U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 660

WEEDS

How to Control Them

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 foregoing principles of weed control he can practically rid his farm of especially troublesome 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.

Washington, D. C.

Issued May 12, 1915
Revised June 1931
Slightly revised October 1939

WEEDS: HOW TO CONTROL THEM[1]

By H. R. Cox, formerly *Agriculturist, Division of Forage Crops, Bureau of Plant Industry*

CONTENTS

	Page
Importance of weed control	1
Good points about weeds	2
Damage due to weeds	3
Classification of weeds according to length of life	4
The control of weeds	5
How to control annual and biennial weeds	6
How to control perennial weeds	6
The control of weeds—Continued.	
Preventing weeds from going to seed on the farm	6
Preventing weed seeds from being brought to the farm	13
Preventing the top growth of perennials	18
Conclusion	23
List of 50 of the worst weeds	26

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.

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 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.

[1] Revised in 1931 by Frederick V. Coville, principal botanist in charge, Division of Botany, and M. W. Talbot, senior botanist, in charge of weed investigations, Division of Botany, Bureau of Plant Industry. The section on Use of Chemicals was revised in 1939 by L. W. Kephart, senior agronomist, in charge of weed investigations, Division of Cereal Crops and Diseases, Bureau of Plant Industry.

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.

Weeds are able to maintain their existence under adverse conditions. 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.

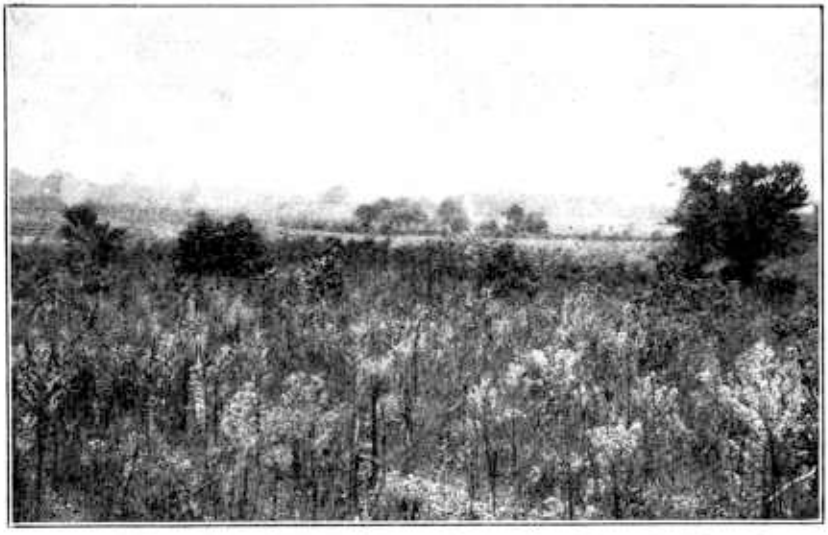

FIGURE 1.—A field of poor land in Virginia "turned out to rest." Under such conditions weeds improve the fertility of the soil by adding organic matter

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 customary 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 holding snow and 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, however, all these benefits may be realized through proper rotations; in that 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

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

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.

Further losses are incurred when grain containing weed seeds is stored and when it is marketed. Weed seeds in grain increase the cost of handling, storing, and shipping the grain, cause spoilage of the grain in storage, lower its grade, and reduce its market value.[2] Investigations conducted by the office of grain investigations, Bureau of Agricultural Economics, showed that approximately 33,000,000 bushels (of 40 pounds each) of dockage was contained in the wheat and flax alone produced in Minnesota, North Dakota, South Dakota, and Montana in 1928. This was an average of 7 per cent dockage

[2] Farmers' Bulletin 1542, Cleaning Grain on Farms and in Country Elevators. 5 cents from the Superintendent of Documents, Government Printing Office, Washington, D. C.

in the wheat and 16 per cent dockage in the flax. Practically all of this dockage consisted of weed seeds.

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 buffalo bur and jimson weed. Furthermore, some weeds are poisonous or otherwise injurious to man, livestock, or livestock products. Poison ivy, jimson weed, and the seeds of corn cockle are poisonous to man; wild garlic and bitterweed spoil dairy products; larkspur, waterhemlock, and loco weed are poisonous to stock; and the barbed seeds of foxtail barley and porcupine grass penetrate the noses and mouths of livestock, causing painful sores.

FIGURE 3.—A plant of crabgrass, an annual weed

FIGURE 4.—A plant of blueweed, a biennial

It is difficult to estimate the damage of weeds, but undoubtedly 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.

Annual weeds live only one year, maturing their seeds and then dying. Ragweed, wild oat, and crabgrass are examples of annual weeds. Figure 3 shows an entire plant of crabgrass. 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, chickweed, and henbit.

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 biennial weeds are blueweed, bull thistle, and wild carrot. Figure 4 shows an entire plant of blueweed.

