Weeds
Guardians of the Soil

by

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Author of Trampling Out the Vintage

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Publisher's Preface

SO FAR as we are able to determine this is the first book to be written in praise of weeds. Many are the books which treat weeds as pests, and each season sees an advance in anti-weed campaigns and techniques; a host of chemicals, mechanical eradicators and even flame throwers are making life increasingly hard for nature's greatest and most widely dispersed group of plants -- the plants which stand condemned because they are deemed "out-of-place."

That the ordinary garden and roadside weed might have a vital function in the scheme of things and be of inestimable value to mankind seems not to have occurred to most agriculturists, whether in the classroom, the departments of agriculture or on the farm.

The author of this book has been teaching conservation and biology for close to fifty years. But he has been a student as well and a keen field man who has specialized in the ways of weeds, not only in his home state of Oklahoma where he has spent much time learning from the Indians, but in other parts of the world -- in Europe, India and the Philippines, particularly.

According to Joseph Cocannouer, weeds -- the common ragweeds, pigweeds, pusleys and nettles, to mention four -- perform the following valuable services among others:

1. They bring minerals, especially those which have been depleted, up from the subsoil to the topsoil and make them available to crops. This is particularly important with regard to trace elements.

2.When used in crop rotation they break up hardpans and allow subsequent crop roots to feed deeply.

3. They fiberize and condition the soil and provide a good environment for the minute but important animal and plant .life that make any soil productive.

4. They are good indicators of soil condition, both as to variety of weed present and to condition of the individual plant. Certain weeds appear when certain deficiencies occur.

5. Weeds are deep divers and feeders and through soil capillarity they enable the less hardy, surface feeding crops to withstand drought better than the crop alone could.

6. As companion crops they enable our domesticated plants to get their roots to otherwise unavailable food.

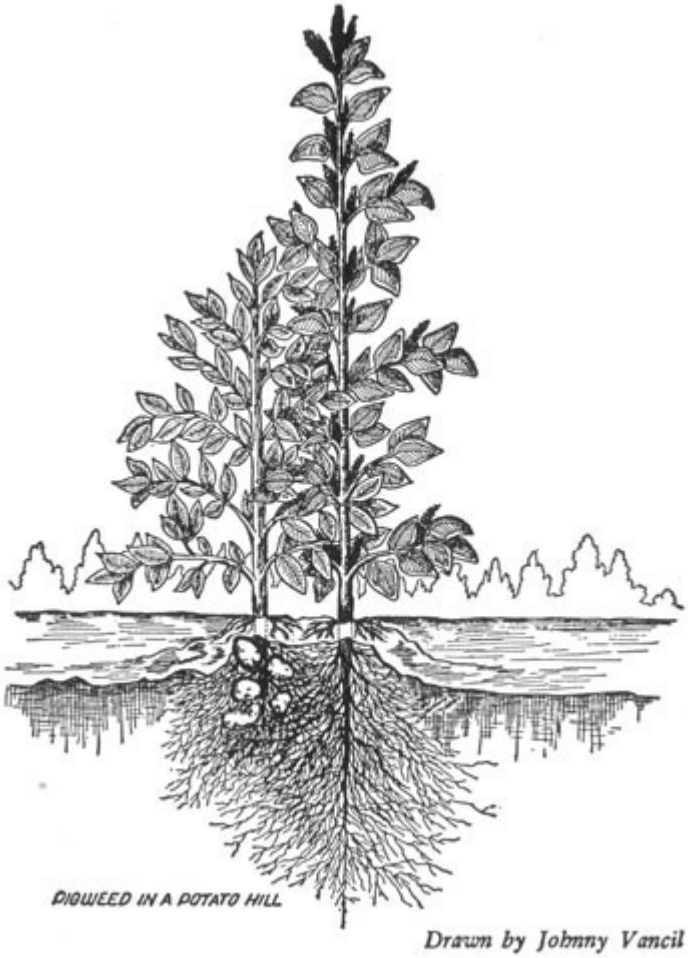
7. Weeds store up minerals and nutrients that would be washed, blown

or leached away from bare ground and keep them readily available.

8. Weeds make good eating -- for man as well as for livestock. The publisher can vouch for the superiority of lamb's quarter -- a favorite of the author -- over any other domestic form of spinach or cooked greens.

No, Professor Cocannouer does not believe that weeds should be allowed to go rampant and take over our farms and gardens. The function of this book, a pioneering work, is to demonstrate how the controlled use of weeds can be sound ecology, good conservation and a boon to the average farmer or gardener.

D. A. G.



PIGWEED IN A POTATO HILL

Drawn by Johnny Vancil

1. Weeds and Youth

DURING my early boyhood years on the farm, weeds spelled misery. At the first break of spring, weeds carpeted the land -- yesterday drab; today dense green everywhere. And mother saw every weed as a separate, individual enemy with which we must join battle.

"Bring the hoes from the loft and file them right away, boys!" I can hear her voice now, coming out of the long ago. "We simply mustn't let the pesky things get ahead of us!" I wonder how many weed hoes I have filed in my dreams!

Our little Kansas farm, even at that period, was in sore need of what *controlled* weeds could have done for it. But weed superstition reigned then as it reigns today. We hated all weeds in all situations because we hadn't learned to interpret some of the simplest laws by which Nature maintains the productiveness of land.

Even during those trying years when I could see nothing good in weeds save as potherbs or as feed for hogs, I always liked to pull or hoe

weeds for Sol Benson. Sol was a successful farmer who owned considerable land -- and who didn't treat me as a kid as did so many other farmers. Sol also usually gave me a few cents extra when he paid me off.

A certain day in Sol Benson's cornfield started me on a research journey that has spanned a half century. I happened to be hoeing in one of Sol's best fields, which I had contracted to clean of weeds for a definite sum. The corn was tree tall and the morning promised a scorching day. This particular field, fortunately for my feet, was quite solidly carpeted with purslane -- the dirt where the sun reached it was hot. "Pusley" was then a much more common weed in Kansas cornfields than it is now. (When I not long ago queried a young farmer why that was so, his reply was characteristic: "Good cultivatin' machinery and weed sprays -- we're gettin' the weeds licked!" I didn't say what I thought then. His fields spoke for me.)

I was soon so absorbed in those weeds in Sol Benson's field that I forgot everything except to keep my toes away from the edge of the hoe. With great spreads of pusley rolling up over my feet, my battered straw hat pushed back on my head and the sweat trickling down my face --

"Hold on there!" The voice was right behind me.

I turned -- and there was Sol Benson grinning at me. Then Sol very quickly seemed to forget that I was present. Very seriously he started to examine the roots of a large pusley plant he had brought with him. It wasn't one of the plants I had hoed up, for it carried a husky set of roots. Sol was fingering the pusley roots thoughtfully. I jerked my hoe loose and walked closer to him, wondering what there was about that pusley plant that made it so interesting.

Sol lifted his head quick-like then, same as he always did when he was going to say something important. "Joe," he said; "Joe, I been watchin' this pusley weed in my fields for a long time, and I've come to the conclusion that it not only don't do any harm, but it does good! This thing of considerin' all weeds as bad is nonsensical. Lot of guessin' without knowin', way I look at it. So I aim to do some guessin' of my own -- we're goin' to stop cuttin' pusley out of my corn!"

I stared at Sol Benson for a long moment, completely dazed. "But -- but pusley is weeds!" I finally managed to gulp. "Weeds is allers bad in fields where crops is growin' -- "

"That's only what people *think*!" Sol interrupted me sharply. "I'm convinced we been thinkin' wrong about weeds. Look here -- " he showed me some broken corn roots scattered among the pusley roots. "Know what that means? It means that the pusley roots are openin' up the dirt for the corn roots, so the corn can go deeper into the ground

and get more to eat. Now come with me and I'll show you somethin' else -- "

Sol went striding away through the corn and I trotted along behind him, still not sure he wasn't having a fit. Of all the silly ideas -- pusley makin' a road so the corn roots could go deeper into the ground!

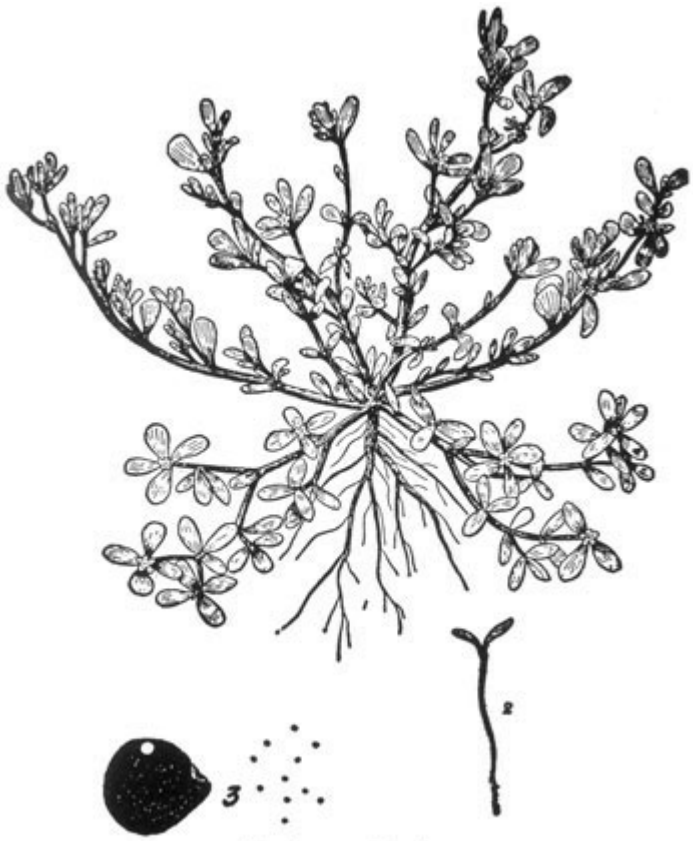
When we came to a part of the field where there was almost no pusley, Sol stopped and began pointing out the corn to me. "See the difference?" he said. "Not near as good as where the weeds are thick back there. Same kind of dirt, too. Somethin' is makin' a difference in that corn, and I figure it's the pusley. It's like that in all my fields. Where the pusley is thickest I get my best corn. Most farmers will say the corn is doin' good in spite of the pusley. That ain't it at all! The pusley is *helpin*' the corn to grow better."

I could see a difference in the corn all right, but the very idea of the pusley being responsible for that difference! "Sol, it jist must be somethin' else!" I told him courageously. "I know yer a good farmer and all; but nobody thinks that weeds is good for anything but hog feed and greens -- '

"I know they don't! Remember, people used to believe the world was flat -- "

"But that was 'cause people used to be ignorant and superstitious-like -- "

And right then something hit my brain a terrible wallop. People had been ignorant and superstitious and all, about the shape of the earth. Could it be that people were superstitious about weeds, too? Somebody had to discover that the earth isn't flat. And Sol Benson was smart enough for most anything -- even smart enough to discover that pusley could be helpful to corn!



Purslane or Pusley

Sol Benson has long since departed from the earthly scene. His name has been forgotten save by a few. The pusley of those yesteryears is also gone -- most of the present soil on that Kansas farm of my boyhood will not support it.

But, starting with Sol Benson's cornfield, I can see a winding trail; a dim trail at first, winding its way persistently into the years, traversing many parts of my own country and many foreign lands. Along this trail came soil studies in numerous regions of Asia, with its ancient agriculture; the desert lands of Africa; the semi-wild man and his crude farming; Europe offering the best in modern soil science. And with "weeds" ever a major part of every picture or episode where soil fertility entered in.

During much of my youth my weed trail was beset with skepticism and doubt, despite my confidence in Sol Benson's wisdom as a farmer. Weeds helpful to the crop with which they were growing -- all evidence seemed against the idea. Then there were the teachings of my mother. Those would not give way until I had undeniable proof that her concept of weeds was wrong.

As I grew older, support of Sol Benson's conclusions poured in upon me, often from the most unexpected sources. Weeds could be friends of the land! Day by day this evidence drove me deeper into the study of Nature's laws which supported the evidence: the laws pertaining to

the constructive relationship ever existing between soil and deep-feeding herbaceous plants.

Now as I look back across those years, I am able to evaluate more scientifically my varied sources of information: sound knowledge gleaned from a Pawnee Indian in his wigwam; a Chinaman fighting for survival on a small area of land and employing weeds as his fertilizer; from still wider acquaintance with the jungle man and his "mother weeds" on his primitive farm -- and coming close to understanding the science back of his procedures; or from some progressive American or European farmer who had discovered weed values and who was ready to support his findings with proof.

Then, too, there came further penetration into the natural laws of soil fertility; personal experiments -- all have convinced me that Sol Benson was a soil scientist who knew his pusley and its value in correct land management. Thus the chapters which follow.

2. Weeds and Weeds

"WEED: any plant growing out of place." But who or what is going to decide when a plant is out of place? Mustard going to seed in a field of ripening wheat is certainly out of place, as are weeds that shoot up like a magic green carpet in a field of young sugar beets. But if a plant is strengthening the soil in a given location, according to the laws of Nature, it is not out of place as a fundamental in maintaining land productiveness.

Some plants always seem to be harmful: poison ivy, for instance, and puncture weed and dodder -- and many others. Some can be harmful under certain conditions: pigweeds growing so thickly that they smother both themselves and the domestic crop. Yet, there are situations a plenty where the wild plant is beneficial both to the soil and the domestic crop with which it may be growing. An example of this is pigweeds in a heavy-soil potato field, the weeds spaced far enough apart to permit strong root development without crowding the potatoes; or a combination of pigweeds and lamb's quarter and sow thistles, scattered thinly in a tomato garden or an onion patch -- or even in a cornfield. In such cases the weeds can become valuable "mother weeds" instead of pests.

In southeast Asia there is a wild plant that spreads in tangled growth along the edges of the fields of the native farmers, often creeping far out into the fields. No other wild plants in that region equal this one in spreading vigor. Though the Malays relish the young pods, farmers insist that it is a bad weed, since they must labor to keep it from growing too near their rice and vegetables. That bad weed in Malaya is the fore-parent of our American cowpeas. When I questioned the Malay farmers, they admitted they usually harvested their best crops near where the *payaap* was growing. Even so, in their estimation it was a harmful weed.

Nature may at times compel us to discover the value of her wild plants; her weeds. In pre-colonial times a group of explorers, after navigating the Amazon for a lengthy period, decided to strike overland to a point towards which they were heading, hoping thereby to save weeks of time. The little band became lost in the jungles.

After many days of wandering, the men finally came upon a seemingly endless growth of vines bearing great quantities of pods filled with plump seeds that looked temptingly edible. But the explorers had already learned jungle caution. After considerable mental struggle, they decided to cast lots in order to choose a victim, who should risk his life by eating these *habichuelas*. Thus were our most popular beans discovered. Not only are these beans a staple article of food in many

parts of the world; they are soil improvers wherever grown.

I call to mind an old woman in south China whom I saw gathering herbaceous wild plants from an almost barren hillside. She was creeping over the rocks and along the steep banks in search of a few wretched weeds that would help make her tiny plots a bit more productive. My guide explained that the old woman was looking for particular kinds of weeds, though he did not know in what way they were particular. I examined the plants after the Chinese woman had brought them to her field. They or their relatives are common in many parts of the world: two or three varieties of thistle, a poppylike plant, a milkweed and a spurge. There were others I did not recognize. The important thing was that those wild plants -- those weeds -- were treasures in that Chinese woman's desperate economy. They fed the soil that must feed her.

Once, while in Europe, traveling through rural Bavaria, I came upon a man who was cutting green weeds from the roadside, apparently to mix with the manure sweepings which he was also gathering from the road. Among his weeds were nettles, lamb's quarter, thistles, mallow, and bindweed. Immediately I wanted to ask questions, but soon found that my college German was of little use. I did manage to get an invitation from the man to visit his neat farm, where I was introduced to a daughter who spoke English.

