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WEEDS

AND

HOW TO ERADICATE THEM

BY

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THIRD EDITION

(REVISED)



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PREFACE.

The aggregate of loss to the farmer resulting from the extent to which weeds prevail on the average farm is very great. It is equally true that such loss could in a great measure be prevented. That it is not prevented is due not so much to indifference on the part of the farmer as to the extent to which the presence of weeds will be tolerated, as to a lack of information with reference to the most effective methods of fighting them. This book has been written in the hope that it will in some measure supply this need. In this, the third edition, several weeds are included in the discussion that are not considered in the previous editions. Much has also been added with reference to effective methods of eradication based upon recent experimentation.

The author wishes to acknowledge his indebtedness to Hon. Geo. H. Clark, Seed

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THOMAS SHAW.

St. Paul, Minn., Feb. 2, 1911.

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CHAPTER I.

THE PREVALENCE OF WEEDS.

“Cursed is the ground for thy sake; in sorrow shalt thou eat of it all the days of thy life; thorns also and thistles shall it bring forth to thee; and thou shalt eat the herb of the field.” So reads the doom that was hurled down the centuries from the gates of Eden, when man was ejected from a paradise lost, to earn his bread by the sweat of his brow. From that day to the present weeds have followed in the foot prints of man. He no sooner pitches his tent or builds his more permanent home than they entrench themselves around it. He no sooner commences to till the soil than they commence to dispute its possession with the plants that he sows, and thus they harass and perplex him, and complicate all his best devised methods for subduing the earth.

It is true at the same time that in lands that have never been tilled, we find some

weeds, but they are native to the soil, and the number of the species is not only limited, but those which do exist seem unable to multiply to any great extent in the natural surroundings amid which they grow. On the other hand, in lands that have long been cultivated, we frequently find that foreign varieties of weeds are far more numerous and aggressive than the native species. Regions that have been settled with inhabitants drawn from different countries are peculiarly liable to be infested with the weeds of the various countries from which these inhabitants have come. The seeds of the weeds are imported along with the grain that is brought for sowing, and are introduced in various other ways. Some of the varieties thus imported do not take kindly to the new conditions, but other sorts, like the people who have brought them, oftentimes find their new surroundings pre-eminently favorable to a greatly increased development.

The "prevalence of weeds" depends (1) on the number of weed species found in any locality; and (2) on the extent to which these various species are allowed to multiply.

1. *The number of weed species.* The number of the various species of weeds which infest the different portions of the United States and of the provinces of Canada has not yet been accurately determined. The story of their distribution has not yet been fully told, and their number is constantly increasing. It would serve no good purpose to enumerate the various species, or even to try to give an approximation of their number. Weeds are probably quite as numerous and varied now in America as in Europe, where it is well known that they have been constantly increasing in number and variety with every passing century. In addition to the noxious weeds of America that are native to the continent, the greater portion of those that have long harassed the inhabitants of Europe are now giving trouble to the inhabitants of America.

Our most troublesome and aggressive weeds are foreigners. The Canada thistle, which seems so completely at home in the central provinces of the Dominion and the northern portion of the United States, was imported from Europe. The same is true of some varieties of the sow thistle. The wild oat, the ox-eye daisy, the burdock, the

wild mustard, the Russian thistle, the prickly lettuce, the corn cockle and indeed nearly all the various forms of weed life that are greatly troublesome to us, come from a foreign source. Foreign weeds in this country are even more numerous and characteristic than the people who brought them hither, and so they are likely to remain, for weeds, unlike nationalities, do not fuse and blend so as to lose their several individualities. For some of them, as the Canada thistle, the new conditions have been found so favorable that they flourish to a greater extent than even in the lands whence they came.

Although the presence of weed life in any form is not desirable, some varieties, as for instance the dandelion, are not greatly harmful, while others, as the sow thistle, quack grass and the Canada thistle, if given a chance, will soon render the growing of certain crops quite unprofitable. A large majority of the weeds found in this country may be kept in check by what may be termed good cultivation, that is to say, by such cultivation as is necessary to grow good crops; but other varieties require specific modes of treatment if, when the

attempt is made to exterminate them, it is to prove successful. Happily the number of varieties of weeds which are really seriously harmful to crops and difficult to eradicate is not very large. In the present state of our knowledge of the subject, it would not be safe to name a definite number which would cover the entire list, nor would it be judicious to do so, as new varieties are coming forward all the time. Notwithstanding, it would probably be not incorrect to say that at the present time the varieties of really noxious weeds in the United States and Canada do not number more than thirty or forty, and it is greatly encouraging to reflect that we seldom find more than half a dozen kinds entrenched in any one locality.

2. *The extent to which weeds have been allowed to multiply.* The extent to which certain varieties of noxious weeds have been allowed to multiply is simply alarming. Some of them are, in a sense, taking possession of the land. Notably is this true of wild mustard, the Canada thistle, and wild oats in the Red River Valley and similar grain-growing sections, of quack grass in some localities, and of wild barley and

the Russian thistle in others. In some sections the seeds of wild mustard are so numerous in the soil that, though no more were allowed to ripen during the present generation, there would probably still be a few left to grow plants for the next generation to destroy. Other varieties than those named are increasing with alarming rapidity. Unless some effective measures are taken to destroy them, they will increase more and more, to the great injury of our agriculture. It is surely a stigma on the agriculture of any country and a withering criticism on the defectiveness of the modes of cultivation that are practiced in it, when weeds increase rather than decrease. In the hope of doing something to stay the progress of the great tide of weed invasion and weed aggression, this book has been written. The writer cherishes the hope that every interested reader will exert himself to the utmost to stay the progress of weed extension by doing his best to utterly annihilate weeds in all their seriously noxious forms.

CHAPTER II.

THE EVILS WHICH ARISE FROM THE PRESENCE OF WEEDS.

The evils which arise from the presence of weeds are very many and very great; so many and so great that it would seem inconceivable that any one should be found willing to offer an excuse for weeds on the ground of their utility. Nevertheless, we sometimes find persons enlarging on their value for fertilizing purposes, and on their utility in arresting the escape of nitrates from the soil through leaching. It is true that weeds may sometimes be turned to good account in enriching the land, if they are plowed under as a green crop before their seeds mature, but more commonly it will be found far better to sow a crop properly suited to the purpose, and one that will at the same time afford pasture if necessary. A green crop thus sown will also hinder the

escape of nitrates more effectively than a crop of weeds, owing to its greater uniformity. Whenever weeds grow spontaneously in sufficient numbers to be of much service in either of the ways named above, they are sure to give trouble to whatever useful crop is grown upon the same land, much more than will offset any advantage to be gained from them.

In good farming weeds should not be tolerated at all, because (1) they rob the useful, cultivated plants of their due share of plant food and moisture; (2) they also injure them by crowding and shading; (3) they harbor insects and plant diseases; (4) they add greatly to the labor of cleaning grain for market and for seed; (5) they frequently interfere with a regular rotation; and (6) they are usually not of much value as food. To all these things may be added the statement that the longer they are left to grow unchecked, the greater is the work required to completely subdue them.

1. *Weeds rob useful plants of their due share of plant food and moisture.* Weeds feed upon precisely the same kinds of food as the useful plants among which they grow, and they draw heavily upon the avail-

able soil moisture. They are often more capable of gathering food and moisture from the soil than the useful crop, as their root systems are usually more vigorous and penetrate to a greater depth. When found growing in a crop, therefore, they deprive either that crop or the crops that come after that one, of precisely that amount of water and plant food which they consume during their period of growth. The quantity of plant food which weeds take from the crops and the soil will be in proportion to the numbers in which they are found. It should not be forgotten that plant food externally applied, often at much cost, as in the case of commercial fertilizers will be utilized by weeds quite as readily as the plant food naturally available in the soil itself.

✓ 2. *Weeds injure useful plants by crowding and shading them.* When useful plants and weeds commence to grow at the same time, the weeds will nearly always leave the useful plants behind in the race. This is owing to the superior power of gathering plant food which nearly all varieties of weeds possess. When present in a crop, they usually grow more vigorously than the crop itself, and as the latter is intended to

grow so thickly that it will require all the room that can be given it to enable it to perfect its growth, it follows that the injury through crowding from weeds will be in proportion to the number and vigor of the weeds. Weeds also grow more quickly than useful plants, hence by their shade they hinder that perfect development of the useful plants which abundant sunlight is necessary to secure.

3. *Weeds harbor injurious insects and plant diseases.* Weedy fence rows, waste places, and stubble furnish winter lodgment to the chinch bug and various other injurious insects. Certain weeds, by their dense growth, form an excellent harbor for plant lice. The dense shade formed by a rank growth of weeds furnishes conditions favorable to the development of rust, mildew, and other plant diseases. Some of the diseases of the cabbage, cauliflower, and turnip also occur on the wild mustard and similar plants, and are spread by them.

4. *Weeds add much to the labor of cleaning grain for market and for seed.* Were it not for the presence of weed seeds, it would not be necessary to spend much time in cleaning grain intended for sale. It is

evident that grain entirely free from the seeds of weeds always commands, even in the ordinary market, a higher price than grain that is unclean. When grain containing weed seeds is put on sale for sowing, the depreciation in value is much greater relatively. The seedsman cannot afford to pay good prices for seed grain of any kind if he must spend much time and labor upon it in removing the seeds of noxious weeds. Oftentimes it is found impossible to completely separate weed seeds from the grain in which they are found by any other process than that of hand-picking. With the farmer, in preparing a crop of any kind for market, this would be simply impossible. All kinds of grain should be considered as unfit for seed, however, so long as any seeds of noxious weeds are found in it.

The difficulty in removing the seeds of weeds from those of grasses and clovers is much greater than in removing them from the small grains, owing to the greater relative uniformity in the size of the weed seeds and the seeds of the grasses. The labor of the cleaning process, therefore, is also relatively greater, and in very many instances

the cleaning cannot be accomplished by any process. The only possible way of preventing the presence of the seeds of certain noxious weeds in many kinds of seed grains, clovers, and grasses, is to prevent them from ripening in the crops which produce these seeds.

5. *Weeds frequently interfere with a regular rotation.* Ordinarily, farming cannot be carried on successfully without a regular rotation. This fact is admitted on every hand by the most successful agriculturists. The nature of the rotation will depend upon such considerations as relate to the capabilities and requirements of the soil, the markets, and the facilities for obtaining supplies of plant food. "The fertility of the soil can always be sustained in more even balance when a suitable rotation is practiced. When weeds become numerous in any of the crops of a rotation, they greatly hinder the profitable growth of these crops." In some instances, this hindrance may be so great as to render the growth of the crops of the regular rotation quite unprofitable until prompt measures have been taken to remove the weeds. The adoption of these meas-

ures may necessitate the growing of such crops for a time as may not be desired.

6. *Weeds are usually not of much value for food.* If weeds were of much value as food either for man or beast, there would not be the same necessity for waging against them a war of extermination, but usually they are of no value. When live stock feed upon them, it is generally because of short supplies of their proper food, unless it be when the weeds are very young. Nearly all forms of weed life are possessed of acrid or bitter juices which render them distasteful to live stock, and many of them become so woody at a comparatively early stage of their growth that they are in consequence left undisturbed. Quack grass, it is true, forms an exception, but quack grass is not more valuable than many other kinds of grass, and when we consider the difficulty found in eradicating it, we cannot regard it in any other light than that of a most troublesome weed. The value of weeds for food is so trifling, compared with the mischief which arises from their prevalence, that we ought never to sow them or tolerate their presence for such a use.

Finally, the longer weeds are left to grow unchecked, the greater is the labor required to completely subdue them. Were it not for the presence of weeds, the art of tilling the soil would be very much simplified. They are more or less responsible for the introduction of the bare fallow, which is not only costly in respect of time, but also involves much labor. Once get the mastery of the more noxious forms of weed life, and the bare fallow is no longer an absolute necessity on any farm, except possibly for the conservation of moisture in the semi-arid districts. Weeds also add greatly to the cost of growing crops which require cultivation, such as corn and roots, as those engaged in raising these crops know very well. It would be impossible even to approximate to the cost of labor expended annually in the destruction of weeds, but it is a very large sum, and one that in many portions of this continent is continually increasing, since the cost of subduing weeds must always increase as the weeds themselves increase in number.

CHAPTER III.

THE POSSIBILITY OF DESTROYING WEEDS.

The prevalence of noxious weeds in the United States and Canada is simply alarming. They abound on every hand. In many sections, in one form or another, they flourish in every field and luxuriate in every crop. Gardens, which above all places on the farm should be clean, are literally overrun with them. They occupy the sides of nearly every road throughout the whole continent. To so great an extent do they prevail everywhere that they form one great dark blot upon the boasted progress of the twentieth century, and are a reproach upon its civilization.

The extent to which weeds prevail in nearly all parts of this continent would lead one to suppose that the farmers had abandoned all efforts to destroy them, and were content to gather from their fields,

in the form of crops, merely what the weeds allowed to grow there. This apathy seems to arise, in part at least, from a lack of belief in the possibility of destroying weeds without incurring so much labor and expense as to make the work unprofitable. As the matter presents itself to the writer, there is not a shadow of a hope that the weeds of this continent will ever be destroyed by the farmers, so long as their complete eradication is looked upon as impossible, or so long as the belief is harbored that the outlay of labor and expense in completely eradicating them will not be repaid by the greater gains that will be obtained when once their destruction is effected.

Four propositions are now submitted which bear upon the subject of the complete eradication of weeds. So confident is the writer of the soundness of these propositions that he makes them as strongly affirmative as possible. They are as follows:

(1) The noxious forms of weed life can be completely eradicated on every farm throughout the whole continent if the farmers of these farms resolve that it shall be done.

(2) Complete eradication can be effected without heavy outlay, if the work be done in the proper way.

(3) When weeds are once under control, it will be easily possible, with but little outlay, to keep them so.

(4) The profits of farming will be, relatively, much larger where farms are kept entirely free from noxious weeds.

The writer is by no means unconscious of the fact that these propositions will be received doubtfully by some who read them, but he finds comfort in the reflection that they will be distasteful to no one whose heart is really set upon the complete eradication of the noxious weeds that may exist on his own farm.

1. The noxious forms of weed life can be completely eradicated on every farm. By the assertion that the more troublesome forms of weed life can be completely eradicated, it is meant that they can be so effectually exterminated that they will practically cease to interfere with any rotation that may be desired. It even implies that they can be completely banished from every farm where the attempt is made, except as their seeds are brought back again by natu-

ral or other agencies, and that with the necessary watchfulness, the plants which grow from these can in turn be destroyed with but little difficulty. Many persons seem to hold the view that while weeds may be held in check and kept from seriously hindering the growth of crops, they cannot be wholly destroyed. They claim that while weeds may be thus far conquered, nevertheless they will come again, and therefore that the hope of eradicating them completely is not to be cherished. Those who hold this view shape their practice accordingly. They adopt some method of cleaning a field that proves fairly successful, and then during the years that immediately follow give the same field no further special attention. The consequence is that this field soon again requires to be put through some special cleaning process, owing to the increase of the weeds which were but partially eradicated by the previous one. If this practice were a good one, it would involve the correctness of the untenable theory that in correcting error and uprooting evil, it is better to do it partially rather than wholly. So long as the belief is cherished by those who are most interested, that the complete eradication of

noxious weeds is impossible, so long will weeds continue to prevail. To so great an extent is this belief indulged in that it would probably be found a greater task to correct it in the minds of many farmers than to uproot the weeds themselves from their fields.

To banish weeds completely from any farm will not only require the wise and diligent use of measures of a certain character, which will be described in succeeding chapters, but when once they are gone, it will also require the most persistent watchfulness to keep them away. With public sentiment on this subject as it is at present, it will be found impossible to get those who are most directly interested to act in concert in destroying weeds, hence the work of even materially reducing their numbers will necessarily be slow. The work of banishing weeds from any country would not of necessity extend over many years if all the farmers of the country would but act together. The spectacle would then be witnessed for the first time of an inhabited country without noxious weeds to harass and annoy the tiller of the soil. Because farmers cannot all be persuaded to put forth

the effort to banish weeds from their premises, no one engaged in agriculture should refrain from doing all that he possibly can to bring about this result. Though our neighbors should not now believe in the possibility of being able to banish noxious weeds from their farms, if our own farms are made clean and kept clean, the evidence thus presented will in time have its due measure of influence.

2. *The complete eradication of noxious weeds can be effected without heavy outlay if the work be done in a proper way.* To argue the truth of this proposition in an abstract, theoretical fashion would be to spend time to but little purpose. It would not succeed in winning many converts to the truth. Those who cherish the belief in reference to weeds that "the thing that hath been is that which shall be" cannot be reached by any such line of reasoning. The evidence of actual accomplishment is the only testimony which they will not be inclined to reject. Evidence of this kind is not very plentiful, as our farmer readers must know very well. Therefore, because of the lack of the necessary data from other sources bearing upon the cost of cleaning

farms from weeds, the writer must fall back upon his own experience, and use as evidence the work that was accomplished at the Ontario Agricultural Experiment Station at Guelph from the time it came under his supervision in the autumn of 1888.

At that time the farm was not in a clean condition. The Canada thistle prevailed to a greater or less extent over the whole of it. In some of the fields the spring grain crops were so infested with this pest that they had to be cut in the green stage to prevent the maturing of thistles in countless numbers. In several of the fields, ox-eye daisies spangled meadows and pastures with a glory all their own. The yellow blossoms of the wild mustard lent variety to the foliage of every field, and in some fields their beauty was painfully profuse. Burdocks revelled among the stones that were strewn along the numerous fence borders. Wheat-thief and false flax were plentifully sprinkled in some localities, while in others the sow thistle had obtained a firm and menacing footing. Quack grass had monopolized more than one field. Ragweed was plentifully strewn over one or two fields. Bindweed had taken possession of small

areas here and there, and blueweed had fixed its firm grip on some of the pastures. Here, then, was a capital opportunity for experiment in the eradication of noxious weeds.

It would not be correct to say that any one of these varieties of weed life was completely eradicated in the five years from that time till this little book was first written. A few stragglers still survived from year to year, but these, in nearly all instances, came from the seeds which were in the soil ready to spring into vigorous existence when favorable conditions occurred for them. It may be said in all fairness, however, that none of these various forms of weed life were present in sufficient numbers to cause serious annoyance to cultivation or real injury to the crops.

To estimate with absolute precision the cost of bringing this Station Farm into the condition of cleanliness indicated would probably be an impossible task, owing to the many complications that arise in fixing the proportion of the outlay that should be charged to the growing of the crops and to the eradication of the weeds respectively. The utmost that can be hoped for is an

approximation to the real cost. Such an approximate estimate was made and published in the *Annual Report* of the Ontario Agricultural College and Experimental Farm for 1891, pp. 51 and 52. No better course, probably, can be adopted here than to make a quotation from the Farm Department portion of this report, prepared by the writer. The subject in hand is therein discussed in the following language:

“The question of the cost of cleaning this farm will doubtless be raised by the enquiring mind, and it is well that it should be. In reference to this, I desire to say that I am satisfied that the only outlay for which there was no direct return was that paid for hand spudding. The hoed crops would certainly all pay for the cost of producing them. On much of the land, two crops were grown each year during the cleaning process. On the land gang-plowed after harvest, compensation for the outlay was frequently obtained in the catch crops grown. I regret that no account was kept of the exact amount expended for hand spudding in 1889. In 1890 the time spent in spudding was 498½ hours by one person, which, at \$1.25 per day of ten hours,

would amount to \$62.31½. In 1891 the time thus spent upon the farm amounted to 489 hours, which would cost \$61.12½. For the two years, then, the outlay for spudding was \$123.44. This does not include spudding on the road. On the supposition that as much was expended in spudding in the year 1889 as in the two following years, and this estimate is certainly a liberal one, the whole outlay for spudding in the three years would not be more than \$250.00. Now, suppose the 400 acres, or thereabouts, of arable and pasture land on this farm had been cleaned by the process of the bare fallow during these three years, that is to say, one-third of it each year, the cost of hired labor of man and team, with rental of land added, in the absence of crop, would have been from \$3,200 to \$4,000. This calculation is based on the assumption that the cost of the bare fallow, when all the labor is hired and the rental of the land included, would be fully \$8.00 to \$10.00 per acre."

When the work of the bare fallow is done by the farmer, it will not, of course, be nearly so costly to the person doing it as when the labor of man and team is hired;

but in whatever way it may be done, it will cost several times more per acre than the sum actually paid per acre for spudding during the three years in which the Ontario Agricultural Experiment Station at Guelph was being freed from weeds.

3. *When noxious weeds are once eradicated, it will be easily possible, with but little outlay, to keep them in check.* This proposition is so reasonable that it should scarcely require any argument to demonstrate its correctness. Nevertheless, it is one which runs strangely counter to popular opinion. We find many ready to say that the task is a hopeless one, that weeds will continue to come through all time, and that to keep them completely under control will be found a process costly out of all proportion to the benefits accruing. That noxious weeds, even when once eradicated, will come again is certainly true, and that they will keep coming is equally true, but that it will cost more to keep them wholly banished than only partially banished is altogether illogical.

Such reasoning would involve the untenable assumption that when weeds are plentiful they are relatively easier to fight than

when they are few, and that while it would be a wise and commendable course to reduce the number of weeds on a farm, there is a limit beyond which further reduction ought not to go.

If a farm that is very dirty can be made partially clean with advantage to the farmer, it seems reasonable to think that to go a step farther and to render it altogether clean would be a still greater advantage, and that if a farm can be partially cleaned and yield profit to the owner, this profit will not only be correspondingly greater if the farm be perfectly cleaned, but that the labor and cost of maintaining cleanliness will continually decrease with the increasing perfection of the cleanliness.

It may be well to state here that the term "clean," as applied to freedom from the presence of noxious weeds on farms, is necessarily used in this work in a relative sense. So long as weed seeds are carried from place to place by means of such agencies as birds, waters, and winds, we shall never be able to say that a farm is absolutely clean. Though one year it were to be made perfectly free from noxious weeds, the following year a number of weeds

would probably grow from seeds brought by some one or other of the various agencies concerned in weed distribution. When, therefore, a farm is spoken of as clean in this work, it is meant (1) that it is so free from noxious weeds that they do practically no injury to the crops that may be grown upon it; and (2) that such weeds as are found upon it are so few in number that one can remove by hand or with the spud, in one day of ten working hours, all of them found growing in any ten acres of the farm. Such a definition may seem arbitrary, but since *absolute* freedom from noxious weeds is not, at any rate for the present, to be looked for, some definition seemed necessary to prevent misconception. A definition was chosen, therefore, within reasonable reach of attainment, and such as would serve all practical purposes. The mode of securing and maintaining the above-defined degree of cleanliness will be described in subsequent chapters.

To show that the work of *maintaining* cleanliness is not necessarily expensive, it will be sufficient to quote again from the Report of the Ontario Agricultural College

and Experimental Farm for 1891. On page 52, the following statements are made:

“It may not be amiss here to venture two or three remarks that are general in their nature in reference to cleaning farms. I desire to say, *first*, that it is my firm conviction that the farmers of this province may have clean farms if they so desire it; *second*, that farms may be cleaned without great outlay, and ordinarily without resorting to the bare fallow; and, *third*, that when farms are thus cleaned the work of keeping them clean will not be difficult, providing due vigilance is exercised. When a field is cleaned, it can easily be kept clean by the use of the spud and autumn cultivation, in addition to the cultivation necessary to the production of the crops grown. When thus cleaned, the hand spudding, essential in keeping fields clean of weeds, should not be more than \$25.00 per year for 100 acres. We expect to keep this farm clean henceforth at an outlay of not more than \$75.00 per annum, over and above the ordinary outlay required in good cultivation. This estimate includes private roads, fence borders, unbroken pastures, and by-places.”