Perennial weeds produce each year underground 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

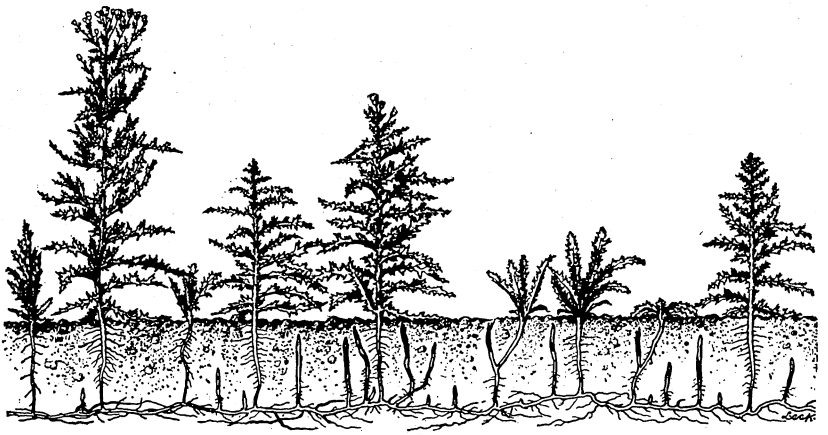

FIGURE 5.—Diagram showing the characteristic root growth of the Canada thistle, a perennial weed

less horizontal roots, as in the case of the horse nettle, milkweed, and 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 garlic, 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 to cure the evil. A farm can be made almost free of especially troublesome weeds by strictly observing the following principles: (1) Prevent weeds from going to seed on the farm; (2) prevent weed seeds from 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 these three preventives is discussed in the following pages.

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 foregoing principles.

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

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 principles already laid down.

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 100 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; some 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.

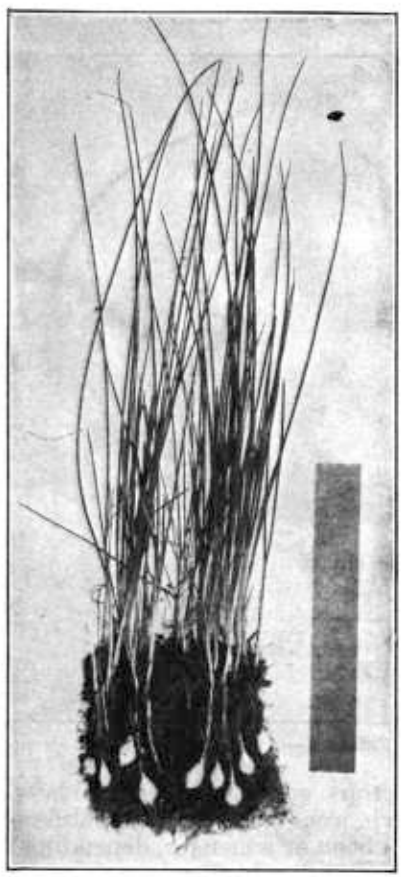

FIGURE 7.—Wild garlic, a perennial weed, showing the bulbs

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.

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 dragging 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.

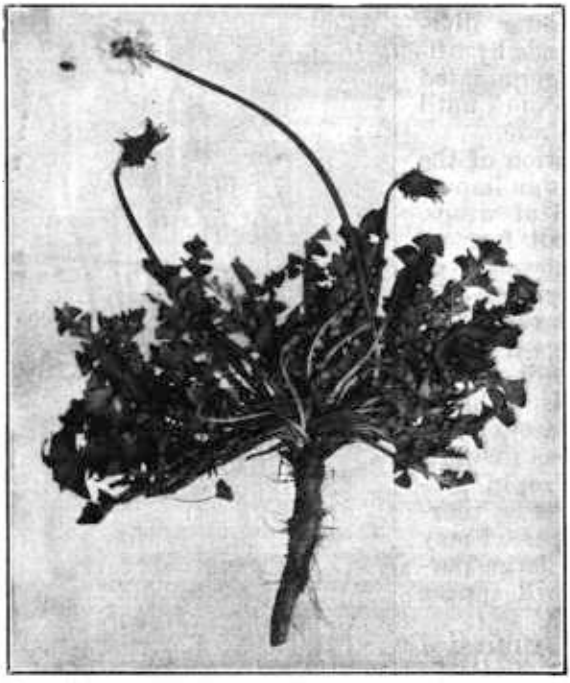

FIGURE 8.—A dandelion plant, a taprooted perennial weed

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

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.

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

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

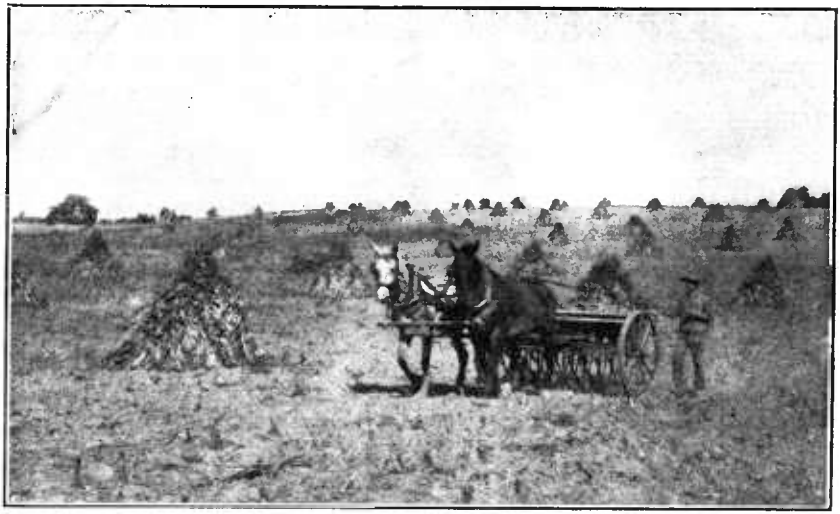

FIGURE 11.—A cornfield being planted with a winter crop. Planting the land in this way kills many weeds

