GOOD ROTATIONS and efficient farm practices will subdue weeds.

Three main principles of weed control must be observed: (1) Prevent weeds from maturing seed on the farm, (2) prevent the introduction of weed seeds on the farm, and (3) prevent perennial weeds from making top growth.

The principles are the main thing; the particular method employed is of lesser importance.

Next to the principles ranks the man behind them. Many men make a start to clear their farms of weeds but give up too soon. Often the campaign is stopped when success is in sight, and the weeds soon recover.

Clearing a farm of weeds, especially perennials, is no easy task; it requires more than average intelligence and perseverance. If, however, one faithfully carries out a plan of attack based on the above principles of weed control he can practically rid his farm of weeds without a great amount of extra labor and expense.

Weed control is frequently a community problem, and for the greatest permanent success cooperation among farmers is required.

WEEDS: HOW TO CONTROL THEM.[1]

CONTENTS.

IMPORTANCE OF WEED CONTROL.

IN a sense, farming might be called a warfare against weeds. Some farmers emerge from the struggle victorious, while others go down to defeat. So powerful are weed enemies in reducing crop yields, while at the same time multiplying labor, that the farmer should at every turn strengthen his position against them. He should bear these invaders in mind in planning the crops he will grow and in deciding on the fields where he will grow these crops, in choosing the implements he will use, in buying his seed, and in many other farm activities. Lack of careful planning with reference to weeds is apparent in nearly every community. Here a man planted more corn than he could properly care for. There a man has left his field in meadow too many years. Here a man did not thoroughly prepare his land for alfalfa. There a man has seeded clover that was full of weed seeds. And for just such causes weeds not only make serious inroads on the current crop yields, but at the same time thoroughly infest the land and fortify themselves against future attacks.

The importance of keeping weeds in subjection can not be emphasized too strongly. It has been shown in experiments with corn made by the United States Department of Agriculture[2] that weed eradication is the principal, if not the only, beneficial result of cul-

[1] This edition has been revised by H. R. Cates, Scientific Assistant, Office of Forage-Crop Investigations.

[2] Cates, J. S., and Cox, H. R. The weed factor in the cultivation of corn. U. S. Department of Agriculture, Bureau of Plant Industry Bulletin 257, 35 pp., 10 figs., 1912.

tivating this crop after planting. This means that in cultivating the corn crop the implements used should be designed primarily for accomplishing the destruction of weeds in the easiest and cheapest way. It seems to indicate, further, that as weed control becomes more thorough, intercultural tillage of growing crops may be accordingly decreased.

Some men do not attack weeds with enough vigor; they look for rocking-chair methods of work. There is no royal road to weed control. In the main, the old doctrine of "hard work and plenty of it" must be observed, but unless this work is applied intelligently a vast amount of labor may be expended and but little accomplished beyond than a temporary abatement of the evil.

It may be seen, therefore, that thought as well as work is a requisite in the control of weeds. It is with the idea of directing thought to this important subject that this bulletin has been prepared.

There are three main principles of weed control. It is believed that an understanding of these principles and the methods by which they may be put into practice, as given in the following pages, will greatly lessen the amount of work required to subdue weeds.

WHAT IS A WEED?

A weed has been defined as a plant out of place. This definition is not entirely satisfactory, for two reasons: (1) Because a plant may be out of place and still not be a weed in the popular sense, as rye growing in a wheat field or Kentucky bluegrass in an alfalfa field; and (2) because a plant may not be out of place and still be a weed in popular language, as is described in a subsequent section of this bulletin on the good points about weeds. In reality a weed is a wild plant that has the habit of intruding where not wanted.

Weeds, even under adverse conditions, are able to maintain their existence. Some weeds produce immense quantities of seeds; some mature seeds in a very short time; some have seeds which are difficult to separate from crop seeds; some possess roots or rootstocks that live for a number of years. Weeds persist, therefore, because they are well equipped by nature in one or more ways to hold their own in the struggle for existence.

GOOD POINTS ABOUT WEEDS.

Weeds are not always useless. Sometimes they are the principal means by which organic matter is restored to the soil, and, generally speaking, a soil is productive in proportion to the quantity of organic matter it contains. In many parts of this country it is cus-

tomary to farm land until the crops are too poor to be profitable and then "turn it out to rest," as shown in figure 1. This merely means that weeds are permitted to grow on it for several years; after that the soil will be more productive.

Weeds are also useful at times in preventing soil erosion, especially during the winter months. Weeds are further useful in collecting and holding the nitrates and other soluble salts during periods when crops are not being grown, thus preventing these valuable nutrients from being washed out of the soil. Ordinarily,

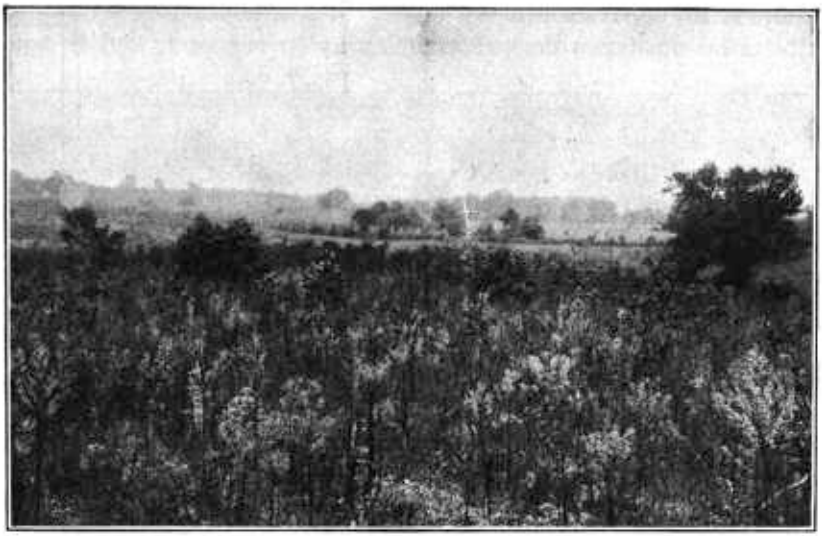

FIG. 1.—A field of poor land in Virginia "turned out to rest." Weeds improve the fertility of the soil by adding organic matter.

however, all these benefits may be realized through proper rotations, in which case it is a serious mistake to let weeds grow.

DAMAGE DUE TO WEEDS.

The full reason why weeds reduce yields is not definitely known. It is well recognized that weeds deprive crops of moisture, plant food, and sunlight, and by these means cause decreased yields. Experiments have shown, however, that even where there is a supply of moisture and plant food sufficient for the needs of both the weeds and the crop, weeds still exert a detrimental effect. This may be due in part to the weed roots giving off substances which are poisonous to crops. A more generally accepted explanation, however, is that the roots of the weeds interfere with the root development of the cultivated plants. This is thought by many to be the principal factor involved, and undoubtedly it plays an important part. The fact that weeds do harm in more ways than has been supposed is all the

more reason why the farmer should make strenuous efforts to subdue these invaders. Land that should produce 60 bushels of corn may yield no more than 20 bushels if weeds are not kept down by adequate cultivation, and the net profit to the farmer is relatively much less for the resulting poor crop than these figures on yield show. Figure 2 illustrates a rather common sight of many weeds and poor crops.

Another loss results from the presence of weed seeds in crop seeds. This necessitates much labor in separating or results in dockage by dealers if the separation is not made. Wheat containing wild-onion bulblets is sometimes docked as much as 50 per cent, and in some

FIG. 2.—A cornfield with a small crop, due partly to the presence of many weeds.

cases there is no sale at all for such wheat. The agricultural experiment station of Minnesota estimates that in that State alone the damage to wheat due to weed seeds amounts to two and a half million dollars yearly.