Some of the statements in the quotation just given may appear extravagant, even to practical men. The idea of bringing farms into a clean condition and then keeping them so seems to be entertained by so small a number that those who advocate such views will be looked upon by many as enthusiasts. The writer feels free to say, however, that this opinion is not the view of a mere enthusiast, and no man should regard it as such until he has first *honestly* made the attempt to clean his own farm on the lines laid down in this book, and found that he cannot profitably do so. This opinion, it may be added, is sustained by the experience of 1892 in the management of the Ontario Agricultural Experiment Station at Guelph. An accurate account was kept of the time spent in hand spudding that year. It amounted to 512 hours, which, at \$1.25 per day of ten hours, cost but \$64.00, a sum considerably less than \$25.00 per 100 acres. And this cost includes the entire work done in the way indicated on "private roads, fence borders, unbroken pastures, and by-places," in addition to that expended on the cultivable portions.

4. *The profits of farming will be relatively much larger where farms are kept entirely free from noxious weeds.* The correctness of the proposition here made will surely be apparent to the reflective mind, but if proof is wanted, it is easily found.

Since weeds feed upon identically the *same food* as useful plants, it follows that, where the former take up a portion of the plant food there will be just that much less for the crops in which the weeds grow. Where weeds are more numerous in a crop than the plants of the crop, much more of plant food is used by the weeds than by the crop, for weeds are more ravenous feeders than useful plants. Moreover, through the *crowding* and *shading* by weeds of the crop plants, crops are very much injured, as was stated in a previous chapter. Here, too, the injury will be in proportion to the number and strength of the weeds, and crop-yields will be correspondingly diminished. The view has been advocated that sometimes noxious weeds should not be cut down in pastures, for the reason that they encourage the growth of grasses, inasmuch as they furnish shade to them. This would

be equivalent to saying that grasses robbed of nutriment by overshadowing weeds, and grown in the absence of sunlight, would be more abundant and nutritious than grasses occupying the ground alone. Such argument should be consigned to a deeper shade than the rankest weeds can possibly furnish.

Again, weeds growing in crops increase the labor of *handling* the crops, and to no useful purpose. Here, too, the increase in labor will be in proportion to the extent to which the weeds are present, and with all increase in labor that is not followed by a corresponding return, there must be a decrease in the profits. Weeds increase the labor of harvesting the crops amid which they grow, whether these are cereal or cultivated crops. *Grain crops* are much more difficult to reap where weeds abound, since the latter are more branching in their habits of growth than cereal plants, are more woody in fibre, and are of greater height proportionately—the latter characteristic resulting from a tendency to a more prolonged state of greenness in some portions of the plants. *Cultivated crops* are much more difficult to harvest where weeds abound, since weeds frequently hinder free-

dom of locomotion on the part of the workmen, impede the working of the implements used, and increase the difficulty of handling the crop. Moreover, weeds materially increase the difficulty of curing both cereal and grass crops by prolonging the curing period, and in proportion as this period is prolonged, the liability to loss from adverse weather is increased.

When weeds become so numerous as to disturb the regular *rotation*, they necessarily interfere with the profits that would otherwise accrue. A disturbed rotation generally leads to the growing of some crop that is less desirable than that usually grown. This, in turn, may lead to disturbed market relations, a greater necessity for the purchase of artificial fertilizers, and even of certain farm foods that may be wanted, and to various other evils, some of which have been mentioned in Chapter II.

The *labor* required in cleaning the ground from weeds increases with the increase of the weeds, and the farm profits are therefore to that extent reduced. More particularly is this the case in growing cultivated crops. With the multiplication of weeds hand labor especially is increased, because

more labor is required to remove weeds from the line of the rows, and the hand labor thus employed is always relatively more expensive than horse labor. Because of this, the untenable conclusion has been reached by some that in America it will not pay to grow crops which require hand labor to keep them clean. The labor of cleaning by other modes, such as the bare fallow, is also increased as weeds multiply, and this increase of labor not only results from the greater frequency with which the bare fallow would have to be resorted to by those who practice it, but also from the thoroughness with which the bare fallow would have to be managed to make it effective when weeds are plentiful, to say nothing of the loss that is occasioned by the greater frequency of the seasons when crops can not be grown because of the land lying idle in bare fallow.

CHAPTER IV.

THE AGENCIES CONCERNED IN THE DISTRIBUTION AND PROPAGATION OF NOXIOUS WEEDS.

The means or agencies concerned in the distribution and propagation of noxious weeds are chiefly the following: seed grain, grass seed, clover seed, etc.; farm live stock; purchased feed stuffs; farmyard manures; packing-cases, crates, etc., that have been used for the carriage of goods; road and farm vehicles, etc.; implements of tillage; thrashing machines; railways; birds; wild animals; waters; winds; and the inherent powers of the weeds themselves. Some of these means or agencies are entirely under the farmer's control, as the last mentioned; some of them are but partially under his control—that is, as far as weed distribution is concerned—as the vehicles that pass along his roads or are used upon his

farm; and some are entirely beyond his control, as waters and winds. These various means or agencies will now be considered in the order in which they have been mentioned.

1. *Seed grain, grass seed, clover seed, etc.* By no other agency, perhaps, are weeds so widely and so generally distributed as by the grain seed, grass seed, and clover seed used by the farmer, more especially the two latter. Carrying facilities are now so complete that seed intended for sowing can be brought from great distances to be sold in any market where there is a demand for it. This is particularly true of the less bulky and lighter sorts of seeds. Owing to the ready means which are thus afforded for obtaining supplies of these seeds, there is a tendency in those districts where fair yields are not commonly obtained to purchase them from distant parts rather than to raise them at home. The demand thus sustained encourages the growth of the various sorts of seeds in those centers that are found most suitable for them. Unfortunately, those centers which are generally possessed of unusual fertility oftentimes produce the seeds of hurtful weeds quite

as freely as those of the useful clovers, grasses, and grains; and owing, in very many instances, to their similarity in size to the useful seeds in which they are found (especially in grass or clover seeds), it is almost impossible, by any process of cleaning that may be adopted, to separate the seeds of weeds from the useful seeds which are intended for sowing. The distribution, therefore, of these weed seeds is as wide as that of the useful seeds in which they are found, and, it may be added, is as continuous. The seeds of millets are also a fruitful agency for the dissemination of weed seeds, though not perhaps to the same extent as are seeds that are smaller.

Renewing the stock of small grains by the purchase of new seed, or by the exchange for seed grown by others, is a common practice among farmers, and it has many things to commend it; but along with the new seed there too frequently comes an influx of the seeds of the most troublesome weeds. Although this is a less fruitful source of weed-seed dissemination than that which has just been spoken of, it furnishes the explanation of the arrival upon our farms of many forms of weeds, the pres-

ence of which we could not otherwise account for.

Moreover, farmers sometimes test by local trial the suitability of the various sorts of farm seeds that are to be obtained in foreign countries. This work has its dangers as well as its benefits. In the old world, as in the new, it is almost impossible to buy seed in the open market entirely free from the seeds of foul weeds. When foreign seeds are distributed through the medium of our agricultural experiment stations, a considerable degree of assurance is furnished the farmer that he will get pure seed; but it would probably be claiming too much for those stations to say that, even when the farmer takes this precaution, there would be no danger. As long as farm seeds are bought in the open market, there will be some danger that the seeds of noxious weeds will be brought to our farms by means of them.

2. *Farm live stock.* Very frequently weed seeds are introduced upon a farm by being carried in the hair or wool of live stock brought from other localities. Sometimes the weed seeds cluster about the hair of the mane and tail. When the animals are given

the freedom of a pasture, or, as is sometimes the case, the freedom of the farm, these seeds lose their hold, and, dropping to the ground, begin at once to grow and multiply. If a flock of sheep were bought in a locality where weeds abounded, and were brought to a clean farm, and there hurdled in a corner of a field while they were being tagged, the number and variety of the weeds that would be found growing in that spot the next season would be surprising. The writer can testify to the correctness of this statement from personal experience and observation.

Again, live stock distribute the seeds of various sorts of weeds by means of their droppings. This mode of weed distribution, though somewhat local, is very common, and should be borne in mind when removing cattle from fields infested with noxious weeds to other portions of the farm which, as yet, may not be infested with them.

3. *Purchased feed stuffs.* Weeds are very frequently introduced into new localities by being carried in the feed stuffs that are brought from distant places to supplement the food that is grown upon the

farm when local supplies run short. More especially is this likely to be the case in those localities where dairying or the fattening of live stock is carried on extensively. Weed seeds have long been thus distributed in both grains and fodders; but only locally, until recently, in the latter, owing to the difficulty which has existed of transporting fodder long distances. Now that fodders are baled for ease of transport, weed seeds are carried long distances in them as well as in grains. Indeed, fodders are now a more dangerous means of weed distribution even than grains, since fodders are usually fed without being subjected to steaming, while grains may be steamed or ground before they are fed, for the purpose of destroying the vitality of such weed seeds as may be found in them. Persons who purchase mill screenings which have not first been ground or crushed, and who feed them without steaming or grinding are certain to bring noxious weed seeds to their farms in countless numbers.

4. *Farmyard manures.* Weeds are distributed in countless numbers by the agency of barnyard manures, a fact which farmers generally know very well. More especially

are they distributed by means of the manures which are purchased in towns and cities, owing to the various sources from which the feed stuffs which are used in these places often come. The purchaser of feed stuffs in towns and cities has not the same interest in looking into the purity of what he buys as the farmer; hence it would probably be exceptional to find the manure obtained from him entirely free from the seeds of foul weeds. Although manure is one of the most common agencies by which weeds are distributed, the weeds that are distributed by means of manure are likely to be local in character, rather than distant and foreign.

5. *Packing-cases, crates, etc., that have been used for the carriage of goods.* Noxious weed seeds are frequently introduced into new localities by means of the straw or chaff in which goods have been packed for shipment. The packing-cases which have held the goods during transport are often purchased by farmers for other uses. When these are brought home by the purchasers, the packing material is thoughtlessly emptied out upon the manure heap or thrown aside, the weed seeds which it contains are

then given opportunity to produce plants in centers perhaps hundreds or thousands of miles distant from the nearest point where any of the same species may be growing. In this fact we find an explanation of the sudden appearance of weeds in new centers where their presence otherwise would be hard to account for; and this is more especially true of sections in proximity to cities.

As a similar method of weed distribution, it may be mentioned that in the days of early settlement, travelers used to carry many weed seeds in the provender that they brought with them for their horses, and which the animals ate by the road sides, or wherever convenient; and the same statement is true of the pioneer settlers of the Northwest, who thus often introduced weed seeds into their allotments before they sowed their first crop.

6. *Road and farm vehicles.* Noxious weed seeds are frequently brought to farms by the wheels of vehicles which have been driven along the highway. The spread of ragweed furnishes a familiar example of this sort of weed distribution. The seeds of this weed, and also of others that grow

along the public roads, are carried in the mud and dirt and dust that cling to the wheels of every passing vehicle, and in this way they are brought onto the farm. Sometimes they are thus conveyed for miles, not merely by the vehicles used by the farmer himself, but also by those belonging to others; from this sort of invasion the farmer is, in a sense, powerless to protect himself. In a similar manner, weed seeds are also conveyed from one part of the farm to another.

7. *Implements of tillage.* Weeds are, to a considerable extent, distributed by the ordinary implements of farm tillage, to which they cling during the various processes of cultivation. While this is true to some extent of all kinds of weeds, it is more especially true of those weeds which multiply by means of creeping root-stocks. These root-stocks readily cling to the plow, harrow, or cultivator, and are thus carried from one portion of a field to another, or even from one field to another; and thus new centers of distribution are constantly being established. This is especially true when the ground is so damp that it tends to stick to the implements used. Seeds or

root-stocks embedded in the earth that is thus carried from place to place are deposited in new centers, where they spring up to carry on the work of further multiplication. The distributing power of the implements of tillage under favorable conditions furnishes us with one explanation of the rapid multiplication in our fields of such weeds as quack grass and the Canada thistle, when once these pests have obtained a footing in them.

8. *Thrashing machines.* Thrashing machines, during the season in which they are used, are continually bearing the seeds of noxious weeds from farm to farm, and from district to district; for at every thrashing, if weed seeds are present at all, some of them are sure to become lodged in the various parts of the machines, and to remain long enough to be carried away. In this manner, from year to year, a very general local distribution is sure to be effected of every form of noxious weed which matures its seeds in a grain crop. Farms that are managed in the best manner often become thus infected with noxious weed life.

9. *Railways.* Railways seem to be a wonderfully effective agency in the distribution of weeds, by means of the fodder supplied to the horses and other animals used in constructing them, and the bedding of cars in which live stock is carried. The litter with which these cars are supplied frequently contains noxious weed seeds; these, falling to the ground, grow in the soil along the track and commence to reproduce their kind. A third explanation is found in the fact that oftentimes the weed seeds contained in the grain that is being shipped escape through leaks in the cars and fall to the sides of the track, where they often find conditions quite suitable to their germination. In these and other ways, the railways of the country have become largely responsible for the introduction of new and troublesome weeds into localities where previously they were unknown.

10. *Birds.* Birds carry weed seeds to great distances. A sprig of a plant on which the seeds have not left the capsules in which they grew is caught up by a bird and carried to some distant place where the food which its seeds afford can be enjoyed without molestation. Some of the

seeds thus carried fall by the way, and start new centers of weed distribution. The instinct for nest-building not infrequently leads to similar results. In this fact we find an explanation of the unexpected appearance of weeds along the edges of forests, and in other localities where the soil has never been subjected to cultivation.

11. Wild animals. Certain wild animals are the local distributors of weeds, for, being fond of a varied diet, they include the seeds of certain weeds in their list of desirable foods. Sometimes they bury or store away weed seeds when laying up their winter's supply. They also use the foliage and stems of weeds in building their lairs or nests. When gathering these, they sometimes attempt to carry loads which are more than they can manage, and so leave a part upon the way, for which they may not return. The seeds that are thus distributed here and there on the soil, or are dropped at the mouth of the burrow, or left unconsumed in the nest, spring at length into vigorous life, and commence again the work of weed distribution.

12. Waters. Few agencies are more potent in the distribution of the seeds of

weeds, especially of such seeds as float readily, than water. When the valleys are deluged by heavy rains, or when they are turned into streams or rivers by the melting of the snows, such weed seeds are carried in countless numbers to lower levels, on the soil of which they are deposited when the waters recede. A fresh seeding is in this way scattered from year to year over the surfaces that are thus exposed. At present, there is no effectual protection from this sort of invasion. So long as careless farmers on the higher grounds allow the seeds of noxious weeds to ripen annually on their fields, so long will the farmers on the lower levels have weed seeds strewn upon their fields in countless numbers. The only remedy is for the law in some way to intervene and compel the careless farmer to cease troubling, in this most reprehensible way, his unoffending neighbor.

13. *Winds.* Some forms of weed life are widely distributed through the agency of winds. This is especially true of those weeds, the seeds of which have downy attachments that enable them to rise in the air when they are fully matured. Happily for the agriculturist, many of the seeds so

endowed do not grow for lack of proper fertilization; but enough are fertilized to give the farmer much trouble. Hence many sorts of weeds are continually finding their way to new centers, to which they have a passage as silent as it is free. Some of these downy travelers are able to sustain their flight to incredible distances; others, on account of their greater weight, are carried but for short distances. It should certainly fill us with some concern to reflect that the winds while purifying the atmosphere, are also engaged, especially in certain seasons of the year, in scattering everywhere the seeds of many exceedingly troublesome weeds. While it is greatly important that no form of noxious weed should ever be allowed to mature its seed, it is doubly so in the case of weeds, the seeds of which are able to rise in the air.

Winds distribute the seeds of weeds by their driving as well as by their carrying power. The seeds of some weeds remain in their capsules long after their season of growth is over; in some instances even until the approach of spring. These are often shaken out by the force of the winter winds, and are driven incredibly

long distances, till at length they find a resting place. Then, when spring arrives, they begin their work of reproduction.

In the carrying and driving power of the wind, we find an explanation of what would otherwise be difficult of solution, namely, the sudden appearance of weeds in countless numbers in areas which have been broken for the first time, or from which the forests have been but recently removed. In some instances, the weeds appear in numbers so great that for a time they form the principal product of the soil. It is this phenomenon which has given rise to the baseless opinion, still cherished by many, that weeds originate spontaneously, springing into life without a seed germ, or else that they grow from seed which has been for ages lying in the soil.

14. Inherent powers of the weeds themselves. Weeds also spread and distribute themselves by means of what may be termed their own inherent powers; that is to say, by ripening seeds which are shed on the ground around the parent stem, or by means of creeping root-stocks. By the former method, whole families are often reproduced around one parent stem in a

single season ; and by the latter many weeds are continually spreading and occupying wider and wider areas. These powers of reproduction enable weeds to multiply rapidly, without the aid of any of the agencies previously mentioned, when once they have been brought into new centers by one or another of these agencies.

With the agencies that have been mentioned continually engaged in the work of weed distribution, and also with others that have not been mentioned, the task of the eradication of weeds at first thought seems appalling. While the power of weeds to multiply and spread is very great, the power of man to destroy them is greater, unless this limitless power is allowed to pass unutilized with the rush of crowding opportunities. While it is true that there can be no discharge in this war, it is equally true that there can be no defeat for the resolute tiller of the soil who persistently and constantly strives to keep his farm clean.

It has already been mentioned that over some of these agencies of weed distribution we can exercise but little or no control. These are the agencies of nature—as wind

and water, and such other agencies as wild animals and birds. So far as these are concerned, we must submit to the inevitable, and fight them, when we are subjected to their influence, as best we may. Our resource here is to kill the weeds as soon as possible after they appear, or at least before they mature their seeds.

Where the agencies are but partially under our control, as implements of tillage or thrashing machines, our duty is, by watchfulness, patience, and care, to control the agencies so far as we have power. The judicious exercise of this control will always be found easier than the eradication of the weeds which they have been allowed to bring to us.

When the agencies are practically completely under our control, as that of the inherent power of the weed plant to ripen its own seeds, or to spread itself by means of creeping root-stocks, the measure of the persistency of our efforts to defeat this power will be the measure of the time required to effect complete extermination. If weeds multiply upon our farms by the shedding of their seeds, it is because we allow them to do so; and if they multiply

by means of lateral root extension, it is because we do not use the resources which we have at command to prevent this extension. The farmers who tolerate either of these methods of weed distribution will never have clean farms. We sympathize with the man of scripture in whose fields, when he slept, the enemy sowed tares; but he deserves no sympathy who negligently allows weeds to ripen their seeds upon his farm, or to propagate themselves by means of root extension. Such a man is indifferent to his own true interests, for he allows voracious intruders from year to year to prey upon the sources of his own prosperity.

CHAPTER V.

METHODS AND PRINCIPLES GENERALLY APPLICABLE IN THE DESTRUCTION OF WEEDS.

In the conflict with weeds, there are certain general methods and principles which are applicable in a greater or less degree for the destruction of all weeds; and there are also certain specific modes of treatment which apply only to the eradication of particular sorts of weeds. In the present chapter we shall consider the general methods and principles applicable in weed destruction, and in the following chapters treat of the specific modes which are applicable only in particular cases.

The general methods and principles applicable in weed destruction which, in the writer's opinion, are of the most consequence, may be described as follows:



(1) The persistent and careful study of the habits of growth of all the various sorts of weeds with which one's farm is infested, so as to be able to deal with them in the most rational way possible.

(2) The modification (when necessary) of the scheme of rotation that has been adopted, so that such crops as allow the seeds of the weeds which infest them to ripen may, for a time, be omitted from the rotation.

(3) When certain methods of eradication have been fixed upon, the careful and wise adaptation of these methods to such conditions of soil and climate as are found in the locality concerned.

(4) The exercise of due care, when seeds are purchased, to see that they are perfectly pure, that is, perfectly free from the seeds of weeds; and also the exercise of due care with respect to such seeds as are grown at home to see that they, too, are perfectly free from weed seeds.

(5) The exercise of due care to see that the thrashing machine, especially when it comes directly from a farm infested with any form of noxious weed, is thoroughly cleaned before it is used.

(6) The exercise of due care to see that the chaff from the fanning mill, when it is suspected of containing any weed seeds, is burnt or otherwise thoroughly destroyed and that all screenings are also carefully looked after.

(7) The growing of cultivated crops upon the farm infested, to the largest extent that is practicable.

(8) The growing of clover and alfalfa, so far as this can be done with profit.

(9) The growing of soiling crops, to the extent that may be found practicable, both because of the fact that they can be cut almost at any time that is desirable, and also because of their "smothering" properties.

(10) The utilizing of sheep for the destruction of weeds in pastures.

(11) The growing at home, as far as possible, of the food required by the live stock of the farm, instead of purchasing it elsewhere.

(12) The keeping of the land of the farm constantly at work, so far as this can possibly be effected.

(13) The stimulation of the soil to a constantly vigorous production by means of

thorough working and a large use of manure.

(14) The practice of autumn cultivation to the largest extent that is possible.

(15) The exercise of the utmost possible precaution that no weed seeds ripen upon the farm, if by any means their ripening can be prevented.

(16) The sowing of two or three crops in succession the same season and grazing them down with sheep.

(17) The giving of due heed to all the agencies by which weeds are distributed and propagated, so as always to be able to counteract or defeat those agencies.

(18) When once the work of eradication has been undertaken, the making of it as thorough as possible, and the accomplishment of it in the shortest possible time.

(19) When once a state of cleanliness has been secured, the maintenance of it thereafter as perfectly as possible under all circumstances.

It is greatly important that these general principles and methods of weed destruction should be well understood and carefully observed; for these are even more important than those specific modes of weed

destruction which are described in the following chapters. In fact, unless in our management of the farm we pay the utmost heed to these general principles and methods of weed destruction, we can never hope to be completely successful in our war with weeds. As the writer has made it his habit for many years to test the value of these general principles and methods by constantly putting them into practice, he will here set down in specific directions, for the benefit of his brother farmers in this most important question of weed destruction, such remarks as he thinks his experience entitles him to make.

1. *Study their habits of growth.* In the war with weeds, we must study their habits of growth, and adapt our methods of fighting them to fit in with these habits. Weeds, like other plants, are classified as annuals, biennials, and perennials.

Annuals, as their name implies, complete the cycle of their existence in a single season, although in some instances they may start growth in the fall, particularly in the warmer sections. They are then called *winter annuals*. Common examples of this class are shepherd's purse, chickweed and

cheat, while among our cultivated crops, winter rye and winter wheat are winter annuals. More commonly, annuals begin to grow toward the approach of spring. Common examples of summer or ordinary annuals are ragweed, foxtail and pigweed, while among our cultivated crops we have corn, oats, flax, spring wheat, and many others. It follows, then, that as annual weeds can live but a single season, if the plants of any particular sort of weeds of this class on any farm are prevented from ripening their seeds year by year through successive years, the time must come sooner or later when that sort of weed will be completely destroyed on that farm. This is true whatever may be the means that may be adopted to prevent the seeds from ripening. In fact, the weeds would all be destroyed in a single year were it not that many seeds have great power to resist decay, and many remain in the soil for many years without their vitality being lost or even impaired. Some seeds of this class of weeds, as those of wild mustard, retain their vitality for an incredible length of time; so that whenever they are brought sufficiently near the surface by cultivation,

or by other means, at any time during the congenial season of growth, they at once spring into vigorous life. The means to be taken in destroying weeds that are annuals should be, first, to prevent them from maturing their seeds; and, second, to adopt such modes of cultivation as will most quickly force the seeds that are in the soil into germination, so that they may spring up and be destroyed. The means best fitted to secure this quick germination of the buried seeds of annuals are the growing of cultivated crops and "autumn cultivation." At all events, when the seeds of annual weeds are kept from ripening year after year, and when the agencies concerned in their dissemination are effectually looked after and checkmated, the time cannot fail to come when this class of weeds will all be destroyed.