FIGURE 12.—A fence row that has been mowed regularly, the weeds being thus kept from going to seed

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 grainfields thick with weeds, it will pay to cut them, grain and all, before the weeds start

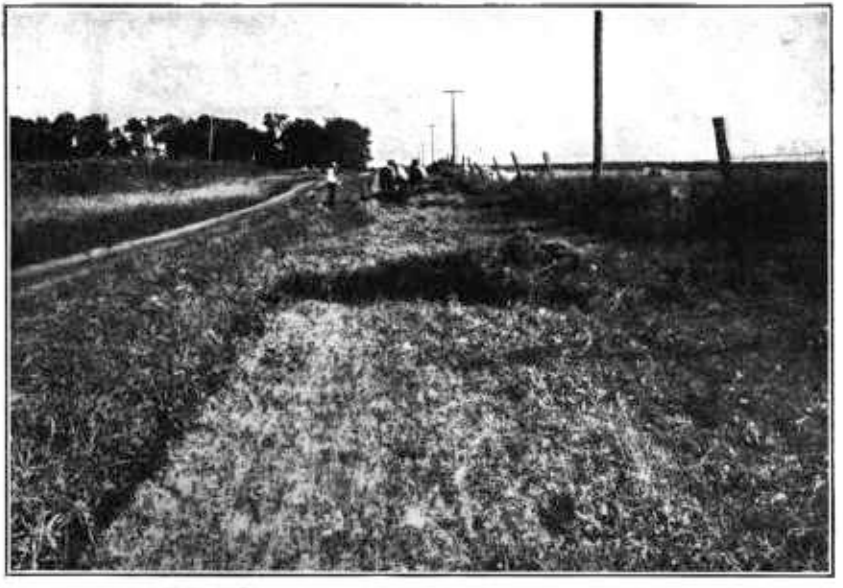

FIGURE 13.—Making hay along a fence row in Illinois, thus preventing weeds from going to seed and also incidentally increasing the farmer's income

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 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

Sometimes 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 should be pulled or cut off when they are in full blossom. The spud (fig. 15) is a tool with a long handle and a narrow chisellike blade at one end. This is very effective in disposing of weeds with thick roots, such as bull

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

thistle, mullein, and chicory. Many farmers have cleaned their farms of corn cockle, wild mustard, and many other weeds by a few hours of hand work each year when these weeds were in full blossom.

CHEMICAL SPRAYING TO PREVENT SEEDING

Spraying fields of growing grain to control wild mustard and other annual weeds usually is impracticable under present farming conditions.

SHEEP PASTURING TO PREVENT SEEDING

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

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

PREVENTING WEED SEEDS FROM BEING BROUGHT TO THE FARM

The second of the three main points in weed control is to prevent 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

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

developing noxious tendencies. When a plant shows any tendency toward becoming a troublesome weed, it should be called to the attention of some one in authority and every effort made to keep it under control.

Weeds may be brought to the farm in various ways but principally 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 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

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

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 often 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.[3] In either case it is necessary to get the test under way well in advance of the time

[3] Farmers' Bulletin 428, Testing Farm Seeds in the Home and in the Rural School. Out of print, but may be consulted in libraries.

of seeding. In purchasing seed of alfalfa and clover the most important 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