There are other causes of damage resulting from weeds, which in some cases are important. The harvesting and curing of crops are sometimes made difficult by the presence of weeds. Russian thistle, bindweed, and Canada thistle usually are a source of great annoyance at harvest time to the growers of small grains. Again, some weeds harbor fungi and insects which attack near-by crops; the clubroot of cabbage is fostered on the wild-mustard tribe of weeds, and the Colorado potato beetle lives also on nightshade and henbane. Furthermore, some weeds are poisonous or otherwise injurious to man, live

stock, or live-stock products. Poison ivy, sumac, jimson weed, and the seeds of corn cockle are poisonous to man; wild onion and bitterweed spoil dairy products; cowbane, water parsnip, and loco weed are poisonous to stock; and the barbed seeds of squirreltail grass and porcupine grass penetrate the noses and mouths of live stock, causing painful sores.

It is difficult to estimate the damage of weeds, but it is probable that they cost the American farmer several hundred million dollars every year.

CLASSIFICATION OF WEEDS ACCORDING TO LENGTH OF LIFE.

In fighting weeds it is extremely important to know how long they naturally live and their habits of reproduction. Weeds are divided into three classes according to their duration or length of life: (1) Annuals, (2) biennials, (3) perennials.

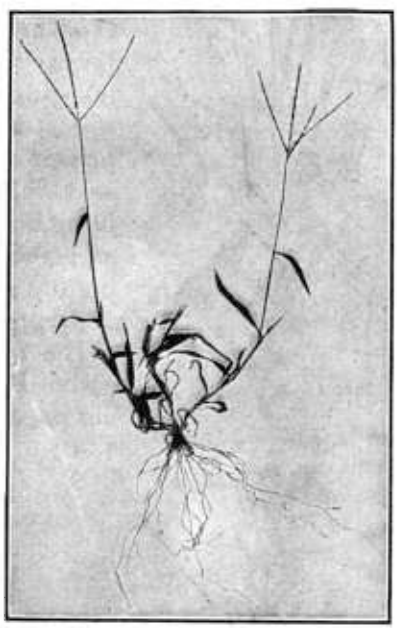

FIG. 3.—A plant of crab-grass, an annual weed.

Annual weeds live only one year, maturing their seeds and then dying. Ragweed, smartweed, and crab-grass are examples of annual weeds. Figure 3 shows an entire plant of crab-grass. Some annuals germinate in the fall, live through the winter, and mature their seeds in the spring. These are called winter annuals. Examples of winter annuals are shepherd's-purse, peppergrass, and fleabane.

Biennial weeds live two years. During the first year they grow rather slowly, producing usually a taproot and a rosette of leaves close to the ground, but the second year they send up flower stems that produce seed, and then die. Examples of biennnial weeds are blueweed, bull thistle, and wild carrot. Figure 4 shows an entire plant of blueweed.

Perennial weeds produce each year undergraund parts which live over to the next year and produce top growth. These underground parts may be of various kinds. They may consist of long, more or less horizontal roots, as in the case of the bull nettle, milkweed, and

FIG. 4.—A plant of blueweed, a biennial.

Canada thistle, or the underground parts may consist of rootstocks or underground stems, as in the case of quack-grass, Johnson grass, and perennial sow thistle. Figure 5 illustrates diagrammatically the growth of the Canada thistle, while figure 6 illustrates the growth of Johnson grass. Again, the underground parts may consist of bulbs that split up, as in the case of wild onion, shown in figure 7; or they may be more or less in the form of a taproot, as with dandelion (fig. 8).

THE CONTROL OF WEEDS.

Far more important than to kill weeds is to avoid having weeds to kill. In other words, the farmer should aim to prevent rather than cure the evil. A farm can be made almost free of weeds by strictly observing the following principles: (1) Prevent weeds from going to seed on the farm; (2) prevent weed seeds being brought to the farm; and (3) in the case of perennial weeds, prevent them from making top growth and thus finally starve out the underground parts.

The application of the three preventives outlined here is fully discussed in the following pages.

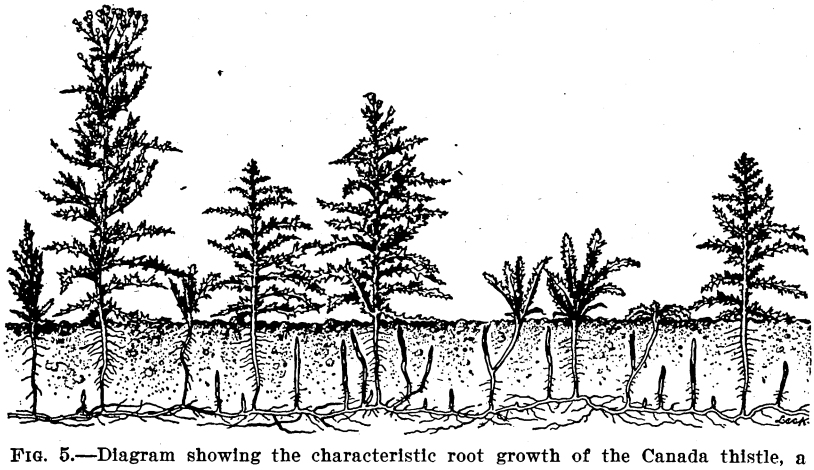

FIG. 5.—Diagram showing the characteristic root growth of the Canada thistle, a perennial weed.

HOW TO CONTROL ANNUAL AND BIENNIAL WEEDS.

The annuals and biennials propagate themselves by seeds alone. In dealing with them it is necessary to observe only the first two of the above principles.

HOW TO CONTROL PERENNIAL WEEDS.

Most perennials propagate themselves by their underground parts as well as by their seeds; hence, even if prevented from going to seed they still keep on growing. In dealing with them, therefore, it is necessary to observe all three of the above principles.

FIG. 6.—Johnson grass, a perennial weed, showing its rootstocks.

PREVENTING WEEDS FROM GOING TO SEED ON THE FARM.

Most persons do not realize what an enormous number of seeds are produced by weeds. The number varies with different species, most kinds producing from one hundred to several thousand seeds per plant. Some weeds, such as wild carrot, burdock, and sow thistle, are capable of producing 20,000 or more seeds to the plant. Moreover, not all weed seeds germinate at once, but delay sprouting for a period, some of them for several years. This is the basis of the old saying, "One year's seeding makes seven years' weeding."

If it is not practicable for the farmer to dispose of his weeds when they are small he should make every effort to prevent them from going to seed. If weeds are attacked when the most advanced have just reached the full-blossom stage, they can be prevented from seeding. At this stage, too, the roots are at their weakest, especially those of the annuals and biennials, which are largely exhausted. No

time should be lost, however, in disposing of weeds when the full-blossoming stage has been reached, as seeds will shortly be formed. Some weeds, such as pigweed, produce blossoms that are very inconspicuous, so that unless closely watched they will go to seed before one is aware of it.

Tillage to control weeds.—While tillage in its relation to weeds usually is practiced for the benefit of the immediate crop, it also may serve the purpose of preventing hosts of weeds from maturing seeds. Thorough tillage serves the additional purpose of encouraging the rapid germination of weed seeds in the soil while killing the weed seedlings when young. In no way is the old adage "A stitch in time saves nine" better illustrated than in killing weeds by tillage soon after they have germinated rather than delaying the work until they have attained some size.

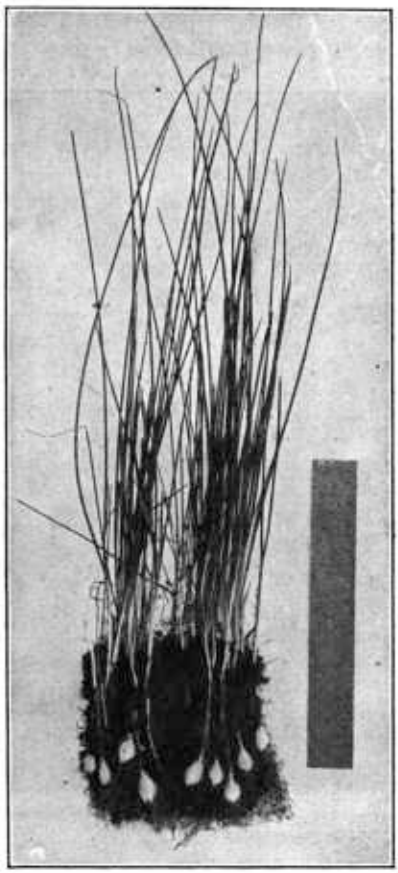

FIG. 7.—Wild onion, or garlic, a perennial weed, showing the bulbs.

