Masonry.—The foundation of the separator must be strong, durable and firm The separator must be kept from jar. It must run smoothly. It must therefore be securely anchored to such foundation as will hold it perfectly level and without vibration.

A heavy bowl at the top of a long spindle is no strain at all upon the upper bearing when the machine is level and free from shaking but is a hard test of the workmanship of the builders when the spindle is at an angle with the vertical, no matter how small that angle may be. It is well to have the foundation of the separator rest directly upon masonry on the ground. This implies a location not in the second or third story.

A separator is necessarily a delicate machine requiring intelligence and some skill in its manipulation. Not only must it be properly placed, it must be kept in perfect condition. The bearings must be kept clean and well oiled. The fixtures in the bowl must be put in as the directions require. The cap of the bowl must be screwed on tight; the tinware must be put in place and kept in place and the separator must be turned at the speed designated by the makers.

Factors Determining the Richness of the Cream.—The richness of the cream in fat depends upon many conditions. If

GEAR DRIVE CREAM HARVESTER "BLUEBELL."

the separator be turned faster than the regulations call for, the cream will be richer in fat. If turned slower than it ought to be turned the cream will be poorer in fat.

If the milk be rich in fat, the cream will have a higher per cent of fat than will the cream from milk with less fat in it.

If the milk flows into the separator too fast, the cream will be low in fat. If the feed be restricted, the per cent of fat in the cream will go up.

The temperature of the milk affects slightly the per cent of fat in the cream, but not to an important degree.

The richness of the cream is controlled almost absolutely by the position of the cream screw. Each machine can thus be regulated to turn out from milk of given composition a cream of any richness desired. For buttermaking the cream should be as rich as is consistent with perfect skimming.

Daily Care of the Separator.—The rules in regard to the care of the separator are simple and inevitable from the considerations already had.

In the first place the separator must be washed every time it is used. The washing should be done methodically, rinsing off the milk in tepid water, then washing with very hot water containing a cleansing powder or borax, then rinsing in boiling water and steaming, if possible.

Let the bowl dry without wiping. Wash the tinware in the same way, doing the work most thoroughly.

Next the separator stand must be kept clean, free from dust. All exposed parts should be wiped clean, the surplus oil removed and the whole surroundings maintained in sweet and sanitary condition.

Experiment Stations have shown that the foul bowl will increase the bacterial content of milk to an incredible extent. When the separator is washed but each alternate day the number of bacteria in the milk forced through it is so large that the skimmilk is unfit to feed to pigs. If the separator is clean, running milk through it reduces the number of bacteria fully a fifth and often a fourth.

The slime collecting on the inside of the bowl should be burned as it contains the bulk of the germs contained in the milk.

Places should be provided for the parts of the separator when taken apart. They must be kept out of dust.

Operating the Separator.—If the separator is to do good work, is to remove the fat from the milk down to one or two one hundredths of a per cent it must be run right, as well as be put together right.

In actual practice, the point most often disregarded is the item of speed. The monotony of turning a crank leads to neglect and the speed falls below the point of good service. The directions may say forty-two turns to the minute. The operator unconsciously allows the speed to drop to thirty-two. A loss of fat in the skimmilk follows.

Again the temperature of the milk may fall too low. Few, if any, separators will do good work at a temperature below eighty degrees, and all separator makers have a right to demand that the users shall have their milk as warm as that.

The milk may be sour and partly loppered. This presents a hard and possibly an impossible problem to the machine. Separators are built to handle sweet milk only.

A separator ought to last a long time and do good work to the last. They may seem costly to the dairyman but the first cost should be divided over many years of use and will be so divided if the machines have good care. Delicate machines cannot be left to care for themselves. The women of the house can take care of them well enough if the men will turn them and will lift out the bowls and take them apart.

To drive the separators various kinds of power are in use. The gasoline engines are popular. Bulls or horses on tread powers do the work. Steam engines are called for in dairies large enough to call for much steam for cleansing purposes. Any source of power will do that will give a steady and unvarying speed.

The Cream Should Be Cooled at Once.—The two products of the separator are the cream and the skimmilk. The cream is the most valuable and its care should receive the attention of the prudent dairyman. Two principal rules are to be observed in reference to it.

In the first place the cream must be cooled at once and kept cold. The bacteria living in cream are of two kinds, as far as their final effects upon the cream are concerned.

"BLUEBELL" READY FOR WORK.

One kind of germs sour the cream, the other kind bring about fermentations resulting in unhealthy products. If the cream is kept cold, neither of these products develop rapidly.

As soon therefore as the separator stops, the can of cream ought to be put in a tank of cold water and cooled down as fast as possible to below fifty degrees.

If ice is at hand it ought to be used, not in the cream surely, but in the water surrounding the can. If no ice can be had, the water about the cream should be changed frequently and often enough to rapidly cool the cream. The low temperature should be maintained until the cream is delivered at the factory or until enough has been gathered at home for the churning.

If delivery to the factory is the fate of the cream, the delivery should be made as often as twice a week that the bad bacteria may have no opportunity to grow. If the churning is to be made at home, it ought to be done as often as twice a week if the best butter is to be made.

The future of the hand separator hangs on the fate of agricultural education. If farmers will take proper care of the separators and of the cream, the hand separator has come to stay. If they will not, the separator must go. Consumers demand that cream shall be made from pure milk and shall be kept cool and free from infection with bad germs.

The dairyman can make pure milk if he will keep his cows and his stables clean, his methods systematic, his utensils bright and sweet, the air of his cow stables and dairy room, pure and free from bad odors. He can make his cream sweet if he will keep his separator clean and will cool his cream and keep it cold and clean.

Value of Skimmilk as Food for Stock.—The signal value of the separator lies in the fact that it leaves the skimmilk at home to be fed warm to calves and pigs. With pigs selling at $3.80 a hundred and with corn meal worth $16.00 per ton the skimmilk was shown to be worth for feeding young pigs fully 24 cents to the hundred; when the pigs were larger, it was worth twenty cents to the hundred. For calves it is usually worth more than it is for pigs.

When feeding either calves or pigs, regularity must be observed. If feeding skimmilk sweet, feed it sweet all the time. If feeding it sour, feed it sour all the time. The trouble with separator skimmilk returned from the whole milk factory is that some days, when the weather is cool, the skimmilk comes home sweet, the next day when it is hot, it comes back sour. The hand separator at home avoids these troubles.

Separator Will Pay for Right Use.—Will a separator pay? In the hands of the right man, Yes! In the hands of the careless man, No! The quality of the man decides this business question as it decides others. The man with good business sense, who can smell a bargain afar off will succeed in business and will accumulate cash.

The man without business capacity may still succeed in the world but he will not be the owner of much of this world's goods. The man of energy, prudence and progress will succeed because he will obey the natural laws that make for success. In his hands the separator will pay.

Clinton D. Smith,
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Increasing Fertility

ELEMENTS OF SOIL AND THEIR VALUE TO CROPS—FERTILIZERS AND SOIL-BUILDING.

By Cyril G. Hopkins

If he who makes two blades of grass grow where only one grew before is a public benefactor, then he who reduces the fertility of the soil so that only one ear or corn grows where two have been grown before is a public curse.

Agriculture is the fundamental support of the American Nation, and soil fertility is the absolute support of agriculture.

Without agriculture, America is nothing. The forest and the earth supply the timber, the stone, and the metal to build and equip railroad and factory and the fuel to operate mill and locomotive, but directly or indirectly these great industries are absolutely dependent on agriculture for their continued existence.

The Two Functions of the Soil.—The soil has two distinct functions to perform in crop production. First, the soil must furnish a home for the plant, where the roots can penetrate the earth upon which the plant must stand. Second, the soil must furnish plant food, or nourishment, for the growth, development, and maturing of the plant.

To improve the physical condition of the soil is to improve the home of the plant, while to add to the soil, or to liberate from the soil, fertilizing materials is to increase the available supply of plant food.

One soil may furnish an excellent home for the plant, but a very insufficient supply of plant food; while another soil may contain abundance of plant food, but the physical conditions may be such as to make an unfit lodging place for the plant.

The Six Essential Factors in Crop Production.—There are six essential and positive factors in crop production; (1) the seed, (2) the home or lodging place, (3) moisture, (4) heat, (5) light, and (6) plant food. Some negative factors are injury from insects and plant diseases.

Good seed is exceedingly important and the quality of the seed selected and planted is largely under the control of the farmer.

By proper drainage and by the use of organic matter and by proper tillage, thus maintaining good physical conditions, the farmer may provide a suitable home for the plant, remove surplus water, render the soil more capable of absorbing and retaining necessary moisture, and control the temperature to some extent by lessening evaporation and by changing the color of the soil as by the addition of organic matter.

More than five times as much heat is required to evaporate water from the surface of the soil as would be needed to raise the temperature of the same amount of water from the freezing to the boiling point. It is because of this that wet, poorly drained soils are cold. Dark soils absorb more heat and consequently are warmer than light colored soils.

Light is a factor over which man has no direct or positive control, but he has full control over some negative factors, such as weeds, which if allowed to grow might largely prevent the light from reaching the young plants. Indeed, the first and greatest damage caused by weeds is due to the fact that they shut off the light from the growing plants. If the supply of moisture or of plant food is insufficient for both the crop and the weeds, then the weeds may rob the growing crop of these essentials to some extent.

So-called nurse crops, such as oats or wheat when growing with clover, may grow so thick and rank as to injure to a marked extent the clover by shutting out the light, also by robbing the clover plants of moisture and plant food. To avoid these injuries or difficulties, the clover should be started with a very light seeding of wheat or oats (about one bushel to the acre) preferably planted in drills running north and south, which will permit the strong midday light to reach the clover plants.

If oats are seeded as the nurse crop they should be an early maturing variety or they may be pastured off or cut early for oat hay. The surest method of obtaining a good setting of clover is to sow it without a nurse crop and clip the weeds with a mower if necessary.

The least understood and the most neglected essential factor in crop production is plant food. Food of required kinds and in sufficient quantity is as necessary for plants as for animals; and it is even more important to provide an ample and balanced ration for corn than for cattle, because cattle are usually able to move about and find some food for themselves, while the corn plants are stationary and limited to the food within reach of their roots.

The Ten Essential Plant Food Elements.—There are ten different elements of plant food, each of which is absolutely essential to agricultural plants. These elements are carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, calcium, magnesium, iron, and sulfur.