The German farmer did not consider many of our common weeds harmful in themselves. According to him the harm came from the farmer's failure to control the weeds while they were growing in his fields. The German had a most efficient, simple method of handling barnyard manure. The manure pile was under continuous construction, and as the manure came from the barn or corral or roadway, it was stacked with layers of manure or litter alternating with layers of weeds. By this method of manure-pile building, the farmer explained, the amount of the final fertilizer was markedly increased through the addition of the food-filled weeds; and firefanging of the manure was prevented because the weed layers permitted proper aeration.

I examined one pile of this fertilizer that had already gone through the processing. The stack on the outside looked like any typical manure pile now and then seen in American barnlots. Inside, the pile resembled true compost somewhat, but was really just mellow, well-rotted manure of a superior quality. I have since wondered if this German farmer could not have been employing a fertilizer-making process handed down from the Romans. The Catholic monks in Europe a few centuries back were known to have employed in their very efficient agriculture some of the teachings of Cato, who had lots to say on this subject.

While weed prowling in one of our midwestern states, I came upon a farm woman who had discovered that dry weeds were a real asset in

successful gardening. When I first saw the woman she was collecting the weeds in a thick patch near her garden, and then carrying them to her vegetable plot where she had already made a sizable pile.

I crawled through the road fence and introduced myself. "Tell me," I said, "but aren't folks supposed to carry the weeds away from their gardens instead of onto them?"

"I suppose so," she smiled. "I guess I'm a little contrary. Anyway, I like to burn weeds on my vegetable plots. Am I scientific?"

"Decidedly! That's what interests me. May I ask how you happened to discover that weed ashes are especially good for your vegetables?"

"By experimenting, and through the smattering of science I learned in high school and college. One who has nibbled a bit at biology is likely to wish to try out new things with plants -- don't you think?"

(For a fuller discussion of burning, see Chapter 7.)

We then walked out into the patch from which she had been gathering her weeds. There were horseweeds, a lighter growth of lamb's quarter, annual ragweeds, and thistles: the usual farm weeds for that locality. I moved the dirt with my foot and pulled up several of the weeds, most of which revealed strong root systems. I also crumbled some of the fibrous, mellow soil in my hands, and as I did that I was taken back across the years to some of the weed coves I had known in the Cherokee Strip during my boyhood. "With all of man's knowledge of soil science, he is not able to produce a dirt like this," I told her. "And all built by the weeds themselves -- the very same weeds that give you excellent ashes for your vegetables."

She trickled a handful of the soil through her fingers. I could tell that she knew how to appreciate good dirt. "There's one thing I've found out about the soil in here: for some reason it warms up early in the spring. Even when there is frost in the ground elsewhere, I can get warm soil here for my seed boxes."

Her words brought back days in the Indian country when I often tramped the woods and hills with a hunter-naturalist who used to say to me: "If you wanta scare up deer on a blizzardy day, always make for a weed patch that ain't too close to any house. Weed patches are warm even in coldest weather, and the deer know it."

Giant Ragweed

One spring back there in those boyhood days I decided to explore the soil in one of my favorite weed coves, with the hopes of discovering just why it should be warmer than the surrounding land. My patch consisted mostly of giant ragweeds, or horseweeds, bordered by annual common ragweeds and thistles and mint. Being quite young and unlearned in the science of geology, I at first imagined that Mother Nature was sending the heat from the interior of the earth as a special favor to weed coves -- or to the deer and other wildlife that sought warmth in such coves. But the further I dug into the soil of my cove, the more I came to suspect that the horseweeds themselves were responsible for the warmth. How -- I hadn't the slightest idea then.

It was not until many years later that I learned why the deer could depend on weed coves to supply them with warmth on frigid days. The soil in such a cove is close to being an ideal organic soil, composed mostly of plant materials in various stages of decay. And since the bacteria that are largely responsible for transforming the weeds into humus are very active and persistent workers when conditions are favorable for them, as conditions are in a virgin weed cove, a great amount of heat is being continuously generated. In such situations the

bacteria keep up their work to a degree, even in winter. This heat is the heat of decay. The woman had discovered this heat in her weed patch, and by using weed ashes on her vegetable plots, she had discovered something else.

Our common weeds, possessing vigorous root systems, go down into the lower soils for a goodly portion of their mineral foods because the minerals which plants require are usually abundant down there. Being strong feeders, the weed roots take up great quantities of the minerals and then bring them up to be stored in the stems and leaves. So, when the weeds were burned on the garden, those minerals were deposited there in the ashes, ready to be taken up easily by the growing vegetables. In this manner -- and in many other ways -- weeds are Nature's *true guardians* of the soil. They are the farmer's friends when he uses them intelligently; often his friends though he fights them.

Generally, the "weeds" in this book are the same old enemies of my boyhood. They were enemies then because I had not yet learned their worth. Grass is not included herein since grass does not improve the soil in the same way as do these deep foraging weeds; the deep-rooted herbaceous dicots. They are annuals usually, though a few biennials and fewer perennials are also reliable soil builders.

Near the top of the list I place pigweeds, two or three strains, and lamb's quarter, both familiar throughout the country in garden and field. Under most conditions these weeds are beneficial to the crop with which they may be growing. The same can be said for some of the nightshades, the ground cherry, and succulent purslane. Even some of the noxious weeds, like the cocklebur and bull nettle, are soil improvers where the individual plants have ample room for full root development. Then there is the goldenrod, an attractive weed that can be used in fiberizing gravelly soils, or loose sandy soils. On slopes where water erosion has done its work, the persistent yard purslane along with a few other creeping weeds will do a good job at starting land comeback.

It is possible that no soil-improving weeds in the United States excel the ragweeds, particularly the common annual rag, because the latter will establish itself in practically all types of soil. The giant ragweed, often called the horseweed, is also valuable but is more selective in its habitats. And not far behind the ragweeds are the sunflower, the milkweed, two or three thistles, the annual wild morning glory, stinging nettles, annual smartweeds, wild lettuce, and several wild legumes, including sweet clover, the latter the aristocrat of all weeds. All of these wild plants have root systems that forage deeply into the soil and can be employed as mother weeds, or as green manures in a rotation. All of them are *soil builders*.

3. Weeds and the Soil World

TO THOROUGHLY understand what those wild plants listed in the last chapter can do in building and maintaining the fertility of land, one must know a good deal about the surface sheet of our planet that supports vegetation, and which I call the *soil world*. For many it is not easy to grasp the fact that the soil world is the absolute dictator of organic life, and that includes human life.

A farm -- or a nation -- blest with unlimited fertile soil is resting on the strongest possible foundation. A nation of fertile soils has little to fear from within or without; for such land breeds national contentment. No such nation exists today -- not excepting our own America. And one of the major causes for the weakened condition of the food-producing lands in the United States has been the wanton destruction of Nature's soil-building plants; her valuable weeds.

A soil world at its best is made up of many active factors, all working harmoniously to maintain the soil's richness. These many factors make up the soil-fertility chain, every link of which has its own indispensable job to perform. This chain is Nature in constructive manifestation.

And wonderful is that soil world, small though it may be, that has no missing links in its fertility chain! One does occasionally run onto such a soil world, even today; an area of land under cultivation where the soil is palpitating with life. It is not difficult to recognize such dirt, through touch and sight and smell: the mellow feel, the odor of mold such as one gets when digging into the virgin organic earth on an undisturbed forest floor. Such earth is usually black, and filled with tiny pieces of broken sticks and leaves in various stages of decay.

I had reached the period of older boyhood when I first explored to my complete satisfaction a soil world like that. We were digging a well in a field containing soil about as rich as Nature could make it. This land had been under cultivation only a few years, and the soil, formed and established strictly according to Nature's laws, had not yet been impaired by man.

Three of us were working, but the other two did most of the digging. I was kept busy catching and penning up the interesting bugs and worms we routed out. That soil was so alive I soon had a menagerie. As we drove the circular hole down into the earth, every layer of soil came out clearly. Before long I lost interest in my bug specimens. That dirt had me.

Common Ragweed

At that time I had already attended college some and had done considerable reading about soil and land management in general -- anything I could get hold of, which wasn't much, compared with today -- but that first layer of soil showed up much more than I had ever found in books. It actually seemed to be in constant motion. It was inert as a whole, yet there were so many individual moving agents in it that the entire surface layer seemed to be shifting about. The surface soil was two-feet deep or thereabouts, and scattered through it and clearly visible were fat earthworms protruding from all parts of the wall -- a sure sign of the soil's richness. Then there were beetles and grubs galore, and millipedes and ants. Other insects were there, too, perpetually on the move, either in earthworm passages or in roadways of their own. It seemed to me that every conceivable size of soil life was in that dirt, from those so small they were almost invisible, up to the large bugs and worms.

And, of course, there was much more in that soil -- much which the boy was not yet able to interpret: the countless millions of bacteria that were playing such a large part in bringing about the normal decay of the organic materials. Valuable molds, too, were certainly there; and minute insects and worms. But all of this had to await later discovery. In those youthful days of adventure and thrilling expectancy, it was

still part of the unknown.

To my hands that surface soil was like the softest velvet. Its mellowness was due chiefly to the great abundance of organic matter, of course; to plant materials in many stages of decay, from the threads weaving around and among the soil particles to broken leaves and stems that had been carried into the ground by ants and other insects. Though disturbed, many insects could be seen keeping right on with their work.

But it was in the subsoil where I met my greatest surprises. Since the land was still almost primeval, the well diggers had not expected to encounter a compact region until we had gone down several feet. This field, however, had formerly been a lush meadow that had possessed few weeds to fiberize the lower soil regions. I still remember that original grass area very well -- it had contained *dense* grass. Consequently we ran into a stiff subsoil around three feet below the surface. The lower soil contained very little fiber -- except in two or three spots which were very conspicuous.

After examining, those spots for a few minutes, I put a stop to all well digging. How well I recall that discovery! The men wanted to know if I had found gold, and I assured them that I had. I had discovered deep-diving weeds actually at work. Despite my limited scientific knowledge, it was a simple matter to explain to the men just what those weed roots were doing. The deep-foraging weeds of course had moved in after the land had been brought under cultivation; they were a part of the new landscape.

There were, needless to say, working roots in the surface soil -- crop roots and weed roots, too. There was a crop of milo on the land at the time. Weeds were few and scattered, for in those pioneer days all weeds were outlaws. But these were a few that had escaped the hoe, and those weeds had all the room they needed for perfect root development.

Immediately I saw what the weed roots were doing in that stiff subsoil, I scrambled up the ladder in order to identify the weeds, and then try to find out which root systems were doing the best job. I remember that I found two or three pigweeds, some nightshades, and a cocklebur or two. It seems there were other weeds there, but I can't now recall what they were. However, the foraging roots of all the weeds were so intermingled I wasn't able to make out which were which. Most of the lateral roots, whether pigweeds or nightshades or cockleburs, were reaching deep into the subsoil. I could distinguish the roots of the milo, many of them accompanying the weed roots right down. For the earthworms and bugs too the weeds had enlarged the feeding zone. And, interestingly, in the areas where there were no weed roots functioning there were only a few milo roots working below the surface soil.

That display of Nature at work was more than just a thriller to me, though I could understand only a part of what I had discovered. It was a whole book of rich knowledge. Here were weeds -- three very common weeds -- enlarging the root zone for cultivated plants, and that in land where there was an abundance of food in the surface soil. That was what seemed most amazing to me: those wild plants didn't need to reach down into those lower soils for their food! Even the well diggers could see that much. *Those weeds were feeding deeply because it is natural for many weeds to feed deeply*. I did not need further evidence to convince me once and for all that Sol Benson had been right about that pusley up there in his Kansas cornfield. Weeds could enlarge the feeding zone for a cultivated crop!

Years later I was again standing there on that well ladder -- in memory. With more years of study behind me now, I was reading in the well picture what the boy had not been able to grasp: I could see what those deep-diving roots could do in re-establishing a lost surface soil. I could now see deep-diving weeds as the natural agents of soil construction. I had reached the point where I was thoroughly convinced that, without the soil-improving weed link, the soil world would in time lose its normal balance. And at this much later date -- well, our food-producing soils in the United States are woefully out of balance! We are living on unbalanced food products. I am certain that *correct* weed utilization will go far in re-establishing balance in both situations.

For convenience of study, we usually separate the soil world into two divisions, the surface soil and subsoil, though the demarcation between the two is not always so clear as what we found at the well. The top layer, in which most crops feed, is commonly considered by agriculturists as the whole soil. Such a concept is all right so long as this surface soil is deep, well balanced -- with no links missing from the soil-fertility chain.

It must not be forgotten that an ideal soil is one where there is no gap in the fertility chain. In the surface soil at the well, and in the subsoil where the weeds were operating, fiber was there in abundance and working according to Nature's laws. So was every earthworm, every beetle, down to the tiniest ant. When the laws of Nature operate without hindrance, as they must to construct a *balanced* soil, the mineral elements are held in the root zone in the organic materials, and then released as the plants need them. Consequently, there is no better evidence that the laws are working efficiently than when there is an abundance of organic matter representing all stages of decay; when the sponge structure is strongly in evidence.

And everyone can learn to be a reliable judge of his own soil. One should form the habit of studying it as one would any other important problem. Look first for the fiber. Pick up a handful of dirt and examine it closely. Fiber must be there to guarantee the sponge structure. The

earthworms, healthy and numerous, will also be conspicuous everywhere, as will other worms and insects -- if the fiber content is right. If all these agents are there and healthily at work, your soil world is probably functioning as it should.

But don't be dismayed if you find a stiff clay only, or a soil that for various reasons seems unpromising. Don't be deceived by superficial appearances! Such soils may still be rich in plant-food materials. Those materials are just not in a condition to be absorbed by the plant roots. Give that land a good dose of fiber -- and watch the favorable response you get. Decayed barnyard manure, compost built from manure combined with weeds -- or a few well-directed crops of deep-foraging weeds will in time make things right. To conquer and establish balance in heavy, fiberless soils sometimes calls for a real battle. Give weeds a chance to do the fighting. They won't let you down -- if you direct them.

As in my boyhood weed cove, the organic materials provide heat and food for the earthworms and bacteria, and for all other sorts of soil life that play any part in getting the plant's food materials ready for absorption by the feeding roots. With our surface soils largely gone in so many regions of our country, our chief recourse for re-establishing this surface layer is to reach down into the subsoil and rebuild from that; to put a sponge structure into the stiff clays and loose sands, besides bringing to the surface the food materials hidden there beyond the reach of most cultivated crops. Here is where deep-foraging weeds are able to prove their worth. Any of our deep divers can be made to reach down several feet if they are kept on the job long enough. Not only valuable nitrogen is brought up from those lower soils, but also phosphorus and potassium, two other very essential plant foods. It is also probable that the deeper subsoils contain most of the "trace elements" we are now hearing so much about.

In some soils a hard, practically impervious layer, or hardpan, at times develops between the lower soil region and the surface layer, cutting the subsoil off almost entirely as a feeding zone for even the hardiest plants. In the alkali sections of the west and southwest it is known as alkali hardpan, and ranges all the way from a few inches to several feet in depth. In sections where rain is abundant, the hard layer may occasionally be developed by the farmer himself through plowing the same depth year after year. When, for any reason, the fiber has vanished completely, the soil particles are pushed together into a compact mass.

Many years after my discovery at the well, I made use of that weed lesson in improving an area of alkali land in California. The land had a layer of not overly thick yet impervious hardpan lying between the surface soil and the subsoil. (We did not then have machinery for breaking up hardpan.)

I had made a thorough analysis of the soil below the hardpan, securing many samples with my soil auger, and had found that this lower soil contained only a small percentage of the injurious salts. The soil above the hardpan, on the contrary, was strong with alkali that had risen to the surface a long time back -- before the hardpan had developed to shut off the capillary movement of water upward. This surface soil was too strongly impregnated for practically all cultivated crops, as well as most weeds common in that section. Except during the winter and early spring, when surface evaporation was at its minimum, the surface of the land looked as if it were covered with a light fall of snow. But I was convinced, once the hardpan was penetrated in enough places, those surface salts could be distributed throughout the larger soil zone below. Thus diluted they would not be injurious to crops for, as is often the case in such alkali regions, the lower soil was deep and extraordinarily fertile.