Biennial weeds complete the cycle of their existence in two years. Many of them are characterized by a tap root, growing deep into the soil. During the first year large quantities of starch are stored up in this root, which is utilized the next year in producing an abundance of seeds. The burdock furnishes an excellent example of

this sort of weed, being well known and common in many lands, while among our crop plants red clover is our most common biennial. As biennial weeds are reproduced from seed only, it is evident that any mode of destruction that will prevent them from producing seed will also in time effect their destruction, but it may take years to accomplish this, as the seeds of this class also have great vitality. Fortunately, however, biennial weeds cannot well resist the destructive effects upon their roots of thorough cultivation; hence we find this class of weeds more common in old meadows and pastures, along roadsides, and in waste lands generally, than in fields that are cultivated. In areas which cannot be cultivated, therefore, their destruction is more difficult than elsewhere. To destroy them in these places persistent cutting with the mower, scythe, or spud is the only method that can be adopted; but it should be borne in mind that with many varieties of biennial weeds there is not only a great persistency of growth, but also, during the second year, a great persistency of effort to produce their seeds, even though they are cut off several times during the season.

Perennials, as their name implies, live from year to year. Of perennial weeds there are two classes, viz., the perennial with an ordinary root, and the perennial with a creeping root-stock. The perennial weed with an ordinary root-stock, or, as we may call it for our purpose, the *ordinary perennial*, is reproduced from seed only. The ox-eye daisy is a common example of this sort of weed, and the plantain is another, while alfalfa is a perennial field crop. The *creeping perennial*, as we may call it, is not only reproduced from seed, but is also propagated by means of its horizontal root-stocks, which run, or "creep," through the soil in various directions from the parent stem. These creeping root-stocks are furnished with many latent buds, each one of which, under conditions favorable to vigorous growth, is capable of sending up a fresh plant to the surface. It follows, then, that the cultivation which does not weaken and destroy creeping perennials necessarily favors their increase, inasmuch as a soil that has been recently stirred is more easily penetrated by the creeping root-stocks than one that has not been so stirred, and has become more compact. Whenever

any disturbing action is brought to bear upon these root-stocks, as, for example, breaking them off from their parent stem by the implements of tillage, a fresh impulse is given to their growth. Each rootlet so severed attempts to develop into a complete plant. Hence it is that, in moist weather, ordinary cultivation is more likely to promote than hinder the growth of this class of weeds. The influence of summer-fallows and of cultivated crops which are poorly cared for, is also in the same direction. Creeping perennials are also likely to cling to the implements of tillage, and thus be carried from one part of the field to another, and even to other fields. The Canada thistle, the common sow thistle, and quack grass furnish familiar examples of creeping perennials; and we are sure the experience of our readers will bear us out in what we have just said of the tendency of cultivation, in moist weather, to promote their increase.

To destroy creeping perennials we must labor either to smother them, or else by cultivation to bring their roots to the surface, where they will perish by exposure to the air and sunshine. By "smothering"

them is meant keeping them constantly under ground. If creeping perennials are kept beneath the surface of the ground for some months during the early spring and summer, they will perish in a single season, and this result will be gained whatever may be the means made use of to effect it, whether spudding, plowing, cultivating, or covering.

It is sometimes asserted, and the assertion is commonly accepted as true, that creeping perennials are more difficult to destroy than other classes of weeds. This assertion is supported by the specious argument, that whereas creeping perennials have two means of propagation, (1) their seeds, and (2) their creeping root-stocks, which push their way through the soil in every direction, annual and biennial weeds, and ordinary perennials also, have but one means of propagation, namely, their seeds alone. It should be remembered that, in making this comparison, other things have to be considered. We must also take into account the number of seeds produced by each sort of weed, their vitality, and the modes by which these seeds are distributed and fresh plants produced, the crops that

are infested by each particular kind of weed, and the power which the various kinds possess of maintaining themselves in permanent pastures and waste places.

Some annuals, such as ragweed, bear seeds in almost countless numbers, whereas the number of seeds produced by creeping perennials is usually not very large. The diversion of the energies of creeping perennials from seed-bearing to increase by means of their root-stocks is, therefore, so far unfavorable to their reproduction that the excess of seed production in annuals not infrequently more than counterbalances the advantage gained by creeping perennials by reason of the dual powers of propagation which they possess. Moreover, the vitality of the seeds of some sorts of annual weeds, as those of wild mustard, is so great that they seem to be able to retain their ability to grow for a much longer period than the seeds of creeping perennials. Again, when the seeds of an annual or biennial weed are transported from place to place by water, or by animals, they are given an advantage which goes far to match the more dangerous powers possessed by the seeds of some perennial weeds, such as the

thistle, in their ability to travel from place to place through the agency of winds. Weeds which mature their seeds along with those of the clovers and grasses, as many ordinary perennial weeds do, are much more likely to be widely distributed than those which mature their seeds along with those of cereals, owing to the great difficulty that is experienced in separating the seeds of weeds from the seeds of clovers and grasses. Again, some forms of weed life, particularly some biennial weeds, find a congenial and permanent home in pastures and waste places, although in cultivated fields they might not prove very harmful. The labor required to remove these weeds from such places is very great, as it has generally to be done by hand; whereas in the same localities annuals and perennials may not be able to get a footing, because of unfavorable conditions. On account of these conditions, and of others not named, such as the congeniality or uncongeniality of soils, it will be found that in some localities the weeds most difficult of eradication will be annuals, in others they will be biennials, in others they will be ordi-

nary perennials, and in yet others, creeping perennials.

2. *Modify the rotation.* In the conflict with weeds, it is greatly advantageous to drop out of the rotation for a time such crops as allow the weeds which infest the soil where they grow to ripen their seeds. Some weeds, as, for example, those which grow as winter annuals, ripen their seeds early in the season. The seeds of these weeds mature in crops of winter wheat, rye, and hay, but ordinarily they do not mature in spring cereal crops, for the reason that these weeds begin their growth in the previous autumn. If, therefore, in the infested fields winter wheat, rye, and hay are dropped out of the rotation for a short time, and spring crops grown in their stead, the destruction of the weeds mentioned and of those of kindred habits will be greatly facilitated. Other weeds ripen their seeds late. Ragweed, for example, more commonly grows up after the early cereal crops and meadows have been cut, and, if undisturbed, it matures its seeds before frost. Grass seed, therefore, in fields infested with this sort of weed, should not be sown for the purpose of producing meadow until the

ragweed seeds have become greatly reduced in number through the growing of crops which require late cultivation. Other weeds, such as the Canada thistle, grow in all kinds of crops, so that when a piece of ground is badly infested with them some kind of cultivated crop should be grown upon it, as the constant cultivation required will tend to destroy them while the crop is growing.

Farmers are usually much averse to a modification of their fixed scheme of rotation, even for a limited time; and more especially so when the modification interferes with those crops which have been their chief source of cash revenue. Notwithstanding this, the truth remains that where the modification required for the destruction of any sort of weed is not made, the ultimate eradication of this weed will be found a very difficult matter.

3. *Adapt methods to conditions.* In our attempts to eradicate weeds, we should carefully adapt the methods that we follow to those conditions of soil, climate, cultivation, etc., which we find to exist. These conditions have, of course, an important bearing on the growth of weeds, and, therefore, upon their destruction. In stiff

clay soils with a hard subsoil, the Canada thistle, for instance, can be destroyed by simply turning the land into pasture, and mowing down the thistles when in blossom, and again at a period considerably later. On other soils of more open texture this mode of destroying thistles would not succeed for a long time, if at all. In some climates a considerable proportion of the seeds of the Canada thistle are fertilized, and will therefore grow; while in other localities it does not seem very harmful to allow the thistle to be harvested along with the crops in which they ripen, because of the inability of their seeds to grow for lack of proper fertilization. Other kinds of weeds, as sheep sorrel, are almost harmless in certain sections; whereas in others they become great pests. Where winter wheat or rye is grown extensively, specific measures might be necessary to destroy winter annuals; whereas, if the wheat or the rye were not of much account in the rotation, it would be an easy matter to get rid of this class of weeds by growing spring crops successively for a few years.

If, therefore, we wish to destroy a particular sort of weed with the least possible

expenditure of labor, we must study the habits of that weed as affected by the conditions under which it grows. Under some conditions, ordinary "good farming" will generally banish a weed; while under others "specific methods," energetically and persistently applied, will be absolutely necessary. It is apparent, therefore, that for the destruction of weeds hard and fast rules that will be equally applicable under all circumstances cannot be laid down, for what would be a proper course to pursue under some conditions may be wholly unfit under others.

4. *Sow only clean seed.* Where farms are to be made clean, and to be kept so, great care should be exercised in the purchase of seeds, and also in the preparation for the sowing of those grown at home. The distribution of weeds is more widely effected through the agency of the seeds sown for useful crops than in any other way, as was shown in Chapter IV. It has, doubtless, been through this agency that nearly all our foreign weeds have been brought to our land. It is not enough for the seedsman to assure us that his seeds are clean, for he may be deceived himself. If his

small seeds have not been carefully hand-picked, he can have no certain assurance except by critical examination that they are clean; and in the preparation for sowing of the great variety of seeds in which he deals hand-picking is out of the question. Purchased seeds, therefore, should not only be examined with the utmost care, and be cleaned again if weed seeds are discovered in them, but the crops that are raised from them should receive the most careful scrutiny while they are growing, so long as there is any ground for suspecting that weeds also are growing among them. As weed seeds are oftener carried in the seeds of clovers and grasses than in other ways, particular care should be exercised in the purchase of any seeds of these crops.

It may, indeed, be wise to grow at home many sorts of seeds that are now commonly purchased, or else to buy them from a neighbor who has a reputation for growing pure seeds. It would be well, too, when attempting to raise one's own seed, to select but a small portion of the crop for this purpose, and to take special pains to prevent any noxious weeds from maturing their seeds in this portion; and this plan should

be followed with all the crops grown for seed, especially grasses and clovers. It has already been mentioned that weed seeds frequently come to us in the seed grains brought to our farms for the purpose of effecting a change of seed. The danger here, though not easily altogether averted, may yet be lessened. If the seed of all cereal grains were carefully prepared by such a process of screening as would sift out all the smaller seeds from it, deterioration in the seed of this class of crops would be very much less rapid than it now is, and a change of seed would much seldomer be required. The farmer who is so careless as to sow unclean seed of his own raising, or so foolish as to purchase unclean seed from the seedsman because it can be bought cheaply is, however, not likely to be greatly concerned as to whether his farm is clean or is not clean.

5. *Thoroughly clean the thrashing machine before using it.* Thrashing machines, especially if they come from a farm with a reputation for uncleanness, should be carefully swept before being set to work. If, in addition, they are made at the first to run empty for a short time,

and the seeds that are caught in the grain box are destroyed, the danger from them is even more completely averted. Because of the fact that thrashing machines are often instrumental in carrying weed seeds from one locality to another, it has often been found advisable for several farmers to club together and purchase a machine of their own. For the same reason, small machines run by tread power are sometimes used by individual farmers. However, these methods of fighting weeds have obvious disadvantages which will prevent their general adoption.

6. *Give attention to grain screenings.* The chaff and screenings from the fanning mill should receive the most careful attention. Whenever weed seeds are suspected, the chaff from the winnowed grain that is being prepared for market, or indeed for any other use, should be burned. The screenings should be ground, boiled or steamed before being fed; or if fed otherwise, they should be strewn on surfaces where the weed seeds they contain are not likely to do any harm. The proportion of weed seeds grown in a crop which collect in the screenings obtained in cleaning it is

relatively very large; hence the opportunity to destroy these weed seeds, when they are thus collected, should by no means be neglected.

7. *Grow cultivated crops.* Wherever it is desired to subdue noxious weeds *wholly*, cultivated crops should be grown to the greatest extent that is practicable. The reasons are obvious. The cultivation of these crops gives opportunity, at almost every period of the growing season, for the combating of almost every form of weed life. The working of the soil necessary for the production of good crops not only destroys, from time to time, the weeds that are growing in them, but it also stimulates the germination of the weed seeds lying in the soil, so that they, too, grow up and are destroyed; and in this way it greatly reduces their numbers in a single season. Many farmers cling to the opinion that, in the fight with weeds, cultivated crops are not very helpful. They point to the fact that they have grown these crops from year to year on the same fields, yet the weeds in these very fields have increased. This may have been true, but when it has been so, the crops have cer-

tainly not been properly cared for; for otherwise the weeds would have gradually decreased, rather than increased. No other result could possibly follow where a succession of cultivated crops had been raised, in which no weed had been allowed to ripen its seeds. Other farmers cling to the opinion that, whatever may be the value of cultivated crops for destroying weeds in general, they are not helpful in the fight with creeping perennials; or, at least, that these crops are not so effective as the bare fallow for the destruction of creeping perennials in a single season. This view is a mistaken one. It has arisen, doubtless, from the too common practice of staying the destructive processes too early in the season. Going over the crop with the hand hoe once, twice, or oftener, after horse cultivation ceases, and removing all stray weeds that may appear, will, as a rule, make a thorough job of the work of destroying creeping perennials, except so far as their seeds remain in the soil. The weather must, however, be fairly dry if success is to be complete.

It is only too true that where cultivated crops are grown, and sufficient attention is

not given to the work of keeping them quite clean, their growth only serves to encourage the increase of weeds in general, and of creeping perennials in particular. Their cultivation furnishes conditions very favorable to the lateral extension of the root-stocks of creeping perennials. It is also equally favorable to the development in robust vigor of annuals; so that it not infrequently happens that where a cultivated crop is grown, and sufficient care is not taken with it, these annual weeds perfect their seeds in great numbers, thus making the state of the field at the end of the season, so far as weed seeds are concerned, worse than it was at the beginning. Where cultivated crops cannot be grown successfully, that is, so far as weed destruction is concerned, a modified form of the bare fallow, as described farther on in this chapter, may take their place.

8. *Grow clover and alfalfa.* Where the conditions are favorable to their growth, the raising of crops of clover and alfalfa will be found helpful in the reduction of weeds; and more especially is this true of the common red clover. These crops are not only valuable in weed destruction

because of the frequency with which they are generally cut, but also because of their "smothering" tendencies, especially on good soil and in suitable seasons. Common red clover may generally be cut twice a year—a process which usually renders it impossible for perennial weeds growing in it to ripen their seeds the same season. Alfalfa may generally be cut oftener than twice a year. When a luxuriant growth is obtained, both these crops tend to smother and weaken the perennial weeds growing among them. When these crops are grown to be cut for fodder, the ripening of annual and biennial weeds growing among them is also pretty effectively hindered, but if they are allowed to mature their seeds, some kinds of weeds will also ripen theirs along with them.

Although alfalfa is even more valuable than common red clover for the purpose of checking the ripening of weed seeds, owing to the greater frequency with which it is cut, yet since it can be grown only on certain kinds of soils its use as an aid in weed destruction is considerably circumscribed. Both crops are also excellent for other purposes, as the bringing of nitrogen

to the soil when they are plowed under, and so providing a more abundant store of this most necessary plant food; hence much attention may consistently be given to growing them for other reasons than the service which they render in weed destruction. It may also be mentioned that after the last cutting of these crops for the season the ground may very profitably be gone over with the spud for the purpose of destroying the creeping perennials which may then be growing. This last precaution will be found to be greatly helpful in speedily completing the work of extermination.

9. *Grow soiling crops.* In the work of eradicating weeds, crops which are to be cut green for feed will be found very helpful, especially where the other requirements of the farm render it advisable to grow them. This is owing to their smothering tendencies; to the fact that they can be cut before certain weeds which grow in them have opportunity to mature; and because in many instances two soiling crops can be grown in a single season, hence the benefits derived from their cultivation can to some extent be duplicated on the same soil in the same year. As these crops are not

designed to mature their seeds, they may be sown more thickly than other crops; hence their smothering power is greater than if they were grown for the grain to be obtained from them; yet if they are required for winter fodder, they may be allowed to become so nearly ripe before being cut that their grain is mature enough to possess considerable feeding value, without allowing many of the sorts of weeds that grow among them to mature their seed. For example, they may be grown in this way and yet be cut before such weeds as the Canada thistle or the perennial sow thistle have opportunity to ripen their seeds; hence the cultivation of soiling crops has a tendency to weaken the vigor of these weeds, and to prevent their further increase. Some of the most mischievous annual weeds and biennial weeds may be prevented from ripening their seeds in these crops; in fact, many of these weeds cannot possibly ripen their seeds if the soiling crop amid which they grow is properly looked after. Because of the further fact that frequently two soiling crops may be grown upon the same field during the same season, the cultivation of these crops becomes an excellent means for

destroying a specially troublesome weed like the Canada thistle, whose habit leads it to grow throughout the whole season, as well as such weeds as mature their seeds very early in the season, or such as mature their seeds very late; or, if it be desirable to take advantage of it, the growing of an early soiling crop gives opportunity for subjecting lands to the fallow process.

10. *Call in the aid of sheep.* Those who have had experience in keeping sheep do not need to be told that where sheep are kept in sufficient numbers some forms of weed life soon entirely disappear, that other forms are much crippled in their powers of growth and so gradually disappear, while still other forms are weakened though they may not be entirely destroyed. On pasture lands with stiff clay subsoils, sheep will eventually prove more than a match for the Canada thistle, if the pasture is at all times kept closely eaten, but several seasons of such cropping may be required to effect this end. Nearly all biennial weeds and some perennials as, for example, the ox-eye daisy, will be greatly checked when thus pastured; and the same is true of some annuals, as ragweed and wheat thief. If sheep are

thus allowed to act as scavengers, they will render excellent service in the work of weed extermination, more especially in permanent pastures, on private roads, along fence borders, in grain stubble and in corners and waste places generally. In order that this work may be done thoroughly, the pastures should be kept closely eaten from early spring. Many weeds are then so tender and succulent that the sheep will eat them; whereas, when the weeds are at a more advanced stage of growth, they will persistently reject them, unless they are impelled to feed upon them through the sheer force of hunger; and when weeds are thus kept closely cropped, the hand cutting or hand spudding that may be required to complete their destruction is greatly reduced. There is probably no way in which weeds can so profitably be used as by turning them into mutton.

II. Grow food supplies at home. To aim to grow food supplies at home, rather than to purchase them elsewhere, is a safe rule in farming, viewed from the standpoint of economy, even when the question of weeds is not taken into account at all. It is a rule that is much affected by considerations of

location, soil, climate, and other conditions, and is therefore not without its limitations; but so important is it, notwithstanding all these considerations, that the aim should usually be to grow food supplies at home to the greatest possible extent. The effort thus made to increase production will prove greatly advantageous in reducing weeds. For example, when corn is grown for the silo to be used as winter fodder, it gives ample opportunity for checking those weeds which may attempt to grow in the corn; whereas if they grew among crops that were raised for the sake of the grain to be sold from them, they might not be equally effectually disturbed; and it is generally evident that where food supplies are grown at home, the farmer has power to prevent the weeds which grow in the crops producing them from ripening their seeds, a power which he cannot possess when the food supplies are purchased elsewhere. It is true that the purchase of food supplies on a more or less extensive scale is sometimes a necessity, as where dairying and the keeping of live stock are largely engaged in, but all grains so purchased, when the presence of weed seeds in them is suspected,

should be ground or steamed before being fed, as was mentioned in Chapter IV. Even when such grains are fed to sheep, unless they are ground, a portion of the weed seeds contained in them is sure to find its way into the manure, and thus into the soil of the farm. When fodders containing weed seeds are purchased, the seeds contained in them cannot be prevented from getting into the manure unless the fodder is cut and steamed, a practice which is generally impracticable.

12. Keep the land constantly at work. In the conflict with weeds, the land should be kept constantly at work. Upon some kinds of soil we can easily get two crops a year; and where this can be done, the necessary cultivation will be found very helpful in the work of destroying weeds. The nature of the crops to be so raised will naturally depend largely upon climate, soil, and the requirements of the farm. As was mentioned above in section 9, two soiling crops may sometimes be grown the same season. Again, an ordinary crop of grain or of meadow may generally be followed by a catch crop. In many sections, rye may be sown in the autumn, and be followed the

next spring or summer by a crop of corn, roots, or rape. When this is done, the rye may be cut green or plowed under as a green crop. Such soiling crops as oats and peas may be grown, and be followed by rape, turnips, or some other quick-growing crop. When the soiling crop has grown vigorously, and is followed by one of the crops mentioned, grown in drills and cultivated, the effects in the way of weed destruction are very marked. As all these crops are of use only for feeding stock on the farm at home, the process of incessant cropping, such as we have here described, is helpful rather than otherwise to the fertility of the soil. There is the further advantage in thus keeping arable soils at work, that the nitrates of the soil are largely prevented from being washed out by rains.

13. *Stimulate the land to produce plentifully.* Weeds can be much more easily dealt with when the land is kept constantly stimulated to vigorous productivity than when the soil is left to run down and become infertile for lack of proper manuring. When crops are strong, weeds do but little harm in them, compared with the

injury they work when they are allowed to grow amid crops that are thin and poor. When the soil sustains a vigorous growth, the useful crops leave many forms of weeds behind in the race, especially in the early part of the season. Where the growth is vigorous in the early stages of the crop, the weeds have much less opportunity of monopolizing the growing area. Growing good crops is synonymous with good farming; that is, the raising of good crops is in itself a great hindrance to the multiplication of weeds. This agrees with the well-known fact that the spread of weeds is usually much more rapid and complete in impoverished farms than elsewhere, hence those who desire clean farms will have done much to secure the desired end when they adopt such measures as will also maintain them in a high state of fertility. Much may be done in the way of securing this fertility by growing catch crops for feeding off or plowing under after the earlier crops of the season have been removed. In all localities where the climate is not too severe, peas, buckwheat, and rape may all be grown as catch crops. The cultivation requisite for preparing the ground for these

crops is also good for the destruction of weeds. It may happen sometimes that the season will be so dry that the seeds sown for catch crops will not germinate; when such is the case, the dry weather which produces this result will also be hurtful to the growth of weeds.

14. Practice autumn cultivation. In the war with weeds, one of the very best methods to be adopted is "autumn cultivation." It is questionable if any other means can be made use of that will so well repay the outlay. Autumn cultivation means the tilling of the soil after harvest with a view largely to weed destruction. As soon as the crops are removed, the land that is not sown to grass should be plowed. All weeds that are above the surface of the ground at that time are thus turned under, while the weed seeds lying in the soil are encouraged to germinate. The weeds that grow from these may be destroyed by harrowing or by cultivating, or by the late autumn plowing that just precedes the advent of winter. In this way myriads of weed plants will be got rid of in a single season.

There are two real difficulties which stand in the way: (1) The season at which

this work is to be done is a busy one; and (2) there is frequently too little horse labor available for the purpose, for the reason that too little is kept on the farm. The advantages of this method of destroying weeds are so very important that it is absolutely essential that much effort should be made to secure them. It may be remarked that when catch crops are grown for turning under as green manure, the necessary plowing after the harvest of the main crop, and the plowing under of the green crop for manure are much the same as would be required as autumn cultivation for the purpose mainly of destroying weeds, while if the catch crop has been successful, there is an increase in the fertility of the soil by the application of the green manure.

15. *Allow no weed seeds to ripen.* We should never allow noxious weeds to ripen their seeds, if it is at all in our power to prevent their doing so. When the cleaning of a farm that is foul with weeds is first undertaken, it may not always be possible to hinder the ripening of the seeds of the weeds that infest it, but the ripening may usually be very largely prevented by modifying the rotation for a time. When once

a farm is fairly well cleaned, then it is simply inexcusable to allow noxious weeds—at least those which are most troublesome—to mature their seeds. To allow them to do so is to show an indifference to one's best interests which cannot be defended.