Carbon, hydrogen and oxygen which constitute more than 90 per cent of most agricultural plants are contained in air and water, the supply being unlimited. The four elements, calcium, magnesium, iron, and sulfur, although absolutely essential to plant growth, are required in very small amounts, while they are present in practically all soils in inexhaustible quantities.

On the other hand, the three elements, nitrogen, phosphorus, and potassium, are required by plants in very considerable amounts, and soils are frequently found which are so deficient in one or more of these three elements as to limit the yields of crops. It should be understood that soils are never found which are entirely devoid of nitrogen, phosphorus, or potassium. Even the poorest and most unproductive soils still contain at least some small supply of each of these elements, and as a general rule such so-called exhausted soils contain at least one and frequently two of these valuable elements in large amount, the low productive capacity being due to the deficiency of one or two elements only.

Sometimes the element which the plant fails to obtain in sufficient quantity for its normal growth, the element which positively limits the yield of the crop, is actually present in the soil in very large amount. In such cases the practice should not be to add to the soil more of this plant food element, but to adopt methods of soil treatment and management by which we can liberate a sufficient amount of this element for maximum profitable crop yields. This point will be further discussed in the following pages.

Nitrogen.—The element nitrogen ought never to be bought in general farming. The atmospheric pressure is 15 pounds to the square inch. Of this, about 12 pounds pressure is due to the nitrogen contained in the air. If we compute the value of this nitrogen at 15 cents a pound, the price commonly paid for the nitrogen in commercial fertilizers, we find about eleven million dollars' worth of nitrogen resting on every acre of the earth's surface.

It is true that such crops as corn, oats, wheat, timothy, cotton, and tobacco have no power to make any direct use of this atmospheric nitrogen, but there is a class of plants known as legumes, including such valuable agricultural plants as red clover, alsike, alfalfa, crimson clover, cow peas, soy beans, vetch, etc., upon the roots of which there are or should be small nodules or tubercles, varying from the size of pin heads upon clover roots to that of peas upon soy beans, in which live great numbers of very minute, microscopic organisms, called bacteria, which have power to take nitrogen from the air as it enters the pores of the soil, to cause this free gaseous nitrogen to combine with other elements in suitable form for plant food which is then taken up by the clover or other legumes for its own growth.

If the roots and stubble are left to decay in the ground the nitrogen which they contain becomes available to succeeding crops of corn or other grains or grasses. If the entire legume crop is plowed under as green manure, then all of the nitrogen taken from the air is left in the soil for succeeding crops.

If the crops are fed to animals provided with plenty of absorbent litter or bedding, as straw or refuse shredded corn fodder, so that all liquid excrement is saved, then about 75 per cent of the nitrogen contained in the feed may be returned to the land in the farm manure.

In very intensive farming, as in market gardening near large cities where the land is too valuable to be given up even for a part of a year to the growing of legumes for fertilizing purposes, then it becomes necessary to apply nitrogen and this is also profitable, for the products of one acre frequently bring $100 or more for one season.

Where it can be obtained, stable manure is usually the most economical and satisfactory form in which to apply nitrogen in market gardening, although dried blood, tankage, sodium nitrate and ammonium sulfate are also used with profit at times.

Phosphorus.—If the element phosphorus becomes deficient in the soil, the total supply can be increased only by making an actual application of some kind of material containing phosphorus.

It is well to bear in mind that about three-fourths of the phosphorus required for ordinary grain crops is stored in the seed or grain, while only one-fourth remains in the straw or stalks. Consequently, when corn or wheat is sold from the farm three-fourths of the phosphorus required to produce the crop leaves the farm in the grain.

When the crops are fed to animals, especially to growing animals or milk cows, from one-fourth to one-third of the phosphorus contained in the feed is retained in the bones, flesh, and milk, while about three-fourths is returned in the manure.

The total phosphorus content of the soil on any given farm may be increased by the purchase of stable manure or by using manure made from purchased feeds, especially from grains or other concentrates, as bran, oil meal, or gluten feed; or we may purchase steamed bone meal from the stock yards companies who buy our cattle, slag phosphate from the steel works if the slag contains sufficient phosphorus to make it valuable, or natural rock phosphate direct from the extensive natural phopshate deposits in Tennessee, South Carolina, or Florida, where this mineral is being mined and ground in large amounts. It may be noted that the original stock of phosphorus naturally in the soil is ground rock phosphate.

Potassium.—Potassium, like phosphorus, is a mineral element contained in the soil, and if the supply in the soil is deficient it can only be increased by a direct application to the soil of some material. As a matter of fact aside from peaty swamp lands and some very sandy lands, the potassium contained in most soils is practically inexhaustible. The average corn belt soil of central and northern Illinois contains as much total potassium in the first seven inches as would be required for 100 bushels of corn (grain only) each year for nineteen centuries.

Of course the stalks which are rich in potassium should be returned to the soil, either directly or in manure. Even if they are burned (which should be the exception and not the rule) the potassium remains in the ash.

Peaty swamp soils are frequently exceedingly deficient in both available and total potassium as compared with normal soils, and where the supply of farm manure is limited, commercial potassium salts may be applied to such land with very great profit. Potassium sulfate and potassium chlorid (frequently, though incorrectly, called muriate of potash) are the most economical and satisfactory commercial potassium fertilizers.

Kainit is sometimes used, but it contains only 10 per cent of potassium while potassium sulfate usually contains 40 per cent and potassium chlorid contains about 42 per cent of the element potassium.

About 200 pounds of potassium sulfate or potassium chlorid will supply sufficient potassium for a hundred-bushel crop of corn, and on very peaty land where corn will not grow, such an application is recommended. The subsequent applications may be reduced in accordance with the amounts of potassium returned in the stalks and in the farm manure made from feeding the crop. But in dealing with soils of low productive capacity, of whatsoever class, it must be remembered that we must first grow large crops before we can make large amounts of manure, and if necessary we must always be ready to supplement our farm manure with any needed plant food if it can be obtained and used with profit.

Because soils deficient in potassium are usually abnormal and exist only in restricted areas, this class of soils will not be further considered except to mention in this connection that where such soils are found, as in some swamp regions, then the addition of potassium frequently produces most astonishing increases in crop yields. This is well illustrated by the results obtained on the University of Illinois soil experiment field near Momence, Illinois, in the Kankakee swamp area.

CROP YIELDS IN SOIL EXPERIMENTS.
Peaty Swamp Land near Momence, Illinois.

Plant Food Applied	1903 Corn, Yield per Acre
None	7 bu.
Nitrogen	4 bu.
Phosphorus	5 bu.
Potassium	73 bu.
Nitrogen, phosphorus	4 bu.
Nitrogen, potassium	71 bu.
Phosphorus, potassium	73 bu.
Nitrogen, phosphorus, potassium	67 bu.

It will be seen that potassium increased the yield of corn by more than 60 bushels to the acre. It should be understood that some soils which are peaty in the surface with a heavier clayey subsoil within reach of the plow can be improved merely by deep plowing, for the clayey material is usually rich in potassium. It sometimes occurs that a subsoil exists which contains considerable amounts of total potassium but this may become available slowly unless more actively decaying organic matter than peat is present. In such cases even light applications of fresh farm manure may produce an effect far exceeding that which is commonly expected.

Occasionally peaty swamp soils, like other soils, may contain some injurious alkali, as magnesium carbonate, in the subsurface soil in such amounts as to prevent corn roots from living in it, and hence liberal amounts of available potassium provided in the surface soil may greatly benefit the crop. Deep peat and peat underlaid by clean sand are as a rule deficient in both available and total potassium.

It is well to remember that the seed or grain contains only about one-fourth of the potassium required for a crop, while three-fourths remains in the straw or stalks; also that animals retain practically none of the potassium consumed in the food, almost all of this element being returned in the solid and liquid manure.

Making Plant Food Available.—It is an absolute essential in agriculture to have plant food in the soil. If it is not present in abundance it should be supplied in the manner that is most economical and profitable, and that which is removed in crops should be replaced so far as practicable and profitable, either by returning it in farm manure, or by plowing under green manures, corn stalks, straw, and other coarse products.

With a good supply of plant food stored in the soil, then the thing of greatest importance in the business of farming is the liberation of sufficient plant food during the growing season to meet the needs of maximum profitable crops. While thorough tillage aids in this process, *by far the most effective and practical means within the farmers' own control for liberating plant food from the* *soils supply or from insoluble material, as natural rock phosphate, which may have been applied, is decaying vegetable matter.*

The farmer or land owner whose farm practice includes these two points; that is, (1) plenty of plant food stored in the soil, and (2) plenty of decaying organic matter to liberate plant food for the crop needs, will have in operation a system of agriculture which is permanent.

The one point is no more important or essential than the other. The man who tries to maintain the fertility of his soil and who hopes to continue to grow large profitable grain crops without the use of legume crops or plowing under farm manures or coarse products, but who uses high-priced soluble manufactured commercial fertilizers, is unwise, and utimately his land will probably follow in the history of the lands which have been practically ruined by such practice in the eastern states.

On the other hand, the man who thinks the productive capacity of the ordinary prairie land in the humid regions of Central United States can be permanently maintained, merely by the use of clover in crop rotation, is also unwise, for this is absolutely impossible. So far as phosphorus and potassium are concerned, the use of clover in crop rotation is one of our most effective means of liberating those plant food elements from the soil so that they may be removed in subsequent grain crops. Furthermore, clover and other legumes are themselves gross feeders on phosphorus and potassium.

It is almost inexplicable that there are people who write and speak at great length and with great energy on the tremendous importance of adding nitrogen to the soil as an element of plant food, but who completely ignore and even deprecate the matter of maintaining in the soil a supply of phosphorus and potassium from which we can liberate sufficient amounts for large crops.

No man can afford to ignore the truth. If there are soils which contain so little phosphorus or potassium that we cannot by profitable means liberate sufficient to meet the requirements of large crops, then we should increase the supply; and every man should be sufficiently unprejudiced to ask frankly whether it is more sensible and more profitable positively to increase the total supply of any element of plant food in his soil or to continue to decrease it by means of crop rotations and the use of decaying organic matter.

For the ordinary strictly live stock farm from which only hogs and cattle are sold, there is no such thing as reducing the supply of potassium if all liquid and solid manure is carefully saved and returned to the soil, because, as before stated, practically all of the potassium contained in the feed is returned in the manure. In dairy farming a small amount of potassium leaves the farm if milk is sold.