The thorough preparation of the seed bed for every crop is an important part in the control of weeds. After plowing, nearly all farmers use a disk or a spring-tooth or spike-tooth harrow to reduce the soil to a good seed-bed condition. Each of these harrowings destroys hosts of young weed seedlings. As it is only the weed seeds within a few inches of the surface of the soil that germinate and as the harrowings encourage the rapid germination of the weed seeds, thorough harrowing at this period may be relied upon to kill a large portion of the weeds that will appear during the season. In fact, it sometimes happens that the seed bed has been so well prepared that after planting a cultivated crop, such as corn, cotton, or potatoes, but little cultivation is required.

After planting the cultivated crop the same object, that of attacking the weeds when young, should be kept in mind. To this end a drag harrow or a spike-tooth harrow is frequently used, both before and after the crop comes up. More weeds will be killed by one drag-

ging at this time than by several cultivations when the plants have become larger. The farmer shown in figure 9 is going over his land with a drag harrow after planting potatoes. The weeder is also a valuable implement for use at this stage. By removing some of the teeth of this tool it can be used in corn until the crop is nearly waist high. Indeed, some excellent crops of corn have been grown by the use of the weeder only. Some soils are too stony or otherwise not suited to the use of this implement, but where it can be used the weeder is one of the most valuable tools on the farm. The drag harrow and weeder may also be used to advantage with potatoes, cotton, and other cultivated crops. After the crops have become so large that these implements can no longer be used, the tillage is performed with cultivators. Cultivators that destroy weeds most effectively should be used. The best tools for this purpose vary with the kind of crop and the type and condition of the soil, so that it is difficult to lay down exact rules as to the choice of cultivators. Intercultural tillage is especially effective in controlling weeds if the crop has been planted in checkrows so as to permit the implement to work in two directions, as shown in figure 10.

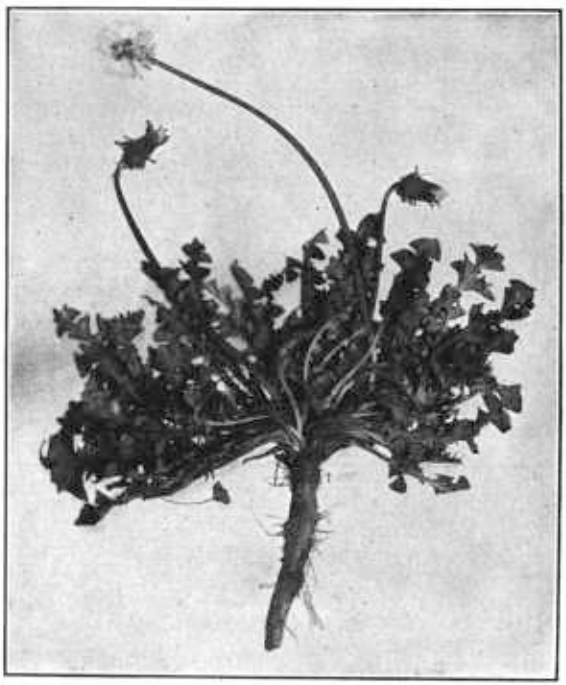

FIG. 8.—A dandelion plant, a taprooted perennial weed.

If the work of preparation and aftertillage has been thorough, few weeds will come up and go to seed after cultivation stops. This is especially true where a winter cover crop, such as wheat, crimson clover, or vetch follows the cultivated crop. Figure 11 shows wheat seeding in Virginia after the corn has been cut and shocked.

Cultivated crops, therefore, offer abundant opportunity to rid a farm of weeds. If properly handled, they are rightly termed "cleaning crops." On the other hand, where these crops are not well cultivated, weeds are actually stimulated to vigorous growth and prolific

FIG. 9.—A spike-tooth harrow in use after a crop has been planted. This practice kills hosts of weed seedlings.

seeding. Such crops are consequently a boon or a menace, depending upon how they are handled.

FIG. 10.—Corn growing in checkrows, a practice which permits excellent cultivation. Not a weed can be seen.

Besides the usual cultivated crops, small-grain crops can also sometimes be cultivated to advantage in the spring with a spike-tooth harrow or weeder. This does not permanently injure the young crop, and it kills hosts of small weed seedlings which would otherwise make trouble. Farmers in the upper Columbia River basin are able to control wild mustard by repeatedly harrowing fall-sown wheat in the spring; without this harrowing the mustard would be very troublesome.

After the small-grain crop is harvested it is often good practice in the Northern States to harrow or disk the stubble to encourage the germination of the weed seeds that are at or near the soil surface. The seedlings are killed by the fall plowing or by cold weather.

FIG 11.—A cornfield being prepared for a winter crop. Planting the land in this way kills many weeds.

Some weeds, such as ragweed and foxtail, start to mature seeds soon after harvest, so that care must be taken to turn the plants under before the seeds approach maturity. Plowing without the preliminary disking would turn under millions of weed seeds to make trouble in future years.

Mowing to prevent seeding.—Mowing is another way of preventing weeds from going to seed. As a rule, it is best to mow when weeds have reached the full-bloom stage. Many farmers mow their pastures once or twice each year and as a result have gradually driven out the weeds and thickened the grass stand. When there are patches in grain fields thick with weeds, it will pay to cut them, grain and all, before the weeds start to go to seed. Most careful farmers mow or cut their fence-row and roadside weeds once or twice a year to prevent their seeding. In figure 12 is shown a fence

row that has been mowed regularly, while the fence row shown in figure 13 has been made a source of profit through the production of hay instead of weeds. Figure 14 illustrates the possibility of producing beautiful lawns from fence rows.

It pays to cut a hay crop early, in order to prevent weeds from going to seed as well as to secure a better quality of hay. After a grain crop is removed, a crop of weeds, such as ragweed or foxtail, usually follows, which, if not disturbed, not only reseeds the land for further crops of weeds, but may do much damage to a young

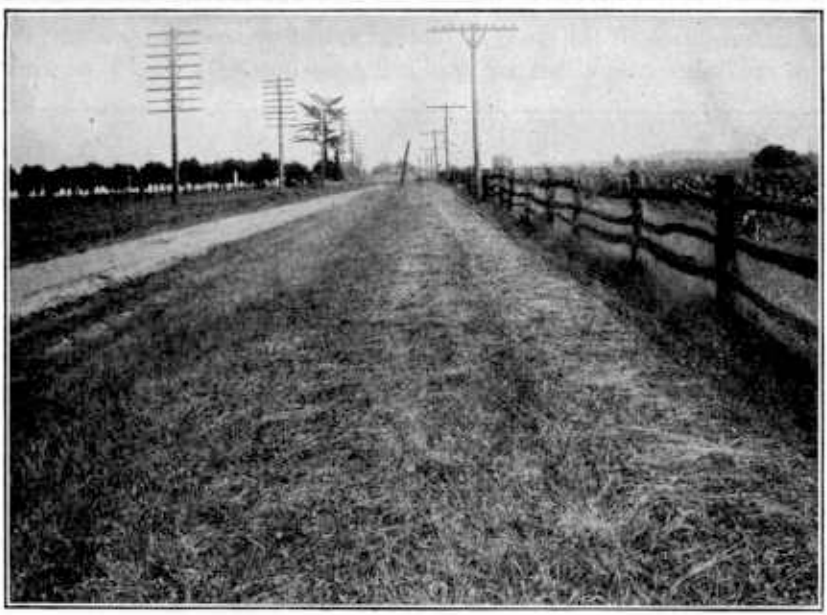

FIG. 12.—A fence row which has been mowed regularly, thus preventing weeds from going to seed.

seeding of clover or grass. Mowing these weeds will prevent most of them from going to seed, and, further, the clippings will be of value as a mulch for the young grass.