The specific modes of hindering weeds from ripening their seeds will of course vary with the particular weed, and also with the crop in which it grows. Several of these specific modes will be described at length in the following chapter.

As was said above, one of the best and most reasonable means that can be adopted for preventing weeds from ripening their seeds is by a modification of the rotation. The correctness of this opinion will at once be apparent when we think, first, of the unreasonableness of growing a crop a very large portion of which consists of weeds, while we may just as well grow some other crop that will mature at a different season and be comparatively free from weeds; and, second, that with some crops, certain weeds cannot be prevented from ripening in them without the infliction of considerable injury to the crop amid which they grow. In any case, however, the hope of

having a clean farm is a vain one if noxious weeds are allowed to ripen upon it even in quantities ever so limited. If any weeds are allowed to ripen their seeds, the farm will never be wholly clean, notwithstanding the fact that the number of weeds may be very considerably reduced.

16. Graze off several crops in succession with sheep. There is probably no more effective method of fighting weeds, especially annuals, than by growing two or three crops in succession the same season and grazing them down with sheep. To do this effectively it is necessary to have two or three fields or enclosures, in which there can be alternation in production and in grazing. The following are among the advantages of this method of attacking weeds: Germination is encouraged in the seeds, especially in the seeds of annuals that may be lying in the soil; the weeds thus germinated are eaten by the sheep along with the other grazing; a very large quantity of grazing relatively may thus be produced from a small area of land; the land is thus put in excellent condition for growing the grain crops that will follow such grazing. Among the crops best adapted to provide

such grazing are winter rye and other small grains, rape, corn, and sorghum. The experience of the author in thus fighting weeds at the Minnesota experiment station was very satisfactory.

17. *Give careful attention to all modes of weed distribution and propagation.* It was stated in Chapter IV that we cannot control some of the modes by which weeds are distributed, that some of them we can but partially control, and that yet others are completely under our control. So many and so varied are the agencies by which weeds come to us, and so many are the means by which they are then propagated, that we cannot afford to give small heed to any of these agencies and means. It will not suffice to concentrate our energies on keeping weeds at bay in one direction when at the same time they come to us in various other directions. Such a course would be about as wise as to try to keep out the waters of a rising tide by closing one breach in the embankment while several others are left open. When everything has been done in this direction, weeds will still come to us. When this is so, there is only one

resource left to us. This we will now describe.

18. Make thorough work. When the eradication of weeds is undertaken, the work should be made as complete as possible, and be effected in the shortest possible time. The cheapness of the process is usually in direct porportion to its completeness, and to the brevity of the period occupied in completing it. It is quite possible to destroy creeping perennials in a single season, except only as to the seeds which remain in the soil. It is the lack of thoroughness in the modes usually adopted, rather than the modes themselves, that renders the destruction of this class of weeds so extremely difficult and so expensive. As a rule, creeping perennials are merely checked by the cleaning processes employed, and by no means destroyed by them. Hence the root-stocks left in the soil at once commence to grow. They push out in every direction. They are carried to and fro with the plow and spring into life everywhere, so that in from two to four or five years they have so possessed the soil again that a similar process of reducing them will have to be

undertaken. Whereas, had these weeds been completely destroyed in one season, and proper means been taken for removing those which afterwards came up from the seeds that remained in the soil when the cleaning process was being accomplished, then the cleanliness of the field would have been maintained, and at a cost that would have been merely nominal as compared with the cost involved in cleaning the field anew. The greatest mistake that can be made in the war with weeds is to carry it on with a lack of thoroughness, when once the war has been undertaken. Men clean *at* fields rather than *clean* them. They reduce weeds, but do not subdue them. To make thorough work may seem costly at the time, but there is no way of getting rid of weeds so cheaply as when the work is done in a comparatively short time.

19. *Maintain cleanliness.* Where cleanliness has once been secured, it should be maintained from year to year at all hazards. To effect this, two things at least are required. First, the general management of the farm must be good, so that good crops may ordinarily be grown, and

second, every portion of the farm must be gone over once or twice a year with the spud, except that part which is devoted to hoed crops. The meadows should be gone over once or twice, according to the weeds that grow in them and the time at which the hay is to be cut. If thus gone over before the time of haymaking, such weeds as dock, the ox-eye daisy, sheep sorrel, and plantain, which would otherwise ripen their seeds, will be destroyed, as well as any other weeds that may be there. After harvest they should be gone over again as often as necessary for the purpose of cutting off the stray thistles or ragweeds, or any other kind of weeds that may be trying to retain a footing. In the same way, the grain crops should be gone over before they head. Where these have been sown with the drill, this may easily be done without injury to the crops. If the grain fields have also been sown with grass seeds, they should be gone over again after harvest; but this will not be necessary when autumn cultivation is to follow. Permanent and other pastures, fence borders, private roads, and waste places should all be gone over twice a year with the spud.

Notwithstanding the great value of the spud in maintaining cleanliness on farms, it must be used with discrimination. When the weeds are numerous beyond a certain limit it will not pay to use the spud. What that limit is will depend somewhat upon the scarcity of labor, and the difficulty experienced in securing it and paying for it. It is not possible to fix a limit that will apply equally well in every case, but in the judgment of the writer, unless the spudder can get over from three to five acres a day, it is at least an open question whether some other mode of reducing weeds should not be resorted to instead. The spud is designed rather to maintain cleanliness than to secure it; although, to a considerable extent, it is helpful for the latter purpose also.

The method of procedure in cleaning a farm, where the work is to be economically done, will be somewhat as follows:

(1) The effort must be put forth to prevent any new seeds from maturing on the farm. It may not be possible to secure this result at first on all parts of the farm, owing to the costliness of the work, and to the amount of labor involved in it; in time,

however, where judicious measures have been used, the end will be attained without great difficulty.

(2) One or two fields should be set aside each year to be cleaned, these being chosen with reference to the rotation, and to the resources of the farmer, and the work of cleaning these fields should be made as thorough as it would be reasonably possible to make it in one season. As each field is thus freed from noxious weeds, cleanliness should be maintained in that field by the use of the spud, until, in the order of the rotation, the field will have cultivated crops grown upon it, by which means the cleaning process will be still further carried on.

(3) The pastures and waste places of the farm should, from the commencement of the cleaning process, be gone over twice a year with the spud. If it happens that in these places the weeds are too numerous to be dealt with by the spud, the scythe or the mower should be used instead. In a few seasons, if thus dealt with, these places will be quite free from noxious weeds. The time occupied in cleaning the farm will depend upon the rotation. It should

be practically free from weeds by the end of the first rotation, counting from the beginning of the undertaking.

Many farmers, however, look upon the use of the spud in any way as a chimerical idea. They object to it on the score of the cost of the labor involved in its use; while the truth, in the mind of the writer at least, is beyond the shadow of a doubt that by no other conceivable means can freedom from noxious weed intrusion be maintained so cheaply, or, indeed, be maintained at all. The matter stands thus: In ordinary practice, the spud is *not* used. The farmer selects a field to be cleaned by the bare fallow or some other process. Fairly good work may be done; but some weeds are sure to be left in the soil, while also some seeds of weeds lie there which will germinate and reproduce their kind in abundance. Unless the field be gone over with the spud after the manner we have here described, it is entirely probable that in from three to five years the field will be as foul with weeds as when taken in hand at the first. On the other hand, if the spud is used in the manner that we have indi-

cated, all stray weeds will be cut off before they can do any harm.

The cost of maintaining freedom from weed intrusion, where once a state of cleanliness has been attained, should not be more than \$30 or \$40 a year for every one hundred acres of land. This estimate is based on the supposition that all the methods of cultivating and managing the crops grown upon the hundred acres are as they ought to be.

With respect to the cost of the weed-cleaning process, it may be mentioned here that when a state of cleanliness has once been secured, the cost of maintaining this state of cleanliness by means of the spud is the only direct charge to be made, for the expense incurred in cleaning crops and in destroying weeds by all the other means described in these pages should be more than met by the increased returns which the crops will show by reason of the improved cultivation which the weed-cleaning process necessitates. On the assumption that every part of a one hundred acre farm be gone over twice a year to keep it free from weeds, and on the further reasonable assumption that the cost of

labor involved in doing this for a day of ten hours is from \$1.50 to \$2.00, the entire outlay for the whole work would not be more than the sum already named, \$30 to \$40. When once a farm has become fairly clean, a workman should easily be able to go over it with a spud at the rate of ten acres a day. That this is possible has been demonstrated over and over again, in the experience of the writer, in the work of cleaning the Ontario Agricultural Experiment Station Farm at Guelph. Ten acres have been frequently gone over in half a day, and in one instance twenty acres were done, but these results grew out of more than ordinary effort and are to be regarded as exceptional. One person can, however, easily get over ten acres in a day, even when some hundreds or even thousands of weeds are to be destroyed. Twenty days thus employed should take the spudder over the farm twice, hence the cost would not be more than the sum named. The whole farm would not, however, require to be gone over thus twice a year. One field of the farm would probably be devoted to a cultivated crop, and would not require any spudding. Several fields

which had produced grain would not require to be gone over more than once, for the reason that they would be plowed or cultivated soon after harvest as a part of the "autumn cultivation," and pastures would soon become so clean that one spudding in a season would suffice for them also. Hence the outlay for spudding should not be more than \$25 a year.

It is certainly unfortunate that the spud is so little known, and so little used in perfecting and maintaining cleanliness upon farms. It is well to remember that those who are most averse to using the spud are usually those who have never used it, and that those who have once tried it fairly are always unwilling thenceforth to abandon its use.

A little reflection will make it clear that the spud is of the greatest use in maintaining cleanliness on a farm. Suppose a ten-acre field in which a crop is growing has only a few thistles in it—so few, perhaps, that the farmer thinks it scarcely worth while to do anything with them. But it may, at the same time, have some dock plants in it, and a few stalks of mustard, a small number of ragweeds, and a few

other noxious weeds; while in the fence corners there may be some burdocks or cockle burs. Now, in one day, one person can remove all these weeds with the spud. If this be done, the thousands and tens of thousands of seeds which these plants would have produced never come into existence, and the future infinite supply of these weeds is also effectually checked. A corresponding saving in the labor that would otherwise have been ultimately required in subduing these weeds is also effected.

It may not be amiss here to describe that form of the spud which in the estimation of the writer, is best adapted to the uses of the farmer. The chisel spud as usually made, may be described as follows: It consists of a light round handle, resembling that of a broom, and of a blade which is shaped somewhat like that of a chisel, but more tapering from the end of the blade to the junction with the handle. Its



The
Chisel
Spud

length is about five feet from the upper end of the handle to the cutting end of the blade. The blade is about eight inches long from the cutting end to the shoulder, and about two and half inches broad at the cutting end, and five-eighths of an inch broad at the shoulder. The blade should be thin, not necessarily more than a quarter of an inch at the shoulder, and still thinner as the cutting end is approached. The blade is fitted into the handle in the same way as a common hoe. The implement is very light, so that it is in no way burdensome to carry.

In few kinds of labor on the farm are quickness and sureness of movement more important than in the use of the spud. When using the spud in a grain crop, the spudder walks astride of a row of grain, the feet being placed between the drills, so that trampling is avoided. He walks along the lines of the drill in which he first enters, and cuts below the surface of the ground all the noxious weeds that may be found within six feet on either side of him. A strip is thus taken at one time of about twelve feet in width. On the return

trip, he walks in the center of an adjoining strip of equal width, and proceeds in this manner until the whole field is gone over.

The spudder should always carry with him a short file, to be used for sharpening the spud whenever this may be necessary. The frequency of the sharpenings will depend on the nature of the soil; but it is greatly important that a good cutting edge be constantly kept. The file should never be forgotten, especially in stony soils, as the spudder never can know how soon he may want it.

Simple as the work may appear, there is great opportunity for the exercise of dexterity in using the spud. One person will so use it in a grain field that very little of the grain will be either trampled upon or cut off, whereas another would make constant havoc in both these respects. It is matter for surprise how large and strong a weed root can be severed by the spud when it is dexterously used. Burdock roots two inches in diameter may be easily severed when the spudder is well skilled in his work.

MODES OF DOUBTFUL ADVANTAGE.

Modes of destroying weeds are sometimes widely practiced of which it may be said that, even when all things are considered, the benefits arising from them are of doubtful character. Two of these will now be dealt with, namely, (1) the bare fallow; and (2) the fermentation of farm-yard or stable manure. Both of these may on occasion be made very helpful in the work of eradicating weeds, but in the opinion of the writer they both are costly modes, and they both can usually be dispensed with.

1. The bare fallow. In destroying weeds, the bare fallow has rendered good service in the past, and where it is properly managed it is a very effective mode, especially for creeping perennials.

Since the bare fallow method as usually practiced requires the land to lie unused during the whole season in "summer fallow" so that a crop cannot be raised the same season, it is evident that the method is a very expensive one; in fact, far too expensive, when compared with some of the other modes of fighting weeds which have been previously treated of in this

chapter. Where these other and less expensive modes are faithfully practiced, it will be unnecessary to resort to the bare fallow for the purposes of weed destruction.

When it is thought necessary to resort to the bare fallow, let it be in some modified form; that is to say, let some crop be grown the same season, before or after the fallowing is done. When a late crop is grown, as one of millet or of rape, during the portion of the season prior to the sowing of that crop the ground may be fallowed with excellent results, both in the destruction of the weeds and in the preparation of the soil for the crop that is to come after. Similarly, other crops which mature early in the season may be followed by the bare fallow for the rest of the season, and so secure nearly all the benefits of the ordinary bare fallow without the missing of a crop. These early-maturing crops include rye, winter wheat, and barley.

In the same way, pastures may be eaten off until some time in June, and then be plowed and worked on the surface, with great injury to the weeds, until it is time to sow winter wheat. The same course may be adopted with early-cut meadows,

with almost equally good results. Where winter wheat is not grown, the length of the season left for working this sort of fallow is much increased, and such a bare fallow, coming after any of the crops above mentioned, will be very effective in destroying weeds. It should be remarked that this mode of fallowing so nearly resembles what has been previously described as "autumn cultivation" that it may better be referred to by that designation.

The costliness of the bare fallow does not all arise from the fact that a great amount of labor is expended without getting a crop the same season; especially in seasons when much rain falls, there is also a serious loss incurred from nitrates leaching out of the soil—a loss which would be almost entirely prevented if a crop were grown upon the land. Inasmuch as the bare fallow reduces the humus in the soil, the soil becomes more compact in consequence. The bare fallow entails, therefore, (1) the loss of a crop; (2) a certain loss of fertility by reason of the leaching out of nitrates; and (3) increased impaction of the soil. It is obvious, then, that in our

fight with weeds we should resort to the bare fallow only in cases of extreme necessity.

Where the bare fallow is resorted to as a means of destroying weeds, the work should be done most thoroughly, especially so far as creeping perennials are concerned. Where these are only partially destroyed, the residue remaining in the soil are given most favorable conditions for lateral root extension, and hence for future multiplication.

In the opinion of the writer, the fallowing process should, whenever possible, be accompanied by the growing of green crops for the purpose of enriching the soil while the process of fallowing is going on. For instance, a crop of rye may be sown in the autumn and plowed under the following spring; this may at once be followed by a crop of peas, buckwheat, rape or some other quick-growing crop, which in turn may be plowed under. The weeds will be greatly reduced by this modification of the bare fallow, and the land will at the same time be much improved in fertility and in its mechanical texture.

2. *Fermenting manure.* Where farm-yard or stable manure is fermented, the process may render substantial service in destroying the germinating powers of the weed seeds found in it, but the price paid is probably too costly. Manure cannot be sufficiently fermented to destroy the seeds of weeds present in it, except with the result of the removal of much of its most useful properties, more especially of the nitrogen, its most valuable constituent. The reduction of manure in the soil where it is to remain is attended with so many advantages of a mechanical and chemical nature that, whenever practicable, the reducing process should always be effected there, rather than in the farmyard, or in wasting heaps in the field.

Fermenting manure, therefore, with the object of destroying weeds, should never be resorted to unless the seeds of some especially troublesome sorts are known to be present in it in unusually large quantities. As a rule it is not necessary to resort to the process at all, for if the modes of fighting weeds that have been already pointed out are faithfully practiced, the seeds that will at length be found in the

manure will be reduced to an insignificant quantity. In this connection it is well to remark that on account of the danger there is of bringing weed seeds to farms where purchased stable manure is used, it may be more judicious, where increased fertility is desired, to purchase artificial fertilizers rather than stable manure.

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CHAPTER VI.

SPECIFIC MODES OF ERADICATING WEEDS OF THE THISTLE FAMILY.

This chapter and those which follow deal with specific modes of destroying certain kinds of weeds which infest the northern part of the United States. Most of these weeds are also troublesome in Canada. Some are local in their distribution, while others are found in greater or less numbers from the Atlantic to the Pacific. While the general methods of weed destruction described in the previous chapter are as a rule equally applicable to all weeds, the specific modes described in this and the following chapters are especially helpful when applied to the weeds for which they are intended.

It should be remembered, however, that the modes described here as especially applicable to certain weeds will also apply to all other weeds not specifically men-

tioned which may closely resemble these in their habits of growth.

The weeds which are discussed in this chapter are all included in the thistle or sunflower family. This is the largest family of flowering plants, including some ten or twelve thousand species in all parts of the world. The individual flowers are usually small and inconspicuous. They are arranged together in considerable numbers in heads at the ends of the stalks. These heads are quite commonly regarded as single flowers, as those of the daisy, the dandelion, or the thistle, but in reality they are made up of a very large number of minute flowers. The family includes many of our most valuable economic and medicinal plants, as well as many of our worst weeds.

The six weeds here discussed are among the most troublesome to the farmer. They are *the Canada thistle, the perennial sow thistle, the ox-eye daisy, the burdock, the ragweed, and the wild lettuce*. The specific modes here described of dealing with these weeds and those which are discussed in the chapters which follow are nearly all based on the actual experience of the

writer; hence they are submitted with a degree of confidence which could not be felt were they based merely on theories, however correct these theories might be.

An outline sketch is given of each of the weeds dealt with. This sketch was in every case prepared from living specimens of the weed illustrated. The root development of each plant is shown, as well as that of the portion above ground. In the work of exterminating weeds, a knowledge of their habits of root growth is frequently of quite as much importance as a knowledge of the growth habits of the portions of the plant ordinarily visible to the eye.

(I) THE CANADA THISTLE.

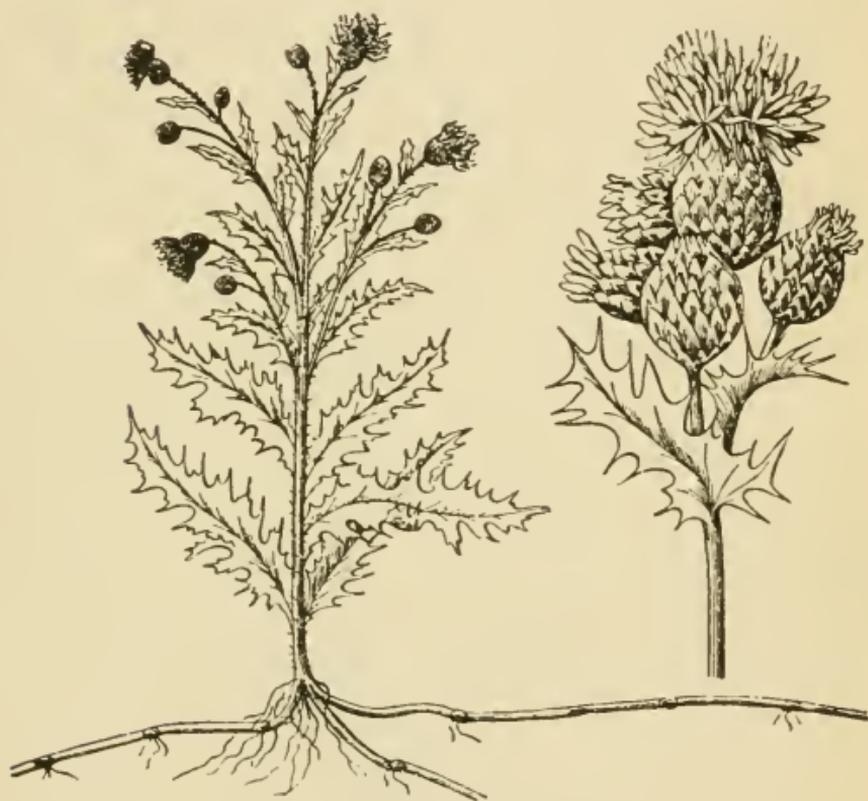
The Canada thistle (*Carduus arvensis*) is a creeping perennial which grows from one to four feet high, according as soils and seasons vary. It is of an upright habit of growth, somewhat branched towards the top, especially when it is not much crowded, but when it is pressed for room it has but a single stem. Its leaves are armed with sharp prickles, which, either when green or dry, but more especially when dry, are exceedingly unpleasant to handle. Its blossoms are of a beautiful crimson, and have a pleasing fragrance.

The Canada thistle comes up early in May, and continues to grow until the time of severe frost in autumn. It comes into blossom in July and August, and matures its seeds principally in the latter month, but sometimes also in the former. When cut off above or just a little below the surface of the ground, it will at once put forth sprouts below the point of excision, several sprouts thus coming up around the parent stem.

The Canada thistle will grow in almost all kinds of soils, but it does not find a congenial home in mucks with moist bottoms. It grows in all kinds of crops that are produced in this country. Its seeds ripen with those of all the cereals, several of the clovers, and timothy and some other grasses.

The Canada thistle is propagated by means both of its seeds and of its creeping root-stocks, but more especially by means of the latter. Its root-stocks penetrate the soil in every direction, and in open soils to distances that are almost incredible. These root-stocks bear numerous latent buds, which, as soon as the root-stocks become broken, at once start to grow, even under

the least favorable conditions. Its seeds are not only carried incredible distances by the wind, but they are also distributed everywhere by means of the seeds of all kinds of cereal grains and of several of the



THE CANADA THISTLE.

clovers and grasses, among which they ripen. They are also distributed by means of manure.

Modes of Eradication.

The following are some of the most effective modes of dealing with this most pernicious weed:

1. *Modifying the rotation.* Until the fields infested with the thistle can be specifically dealt with by one of the modes described below, drop out of the rotation, so far as practicable, all crops which will allow the thistle seeds to ripen before they can be cut.

2. *Autumn plowing and spring cultivation, followed by corn or some other cultivated crop.* Plow the land immediately after harvest. Plow shallow with any kind of plow that will cut the thistles off clean *without breaking up the creeping root-stocks.* Keep the thistles from showing above ground until the late autumn plowing, which should be deep for the sake of the crop that is to come after. In the spring, keep the thistles under by the use of a suitable cultivator until the time for planting the cultivated crop. Give this crop sufficient cultivation to insure a good yield, and take pains to keep the thistles that spring up in the line of the rows cut

off by hand hoeing. Go over the crop with the hand hoe, if necessary, once or twice after the horse cultivation has ceased; and, if the work up to this point has been well done, there should not be one thistle left, provided the season has been a dry one. The most effective part of the work, however, will have been done the preceding autumn.