So, with white sweet clover mixed with sour clover and bur clover, together with the weed growth that had somehow survived on the land, we started in to break through the hard layer. The weeds were alfilaria, lupines, poppies, carpetweeds, dandelion -- and a few others that seemed to come from nowhere. Among these were a few that did not have to give up immediately the hot days struck. All weeds except the clovers came up of their own accord.

Rough Pigweed

The first trial crop did not seem to get us anywhere, and the second to a casual observer didn't seem to accomplish any more. But it was the second crop which first revealed that something was happening to the hardpan: a spot of vigorous clover here and there; or a clump of other weeds that continued green beyond the time those weeds on such land normally withered and died. It was natural to conclude that these weeds were feeding below the hardpan. The sweet clover had first broken through, then the other weeds followed close behind, enlarging the crevices with their roots.

Then, by planning our operations to fit in with the best growing seasons, we finally had enough breaks in the hardpan so that the concentration in the surface soil could be taken care of by means of the winter rains assisted by flooding. From then on improvement was easy to see. It took us four years to complete the job, but by the time we were through we had turned what the community had looked upon as a stretch of permanent wasteland into productive land. I had a report on this land only a few months ago. It is now ranked as some of the best land in that part of the state. And the rebuilding work was done largely with weeds; weeds had revived a soil world that had long been chained by alkali.

4. The Fertility Chain and Soil Balance

THE fertility chain, as stated in the previous chapter, is that series of factors which Nature employs in maintaining the richness in her primeval prairies and on the forest floor. Some of these fertility factors have already been discussed. Fiber is one link vitally necessary as a source of food and warmth for the other links, the bacteria and insects and worms, each of which performs its own specific tasks. Fiber is also important in the regulation of the soil's moisture, particularly in building up and maintaining a reservoir in the lower soil zones.

The earthworms, the tunnel makers, not only build air passages but add to the soil's fertility through their own manure deposits. Earthworms form a link in the fertility chain the value of which would be hard to measure. A weak earthworm population is a good indication that several things are wrong in the soil world.

Nature's constructive wild plants are the most condemned, yet are among the most valuable of all the fertility links. With their strong root systems these "weeds" reach down into the subsoils, open them up, and fiberize such soils so the other agents of fertility can move down and broaden their fields of operation. Sol Benson and his pusley again! Some of the links of the fertility chain are outside the scope of this book: certain soil-improving molds, for instance. There are many links, no doubt, which have not yet been discovered.

That weed cove which meant so much to me as a boy was very close to an ideal example of a soil-fertility chain with no links missing. I have since studied many rich soils in many parts of the world, but rarely have I encountered a soil where there seemed such a uniformity of action among the several workers or chain links. The horseweeds,, never seriously disturbed during their growing periods, year after year had developed, seeded, then died and passed through the various stages of disintegration and decay until the erstwhile weeds were turned into velvety mold. Here other workers took over; the mellow mold was further processed until it became finally plant-food elements ready to be dissolved in the soil moisture so the feeding roots could absorb them. As I see it now, that horseweed cove was an exception to some of Nature's universal laws: save for a border around the outside of the cove, the horseweeds were alone masters of the area; there were no unrelated root systems at work in the cove itself.

Even to one unlearned in the technical science pertaining to the fertility chain, it was both thrilling and instructive to handle and study that living soil which the horseweeds had formed without any external assistance other than that given by the sunlight and rain. If the soil at our pioneer well was constantly moving, the soil in the cove was really

bouncing with life. Working my hands into the cove soil, I could unmistakably feel the life of the soil itself.

That cove held on in its sheltered spot and continued to build velvety soil until the land on the slope back of the cove had become seriously eroded because of improper farming methods, and the holding vegetation along the brink of the ravine had been destroyed. Then the runoff, no longer with any sponge structure to hold it back and absorb it, swept across the slope and poured into the small canyon. From there it roared on to the creek, carrying the surface soil with it. The cove, now deprived of the seepage which it had previously received from the slope water, gradually succumbed. The horseweeds gave way to more hardy species. Common annual ragweeds and thistles took over -- another law of Nature in manifestation: the blanket of vegetation must not remain broken for long. *Nature abhors barren land*.

Then years later man moved out and the almost ruined slope was handed back to Nature. But when I last visited the slope (I couldn't even recognize the spot where my cove had been) I found a grand awakening. The holding vegetation had come back wonderfully along the edge of the ravine; lush grass was creeping over the field that not long ago was spread with soil-building weeds of many kinds. There was still plenty of evidence that the weeds had first taken over and done some constructive work before the grass could move in.

And there was still going on one of the grandest battles of grass versus weeds that I have yet come across. The prairie grass was well on its way to final victory, but the struggle was still tenacious in spots. Invariably where the ground was still hard and lacking in fiber, the grass was unable to push the weeds out. Scattered through every sizable area of weeds were clumps of bluestem grass -- spots where the weeds had built up the soil to the point where it was suitable for the grass roots. There were areas of common annual ragweeds spotted with many grass clumps. Three or four sunflower spots along two sides of the slope were slowly giving way to the grass as were the ragweeds. The blackeyed Susans seemed to be better fighters than the other weeds, probably because they were fiberizing their soil more slowly.

Of all the operations involved in a successful agriculture, maintaining an unbroken fertility chain in farmlands is decidedly the most important. But the farmer's soil-maintenance problems are quite different from those of Nature. Whereas Nature in her virgin fields produces and then turns her production back into the soil almost entirely, the farmer produces and harvests, and thus is forced to weaken his soil-fertility chain -- unless he carries on permanently constructive soil-maintenance operations at the same time. Most of our food-producing lands have sunk below their primitive strength because farmers have failed to play fair with Nature. Even where quantity production has held up fairly well, quality of produce, compared with what came from our lands several decades ago, is much lower than

what producers and consumers realize. The soil-fertility chain has vital links missing!

Removing substances from the soil in order to support life is of course the aim of agriculture; neglecting to keep, up the fertility chain while doing it is poor farm management. It is invariable law that the farmer must put back quantity and quality into his surface soil for quantity and quality removed. That alone will maintain the soil-fertility chain. Rare is the farmer who does not have at his command the very materials that Nature herself uses in maintaining her primeval fertility, and usually in abundance: animal manures, compost materials, legumes and other green crops -- and deep-diving weeds.

But comes the objection: "Those weeds you're talking about will steal the soil moisture! They'll rob the crops!" To which I agree -- in a measure. If the soil is weak and the rainfall light, all of those deep-rooted annuals with which every farmer has to deal are going to demand their share of the upper moisture and food elements for a while. But a farmer rebuilding weak land should always keep in mind that the important things he is after are to strengthen his surface soil and enlarge his crop's feeding zone. That rich stuff which his deep-foraging pigweeds and lamb's quarter and sunflowers and all of the rest of them can bring to the surface from below, is exactly what he needs in the rebuilding. Those minerals and that nitrogen which the weeds are able to pump up will be worth far more than the support the weeds require while they are developing to the stage where their roots are ready to do the pumping. Thereafter the weeds will get most of their support in the lower soils.

"Yes, but why weeds instead of farm legumes or some other cultivated crop?" Here again is the answer to that one: *because few cultivated crops have root systems that forage extensively through the subsoil -- Nature's cellar storehouse*.

Of course, if there is no subsoil from which to pump materials -- better dispense with the weeds; unless the weeds are grown as a green manure. There is not much one can do in the rebuilding of one's land without some sort of a foundation upon which to build.

In improving land with weeds, every sprig of the weed growth should go back into the soil. When weeds are grown alone as a green manure, or when left thinly distributed through a cultivated crop, they should remain on the field as long as possible, but not until they become dry. The weeds should go under while green, yet be given the maximum time to store up materials that have been gathered in the lower soil zones. In this way man is able to improve on Nature's excellent practices. In the wild, the weeds normally can go back into the soil only after they have decayed above ground.

It is quite possible to have a complete fertility chain so far as the

number of links is concerned, and yet have a soil that is not functioning satisfactorily, though the physical condition may be good. Such a condition may obtain when some of the links in the chain are weak while one or more are overly strong. This results in an unbalanced soil. Occasionally a farmer will throw his soil out of balance by pursuing the wrong course in an effort to strengthen the fertility of his land; by overbuilding one or more links to the neglect of the others.

Several years ago I ran onto a case of this kind while checking California orchards for suitable budwood for the various nurseries. The orchard in question had long been an excellent producer. Then it just gave up without any apparent reason. However, when I visited the orchard it was a picture of health and vigor. But it hadn't been that way a great while, and the orchard's owner assured me he had learned a valuable lesson in soil management through a serious mistake.

What had happened was that this man had been fertilizing heavily with a certain commercial product, and had neglected his *organic* fertilizer. Since he was getting good crops of high-class fruits with his system, he increased his concentrates, hoping to raise his production still more. He had promised himself, he told me, that he would get his legumes going the following spring. He felt that would be soon enough. But Nature follows her own laws, not man's whims. She soon showed this orchardist how the breaking of her soil-fertility laws *doesn't* pay.

One day this man noticed that something was happening to some of his trees. The trees appeared anaemic. A branch here and there, he told me; then the whole tree. The trees didn't appear to be actually diseased; just weak and hungry looking, and that right when he was stuffing them with expensive fertilizer.

In less than one season more than half of his trees were affected. All of the trees produced fruit, but only a small percentage of the fruit was marketable. And by the end of the year practically all of the trees were "sick." He sought advice and relief from every available source, but received no encouragement. All he learned was that his orchard was apparently done for and that his only choice was to build him a new orchard -- but not on the same land.

So he finally concluded to pull out his trees, but decided to wait a year before doing it. Not that he had any hope of saving his orchard; only that he believed he could by then give up his trees with greater peace of mind. And he did nothing whatever to his orchard that year except to flood the area occasionally. There was no pruning, no spraying, no cultivating. He turned the orchard over to anything that wanted to grow in it -- which meant a grand array of California weeds.

And those weeds took hold with a vengeance. In places, he said, the weeds grew so tall they almost hid the trees. In early autumn of the second year he happened to notice that the trees along the outer edge,

instead of dying completely as they were supposed to do, had done just the opposite. They were now green and healthy looking. And that discovery sent him exploring in his weed jungle. What he found there brought him more and greater surprises. The trees inside the weed patch were thriving even better than those in the outer rows.

It was easy to see what had taken place in this man's orchard: the orchard soil had been thrown completely out of balance through a too-heavy application of the rich mineral fertilizer. The trees were overfed in one direction. They were not getting enough other food to go along with the strong mineral. At the critical moment the weeds had come forward and with their vigorous roots opened up the lower soil so the concentrates could be distributed by the irrigation water throughout the larger soil zone. The weed growth had probably been too dense to permit a large amount of deep diving; but there had been enough fiberization of the subsoil to save the day. Of course, the weeds themselves made use of great quantities of the minerals, but by the time the fruit grower was ready to roll the weeds down and work them into the soil, the soil zone was sufficiently enlarged to prevent further concentration when the decayed plants released their minerals.

When I last saw this orchard it was very much of a weed patch. Weeds were growing with legumes. I do not recall whether or not the legumes had been inoculated, but I do remember that the weeds and legumes were doing wll together. Which is to say, the weeds were being controlled to a certain degree now. "And my fertilizer from now on is going to be legumes combined with weeds," this man assured me -- "and with plenty of emphasis on the weeds!"

In short, in maintaining the soil-fertility chain, or in keeping up soil balance, watch the fertility chain as a whole. Don't emphasize some links to the neglect of others that are just as important. It is actually true that a soil is no stronger than its weakest fertility link. Keeping a balance in the fertility chain is practical agriculture at its best.

Mr. E. G. Cambell, discussing weed values in the magazine of the American Society of Agronomy (February, 1924), makes some terse observations which agree with my own findings as to the natural place of our common weeds in building and maintaining balance in the soil-fertility chain. Mr. Cambell evaluates weeds highly for their ability to pump the nitrogen back to the surface after it has dropped into the lower soil zones beyond the reach of ordinary crops, and their ability to hold this element in reserve. According to this author, heavy growths of summer annuals are especially valuable as nitrogen retainers.

Farmers are familiar with the weeds that spread over their fields after small grains have been harvested: common ragweeds, wild lettuce, thistles, sunflowers, nightshades, etc. Such weeds through the work of their roots actually fertilize the soil for the next crop. This is an excellent illustration of how Nature's soil builders play a sound part in

maintaining soil balance.

Mr. Cambell hands the weeds along the highway and country roads some deserving commendation. Those weeds, he says, are an asset in a community's agriculture rather than a detriment. Mostly without the farmer's knowledge, the roadside weeds check erosion in numerous ways and thus save many acres that would otherwise be lost. And certainly they protect the highway itself -- but not when they are slaughtered the way they are in so many places.

Any farmer who wishes to learn the true habits of the weeds in his locality can find no better source of information than those strips and clumps of wild plants that border most roads. There he will find growing most of our soil improvers. Using his shovel when the ground is soaked and the weeds near full size, he can discover a great deal about the root growth of the annuals he has in his fields. Usually the roadside will reveal how these weeds grow under adverse conditions, and in what types of soil they seem to do best: whether in the tight clays, the sands, or the coarse gravels.

It will be worthwhile to learn how the weeds thrive in the spots that are very much like that field or two on the farm that may be badly in need of improvement. The roadside patch will show at what season of the year any particular weed makes its best growth -- -and when and how it produces its seed, in case a harvest of seed may be desired. Mr. Cambell emphasizes the value of weeds that grow during the winter. Winter weeds are usually deep feeders. Such weeds should be encouraged for they do their land improving during the off season for cultivated crops.

But -- *weeds are not mushroom soil builders*. Keep mind that weeds, aside from pumping much valuable material from the lower soils up to the surface, also do very constructive work by fiberizing the lower soils. Often it may require several weed crops before any noticeable benefit appears in the cultivated crop above ground. But in due course the weeds, if kept on the job, will re-establish land balance.

5. Plant Roots

ONCE while sitting in on an agronomy class during my first year at college (I wasn't permitted to enroll in the course owing to my not having the prerequisites), the professor announced what he considered a new and very important discovery. "Imagine the young roots of alfalfa making ten times the growth of the stem during the first three weeks! Why, it's almost unbelievable -- "

Forgetting that I was merely a visitor, I bobbed up from my seat in the back of the room -- "It's that way with weeds, Professor! " I chirped right out. "The roots of most all weeds grow lots faster than the tops -- "

All eyes turned suddenly upon me -- and I wilted back onto my bench. The professor went on with his discussion of alfalfa seedlings, ignoring the profound wisdom I had so generously offered to his class.

But it struck me as being nigh to shocking for a teacher of agriculture just then to be discovering that the roots of plants grew more rapidly than the above-ground parts. I didn't know a thing about alfalfa at that time, but I was plenty familiar with the root habits and stem habits of sunflowers and lamb's quarter and cockleburs and a passel of other weeds. On our own farm I think we unconsciously meant weed roots whenever we thought of weed injury to our crops. The vegetative parts were royally disliked, needless to say, but largely because the green parts indicated what was taking place down in the soil. The various leaf changes meant specific root changes; appearance of flowering buds and later of flowers told us what kind of growth the roots were making. Every farm boy knew that, if the weeds were growing thick, like a jungle, most of the roots were feeding close to the surface of the ground. But if each weed had ample room for unrestricted growth, by the time the plants were a foot tall the roots were foraging far from home.

Those gluttonous roots! Mother could see them only as vile enemies of her potatoes and cabbages and sugar corn that must be taken from the soil completely. When we had not been able to eradicate the thistles and pigweeds. and sunflowers and such before they became large, we had to get out and pull the things on rainy days. We had to carry the weeds completely off the field, too, or if the field was large, we grudgingly allowed sufficient space for building weed piles. We never thought of employing the pulled weeds as a mulch on top of the ground where they could have helped to conserve moisture and keep the soil cool. We wouldn't even give the weeds a chance to decay and go back into the soil as fertilizer.

Luckily for our soil, only a small fraction of the weed roots could be extracted, even when the ground was slushy. Since weed eradication could

receive only its allotted time, the weeds often passed beyond the pulling stage before we got round to them. Then they had to be cornknifed. "Can't go fishin' today -- got to cut poison nightshades and sunflowers outa our corn!"