Hand work to prevent seeding.—Quite often a few scattered weeds will occur in a field. These weeds can be removed by hand with little work, whereas if allowed to mature they would thoroughly seed the land and make trouble for the future. Such weeds may be prevented from seeding either by hand pulling or by digging them out with a mattock, hoe, or spud so far below the surface that new top growth will not spring up and mature seeds. Annual and biennial weeds will make no further appearance if pulled or cut off when they are in full blossom. The spud (fig. 15) is a tool with a long handle and a narrow chisel-like blade at one end. This is very

FIG. 13.—Making hay along a fence row in Illinois, thus preventing weeds from going to seed and also incidentally increasing the farmer's income.

effective in disposing of weeds with thick roots, such as bull thistle, mullein, and chicory. Many farmers have cleaned their farms of

FIG. 14.—A fence row turned into a lawn; one way of solving the weed problem.

corn cockle, wild mustard, and many other weeds by a few hours of hand work each year when these weeds were in full blossom.

Spraying to prevent seeding.—In case of certain weeds infesting small-grain crops it has been found profitable to spray with a solution of copper sulphate, iron sulphate, or salt. If this treatment does not entirely kill the weeds, it at least prevents them from going to seed. Such treatment, if well done, does not permanently injure the grain and is effective against the weeds. This method seems to be of most use against the wild mustard family of plants.

FIG. 15.—The spud, an effective tool for cutting off weeds with thick roots below the surface of the soil.

The spray solutions are made by dissolving either 12 pounds of copper sulphate, 100 pounds of iron sulphate, or 125 pounds of common salt in 50 gallons of water. This quantity of solution is sufficient to spray about 1 acre. Any machine that throws a fine mistlike spray may be used. Where areas of considerable size are to be treated, a traction sprayer with a boom 12 to 20 feet long is the most economical equipment. In the case of wild mustard in small-grain fields the best time to spray is when the most advanced of the mustard plants are just starting to bud.

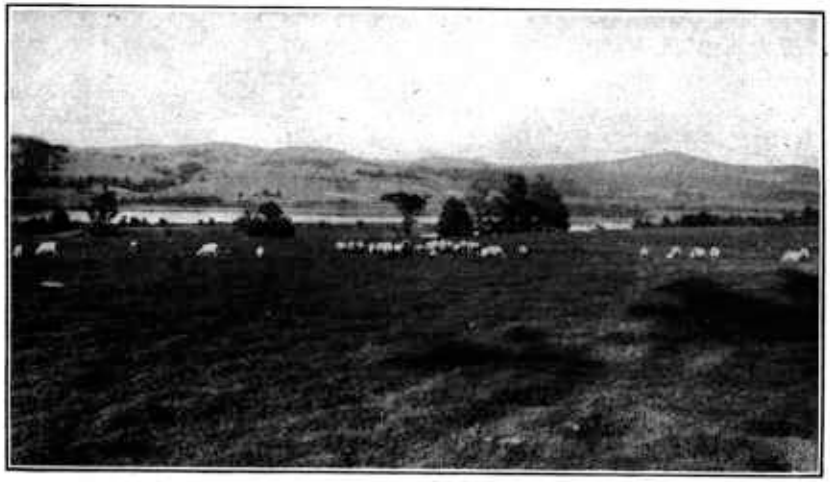

FIG. 16.—Sheep as weed destroyers. This Vermont pasture, on which sheep are grazing, is practically free of weeds.

Sheep pasturing to prevent seeding.—Sheep are of use in preventing weeds from seeding. A pasture on which sheep are running

(fig. 16) is usually more nearly free of weeds than where cattle or horses are pasturing. In some parts of the United States sheep are turned into standing corn after cultivation stops (fig. 17), for the purpose of pasturing off the late weeds. Sheep turned on grain stubble tramp weed seeds into the soil, thus causing many of the seeds to germinate at once. The resulting plants are either pastured off or frozen out.

Burning to prevent seeding.—Burning weeds is often useful in killing weed seeds, both in connection with weeds cut green and allowed to dry and with matured weeds. It is sometimes necessary to gather such plants into piles before they will burn, but it is

FIG. 17.—Sheep in Kansas pasturing off weeds in standing corn after cultivation stops.

always best to disturb them as little as possible, so that the seeds will not scatter.

PREVENTING WEED SEEDS FROM BEING BROUGHT TO THE FARM.

The second of the three main points in weed control is preventing the introduction of weed seeds on the farm. No matter how careful a man may be in preventing weeds from going to seed on his land, most of his work will be for nothing if he permits seeds to be constantly brought to his farm from the outside. Another important point regarding weed control is to destroy pernicious weeds before they have gained sufficient headway to do serious damage. Farmers should ever be on the alert for the appearance of new weeds which are being introduced and for old weeds which are developing noxious tendencies. When a plant shows any tendency toward becoming a

troublesome weed, it should be called to the attention of someone in authority and every effort made to keep it under control.

Weeds may be brought to the farm in various ways. The principal source of introduction is through seeds.

Introducing weed seeds in crop seeds.—Many of the purchased grain, clover, and grass seeds contain weed seeds as impurities. In figure 18 is shown clean clover seed, while in figure 19 is seen clover seed containing various kinds of weed seeds. How can the farmer purchase clean seed? In no permanent way will the quality of seed offered for sale be greatly improved except by greater knowledge

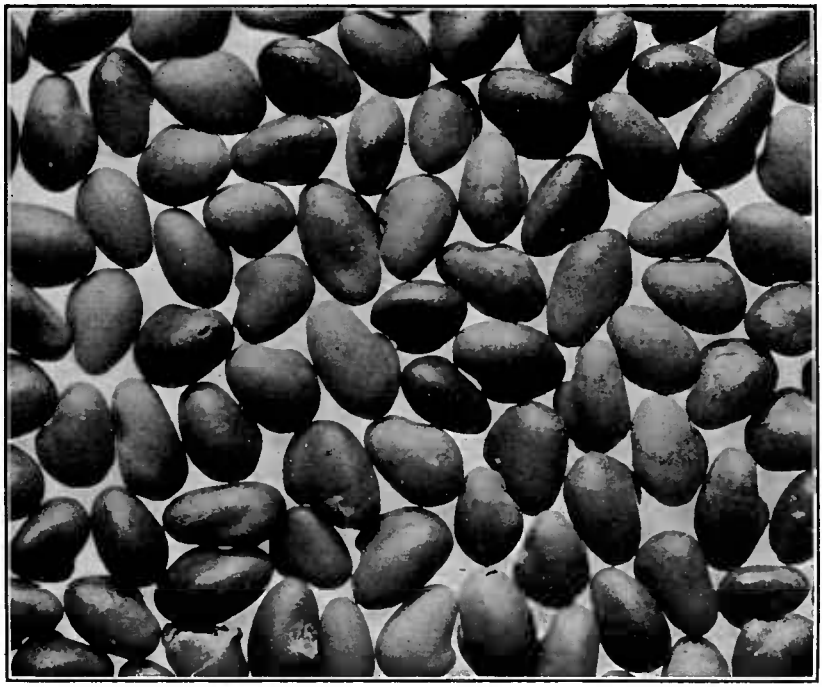

FIG. 18.—Red-clover seed of good quality. Magnified nine times.

and alertness on the part of the consumer. First, the farmer should know what constitutes good seed; second, he should know fairly closely what high-grade seed is worth; and, third, he should be willing to pay a fair price for it. Laxity on one or more of these points is responsible for most of the farmer's trouble over poor seeds. Seedsmen say that they are forced to carry poor seeds in stock because many farmers will not pay for the better grades. Cheap seeds are really the most expensive kind that can be purchased.

In improving his knowledge of what constitutes good seeds, the farmer will find the advice of the State agricultural experiment stations and the United States Department of Agriculture of great

assistance. These institutions gladly test samples of seeds for farmers free of charge. The test will show whether there are any weed seeds or other impurities present and the percentage of germination of the crop seed. Many farmers are now making their own tests and with a little practice any man can learn to do this according to the directions issued by the Department of Agriculture.[1] In either case it is necessary to get the test under way well in advance of the time of seeding. In purchasing seed of alfalfa and clover the most impor-

FIG. 19.—Red-clover seed of low grade, containing many weed seeds. Magnified nine times.

tant point to consider is the presence of dodder seed. Clover seed should also be examined for seeds of the plantains.