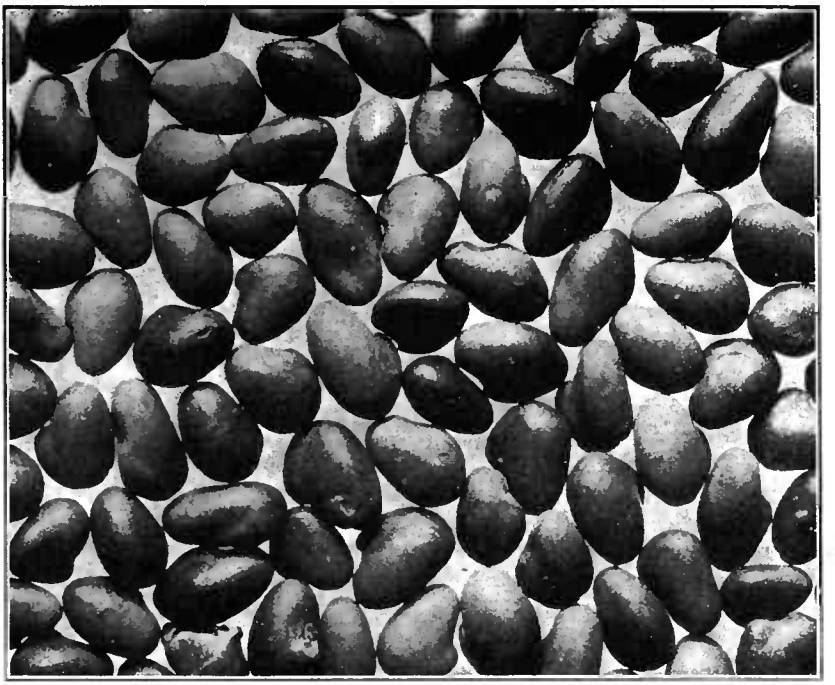

FIGURE 18.—Red-clover seed of good quality. Magnified nine times

especially true of that class of mixed feeds made from mill by-products, because such by-products are partly composed of screenings. These screenings contain 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 on the labels on the bags, and this is desirable in all States. Some States also issue feed-control bulletins, stating the analyses 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 in stock feeds on his farm.

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. 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

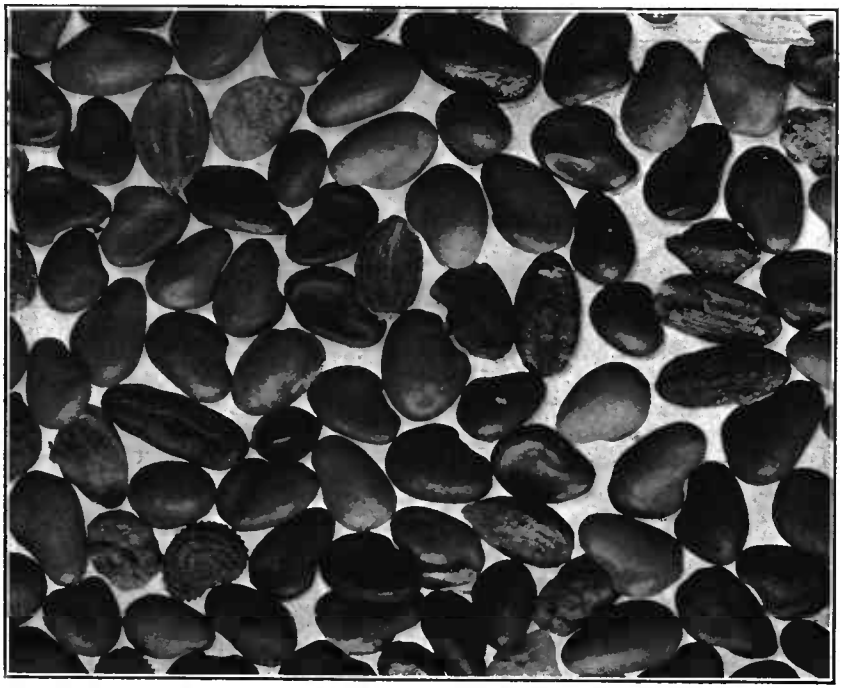

FIGURE 19.—Red-clover seed of low grade, containing many weed seeds. Magnified nine times

exercised the manure will lose some of its value. Still, in many cases it undoubtedly would 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 THRESHING OUTFITS

Threshing 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 that it is cleaned in a place where the weed seeds will not be scattered on the fields. Wild mustard is very likely 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 threshing 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 one continues to buy them there is little chance of having a weed-free farm. The only way to prevent seeds from getting to the land where hay or straw is purchased is to leave the resultant 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

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

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

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.

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

PREVENTING THE TOP GROWTH OF PERENNIALS

The last of the three weed preventives is to keep down the top growth of perennials, in order to starve out the underground parts. This top growth is as essential to plants as lungs are to 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, spud, or mower; (5) application of chemicals; and (6) smothering small patches with 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 unless the soil is rocky. 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 con-

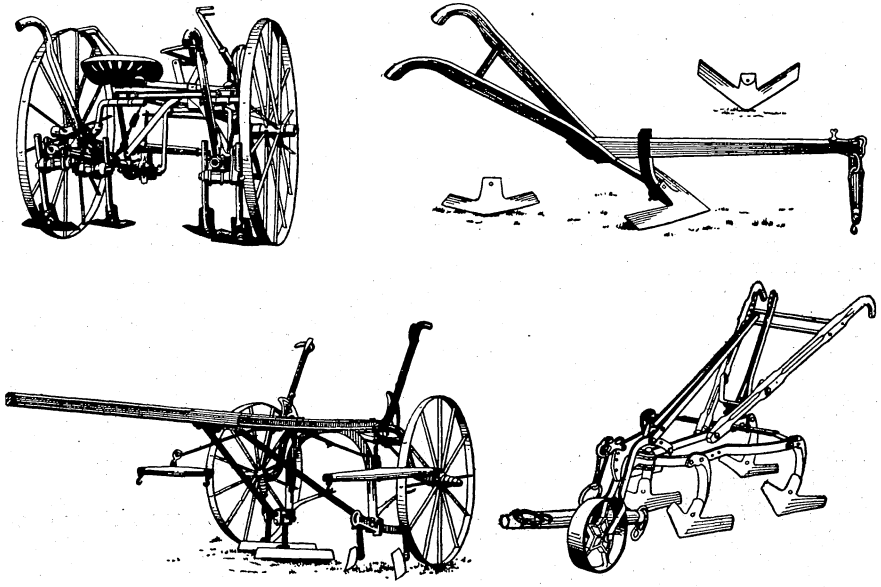

FIGURE 22.—Various types of cultivators equipped with knives or sweeps that are effective in cutting off the stems of perennial weeds below the soil surface

tinue 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 many perennials, although certain especially persistent species (field bindweed, for example) will require additional work the second year.