3. *August plowing, followed by winter rye cut early, and this again by a cultivated crop.* Plow the ground deeply in August, as early in the month as practicable. Sow rye early in September at the rate of two and one-half to three bushels per acre. Cut the rye the following spring, as soon as it is headed out, for soiling or for winter fodder. Then plow the ground deeply with any kind of plow that will effectively bury the stubble, and harrow at once to conserve the moisture. Harrow once a week until it is time to drill the ground for rape or some other quick-growing cultivated crop. Then cultivate and care for the crop as described in section 2 above. In the experience of the writer, this mode of destroying the Canada thistle has proved very effective, but it is not well suited to stiff soils

which will not readily grow cultivated crops.

Another way is to sow the rye in August, and then pasture it both autumn and spring, before the ground is plowed for the following crop. This mode is not quite so effective as the one just described, inasmuch as the rye when pastured does not so effectually weaken the thistles by smothering them as when it is grown for fodder or for the silo.

On the Ontario Agricultural College Experiment Station farm at Guelph, thistle-infested fields have been so effectively cleaned by the mode of treatment recommended here that in the following year one person could go over twenty acres in from ten to fifteen hours, and remove with a spud all the noxious weeds found in the grain crop which followed the rape.

4. *Breaking up pasture land or meadow and sowing to fall wheat and clover.* Plow pasture land in June, or plow land from which a crop of hay has been removed, as soon as possible after the crop has been harvested. Work the plowed ground upon the surface, so that all thistles will be kept under until the time arrives for sowing

winter wheat. In the spring, sow clover in the wheat crop, and after one, two, or three crops of clover have been grown repeat the same rotation. This method is applicable to stiff soils where winter wheat is a leading crop, and is especially successful where the land first broken up was clover sod. In localities where winter wheat will not grow, substitute for the winter wheat either spring wheat or barley, as may be desired. There will then be ample time for autumn cultivation after the sod land has been broken up; if this time is well employed, a great gain in the conflict with the thistles will have been effected.

5. *Smothering by a clover crop, with a cultivated crop following.* Where land has been sown to clover, cut the crop twice for hay, or once for hay and once for seed. Then follow with a properly cultivated corn or root crop. The smothering influence of the two growths of clover, combined with the effect of the two cuttings necessitated, will be found of much service in weakening the thistles.

6. *Using the spud.* When the thistles have been well brought under, they should be kept under by the use of the spud. The

grain fields should be gone over before harvest to prevent the thistles from blossoming, and the meadows and fields sown with grasses should be similarly dealt with after harvest. To spud thistles before their blossoming season will not in itself be found of much service in destroying them; but when they are cut with the spud an inch or more below the surface of the soil at that stage of their development, and are again cut in the same way later on, the effects, as regards their destruction are very beneficial. In the experience of the writer, when thistles have been thus cut two or three times a year, they have been found to disappear entirely from pastures, fence borders, lanes, and waste-places generally.

7. Removing thistles from permanent pastures. In removing thistles from permanent pastures, our mode of procedure must be governed largely by the character of the soil and subsoil. In stiff clays, two or three mowings a year for as many years will cause them to disappear, but on lands with open subsoils the spud will also have to be resorted to.

Observation. The facts relating to an experiment in removing Canada thistles

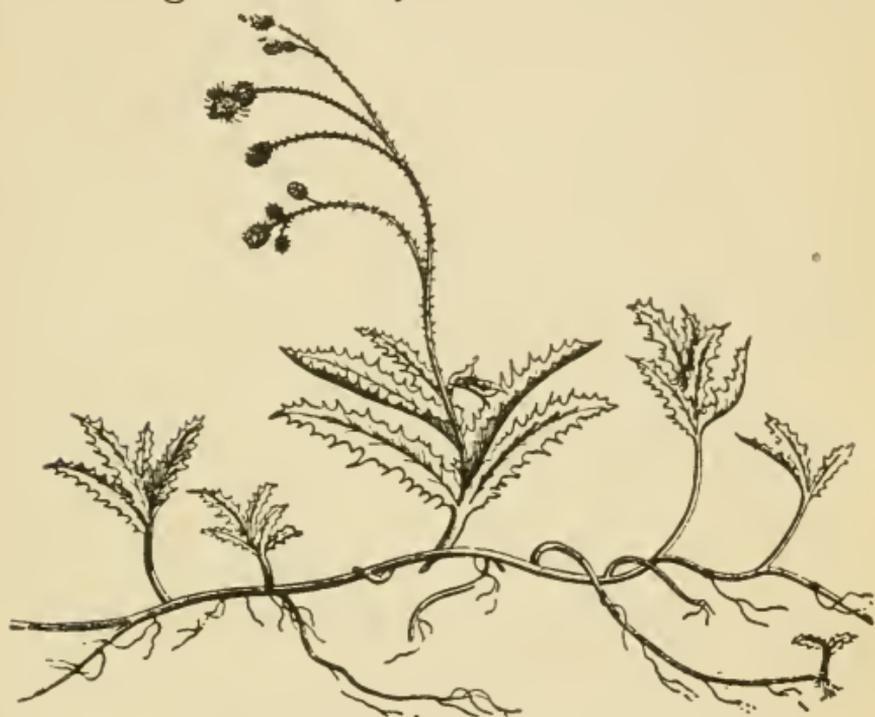
and other noxious weeds from a permanent pasture in the Ontario Agricultural College Experiment Station farm at Guelph may prove interesting. The field contained twenty acres, and had been for several years in permanent pasture, and was badly smitten. The experiment commenced in the summer of 1889, and the work was superintended by the writer, who also took part in it. The facts, as given in the annual report of the station for 1891, p. 50, are as follows: "The first spudding in 1889 took fully 100 hours of one person. The second spudding took 80 hours. In 1890 the first spudding was done on July 9th and 10th, and took 40 hours. The second spudding was done from August 26th to September 7th, and took 32 hours. In 1891 the first spudding was done on July 18th, and took 7 hours. The second spudding was done on about the last day of September, and took 6 hours. The cost of cleaning the field—for it is now clean—was \$22.50 in 1889, \$9.00 in 1890, and \$1.62½ in 1891; or a total, for the three years, of \$33.12½ for the 20 acres. The labor was valued at \$1.25 per day of 10 hours, without board." The annual cost of maintain-

ing cleanliness in this field, so long as it remains a pasture, should not be more than \$2.50.

(2) THE SOW THISTLE.

There are several varieties of the sow thistle, but some of them do not give much trouble to the cultivator of the soil, and it will be sufficient for our purpose here to speak only of the variety known as the perennial or corn sow thistle (*Sonchus arvensis*), as it is the only form of this weed which is very difficult to eradicate. The corn sow thistle is a creeping perennial, while nearly all the other varieties of the sow thistle are annuals. The plant has an upright habit of growth, and grows from one to three feet high, but when the soil is quite congenial it sometimes reaches a greater height. Like the Canada thistle, the perennial sow thistle is somewhat branched towards the top. Its stems are rather hairy or bristly, especially its flower stems; they are hollow, and when bruised a milky fluid exudes from them. The prickles upon its leaves are harmless. Its blossoms are yellow, and the plants are great producers of seed.

The perennial sow thistle makes its appearance in May, and continues to grow until the autumn. It blossoms in July, and ripens its seeds in July and August. It will grow in any kind of soil, but it is



THE PERENNIAL SOW THISTLE

most at home in rich moist loams, and gives least trouble in stiff clays.

The perennial sow thistle, like the Canada thistle, infests all kinds of crops, and it ripens its seeds somewhat earlier than, or simultaneously with, the crops amid which it grows; the only crops of which

this statement is not true being, probably, red clover and alfalfa.

It is propagated by means of its seeds, which are able to float about in the air by reason of the downy attachment which they possess. As its seeds are very numerous, its numbers increase very rapidly in the neighborhood of any place where once they are allowed to ripen. It is an open question if they have the power of sustaining a long flight, like the seeds of the Canada thistle. The perennial sow thistle is also propagated with much rapidity by means of its root-stocks, which are numerous and which, like those of the Canada thistle, are "creepers" bearing a very large number of latent buds, as is shown in the sketch. Its seeds, like those of the Canada thistle, are constantly being widely distributed by being carried about with the seeds of cereals, clovers, and grasses.

Modes of Eradication.

The means to be taken for destroying this intruder are essentially the same as those described for the eradication of the Canada thistle, and therefore need not be repeated here.

(3) THE OX-EYE DAISY.

The ox-eye daisy (*Chrysanthemum leucanthemum*) is a simple perennial with a branching habit of growth. It grows from one to two feet high, according to soil and crop conditions, but usually it does not grow much more than one foot in height. It produces large flowers, consisting of a yellow disc bordered with white rays. The fancied resemblance of the disc in the center to the eye of an ox has probably given rise to the name. The flowers, sometimes called "Marguerites," have been much in favor for bouquets during recent years. The plant, however, is none the less a pestilent weed. It is a great producer of seed.

The ox-eye daisy is very hardy. It can resist in a marked degree the influences of heat, cold, and drought. It commences to blossom in May or June, according to the locality, and under some conditions it will continue to blossom as late as September. The seeds have, in an uncommon degree, the power of maturing on the stalk, even when the stalks have been pulled out of the ground or cut off from their roots before the seeds are quite ripe, and they also pos-

sess great vitality. Although the plants may appear but singly at first, yet if they are allowed to ripen their seeds, these fall to the ground and grow up again so thickly that to eradicate the weed by spudding is almost impossible. Hence, in pastures and waste places where cultivation cannot be introduced, the ox-eye daisy is an extremely difficult weed to deal with. It is not relished by live stock, owing in part to the woody nature of its growth, but they will browse on it to some extent when it is young.

The ox-eye daisy grows in all soils, but is most vigorous and troublesome in those of loose texture. It infests all kinds of crops, and it also grows where the land is not cultivated, as in permanent pastures, and in waste places generally. It is most difficult of eradication in permanent pastures and meadows, more especially as these grow older, since the roots of the daisies then become much interlaced with those of the crops amid which they grow. It is least troublesome in cultivated crops, and these are very effective in destroying it.

This weed is distributed entirely by means of its seed. It is most commonly carried about in the seeds of timothy and

some kinds of clover, but it is also distributed through the agency of the cereal



THE OX-EYE DAISY.

grains. It is often taken from field to field on the farm in the manure, and is also carried about to some extent by birds.

Modes of Eradication.

The following are the modes of eradication that have been found most successful in dealing with the ox-eye daisy:

1. *Modifying the rotation.* Drop meadow out of the rotation until the infested fields have been dealt with.

2. *August plowing, followed by winter rye cut early, and this again by a cultivated crop.* Grow a crop of rye followed by a cultivated crop, as described in section 3 above, where we treated of the methods of destroying the Canada thistle. The plowing in June will turn under the daisies that may have been in the rye, and the stirring of the soil necessary to the cultivation of the crop will be favorable to the germination of the seeds of the weed that may be lying in the soil dormant.

3. *Plowing up meadow land and planting to a cultivated crop.* In the case of meadow land which is infested with the weed, pasture it until the middle of June; then plow it deeply and plant to some cultivated crop, taking pains to cultivate it with sufficient care. The daisies are thus turned under before they have had an opportunity

to ripen their seeds. It may be necessary to grow a crop of corn or of roots the following year in order to complete the work.

4. *After-harvest and autumn cultivation, followed by spring cultivation and a cultivated crop.* Plow the infested field lightly after harvest, and then again deeply just before winter. In the interval give the soil one or more harrowings to induce the daisy seeds to germinate. In the spring, follow this preparation with a cultivated crop, and this, if necessary, next year, by another cultivated crop.

5. *Sowing to rye for pasture or hay, following by millet, or bare fallow and winter wheat.* Sow the infested field with rye, and pasture the rye until June, or cut it for hay. Follow the rye with a crop of millet; or, if thought best, work the ground on the bare fallow system until winter wheat may be sown in September. Where it may not be desired to grow winter wheat, the occasional stirring of the soil should be continued until the close of the season, that the weed seeds lying in the soil may be made to germinate. Then next season some kind of spring cereal may be grown.

6. *Growing a cultivated crop and following by a grain crop sown to meadow.* If a cultivated crop is grown with a view to the destruction of the weed, then it should be followed by a grain crop, which should also be sown with clover, or clover and grass. The grain crop should then be gone over with the spud, and any daisies found in it be cut off. Spudding will probably be necessary in the meadow which follows the grain crop, more especially during the first year of its growth. The best time for spudding the ox-eye daisy is when it is in blossom, as at that time the weeds are very easily seen.

When spudding the ox-eye daisy, it may sometimes be necessary to catch the plant with the hand and strike it over the spud handle to free the adherent earth from the fibrous roots of the weed which have been cut off with it.

7. *In permanent pastures, etc.* Whenever practicable pasture-lands that are infested with ox-eye daisy should be broken up and dealt with in one or other of the methods described above. In pasture-lands which cannot be cultivated and therefore must remain permanent, along fence

borders, on the sides of roads, and in waste places generally, it is difficult indeed to deal with this pest. Any plan that will prevent it from maturing its seeds will in time prove effectual, but several years will probably elapse before the weed will be fully banished from such places.

(4) THE BURDOCK.

The burdock (*Arctium lappa*) is so well known and so easily managed, if the work of destroying it is gone about properly, that it would seem almost superfluous to write about the modes that will prove effective for its extermination, yet there is no denying the fact that the burdock is one of the most general of the weed abominations which disgrace the farms of today. It is a biennial, the leaves of which are very large even in the early stages of the growth of the plant. Its seed is borne on a branched stem, which pushes up from amid the center of the leaves to a height of from two to five feet. The first year of its growth, the burdock, being a biennial, does not produce any seeds, but in the second year it produces them in immense numbers. The seeds are matured in

enclosures at the end of the branches of the stems. The seed sacs, circular in shape, are so armed with hooks that they adhere to almost everything with which they come in contact. Hence we find them



THE BURDOCK.

The large plant in the sketch represents the burdock in the dead state, after it has perfected its growth.

clinging in large numbers to the hair of horses and cattle that pasture where they grow, and also to the wool of sheep, which they oftentimes render practically valueless.

The burdock sends a strong tap root down into the soil wherever the natural or artificial drainage is good, hence it does not suffer readily from dry weather. The root as shown in the sketch is broken off. The burdock comes into flower chiefly in the months of June and July, but more especially in the latter month. If cut off above the crown, even after the seed pods are formed, young shoots will be thrown up around the parent stem, and seed be matured sometimes within a few inches of the surface of the ground, and even many weeks after the harvest season is over. It is forgetfulness of this fact, more than anything else, which allows this plant so long to retain its hold in our fields.

The burdock will grow in nearly all soils that are free from ground water. No other weed, perhaps, is found in so many of the provinces and states of our continent. It is pre-eminently the weed of the outlying and neglected portions of cities, towns and villages, and it is much prone to intrench itself along the fence borders and in the waste places of the farm, but it does not give much trouble where the soil is well cultivated.

The burdock is propagated solely by means of its seed, which is possessed of much vitality. It is very generally distributed through the agency of domestic animals, to the hair and wool of which its seeds most readily adhere. If a burdock plant is left undisturbed, so that its seeds ripen upon its stems, it sheds them upon the ground about it, and there they will continue to give trouble for years after.

Modes of Eradication.

The following are the modes of eradication that have been found most successful in dealing with the burdock:

1. *In cultivated fields.* Where the burdock is found in cultivated fields, it will of course be cut off with the hay or grain amid which it grows. When thus cut during the first year of its growth, the plant is but little injured, and when mowed off during the second year it at once pushes up fresh stems and ripens its seeds in great numbers, as already mentioned. Although the farmer may not notice this, the ripened burs will not fail to find lodgment in the hair of his cattle and the wool of his sheep when they feed upon the aftermath or

gleanings. The only way to prevent this late ripening of the seeds is to go over the fields once or twice after the harvest is over, and cut off with the spud all plants that seem likely to produce seed that season.

2. *In permanent pastures, waste places, lanes, etc.* In permanent pastures, and along fences, in lanes, and around the corners of farm buildings, and in the borders of woodlands, the plants must be destroyed by the use of the spud. In cutting them, however, great care must be taken to strike them below the crown. If this be done the plants will die, no matter what their previous growth may have been. The spudding may be done at any time of the year when the ground is not frozen, but during the second year the cutting must, of course, take place before the plants form their seeds. A few years of this persistent spudding will soon get to the last of them. Farmers who go over their fields twice a year with the spud will not long be troubled with burdocks.

(5) WILD LETTUCE.

The various species of wild lettuce (*Lactuca virosa*, *Lactuca scariola*, and related species) are annuals or biennials. The

most troublesome of them (*L. virosa*) appears first to have obtained a foothold on this continent in the Atlantic states, but has traveled westward at a rapid rate. It is now common in many sections of the United States. The branches are numerous, and on good soils strong plants will attain the height of from 5 to 6 feet, but on ordinary soils the average height will not be more than 3 feet. The blossoms are a pale yellow, and a vigorous plant is capable of bearing from 8,000 to 10,000 seeds. The seeds are provided with a downy attachment which enables them to float in the air, hence they may be carried by the winds to almost any distance.

Wild lettuce comes up early rather than late in the season. It matures its seeds in midsummer. If the plants are cut out before they have reached the blooming stage they will at once send up other branches which in turn will produce seeds. Horses and cattle will crop it off to some extent in pasture, but they are not fond of it.

Wild lettuce will grow on various soils, but rich loams sustain it in best form. It does not give much trouble in grain crops or cultivated crops, but grows freely in



WILD LETTUCE.

meadows and pastures, on road sides, along fence borders and in other waste places.

Wind is the principal agent in distributing the seeds of wild lettuce, but the seeds may also be distributed along with those of clover and some of the grasses.

Modes of Eradication.

The following are the modes of eradication that have been found most successful in dealing with wild lettuce:

1. *Modifying the rotation.* Drop meadow and pasture out of the rotation for a time and grow cultivated crops. This will only be necessary with fields infested with the weed.

2. *Mowing and spudding.* Cut the plants off with the scythe or mower with sufficient frequency to prevent them from maturing seeds. When they are not numerous they may be easily destroyed by cutting them off with the spud an inch or two below the surface of the earth.

Observations. (1) Wild lettuce is not difficult of eradication where care is taken to prevent the maturing of the seeds. (2) Farms cannot be kept free from it in an

infested neighborhood, without concentrated action on the part of the farmers.

(6) RAGWEED.

Ragweed (*Ambrosia artemisiæfolia*) and kinghead (*Ambrosia trifida*) are annual plants, with slender, much-branched stems. There are several varieties of ragweed, but the variety represented in the sketch and the one known as kinghead are by far the most troublesome ones. Ragweed more commonly grows to the height of from fifteen to twenty-one inches, though in some soils it will, under favorable conditions, grow to the height of four feet. Kinghead is usually more vigorous, growing from three to six feet high. The blossoms have a yellowish tinge, but the contrast in color between them and the leaves is not marked. The seeds are small and helmet-shaped, and when ripe are of a dark hue. They are produced on the lower portions of the flower-bearing parts of the branches, and are very numerous. They are so light that they float readily in water, and they are possessed of great vitality.

These weeds usually do not develop until late in the season; they sometimes do



COMMON RAGWEED.

not ripen their seeds in grain crops before these are harvested, or in meadows before the time of cutting. In the stubbles of these crops, if not disturbed, they continue to grow until late in the season. The blossoms and seeds are produced from July till frost, the precise time of blossoming varying with the attendant conditions of growth.

These weeds will grow in all soils that are free from stagnant water, but they very much prefer friable or loamy soils that contain a large proportion of humus. They revel in black loams and muck soils that have been well drained, but do not make much headway in stiff clays, except in depressions and valleys, or along water furrows and watercourses.

While ragweed will grow in all kinds of crops, it does not usually mature its seeds in grain crops, nor does it mature them in the first cutting for the season in a clover meadow. In rich soils, as in the Red River Valley, the rank growth of these weeds in grain fields makes them serious pests. In all kinds of stubble they push on rapidly after the crop has been removed, and if not disturbed, produce an enormous crop



KINGHEAD OR GREAT RAGWEED.

of seeds before the season closes; and in cultivated crops, as corn or roots, they will also produce seed abundantly if due attention is not given to cultivation late in the season.

Ragweed and kinghead are distributed in the seeds of all the late-maturing cereals, and in the seed of mammoth and alsike clover, and of timothy. Ragweed is most commonly distributed in the seed of common red clover, for the reason that by the time the clover crop is harvested for thrashing a large proportion of the seeds of the ragweed growing in it have also ripened. It is in the seed of common red clover that ragweed is usually carried to new centers. The seeds of these weeds are also distributed by the excrement of animals, by clover hullers and by birds. In localities where these weeds once get a foothold, no agent is so potent in effecting their distribution as water. In low-lying, level lands, their distribution soon becomes as wide as the range of the water which overflows them. The water in its subsidence leaves the seeds scattered everywhere over the soil. It is impossible, therefore, to keep entirely free from these

weeds those parts of a farm which are subjected to a periodical overflow of water coming down from lands where they abound. The most that can be done, under such circumstances, is to keep them cut down as they spring up, so that they cannot mature their seeds.

Modes of Eradication.

The following are the modes of eradication that have been found most successful in dealing with ragweed and kinghead.

1. Modifying the rotation and autumn cultivation. Modify the rotation, and give special attention to autumn cultivation. Happily, the rotation will not require serious modification where careful attention is given to the working of the soil in autumn, but late-ripening cereals should not be grown in the meantime, nor should timothy nor any of the forms of clover be allowed to produce a seed crop in the infested fields until the ragweed is much reduced. As soon as the cereal crops are harvested, the ground should be plowed or disked. It may then be occasionally stirred until the late plowing that is given on the approach of winter. Autumn cultivation is peculiarly

helpful in destroying these weeds, for the reason that the plants grow late, rather than early, in the season.

2. *Growing cultivated crops.* Grow cultivated crops, taking special care that the cultivation is carried on well through the season.

3. *Using the mower.* When fields are newly sown to grass, the use of the mower in the autumn will be found very effective. The mowing should be done as close to the surface of the ground as possible, for the reason that the seeds of the ragweed are often formed low down on the stem, and of course it should be done before any of the seeds ripen. Pastures and meadows may be treated in the same way.

4. *Spraying.* Ragweed or kinghead in fields of small grain may be killed or materially checked by spraying with any of the materials recommended in the following chapter, if applied when the plants are about six inches high.

Observations. (1) When infested meadows or pastures are to be broken up, the work should be done, wherever practicable, before any of the seeds of the weed have had opportunity to ripen. (2) When the

plants are well reduced, hand spudding will soon effect the extermination of this weed, but if its seeds have been allowed to become numerous in the soil, several years will necessarily elapse before the work of eradication can be completely effected. (3) Sheep may be made to render substantial service in reducing the prevalence of this weed, more especially if they be allowed to feed upon it during the earlier stages of its growth.

CHAPTER VII.

METHODS OF ERADICATING WEEDS OF THE MUSTARD FAMILY.

The mustard family contains a large number of troublesome weeds, such as wild mustard, false flax, French weed or penny-cress, peppergrass, shepherd's purse, and wild radish, as-well as some of our common garden vegetables, as the cabbage, cauliflower and turnip. The plants of this family may be recognized by the shape of the flowers, as the parts are in fours in opposite pairs, forming a cross. The flowers, which are usually white or yellow, are borne on stems (foot-stalks) which usually arise from a cluster of leaves at the base. They are closely clustered at the ends of the branches, which gradually lengthen into long racemes, with all stages from the unopened flower buds above to ripe seeds at the base. The leaves and stems usually have a decided odor when crushed. Most of the plants of this family are annuals or

winter annuals, though a few are biennials and perennials.