But even in live stock farming with all manure saved and returned to the land we still lose the phosphorus carried away in bones, flesh, and milk, and this fact should not be ignored by the farmer whose crop yields are already limited because of insufficient supplies of phosphorus, even with abundant use of decaying organic matter supplied in clover and farm manure. Indeed not infrequently we find farmers whose land is so rich in nitrogen and potassium that they grow great crops of straw and stalks, but the phosphorus is so limited that the actual yield of grain produced is only one-half or two-thirds what it should be. Let us remember that a balanced ration is just as important for corn as for cattle, and that phosphorus is required largely for the grain.

Soils Deficient in Nitrogen.—It should be understood that the nitrogen in the soil is measured by the organic matter, for the nitrogen is practically all contained in the organic matter. Consequently soils which are deficient in organic matter are also deficient in nitrogen.

There are two classes of soils which are commonly much more deficient in nitrogen than in other plant foods. These are the very sandy soils and the very rolling or steeply sloping hill lands.

INTERNATIONAL HARVESTER COMPANY RETURN APRON MANURE SPREADER "CORN KING" WITH LOAD.

Improving Sandy Land.—While the sandy lands are not rich in phosphorus and potassium, they are as a rule moderately well supplied with those elements, and such soils are so porous that they afford a very deep feeding range for the plant roots, so that the actual percentage composition in mineral plant food does not fully measure the possible productive capacity of sandy soils as compared with more compact silt or clay soils.

"CORN KING" SPREADING A THIN LAYER OF MANURE.

As a general rule if the three elements, nitrogen, phosphorus, and potassium be added separately to three different plots of very sandy land, the nitrogen will increase the yield, while little or no increase will be produced by either phosphorus or potassium. After plenty of nitrogen has been provided then the addition of potassium will still further increase the yield. Actual results obtained on the University of Illinois Soil Experiment Field on the sandy land near Green Valley, Illinois, will serve to illustrate this:

CROP YIELDS IN SOIL EXPERIMENTS.
Sandy Soil near Green Valley, Illinois.

Soil Treatment Applied	1902 Corn, Bushels	1903 Corn, Bushels	1904 Oats, Bushels	1905 Wheat, Bushels
Nitrogen	69	65	44	24
Phosphorus	30	25	20	17
Potassium	23	20	17	17
Nitrogen, phosphorus	57	70	52	27
Nitrogen, potassium	70	73	55	37

It will be noted that where nitrogen was applied the yield is more than double that obtained with either of the other elements. Except in 1902, phosphorus shows some effect when added to nitrogen, but potassium with nitrogen is more effective, especially in 1905, when it gave a yield of wheat thirteen bushels higher than was obtained with nitrogen alone. It should be stated, perhaps, that it is exceedingly difficult to select a number of exactly uniform plots for experimental use on this kind of soil and small differences may be attributed to soil variation, but the marked and uniform effects of nitrogen and of nitrogen with potassium are characteristic of such soil.

These results help to explain the marked effect of farm manure on sandy soils, especially when used for a crop rotation which includes legumes. Both the legumes and manure will furnish nitrogen, and the manure is also well supplied with potassium, the bedding being rich in potassium and all potassium in the feed being returned in the manure. It may be noted that on very sandy lands clover does not grow well, but either cow peas or soy beans is an excellent substitute for clover as both do well on very sandy soil.

It is exceedingly important that as far as possible all crops shall be fed and the manure shall be carefully saved and returned to such land, not only for its plant food value, but also for the organic matter which is needed to improve the physical condition of the soil.

Improving Worn Hill Land.—In actual field experiments on worn hill land on the University of Illinois Soil Experiment Field, near Vienna, Illinois, the following results have been obtained in a three-year rotation of wheat, corn and cow peas. By "legume" treatment is meant the growing of legume crops or catch crops, as cow peas in the corn, or after the wheat, in the same season, which are turned under for the nitrogen and organic matter which they add to the soil.

CROP YIELDS IN SOIL EXPERIMENTS.

Worn Hill Land, near Vienna, Illinois.

Soil Treatment Applied	1903 Yields	1904 Yields	1905 Yields
Wheat, Bushels per acre.			
None	0	7	1
Legume	1	7	11
Legume, lime	1	10	18
Legume, lime, phosphorus	8	15	26
Legume, lime, phosphorus, potassium	11	18	30
Corn, Bushels per acre.			
None	9	31	38
Legume	5	36	43
Legume, lime	8	49	62
Legume, lime, phosphorus	7	49	57
Legume, lime, phosphorus, potassium	11	45	57

The year 1903 was a very poor season for both corn and wheat. It will be seen that lime and legumes (cow peas or clover) have very great power to improve this class of soils.

As yet the addition of phosphorus and potassium has not increased the corn yields, although with wheat phosphorus has given a marked increase and potassium some further gain, notwithstanding the fact that these two best treated plot series were naturally slightly less productive than the other three series. With more organic matter the effect of applied potassium will probably disappear.

Soils Deficient in Phosphorus.—Phosphorus is the element of plant food most likely to be deficient in the common gently rolling prairie or upland timber soils of Central United States, as in Illinois, Indiana, and Ohio. Phosphorus is also commonly found to be the most deficient plant food in most long cultivated soils in Eastern and Southern United States.

The total amount of phosphorus contained in the surface seven inches of the commonest type of soil in the Illinois corn belt is no more than would be required for fifty crops of corn of 100 bushels each, or for about seventy such crops if the grain only were removed from the land. The next soil stratum is poorer in phosphorus than the surface soil and even a rich subsoil is of little value when buried beneath a worn out surface.

The common so-called worn out soil of Southern Illinois contains but little more than half as much phosphorus as the corn belt soil. If clover failure is becoming more frequent than formerly on Illinois soils it is one of the strong evidences of insufficient phosphorus.

The results obtained from the University of Illinois Soil Experiment Field near Bloomington, Illinois, on the typical slightly rolling prairie land of the Central Illinois corn belt will serve to demonstrate that phosphorus is the element which limits crop yields on soils of this character, notwithstanding the fact that this soil is valued at not less than $150 an acre and is still producing very profitable crops even for land of that valuation.

CROP YIELDS IN SOIL EXPERIMENTS.
Typical Corn Belt Prairie Soil, near Bloomington, Illinois.

Plant Food Applied	1903 Corn Bushels	1904 Oats Bushels	1905 Wheat Bushels
None	60	61	29
Nitrogen	60	70	31
Phosphorus	73	73	39
Potassium	56	63	33
Nitrogen, phosphorus	78	85	51
Nitrogen, potassium	59	66	30
Phosphorus, potassium	75	70	38
Nitrogen, phosphorus, potassium	81	91	52
Gain for phosphorus when added to nitrogen	18	15	20

It will be seen that the addition of nitrogen or potassium, separately or together, produces little benefit and sometimes the effect is a decrease in yield, although nitrogen did appreciably increase the yield of oats in 1904. After phosphorus has been applied then nitrogen can be utilized with marked benefit.

Phosphorus produced a large increase in each crop even when applied alone, but when applied after nitrogen the increase was exceedingly marked, amounting to eighteen bushels increase in corn, fifteen in oats, and twenty bushels increase in the yield of wheat. While nitrogen was applied in commercial form (dried blood) in these experiments, these results emphasize the very great importance of using phosphorus in connection with clover and farm manure for improving this soil. The possible effect of phosphorus on the clover crop itself may be seen in the results obtained in 1905 on the University of Illinois soil experiment field at Urbana, Illinois, which is also situated on good Illinois prairie soil. By "legume" treatment is meant the growing of a catch crop of cow peas or clover in the corn when it is "laid by."

CROP YIELDS IN SOIL EXPERIMENTS.
Typical Corn Belt Prairie Soil, near Urbana, Illinois.

Soil Plot No.	Three years' average before treatment. Corn, bushels		Soil Treatment Applied	1905 Clover Tons per Acre	
201	60	Av. 61.8 Bu.	None	1.26	Av. 1.23 Tons
202	64		Legume	1.21	
203	63		None	1.15	
204	61		Legume, lime	1.32	
205	61		Lime	1.21	
206	64	Av. 61.4 Bu.	Legume, lime, phosphorus	2.91	Av. 3.12 Tons
207	62		Lime, phosphorus	2.91	
208	58		Legume, lime, phos., potassium	3.19	
209	61		Lime, phos., potassium	3.19	
210	62		Lime, phos., potassium	3.41	

It will be seen that previously to the beginning of this soil treatment the last five plots yielded no more than the first five, but after four years of soil treatment the yield of clover was only

1.23 tons without phosphorus, while 3.12 tons of well field-cured clover hay were produced where phosphorus had been applied. The effect of potassium was slight.

Of course this increased crop of clover means a larger yield of corn to follow and both clover and corn mean more farm manure for further soil improvement or maintenance.

"CORN KING" SPREADING A THICK COAT.

Soils Deficient in Both Phosphorus and Lime.—Soils on which clover can not be grown successfully even before they are badly worn are usually acid and consequently deficient in lime, but as a matter of fact such soils are usually deficient in both lime and phosphorus.

The effect of lime and of lime and phosphorus in connection with legume treatment on the University of Illinois Soil Experiment Field near Odin, Illinois, will serve to demonstrate the need of both lime and phosphorus on such soils as are commonly called "clay land" which refuses to grow clover.

WHEAT YIELDS IN SOIL EXPERIMENTS.

Typical Wheat Belt Prairie Soil in "Egypt," near Odin, Illinois.

Soil Treatment Applied	Yield per Acre Average of Three Years
None	7 bu.
Legume	9 bu.
Legume, lime	12 bu.
Legume, lime, phosphorus	23 bu.
Legume, lime, phosphorus, potassium	24 bu.
Gain for legume, lime, phosphorus treatment	16 bu.

The treatment recommended for these soils, which are well represented by the extensive worn "clay lands" in Ohio, Indiana, Southern Illinois ("Egypt"), and Missouri, is as follows:

Apply 1,000 to 2,000 pounds to the acre of finely ground natural rock phosphate with as much organic matter as possible (manure, legume catch crops, etc.) and plow under, then apply one to two tons to the acre of finely ground natural limestone and mix with the surface soil in preparing the seed bed, and then grow a good rotation of crops, such as corn, wheat, and clover; or corn, cow peas, wheat, and clover; or corn, cow peas, wheat, clover, wheat and pasture (clover and timothy being seeded with the second wheat crop for one or two years' meadow and pasture). At the end of the rotation another heavy application of rock phosphate should be made, preferably to the pasture ground in connection with all available farm manure and plowed under for corn.