"Mean yer knifin' 'em already?"

"Shore! Nightshades got buds!"

"Gee! Then that means their roots are powerful. Break too many cornroots to pull 'em -- "

"And Pap says it'll take me and Jim three, four days -- "

Lamb's Quarter

The redroot pigweed intrigued me particularly in those days. Not that I had any special admiration for the thing, but because on a plant growing alone the vegetative development used to be such a perfect indicator of what the roots were doing at every stage of growth. The black and shiny seeds of the redroot, produced by the thousands by every full-grown plant, have marvelous vitality. The husky red rootlets go galloping down into the ground immediately the seed germinates, and the subsequent roots don't

stop foraging as long as there is life in the stem. At first this pigweed stem is delicate and innocent looking, but in a short time it takes on the rough, don't-touch-me appearance. By the time the greenish flower clusters appear in every branch axle, which is usually before the plant is a foot tall, the lateral roots, which spring from the strong taproot, have penetrated long distances in every direction. At this stage most of the feeder roots are diving into the subsoil for their food and water.

And by the time the main stalk with its rough flowering parts reaches two feet or so, an even larger proportion of the feeding roots are working in the lower soils. At this period, even if the soil is muddy, the weeds are so well anchored they are difficult to pull up. And what those weeds in all such situations are gathering up to be stored in the roots and stems and leaves! Nitrogen and phosphorus and potash and almost everything else needed in the plant-food line. Nature's soil improvers -- and we were treating them all the time as some of our worst enemies.

And what is true of the pigweed is also true of its usual companions: the sunflower, lamb's quarter, sow thistle, ragweed, ground cherry -- even the trifling cocklebur.

In classifying plant roots, botanists list first the strong or anchorage roots that hold the plant in the ground against the pull of the elements. These roots also support the plant so it can get the necessary sunlight, for the sun is the power plant that supplies the energy for the leaf laboratories. The anchorage roots have to be rigid, yet in a measure flexible to stand the severe strain that may be placed upon them. After the anchorage roots come the great mass of roots known as the food hunters. These roots range in size from slender threads to roots many inches in diameter. Normally the food-hunting roots prowl through all parts of the soil world.

A few domesticated crops, and practically all herbaceous wild plants that I have listed as valuable weeds, appear to have two distinct groups of feeding roots: those which secure their food entirely in the surface soil, seldom wandering far from the base of the mother plant, and which usually are vigorous only during early growth; and those rovers that go far for food and water. I have found these two types of roots on desert plants in Africa, on many tropical plants, and on temperate-zone wild annuals. On some common weeds, like the pigweed, ragweed, and sunflower, the two types of roots are at times very noticeable.

I had my first introduction to these two types of feeder roots when we were digging the well. Practically all weeds do have plenty of roots that feed in the surface soil, and until the deep feeders are well established in the lower soils the former will get their share of the food materials near the surface of the ground. Once the deep feeders are settled to their task of feeding down below, however, most of their feeding is done down there -- unless the subsoil is extremely weak. From then on, provided the weeds don't crowd each other, they will more than pay back to the cultivated crop all they robbed it of.

The reason those common wild plants known as field and garden weeds are persistently classed as pests is because they are judged entirely by what the surface-feeding roots *appear* to be doing. No thought is given to those deep feeders which are improving the soil by fiberizing it and thus enlarging the feeding zone for the cultivated crop -- to say nothing about those large quantities of rich food materials which they pump up to the surface from the lower regions.

The rover roots generally (except in grasslike plants) cannot themselves take up the food materials once they have reached them. This task of absorption must be carried on by the delicate, very tiny root hairs which protrude mostly from the smallest rover roots. These absorbing rootlets are very short-lived, and are developed right where they are to do their work. They have no openings whatever, but can absorb food-substances when the latter are dissolved in water. By providing no openings into the root hairs, Nature guards the plant against many undesirable substances, probably to the ultimate great benefit of the human race.

Since the root hairs are so frail, their ability to function efficiently depends on the condition of the soil world. Actually, it is possible for a soil to be rich in plant-food elements, yet give low production because some of the factors which encourage the growth of root hairs are lacking. The condition most likely to prevent the development of the short-lived feeding rootlets is lack of suitable soil fiber, which means a soil that is either too loose or too compact. Neither can feeding roots grow efficiently in a soil that is too wet, too dry, or too cold. In other words, a soil may be declared strong on chemical analysis, yet give low production because of improper physical condition. The soil may be locked so far as the feeding roots are concerned.

Where farmland is giving poor returns, in the great majority of cases it is the physical condition that needs most attention. The soil probably has all the minerals it needs, if not in the surface soil, then stored in the subsoil. A few lush crops of deep-rooted weeds, grown as a link in a rotation scheme, or as properly regulated companion crops, will go a long way toward righting the situation.

Before the root hairs can absorb any of the food substances, those substances must be dissolved in the soil water, and the water must be in the form of a thin film which surrounds or clings to the particles or granules of soil. Except in water plants, very little water can be taken in by the rootlets save from this delicate film. The root hair coils partially around the particle of soil which contains the food materials and which is enveloped in the water film, then "draws" into itself the film containing the materials in solution. The water stream then moves up through the roots and stems, climbing even to the tops of the tallest trees. Starting in the soil-world laboratory, going through many intricate processes while yet in the soil world and after leaving it, finally ending up in the leaf factory, this stream becomes the greatest watercourse in our Nature world.

When the leaves have completed their part of the entire operation, the result is a finished food product without which there could be no human life -- nor any other life.

When no factors are missing in the soil-world laboratory, there is a reserve supply of food and water in the lower soil zones -- in the fiberized subsoil -- that can be called upon during periods of drought, or when the surface soil is being too heavily mined. But that condition obtains normally only when all major links in the fertility chain are functioning. Such soils will produce crops with far less water than will a soil that is out of balance. In a poor soil it takes a lot of water film to meet the meager food requirements of the plant. Crops dry up quickly on poor land, not only because they need moisture, but because, having been deprived of food, they lack the power of resistance.

And now the question: what is it about weeds that makes it possible for them to do all this soil-improving work not possible with most farm crops? If weeds are directed, or even if given a fair chance to go it alone, they will establish that reserve referred to above, through the fiberizing of the subsoil.

Most wild plants have been forced, through their struggle for existence across the ages, to develop roots which will forage deeply for food and water under adverse conditions. The larger portion of domesticated crops, by virtue of their having been more or less pampered by man, have lost most of the soil-diving ability possessed by their wild ancestors -- if they happened to come from wild ancestors. What has happened is that most crops have received their improvement above ground; their root systems have grown weaker with civilization. The root vegetables are exceptions, of course. As a rule crop roots are not fighters in soils where it requires a real struggle to make a go of it.

Aside from being husky divers, many wild plants have the ability to "eat" their way through compact soils because of special dissolving substances which they exude from their roots. The dissolving materials soften hard obstructions and thus aid root passage. But, so far as I have been able to discover, these dissolving materials are not harmful to the weed roots or to the roots of crops that may be growing with the weeds. Sweet clover is an excellent example of a weed that eats its way through hard soil. Just what weeds put out this dissolving substance is not definitely known so far as I am aware. Sunflowers and ragweeds I think do, and probably cockleburs. The chances are that all deep-diving weeds have some ability to eat their way through stiff soils.

And there always seems to be room in the weed-root tunnels for the roots of cultivated crops. I have found the roots of some garden vegetables following the roots of pigweeds and lamb's quarter down into the subsoil, though ordinarily these same vegetables are not deep feeders. Beans and sweet corn and onions like to send their feeders into the lower soils along with those of the weeds. In a clean onion field the onions feed very close

to the surface. Many normally shallow-feeding crops will forage deeply in a soil if the soil conditions are made right for them.

It is hard to make farmers or gardeners see that the weed roots are not the water robbers they appear to be. If pusley or pigweeds or nightshades or ragweeds or what not are found in a garden or field when a drought strikes, the wild plants are blamed if the crop dries up. The fact is (unless the weed crop is very heavy), the weeds will not only feed in the lower soil zones themselves -- unless there is no subsoil -- but will also be the cause of an upward movement of capillary water *along the outside of their roots*. This will happen even if there is only a small amount of water stored below. The upward-moving moisture becomes immediately available to the crop roots that are feeding in the surface soil. Though the crop may dry up in the end, the chances are that the weeds prolonged its life considerably.

To repeat: a crop growing in a weedy field, provided the weed crop is reasonably thin, will go through droughts better than crops grown on clean land. Moisture comes up along the outside of the weed roots; many crop roots accompany the weed roots into the lower soils and thus secure extra moisture in that manner; and the weed growth checks evaporation from the surface soil.

Cocklebur

Concerning weed roots as good soil fiberizers, a Kansas farmer reported to me what he considered a very important discovery on his part. He said he

had several acres of extremely tight land with which he had been struggling for years. Finally, in disgust, he abandoned the fight -- turned the land over to cockleburs. Or rather, he turned a part of the field over to the burs, while he continued to farm the remainder.

"And you ought to see what the cockleburs have done to that abandoned part!" his neighbor told me. The farmer himself said he was waiting anxiously for the burs to take over the rest of the field as they had done on the first part. He had a mess of cockleburs, all right, on the abandoned area -- and last year made a good profit from corn produced with the help of the cockleburs. The cockleburs, with their deep-forage roots, opened up the tight land and fiberized it. The weeds, not being too thick, had done a good job.

One of Nature's valuable laws is that two unrelated root systems do better when growing together than when either is growing alone. There are, of course, occasional exceptions to this. The wild growth in forest or meadow shows the law wonderfully in operation. Nature keeps her soils in complete balance largely in this manner. Wherever one species of plant occupies an area alone, it will usually not long survive. My boyhood weed cove was an exception. Ordinarily the single species gives way to a mixed growth. And this mixed growth is likely to hold its own for a long stretch of years. This is Nature's system of crop rotation. But she needs to do much less rotating when the roots are dissimilar.

In maintaining her green carpet on the earth, Nature wastes nothing. For instance, some plants secrete strong substances from their roots (substances which are apparently not useful in the dissolving processes) which, if left in the soil, will prove injurious to some unrelated plants as well as to the plants exuding the materials. But many unrelated plants find these substances in no way harmful when contacted by their feeding roots. Actually, the substances may be taken up by these plants as food. Or if not as food, certainly with no ill effects. A few members of the sorghum family leave in the soil considerable toxic material. In the irrigated sections of the west it often takes two or three cropping seasons to eradicate this poison. However, when legumes are grown with the sorghum, the land rarely registers any lowering of production during the following season. The legumes seem to take care of the poison left by the sorghum.

And weeds -- every one of our soil improvers -- will also take care of those toxic materials. I remember a field of grain sorghum that was given little or no cultivation, with the result that the weed crop was more conspicuous than the sorghum, though there was an excellent crop of sorghum growing among the weeds. The land produced heavily the following year, a crop unrelated to sorghum, but an adjoining field that had been kept free from weeds on the same type of land did not do so well. The weeds strengthened the land and took care of the sorghum secretions at the same time.

Several years ago a friend told me about a case of tree planting which indicated how unrelated trees, when employed together in building a farm grove, can mean longer life for the grove than when only one species is planted on the land. It seemed that an "impractical" farmer had moved into the community from the city. In the eyes of the old settlers, this man did everything incorrectly -- and was too contrary to accept advice even when offered to him gratis.

One of this city man's worst sins of commission was that he planted a timber lot, using several types of trees carefully interspersed. I don't remember just what the trees were, other than that they were all hardwoods. The man who gave me the report said he was a boy when the grove was started. He was now past middle age, and the grove of mixed trees was still holding on well in his old neighborhood. All of the other groves had vanished almost completely. It would seem that the mixed grove survived because of the diversified root systems which had been able to work constructively together.

Now to summarize the values of deep-diving weed roots: (1) these roots are persistent explorers in a rich world which is to a large degree unknown to domestic crops -- *until the weed roots build highways leading into it*. Thereafter the crops are provided with a more extensive feeding zone. (2) The weed roots pump those "lost" food materials back to the surface soil; (3) the weed roots fiberize the subsoils and (4) help to build a storage reservoir down there for water; water moves up along the outside of the weed roots -- up to the surface soil and the thirsty crop roots which feed in the surface layer. That is why a crop on "controlled" weedy land can go through a drought better than a clean crop on similar land.

And yet we slaughter them! We destroy with poison the natural source of the essential soil fiber, and with our food-producing soils screaming for fiber and the food elements which the fiber carries with it. Aside from destroying the weeds, we also pour poison into the soil-world machinery. The claim by some spray promoters that the poisons, after the spray has been applied, will vanish into the air, certainly will not hold water in all situations, and probably not in many. A goodly portion of the poison will be in or on the bodies of the dead weeds, and cannot fail ultimately to reach the soil -- unless every sprig of the weeds is removed from the land. Even then it will not be possible to eradicate all of the poison. Perhaps a single spraying will do little or no harm; but the persistent use of "weed chemicals" is pretty sure to bring about a condition which may prove difficult to overcome once the soil has taken up any quantity of it beyond a still unknown danger point.

However, the greatest injury to result from the continuous use of weed sprays on cultivated land will in all likelihood prove to be the deprivation of the lower soils of their fiber content which some of our weeds are particularly capable of putting down there. Without this fiber the soil particles settle close together -- into a *compact* condition. Ultimately the heavier soils become so "run together" that the upward movement of

capillary water is almost entirely cut off. And when this condition obtains, though the surface layer may be amply fertile, the soil world as a whole is in danger of being thrown out of balance, because it is not a completely normal feeding zone for most plants. And, of course, in such cases there is no emergency reservoir to call upon; growth even of crop roots is restricted; and that valuable storehouse of minerals and nitrogen in the subsoil remains locked up.

But even so, there *are* situations where weed chemicals would seem to have a constructive place. There are times, you know, when reputable physicians prescribe strychnine as a medicine. Using chemicals in eradicating poison ivy may well be compared with the doctor and his strychnine. Here is a place for it! And I can see cases where "noxious weeds" may need to receive the same treatment -- as an emergency. On the other hand, there is no sense in slaughtering the mockingbirds and cardinals and song sparrows and other songbirds -- simply because the crows pull up the young corn.

Annual Black Nightshade

Occasionally a report comes in to me that some chemical weed killers actually enrich the soil; enhance crop production directly. Such is entirely possible, for it is not difficult to stimulate soil into *false* production. A few commercial fertilizers will do that, and weed sprays could do it if enough of the spray reached the soil. But *stimulation is not fertilization*.

Then again I have had reports to the effect that some crops on sprayed land did not seem to react favorably to the spray, while others did not appear to be affected either way. What, some wish to know, is the reason for this? Also, why do some crops seem to do very well on sprayed land during a part of their growing season, and do poorly at other periods of their growth? "They don't act that way when we cut the weeds -- "

As I have stated elsewhere in this book, there is much about the workings of the soil world that we do not yet understand. It goes without saying that we still have much to learn about the effects of many of our chemical compounds on cultivated soils. But there is one thing that we do know with certainty: anything that interferes with the constructive laws of Nature down there in the soil world is going to stir up trouble. Whether the poison goes down into the soil through the weed roots, whether it is carried into the soil through the dead bodies of the weeds when the latter decay, or whether the stuff is sprayed onto the soil directly -- there is bound to be some interference with the soil-world machinery. And it is entirely possible that a very small amount of *some* poisons will create far more havoc than is at present suspected of them.

6. Weeds as Mother Crops

COMPANIONING weeds with farm or garden crops *constructively* will probably be the last phase of weed utilization to be accepted by American tillers of the soil. However, right now there are many practical farmers in this country who are employing "weeds" in this manner -- and successfully. A farmer from one of the most progressive states writes me that he has for several years used "mother weeds" in some of his crops, much to his advantage. He considers these weeds as particularly good crop insurance. Furthermore, this man has found that his mother weeds without exception are *conservers of soil moisture rather than robbers*.