Perennials may often be attacked most effectively by clean cultivation without growing a cultivated crop; in other words, by a bare fallow. In grain-growing regions in which moisture conservation is important, in addition to weed control, it often is advisable to fallow for an entire season. A better plan in many other localities is to crop 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 especially successful with 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, as they thrive on many plants that are avoided by cattle and horses. Goats are even more nearly omnivorous than sheep, but the regions where it is profitable to keep goats are more 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 advantage in getting rid of bindweed, or wild morning-glory, and in the "thinning out" of nut grass.

Where it is feasible to confine sheep, goats, or hogs to very restricted areas for one or more seasons without causing serious erosion, many perennial weeds will be killed. Where it is not practicable to graze sufficiently close to destroy perennials completely the grazing still greatly weakens the root system of these plants, making it an easier task to complete their destruction by cultivation.

SMOTHER CROPS

Thick stands and vigorous growths of smother crops may usually be depended on to keep down the top growth of perennials. Smother crops commonly used are alfalfa, sorghum, sweetclover, buckwheat, and soybean. 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 that is to follow.

MOWING OR CUTTING

Cutting off repeatedly the tops of perennial weeds with a mower, scythe, or other tool may sometimes be practiced 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 bracken, a kind of fern which is one of the bad weeds of pastures in New England and New York.

USE OF CHEMICALS

Weed-killing chemicals, because of their cost and because of other objections, are not a substitute for tillage, pasturing, or cropping in general farm weed control. Even such persistent pests as Canada thistle and field bindweed can be killed more cheaply and almost as rapidly by tillage as with chemicals. Chemicals are useful chiefly for destroying small patches of dangerous perennial weeds or for sterilizing the soil on tennis courts, roadways, railroad rights-of-way, and similar places. Limited use is made of chemicals to destroy annual weeds in grainfields, for certain weeds in lawns, and for killing noxious plants like poison ivy.

The best chemical weed killers are sodium chlorate, sodium arsenite, carbon disulfide, oil, iron sulfate, and common salt.

Sodium chlorate is a powerful plant poison, deadly to all kinds of vegetation though not toxic to animal life under ordinary circumstances. By itself sodium chlorate is not dangerous to handle, but when intimately mixed with organic material it becomes an explosive fire hazard. Thus, clothing that has been soaked with a solution of chlorate and dried becomes violently inflammable. Workers using chlorate sprays should, therefore, use extreme care to keep their clothing moist, either with water or with the spray solution, until there is an opportunity to remove the garments and wash them. Dry chlorate spilled on wooden floors or among dry vegetation is a definite fire hazard. An average dosage of sodium chlorate for deep-rooted perennial weeds is 400 pounds per acre, applied either dry or as a spray. More is required on rich soils than on soils low in fertility. For most annual weeds 100 pounds per acre in a spray solution are sufficient. The spray solution contains 1 to 1½ pounds per gallon of water. The wholesale price of sodium chlorate is commonly 7 to 8 cents per pound f. o. b. shipping point.

Soluble arsenicals, including sodium arsenite and arsenic acid, are among the most potent plant poisons known. The majority of proprietary weed killers sold in garden-supply houses consist essentially of dissolved arsenic. The effect of sodium arsenite in the soil is very lasting, a single treatment preventing all plant growth for 2 to 5 years. In weak solution sodium arsenite may be sprayed on annual weeds without much injury to the soil, or by repeated spraying perennials may be killed through continuous defoliation. In California shrubby weeds are killed by stuffing the ends of branches into jars of sodium arsenite solution. A serious objection to the use of any arsenical is the violently poisonous effect on animals and man. In some communities special permission must be obtained before arsenical weed killers may be used. Sodium arsenite is obtainable wholesale for 9 to 12 cents per pound in powdered form or for about half that amount in the form of a concentrated solution.

Carbon disulfide is a volatile, pungent liquid whose fumes are injurious to plant tissues. Large quantities have been used in the Western States to kill deep-rooted weeds by placing 2 ounces of carbon disulfide in holes in the soil 6 inches deep and 18 inches apart.

At a wholesale price of about $1 per gallon the cost of using carbon disulfide is apt to exceed $100 an acre.

Oils, especially the lower fractions of crude petroleum similar to domestic fuel oil, are injurious to plants and are often used to spray the foliage of poison ivy, Japanese honeysuckle, and similar woody pests. Oils are very effective on grassy weeds and on ripe weeds to kill the seeds. Oil on the soil, in large quantities, is apt to make plant growth impossible, but quantities up to 75 gallons per acre are often not injurious.