Introducing weed seeds in stock feeds.—Some kinds of stock feed are free of weed seeds, while others are not. Cottonseed meal, oil meal, brewers' and distillers' grains, corn bran, middlings, and the gluten feeds are practically free of weed seeds; but molasses feeds, oat chop, wheat bran, and the mixed feeds are apt to contain more or less seeds of various weeds. This is especially true of that class of mixed feeds made from mill by-products, for the reason that such by-products are partly composed of screenings. These screenings con-

[1] F. H. Hillman. Testing farm seeds in the home and in the rural school. U. S. Department of Agriculture, Farmers' Bulletin 428, 47 pp., 32 figs., 1911.

tain weed seeds resulting from the cleaning of grain. Some firms grind or heat the screenings that go into mixed feeds, and in such cases the percentage of live weed seeds is very low. A number of States require that the ingredients in stock feed be named in the labels on the bags, and this is desirable in all States. Some States also issue feed-control bulletins, stating the analysis of various feeds offered for sale, including the proportion of viable weed seeds. If the farmer reads these bulletins and the labels on the bags he will be in a position to judge whether or not he is introducing weed seeds on his farm in stock feeds.

Introducing weed seeds in manure.—Nearly all purchased manure is full of weed seeds. If it is hauled to the farm when fresh, many thousands of weed seeds are introduced, so that the farmer is storing up future trouble for himself. As this manure usually has to be removed from the town in the fresh state, the only chance to compost it in order to make the weed seeds rot is after it reaches the farm. It has been found that the weed seeds in manure piles rot quickly under ordinary conditions, so that practically all of them have lost their vitality in two months. Whether the farmer should compost city manure by leaving it in piles after he has drawn it to his farm is questionable. This would require extra handling, and unless care is exercised the manure will lose some of its value. Still, in many cases it would undoubtedly pay to do this for the sake of keeping the farm free of weeds. The answer to this question depends largely upon the farmer's cropping system.

Introducing weed seeds with thrashing outfits.—Thrashing outfits are very likely to bring weed seeds to the farm. It is a wise precaution to see that the separator is well cleaned before it reaches the farm, or at least is cleaned in a place where the weed seeds will not be scattered on the fields. Wild mustard is very apt to be introduced by this means. A very progressive farmer in Vermont, who has driven this weed entirely from his place, goes out with a broom to meet the thrashing machine just before it reaches his farm and attends to cleaning it himself.

Introducing weed seeds in hay and straw.—Purchased hay and straw are almost sure to contain weed seeds, and as long as a man continues to buy them there is little chance for him to have a weed-free farm. The only way to prevent seeds getting to the land where hay or straw is purchased is to leave the resulting manure in a pile, or, better yet, in a pit, for several months before spreading.

Introduction of weed seeds by the wind.—Lastly, weed seeds may get to a farm by being wind blown. This is especially true of chicory, dandelion, broom sedge, Canada thistle, and such other weeds as possess a light, feathery pappus. Figure 20 shows a lawn full of dandelion plants that are ripe. Such seeds may be carried a mile

or more in a strong wind. The Russian thistle of the Western States is perhaps the greatest wind-blown weed pest. The matured plant, which is almost round in shape, rolls across the prairie, scattering seed as it goes. A good fence is very effective in arresting the progress of this enemy.

The individual farmer is almost helpless against the introduction of most weed seeds by means of the wind, and the situation requires community action. Most of our States have weed laws which were enacted to prevent certain weeds from going to seed, but these laws are not rigidly enforced. Some day a more enlightened public

FIG. 20.—A lawn full of ripe dandelions; an example of the harm done by wind-blown seeds.

opinion will require the enforcement of the weed statutes. The individual farmer, however, can greatly lessen the evil effects of wind-blown weeds by keeping a continual lookout on the boundaries of his farm, especially on the side of the prevailing winds, and by destroying the weeds as they appear. A certain good farmer in Virginia, who has his place largely in pasture, has a shiftless neighbor whose farm is full of broom sedge, the weed illustrated in figure 21. The shiftless man is on his west side, so that the seeds blow over to his land every year in large numbers. Many broom-sedge plants start growing in his grassland, but by chopping out the plants where they are rather scattered and by plowing up the field and running it through rotation where the broom sedge has become thick, he

manages to prevent the weeds from spreading to the remainder of his farm..

PREVENTING THE TOP GROWTH OF PERENNIALS.

The last of the three weed preventives is keeping down the top growth of perennials, in order to starve out the underground parts. This top growth is equivalent to the lungs of animals; without it they can not live. Any methods that successfully keep down the top growth and at the same time suit the farmer's convenience may be used. Among the ways that may be adopted for keeping down top growth are the following: (1) Clean cultivation; (2) pasturing; (3) growing smother crops; (4) frequent cutting with a hand hoe,

FIG. 21.—A field of broom sedge and scrub pine. The seeds of broom sedge are carried long distances by the wind, infesting other lands.

spud, or mower; and (5) smothering small patches with building paper or other material.

Clean cultivation.—In most cases cultivation will have to be relied upon to destroy perennials. The work may be done either with or without a cultivated crop growing on the land. Many farmers have eradicated perennial weeds by giving thorough cultivation to a crop. Cultivation is especially effective if the crop has been planted in checkrows, so as to permit working in two directions, as shown in figure 10. The ordinary shovel and tooth cultivators permit many weed stems to slip through unharmed. It is often best, therefore, to use cultivators of the sweep or weed-knife type. These sweeps skim along under the surface of the soil and cut off all weed stems. On many of the modern cultivators, sweeps 9 to 18 inches wide may be attached in place of the shovels. Figure 22 shows a number of implements of the sweep type.

No matter how thoroughly the tops have been kept down during the period of cultivation, most well-established perennials will continue to send up tops after cultivation stops. This situation may be met by frequent choppings with a hoe. Hand hoeing in such cases is not as tedious as it may seem, since most perennials do not occupy the land solidly, but occur in patches. If the top growth is thus thoroughly kept down, one year is usually sufficient to eradicate even the worst of our perennials. This plan is especially effective against Canada thistle, bull nettle, and bindweed, or wild morning-glory.

Perennials may often be attacked most effectively by clean cultivation without growing a cultivated crop; in other words, by a bare

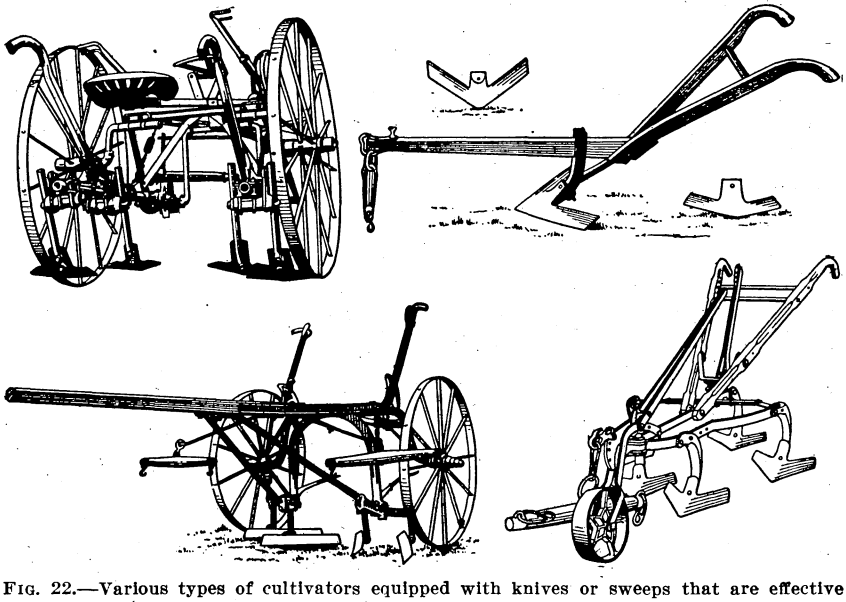

FIG. 22.—Various types of cultivators equipped with knives or sweeps that are effective in cutting off the stems of perennial weeds below the soil surface.