Mr. F. C. King, noted agriculturist in England and author of the excellent book *Gardening With Compost* (Faber & Faber), also considers the weed link in the soil-fertility chain as very essential to successful crop production. A few of Mr. King's pertinent declarations about weeds are worth noting here: "A right cultivation of weeds, therefore, will do much to promote soil fertility -- Raise the quality of a weed crop in a garden and quality in the vegetable crop will be a foregone conclusion, FOR THE TWO ARE INTERDEPENDENT -- Seed saved from the best plants (weeds) should be sown on land which is carrying a poor weed crop -- It is my rule never to deprive the soil of weeds for longer than is absolutely necessary -- During the course of the growing season there is room for both crop and weeds -- *I have never found that* CONTROLLED *weeds interfere with the crop* -- "

Controlled weeds! Farmers and gardeners should not get the idea that companioning weeds with crops indicates a careless system of farming. It is true that with some crops the weeds can be permitted to go their own way; allowed to grow how and where they please, and still they will do constructive work. But as a general practice the weeds must be controlled for consistently beneficial results. They should be thinned so there is no crowding in garden or field of the domestic crop, and no crowding of the mother weeds themselves. It is the vigorous root system of the weed that does the valuable work, and those roots must have room to develop. That means weed spacing of one, two, or more feet, depending upon the type of soil and the kind of cultivated crop, as well as upon the weeds employed as the companions. With garden crops, weed spacing is even more important than it is with field crops, because vegetables as a rule are more sensitive. Extra work? Surely! To rebuild land, as Nature does, spells work.

Not long ago I inspected an excellent field of corn where the wild annual morning-glories had moved into a goodly portion of the field -- and those vines were *not* being controlled. The farmer told me that he had always had some morning-glories, but this was the first year they

had come up like a jungle. "My very best corn is out there in those vines, too! See the ears?"

That the vines hadn't harmed this man's corn, the ears were ample evidence. Later he showed me a section of the same field that contained no morning-glories. The corn there was also good, but not equal to that where the vines were growing. We examined the soil that was weed free, and also that on the vine-covered area. The farmer was certain he could see a difference between the two soils -- and a shovel revealed the cause. The roots of the morning-glories were worming their way through the ground, many of them pushing far down into the lower regions.

I asked him, "Do you really think those vines are helping your corn, or is it just a case of the corn making a good go of it in spite of the weeds? "

He hesitated a moment. "Well, I'll give you the same answer my neighbor gave me. I don't think there is a bit of doubt about wild morning-glories being helpful to corn! How -- I won't try to answer that -- "

One of the most shocking sights near our new home in the Cherokee Strip was the weed patches near the main camp of the Pawnees from which the squaws harvested excellent com and pumpkins. To me it didn't make sense for weedy fields like those to be turning off such good crops. My first thought was -- only Indians could farm like that and grow anything to harvest.

It was not long after my arrival in the Strip that my hunter-naturalist friend told me about a wise old Indian who, he said, was different from any Indian I had ever read about. John Brown (according to Louie Bean, the hunter, John preferred to be known by his white-man name) had profound respect for all wild things, because wild things were all good and necessary for the Indian's existence and happiness. And since what the white man called "weeds" were useful both for healing and for food, those wild plants could not possibly do harm, even when growing with the corn and pumpkins and beans.

Of course, I was keenly interested in what Louie told me about Indian John, but after Louie had arranged for me to visit him, I wasn't sure I wished to go, especially alone. Louie insisted that I go alone, for John mustn't get the idea that I was afraid of him. So at last alone I went, over to John Brown's lodge on Salt Creek. And Indian John, much to my relief, put me at my ease immediately. Not that he said much to me; he just acted friendly. He grunted me a greeting, Indianlike, then, sitting crosslegged, he smoked his long pipe and acted as if he expected me to do all the talking. And to save me I couldn't think of a single question I had worked out in advance to ask him.

But after a few agonizing minutes my nervousness vanished. My store of questions came flooding back -- and I started hurling them at John. "Why is it, John?" I said, "that the Indians never cut any of the weeds out of their fields? Is it just 'cause Indians are lazy, or what?"

John was quick enough with his words then. It's a wonder he didn't scalp me on the spot. "Indian not lazy! " he wanted me to know. "Indian let weeds grow in field because Indian eat weeds!"

"You mean the squaws let all of the weeds grow so they can have plenty to cook for greens?"

John frowned a bit at that. Apparently the word "greens" was new to him. "Indians eat plenty green weeds," he said presently; "all same eat corn, pumpkin, fat dog."

"But there are acres of weeds outside the fields -- more'n all the Pawnees could ever eat!" I reminded him. "Are the weeds that grow with the corn supposed to be better?"

It was then that Indian John really opened up. The weeds in the field were superior as food weeds, just the same as any crop is better when it is given a bit of attention during the growing period. In the field soil the weeds grew fast, he said, and produced an abundance of tender leaves and stems, whereas the wild weeds became tough soon after they had made a little growth. To make sure that their weeds would grow as they wished them to grow, the squaws thinned their weeds a little. This gave the weeds a chance to grow larger roots, and when weeds had large roots they were able to go down into the soil for water, which in turn kept them green and succulent longer.

Whenever the squaws cultivated their corn, which was seldom, they of course gave the same cultivation to the food weeds and pumpkins. And by then my head was buzzing -- I couldn't accept the idea of anybody *cultivating* weeds. Sol Benson never thought of cultivating his pusley, other than incidentally. And before my senses straightened out, John hit me with another bombshell: if you could grow corn and beans and pumpkins and weeds on the same piece of land at the same time, with all of those crops getting along well together and producing well, why go to the trouble of working the separate fields? And my dizzy brain could only echo -- Indians *are* nutty!

In answer to my question as to whether he had really meant that the weeds were not harmful to the corn and pumpkins, John came back even more decisively. The corn and pumpkins were not harmed by the weeds that the Indians grew as food weeds, which, as I recall, generally meant two strains of pigweeds, lamb's quarter, sunflowers (for their seed), a variety of wild lettuce, purslane, and milkweeds. John had all his life seen the harvests from clean fields such as white men always had near the agency, and he had been brought up near

weedy fields. When the weeds grew the Indian way the weeds never reduced the production of the planted crop. Indeed, Indian John said he had come to the conclusion that the weeds helped to produce *more* corn and pumpkins in some of the fields with which he was familiar.

When John went so far as to insist that weeds were helpful to the planted crop, I immediately thought of Sol Benson and the pusley in his corn. By now it wasn't so difficult for me to accept weeds as not being harmful to the crop, provided the weeds were not growing overly thick. But to have John declare that *all* weeds were beneficial to the planted crop with which they were growing -- well, that was a bit too rich for me at that stage of my weed schooling.

Many years after that important weed lesson with Indian John -- plus several other lessons I had from him -- I made a survey in Mexico of the mountain Indian's agriculture. I was at that time particularly interested in the tillage practices which those Indians employed on their "hanging farms" where one could fall out of a field and with considerable ease break one's neck. Yet on those almost perpendicular farms I found the Indians growing crops with unbelievable efficiency. I wanted to know how they could do it and still keep their land from sliding off the mountain.

It was while I was seeking this information that I came upon a very steep farm which abruptly brought Indian John and the Pawnee weed patches back to memory. Though the Mexican as a rule practices clean cultivation, this farm had a rich crop of weeds. I was more than mildly surprised at this breaking of unbreakable rules, for the early Spanish padres taught the Mexican Indians their first "scientific" agriculture, which called for fields as free from weeds as a cathedral floor. Now here was an apparently successful farm where the weeds were more in evidence than the domestic crops -- though the domestic crops were there, several types of them, growing luxuriantly among the weeds. This Mexican Indian was not onlv growing weeds with his crops; quite clearly he was spacing his weeds and *pampering* them.

I was able to speak enough Spanish to ask questions. So I learned from this Indian farmer that he had discovered through trial that weeds, when they produced strong roots that spread through the ground, were better anchorages for his soil than were his corn or beans or squashes. He was more scientific than Indian John, since the Mexican controlled his weeds very definitely in order to accomplish his purpose. The large weeds, aside from being soil preservers, also served as mother weeds for his vegetables, though he wasn't quite sure just *how* they helped his pimientos and calabasas.

In companioning weeds with his growing crops, whether in the garden or in the larger field, the farmer or gardener should be concerned first with what the weeds will do to his immediate crop; second, he should be interested mostly in what they can do toward improving his land. If

his land is already fairly productive, he will probably be more concerned with the immediate effect of the weeds on his growing crop. In this situation, his problem will be to use the weeds in a way that will help his soil and his growing crop, too. But if his soil is seriously eroded or otherwise depleted, he should take a long-range view of his problem. He should be chiefly interested in the *permanent* improvement of his land, even if the weeds would seem to be temporarily injurious. What he loses through this severe soil-building period will be more than paid back later.

How not to produce an oversupply of weed seed when the weeds are used as mothers with row crops is a problem that every farmer will have to work out for himself. Some may choose to go through the field or garden and behead most of the vigorous weeds before the seeds develop. With annual weeds it is possible to destroy a large percentage of the seedlings soon after the seeds germinate in the spring, through surface stirring before the domestic crop is planted, or during early cultivation. No matter what system is employed, unless the soil is extremely poor there will still be enough weeds to cover the land correctly when the weeds are put to work as a mother crop.

Weed farming cannot be learned completely from a book. All that a book can do is to offer the basic principles. Anyone who enjoys working with soil and plants is in a position to make many interesting discoveries anent weed values if he desires to do so. He can prove that those very wild plants he has looked upon as annoyances can be made to serve him as helpers in many ways. And the first thing he should do, if he hasn't already done it, is to become intimately acquainted with his weeds -- *where* they grow normally and exactly *how* they grow.

Milkweed

I am partial to the redroot pigweed, because this weed can be made to do a good job on most soils. On heavy soils, if the weeds are not crowded, it will loosen the soil for root crops such as carrots, radishes, beets, etc. And potatoes -- a husky pigweed every two feet in the row may often increase the production of the potatoes, or in very heavy soil be the main factor in making a crop possible at all. Weeds in a potato field will enhance the keeping qualities of the potatoes. Pigweeds and tomatoes, peppers, eggplants, all get along well together. An excellent gardener once told me she wouldn't think of having a tomato garden without a smattering of pigweeds growing in it. The weeds improved the quality of her tomatoes and protected the plants from insect pests.

If the gardener hasn't any pigweeds to employ as mother weeds for his vegetables, many other deep-rooted weeds will do as well: the sow thistle, lamb's quarter, annual nightshade, ground cherry, ragweed, and many others. I have seen situations where the bull thistle was boring down into the stiff subsoil better than the neighboring pigweeds -- and the vegetables showed that they appreciated their thistle mother. If one wishes to grow sweet potatoes, but has only stiff soil in which to grow them (sweet potatoes are especially partial to sandy soils), one will find almost all members of our weed family reliable helpers if they are permitted to grow on the ridges. The strong roots of the weeds expand and open the soil in the ridges so that the potatoes can grow large without becoming woody.

In the sandier spots there are likely to be annual nightshades offering their service, or perhaps some goldenrod. These weeds are good soil improvers, aside from their beauty. Lamb's quarter is a good weed in many places if given ample room. This weed usually needs to be topped so that it won't grow tall. Annual ragweeds, one of the best for most soil-improving purposes, are not so well adapted to vegetable conditions as are several others, since the rag's root system is not overly large. This weed serves best in a rotation where the entire crop is weeds. Sunflowers also do not serve well as mothers in a garden, owing to their height. But both ragweeds and sunflowers scattered through farm crops do a lot of good. I have no doubt that sunflowers, growing in a Kansas cornfield as companions of the corn, have across the years meant many an extra bushel to the farmer who could never get round to cut them out.

The ground cherry is an especially valuable garden weed. It is a good-natured annual, and a fair diver, which can prove helpful in more than one way. It not only brings up food from the deep soils and does some excellent fiberizing at the same time, but it supplies fine shade for the ground during the period when the sun is particularly scorching. And aside from all this, the fruit of the ground cherry makes excellent preserves and pies. Then there is wild lettuce, a winter annual in many places. And here I wish especially to emphasize the value of the sow thistle, a member of the lettuce family. These weeds are good feeders in the lower soils, and when a gardener is fortunate enough to have a good crop of them to turn back into the soil, he is applying the very best fertilizer to his land.

I have often heard gardeners complain about not being able to grow this or that kind of vegetable, though every possible effort was made to do so. Mothering such vegetables with the right kinds of weeds will often solve the difficulty. Root crops, like beets, carrots, etc., need a deep, friable root zone with food materials easily available. Mother weeds will loosen the soil so the roots can enlarge easily. Root crops are usually hardy, but to be highly nutritious and savory, roots must not be forced to fight a compact soil. With leaf crops, or any other vegetables that don't seem to be responding as they should, an intermingling of the weed roots with the vegetable roots will often perk up the vegetables amazingly.

Once I heard from an observing farmer: "Even if weeds did all the harm that most people seem to think they do, they'd still have to be given credit for doing a lot of good." And he added, "Weeds stop the rain and keep it from pounding the dirt into cement. Stopping rain in that way is mighty important. With weeds in a field where a crop is growing, the rain first hits the green stuff, then trickles down to the soil. By reaching the dirt in that way it soaks in without sealing up the top of the ground and then running off."

How right he was! Have you ever watched rain pouring down on land

that has been newly plowed? The beating drops soon cement the surface of the soil by driving the particles together, unless the land is rich in fiber. With the surface of the soil in this condition the water cannot soak in readily and consequently must run off or form puddles, and every drop of water that leaves the land carries soil with it.

And here's another weed value that farmers and gardeners should not forget: unless there is a crop of some kind on the land continuously to take up the food materials that are under continuous preparation by the soil-world agents, much of this food will be lost through washing or leaching, or will disappear in some other manner. No agents can excel deep-rooted weeds for gathering up and storing this rich food. When the weeds are turned under and later decay, the food substances are released into the surface soil for the oncoming crop. Bare land spells wastefulness.

Weeds have a place in the flowerbed, too, growing as companions of the flowering plants. As in growing quality vegetables, the flower gardener should center her interest on the feeding zone of her flowers. I once knew an old lady who was famous for her old-fashioned flowers: zinnias, marigolds, peonies, pansies -- all the varieties that our grandmothers used to grow. Granny's beds were always a riot of color, and she enjoyed telling folks that she produced her flowers with the help of lamb's quarter. I recall that the big weeds stood three or four feet apart, and usually were larger than the flowering plants. But the weeds did not detract from the beauty of the beds. The weeds, too, seemed to be bearing an assortment of bloom. People used to go to Granny for flowers for special occasions -- the gorgeous flowers that were produced with the help of weeds.

Rose bushes are often baffling. Many kinds of roses grow satisfactorily and blossom without much care, but even the most hardy of roses respond to a bit of special treatment -- and weeds stand ready to help. Rose growers know that the most difficult time is the period of very hot weather in summer. In some sections many of the choicest varieties do not weather hot days without injury, though water for irrigation may be ample.

In such situations, carpeting the ground around the rose plants with weeds may serve a good purpose. Encourage any low-growing weeds that happen to be available, to grow around and close to the rose plants, and water copiously if possible so as to keep the weeds green. Plant or transplant the weeds if necessary -- but don't permit grass to grow as a carpet. Grass feeds differently from the weeds. Only the weed roots work down into the soil and intermingle advantageously with the rose roots. Here we have unrelated root systems working together to the benefit of both. If water is not available for irrigation, only very hardy weeds should be used -- spreading spurge, for instance -- and these should be thinned so as to leave on the ground only enough to cover it well. Even though the weeds may rob the roses of

some moisture, they will more than pay for the stolen water through strengthening the sponge structure around the rose roots, by enlarging the feeding zone to a slight degree, and by regulating the temperature.

Most market gardeners would probably consider it a bid for low-quality produce were they to encourage a weed growth in their gardens. Yet, when labor became scarce during the late war, not a few gardeners found the weed an unexpected friend. Here is a report of one such case. This gardener has long been a heavy producer of vegetable crops near a large city. Labor shortage hit him at the most critical time; the draft left him with only a small percentage of his original help. He was forced to restrict his garden operations at the outset. Then after his crops were in, he lost more of his help. This left him with no alternative but to neglect a part of his land that had been planted. And there was where the unexpectables began bobbing up.