If necessary lime must be added occasionally to keep the soil sweet. (Blue litmus paper, which can be obtained from a drug store, if placed in contact with the moist soil for 20 minutes will be turned red if the soil is sour).

The Value of Farm Manure.—Farm manure always has been and probably always will be the most important and most abundant material for soil improvement. It is a necessary product on every farm and on stock farms a product which accumulates in very large amounts. If not used for soil improvement it becomes a worthless nuisance about the stables, whether in the city or in the country.

INTERNATIONAL HARVESTER COMPANY ENDLESS APRON MANURE SPREADER "CLOVERLEAF" BEFORE LOADING FOR THE FIELD.

A conservative estimate places the annual production of farm manure in the United States at two billion tons. The actual agricultural value of fresh farm manure containing both the liquid and solid excrements is not less than $2 a ton, whether the value is measured in terms of plant food elements actually contained in the manure as determined by chemical analysis of the manure and the market values of the elements, or whether the value is measured by the actual increase in crop yields produced by the use of the manure on ordinary long cultivated soils.

Waste of Farm Manure and Land Ruin. — If fresh farm manure is spread out and exposed to the weather for six months in summer, one-half of its total weight of dry matter is lost, and more than one-half of its value as a fertilizer is lost. In most newer countries there is enormous and shameful if not wicked waste of farm manure. In older countries it is the rule to save all possible farm manure with very great care, although this rule is too frequently broken by the careless, ignorant, or short sighted.

As a whole the unnecessary waste and loss of farm manure which occurs in the United States each year is equal in value to more than ten times the value of all commercial fertilizers used in this country. Sometimes the waste of farm manure and the purchase of commercial fertilizers occur upon the same farm. In such cases the commercial fertilizer used is usually an acid phosphate, or a so-called "complete" fertilizer containing acid phosphate with a trace of nitrogen and potassium too small to add appreciably to its value, and it is commonly applied in amounts which supply less plant food than the crops actually remove, the small amount of soluble plant food applied being supplemented by that which the soil would naturally give up, together with what can be forced from the soil by the stimulating action of the soluble corrosive acid salts and manufactured land plaster contained in such fertilizers.

Saving Farm Manure.—In order to retain the full amount and full value of farm manure, it should be removed directly from the

ENDLESS APRON SPREADER "CLOVERLEAF" IN OPERATION.

stall or covered feed lot and spread at once upon the land. Where the winters are moderately cold and free from heavy rains there is little loss if the manure is allowed to accumulate during such weather in a small uncovered feed lot, provided it is hauled out and spread upon the land in the early spring. Manure may be allowed to accumulate without much loss in deep stalls for several weeks if plenty of absorbent bedding is used, and then it may be hauled from the stall directly to the field and spread.

It should be the rule never to handle manure more than once. When taken from the stable or feeding shed it should be at once loaded onto the spreader and hauled to the field. If manure is produced at the rate of two loads or more a week the convenience and importance of taking this manure directly from the stable and spreading it at once upon the field will certainly justify providing a manure spreader or special wagon to be used solely for this purpose.

Increasing the Value of Farm Manure.—While ordinary fresh farm manure is worth $2 a ton for use on ordinary soils, its value can easily be increased to $3 a ton net, by replacing in liberal amounts of low-priced natural rock phosphate, the element phosphorus, which the animals have extracted from the feed and used in making bone, thus leaving the manure poor in phosphorus as compared with the crops grown and fed.

It should be remembered that practically all potassium contained in the feed is returned in the liquid and solid excrements, and that the nitrogen, which is in part retained by the animal and in part returned in the manure, can be fully maintained by supplementing the farm manure with clover grown in the crop rotations or as catch crops.

By far the most complete and valuable work ever reported upon the subject of increasing the value of farm manure by the addition of natural rock phosphate has been done by the Ohio Agricultural Experiment Station under the direction of Professor Charles E. Thorne in an extensive and most trustworthy series of experiments extending over a period of nine years.

As a rule for use on land which is deficient in phosphorus, rock phosphate should be mixed with average manure in such proportions that at least 250 pounds of rock phosphate per acre would be provided for each year. Thus for a four-year rotation, including corn for two years, oats for the third year and clover for the fourth year, about 1,000 pounds of rock phosphate an acre should be applied to the clover ground in connection with all available farm manure and plowed under for corn. If the land is manured once in four years with ten loads of manure to the acre, then 100 pounds of rock phosphate should be applied with each load.

A very simple and satisfactory method of applying rock phosphate to the land, which involves practically no extra labor or loss of time, is to load the manure spreader part full of manure, then scatter 100 pounds of rock phosphate over it as uniformly as possible, finish loading, and drive to the field and spread the phosphated manure. This brings about a very complete and intimate mixture of the manure and rock phosphate and this is exceedingly important because the decaying organic matter must be in intimate contact with the rock phosphate in order to liberate the phosphorus for the use of the crops.

A System of Permanent Agriculture.—This practice of applying liberal amounts of natural rock phosphate in connection with all of the farm manure which can be made on the farm from the hay, straw, and other coarse products and from the oats or other low-priced grains, together with the use of a good rotation, including plenty of clover, provides for an absolutely permanent system of agriculture, even though high-priced grains and animal products are sold from the farm. It is a system under which the land grows richer and richer and more and more productive and valuable, instead of becoming poorer and less productive as has been the case with by far the larger part of the older cultivated lands in the United States.

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Power on the Farm

GAS ENGINES—THEIR PRESENT FARM USE AND POSSIBILITIES.

By Fred R. Crane

OLD Powers Proving Insufficient. — The power necessary to operate modern farm machinery is receiving no small amount of consideration at the hands of those who are making a deep study of the practical side of farm life.

The farmer who would better his conditions is now looking for some power which will make the farm work lighter and at the same time give increased cash returns.

The old tread mill he has discarded as a machine into which no humane person would lead a horse.

The sweep mill is unsatisfactory in that it is unsteady and requires constant attention.

The wind mill is a small power, unsuited to operate heavy machines and is unreliable in the majority of places, although on the smaller farms where a limited amount of water is used and where large storage tanks are possible, they are giving general satisfaction.

Gasoline Engine as Farm Power.—The gasoline engine is now prominently before the agricultural people as a farm power, and the experiences of the writer have led him to the conclusion that the gasoline engine is to be recognized as a power on which the farmer can depend, and that there is money in such an investment where he has work for it to do. This article is written with this thought in mind and in the hopes that the gasoline engine may be widely introduced into the farming districts.

"Failure to do its duty," need never be put down against a thoroughly well built gasoline engine of the standard four-cycle-makes now on the market. It can be depended upon to work at all times if sensible management is used in the care of its parts. The conditions in many instances go to prove that many troubles of the amateur operator are not engine troubles, but are probably due to the fact that the operator has succeeded in using a wrench or some other tool intended never to fall into his hands.

Powers Various Lines Demand.—For pumping and running the smaller machines, possibly including a small feed grinder, a power ranging from 2 h. p. to 5 h. p. will answer the purpose according to the needs. For the larger grinders, feed cutters, etc., 8 h. p. to 12 h. p. will give results.

Larger powers are needed in many instances and any purchaser may well accept the judgment of an expert coming from a trustworthy firm. No manufacturing company of any standing will recommend an engine of too little capacity, as it is to its advantage to have any power plant, in which its engine is the life of that plant, run smoothly.

An electric lighting plant for farm use is a coming thing; in some places electric lighting plants have been established and there is no question as to their success. The future will see much development along this line of farm lighting systems. The gasoline engine was first used on the farm as a substitute for the unreliable windmill and at once the practical fellow found other things for it to do.

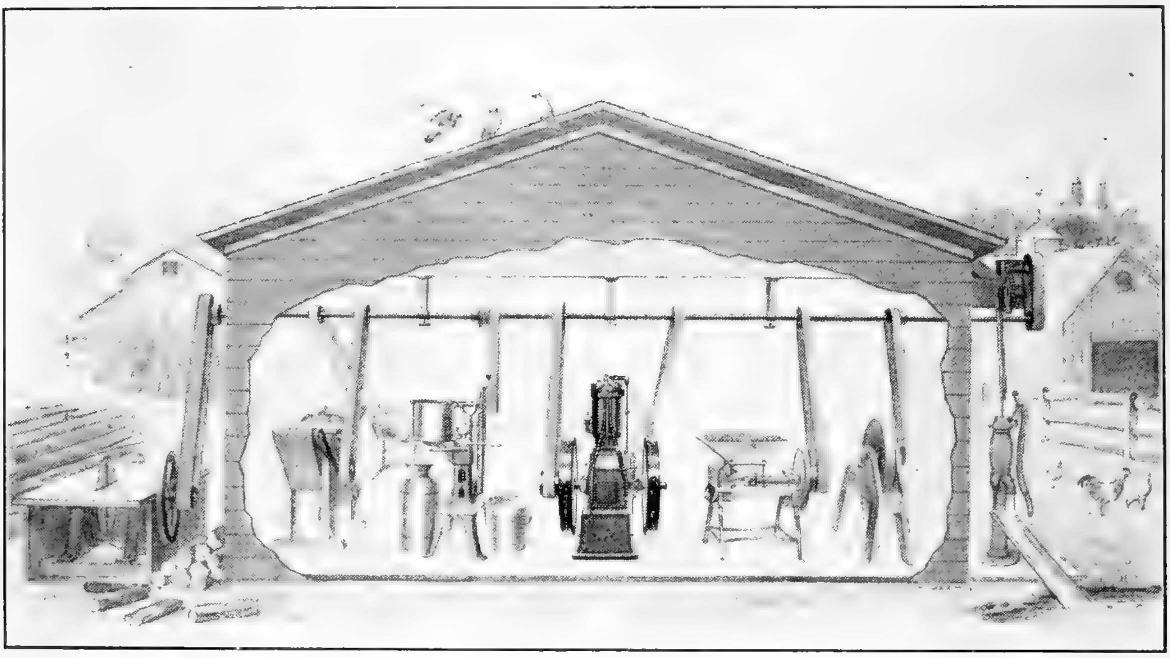
In this he is helped by the wide range of machines used on the farm. These may be divided into three classes.

(1) Those which do not require a larger power than that which a man could exert.

(2) Machines which require more than a man power in their operation.

(3) Special machines, such as spraying outfits and lighting systems for the farm.