Common salt is the oldest known herbicide and is still much used to kill grass in brick sidewalks and the like. Although closely similar chemically to sodium chlorate, salt is only one-tenth as toxic to plants. Ten tons per acre or more are required to sterilize soil, but once sterilized the soil remains bare of plant growth almost indefinitely.

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

Certain chemical fertilizers, applied to lawns or golf greens, have some value for weed control also. In experiments conducted by the Rhode Island Agricultural Experiment Station and by the United States Department of Agriculture, acid-reacting fertilizers such as ammonium sulfate and ammonium phosphate were applied to bentgrass plots. Results indicated that an increase in soil acidity was accompanied by a decrease in weeds. Some weeds, of course, do not thrive on acid soils. On the other hand, certain weeds thrive on acid soil just as bentgrasses do. It is believed, however, that the vigorous growth of lawn grasses resulting from a liberal fertilization is an important factor in holding weeds in check on any kind of soil. Applications of fertilizers have not proved effective for the eradication of deep-rooted perennial weeds like dandelions after they have gained a firm foothold.

SMOTHERING WITH PAPER OR OTHER MATERIAL

Where perennial weeds occupy very limited areas it is sometimes practicable to kill them by covering the infested area with heavy

durable paper, taking care to lap over and fasten down the ends and edges to exclude all sunlight. Manure, straw, leaves, and other materials have also been employed for this purpose, with varying degrees of success.

Experiments relating to crop-plant stimulation with paper mulch [4] have shown that, in various crops, paper can also be employed effectively for weed control.

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.

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 meadow which produced only one-half ton of hay per acre.

FIGURE 24.—A meadow free of weeds; yield about 3 tons per acre

It is full of weeds. The meadow in Figure 24, which produced 3 tons per acre, is practically free of weeds. Furthermore, pastures that are given good care by top-dressings, with fertilizers free from weed seeds and by close but not destructive grazing, always contain fewer weeds and more grass than those poorly managed. Figure 25 shows an overgrazed pasture in the State of New York, where 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. Adequate fertilization while the land is in cultivated crops and careful seeding when it is put into sod are both important. By thus creating conditions favorable to the grasses desired, such a vigorous growth will be secured that many of the weeds will be crowded out. This is one of the secrets of good pasture management.

[4] U. S. Department of Agriculture Technical Bulletin 75, Crop-Plant Stimulation with Paper Mulch. Out of print, but may be consulted in libraries.

The farmer should know the kind of weeds that he has to fight, because in the case of some of them special methods have been dis-

FIGURE 25.—A poorly managed, weedy pasture in New York. The dark patches are sweetfern

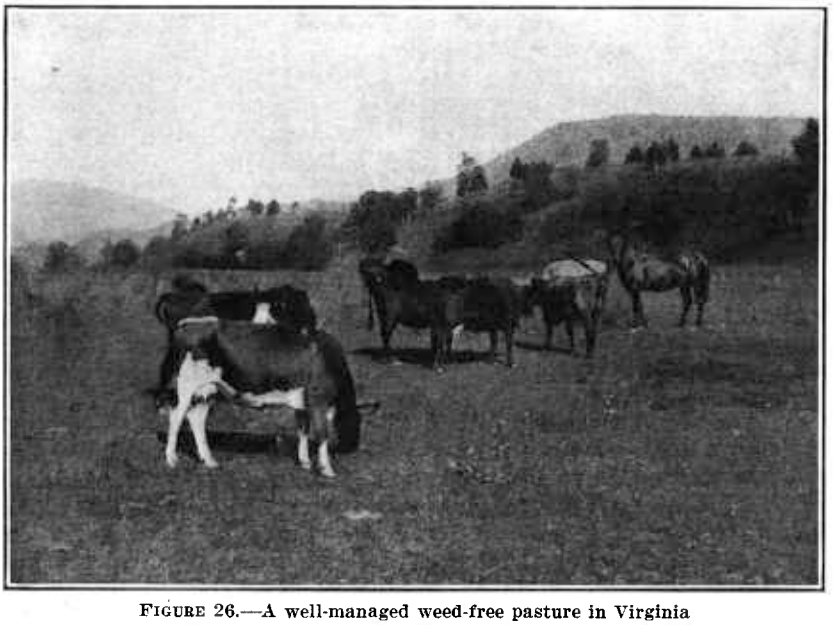

FIGURE 26.—A well-managed weed-free pasture in Virginia

covered which greatly reduce the amount of work necessary. Further information may be obtained by writing the Division of Cereal Crops and Diseases, Bureau of Plant Industry, Washington, D. C.

An important benefit from practicing a rotation is 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 in succession these weeds do not have the opportunity to make nearly so 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 they also lessen weed reproduction, as they are cut for hay before seeds of most weeds ripen.

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

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 certain grain-producing localities in which wheat is grown continuously, 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, wild carrot, and other weeds. (Fig. 27.) Introducing a cultivated crop and a grain crop soon disposes of most of these 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.