fallow. It is seldom advisable to fallow for an entire year, since this does not permit the farmer to get any use of his land. A better plan is to use the land during the early part of the season and to fallow it the latter part. For instance, the land may be pastured until midsummer, or a crop of hay or small grain may be taken off before starting the fallow. This plan has the additional advantage of starting the work of eradication by fallowing at a period when nearly all weeds are in their most susceptible stage. Under this plan the work of fallowing should be started as soon after harvest as possible; the land should be plowed and then harrowed or disked at frequent intervals during the remainder of the season to prevent top growth. Ordinarily, shallow plowing is best in fallowing for weed

control, as this keeps the mass of weed roots at or near the surface, where they will be more easily dried out by the sun. If this fallowing be well done, many kinds of perennials will have died by the close of the season, but it is usually advisable to plant a cultivated crop the next spring in order to destroy such weeds as may persist. Under this plan the greater part of the work of eradication is done expeditiously by large implements and without the hindrance of cultivated crops; furthermore, it is done at a time of year when the farmer is ordinarily not pressed with other work. This method is quite successful against the weedy grasses, such as Johnson grass, Bermuda grass, and quack-grass.

Pasturing.—Pasturing may often be found of much help in keeping down the top growth of perennials. Sheep are of first importance in this connection. They will browse upon almost all kinds of weedy growths and fatten under the process. In parts of the West, when the pasture grasses become brown during the summer, sheep will turn their attention to the weeds, which are the only green feed in sight. This fact has been taken advantage of in killing bindweed and the small-leaved milkweed. Goats are even more omnivorous than sheep, but the regions where it is profitable to keep goats are limited. Hogs are of some value in weed eradication, because they will root for the underground parts of many weeds. These animals have been used to great advantage in getting rid of bindweed, or wild morning-glory.

Where it is feasible to confine sheep, goats, or hogs to very restricted areas for one or more seasons, they will in most cases completely kill perennial weeds. Where it is not practicable to graze sufficiently close to entirely destroy perennials the grazing still greatly weakens the root system of these plants, making it an easy task to complete the destruction by cultivation.

Smother crops.—Thick stands and vigorous growths of smother crops may be depended on to keep down the top growth of perennials. The most commonly used smother crops are alfalfa, buckwheat, soy beans, millet, sorghum, and bur clover. Some weeds are more susceptible to this treatment than others. Bermuda grass may be eradicated by a continuous succession of smother crops. Alfalfa, where it succeeds well, is the most effective smother crop, largely because it combines frequent clipping with the smothering effect. It may be relied upon to reduce greatly or even to eradicate entirely most perennials except some of the grassy weeds. In the case of smother crops, as with pasturing, the principal value is to weaken the root systems of perennials, which facilitates the work of cultivation which is to follow.

Mowing or cutting.—Cutting off repeatedly the tops of perennial weeds which a mower, scythe, or other tool may sometimes be used to advantage. This is of most use on pastures, roadsides, and other uncultivated places. It has been found that mowing twice a year for two years will eradicate the fern brake, one of the bad weeds of pastures in New England and New York.

Smothering with building paper and other materials.—Where perennial weeds occupy very limited areas it is often practicable to prevent further spread by covering the infested area with building paper, taking care to lap over and weight down the ends so as to exclude all sunlight. Building paper suitable for this use normally may be obtained at from $2.25 to $4 per thousand square feet, or $97 to $172

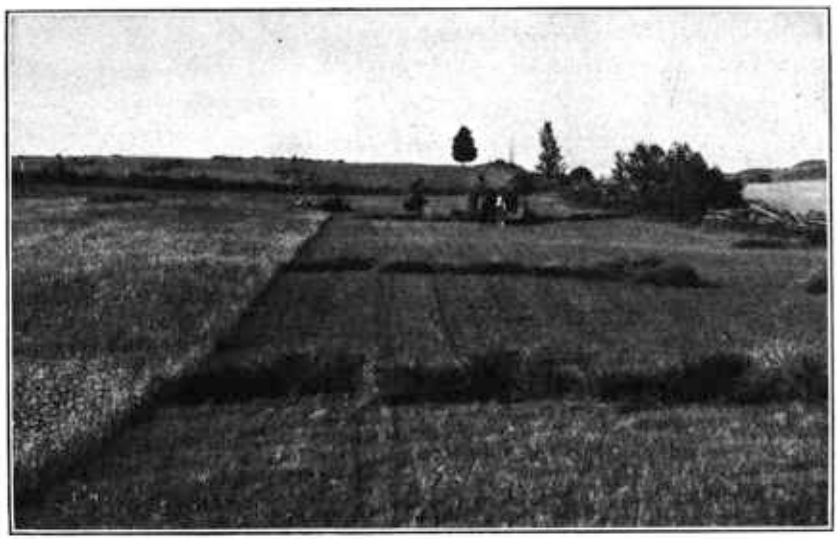

FIG. 23.—A very weedy meadow; yield about one-half ton per acre.

per acre, depending on its thickness. Manure, straw, and other materials are also employed for this purpose.

CONCLUSION.

The problem of suppressing weeds is a many-sided one and an important part of the management of the farm. Successful crop management includes successful weed management.

Larger crops mean fewer weeds.—Generally speaking, the larger the crops, the fewer the weeds present. This is especially true with small grain and hay, since good stands of these crops will tend to smother out weeds. Figure 23 shows a weedy meadow which produced only one-half ton of hay per acre, while the meadow in figure 24, which was free of weeds, produced 3 tons per acre. Furthermore,

pastures that are given good care by top-dressings and by not overgrazing always contain fewer weeds and more grass than those poorly managed. Figure 25 shows an overgrazed pasture in the State of

FIG. 24.—A meadow free of weeds, yield, about 3 tons per acre.

New York, where the sweet fern has worked in badly, as indicated by the dark patches, while figure 26 shows a well-managed pasture in Virginia that is almost free of weeds.

FIG. 25.—A poorly managed, weedy pasture in New York. The dark patches are sweet fern.

Special methods of handling certain weeds.—The farmer should know the kind of weeds which he has to fight, because in the case of some of them special methods have been discovered which greatly reduce the amount of work necessary. The United States Department of Agriculture has issued bulletins treating individually a number of the worst weeds and these publications may be obtained on request.[1]

Rotations and weeds.—An important benefit from practicing a rotation is in the control of weeds. If land is planted to the same crop year after year, certain weeds have ample opportunity to make top growth and mature their seeds, and these weeds therefore become firmly established; but if the land is planted to different crops

FIG. 26.—A well-managed, weed-free pasture in Virginia.

in succession these weeds do not have the opportunity to make nearly as much headway.

Furthermore, adopting a rotation usually means the growth of grass, clover, or other forage crops. These crops not only discourage many kinds of weeds by their shading effect, but also give weeds a poor chance to mature seeds, as they are cut for hay before most weeds ripen.

[1] The following Farmers' Bulletins on weeds may be obtained free of charge on application to the Secretary of Agriculture: No. 279, A Method of Eradicating Johnson Grass; 368, The Eradication of Bindweed, or Wild Morning-Glory; 464, The Eradication of Quack-Grass; 545, Controlling Canada Thistles; 610, Wild Onion: Methods of Eradication; 687, Eradication of Ferns from Pasture Lands in the Eastern United States; and 833, Methods of Controlling Wild Oats in the Hard Spring-Wheat Area.

The following mimeographed circulars may also be obtained by addressing the Office of Forage-Crop Investigations of the United States Department of Agriculture Orange Hawkweed, Skeleton Weed, Spraying for Wild Mustard, Nut-Grass, Chickweed in Lawns, Dandelions in Lawns, Crab-Grass in Lawns, Killing Vegetation with Plant Poisons, Sheep Sorrel, Wild Carrot, and Poison Ivy.