To begin with, the planted vegetables that he had discarded went right on growing along with the weeds. "And imagine what I found when I happened to go over to that section of my garden one evening!" he said to me. "There they were, a lot of fine vegetables sticking up through the weeds. I harvested some of my very best vegetables right out of that weed patch; from the very weeds I had long fought as enemies: pigweeds, sow thistles, nightshades, sunflowers, ragweeds -- even bull nettles."

This man said he was even more amazed at his production the following year from that weed-patch land. That area became his main garden the next season, and he started out to keep it clean. He admitted that his experience with weed gardening the previous year hadn't quite convinced him that he should give up his clean cultivation. But labor again -- he was forced to leave the weeds on some of his vegetable blocks. And he harvested his best vegetables from this weed-infested land. He was now certain that the weeds had not only enriched his soil while growing with the vegetables; the weeds had given his land a dose of much-needed pep.

It took an excellent farmer, a farmer in whom my mother had high confidence, to convince her beyond any doubt that weeds in a potato field could actually mean the difference between a good crop of potatoes and no production at all. Our neighbor had planted a fairly large field of potatoes, then for some reason was not able to take care of the whole patch. Weeds, mostly pigweeds, moved in and the potatoes soon disappeared from sight. Then to make matters worse, it turned out to be a dry season, the drought and scorching heat hitting the potatoes right when they needed moisture most. The potatoes in the clean field soon turned a bluish green, a sign they were done for. The weedy part of the field remained green longer, but our neighbor, supposing that the weeds would themselves put an end to the potatoes if the drought hadn't already done so, concluded that his potato crop for that season had fizzled out and let it go as just another stroke of hard

luck.

When digging time arrived, he decided to plow his entire potato field, more to get it ready for fall turnips than because he expected any potatoes. It still hadn't rained to amount to anything and the soil was extremely dry and hard. From the clean part of the field he turned out a few marbles; nothing worth picking up. But when he got into the weedy area he met with a happy surprise. He turned out several sacks of excellent potatoes. The potatoes were of only fair size but of a superb quality. After seeing that irrefutable demonstration of what could come out of a weed patch, Mother thenceforth accorded the pigweed considerable respect -- so long as it kept clear away from her choice vegetables.

One woman showed me some Bermuda onions she had harvested from a jungle of weeds. Every onion was a picture of perfection. "I thought the onions in that part of my garden were gone because I never could get the weeds cleaned out of them," she told me. She then showed me the onions she had harvested from her cultivated rows. "After all my work -- look at the difference! And my weed onions are keeping better, too. Not a one of them is rotting!"

The clean-land onions were only little more than half the size of the weed-patch onions. I was a bit surprised there, because her weeds were growing entirely too thick. However, onions collect their food materials in the shallow surface of the ground, excepting where there are weed roots to open up the lower soil. As it happened, practically all of this woman's weeds were deep divers. While they seemed too thick to feed very deep, they still fed deep enough to provide the onions with a larger than usual feeding zone.

Annual smartweed

Ground cherry

Sow thistle

Any farm boy can tell you that the best watermelons come from the weediest part of the patch, even from among the nettles that are thick with thorns. A farmer told me he harvested his best pumpkins from a plot that was covered with jimson weeds. Most cucurbits, like muskmelons, pumpkins, cucumbers, etc., dislike grass particularly, but often do well among weeds if the latter are not too thick.

And as a final word about mothering crops with deep-rooted weeds: don't expect miracles, especially if your soil has received one-sided treatment for a long stretch of years, or no constructive treatment at all. If you approach this type of farming seriously, you will discover that you have a means of improving your land -- and doing it without harming your main crop. All of the weeds mentioned so often in these discussions make excellent mother weeds -- if you control them.

However, anyone who expects to take a mediocre or poor piece of land and get a good crop of vegetables from it solely through mothering the vegetables with weeds, is likely to be in for some real disappointment. The weeds, if handled correctly, will do constructive work in the soil -- but they won't perform magic. Nature is no magician; she is a slow, reliable builder. One never loses by following her laws.

7. Weeds in the Rotation

WHILE it is possible to build a sound rotation practice through a proper shifting of the regular crops, so long as legumes play a major part in the scheme, nothing can quite take the place of deep-foraging weeds as one of the links in the rotation chain. Deep-diving weeds do a complete job of revitalizing land. Being Nature's tillers in the lower regions of the soil world, when employed as a green manure the deep foragers enlarge and strengthen the feeding zone for the crop that follows. Weeds employed in this manner maintain soil balance as few other fertilizers can. Since the main reason for crop rotation is to establish and maintain a balance of food materials for the cultivated crops, where there are helpful weeds at work the farmer has double assurance this will be accomplished.

Soils, like dwelling houses, need an occasional overall cleansing, no matter how fertile the land may be. As stated elsewhere, toxins or toxic substances often get into the soil, either through running the same crop on the land for a long period of time, or as the by-products left from organic decay, or through poor tillage practices. Wherever vigorous bacteria are abundantly present, as they always are in a normal soil, some toxic substances may result from their work. These substances are not food materials, and though not harmful to some crops they can be more or less injurious to others.

Where such situations obtain, a mixed crop of deep-foraging weeds will do a good job of cleansing. Exactly how the weed roots do it is not clear. But heavy weed fallowing has been known to have a markedly beneficial effect on toxic soils. Whether the weeds transform the toxic materials, or merely distribute them so as to make them less harmful, I am not certain. But I am certain that weeds, handled properly, will both purify land and enrich it at the same time.

Where there is a mixture of weed varieties, as is usually the case where weeds serve as one link in the rotation scheme, toxic materials that might be missed by one set of roots will be taken care of by another. If a farmer wishes to be sure that a piece of land is made safe against toxic materials for some exacting crop, he should precede that crop with a vigorous crop of annual weeds thoroughly disked up and turned under -- just after the weeds have wilted and started fermentation, but before they become dry. Wilted weeds will decay much more rapidly than will those turned under fresh.

Many garden areas, as well as flower plots, after they have been producing for several years, reveal the need of being toned up; show that they need a general house cleaning, no matter how much intensive care the plots may have previously received, or how rich they may be

in plant food. "Why is it my garden won't produce like it used to? I fertilize and everything -- " is a question I often get from gardeners. What is needed in a great number of such cases is an all-round cleansing of the soil. Which is the same thing as saying that the land needs to be turned over to weeds for a season. And don't forget that the weeds must always be worked back into the soil, else soil depletion may be the harvest instead of soil purification.

Controlled weeds, employed as soil builders and soil purifiers in a crop rotation -- that is exactly what I mean! After the farmer has fitted the weed crop into his rotation scheme, he will find the weeds taking their place as his reliable helpers without any disturbance of his rotation setup. The real pain will come from having to adapt himself to new habits; from having to admit that his weed concept has in the past been wrong. If a field happens to be weak in the right kinds of weeds, he may find it desirable to encourage those weeds to take hold. He may find it necessary to plant weeds and actually coax some of them to grow where he wishes them to grow.

On most land, particularly weak land, annual weeds used in a rotation should be given two years to make a start. The first crop is likely to have a tougher job than any of the subsequent ones. Growth may be scanty owing to a scarcity of weed seed -- if there was no planting of the weeds; or the surface soil may be so weak in fiber that it bakes readily, thus choking the young weeds soon after they come through the ground; or the subsoil may be extremely hard to drive through. It will often take a second crop even when the weeds are given all possible encouragement, or maybe a third or fourth crop, before much constructive work can be in the lower soils.

And abandoned or badly eroded land may require more than four years before there will be enough deep divers to accomplish a great deal. On such land all available weed seed should be planted copiously. In most cases the weed growth, after once well established, should not be left on the land more than two years. The valuable weeds in such situations commonly drop in efficiency after the second year of heavy growth, because by then less valuable weeds start taking over. The deep divers become thinner and thinner, and grass, a more persistent fighter after the weeds have strengthened the soil, creeps in. While this habit of grass is desirable in pasturelands, it has no place in cultivated fields.

Owing to the fact that most soils are likely to be deficient in nitrogen, the element which is the basis of the valuable protein in plants, it will be better to turn the weeds under when the majority of them are at the flowering stage. The nitrogen content of the leaves and stalks is generally greatest at this period. Since this valuable nitrogen has been gathered from the subsoil below the reach of most cultivated crops, a lush growth of weeds worked into the surface soil may add more nitrogen than a growth of legumes which supply the nitrogen through their nitrogen-fixing bacteria.

In turning under any kind of a green manure, whether weeds or legumes or what not, modern farmers or gardeners may well take a page from an ancient's guidebook of farming. Said Marcus Cato, grand old Roman friend of the land: "Coarse materials should not be applied directly to the soil; they should be processed in the manure pits first. If the latter operation is not practicable, the green materials should be cut and permitted to start decay before inculcating them into the land. One is unkind to the soil who asks it to do the work which has been assigned to the farmer. The soil's work is to feed the plants. It cannot take on the extra work without lowering crop production."

In other words, green crops should be cut or broken down and permitted to *wilt* before working them into the soil. This may seem like an unimportant operation. The wilting of the weeds, I mean. Yet it can easily mean the difference between quick decay and having the materials lie in the ground a long period before disintegration is complete. If the fermentation is permitted to start above ground, the decay processes will usually continue without check until the stuff reaches the fiber stage.

The fact that one may not have much choice in the selection of one's garden plot in town need not deter one from having a good garden and also supporting the soil as Nature would do it. Poor land can be transformed into good soil -- but not by persistently stimulating it with shots of chemicals as some gardeners do. If a gardener has depth to begin with, he can build very poor dirt to the point where it will give him excellent vegetables, if he will use weeds as one of his building agents. Seldom is there a piece of ground that weeds can't straighten out if the weeds are directed. Where possible, weeds should be put to work along with barnyard manure or compost in order to hasten the job. If the land is extremely obstreperous and the weeds do not move in readily, it is good gardening to help the weeds take hold. Gather the seed of desirable weeds and plant them. Gardeners in England are following this practice at the present time, and successfully. Recently European gardeners have found that annual weeds -- many of them our own familiars -- make it possible for vegetable growers to get production higher in both quality and quantity than what they received before discovering these weed values.

To supply "weed mothers" most advantageously to the garden -- or weeds for special green manure -- as has already been suggested, the gardener should know exactly the month or months that the most valuable weeds make their best growth. With this knowledge, when he has ample garden space it is often possible to get a fine green manure, made up entirely of weeds, on the part of his garden where he plans to plant his late vegetables. If he is in a region where there is time to permit the weed growth to remain until strong root systems have had a chance to develop, the land will be greatly improved for whatever crop or crops are to follow the weeds. The weeds in such a case will need to

be severely disked or otherwise broken up, and permitted to wilt before being inculcated into the soil. Then the land should be double disked, or given an extra spading if the garden is small, so as to destroy large air spaces. Such a weed crop will enhance the productivity of the land more than anything else, with the possible exception of an abundance of well-rotted barnyard manure or correctly built compost -- or a combination crop composed of inoculated legumes and annual weeds.

When late summer and early fall are not parched, it is often possible to get a good weed growth in the garden before frost. Gardeners should take full advantage of these weeds, unless they happen to be growing fall vegetables in a manner that prevents their doing so. This autumn crop of weeds can with advantage be turned under without any preliminary mutilation, and the land left in the rough throughout the winter. The loose condition of the land will permit a mellowing of the soil through freezing. Then, too, at the end of the gardening season there are plant remains, etc., all of which are valuable. This material will help to replace the plant foods that have been removed in the vegetables. The gardener can use these summer leftovers in various ways, but the best procedure is to turn them directly into the soil unless he is in a position to make them into compost.

In any case, he shouldn't burn the stuff. Burning, since the ash is left on the ground, is of course better than carrying the rubbish off; but burning destroys the fiber which is probably what the soil needs more than fertilizer.

In the April, 1932, issue of *The Country Gentleman* there appeared an ably written article by J. E. Cates, treating of weeds as soil-building green manures. Weeds, used as a rotation link, were being employed as a means of fertilizing the land in some of the tobacco districts of the South. Mr. Cates found that the tobacco growers had learned, through trial and error, that land which had been weed fallowed immediately preceding tobacco not only gave an increased tonnage but also turned off a higher quality product than that obtained from any other fertilizing system. Commercial fertilizers, various green manures other than weeds -- not any of them gave a harvest that came near that obtained through green manuring with weeds.

And the weeds employed were those common in most sections of our country: common and giant ragweeds, lamb's quarter, thistles, sunflowers, to mention a few that belong in those sections. All of these weeds have penetrating root systems. According to the tobacco farmers, the weeds gave them a superabundance of organic matter, and in a condition especially demanded by tobacco. Here is a clear example of how farmers, ignoring the bugaboos of the usual run of weed publications, were courageous enough to crash the long-established barriers of superstition, and to their outstanding benefit.

And with tobacco at that. Tobacco comes very close to being the most

exacting of crops so far as soil is concerned. I had ample opportunity to discover the idiosyncrasies of tobacco while in charge of an experiment station in the Philippines. Every observant tobacco grower knows that the quality of the leaf is very largely dependent upon the type of soil on which it is grown. There was no question among those southern tobacco growers as to the value of green manuring tobacco land with weeds. Cash returns spoke for themselves.

Notwithstanding the tobacco grower's marvelous results secured from a green manure consisting of mixed annual weeds, I am convinced that a weed-legume combination is best as an unfailing system of soil improvement. A crop of inoculated legumes, interspersed with annual weeds, both growing vigorously as companions, is the superb fertilizer for building up and holding the fertility of soil. This is a system of manuring that can be adjusted to all conditions where plants will grow at all, for there are both legumes and annual weeds adapted to nearly any condition. These companions need only to be put to work.

If it is necessary to plant the weeds in order to secure a desired stand, then the weeds should be planted. Furthermore, extremely poor land should be stimulated if such is necessary to induce the weeds to take hold. A farmer will find plenty of such stimulants on the market. For a good rotation on land that still has considerable life in it, the weeds as a general rule will not need to be planted in most sections, though planting weeds should be looked upon as sensible agriculture fully as much as is the planting of the legumes. Weeds should be welcomed on land that is under improvement, because the fact that the weeds are growing there means they are naturals in that locale and ready to get to work constructively. With the weed-legume combination, the weeds will pump the nitrogen and other food elements up from the lower soils, while the legumes "manufacture" the nitrogen in their nodules. Food put into the surface soil in that manner certainly will mean maximum fertilization -- achieved according to natural laws.

Whenever I think of weeds as agents to prepare the land for some special crop, I am reminded of Granddad Olsen and his potatoes. Granddad Olsen was past eighty at the time I visited him. He had staked his claim in the Run. A pretty good claim, too: some small bottoms along a rocky creek, and quite a bit of other tillable land that wasn't overly sloping. Granddad, like most of the early settlers, had done well for several years. His land had produced abundantly and he had hauled off his crops without stopping to realize that his soil could not keep on turning off such produce without some assistance from him.

But when the years began to close in on him, Granddad Olsen realized abruptly that something had happened to his farm. "When I think of them good acres I used to have, seems like I ain't got no farm anymore!" The tears welled into his tired eyes. "Eighty-three years old, and now nothing hardly left!"

It was such a common story: good land worn out or lost because of mismanagement. He told me that Jack, his youngest son, was farming the place the best he could, but now they didn't have a piece of ground where they could grow decent potatoes. "Used to be I could win with my taters at the county seat -- I mean the county fair -- most every year. Now we can't grow taters hardly fit to eat!"

To cheer Granddad up a little, I called his attention to a small field of weeds, around an acre, that lay between his old stable and the creek. From where I stood, it appeared like a good assortment of weeds, and I could see that the big weeds had been able to hold their own against intruders. The patch was somewhat like the weed coves of our pioneer days, only larger.

"There is your potato patch waiting for you," I told him. "Those weeds down there have probably built you a potato soil as good as any you ever had on the farm. How long has that been a weed patch?"

The old man looked at me thoughtfully for a moment. "Gracious -- for a long spell! Used to grow truck down there. And you say weeds make dirt good for taters?"