LIST OF 50 OF THE WORST WEEDS

Table 1 gives an alphabetical list of 50 of the 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 1.—*Descriptive list of 50 of the 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
Barley, foxtail barley (*Hordeum jubatum*), P.	Green; spike with long bristly glumes.	Minnesota to Texas and California.	Hay, animals, wind	Meadows and pastures; barbed seeds produce sores on livestock.
Bermuda grass[1] (*Capriola dactylon*), P.	Purple; 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 flaxseeds; creeping roots.	Rich, moist soil; grain and hoed crops.
Bindweed, hedge bindweed (*Convolvulus sepium*), P.	White or rose; 2 inches; solitary.	Mississippi Valley region.	Grain and flaxseeds; rootstocks.	Rich prairie and river bottoms; corn and small grain.
Bitterweed (*Helenium tenuifolium*, A.	Yellow; 3/4 inch; head.	Virginia to Kansas and southward.	Wind, hay, animals	Meadows and pastures; injures livestock and taints milk.
Bracken, brake (*Pteridium latiusculum*), P.	No flowers	Northwestern States and the Pacific coast.	Spores scattered by wind; running roots.	Logged-off land, meadows, and pastures.
Broom sedge (*Andropogon virginicus*), P.	Green; 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 (*Solanum rostratum*), A.	Yellow; 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.
Bur-sage, woolly bur-sage (*Franseria tomentosa*), P.	Yellowish; heads; 1/8 inch.	Montana to Mexico.	Farm machinery; running rootstocks.	Unplowed areas and cultivated fields.
Carrot, 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.
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; 1/4 inch; cymes.	Entire United States.	Grass and clover seed, animals; has a long seeding period.	Meadows, lawns; winter 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.

TABLE 1.—*Descriptive list of 50 of the worst weeds, etc.*—Continued

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
Cocklebur (*Xanthium* spp.), A.	Green; ¼ inch; head.	Entire United States.	Carried by animals	Cultivated fields and waste places; hoed crops and wool.
Crabgrass (*Syntherisma sanguinalis*), A.	Green; spikes	Entire United States, especially the South.	Clover and grass seed, hay, animals.	Cultivated fields, gardens, lawns, hoed crops.
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 (*Leontodon taraxacum*), P.	Yellow; 1¼ inches; head.	Entire United States.	Wind; taproot, which spreads but little.	Lawns, meadows, waste places; hay and lawns.
Dock, curly dock (*Rumex crispus*), P.	Green; ¼ 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 cannabinum*), P.	Greenish white; ¼ inch; terminal clusters.	Upper Mississippi Valley.	Wind; creeping root	Fields with sandy soil; pasture, grain and hoed crops.
Foxtail, yellow foxtail, pigeon grass (*Chaetochloa lutescens*), A.	Green; spikes	do	Animals, hay, grain, and grass seeds.	Land cultivated in early part of season; young grass and clover seedlings.
Garlic, wild 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.
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.
Horse nettle (*Solanum carolinense*), P.	Purple; 1 inch; solitary.	Entire United States.	Plants rolled by wind; running roots.	Everywhere; grain and hoed crops, pastures.
Ironweed (*Vernonia noveboracensis*), P.	Purple; ½ 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 (*Chenopodium album*), A.	Green; very small; panicle.	Entire United States.	Grain and grass seed	Grain fields and hoed crops.
Lettuce, prickly lettuce (*Lactuca scariola*), A.	Yellow; ¼ inch; heads in panicles.	Ohio to Iowa, Utah to California.	Wind	Everywhere; all crops.
Morning-glory (*Ipomoea hederacea*), A.	White, purple, or blue; 1½ inches; 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; ½ inch; racemes.	Maine to Washington.	Grain, grass, clover, and rape seeds.	Small-grain fields and meadows; grains.
Nut grass, coco (*Cyperus rotundus*), P.	Brown; ⅛ inch; spikelets.	Maryland to Florida and Texas.	Wind, nursery stock, hay, and grass seed; tubers.	All soils; hoed crops.
Pennycress, French weed (*Thlaspi arvense*), A.	White; ⅛ inch; racemes.	North Dakota and Minnesota.	Wind	Grain fields and pastures; grain and dairy products.
Peppergrass, perennial peppergrass (*Lepidium draba*), P.	Whitish; ⅛ inch; corymbs.	Rocky Mountain region chiefly.	Farm implements, irrigation water; rootstocks.	All crops.