In the first class are found the pump, the saw, washing machine, cream separator, churn, grindstone, drill press, small lathe,



CONVENIENT ARRANGEMENT FOR OPERATING FARM MACHINE.

etc. In the second class come the feed grinder, feed and ensilage cutters, shredders, threshing machines, corn shellers, etc.

Many a farm can now have a power house centrally situated and by putting up a line shaft in connection with a gasoline engine, a number of machines can be run at one time. This is probably the most satisfactory system of employing power.

Question of Engine's Size.—The size of an engine to buy is a question which we should consider, taking careful thought as to the amount of work you may wish the engine to do at any one time. Future needs must not be forgotten; many a purchaser has used his engine for a time only to find that he has much other work which he would do with it had it sufficient power.

It is poor economy to load any machine beyond its limit, and one who is about to buy an engine should consider the total horse power needed and then before buying add 33 1-3 % to that power, remembering that in loading a machine to its capacity or even close to it, you are exerting a strain which quite materially shortens the life of the engine and makes necessary constant adjustment.

Types of Engines on the Market.—There are two types of engines now on the market,—2-cycle, and 4-cycle. We will pass over the 2-cycle and confine our attention to the 4-cycle engine as the writer feels that the 4-cycle principle will give better results in the farm work.

To show more clearly why preference is here given the 4-cycle engine, it would be well to say a few words as to why the 2-cycle engine is not further discussed.

The 4-cycle type of engine gains an impulse during two complete revolutions of the fly wheel, and should have a larger cylinder in order to obtain a power equivalent to that of the 2-cycle; also heavier fly wheels must be used. However, the control of the mixture, the cleaning of the cylinder of the 4-cycle engine on the idle stroke, and a reduction of chance of leakage give this type the advantage.

The 2-cycle engine must have a separate compression chamber, and here leakage may occur causing poor combustion of the mixture, and a great reduction of efficiency.

Superiority of 4-Cycle Type.—Economy and ease of regulation demonstrate the superiority of the 4-cycle type. In this type of engine one should master the working principles as follows:

1st cycle, — Charging:—In this act the piston starts from the front of the cylinder, moving outward as far as the stroke will allow; the gas and air mixture is drawn in by suction through the intake valve, and the fly wheels have executed a one-half revolution.

2nd cycle,—Compressing:—In this act the piston moves back into the cylinder as far as the stroke will allow; the mixture has now been compressed into a small clearance or dead air space around some method of ignition; the intake and exhaust have been shut during this movement, and the fly wheels have executed a second half revolution.

3rd cycle,—Discharging:—In this act the charge is ignited and the resulting explosion is the power which drives the piston outward again as far as the stroke allows; the intake and exhaust valves have been shut during this movement, and the fly wheels have made a third half revolution.

4th cycle,—Cleaning:—In this act the cylinder is cleaned of the charge by the exhaust valve opening and the piston moving back into the cylinder as far as allowed, forcing out the burned charge; the fly wheels have now made a fourth half revolution.

Following closely this explanation, one notices that the fly wheels make two complete revolutions for each time the engine may receive power from the fired charge of gasoline, and observes further the movement of the piston and the time of opening and closing the intake and exhaust valves.

The understanding of the parts, as outlined, the office of each, and a thorough knowledge of the working principles of the 4-cycle engine as described, will give the operator all the information needed to operate successfully the gasoline engine under all circumstances.

Parts of Gasoline Engine.—Before attempting to operate a gasoline engine one should know the parts and the manner in which they operate. An expert can explain in a short time these parts so that one can have a clear idea of them.

Some men are of a mechanical bent and master the engine in going once over the operating principles. Others may take to them slowly, but as far as understanding and successfully operating the gasoline engine, the person of average ability need have no fears.

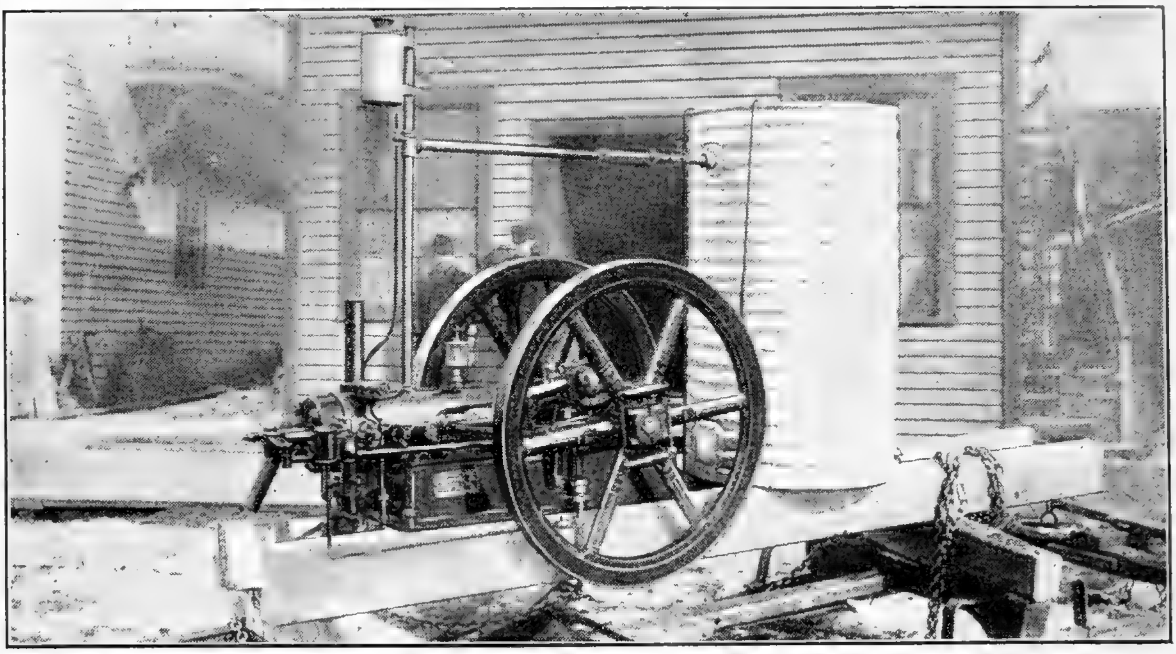
The purchaser should insist on an explanation of all parts and not release the expert until they are thoroughly explained to him.

By reference to the diagram Fig. I and Fig. II and outline one can quickly locate the parts, as follows:

ENGINE OUTLINE, FIG. I-FIG. II.

1. Engine Bed.
2. Cylinder.
3. Cylinder Head.
4. Fly Wheels.
5. Crank Shaft Boxes.
6. Water Jacket.
7. Outlet Water Pipe.
8. Inlet Water Pipe.
9. Pipe from Gasoline Tank.
10. Gasoline Pump.
11. Overflow Tank at Mixer.
12. Air Supply for Gasoline Mixture.
13. Sparking, "make and break method."
14. Piston.
15. Steel Piston Rings.
16. Crank Shaft.
17. Exhaust Rod.
18. Needle Valve.
19. Belt Pulley.
20. Intake Valve Port.
21. Exhaust Valve Port.
22. Connecting Rod.

Work for Stationary Engine.—When the work for which the engine is needed is so situated that the engine need not be moved, a stationary engine should be bought and placed apart by itself, but above all, never locate a gasoline engine where there is lack



ENGINE EQUIPPED FOR TRANSPORTING.

of light, in a damp basement or in any position which makes it hard to get at any part of it.

As to a foundation, do not believe that this is unimportant and that an engine can be set on "any old foundation." The best work is done by an engine when held rigid, in fact a gasoline engine needs a better and a stronger foundation than a steam engine of the same horse power. This is particularly noticeable in the engine the cylinder of which is horizontal, and the fact that the foundation must be strong is no disparagement of a gasoline engine.

When Portable Engine is Necessary.—When the work is in several places widely separated, as previously mentioned, a portable engine becomes necessary. This is generally one mounted on wheels. The ordinary stationary engine can be loaded on skids or shoes. These are then drawn from place to place as desired. This system of using the gasoline engine as a power is thoroughly practical.