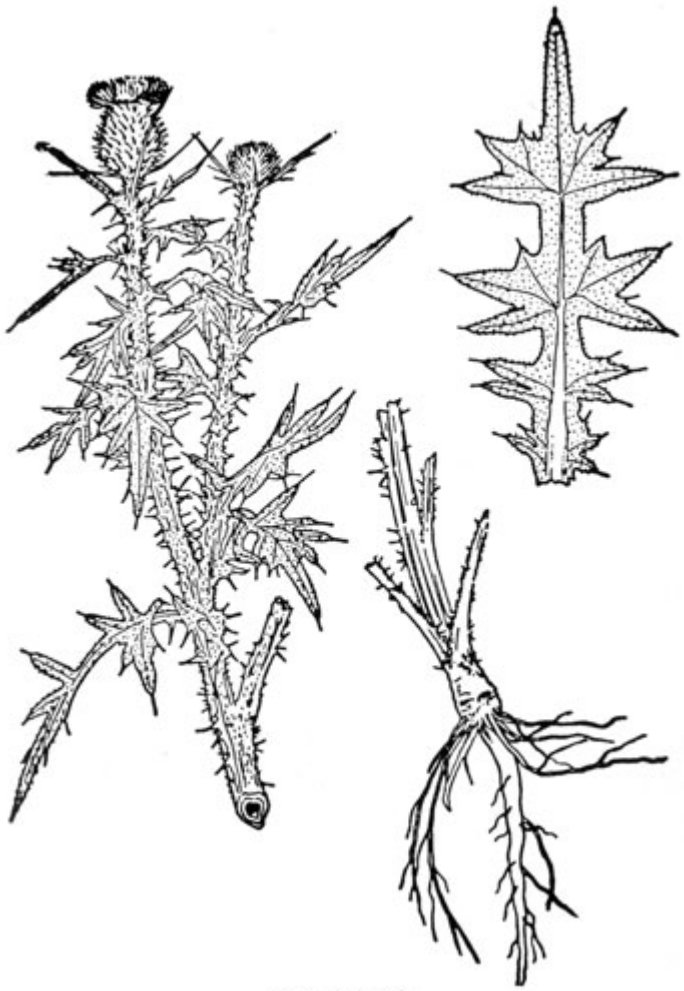
"Nothing can do it better," I assured him. "But you'll need to have Jack get in there and roll or disk the weeds before turning them under. And be sure they are turned into the soil thoroughly. Don't burn 'em! That is, get those weeds turned into dirt if you wish to raise prize-winning potatoes again."

"I declare! " Granddad's eyes were sparkling now. I knew he was thinking of those potatoes of the long-ago county-fair days. "I'll shore have Jack 'tend to them weeds 'fore tater plantin' time!"

Granddad then pointed to a denuded field that lay a short distance to our left. The field looked as if something had rolled the soil up like a blanket and then carried it completely away. "Now wish you'd tell me what to do with that field!" he sighed dolefully. "It growed good crops one time -- now look at it! Won't even grow weeds!"

"It formerly grew good crops of weeds?" I asked. There were small, sickly clumps of thistles and common ragweeds that were indicative of "lost soil."

"Lots of 'em oncet -- all kinds. You can see what washin' has been doin'."



Bull Thistle

Again I called Granddad's attention to that field of weeds below his old barn. "You have an abundance of weed seed down there," I said. "Why not re-establish the weeds up there on that slope? Not all of those weeds growing there below your barn will be willing to take hold on your eroded slope without a lot of coaxing; some of them you probably can't even coax to grow up there. But some of the most valuable weeds will make a go of it if you help them a bit. Try the pigweeds and horseweeds and those bull thistles that are growing so well down there -- "

"But you don't mean to plant weeds!" Granddad interrupted me. "Why, everbody would think we was crazy if we started doin' that! I can't imagine Jack a doin' that at all -- "

"Then you'd rather have that field lie there and continue to get worse instead of better?"

"No -- I didn't mean it that way! I'd be willin' to do most anything, to get some dirt back on that field! But to plant weeds! I'll talk to Jack about it; see what he thinks -- "

I learned later that Granddad Olsen followed my instructions about his potato patch, and harvested some excellent potatoes. But I don't know whether he ever planted weeds on his eroded slope or not. Probably didn't. Eighty years of superstition wouldn't give way easily. He couldn't risk being caught planting weeds, though the weeds could have helped him save his farm.

But I predict that in twenty-five years, possibly sooner, farmers will have accepted many of our common annual weeds as a vital link in any constructive rotation scheme.

Someday they will gather and preserve the seed of a large number of weeds that are now considered pests, just as they save the seed of sweet clover and a few other wild legumes. Food producers will awaken to the realization that a right kind of weed science is going to be necessary as a practical part of our agriculture if our farmlands are to be saved and permanently improved.

Green manuring land with weeds, if the greatest value is to be obtained from them, may call for weed treatment other than that of turning the weeds loose to grow as they will. Thick growths may have to be thinned in order to encourage the growth of strong root systems. However, with a dense growth of healthy weeds, a fairly large percentage of the plants will fight their way down into the lower soils. Nature will employ her soil builders constructively -- if man gives her a chance to put her laws into operation without any interference from himself.

8. Weeds and Pasture Improvement

WERE it not for the constructive work of several important pasture weeds, most wild-grass pasture areas in the United States would today be barren.

In the *Chicago Naturalist* (Volume 8, Number 2, 1945) there appeared an article entitled "The Role of Weeds in Maintaining the Plains Grasslands," by Anna Pederson Kummer, which substantiates my own findings. Weed growth -- or some special domestic crop capable of doing the work of the weeds -- is necessary for the return of the grass to land where the grass has been completely killed out, or seriously thinned through overgrazing, sheet erosion, or because of a long period of drought.

While the author of this penetrating article treats only of the short-grass regions of our middlewest and west -- that fabulous land where the buffalo and antelope by the millions roamed and grazed -- the natural laws by which those heavily grazed areas were sustained are invariable. The unbelievably large herds that gathered their food almost entirely on the short-grass plains throughout countless decades must at times have come close to the borderline of famine. Yet the herds survived because of the work performed by weeds.

I am convinced that the same laws of Nature apply to tallgrass regions no less than they did to the buffalo ranges. Some of the observations of the author of the article in question are particularly worthy of note here. There were, she assumes, dry periods during those buffalo years, just as there have been modern dust-bowl periods in that same section of the country. During those extremely dry years weeds took over the plains and provided food for the roaming wildlife of many kinds. Not food equal to the short grass, probably, but enough to support life.

And those same weeds are out there today in those once short-grass plains, doing their level best to save the soil against the modern destructive tillage practices of man. Dust storms can, in a very large measure, be prevented by the correct utilization of those plains weeds!

But, though vitally important as an emergency forage, important in staving off what would otherwise have meant certain death to millions of bison, that was not the weed's greatest value, even to the bison themselves. The weed's real worth came through its ability to pave the way for the return of the grass.

The plains weeds -- milkweeds, thistles, tumbleweeds, ragweeds, to mention a few -- are almost all on our list of constructive weeds. Quoting the aforementioned author directly: "While the weed cover

seems a deterrent to successful reoccupation of the short grass, it is actually necessary to that process." And again, "Without them [weeds] the short grass could not have survived as a climax vegetation."

Wild Mustard

The weed-grass relationship in rebuilding grasslands, I feel reasonably sure, holds almost invariably true not alone in our short-grass regions but for all types of dryland grasses that normally form prairies or meadows. I have seen this law functioning in the desert regions of Africa where a few persistent weeds serve as the forerunners of the grass that is ever struggling to get a foothold on the borderline of vegetation. In the tropics, where rainfall part of the year is enormous, some of the more intelligent native farmers are careful not to overgraze their small *kogonales*, or grazing grounds, lest the grass become so weakened that jungle weeds are able to move in and take over.

The grass will fight its way back if the carabao and cattle and horses are kept off, but usually only after the weeds have transformed the soil. In America this law is in evidence everywhere, both in hay meadows and pastures. Pasture grass, once it has given out, will not often re-establish itself until the soil has been refiberized by weeds or some domestic crop that has the power to do the job.

What actually happens in the interesting relationship which exists between grass and weeds is this: prairie grass demands a soil that is highly fiberized; a soil that is porous. In a good pasture or lush

meadow there is an abundance of sod, and the grass maintains this sod condition as long as normal growth is not interfered with; or as long as the soil, for any reason, does not compact around the grass roots. But when any adverse factor does come along and kill out the grass, usually grass cannot move back in and refiberize the soil by means of its own roots. It must wait until some other agent does the pioneering job for it. Then the grass moves in, takes over the work, and continues it.

This pioneering agent of Nature is the so-called weed. The weed roots unlock the tight soil, fill it with fiber, and thus re-establish its porosity. *But the weeds do not drive out* the grass. Something else does that. And fortunate is the farmer who is able to watch a strong crop of weeds take over his pasture immediately his grass has become seriously weakened. The weeds also lessen erosion, if the land is at all sloping, in addition to getting the land ready for the comeback of the grass.

Mr. Basil was a businessman and an absentee landowner who for some time had been urging me to go with him and inspect a new place he had just purchased; wanted me to tell him especially what to do about his pasture. The pasture was a deplorable sight, he said; not enough grass on thirty acres to support a cow. I was not overly enthusiastic, for I had long since learned that absentee landowners were all very much alike. They want you to give them advice on how they should handle their land constructively; then proceed to do nothing about it, though they'll admit your ideas are good. But when Basil said that this new pasture of his had the best crop of weeds on it he had seen in all his born days, I was all eagerness to go.

That pasture was a superb soil-building demonstration. Nature was gloriously at work. As we walked over the area, I gave Mr. Basil a pasture improvement lecture which stuck -- I hope. Actually, it was Nature herself who did the lecturing. Weeds -- weeds everywhere, fairly shouting one of Nature's laws in operation. There were annual ragweeds, horseweeds, thistles of several kinds, prairie pigweeds, wormwood, ironweeds -- almost all of our familiar land improvers plus a number of worthy extras. And every one of those weeds was at work fiberizing the erstwhile beaten and overgrazed pasture; busy getting the land ready for the regrowth of the grass. Mr. Basil had a superb pasture in the making and didn't know it.

Most of us are familiar with our old reliables in pastures; the weeds that are classed by most folks as undesirables: thistles of several kinds; the tumbling tumbleweed, but before it went tumbling. Then there is the milkweed, more than one kind, to be exact; several wild legumes; goldenrod, the queen of autumn flowers; common and giant ragweeds -- the list could be a long one for any community. Most of these pasture weeds are deep divers. Nature has assigned them a vital part in helping to maintain the earth's green carpet.

Amd the grass will return on pasture areas wherever those weeds are vigorously on the job, not only on Mr. Basil's farm, but in any pasture where the weeds have taken over. That is Nature's law for the rebuilding of grasslands. The time of the return of the grass will depend on how long it takes the weeds to complete their preliminary fiberizing. The land may have become so depleted that this will take several years, even decades, or the grass may move back in two or three seasons. In successful pasture building, man works as assistant to Nature in carrying out her important law.

Grass has the power to rout the weeds when conditions are right for the return of the grass. This is also an interesting segment of the weed-grass cycle. Grass can conquer the weeds when the soil is rich in fiber. It is not uncommon to hear farmers complain about weeds killing out their grass. "Looks like my pasture is goin' to be all weeds pretty soon! Weeds are killin' out my grass more every year." Just the reverse is really the case. The grass gives way because the soil particles have run together, thus destroying the porosity so essential to grass roots. When this happens the weeds take over -- and do the very things that Nature has assigned them to do. Sometime later the weeds will be replaced by the grass. Wild meadows all contain weeds, and many of those weeds are constantly shifting about in the meadow or pasture; imperceptibly improving weak spots so the grass can move back.

It is hard for farmers to conceive how the weeds can possibly be helping their meadows when the superficial evidence is so strongly against the weeds. There are plenty of indications that many of the weeds companion with the grass, perhaps to the benefit of both, in somewhat the way Sol Benson's corn and pusley roots worked together, the weed roots leading the grass roots a bit deeper into the soil. But the chief value of weeds in grasslands comes from their fiberizing powers; from their ability to strengthen the weak spots in the upper layer of soil, and to fill those spots, as well as the lower soils, with fiber.

I always like to defend the common annual ragweed. These weeds are a familiar sight in most pastures. Cows eat the rags because, for the cattle, ragweeds are ration balancers; bovine vitamins, they could be called. They provide something that more dignified forage does not supply. And those large ragweed patches in the pasture have not driven out the grass! Ragweeds are quick to take over once the grass weakens, and it usually takes vigorous grass to rout the weeds. But when the ragweeds do move out, either through man's help or when the grass is able to overpower them, the weeds leave the soil in far better condition than it was when they took over.

During the drought of 1936 many pastures and meadows in the Mississippi Valley were injured or completely destroyed -- apparently -- by the relentless heat and dust-laden winds. For a time it looked as if

deserts had moved in a few years ahead of schedule; that schedule which prophets have assigned them. But right when many pastures looked most desolate, a change took place abruptly in the desertlike landscape. Weeds shot up in many places, almost overnight. I remember that the most conspicuous to appear in my own community were annual ragweeds and blackeyed Susans. The author of the article on weeds in the plains' grasslands makes a statement which did not need the short-grass region for verification: "Probably there is never a dearth of either variety or number of weed seed in the soil." The Susans came on and thrived until in bloom they resembled a solid yellow carpet -- acres and acres of them where they had not been noticed before.

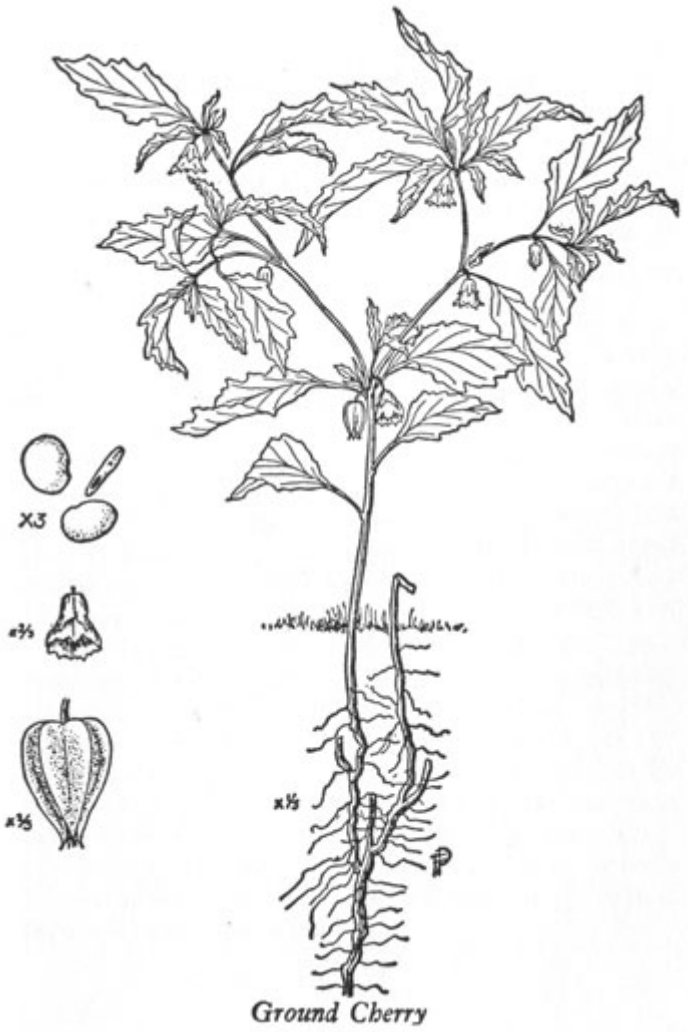
But after two seasons of weeds the grass moved back onto the land, in pasture after pasture thicker than it had been before the drought. The big drought in the long run had proved beneficial to many an acre of grassland. The severe dry siege gave the hardy weeds a chance to open up and fiberize the soil. Farmers in many sections found themselves with better pastures three or four years following the drought than they had seen on the land for several years previous to it.