TABLE 1.—*Descriptive list of 50 of the worst weeds, etc.*—Continued

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
Pigweed, redroot, careless weed (*Amaranthus retroflexus*), A.	Green, very small; spikes in panicles.	Entire United States.	In grain and grass seeds; plants blown by wind.	Plowed land; hoed crops.
Plantain, buckhorn, (*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.
Poison ivy (*Toxicodendron radicans*), P.	Greenish white; 1/8 inch; panicles.	----do----------	Does not spread fast by seeds; running rootstocks.	Moist rich land, along fences; poisonous by contact.
Puncturevine (*Tribulus terrestris*), A.	Pale yellow; 1/2 inch; solitary.	Kansas to California.	Animals, wind, automobile tires.	Waste areas, roadsides, fields.
Purslane, pusley (*Portulaca oleracea*), A.	Yellow; 1/4 inch; solitary.	Entire United States.	Tillage implements; has a long seeding period.	Rich cultivated land, especially gardens; hoed crops.
Quack 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, common ragweed (*Ambrosia elatior*), A.	Yellow; 1/4 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 (*Salsola pestifer*), A.	Purplish; 1/4 inch; solitary.	Minnesota to Washington and southward.	Wind rolling matured plants.	Everywhere; small grain and hoed crops.
St. Johnswort (*Hypericum perforatum*), P.	Yellow; 3/4 inch; cymes.	Maine to North Carolina and Iowa.	In hay and grass seed; rootstocks.	Meadows, pastures, and waste places.
Sand bur (*Cenchrus pauciflorus*), A.	Green; 1/3 inch; bur.	Maine to Florida and westward to Colorado.	Animals, especially sheep.	Sandy land pastures and waste places; pastures and wool.
Smartweed (*Polygonum pensylvanicum*), A.	Light rose; 1/16 inch; racemes.	Maine to Minnesota, Florida, and Texas.	Wind carrying matured plants.	Moist, rich soils; hoed crops and young grass seedings.
Sorrel, sheep sorrel (*Rumex acetosella*), P.	Red; 1/8 inch; panicles.	Entire United States.	In clover seed; creeping roots.	Meadows and pastures.
Sow thistle, perennial sow thistle (*Sonchus arvensis*), P.	Yellow; 3/4 inch; heads.	Maine to Minnesota.	Wind; running rootstocks.	Grain fields and hoed crops.
Thistle, Canada thistle (*Cirsium arvense*), P.	Purple; 3/4 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 oats (*Avena fatua*), A.	Green; panicles; similar to oats.	Wisconsin to Washington.	In seed oats----------	Oat fields; awns injurious to stock.
Wintercress, yellow rocket (*Campe barbarea*), P.	Yellow; 1/4 inch; racemes.	Maine to Virginia and westward.	In grain, clover, and grass seeds.	Grain fields, pastures, and meadows.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE WHEN THIS PUBLICATION WAS LAST PRINTED

Secretary of Agriculture	HENRY A. WALLACE.
Under Secretary	M. L. WILSON.
Assistant Secretary	HARRY L. BROWN.
Director of Information	M. S. EISENHOWER.
Director of Extension Work	C. W. WARBURTON.
Director of Finance	W. A. JUMP.
Director of Personnel	ROY F. HENDRICKSON.
Director of Research	JAMES T. JARDINE.
Director of Marketing and Regulatory Work	A. G. BLACK.
Solicitor	MASTIN G. WHITE.
Land Use Coordinator	M. S. EISENHOWER.
Office of Plant and Operation	ARTHUR B. THATCHER, *Chief.*
Office of C. C. C. Activities	FRED W. MORRELL, *Chief.*
Office of Experiment Stations	JAMES T. JARDINE, *Chief.*
Office of Foreign Agricultural Relations	LESLIE A. WHEELER, *Director.*
Agricultural Adjustment Administration	R. M. EVANS, *Administrator.*
Bureau of Agricultural Chemistry and Engineering.	HENRY G. KNIGHT, *Chief.*
Bureau of Agricultural Economics	H. R. TOLLEY, *Chief.*
Agricultural Marketing Service	C. W. KITCHEN, *Chief.*
Bureau of Animal Industry	JOHN R. MOHLER, *Chief.*
Commodity Credit Corporation	LYNN P. TALLEY, *President.*
Commodity Exchange Administration	J. W. T. DUVEL, *Chief.*
Bureau of Dairy Industry	O. E. REED, *Chief.*
Bureau of Entomology and Plant Quarantine	LEE A. STRONG, *Chief.*
Farm Security Administration	W. W. ALEXANDER, *Administrator.*
Federal Crop Insurance Corporation	LEROY K. SMITH, *Manager.*
Federal Surplus Commodities Corporation	MILO R. PERKINS, *President.*
Food and Drug Administration	WALTER G. CAMPBELL, *Chief.*
Forest Service	FERDINAND A. SILCOX, *Chief.*
Bureau of Home Economics	LOUISE STANLEY, *Chief.*
Library	CLARIBEL R. BARNETT, *Librarian.*
Division of Marketing and Marketing Agreements.	MILO R. PERKINS, *In Charge.*
Bureau of Plant Industry	E. C. AUCHTER, *Chief.*
Rural Electrification Administration	ROBERT B. CRAIG, *Asst. Admin.*
Soil Conservation Service	H. H. BENNETT, *Chief.*
Sugar Division	JOSHUA BERNHARDT, *Chief.*
Weather Bureau	FRANCIS W. REICHELDERFER, *Chief.*

U. S. GOVERNMENT PRINTING OFFICE: 1939

For sale by the Superintendent of Documents, Washington, D. C. - - - - Price 5 cents