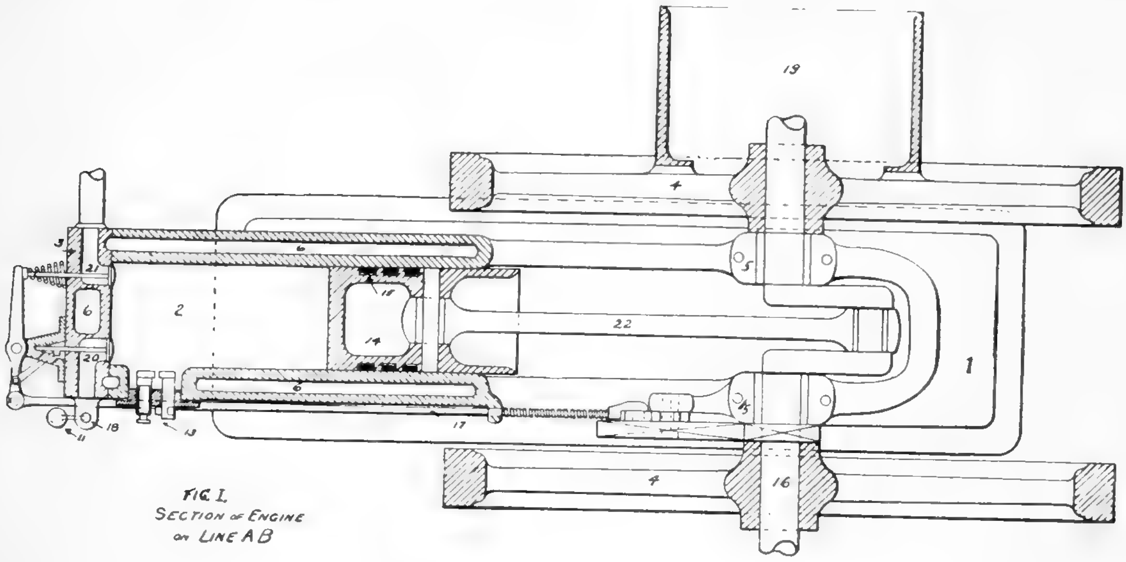


FIG. I.
SECTION OF ENGINE ON LINE AB

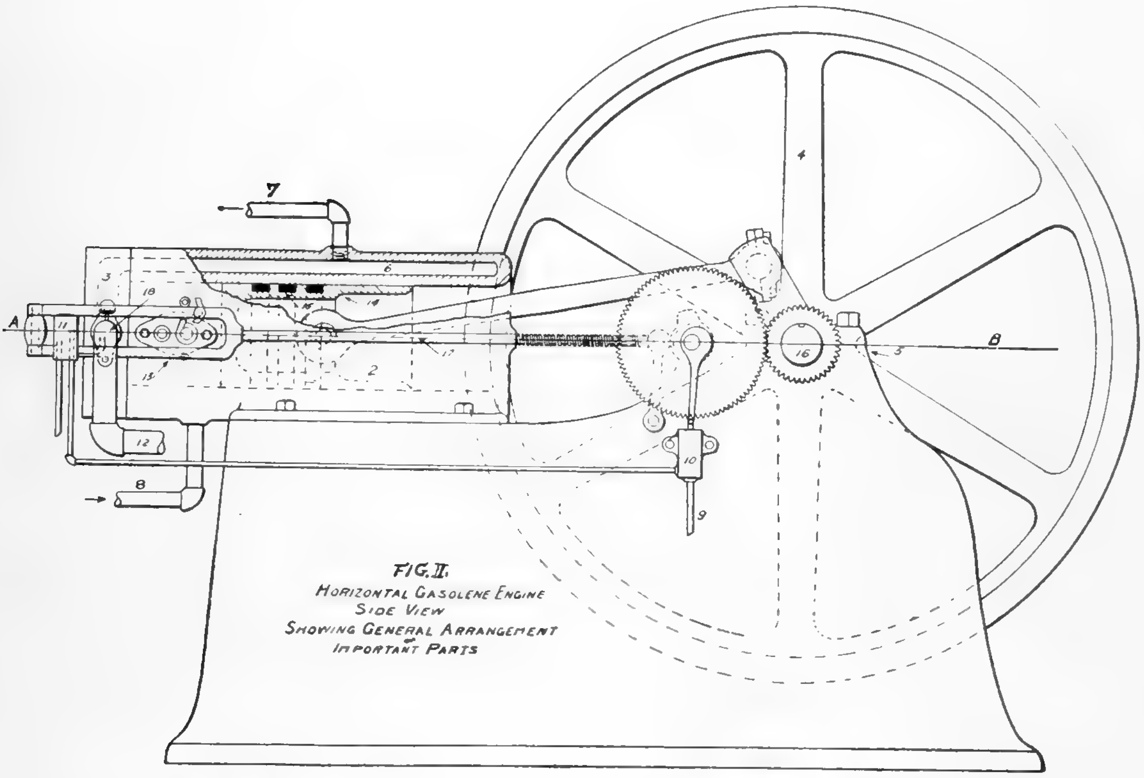


FIG. II.
HORIZONTAL GASOLENE ENGINE
SIDE VIEW
SHOWING GENERAL ARRANGEMENT OF IMPORTANT PARTS

FIG. IV.
JUMP SPARK PLUG
Section to Show Insulation

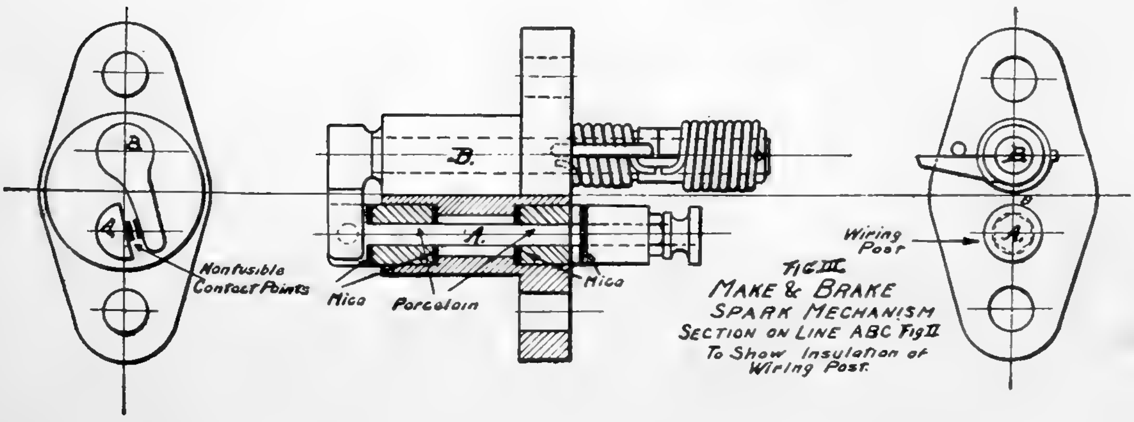


FIG. III.
MAKE & BRAKE SPARK MECHANISM
SECTION ON LINE ABC FIG. II
To Show Insulation of Wiring Post.

Electric Ignition the Best.—The electric ignition for firing the mixture within the cylinder may well be regarded as by far the most efficient method of effecting the explosion in the gasoline engines. The surety and nicety with which it can be controlled, give it an undeniable advantage.

This requires a source of electric energy—the battery of cells, the auto-sparker or magneto. These will be described later in their application.

The electric current as used may be compared to the race track, using the insulated copper wire to make a complete circuit, the current always trying to return to its starting point, and, unless so arranged there will be no passing of electricity.

The insulation protects the wire, allowing no electricity to pass off only at the points where desired.

Without insulation the current will be lost on the first metallic contact. The wire must be carried to the engine where the ignition is caused, either by the "MAKE-AND-BREAK" or the "JUMP-SPARK" method.

The Make-and-Break Ignition.—The make-and-break method of ignition, Fig. III, has leading through the cylinder walls to the interior, two electrodes, one of which is well insulated, (A), the other a movable one (B) and not insulated. The points of these electrodes are then arranged to make and break automatically the electric current as furnished. On breaking the contact the spark caused, fires the mixture.

The time of firing requires careful adjustment and should occur just before the engine is on the dead center and near the end of the compression stroke. This gives the engine opportunity to get the full force of the explosion at the point of highest compression.

When a vibrator is used with the spark coil, a series of sparks occur at the terminals within the cylinder each time the cam closes the primary coil circuit.

Hot Tube Method of Ignition.—The hot tube employed as a method of ignition is, in all modern engines, a small tube varying in length, approximately from 2½ inches to 6 inches. It may be ½ inch in diameter or possibly less. This is then closed at one end and screwed into the cylinder head in such a manner as to open into the compression or dead air space.

The tube is heated to a dazzling red by some exterior flame and on the compression cycle the charge is forced into the tube and against its red hot walls causing the mixture to fire. The length and diameter of the tube is such that the mixture is fired just before the point of highest compression, and the impulse is given the piston as the crank shaft passes over the center.

The hot tube seldom fails to ignite the charge but the timing of the explosion can be changed only by changing the length, the diameter, or both, of the hot tube.

The hot tube ignition is practiced with entire success, but the writer feels that there are other methods giving better results.

Make-and-Break Method Preferable.—Of the several methods of ignition the make-and-break electric receives preference in the engine designed for farm work because of its simplicity, ease of adjustment and the little attention needed. This is preferred to the jump-spark, because of the tendency of the vibrator, when used in the jump-spark coil, to get out of order, and the difficulty in obtaining perfect insulation in the spark plug, which is a particularly delicate part. The points of the electrodes on the jump-spark plug become over-heated, break or become foul by deposits or refuse, and no spark will pass the space thus closed. This then entails great care of the spark plug and vibrator,—care, such that the average beginner would have some trouble should anything go wrong.

Need of Strong Battery Current.—The battery is much used to furnish the current which is the vital principle in electric ignition. This battery may be composed of dry cells with electricity stored which will furnish a current until the spark becomes too weak to fire the charge.

A weak electric current causes much trouble by non-firing. There is a feeling that for stationary use the wet cells are preferred for the farm engine, although in a portable or traction power the dry cell is best. One of the best types of wet cells is made of carbon and zinc plates immersed in a solution of, water 3 quarts and potash 1 pound; over the surface of the material, which is contained in a porcelain can, a layer of paraffin oil about ½ inch deep is spread. This prevents evaporation.

Five of these wet cells, with the primary Ruhmkorff coil, are used in a circuit when the make-and-break contact within the cylinder is used.

Dry cells give splendid results and are satisfactory in case the operator will discard the run down cells for new ones as soon as the current shows weakness.

Troubles Traceable to Battery.—Most of the troubles arising with the electric ignition can be traced directly to the battery. Only first class batteries should be used and they should not be expected to last forever without renewing. When dry batteries are employed, replace them with new.

In the wet cells, replace any worn out parts and put in a new mixture.

The battery cells are comparable to so many pails of water, in each of which there are so many drops of water, and, when used, they must be renewed.

High speed engines will use the battery faster than slow speed ones, and the size of the engine will make no difference with the size of the spark needed or in the life of the battery.

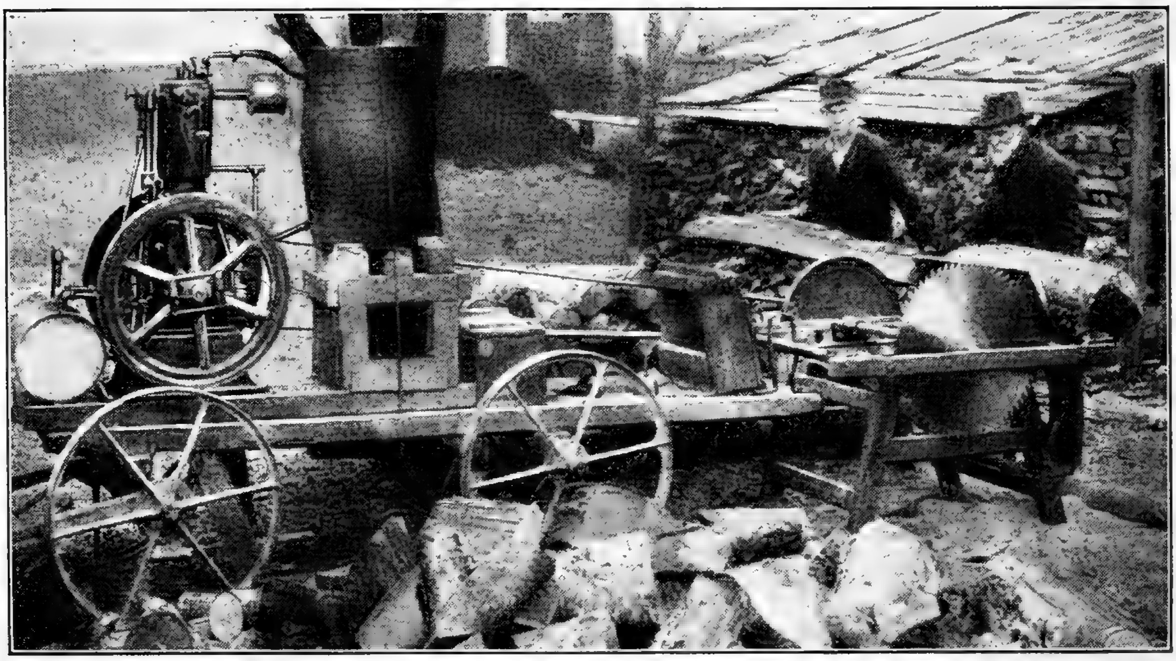
Just what the life of a battery should be, will depend on the duration of the contact and the hours of use of the engine. One thing, however, is sure, that to leave the battery turned on over night, or while the engine is idle, will, if the contact is made, run down a battery more than months of steady use of the engine. Many an operator ruins a battery by leaving the switch closed over night.