Again, adopting a rotation often means growing cultivated crops on land where such crops have not been raised. The value of cultivated crops in cleaning land of weeds has already been emphasized.

Demonstrations of the value of a rotation in controlling weeds are available in many localities. For example, in western Kansas wheat is usually grown continuously, and when this is the case weeds are very troublesome; but when a rotation, including a cultivated crop and a forage crop is adopted, the weeds that are so common under continuous wheat growing do not have so much chance to make growth and to mature their seeds. Hence, weeds become very much reduced. Another example is furnished in parts of eastern New York, where it is customary to keep land in meadow for many years. These meadows become foul with orange hawkweed, oxeye daisy,

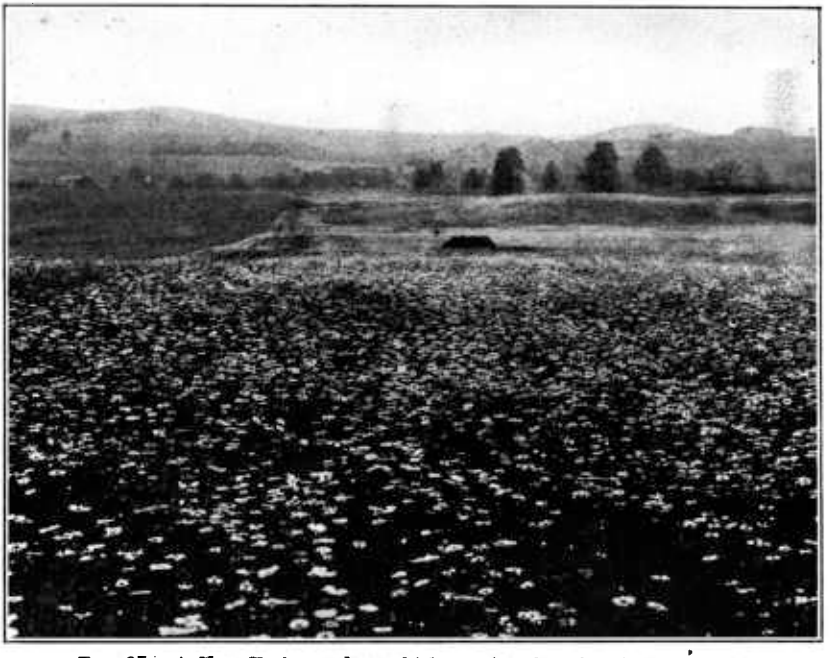

FIG. 27.—A New York meadow which consists largely of oxeye daisy.

wild carrot, and other weeds. (Fig. 27.) Introducing a cultivated crop and a grain crop soon disposes of most of these weeds.

Cooperation in controlling weeds.—Probably no feature of weed control is more important than cooperation among those concerned. Weed control is a community problem rather than one for the individual farmer to solve, and without the cooperation of his neighbors the results of the individual farmer's efforts are more or less discouraging, because where weeds are allowed to grow undisturbed they produce sufficient seeds to infest the adjacent lands. The necessary cooperation might be arranged through agricultural clubs and other farm organizations.

APPENDIX.

FIFTY WORST WEEDS.

Table I gives an alphabetical list of the 50 worst weeds of the United States, with such information as will enable the reader (1) to identify them, (2) to determine the nature and place of their greatest injuriousness, and (3) to determine their duration or natural length of life; that is, whether annual, biennial, or perennial. With this knowledge one will be able to attack much more intelligently any troublesome weed.

TABLE I.—*Descriptive list of the fifty worst weeds of the United States.*

[A=annual, B=biennial, P=perennial.]

Common name, botanical name, and duration of life.	Color, size, and arrangement of flowers.	Sections where injurious.	Method of seed distribution; vegetative propagation of the perennials.	Place of growth and products injured.
Bermuda[1] grass, wire-grass (*Capriola dactylon*), P.	Purple; $\frac{1}{12}$ inch; spikes.	Maryland to Missouri and southward.	Seeds sparingly; rootstocks.	Fields and lawns; hoed crops.
Bindweed, field bindweed (*Convolvulus arvensis*), P.	White or pink; 1 inch; solitary.	Entire United States, especially California.	Grain and flax seeds; creeping roots.	Rich moist soils; grain and hoed crops.
Bindweed, wild morning-glory (*Convolvulus sepium*), P.	White or rose; 2 inches; solitary.	Mississippi Valley region.	Grain and flax seeds; rootstocks.	Rich prairie and river bottoms; corn and small grain.
Bitterweed, fennel, yellow dog fennel (*Helenium tenuifolium*), A.	Yellow; $\frac{3}{4}$ inch; head.	Virginia to Kansas and southward.	Wind, hay, animals.	Meadows and pastures; injures live stock and taints milk.
Broom sedge (*Andropogon virginicus*), P.	Green; $\frac{1}{4}$ inch; racemes.	Massachusetts to Michigan, Florida, and Texas.	Wind; short rootstocks, plants in tufts.	Fields and waste lands; pastures and meadows.
Buffalo bur, sand bur (*Solanum rostratum*), A.	Yellow; $\frac{1}{2}$ inch; solitary.	Illinois and Colorado to Texas.	Plants rolled by wind; seeds in hay and by animals.	Fields; grain and hoed crops, wool.
Bull nettle, horse nettle (*Solanum carolinense*), P.	Purple; 1 inch; solitary.	Entire United States.	Plants rolled by wind; running roots.	Everywhere; grain and hoed crops, pastures.
Bur-grass, sand bur (*Cenchrus carolinianus*), A.	Green; $\frac{1}{3}$ inch; bur.	Maine to Florida and westward to Colorado.	Animals, especially sheep.	Sandy land pastures and waste places; pastures and wool.
Chess, cheat (*Bromus secalinus*), A.	Green; spikelets in panicles.	All grain sections.	Grain seed; especially wheat.	Everywhere; grain fields.
Chickweed, common chickweed (*Alsine media*), A.	White; $\frac{1}{4}$ inch; cymes.	Entire United States.	Grass and clover seed, animals; has a long seeding period.	Meadows, lawns; winter crops.
Cocklebur, clotbur (*Xanthium americanum*), A.	Green; $\frac{1}{4}$ inch; head.	.....do.....	Carried by animals.	Cultivated fields and waste places; hoed crops and wool.
Crab-grass (*Syntherisma sanguinale*), A.	Green; spikes.....	Entire United States, especially the South.	Clover and grass seed, hay, animals.	Cultivated fields, gardens, lawns; hoed crops.

[1] The fact that Bermuda grass is often troublesome as a weed in places where it is not desired is in no way contradictory to the fact that it is the most valuable pasture grass in the South. With proper rotations Bermuda grass is rarely a serious weed. Where only intertilled crops are grown, such as cotton, Bermuda grass perhaps occasions more additional cultivation than any other plant. For the valuable features of Bermuda grass consult Farmers' Bulletin 814.—C. V. PIPER.

TABLE I.—*Descriptive list of the fifty worst weeds of the United States*—Con.