The weeds included in this family usually occur in grain fields, gardens, lawns and thin meadows. As they grow rapidly and ripen their seeds with the grain, they are difficult to combat by ordinary means in sections where small grains are grown continuously on the same land for a period of years. Where winter wheat and other winter grains are grown, many of the mustard-like weeds grow as winter annuals, developing a rosette of root-leaves in the fall, and starting into bloom and the maturing of seeds very early the following spring. As most of the weeds of this family are annuals, they are easily killed by cultivation when small and give little trouble where a good rotation is practiced, with the frequent introduction of crops which require frequent cultivation. Naturally, as with other annuals, preventing the plants from seeding is effective, but as the seeds of most of the plants of this family have an oily or mucilaginous covering which effectually prevents decay, they maintain their vitality in the soil for many years, and if

once allowed to ripen a crop of seeds will give trouble for a long time thereafter.

The habits of growth of most of the weeds of this family are quite similar, so that a method which is effective in eradicating one of them is usually equally so in keeping others in check. For that reason, the methods which are generally applicable will be first discussed, followed by brief descriptions of wild mustard, false flax, French weed and tumbling mustard, the members of this group which are most frequently troublesome.

Among the methods which may be used in eradicating weeds of the mustard family may be mentioned sowing clean seed, harrowing spring grain, maintaining a regular rotation, fall cultivation of stubble fields, growing cultivated crops, bare fallow, hand pulling and spraying. To obtain the best results from these methods, it is sometimes wise to use two or more of them together, as, for example, following fall cultivation of stubble with a cultivated crop in the spring.

1. Sowing clean seed is one of the most effective ways of keeping the weeds discussed in this chapter in check. As the seeds of most of these plants are small,

they are quite easily removed from wheat and barley by screening. They are more difficult to take out of seed oats, as a small proportion will stick in the crease of the larger oat grains. They are exceedingly difficult to remove from the seeds of clover and alfalfa, however, as they are about the same size and shape as the seeds of these plants. Care should be taken in purchasing clover and grass seeds to see that they are free from seeds of these and other weeds.

2. *Harrowing spring-sown small grain fields in the early spring*, when the young grain begins to appear, and again when it is about three to five inches high, is quite effective in killing the young mustard and similar plants. In some instances three and even four harrowings may be given, especially in areas where the grain also will be benefited by harrowing it thus frequently. This method can only be practiced to advantage on drilled grain, as the harrow will pull out the young grain as well as the weeds in broadcast fields, nor should it be used where the ground is very wet in the spring. It is not particularly effective on fall-sown grain, as the weeds

which come up in the fall along with the grain are too securely rooted in the spring to be removed by the harrow.

3. *A regular rotation* of crops which includes the introduction at frequent and regular intervals of cultivated crops and meadow, with the recurrence of small grain not oftener than once in three years, is an excellent means of preventing the growth of mustard and similar weeds, but one which in many sections can hardly yet be deemed practicable. Where such a rotation is practiced and proper attention given the cultivated crop and the sowing of clean seed, these and similar weeds are not likely to give trouble. If they are introduced in some way, a modification of the rotation may be necessary in any particular field where they become common, by dropping small grains out of it till these weeds are subdued.

4. *Fall cultivation of stubble fields* is effective, but of course can only be practiced where clover or grass seed has not been sown with the grain. A shallow plowing or thorough disking immediately after harvest will cause the seeds of mustard and many other weeds to sprout if moist-

ure conditions are right. Occasional harrowings will then kill the small weeds, and encourage germination of more seed, which in turn can be destroyed. This method is particularly good when it can be followed by the growing of a cultivated crop in the spring, as outlined below. If it is necessary to grow small grain on the field on which autumn cultivation is practiced, harrowing in the spring after the grain is up, as outlined in the preceding section, is strongly to be recommended.

5. *Fall cultivation, followed by a cultivated crop in the spring.* Fields which are pretty thoroughly infested with mustard can be cleared of this weed, except as the seed remains in the ground, by the autumn cultivation advised in the foregoing paragraph, if it is followed by a cultivated crop in the spring. As previously noted, the weeds of the mustard family do not give serious trouble where thorough cultivation is practiced. Growing a quick-maturing, vigorous soiling crop which will tend to smother the weeds and at the same time be removed early enough to prevent the ripening of seeds in any quantity is also a good method of fighting annual weeds in con-

junction with fall cultivation of stubble fields.

6. *The bare fallow* which is maintained throughout the season, though effective, is an expensive method of fighting weeds of this class, both in the labor required to maintain it, and the soil fertility which is lost through leaching, especially where the rainfall is considerable. A modification of the bare fallow which is maintained throughout the year can be made by combining the fall cultivation advised in section 3 with disking and harrowing in the spring for a few weeks, followed by late planting of a cultivated crop or a rank-growing soiling or green manure crop. This is a good method of fighting weeds of all kinds, and is less expensive than fallowing through the entire season, while it does not require the land to lie idle throughout the year and thus lose a crop.

7. *Hand pulling* is practicable only when mustard and similar weeds occur in small numbers when first introduced, or when they have been greatly reduced by other methods. Hand pulling is more effective than spudding, as the weeds can then be carried from the field and burned or other-

wise destroyed. This is particularly necessary with wild mustard and similar weeds, which have the power of maturing their seeds even after the plants are removed from the ground.

8. *Spraying*. A method which has been quite commonly practiced in some sections in recent years, and is now considered by many to be one of the best means of combating mustard and other broad-leaved weeds in grain fields, meadows and pastures, is *spraying* with a solution of salt, iron sulfate, or some other chemical. Spraying experiments to kill weeds were first begun in this country about 1896, but it is only in recent years that the practice has become at all general. This method, even as it is at present developed, can not take the place of the more generally recognized methods of fighting weeds, such as the sowing of clean seed, thorough cultivation, and crop rotation. It is effective, however, in checking the growth of weeds in those sections where no definite crop rotation which includes the growing of cultivated crops is practiced, but where crop after crop of small grain is grown on the land.

The weeds which can be killed or seriously checked by spraying include most of the broad-leaved plants, such as those included in the mustard family, kinghead, ragweed, dandelion, and even the Canada and bull thistles. Perennials and biennials like these latter, however, must be sprayed several times throughout the season to prevent the growth of new shoots from the roots. Other methods will usually be found cheaper and better in fighting these weeds, with the possible exception of dandelions in lawns. The spray, *if properly applied*, will not injure the small grains, or grasses which may have been sown with the grain, as timothy or brome grass. *Flax* should not be sprayed after it is three or four inches high. *Spraying is injurious to clover and alfalfa*, and should not be used on any grain field in which seeds of these crops have been sown, or in meadows containing them. *It is not effective* in fighting wild oats, quack grass, foxtail, or other weedy grasses.

The best time to spray is when the first of the mustard, Frenchweed, or false flax plants are in blossom, but before they have formed pods, as the plants are often not

entirely killed by the spray and the roots and stems may contain sufficient vitality to mature the seeds, even after the leaves are killed. The proper time to apply the spray of course varies with the locality, but it is usually in May or early June. The most effective work can be done if the spray is applied in damp, cloudy weather, or toward evening, when the evaporation will not be rapid. Naturally, the work should not be done when a rain is imminent, as the rain will wash the chemical off the leaves and destroy its effectiveness. Weeds are more easily killed when the growth is rapid than when it is slow. Usually one spraying is sufficient, but if the weeds are numerous, an additional application a week or ten days later may be necessary.

The materials used in spraying are usually solutions of iron sulfate, copper sulfate, or common salt. Iron sulfate (copperas) is generally considered to be the most effective chemical for use in destroying mustard and similar weeds. About 50 to 55 gallons of any of these solutions are required to cover the weeds on an acre of land properly. The proper strength of the

solution is about 75 to 100 pounds of iron sulfate to 50 gallons of water; 75 pounds are sufficient if the weeds are young and growing rapidly. From 12 to 15 pounds of copper sulfate, or about one-third of a barrel of common salt, in 50 gallons of water, will make the solution of proper strength for good work when these materials are used.

The machinery for spraying varies with the acreage on which it is to be used. If only a small area is to be sprayed, as in lawns or the eradication of small patches of some particular weed, any of the ordinary knapsack or bucket spray pumps, if fitted with a nozzle which will give a fine, misty spray, will be found satisfactory. If a large acreage is to be sprayed, a power sprayer of the type shown in the frontispiece is necessary. This machine, or a similar one, can be purchased from dealers in spraying apparatus for from \$75 to \$150, the cost varying with the size and effectiveness of the machine. It is essential in any case to use a machine with sufficient power to give a strong, misty spray; a sprinkler will not do. It is desirable in purchasing a sprayer to select one which can be used

for other purposes if possible, such as the spraying of potatoes or orchard and truck crops.

The cost of spraying varies according to the material used, the machinery with which it is applied, and the time necessary to apply it. The material, whether it be iron sulphate, copper sulphate, or common salt, should not cost more than \$1.25 an acre, and may run as low as 75 cents, according to the cost in the local market, the material, and the quantity used. Salt is probably the cheapest of the three, and should not cost more than 75 cents. A field sprayer like that illustrated should spray from 25 to 40 acres in a day. In addition to the driver and horse or team necessary for this outfit, another man and team to haul water will be needed for rapid work unless the spraying is done close to the water supply.

The weeds of this family for which special descriptions are given are the ones which are most commonly found troublesome. They are *the wild mustard, false flax, French weed or pennycress, and tumbling mustard*. The methods of eradication outlined in the foregoing pages will be found effective in combating these and sim-

ilar weeds of the mustard family, such as peppergrass, shepherd's purse, and the wild radish.

(I) WILD MUSTARD.

Wild mustard (*Brassica arvensis*) is one of the most difficult weeds to dislodge found on this continent, when once it gets a strong foothold in the soil. Owing to the extraordinary vitality of its seeds, a very long time is required to completely effect its removal from any soil infested by it, for the reason that for years and years the seeds lying in the soil continue to germinate with each successive cultivation that may happen to bring them near the surface.

Wild mustard is an annual plant which, in the earlier stages of its growth, bears some resemblance to the radish and to the yellow-fleshed varieties of the turnip. It has a spreading, fibrous root, as shown in the sketch. Its stem is more or less branched, according as it is crowded or not when growing, and it bears a bright yellow blossom, which can be seen at a considerable distance. Its seeds resemble those of the turnip so closely that they cannot easily be distinguished from them, and they also

closely resemble the seeds of some varieties of rape.

Wild mustard comes up in spring as soon as the weather gets really warm, but seeds that come sufficiently near the surface will germinate as long as the season of growth



WILD MUSTARD.

lasts. It grows very rapidly, and matures an immense number of seeds. It sometimes grows to the height of more than two feet, but when it ripens amid grain crops is about eighteen inches in height. Its seed pods

are usually about an inch in length. The first flowers, or those borne by the earlier developed plants, appear in May or early in June, but the late plants will produce seeds on into the month of September, or even later. Fortunately, it is not a plant that can withstand severe frost, hence it is not found to any considerable extent in meadows or pastures, or in fields of winter wheat or rye. It is not positively known how long its seeds will retain the power of germination when lying in the soil, but it has been claimed that they may lie buried for at least fifty years and yet immediately spring into vigorous life when brought to the surface of the soil under favorable conditions.

Wild mustard will grow in all kinds of soils, but not equally well. It is most at home in friable limestone soils that possess good drainage, but it will also grow in great luxuriance on loamy prairie soils. On stiff clays it does not grow so readily; but it will make fair headway even in these when given the opportunity.

Wild mustard grows in all kinds of grain crops that are sown in the spring, and usually it matures its seeds before the grain in

which it grows is ripe. It is manifest that where spring grains are chiefly grown the contest with this weed will be a difficult one. It has been argued by some persons that wild mustard does not interfere to any serious extent with the yields of the crops amid which it grows, but it must be evident to any one who understands the way in which plants feed that a soil cannot produce a crop of mustard and one of grain at the same time, with the result that the grain will yield as well as if the mustard had not been there.

Wild mustard is distributed by means of various agencies. Some seeds are carried from place to place by birds, but usually this weed finds its way to new centers by the seed being carried in grain. The thrashing machine is also a potent means of carrying it from farm to farm. It is further distributed over farms on which it grows by means of the droppings of cattle, and by the manure. It is also very frequently distributed by spring floods; when this is the case the farmer has great difficulty in dealing with it.

(2) FALSE FLAX.

False flax (*Camelina sativa*), sometimes known as wild flax, has probably gained its name from the prevalent, but mistaken, notion that it has originated in the degeneracy of cultivated flax, whereas cultivated flax is a plant of another order. False flax usually grows to the height of about eighteen inches, but sometimes it grows considerably higher. Where the seeds have been shed numerously the previous year around some parent stem, it frequently comes up so thickly that some of the plants cannot grow more than a few inches above the ground. In the earlier stages of its growth false flax is somewhat leafy, but after its blossoming stage is passed the upper portions of the plant consist mainly of stems and seed pods, as shown in the sketch. The blossoms are small, and of a pale yellow color.

Ordinarily, false flax is classed as an annual, although it usually commences to grow in the later portions of the year previous to that in which the seeds are matured. False flax is very hardy, and can withstand considerable frost. Its seeds, which are



FALSE FLAX.

very numerous, are easily shed, hence when the ripe plants are disturbed by the jar of the machines used in cutting the crops amid which they grow, many of their seeds are shed upon the ground. The seeds of false flax have some resemblance to the seeds of common flax, but they are much smaller.

False flax is a weed that will grow in any kind of soil adapted to winter wheat or meadow, hence it will flourish on a wide range of soils. It seems equally at home in the stiffest clays and in the mild, humous loams of the prairie. False flax peculiarly infests winter wheat, rye, meadows and pastures. It does not usually grow to any considerable extent in spring crops, but sometimes stray plants will be found in these crops. These stray plants, however, usually have sprung up in the preceding fall, and have survived the cultivation involved in preparing the ground for being sown in the spring.

This plant is distributed by means of the seeds of the crops amid which it grows, by farmyard manure, and by droppings of cattle, but it is more widely distributed by being carried in the seed of timothy than in any other way. In this fact we find a

chief explanation of the sudden appearance of false flax in new centres where formerly it was not known.

Observations. In the conflict with false flax it will be well to bear in mind the following: (1) That grass seeds should invariably be sown along with spring grain, as wheat or barley; (2) that autumn cultivation is always the most important thing to be attended to, owing to the natural tendency of the weed to germinate from seed in the fall of the year; (3) that when false flax is found in meadows merely in detached patches, the infested parts may be cut and used for soiling purposes, while the remainder of the crop may be harvested in the usual way; (4) that where alfalfa can be substituted for the ordinary meadow crops it is well to make the change, inasmuch as in that case the first cutting of the alfalfa would take place before the false flax would be ripe.

(3) FRENCHWEED.

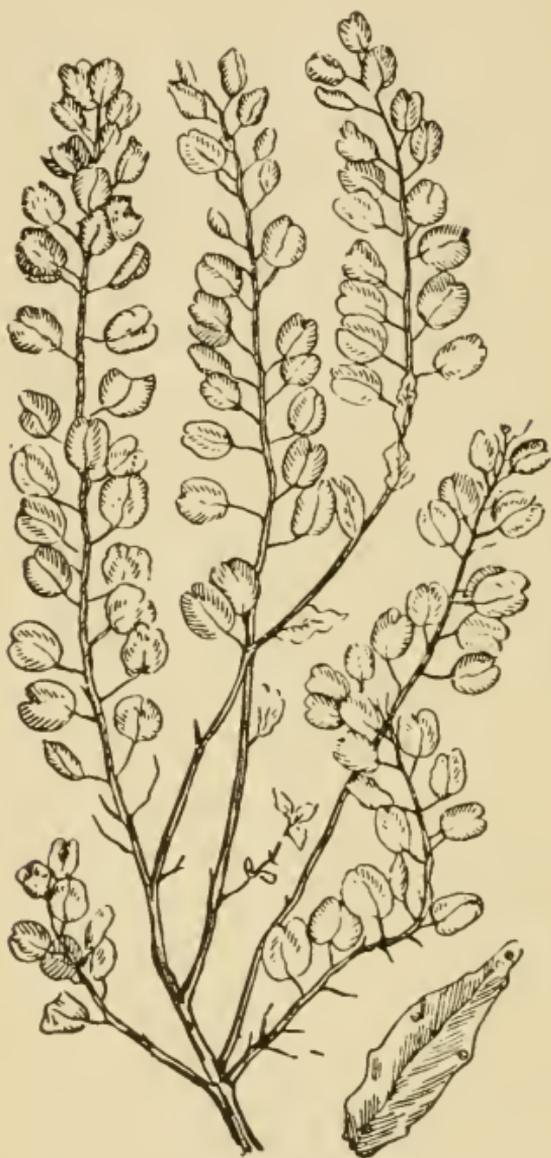
Frenchweed (*Thlaspi arvense*), also known as pennycress and stinkweed, is an annual, but when it has not yet produced seeds in the autumn, it will live through the

winter and mature them the following spring and summer. The name stinkweed is due to the offensive odor which it possesses, and which it imparts to the beef and milk of animals which feed upon it. It is of the same family as mustard, and, like all weeds of that family, it is difficult to eradicate. In certain sections of the western prairies it is giving very much trouble, more especially in Minnesota, the Dakotas and Manitoba.

Frenchweed is usually about a foot high, but under favorable circumstances it will reach the height of two feet, and the plants are capable of bearing seeds though not more than 2 inches high. The branches are numerous. The leaves are oblong in shape and of a deep green shade. The flowers are very small and white in color. The seed pods are elliptical and flat, and from one-fourth of an inch to half an inch in diameter. They are very numerous and each pod contains several small seeds.

Frenchweed will ripen its seeds at any season of the year from June until the arrival of the autumn frosts. The season of maturity is dependent chiefly on the time of the year at which the plants commence

to grow. Those which get a start in the autumn blossom in May, and by the arrival



FRENCHWEED.

of the harvest season the seeds will nearly all be shed on the ground. It is claimed

that plants from seeds which have fallen early in the season will in turn mature before the coming of winter.

Frenchweed will grow least vigorously on stiff clays, and most luxuriantly on the vegetable soils of the prairies. It harms grain crops much more than pasture or meadow or cultivated crops, and it does more injury to grain crops which ripen early than to those which ripen late.

Frenchweed is distributed through the medium of the seeds. They are carried along with the seeds of cereals amid which they have grown. They may also be distributed in manure and in the droppings of cattle, and to some extent they are conveyed by water and carried by wind. The seeds are possessed of great vitality, but they will not germinate unless they are near the surface of the soil.

(4) TUMBLING MUSTARD.

Tumbling mustard (*Sisymbrium altissimum*) is another bad weed of the mustard family. In some localities it is known simply as "Tumble weed," but in central Europe it is called Hungarian mustard. It is thought that it was brought to this con-

continent by certain Austrians employed in the construction of the Canadian Pacific railway. About the year 1889, it began to arrest the attention of the farmers around Indian Head, Saskatchewan. Since that date it has spread rapidly over a large section of the Canadian Northwest, and to some extent into the adjoining portions of the United States.

Tumbling mustard is an annual or winter annual. When it grows amid small grain crops, its branches are not numerous, but they are long and slender. When it has room to grow the branches are quite numerous and they bear an enormous number of seed pods. The seeds are small, and of a dark reddish brown color. The plants commonly grow about two feet high but the height varies with the soil and season. The flowers are a pale yellow and the plant bears a close resemblance to common wild mustard.

Tumbling mustard will grow at all season between the time of the spring and autumn frosts. The seeds usually mature at the same time as those of the small grains or even a little earlier, but under

certain conditions they will continue to ripen until the arrival of the autumn frosts.



TUMBLING MUSTARD

If cut off before the blossoming stage, more branches will be produced.

While tumbling mustard infests all kinds of crops, it is peculiarly troublesome in cereals. Where these get an early and vigorous start in the spring, they will keep the weeds in check for that reason, but when from any cause the crops are weakly, the weeds will soon overshadow them. It does not give serious trouble in pastures or meadows. This plant will grow in various classes of soils, but it thrives most vigorously on those essentially humous in their composition.

Tumbling mustard is propagated chiefly by such agencies as wind, water, birds and the seeds of cereals and millet, but of these the first mentioned is by far the most potent and dangerous. As the wind is such an effective agency in its distribution, anything that will stop the spread of this weed by this means, as a wire fence, will be useful. If the mustard and other plants which collect along the fence are then gathered up and destroyed, they will be prevented from again blowing out into the fields when the direction of the wind changes.

CHAPTER VIII.

ERADICATION OF THE WEEDY GRASSES.

The grass family includes a large number of our most useful plants, such as corn, wheat, oats, barley, and all the forage grasses, and is the most valuable of all the great botanical divisions. On the other hand, it includes some of our most troublesome weeds, which, because of the persistence of their creeping root-stocks, as in quack grass, or the similarity of their growth and seed habits to the cereals in which they grow, as with wild oats, or for some other reason, are very troublesome to the farmer and very difficult to eradicate.

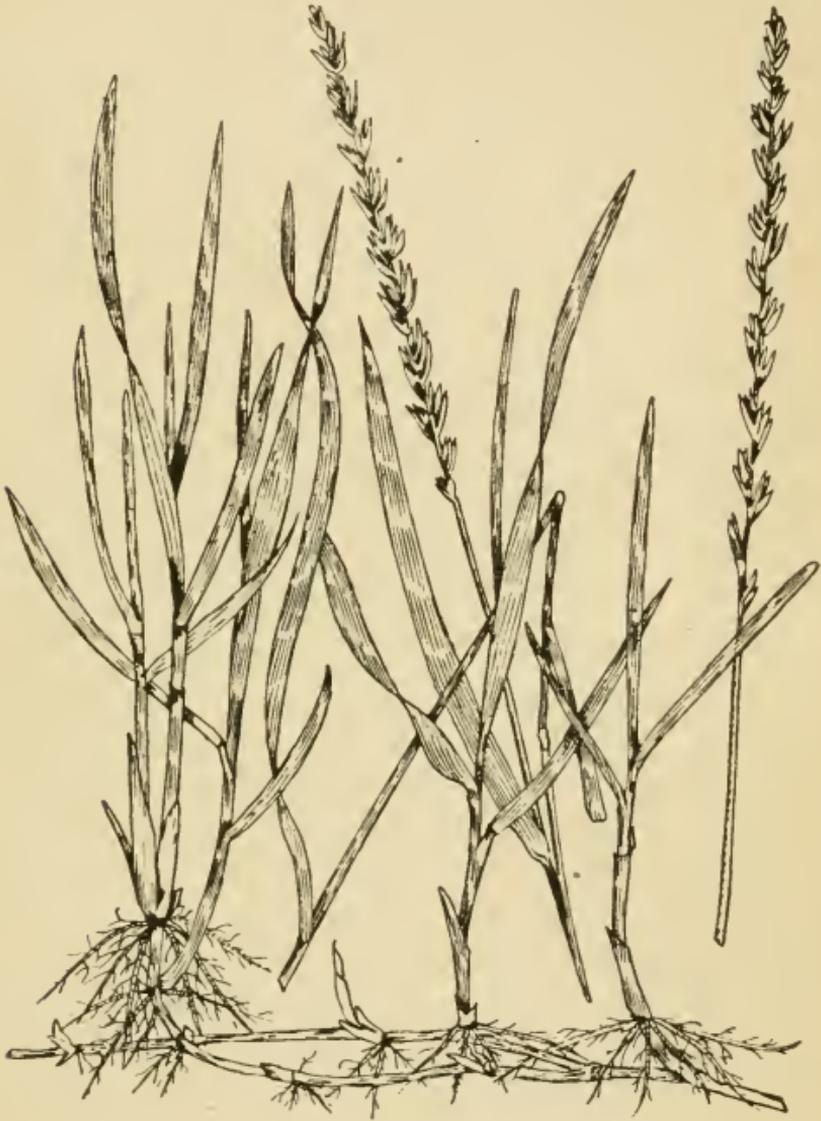
The three most troublesome grasses to the farmers of Canada and the northern United States are quack grass, wild oats, and foxtail. Wild barley or squirrel-tail grass is also a very serious weed pest in prairie pastures and meadows, but one which rather quickly succumbs to cultivation. On land that cannot be cultivated,

cutting before the seed ripens will be effective in preventing its spread. Nearly all the other weedy grasses quite closely resemble some one of the three mentioned in the beginning of this paragraph, and may be eradicated by using the methods recommended for the one they most nearly approach in their habits of growth.