The Auto-Sparker Current.—The auto-sparker for electric ignition, is a favorite method with the modern engines. A battery is needed in starting the engine, but is at once shut off, and can be used almost indefinitely when kept dry.

The reason for the limited use of this method is due more to the limited knowledge of the purchaser and to a feeling that he can get along with the battery. However, when once the operator has used the auto-sparker, he will hesitate to go back to the battery.

Remarks on Electric Ignition.—Electric ignition troubles are generally much magnified, and they are due to abuse resulting from ignorance. Many an operator feels that knowledge of electricity sufficient to understand thoroughly the electric ignition as applied to gas engines, is far beyond his powers of comprehension. In that, he is much mistaken. It is a simple, plain process and easy of grasp.

A current of sufficient strength fed by either a battery or a dynamo passes over the coil as mentioned elsewhere in this article. The core of this coil is soft iron and becomes instantly highly magnetized. It acts as a storage tank for the electricity, filling absolutely full, the surplus fairly bursting to get out.



VERTICAL ENGINE SAWING WOOD.

When the current is broken at the separation of the ignitor points, the pressure of the electric current is at once shut off, and the magnetized core must immediately unload.

The current is then crowded upon the coil of wire which is the nearest conductor. The core of soft iron must return to its former unmagnetized state, and, in so doing, forces a strong current back on the coil of wire. Running along this, it comes to the break or separated electrodes, and, in its efforts to connect, it bridges the space, tumbling off into the gap, resulting in a flash of fire, the strength of which depends upon the strength of the original current.

Things Operator Should Know.—The operator who will master the few principles here mentioned will soon be able to locate and correct any trouble with the engine arising from the electric ignition.

1st. There is a source of electricity, either the battery, auto-sparker or magneto.

2nd. A circuit through the engine, either directly or indirectly, to the electrodes.

3rd. The spark coil connections.

4th. The automatic arrangement which makes and breaks the current.

Methods of Cooling Cylinder.—The water cooling system is probably the best one to employ,—the disadvantage being, the freezing during winter weather which cracks the jacket.

By the addition of chemicals to lower the freezing point, this difficulty is somewhat lessened. In using the chemicals the operator should notice at times whether any deposit occur in the passages which must be kept open. Another method of prevention of freezing is, the use of glycerine and water mixed, one part of glycerine to three of water. This is costly and none of these methods where any water is used, will be absolute proof against freezing, although they often protect a cylinder from cracking.

The only sure way is to drain all parts of the engine and cooler apparatus when not in use during winter weather.

The water cooling method is used in the great majority of engines, and is to be recommended in the gas engine for the farmer.

Things That Need Attention.—It is a common remark that a gasoline engine needs no attention. This is true to the extent that if the engine is running properly and the supply of fuel and lubricating oil is adjusted, the operator is free to leave the engine. It is generally the case that the engine needs no attention while at work, but there are slight adjustments, and the cleaning of the engine, to which attention must be given after each run, and without which the efficiency is much cut down.

Before discussing the care and management of the vital parts of the engine, it is well to lay down the rules to be followed in starting and stopping.

Process of Starting Engine.—If the electric method is used, trace the current through its entire circuit and, after all connections are made, connect direct across from the outside of one electrode to the outside of the other, making sure they are not touching within the cylinder. A bright spark should jump as we break the outside connection.

Then connect the electrodes within and if we get no spark from without when breaking the cross connection, we are reasonably sure that the ignition is satisfactory. Examine all oilers, drip or otherwise, and be certain that they are working properly. It is good practice to drop a little coal oil upon the stem of each valve before starting.

If the hot tube ignition is used, the burner should first be lighted and regulated so as to burn correctly, throwing a blue flame upon the tube. During the few minutes necessary to heat the tube to a dazzling red heat, and ready to use, one can attend to the other preliminaries.

Be certain that the water is circulating through the jacket; in case a cooling tank is used which depends upon the gravity method, the water must stand above the pipe leading from the jacket.

After examining the lubrication, turn the engine piston to the starting point which is at the beginning of the explosion cycle.

Thus far the steps are the same for all gas engines; each engine has its own method of charging and the operator is cautioned to follow carefully the rules laid down by the manufacturer, in the interest of safety, and under no circumstances to place his foot on the spoke of a fly wheel in the starting operation.

As soon as the engine is started, regulate the throttle to the proper mixture of gasoline and air and notice the governor that there may be no possibility of racing, caused by a failure to work on the part of the governing device.

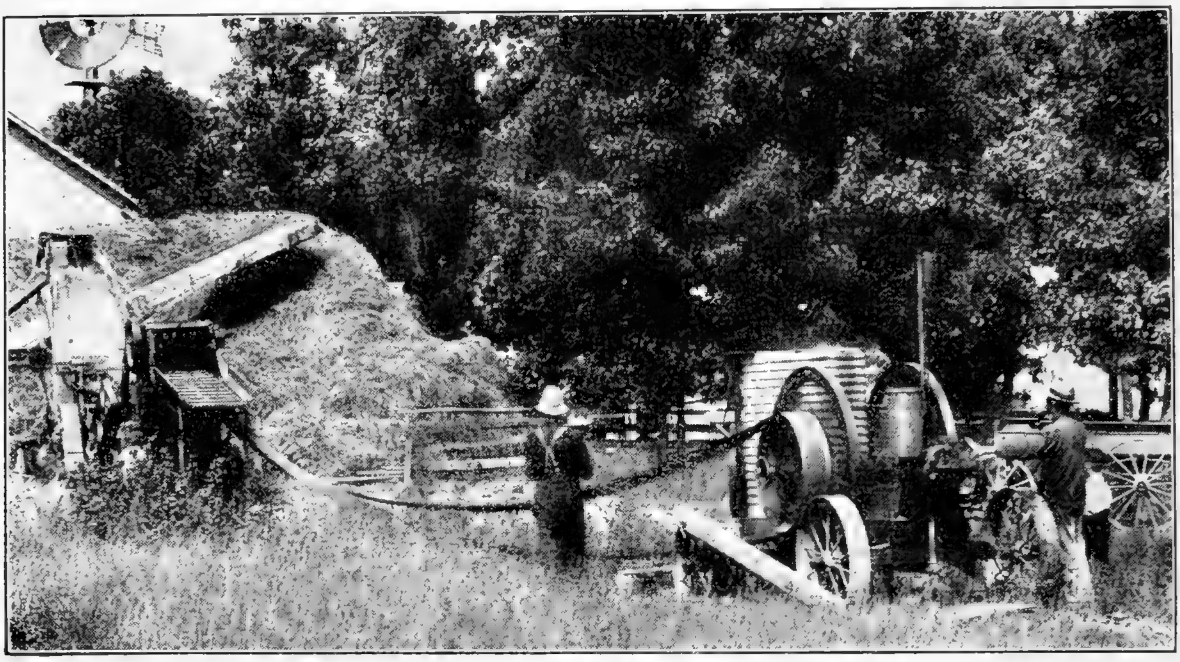
How to Stop the Engine.—Shut off the supply of gasoline by closing the needle valve tight.

Turn off the battery, or, if the hot tube is used, shut off the burner which heats it.

Stop all lubrication which does not close automatically. Notice carefully all bearings if worn or hot.

Wipe the engine ready for the next run and fill the oilers.

If in winter, drain the water jacket and all parts which freezing would in any way injure.



THRESHING SCENE.

Some Points on Lubrication.—Lubrication of the working parts of the gasoline engine is of course of much trouble to the inexperienced operator when it comes to the cylinder.

For cylinder lubrication, use the best grade of gas engine oil sold by the oil manufacturers. This oil is a high grade article and will stand against the great heat evolved within the cylinder of all explosive engines, maintaining a perfect lubrication. The cylinder oil recommended for this purpose is a light mineral oil, having a flash point of not less than 360 degrees Fah. and a fire test of 420 degrees Fah.

If waste oil filtered is used, this oil must not again be employed for cylinder lubrication.

If too much oil is allowed to feed through the oiler into the cylinder, or rather onto the surface of the piston, the surplus will cause fouling within the cylinder. This is followed by deposits on the valve seats and gumming of the piston rings, which means lost compression and a reduction of power; at times it causes a short circuit by connecting the separated electrodes.

If too little oil is fed down, the piston becomes dry on its wearing surface, and, while extra wear will occur, it often happens that the heat generated will expand the piston until it sticks in the cylinder.

An engine will soon give trouble where there is an incorrect adjustment in the supply of lubrication, be it too little or too great.

If too much oil is used, the exhaust will show a thick, heavy, gray smoke; if too little oil is used, there will be a barking sound at the free end of the cylinder, caused by the leakage of the mixture by the piston rings.

The wrist pin within the piston is subject to heat, such, that it, also, must be oiled by the high grade oil. Constant lubrication at this point is difficult and rapid wear is generally the case. Here is where the beginner often gets into trouble which can be avoided if given attention.

Hard oilers are used very successfully on other parts of the engine and are to be recommended.

When Engine is Working Well.—If the engine is working in a correct manner, this is apparent at once and there is no knocking or pounding, either within the cylinder or in any of its bearings. The piston should work true, without leakage and well oiled. There should be no color to the escaping exhaust and a marked regularity should be noticeable throughout the engine.

The piston should be examined occasionally, possibly to the extent of uncoupling the piston rod from the crank shaft and withdrawing it from the cylinder.