Common name, botanical name, and duration of life.	Color, size, and arrangement of flowers.	Sections where injurious.	Method of seed distribution; vegetative propagation of the perennials.	Place of growth and products injured.
Daisy, oxeye daisy (*Chrysanthemum leucanthemum*), P.	White with yellow center; 1 inch; heads.	Maine to Virginia and Kentucky.	Clover seed, hay; woody, rather short rootstocks, but largely by seed.	Pastures, meadows, roadsides; hay, pasturage.
Dandelion (*Taraxacum officinale*), P.	Yellow; 1¼ inch; head.	Entire United States.	Wind; taproot, which spreads but little.	Lawns, meadows, waste places; hay and lawns.
Dock, yellow dock, sour dock (*Rumex crispus*), P.	Green; ⅛ inch; panicle.	.....do.....	Hay and straw, clover and grass seed; taproot, which spreads but little.	Hay, small grain and hoed crops.
Dodder, alfalfa dodder, field dodder (*Cuscuta arvensis*), A.	Yellow; ⅛ inch; clusters.	All clover and alfalfa regions.	Hay, clover, and alfalfa seed.	Clover and alfalfa fields.
Dogbane, Indian hemp (*Apocynum cannabium*), P.	Greenish white; ¼ inch; terminal clusters.	Upper Mississippi Valley.	Wind; creeping root.	Fields with sandy soil; pasture, grain and hoed crops.
Fern, brake (*Pteridium aquilinum*), P.	No flowers.....	Northwestern States and the Pacific coast.	Spores scattered by wind; running roots.	Logged-off land, meadows, and pastures.
Fleabane, horseweed (*Erigeron canadensis*), A.	White; ⅛ inch; heads in cymes.	Entire United States.	Hay, grass, and clover seeds.	Meadows, pastures, and grain fields.
Foxtail, yellow foxtail, pigeon grass (*Chaetochloa glauca*), A.	Green; spikes.....	.....do.....	Animals, hay, grain, and grass seeds.	Land cultivated in early part of season; young grass and clover seedlings.
Hawkweed, orange hawkweed, devil's-paintbrush (*Hieracium aurantiacum*), P.	Orange; 1 inch; heads.	Maine to Ohio.	Wind, grass and clover seeds; runners similar to strawberry.	Untillable pastures and meadows.
Ironweed (*Vernonia noveboracensis*), P.	Purple; ⅜ inch; heads.	Maine to Maryland and Iowa to Kansas.	Wind; short thick rootstocks, making plant grow in bunches.	Pastures and meadows.
Jimson weed (*Datura stramonium*), A.	Purple; 3 inches; solitary.	Maine to Minnesota and Texas.	Pods and plants blown by wind.	Pastures, barnyards, and waste lands; seeds, flowers, and leaves poisonous.
Johnson grass (*Holcus halepensis*), P.	Green; ⅛ inch; panicle.	Virginia to Texas and California.	In hay, grain, and grass seed; running rootstocks.	All crops except hay.
Lamb's-quarters, pigweed (*Chenopodium album*), A.	Green; very small; panicle.	Entire United States.	Grain and grass seed.	Grain fields and hoed crops.
Lettuce, prickly lettuce (*Lactuca virosa*), A.	Yellow; ¼ inch; heads in panicles.	Ohio to Iowa, Utah to California.	Wind.....	Everywhere; all crops.
Milkweed, common milkweed (*Asclepias syriaca*), P.	Purple; ½ inch; umbels.	New York to Minnesota.	Wind; creeping roots.	All crops and in pastures.
Morning-glory (*Ipomea hederacea*), A.	White, purple, or blue; 1½ inch; solitary.	New York to Missouri.	Corn stover, straw, and wind.	Cultivated fields, especially corn, and small grain.
Mustard, wild mustard, charlock (*Brassica arvensis*), A.	Yellow; ¼ inch; racemes.	Maine to Washington.	Grain, grass, clover, and rape seeds.	Small-grain fields and meadows; grains.
Nut-grass, coco (*Cyperus rotundus*), P.	Brown; 1/16 inch; spikelets.	Maryland to Florida and Texas.	Wind, nursery stock, hay, and grass seed; tubers.	All soils; hoed crops.
Pennycress, Frenchweed (*Thlaspi arvense*), A.	White; ⅛ inch; racemes.	North Dakota and Minnesota.	Wind	Grain fields and pastures; grain and dairy products.
Pigweed, redroot, careless weed (*Amaranthus retroflexus*), A.	Green; quite small; spikes in panicles.	Entire United States.	In grain and grass seeds; plants blown by wind.	Plowed land; hoed crops.
Plantain, buckhorn, ribgrass (*Plantago lanceolata*), P.	White; 1/16 inch; spike.	.....do.....	Hay, clover and grass seed; spreads but slowly from a crown.	Everywhere; meadows, pastures, and lawns.

TABLE I.—*Descriptive list of the fifty worst weeds of the United States*—Con.

Common name, botanical name, and duration of life.	Color, size, and arrangement of flowers.	Sections where injurious.	Method of seed distribution; vegetative propagation of the perennials.	Place of growth and products injured.
Poison ivy, poison oak (*Rhus toxicodendron*), P.	Greenish white; ⅛ inch; panicles.	Entire United States.	Does not spread fast by seeds; running rootstocks.	Moist rich land, along fences; poisonous by contact.
Purslane, pusley (*Portulaca oleracea*), A.	Yellow; ¼ inch; solitary.	.....do.....	Tillage implements; has a long seeding period.	Rich cultivated land, especially gardens; hoed crops.
Quack-grass, witch-grass (*Agropyron repens*), P.	Green; spike.....	Maine to Pennsylvania and Minnesota.	Seeds of grain and coarse grasses; creeping rootstocks.	All crops on the better soils; hoed crops.
Ragweed, smaller ragweed (*Ambrosia elatior*), A.	Yellow; ¼ inch; small heads on spikes.	Entire United States.	Wind carrying matured plants; in grain and red-clover seeds.	Everywhere, especially grain stubble; hoed crops and young grass seeding.
Russian thistle, tumbleweed (*Salsola pestifer*), A.	Purplish; ¼ inch; solitary.	Minnesota to Washington and southward.	Wind rolling matured plants.	Everywhere; small grain and hoed crops.
St.-John's-wort (*Hypericum perforatum*), P.	Yellow; ¾ inch; cymes.	Maine to North Carolina and Iowa.	In hay and grass seed; rootstocks.	Meadows, pastures, and waste places.
Smartweed (*Polygonum pennsylvanicum*), A.	Light rose; $\frac{1}{16}$ inch; racemes.	Maine to Minnesota, Florida, and Texas.	Wind carrying matured plants.	Moist, rich soils; hoed crops and young grass seedings.
Smartweed, marsh smartweed, devil's-shoestring (*Polygonum muhlenbergii*), A.	Rose color; $\frac{1}{16}$ inch; spikes.	Indiana to Iowa.	Wind and farm machinery; rootstocks.	Wet land, prairie, and muck soils; hoed crops, hay, pasture.
Sorrel, sheep sorrel, horse sorrel (*Rumex acetosella*), P.	Red; ⅛ inch; panicles.	Entire United States.	In clover seed; creeping roots.	Meadows and pastures.
Sow thistle, perennial sow thistle, field sow thistle (*Sonchus arvensis*), P.	Yellow; ¾ inch; heads.	Maine to Minnesota.	Wind; running rootstocks.	Grain fields and hoed crops.
Squirreltail grass, squirrel grass, foxtail, wild barley (*Hordeum jubatum*), A.	Green; spike with long bristly glumes.	Minnesota to Texas and California.	Hay, animals, wind.	Meadows and pastures; barbed seeds produce sores on live stock.
Thistle, Canada thistle (*Cirsium arvense*), P.	Purple; ¾ inch; heads.	Maine to Pennsylvania and Washington.	Wind, in hay and straw and in clover and grass seed; creeping roots.	All crops.
Thistle, common thistle, bull thistle (*Cirsium lanceolatum*), B.	Reddish purple; 1 inch; heads.	Maine to Virginia and Washington.	Wind, in alfalfa, clover, and grass seeds.	Pastures, meadows, and winter wheat.
Wild carrot (*Daucus carota*), B.	White; very small; umbels.	Maine and Virginia to the Mississippi.	In foreign clover and alfalfa seed; carried by animals and wind.	Meadows and pastures.
Wild oats (*Avena fatua*), A..	Green; panicles; similar to oats.	Wisconsin to Washington.	In seed oats.....	Oat fields; awns injurious to stock.
Wild onion, garlic (*Allium vineale*), P.	Flowers rare; umbels with bulblets.	Rhode Island to Georgia and west to Missouri.	Seeds rare; bulblets carried in wheat; underground bulbs.	Everywhere; wheat and dairy products.
Winter cress, yellow rocket (*Barbarea vulgaris*), P.	Yellow; ¼ inch; racemes.	Maine to Virginia and westward.	In grain, clover, and grass seeds.	Grain fields, pastures, and meadows.