(1) QUACK GRASS.

Quack grass (*Agropyron repens*) is known by a great variety of names, as quack grass, scutch grass, quick grass, quitch grass, and dog grass; but it is generally called either quack or couch grass. Quack grass is a creeping perennial, the root-stocks of which are so numerous that they soon fill the soil. They resemble considerably the roots of Canadian blue grass (*Poa compressa*), but they are much larger and stronger and more vigorous in every way, and they are very much more tenacious of life. The root-stocks of quack grass are so strong and unyielding that they have been known to push their way through the tuber of the potato. The stems grow to the height of one to three feet, according to soil and season, and each of them is terminated by

a slender spike from two to several inches in length. The leaves bear much resem-



QUACK GRASS.

blance to those of timothy, but are somewhat larger, and are characterized by a deeper shade of green.

Quack grass makes a good growth early in the season. Its seeds usually mature in August, about the same time as those of timothy. It will grow in almost any kind of soil, but is most partial to loams and soils of a decidedly open texture. It is least at home in stiff clays, and in these it is much more easily destroyed than elsewhere.

Quack grass grows in all kinds of crops from early spring until late autumn, and during this entire period the work of propagation goes constantly on by means of its creeping root-stocks. When once it gets a footing, its power of crowding out other crops is very great. Like the Canada thistle and the perennial sow thistle, quack grass also is easily distributed by means of the seeds of the useful grains and grasses, for its seeds ripen at the same time as those of the cereals, and those of some of the clovers, as for example alsike and mammoth, and those of timothy. It is also distributed through the agency of farmyard manure, both home-made and purchased.

Quack grass has some redeeming qualities. It furnishes a considerable amount of food of a nutritious character, both as

pasture and as hay, and when cut as hay it affords a considerable aftermath. It is so hardy that the cold of winter and the heat of summer cannot destroy it. Hence it has been deliberately bought and sowed to provide permanent pasture, but after a few years its roots become so matted that the plants fail to produce a vigorous growth. When this is so, the pasture may easily be renovated by simply plowing it, and leveling it down again with the harrow. Quack grass, however, is generally looked upon as a great pest, owing to the difficulty of getting rid of it when its absence is desired, and this view is doubtless the correct one to take of it.

Other weedy grasses which resemble quack grass more or less closely and are sometimes mistaken for it include vanilla grass or holy grass, western wheat grass, and dropseed grass. All of these grasses may be eradicated by the methods recommended below for the eradication of quack grass.

Modes of Eradication.

When the attempt is made to destroy quack grass, effective work should be made of it, and this in a single season. The fol-

lowing modes of dealing with it will be found successful, except in season of unusually heavy rainfall.

1. *After-harvest and autumn cultivation, followed by spring cultivation and a cultivated crop.* After harvest, plow the infested fields lightly, and then harrow with the ordinary harrow—if necessary, using also the spring-tooth cultivator to shake the roots of the grass free from the soil. Then draw the roots into light windrows with the horse rake, and, when they are dry enough, burn them. If the weather should not be dry enough for burning them, the root-stocks may be carted into a compost heap. Repeat the operation a second time and even a third time the same autumn if the weather will admit of it, plowing the ground more deeply each time in order to bring up fresh root-stocks. In no case, however, should the disturbing work go on in wet weather. When the late autumn arrives, rib the land by turning two furrows together from opposite directions, or plow the land so that the largest possible amount of surface shall be exposed to the action of the frost in winter. The frost has the effect (1) of kill-

ing the roots that are exposed by the plowing, and (2) of freeing them from the soil. In the spring use the harrow and cultivator occasionally in time of dry weather, and the horse rake also if necessary, until it is time to plant corn, roots, or some other cultivated crop. Then cultivate this crop properly, giving it such hand work as may be deemed necessary along the line of the rows.

2. *Plow under deeply after the grass has been cut for hay.* Allow the grass to grow until near the blossoming stage. Then mow it for hay. Then plow the land deeply, not less than 8 or 9 inches, and if it can be plowed to a greater depth the results will be even more satisfactory. The plowing should be done with much care so that all the grass is deeply buried. The disk should then be run over the land every seven to fourteen days subsequently during the growing season. In a dry season this method will prove very effective.

3. *Grow two crops of corn in succession.* Grow two crops of corn in succession, planting the corn so that it can be cultivated both ways. The cultivation should be so thorough that the quack grass will be

all destroyed between the rows of corn. The following season run the disk over the land quite frequently until the middle of June. Then sow millet at the rate of one bushel of seed per acre. The growth of millet thus secured should smother any plants of the quack grass that may have survived.

Observations. If the first method outlined is thoroughly followed out, then by autumn the quack grass will be completely destroyed. An infested field was very thoroughly cleaned by this method in one season at the Ontario Experiment Station farm at Guelph in 1891, the cultivated crop used being corn. It should be remarked that more constant and careful cultivation was given to this crop than a corn crop usually receives, and this is true in respect to both the horse labor and the hand labor. In a wet season, however, it would scarcely be possible to eradicate quack grass without an expenditure of labor too costly for such a result. Indeed, quack grass should never be disturbed when the ground is wet, for at such a time the growth of the grass would in some respects be encouraged by stirring the soil.

In fence borders it will usually be found very difficult to dislodge quack-grass without first removing the fence for a time, and then cleaning the ground as described above. However, another mode would be to smother the weed by piling litter or manure upon it, but this mode would only be applicable in the case of small patches. It must not be forgotten that the weed should be destroyed in such places, otherwise it will be continually pushing itself out into the field and giving trouble.

(2) THE WILD OAT.

The wild oat (*Avena fatua*) is an annual grass that is one of our most pernicious and troublesome weeds. In fact, the attention has never been given to this pest that its banefulness merits, but we would advise all farmers to spare no pains to exterminate it utterly from their land. The wild oat will grow readily at different seasons of the year, but it makes its most vigorous growth in the warm, moist weather of spring, though not in early spring. It bears considerable resemblance to the common oat, but there are some distinctive points of difference. In the wild oat the chaff scales

which adhere to the grain are thick and hairy, while in the cultivated varieties these scales are not so coarse and are hairless. The wild oat has a long, stiff awn, which



WILD OATS.

is usually twisted near its base; in the cultivated varieties, the awn is either entirely wanting or, if present, is not so stiff, and is seldom bent. When the awn of the wild

oat is dry, it is generally twisted closely upon itself, but when it is moistened by dew or rain, it slowly uncoils. This uncoiling of the twisted awn causes the seed to sprawl and spring about upon the ground, and is a means of forcing the seed into the ground in damp weather. The grain of the wild oat is light, being composed chiefly of hull, and it is therefore of but little value as a feed.

The resemblance of the wild oat to other cereals before heading is so close that when it grows along with them it is impossible to detect its presence without very careful scrutiny. It matures its seeds earlier than nearly all the varieties of the useful cereals, but of course not so much so in the case of fall wheat as of the spring cereals; hence it is especially troublesome in the localities where cereal crops are much grown. It is very troublesome, too, from the fact that it begins to shed its seeds upon the ground as soon as ripe, and the operation of harvesting the crops amid which it grows greatly helps it to shed its seeds. It is a very hardy plant, and will endure adverse conditions of soil and weather in a remarkable degree, but its seeds will not germinate

very early in the spring, nor in the autumn, unless the weather be warm and moist. It luxuriates in soils that are well adapted to the growth of cereals, but it will also grow in various other soils. The wild oat does not give serious trouble in meadows or pastures. Its seeds are possessed of great vitality, and will spring into life when brought under suitable conditions, although they may have been buried in the ground or in unrotted manure for years and years.

The wild oat is distributed most freely by means of the seeds of the small grains, for the reason that, if left to grow among these crops, it is sure to ripen before them, and therefore to have a portion of its seed mixed with the thrashed grain. It is also very largely distributed by manure, since its seed is so light that there is no means of preventing it from being very freely mixed with the straw of the crops amid which it has grown. When once among the straw of the manure heap, its seeds will maintain their vitality for years, unless the utmost pains be taken to thoroughly rot the manure, which should always be done before the manure is placed on the land if wild oat seeds are suspected of being present in it.

The watercourses also carry down the seeds of wild oats from higher levels, and some seeds are brought into new localities by thrashing machines. On the farm it is also further distributed by being carried in the droppings of animals.

Darnel and cheat are annual weedy grasses which give much trouble in some sections. They can be eradicated by the means here recommended for the wild oat.

Modes of Eradication.

The following are the modes of eradication that have been found most successful in dealing with wild oats:

1. *After-harvest and autumn cultivation, followed by a cultivated crop.* In fields which have borne grain crops, plow the land just as soon as this can be done, starting the process even before the shocks of grain have been removed from the fields—the reason for this early plowing being that many of the wild oat seeds which have been recently shed upon the ground may at this time be induced to germinate, whereas they could not easily be induced to germinate later on. Plow a second time, and then cultivate or harrow the land occasionally,

until the time of late plowing in the fall. Other wild oat seeds lying in the upper portions of the soil may thus be encouraged to germinate. It will be an additional encouragement if the land be rolled once or twice during the process, especially if the season be dry, for the rolling tends to retain the moisture of the soil, and when the soil is not moist the oats do not germinate readily. In any case, it must be remembered that they do not germinate so readily in the autumn as in the warm and moist days of spring. When the late autumn has come, plow deeply, so that the lower section of the cultivated portion of the soil will be brought to the surface. Then in the spring stir the surface soil occasionally until it is time to plant corn or some other cultivated crop.

2. *Growing two cultivated crops.* Grow two cultivated crops in succession on the land, giving careful attention to the previous autumn cultivation and to the subsequent preparation of the soil for seed, and to the cultivation of the crops while they are growing.

3. *Encourage germination, kill the young plants, and sow a late crop.* Allow the wild

oats to start in the early spring. Then plow the land in order to bury the myriads of oats that have germinated. The ground should be at once harrowed to encourage the germination of the oats in the upper section of the soil. When another crop has started the disk should again be run over the land. It should then be sown to millet or barley during the first half of June. These crops should be cut before any stray wild oats that may have survived have produced seed. The ground should then be at once plowed again to bring up the lower section of the furrow slice, which will contain seeds. The next year the same process should be followed. But few wild oats will then remain in the soil. If a cultivated crop, as corn, follows, the wild oats should be all destroyed.

4. *Seed the land to alfalfa.* One of the most effective ways to eradicate wild oats is to seed the land to alfalfa. The frequency of the cutting of the alfalfa crop will prevent any of the oats from maturing seed. If the alfalfa is harvested for several successive years, the seeds of the wild oats remaining in the soil will lose their germinating power. The two methods last

submitted are specially applicable to north-western conditions.

Observations. (1) In all districts infested with wild oats, darnel, or cheat, the greatest care should be taken to get pure seed for sowing, especially of spring oats, wheat, and barley, for these weedy grasses will in many cases ripen earlier than any of these. (2) If these weeds exist on any farm, their seeds, owing to their lightness, are sure to get mixed with the straw of the thrashed grain, and thus get into the manure. Owing to the remarkable vitality of the seed of wild oats, whenever there is a suspicion that the manure contains wild oat seed it is particularly essential that it should be thoroughly rotted before being used. (3) Owing to its reluctance to germinate in the fall, autumn cultivation does not do as much for the eradication of this weed as for many others. The greatest pains, therefore, must be taken to induce its seeds to germinate by the earliest possible cultivation after harvest. As its seeds will not germinate in autumn unless the weather is warm and moist, the wild oat is very hard to deal with in the American and Canadian Northwest, where the autumn days are

never warm enough to secure the germination of the seeds. The soil there is so suitable to the weed that it grows with great vigor, even to a height of six feet.

(3) FOXTAIL.

Foxtail (*Setaria glauca*) is better known in the Northwestern states as summer grass or pigeon grass. It grows to a greater or less extent in nearly every section of the continent where the land has been tilled, even if only for a few years. It gives great trouble in prairie countries where one kind of cereal is frequently grown for many years in succession on the same lands. It is also troublesome in all crops in the corn belt, particularly in Iowa and the adjoining states. Green foxtail (*Setaria viridis*) is a closely related species which is more common in the East. Practically the same description applies to it, and the same methods of treatment are applicable. Foxtail usually grows to the height of about one foot when matured, although the height varies much with the richness of the soil. It is capable of maturing seeds even when but a few inches high. The leaves bear a very close resemblance to those of

millet, but they are much smaller. The head is covered with fine, soft hairs, and it produces many seeds.

Foxtail commences to grow as soon as the soil gets warm, and the seeds, which have great vitality, will germinate under favorable conditions until the arrival of cold weather in autumn. After the cultivation has ceased in corn, potatoes, and similar crops, the seeds which lie in the soil will grow when it is sufficiently moist. The plants produced under these conditions grow very rapidly and mature seeds in an incredibly short space of time.

Foxtail will grow on almost every class of soils, but on rich prairie soils it luxuriates. It infests almost every form of crop grown, but does not give much trouble in rye, winter wheat, or on cultivated meadow, owing to the early period at which these crops mature. It is specially troublesome in cereals sown in the spring, as in these the plants frequently grow in such numbers as to greatly hinder the growth of the crops.

Foxtail is distributed through the agency of birds, wind and water, and to a still greater extent probably through that of seed



FOXTAIL

grain, manure and droppings of animals.

Other annual weedy grasses which can be eradicated by the methods given below include barnyard grass, fingergrass, and crabgrass.

Modes of Eradication.

The following are the modes of eradication that have been found most successful in dealing with foxtail:

1. *Modifying the rotation.* Increase the acreage of rye, winter wheat, cultivated grasses and permanent pastures.

2. *Autumn cultivation.* Practice autumn cultivation to the greatest possible extent. If the fields which have grown cereals are at once ploughed, as soon as the grain is removed, the maturing of many of the seeds will be prevented, but not of all of them.

3. *Growing cultivated crops.* Grow cultivated crops so far as practicable, more especially crops of corn. In these the cultivation should be continued as late in the season as possible.

4. *Harrowing the grain.* Harrow the grain in the spring with a light harrow, with many teeth in it, just after the fox-

tail plants have appeared in large numbers above the surface of the ground. This should never be attempted when the ground or the grain is wet. When the work of harrowing is judiciously done it will also prove helpful to the crops which are thus dealt with.

5. *Pasturing with sheep.* Utilize sheep in pasturing off the stray plants in pastures and in the aftermath of meadows, and in eating off the myriads of plants which frequently grow among the stubbles of cereal crops, in corn crops and in waste-places generally. A flock of sheep will soon clean out all the plants growing in a crop of corn, and without injury to the corn, when the sheep are turned in to feed amid the corn at the proper season.

Observations. (1) In fighting this weed the aim should be to give prominence to those methods which will most effectively secure the quick germination of the weed seeds in the soil. Until these germinate they cannot be removed. (2) To get the complete mastery of the weed it will probably be found necessary to cease to grow cereals which are sown in the spring from year to year upon the same lands.

CHAPTER IX.

SPECIFIC MODES OF ERADICATING MISCELLANEOUS TROUBLESOME WEEDS.

The most important of the weeds which give trouble to the farmer in the northern United States which have not been treated in the three preceding chapters are *the Russian thistle, the plantains, bindweed, wild buckwheat, corn cockle, wheat-thief, blueweed and wild carrot*. The last three of these are most serious in eastern Canada and the eastern United States. Wheat-thief and the blueweed belong to the same botanical family, as do the Russian thistle and the wild buckwheat. With these exceptions, the weeds mentioned in this chapter are not closely related.

(1) THE RUSSIAN THISTLE.

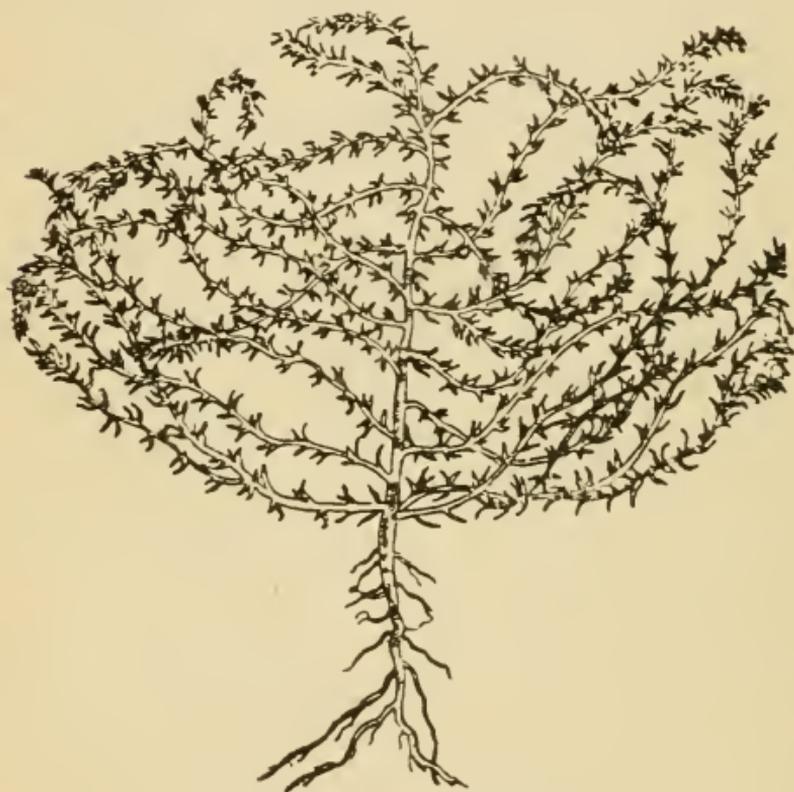
The Russian thistle (*Salsoli kali* var. *tragus*) is one of the most aggressive weed pests that has ever come to the prairies of the west. It is frequently called the Rus-

sian cactus, but strictly speaking it is neither a thistle nor a cactus.

This plant, it is claimed, first obtained a foothold in the United States in Bonhomme county, South Dakota, about the year 1873. It is supposed to have been brought in flaxseed from the plains of Russia, where it has been growing increasingly formidable for at least two centuries. So rapid was the spread of the Russian thistle in the United States that it was soon considered a serious menace to successful agriculture in several of the prairie states bordering on the Mississippi and Missouri rivers. It has also made its appearance in states farther to the east, but nowhere is it now so seriously regarded as it was a few years ago, though it is still a very troublesome weed in the prairie sections.

The Russian thistle is an annual. The early leaves of the young plants are smooth and slender, about two inches long, and each is tipped with a spine. Above the early leaves branches grow out which produce many spines, and the number and length of the branches vary much with the attendant conditions of growth. The spines grow in clusters of three, and as the plants

near maturity they become so rigid that the legs of horses require protection when they have to travel among the mature weeds. When near maturity the plant appears to be almost leafless. Specimens of the plant have been found with a diameter not less than five feet.



THE RUSSIAN THISTLE.

The Russian thistle does not begin to grow very early in the season, hence if grain crops are given an early start in the spring the thistle which infests them will

be so far kept in check that it may not seriously injure the crops. It frequently continues to grow and mature seeds until the frosts become severe enough to destroy its vitality. The earlier plants mature much of the seed in the latter part of August and in September, hence all plants cut off or pulled up after that time should be burned. It is claimed that an average sized plant is capable of maturing from 20,000 to 30,000 seeds.

This weed is specially troublesome in grain crops; the later the crops and the more weakly they are the greater will be the injury done. It grows with sufficient vigor under some conditions to prevent the harvesting of the grain by the ordinary binder, and in all cases on account of its bulk it makes harvesting difficult and expensive. It infests all kinds of crops, but is easily destroyed in such as are cultivated. This weed grows to some extent on the native prairie, but not so much where grasses are well established in the soil, as where prairie fires, gophers or prairie dogs have prepared a seed bed for it.

The Russian thistle is propagated solely by means of its seed and its marvelous

power of propagation is attributable to the ease with which the winds send it tumbling over the prairie for miles in succession, the number of seeds which it produces, and the readiness with which the seeds germinate under favorable conditions. Railways are largely responsible for the conveyance of the seed to new centers. It has also been carried in flaxseed and in the seed of cereals.

Modes of Eradication.

The Russian thistle is not difficult of eradication. Its great weakness lies in the inability of the seeds to maintain vitality under normal conditions for a longer period than two years. Under a good system of farming it may be eradicated without great difficulty. Any system of farming that will prevent the plants from maturing their seeds for two successive years will accomplish this end.

The following are the modes of eradication which have been found most successful in dealing with the Russian thistle:

1. *Modifying the rotation.* Cereal crops and other crops which favor the maturing of the seeds may be omitted for two successive years, and other crops grown in

their stead, such as cultivated crops or the tame grasses.

2. *Spudding.* When the weed plants are not numerous they may be destroyed by cutting them off with the spud below the crown any time before the seeds are matured, but the work will be much more easily done at an early rather than at a late stage of growth. Along fence borders and in waste-places they may also be thus destroyed.

3. *Growing two cultivated crops.* If two cultivated crops are grown in succession on the same land, and if at the same time proper cultivation is given to them, the weeds will be all destroyed.

4. *Growing forage crops and pasturing them with sheep.* The Russian thistle may be easily destroyed by growing certain forage crops and pasturing them with sheep for two years in succession. Winter rye should be given a prominent place among these crops where it can be successfully grown. The rye may be followed about the end of May with corn, sorghum, millet or rape. Sheep seem to relish the thistles when young and tender.

5. *Harrow small grain in the early spring.* Harrow the grain crop with a light steel harrow as soon as the blades begin to show. The teeth should be given a backward slant sufficient to produce the result sought. When the grain is four or five inches high, it should be harrowed a second time, and even a third and fourth time under some conditions. This method of destroying Russian thistles has special adaptation to dry areas where the harrowing of the land has also a beneficial influence on the growth of the crop.

6. *Autumn cultivation.* Autumn cultivation will be found very helpful in destroying the Russian thistle, and also in preventing its further increase. It is efficacious in proportion to the early date at which the plowing is done.

7. *Legislative enactments.* When vacant lands have become infested, stringent legislation is necessary to keep the weeds properly in check.

(2) THE PLANTAIN.

The two most important varieties of the plantain are known as the common plantain (*Plantago major*) and the buckhorn or

English plantain (*Plantago lanceolata*).

The common plantain, which seems to follow everywhere in the wake of civilization, is not a very troublesome weed. It grows about dwellings, in paths where the grass has been much trodden, and in waste places generally where the soil is rich. Good cultivation in nearly all cases will suffice to keep it at bay.

The buckhorn or rib grass is a much more troublesome weed, and has become a source of great annoyance in the many sections of our continent into which it has been introduced from Europe. It is a simple perennial. Its leaves are long, ribbed, hairy, and narrowed at the base. The stems which support its seed-spikes are usually about a foot high, though they sometimes attain a height considerably greater. Several spikes are commonly borne by each plant. These spikes are usually from one to two inches long, much shorter relatively than those of the common plantain.

The buckhorn continues to grow throughout the greater part of the growing period of the year. If it be cut off above ground, as with the scythe, after the spikes begin

to appear, other spikes will at once commence to grow in their place. Its effort to produce seed is thus sustained until late in the season. It comes into flower in June,



THE BUCKHORN

and seems capable under certain conditions of maturing seeds during all the months following until cold weather is near.