This should be done when there is sticking of the piston or excessive leakage of the mixture past the rings. If the piston is black and gummy, it is due to a free use of lubricating oil and to imperfect combustion. Wash thoroughly with coal oil and carefully clean around each ring, then fit each ring in its proper place. Clean all foul material from within the cylinder and, before returning the piston, carefully oil the walls of the cylinder and sides of the piston.

When the Valves Give Trouble.—The valves give trouble only when fouled or worn in their adjustments. If fouling occurs, this is noticeable in a loss of compression. To locate this, turn the piston on the compression stroke and listen at the valve stem for the sound of escaping gas. When this escape is apparent, it is necessary to *grind the valve seat and valve* by placing a little fine emery mixed with oil on the valve seat, then lower the valve upon it, having previously loosened the spring so that the valve is free. With a brace and bit fitted as a screw driver point set on the valve, and turn until a bright surface appears all the way around the valve seat in the casting and on the valve itself. Work the valves until the seats are true, then wipe entirely clean.

A little emery dust escaping to the walls of the cylinder will cut into the wearing surfaces of the piston and cylinder and cause much trouble. In view of the carelessness sometimes exhibited, it has been suggested by some that pumice stone be used in place of emery, but if a reasonable amount of care be exercised in the cleaning, there is little danger.

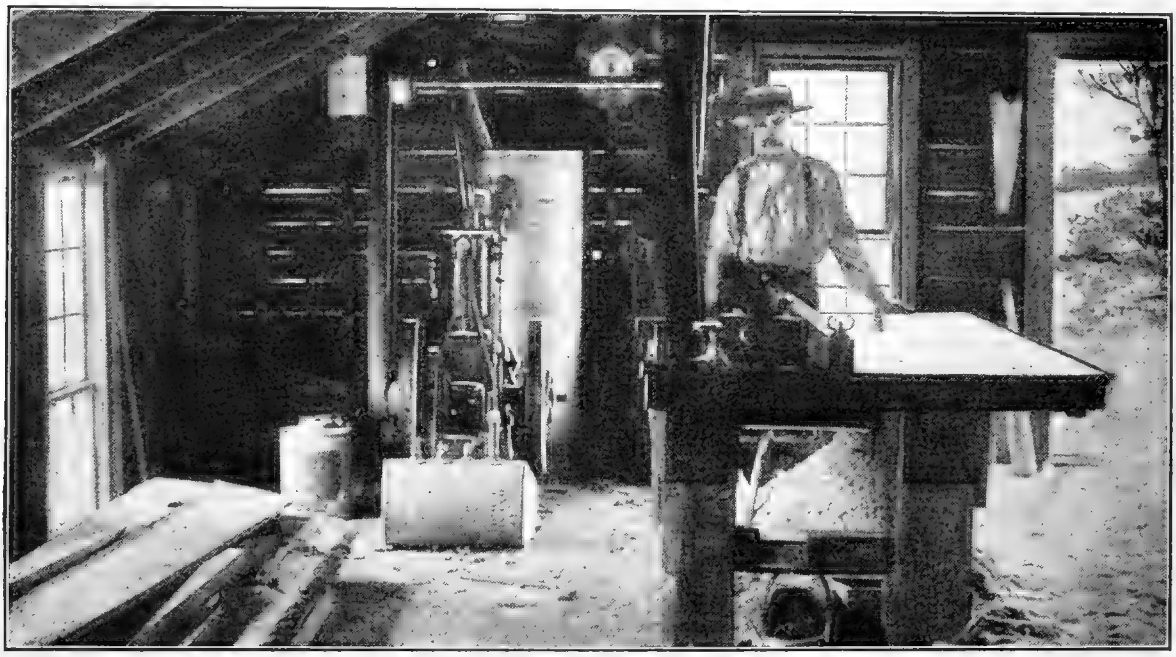
Readjustment of Valve Gearing.—Troubles often arise with the time of opening and closing of the intake and exhaust valves, due to the wearing of the levers, cams, etc., and is noticeable in a retarded action of the valves in opening and closing early. This causes an improper mixture and a loss of efficiency.

The remedy is a *readjustment of the valve gearing,* especially is this true in the high speed engines, where the exhaust valve begins to open at a point about 40 degrees past the dead center, and closes on the dead center.

The intake valve, when operated entirely by suction, has a spring strong enough to hold the valve in place until the engine has passed the center about 25 degrees, and remains open during the operation of the suction force, closing on the dead center.

Exhaust a Good Indicator.—The exhaust has a sound, by which the experienced operator soon learns to tell when the engine is or is not doing its work correctly. He needs only to be near enough to hear the sound of the exhaust, and the ear will at once tell if the engine is in trouble.

If at any time a black smoke is thrown through the exhaust, it shows too great a feed of gasoline causing an improper mix-



ENGINE AT WORK IN A SAW MILL.

ture, and an improper combustion as a result; if, however, the smoke is a dense light gray, then, as has been stated before, the cylinder lubrication is wrong, and should receive attention.

An improper mixture will often not be fired and with the exhaust will pass over into the muffler pot. When this occurs, the charge will often be fired in the muffler, causing a barking noise which is not dangerous, but denotes faulty firing, generally due to an insufficient supply of gasoline in the mixture.

This firing in the exhaust pot has given rise to the saying "She is barking for more fuel," and can be remedied by opening wider the throttle allowing more gasoline to pass in with the mixture.

Causes of Trouble and the Remedy.—Troubles come from many minor causes and may give rise to the feeling that the gasoline engine is not to be trusted.

Often in attempting to start the engine, there is complete failure. When this occurs, look over the several working parts and trace each part through its entire action.

Turn the piston on the compression stroke, as noted previously, and look for lost compression. It is possible in a new engine that the valves do not seat properly, locate the cause and apply a remedy, of grinding if necessary, or of adjusting the valve lever which may not allow the valve to fall down upon its seat. The binding of valve stems or bending caused in shipping will cause sticking and loss of compression.

Imperfect Mixture Will Not Fire.—Imperfect mixture of gasoline and air will not fire, and it sometimes becomes necessary to reduce the air inlet. In fact some engines are fitted with valves which partly close the air feed pipe, and the air is then drawn with greater force through the restricted opening, taking with it larger quantities of gasoline in the form of spray or gaseous vapor. This restriction of the intake pipe is often necessary in starting an engine and before it gets up to speed.

Weak Spark—Test the Current.—Poor ignition may be caused by weak batteries, or an imperfect wire connection in the battery. As remedy for this, test the current for intensity. If it gives what is known as a "fat" spark, all is well with it, but beware of the scattering weak one.

See that wires are held firmly and that the insulation is not worn off causing a short circuit to exist. A short circuit will soon run down the best battery made.

If the jump-spark is used and faulty ignition occurs, test all the batteries in the same way, then remove the plug and place it on some clean metal part of the engine where the secondary circuit is completed. If all is well, a bright spark will appear on closing the primary circuit and the vibrator will give its customary hum, which the operator should train himself to recognize.

Fouling of Ignition Points.—Deposits on the electrodes within the cylinder give trouble at times, generally due to excessive feeding of lubricating oil or too much gasoline in the firing mixture. To overcome this, clean the spark electrodes of all foul material, test them for perfect insulation, and remove the cause of fouling.

What Causes Pre-Ignition.—Premature ignition may occur from a faulty regulation of the ignition cam, or it may happen when excessive heat occurs on the internal parts of the engine. This last is caused by excessive loading, poor circulation of water in the cooler or by carbon deposits within retaining sufficient heat to fire the incoming charge.

At times a back firing appears in the suction passage, and is generally due to a poor seating of the intake valve, or to an ignition, caused during the suction period by white hot particles of refuse retained within the cylinder.

To substantiate the assertion that excessive heat within the cylinder might cause pre-ignition, it might be well to explain that the temperature of any mixture is increased according to the degree of compression to which it is subjected and any proper mixture of gasoline and air might be compressed to such a degree as to raise it to the igniting point, causing firing from its own temperature. This is sure to take place on the compression stroke in any gas engine cylinder, where the constant burning of charges maintain a degree of heat not controlled absolutely by the cooling device.

What to Do When Engine Pounds.—Should knocking or pounding occur, look at once for one of the following causes:

Pre-ignition; loose bearings at the wrist pin or at the crank shaft; loose fly wheel; leaking past the piston rings which may be mistaken for pounding; or broken piston ring.

Loss of power is caused by insufficient lubrication, poor compression, poor mixture and an over-heated piston.

Water Within the Cylinder.—Water in the cylinder due to condensations at times, but generally because of leakage around the packing at the cylinder head, will cause loss of power and if not stopped, will shut down the engine.

If air bubbles come up through the water pipe leading from the water jacket, one can be very sure of a leak in the packing, or if not there, it is directly through the walls of the cylinder where doubtless there is a flaw in the casting.

Remedy these at once by repacking, or, if in the cylinder walls, call a machinist. This leakage through the walls is more likely to occur in cylinders which have been rebored, as a trustworthy manufacturer will seldom put a faulty cylinder upon the market.

Economy in a Gasoline Engine.—The original cost of the gasoline engine as compared with other machines of equal horse power, is far in favor of gasoline as a power in farm work.

The placing of the engine in position is a simple operation and a mechanic is not necessary to superintend the work. The strongest support which the gasoline engine receives from the users of this power lies in the great reduction in the cost of the engine's operation.

Cost of Engine's Operation.—When working the gasoline engine the price of one pint of gasoline would represent the cost to the user of each horse power used per hour, and it is reasonable to assume (from tests made by the writer) that should one use a small amount of power taken from a large engine, the cost of the power will not be materially increased over the cost of the same power taken from a smaller machine. In fact it should always be the practice never to ask of an engine all the power it is capable of producing.

When ready to begin work the operator goes to his machine, switches in a battery and turns the fly wheel. The engine starts and in less than 60 seconds is up to full speed and ready to deliver its power in any quantity up to the limit.

The engine requires no attention until ready to use, there is no half hour wait to get up steam, and no early rising for the operator. When one wishes to stop for a few minutes the engine can be stopped and fuel is saved.

Engine Factor of Farm Economy.—The operator of an engine is free to work at something else, as the only time the engine needs his attention is in starting and stopping and then for less than one minute each time. When the engine is idle the operator pays nothing for use of the machine and it does not decrease in value.

Taking into consideration the original cost, the small space in which it can operate, the ease of management, and the great saving in the care of the gasoline engine, there is nothing more sure than that, at the present time, the gasoline engine as a farm power has no equal and will have none for a number of years to come.

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