The buckhorn is most troublesome in meadows and pastures, more especially in

the latter. It also infests lanes, roadsides and waste places, but it is not specially troublesome in tilled fields, as it does not seem to have much power to withstand good cultivation. Its favorite soils are those which may be termed sandy loams, or loams of mild constitution.

This weed is most commonly distributed by means of the seeds of grasses and clovers, but it is also distributed to some extent in the seeds of cereal grains which have not been carefully cleaned. It is also distributed in manure, and by means of other agencies. Its seeds are about the same size as those of red clover, and are much the same in color. In shape each seed is slightly elongated, and furrowed on one side.

Modes of Eradication.

The following are the modes of eradication that have been found most successful in dealing with the buckhorn. They are also effective in killing the common plantain and closely related plants.

1. *Breaking up meadow-land and following it with a cultivated crop.* In the case of meadows, plow them just after they have been cut, and cultivate on the surface until

the late autumn. Grow a cultivated crop the following season.

2. *After-harvest and autumn cultivation, followed next season by a soiling crop, and this by a quick-growing cultivated crop.* In the case of tilled fields that are infested, plow just after harvest, and thereafter give due attention to surface cultivation. Next season grow a soiling crop, and follow that with rape, sorghum, or some other quick-growing cultivated crop, grown as described in section 3 of our treatment of the Canada thistle.

3. *Using the mower, or scythe.* In places where cultivation cannot be introduced, persistently use the mower or scythe to keep the plants from maturing their seeds, or, if practicable, use the spud to cut off the plants below the surface of the ground.

(3) BINDWEED.

The two common species of bindweed (*Convolvulus sepium* and *C. arvensis*) are very similar creeping perennials with trailing habits of growth. As they are so similar, they will be discussed under the same heading. Bindweed, or as it is often called, wild morning glory, usually grows to the

length of two to three feet, but on some soils it attains a much greater length. This weed bears a close resemblance to the morning-glory. Its leaves are cordate or heart-



BINDWEED.

shaped, and its blossoms are sometimes white, but more commonly they are of a pinkish white, which may be tinged with veins of blue. Its roots are larger than the

vines. They form a network in the soil, and also go down deeply into it.

Bindweed begins to grow usually in the month of May, and maintains its greenness until the time of early frost, although its growth is most vigorous during the early months of summer. It commences to blossom early in the season, and continues to bloom for a long time. Bindweed grows in various crops, but it is most troublesome in grain crops; yet when it is found in hoed crops, it greatly adds to the trouble of keeping them clean. It climbs up the stalks of the grain amid which it grows, and, after twining around them, it gradually draws them down toward the ground. So completely intertwined and entangled are the vines within themselves that they sometimes greatly hinder the progress of the mower or binder. This weed will grow in various soils, but is most at home in soils which contain a large amount of humus.

Bindweed is generally distributed by means of the seeds of cereal grains, but it is also carried from place to place by the agency of water. In this last fact lies one explanation of the extent to which it is sometimes found in bottom lands. It is

also distributed by means of manure, and in cultivated land it is propagated very largely by means of the root-stocks which it so numerously possesses.

Modes of Eradication.

The following are the modes of eradication that have been found most successful in dealing with bindweed:

1. *Modifying the rotation.* In the infested fields drop grain crops out of the rotation until the fields have been subjected to a cleaning process.

2. *After-harvest and autumn cultivation, followed by spring cultivation and a cultivated crop.* Plow the infested fields immediately after harvest, and cultivate or plow them sufficiently often thereafter to keep the plants from breathing until the period of growth ceases. The plowing should be shallow, but at the same time thorough. The last plowing, however, should be deep, to prepare the soil for the next crop. In the spring proceed in the same way as in the autumn cultivation; that is, keep constantly stirring the soil near the surface until it is time to plant a cultivated crop, as corn or roots. Then give this

crop careful culture throughout the remaining part of the season.

It may here be remarked that, as this weed is usually a singularly persistent grower, it requires much labor and constant watchfulness in order to eradicate it completely in one season.

3. *Calling in the aid of sheep or hogs.* When bindweed grows in pastures and waste-places, its growth may be checked by allowing sheep to have access to the places where it grows, inasmuch as they are not disinclined to feed upon this weed, especially early in the season, while yet the plant is tender. Hogs that have not had their noses rung or slit to prevent rooting will be a very efficient aid in eradicating bindweed, if they are pastured on it or turned on to a plowed field which contains the roots. They dig up the fleshy, succulent roots and eat them freely.

(4) WILD BUCKWHEAT.

Wild buckwheat (*Polygonum convolvulus*), sometimes improperly called bindweed, is a plant possessed of a creeping, and also a twining and clinging habit of growth. In some aspects it resembles

bindweed previously described, but the roots grow very differently, and there is no resemblance between the blossoms or the seeds of the two plants.

The plants grow singly, but oftentimes in great numbers. The tendrils spread abroad in different directions, and cling to the vegetation amid which the weeds grow. They will then clamber up to the very top of the stalks of matured grain, and will oftentimes cause it to lean toward the earth in consequence of their weight.

The seeds resemble those of cultivated buckwheat both in shape and color, but they are not quite so large. They are possessed of a considerable degree of vitality.

Wild buckwheat begins to grow almost as soon as the cereal grains, and it continues to grow and mature seeds until the time of severe frosts. In spring cereals many of the seeds are matured before the grain can be harvested. It infests all kinds of crops, but is much more troublesome in cereals than in other crops. It gives but little trouble in pastures and meadows.

Wild buckwheat will grow in various soils, but it grows much more vigorously in rich vegetable loams than in soil stiff,

and heavy or deficient in vegetable matter. It has come to be a grievous pest on prairie soils in localities where cereals are grown on the same lands from year to year.



WILD BUCKWHEAT

rie soils in localities where cereals are grown on the same lands from year to year.

Wild buckwheat is distributed by means of birds, wind and water, and to a greater extent probably through the agency of manure, the droppings of cattle and the seeds of cereals.

Modes of Eradication.

The following are the modes of eradication that have been found most successful in dealing with wild buckwheat:

1. *Varying the rotation.* Vary the rotation so that much greater prominence will be given for a time to meadow and pasture and to cultivated crops. It may be mentioned here that in the judgment of the writer, too little attention is given to the growth of cultivated crops in nearly all parts of the Northwest. If these were more extensively grown and suitably cared for, noxious weeds would soon be materially lessened.

2. *Growing cultivated crops.* Grow cultivated crops and clean them so effectively that none of the seeds of the wild buckwheat plants will mature.

3. *Sowing clean seed.* Make sure that only clean seed is sown, and use special care in preparing the seed of cereals for

sowing, or in purchasing the same for seed.

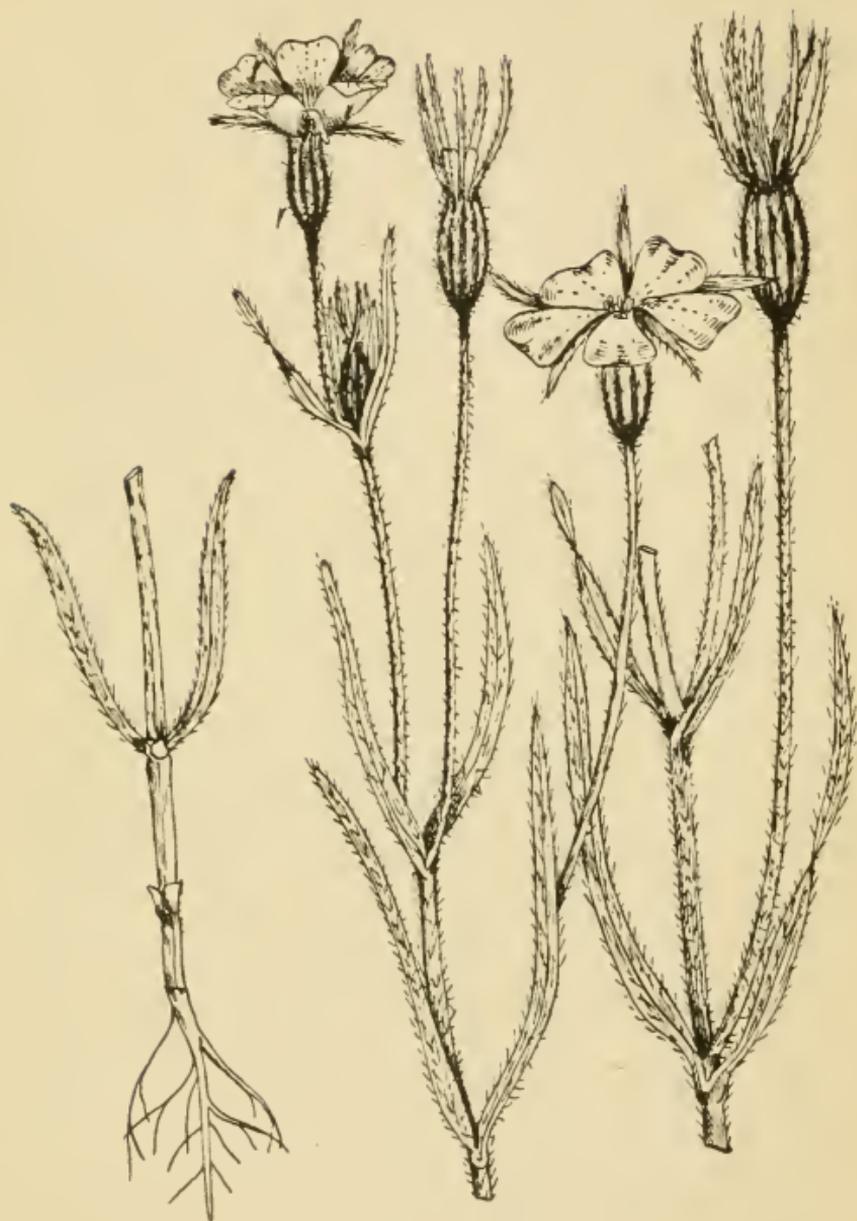
4. *Autumn cultivation.* Plough the land immediately after harvest when possible, to prevent the further maturing of the seeds.

5. *Harrowing cereal crops.* Draw a light harrow possessed of many short teeth over the cereal crops when the plants of the wild buckwheat have appeared numerous above the surface of the ground. When the work is judiciously done it will be found very effective in relation to the labor expended.

(5) CORN COCKLE.

The corn cockle (*Agrostemma githago*), also called purple cockle or pink-flowered cockle, is a common annual weed in wheat fields. It does not commonly occur elsewhere, though it may grow in other grain. In the winter wheat district it is a winter annual.

The plant grows from one to three feet high, usually with few branches; the leaves are long and narrow, and the whole plant is thickly covered with silky hairs. The conspicuous purple or pinkish-purple flow-



CORN COCKLE.

ers are borne on the ends of the branches; the calyx, which encloses the seed pod, becomes much swollen as the seed develops. The plant blooms in June and July, and ripens its seed with the grain.

The rather large, somewhat flattened black seed occurs commonly in thrashed wheat, where it is easily recognizable and difficult to remove. This seed is particularly objectionable in wheat, as when it is ground with the grain, it gives the flour a dark color and unpleasant taste, and is said to be unhealthy. The seed is poisonous to chickens, hence screenings which contain it should not be fed to poultry.

The white cockle (*Lychnis alba*) and the sticky cockle or night-flowering catchfly (*Silene noctiflora*), the former a white-flowered biennial and the latter a sticky, hairy annual with yellowish-white flowers, are closely related plants which sometimes occur in grain fields and meadows. A short rotation, with the rather frequent introduction of a thoroughly cultivated crop, will keep both these weeds in check. The methods of eradicating corn cockle are equally effective in handling white cockle and night-flowering catchfly.

Modes of Eradication.

1. *Sow clean seed.* The best method of preventing the growth of corn cockle in grain fields is to sow clean seed. When the weed is once introduced it is rather difficult to eliminate from wheat fields where the crop is grown continuously. Screening will remove some of the seeds from seed grain, but as they are nearly as large as a grain of wheat, they are difficult to eliminate.

2. *Proper rotation.* As corn cockle is an annual weed which soon gives way to thorough cultivation, a system of rotation which introduces a cultivated crop every two or three years will, if proper care is used in sowing clean seed grain, soon eliminate it.

3. *Hand pulling* or spudding the plants which occur in wheat fields, if they are not too numerous, is the surest way to check the spread of this weed. The conspicuous flowers make the plants easy to locate in the field, and as they are readily removed, this method is not as slow or difficult as might at first appear.

4. *Harrowing small grain in the spring* when it first appears above the ground, and

again when it is about three inches high, will kill cockle and many other weeds. This method is less effective on winter grains, as the cockle starts in the fall with the grain and many of the plants are too firmly established by spring to be removed by the harrow. Harrowing winter grains as soon as growth starts in the spring does kill many small weeds, however.

Observations. While this weed is easy to eradicate if proper attention is given to the methods just outlined, it will be found to be quite persistent where wheat is the main crop and no rotation is followed, on account of the difficulty of removing the seeds of cockle from the seed grain, hence the necessity for exercising care in preventing its introduction through seed grain wherever possible.

(6) WHEAT-THIEF.

Wheat-thief (*Lithospermum arvense*) is sometimes known as gromwell, pigeon weed, and redroot. It usually grows from eight to sixteen inches high, but sometimes in rich soils it becomes considerably taller. It is more or less branched in its habits of growth. Its leaves are narrow and about

an inch long, and are noticeable from the fact that they are of a lighter tinge of green than those of the cereals and grasses. Its flowers are small, and white or of a pale cream color. Its seeds cluster along its



WHEAT THIEF.

stems, and are produced abundantly. They are endowed with much vitality.

Wheat-thief is an annual, but like false flax, it usually comes up in the fall of the

year previous to that in which it matures its seeds. Its blossoms appear during the latter part of May or early in June, hence its seeds ripen before our meadows are ready for harvesting, or before our crops of winter cereals can be cut. It is so hardy a plant that frosts do not destroy it. It usually grows a little in advance of the crop in which it is found, hence its presence may most readily be detected just when it is coming into blossom. The lighter shade which its leaves possess also enables it to be somewhat easily distinguished. It will grow in any kind of soil free from stagnant water, but is most partial to sandy loams.

Wheat-thief is most troublesome in crops which mature early, and have been sown the previous season, such as winter wheat, rye, and meadows. It is also found in pastures, but it seldom infests spring crops to any considerable extent, although some plants may survive the early cultivation necessary for the preparation of the ground for these crops.

Wheat-thief is most commonly distributed through the agency of the seeds of the winter cereals and of the seeds of timothy,

mammoth clover, and alsike clover. It is not carried in the seed of common red clover. It is further distributed by the droppings of cattle, by the manure of the farm-yard, by thrashing machines, and by birds.

Modes of Eradication.

The following are the modes of eradication that have been found most successful in dealing with wheat-thief:

1. *Modifying the rotation.* Drop out of the rotation winter wheat, winter rye, and meadow crops, but not necessarily pastures, if these are kept eaten bare. The omission of these crops from the rotation need not continue for more than two or three seasons if due attention be given to autumn cultivation, as described in the next section. In respect to pastures that are infested, it will generally be sufficient to deal with them by means of hand pulling.

2. *Autumn cultivation.* Give careful attention to autumn cultivation, for it is in the autumn that the seeds of this weed germinate most freely. The first plowing after harvest may be either shallow or deep, as may be desired. If the seeds of this weed have fallen numerously during the

harvesting of the immediately preceding crop, cultivating the surface soil will be preferable to plowing it.

Specific Modes of Eradication.

3. *Growing cultivated crops.* Where the land is suitable, grow cultivated crops, or else grow rye and follow it by a cultivated crop. Where cultivated crops are grown alone, give careful attention to the autumn cultivation which precedes their sowing.

4. *Hand pulling and spudding.* Where the weeds are not numerous, resort to hand pulling or spudding. This work, to be easily done, and to fully accomplish the end intended, should be undertaken while the plants are still in bloom.

Observation. Whenever it may be necessary to sow to grass, then, as in the case of false flax, it should only be done with such crops as spring wheat, barley, and oats.

(7) BLUEWEED.

Blueweed (*Echium vulgare*) is a biennial. It is sometimes known as viper's bugloss, but the more common name for it is blueweed. In the Southern States it is

sometimes called the Canada thistle, although it bears but little resemblance to that weed. It is most common in Ontario, New York and the states to the southward.

Blueweed is both upright and spreading in its habits of growth, each plant having several branches springing from a single stock. It grows to the height of from one to three feet, according to the character of the soil which it infests. Its leaves are rather large, and those which grow nearest the crown spread out so that they lie near the surface of the ground. Both leaves and stems are covered with numerous hairs, which stiffen with the advancing growth of the plant, which explains why blueweed is not relished by live stock. These hairs are also far from agreeable to the touch when one tries to pull the plant. Its flowers are large, and of a deep, rich blue color, thus giving the fields where blueweed grows a very beautiful appearance at the season of the year when it is in bloom.

Blueweed is a biennial. During the first season of its growth, it sends a strong tap root down deep into the ground, and from this several smaller roots branch off. Blue-

weed does not blossom in its first year, but in the second year the stronger plants begin to come into bloom in the month of June, and the weaker ones later on, so that the period of bloom usually extends over several months. The blooming season is also



BLUEWEED.

extended by efforts made to eradicate the weed, for when it is cut off above the surface of the earth, as with the scythe, horizontal branches at once start out from the crown and soon begin to bloom and bear seed. Some of these newly formed hori-

zontal branches hug the ground so closely that, when the field is gone over again with the scythe, it is not at all easy to cut them off; as the same thing occurs with each cutting, as long as the growing period continues, and as the weed is a very prolific seed producer, and as its seed is also very tenacious of life, it follows that in places where cultivation is impossible, this pest is not a very easy one to deal with.

Blueweed grows in various kinds of soil, but its favorite feeding grounds are those soils which contain much lime. It grows vigorously in gravelly soils, even in those which are suitable for use in road-making, hence we frequently find this plant growing right up to the travelled portions of the roads.

As in the case of all or nearly all biennials blueweed is not very difficult to keep out of the cultivated portions of the farm, but it is a very different matter when we come to deal with it in fence borders, in permanent pastures, on road sides, and in waste places generally. In all these places blueweed soon finds a congenial home, from which it cannot be easily dislodged.

As regards the distribution of blueweed, it is probable that the wind is the chief agency employed in effecting its spread from place to place. The seeds of blueweed cling long to the receptacles in which they grow, but in winter or toward spring, the wind shakes many of them out of their receptacles and drives them for miles over the encrusted snows. This fact no doubt will generally account for the sudden appearance of blueweed in new centers, where previously it had not been known to exist. Blueweed is also probably distributed to some extent by means of clover seed, where careless methods of farming allow it to mature its seeds while growing in meadows.

Modes of Eradication.

The following are the modes of eradication that have been found most successful in dealing with blueweed:

1. In cultivated fields. Really good cultivation will keep blueweed from getting much of a footing in the cultivated portions of the farm. When stray plants put in an appearance in a field that is not desired to be broken up that same season, the spud is

the most effective means for removing them. The spud should in all cases be made to go below the crown, for when the plant is cut off below the crown at any stage of its growth, it will surely die, but not otherwise.

2. *In permanent pastures, waste places, lanes, etc.* In permanent pastures, and in waste places generally, if the plant has got a strong foothold in them, it will be found that any plan that will keep it from maturing its seed will soon prove effective in destroying it. Whether the spud or the scythe be used must be determined by the number of the plants to be destroyed, but in either case the work will have to be done more than once in a season, and also for several seasons. It will have to be done more than once in a season because, when cut with a scythe, the plants at once spring up again and begin to blossom. When the spud is used, some weaker ones are certain to be overlooked in the first cutting, but these also will blossom and bear seed later on. The scythe or the spud will have to be used for several seasons, inasmuch as the seeds lying in the soil, being possessed of

considerable vitality, will continue to germinate for years.

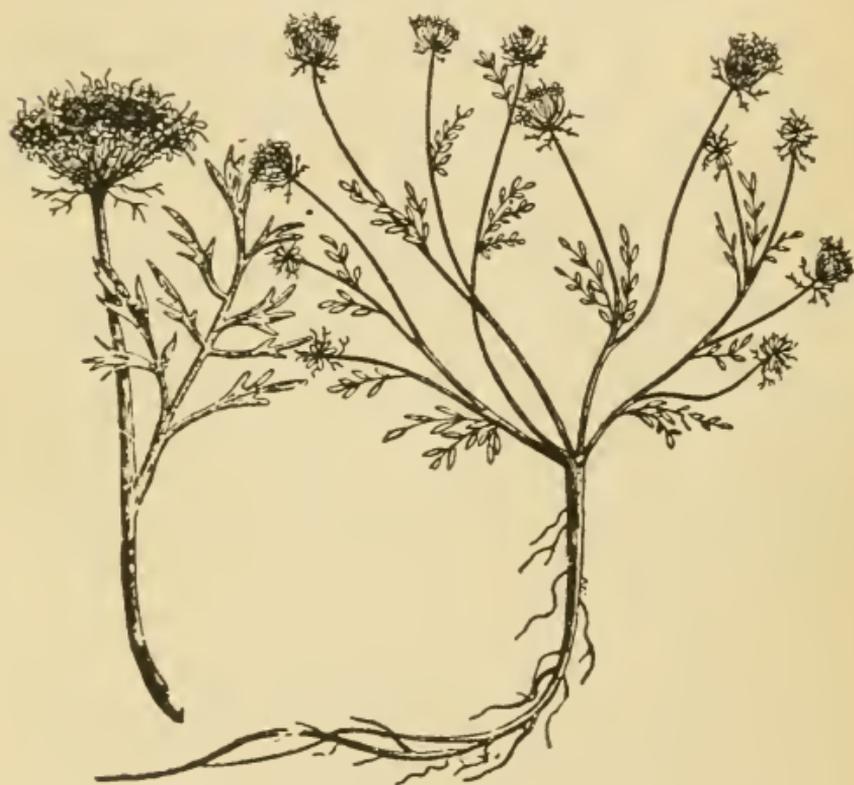
Observations. When fields containing blueweed are pastured closely early in the season, the production of the seeds will be very much hindered. This method will not alone be sufficient to eradicate the weed, however, for some of the plants will be sure to ripen their seeds unless some other method of eradication be employed.

(8) THE WILD CARROT.

The wild carrot (*Daucus carota*) is a biennial. It bears a close resemblance to the cultivated variety, more especially in the portions above ground. It has a tap root, which is more or less branched.

The wild carrot comes up early in the season. It sends up long flower stems, which terminate in an umbel or flower cluster. It thus produces seeds very numerous, and when cut off by the scythe or otherwise it sends up other stems, and this continues to put forth the effort to produce seeds until late in the season. Owing to its acrid juices, live stock do not care to feed upon it.

The wild carrot is not greatly troublesome to crops where the usual cultivation is good. Like blueweed, it is more commonly found in pastures, along roads and railroads, and in waste places generally, and to a less extent in meadows. It grows



THE WILD CARROT.

most readily in vegetable soils, but it also flourishes in mild loams.

The wild carrot is brought to new centers through the agency of railways, and to some extent by birds. Wind and water,

however, are the great agencies for carrying and scattering its seeds.

Modes of Eradication.

The following are the modes of eradication that have been found most successful in dealing with the wild carrot :

1. *In cultivated fields.* Give the arable portions of the farm good cultivation. If this be done, the wild carrot will soon cease to appear in them.

2. *In permanent pastures, lanes, waste places, etc.* In pastures and waste places keep the plants cut down during the second year of their growth, cutting them off with the scythe as often as they attempt to mature their seeds. If this be done thoroughly, at the end of two years all the plants will be destroyed.

3. *Using the spud.* Where the plants are not too numerous, they may be destroyed with the spud by cutting them off below the crown at any stage of their growth.

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