I have been asked many times where the grass came from. The fact of the matter was, a goodly portion of the grass crowns had not succumbed completely. Now, with the soil improved by the weeds, when the rains returned green shoots quickly appeared, coming out of the dead-looking clumps. There were grass seeds everywhere, too, just waiting for those favorable conditions in order to sprout. This new grass added immeasurably to the rebuilding.

Weeds, and probably grass also, seem to produce two kinds of seed at the same time: seeds which sprout readily when growing conditions are favorable and which play the main role in maintaining the life cycle of the plant; and seeds which seem to germinate best under abnormal conditions -- when that particular species of plant is facing a severe struggle of some sort. Some weeds produce seeds that lie dormant for a long period of time, though sprouting conditions may appear to be excellent. Cockleburs, for example, are known to produce several types of seed on each plant. Some of the burs germinate in one year, others in two years, and so on until there are some seeds that remain dormant for five years or more. Since weeds are essential in maintaining natural soil fertility, Nature makes certain that no situation can arise where varieties of weeds are not there and ready to go to work when necessity calls. Only when the land has been completely peeled by erosion, and the surface soil together with all weed seed has been carried away, will there be a complete dearth of weeds on the land.

In some sections of our country there are encouraging signs that farmers are beginning to realize that something constructive must be done toward repairing the native pastures which have in many parts just about vanished so far as forage production is concerned. Some

good work in pasture improvement has already been done, and this movement will accomplish lasting good if it steers the right course. It will not be difficult to get a temporary response from the grass by means of superficial scratching of the land and the application of stimulants., But there is danger that such treatment will not build a permanent pasture.



As already pointed out, the death or weakness of the grass, even where overgrazed, is likely to be due to the soil's having compacted. The grass cannot come back permanently until the soil has been refiberized; made porous. This, Nature, if left to go it alone, will do with her weeds. Man can help with domestic legumes, particularly those that have strong root systems. Clover along with several other legumes will do the fiberizing work, whether planted along with the grass or before it. The grass roots will follow the clover roots down into the soil to a fair depth, and from then on will do their own fiberizing; will build their own permanent sod.

The legume-grass combination will work the same as the weed-grass combination in pasture improvement. If weeds have already taken over and done a fair job of fiberizing, the clover should still be planted for

the quick nitrogen it can supply. Young grass needs an abundance of nitrogen, and the weeds and clover will take care of that. Terracing and the application of lime may be necessary in many sections, and an application of rock phosphate will commonly be found advantageous. But better keep away from most of the stimulants, if not all of them. Build your pasture Nature's way if you want it to last.

9. Weeds in the Compost

COMPOST farming is a type of soil fertilization that dates back to the first recorded agricultural history. One modern dictionary defines compost as "a fertilizing mixture." Which really doesn't define a great deal, for there are many fertilizing mixtures that fall far short of properly built compost. In ordinary language, compost is what results when vegetable materials are thrown into a hole or stacked up on the level in some out-of-the-way place and permitted to rot as they will.

Scientific compost making, however, follows a more exacting formula. A true compost is a mixture of plant ingredients, all right, but there is more to the processing than is generally believed. Actually, almost anything organic short of saw logs can be turned into good fertilizer if the right procedure is followed.

Probably the first compost formula was the one introduced and developed by Marcus Cato, a Roman scientist, statesman, and general all-round farmer who lived and lectured on agriculture some two hundred years before the Christian era. At least, I think Cato's compost formula is the first that history records. Until the fall of Rome, the teachings of Cato were the last word in farm management. There is little doubt that this old Roman was one of the world's greatest agriculturists. Many of our modern agricultural discoveries were advocated by him.

Cato was a strong believer in compost as *the* soil builder. Indeed, one gets the idea from his writings that he considered compost making and compost fertilization indispensable if one expected to hold one's land to a high production level. Farm animals were kept as much for what they could supply to the compost pits in the way of manure as for any other purpose.

Cato's method of compost making required two deep, covered pits, one to hold the finished fertilizer, the other to take the stuff as it came from the barnlot or field. On the larger estates the pits were in charge of men who were thoroughly versed in the science of compost making. As a first step in getting the materials ready for the pit, Cato directed that everything should first be scattered in the corrals or used as bedding in the animal stalls, to be trampled under the feet of the livestock. Treating the vegetable materials in this way did two very important things: the trampling broke up the roughage and insured quicker disintegration in the pits; also the spongy material collected the liquid manure which otherwise would go to waste. After this initial treatment, the ingredients went into the pit, where they remained a year. During this period the stuff was turned periodically to bring about uniform disintegration and assure against loss from firefanging.

One of Cato's most interesting -- and certainly progressive -- agricultural principles was that the raw materials must always be composted before being inculcated into the soil. This, he claimed, saved the plant roots from having to do a lot of extra work that was not directly connected with the production of crops. He wanted plant food materials served ready for immediate consumption. No raw manures or other undecayed ingredients should ever be applied directly to the soil.

Curled Dock

Some suggest that the Romans may have learned compost making from the Chinese. I doubt this, for the Romans seem to have employed only dry materials for making their compost, whereas the Chinese always have preferred green vegetation. It is true that dry rubbish is never wasted in China; but during my explorings over there I never met a farmer who did not rank the green vegetation above straw and other dry refuse.

The only reason I could discover why the Chinese were partial to the

green material was because the processing was quicker. A few farmers I talked to also considered the "green compost" more quickly available when applied to the soil. I found only occasionally a Chinese farmer who was building or had built what he considered a complete compost, though any of them could tell you all about Chinese composts. Green weeds would be the best possible materials for making composts, they say, but these are no longer to be found in sufficient abundance on the hills. As a general rule, like the old Chinese woman already described, they chop up the small amount of green stuff they are able to gather and apply it directly to the soil.

The people in several countries of Europe prior to the outbreak of the last war were far more compost conscious than American farmers and gardeners have ever been. Farmers in America seem to think of compost making as kid work; not a man-size job of farming. Compost for a small house garden is all right, some will tell you; but for a cornfield -- well, men have enough to do without wasting time hauling and tossing rubbish into a hole in order to get a hatful of fertilizer after waiting several months.

To compost organic materials into the superb fertilizer that is possible is a man's job from start to finish. Yet the composting of plants or plant refuse is simple in comparison with the results obtained. Nature's constructive laws are usually like that. They are exacting but easy to follow, and the returns are great.

An English agricultural scientist, the late Sir Albert Howard, was beyond doubt the outstanding compost authority of modern times. Making use of the best compost knowledge to be found in the Orient and elsewhere, he added to this the results of his own extensive experience and experiments in several parts of the world, until he came up with a formula which, if followed, results in a fertilizer that ranks with Nature's best.

Fertilizer made according to the Howard formula will re-establish balance in weak soils in a much shorter time than will any of the fertilizers with which most of us are familiar; and it reveals its richness in the harvested produce in a way that is almost unbelievable. Both quality and quantity are enhanced. In some respects, soil built up by means of the Howard compost surpasses virgin land in that it can be held to a more uniform balance because the farmer has the soil-improving operations completely under his control.

For full information about the Howard compost, its method of processing and so on, the reader is referred to *The Soil & Health*, by Sir Albert Howard, the great scientist's own record of his life work. (Published by The Devin-Adair Company, New York.)

What I wish particularly to bring out here is the place of weeds as compost material; weeds in the light of the Howard compost. Just as

the Chinese have proved through long experience that weeds, when used green, differ in their fertilizing ability, so should we expect to find that different kinds of weeds in our own country will differ in their ability to enrich the soil, both while they are growing and foraging for food materials and when they are employed for making compost. Unfortunately, our knowledge of this difference between our valuable weeds is at present very limited. What we do know is that several familiar weeds are excellent soil improvers and that all weeds rank high as compost material. Consequently, the farmer or gardener should employ in his compost as many kinds of weeds as he can get hold of, from sunflowers to carpet weeds, with all the in-betweens, and at every stage of growth.

Most farms have an abundance of compost material. Here is one worthy use for the weeds along the road or highway. Those weed areas should not be denuded. Ample weeds should always be left to hold the soil and to provide seed for the next crop. And rare is the farm that does not have some vigorous weed patches temptingly available other than the weeds along the highway: next to fence lines and in fence corners; around out-buildings and here and there in the barnlot. Also, there are those weed strips along the forest edge, or weed coves that have grown undisturbed for a long period of time. On depleted land and on eroded farms, weeds are likely to be scarce. At least, the most desirable weeds. In such cases the roadside weeds may prove to be a valuable asset capable of lending aid well worth considering in soil conservation.

Burdock

In the small town garden, compost can really prove its worth. For all types of small gardens compost is beyond question the most economical as well as the most desirable fertilizer. This is because the Howard-type compost makes it possible for the gardener to get an amazingly high production of quality vegetables from a small plot. For vegetable plots, shrubbery, or flowerbeds, compost made from weeds combined with barnyard manure, the mixture correctly processed, will satisfy every plant-food demand. The town gardener, though his plot may not be larger than a four-by-ten table, should learn how to build compost the Howard way, and then use it for all it is worth along with green weeds turned under occasionally, and with mother weeds in his plots wherever the latter is practicable.

As a compost gardener, the town gardener will then never burn the leaves from his street trees. Fallen leaves are tops as compost material. Aside from containing excellent fiber, which all soils need, tree leaves are rich in minerals. Do not forget that tree roots delve deeply into the soil for food and moisture. They bring up enormous quantities of these food substances, a goodly portion of which go back to the soil when the leaves fall, after having completed their work as the food-processing laboratories of the plant.

In case a gardener does not feel he can spare the time and effort to build a Howard compost pile, he can still make use of his fallen leaves in a manner that will give him a lot of feeding material for his garden, his flowers in the yard, his lawn, or his shrubbery. A simple compost stack -- or pit -- can be built to meet restricted conditions in town. And here is a word of caution about the composting of leaves: weeds should always be mixed with the leaves when building the compost, whether a shallow pit is used or the stack is built on level ground, since the leaves, when piled up alone, have a tendency to compact together. This compacting of the leaves prevents suitable aeration while the stack is processing. By alternating a layer of weeds with a thin layer of leaves, this can be eliminated. And in order to have a more nearly balanced fertilizer, there should also be a layer, some two or three inches thick, of reasonably fertile soil, this also alternated regularly with the leaf-weed layers. The soil, wherever possible, should be mixed with poultry or other animal manure, as well as a bit of slaked lime or ground limestone. If dry materials are employed for making the compost, all of the stuff should be thoroughly soaked with water as the different layers are put in.

Mullein

Being unable to meet all the requirements for an ideal compost mixture should not deter one from doing the best one can. Weeds and leaves

alone will give back a very desirable fertilizer. If you have some reasonably good dirt handy, just build a three-layer stack as follows: weeds, leaves, soil; weeds, leaves, soil, etc. Or, weeds and soil; weeds and soil. Where manure is used, weeds, manure, leaves; weeds, manure, leaves, work out well. The point is, make use of those lawn mowings, fallen leaves -- all stuff that will decay in a reasonable time -- for making a better fertilizer than you can possibly buy.

No farmer or gardener has a valid excuse for not getting some value out of his weeds. If he is unwilling to welcome weeds as a green manure in his rotation, or as mother weeds in his cultivated crop, he can still compost his weeds into a fertilizer that will live up to every claim made for it. And once tried, those thistles and pigweeds and sunflowers -- all kinds of weeds will be seen as possessing some worth, though many may rightly be pests in some situations. Some of the very worst weed villains make the very best of compost.

In a town where there are gardening enthusiasts, there should be compost clubs in which the Howard system of compost making should be studied as a science and through actual demonstrations. This can be done, and is practical. After a gardener learns through his own efforts what quality of flowers or vegetables he can harvest from a few square yards of land, that gardener will be a compost booster wherever he goes. He may even reach the point where, like many gardeners in Europe at the present time, he will plant weeds in a special plot so as to make sure of an ample supply of this best of compost material. He will discover also that practically all vegetable refuse and discards from the kitchen, lawn mowings, prunings, garden leftovers, fallen leaves -- all can be turned into rich plant food -- a far better fertilizer than he can purchase on the market.

10. Weeds as Food

A VERY large percentage of our soil-building weeds are in one form or another edible. Most of them are very nourishing. And my Nature-loving mother did know her potherbs. She searched the forest and meadows for her weed greens, often the very same weeds she fought so relentlessly in her garden. Mother considered the wild, eating weeds far superior to any greens that even she could grow. She planted mustard to give a bit of tang to the more delicate wild plants, or to assure our daily minerals if something prevented her gathering the wild greens. Turnip greens she grew in the fall when edible weeds were not plentiful. But the domestic greens were only for emergencies. Wild plants when available were the favorites.

In the spring, from the time of the first chirp of the little bird she always called the pewee, we were constantly cautioned to be on the lookout for the old standbys in the coves or in the protected forest spots. As soon as we reported that the young weeds were two inches tall, every morning soon after breakfast mother was off for the fields, her "yarb" kettle on her arm. Neither rain nor mud stopped her. Those weeds that she hated in her garden were now a special gift to her from Nature; weeds were now food, not pests.

Mother's weed collection was not large. I think she placed curled dock first and lamb's quarter second. Poke she ranked high. The poke weed, known for its poisonous roots, was particularly prized because it was the one weed that mother liked to cook with her meat. And because of the danger of harvesting a bit of the poison-filled root, she wouldn't trust anybody but herself to gather those "asparagus" shoots of the poke. I don't recall how mother cooked the poke shoots. I just know they were delicious.

She served up to us the sow thistle, the smooth-leaf pigweed -- but never the coarse-leaf villain. Stinging nettles occasionally came onto the table when the plants were young and tender. Dandelion and wild lettuce were sometimes combined, but as a rule they were served alone like other weeds. These two weeds were looked upon as a sort of "Sunday greens," because they were rarely abundant on or near our farm, and Mother was especially fond of their flavor.

As I recall, our weeds were always cooked much the same way: boiled in a large kettle and seasoned sometimes with a bit of bacon or ham grease, or more often served without any seasoning at all. Each of us seasoned to suit his taste,. And it was a long time after my mother's day that I learned why those wild plants were so much more savory than the majority of cultivated vegetables: even young weeds, by the time they are big enough to start going into the "greens kettle," are

foraging extensively; their husky roots are already near, or in, the lower soils, feeding in that rich store-house down there.

Pokeweed

The Pawnee Indians almost invariably cooked their weeds with meat of all kinds, preferably after the meat had become stale. Before edible weeds appeared abundantly in their cultivated fields, the squaws were weed gathering daily in the forest and gulches. The Indian women harvested all the weeds that were my mother's favorites, plus many others. They prized the rough pigweed, and purslane they also valued highly, often drying the stems and succulent leaves of the latter for winter food. The Pawnees -- the very old members of the tribe -- ate weed roots of several kinds. The wild morning-glory and the wild turnip I remember particularly. Weed seeds were eaten, but probably not so extensively as with Indians of some other tribes. The seeds of both pigweed and lamb's quarter were harvested by some of the squaws and ground or pounded into a sort of flour to be mixed with meal in making bread or porridge.

Professor Edward F. Costetter of the University of New Mexico, in his studies of the food habits among some of the Indian tribes of the Southwest, has brought to light interesting information on the use of

many common weeds as human food. The Indians of Arizona and New Mexico still employ weeds much as did the Pawnees formerly. Some weeds, however, are put to more extensive use. Pigweeds, for instance, after being first boiled, are then fried in lard. These weeds are also canned for winter food. The Southwest tribes commonly grind the seed of both pigweeds and lamb's quarter for bread and porridge.

Several years ago, while exploring in Arizona and old Mexico, I now and then ran onto small plots of wild lamb's quarter that was being grown for the seed. Professor Costetter reports that the common milkweed is especially prized in some places, the young stems and leaves being cooked with meat. The roots and young pods of this plant are eaten both raw and cooked.

The late war in Europe, despite the suffering and destruction it brought about, gave birth to a new weed knowledge that should play an important role in rebuilding some of those ravaged countries. Necessity forced the investigation of the food value of many weeds that until then had been given little attention. Some weeds that had long been looked upon as worthless were found to be highly nutritious fodder for livestock. Once these weeds were correctly processed, that is, cut and cured into hay or made into ensilage, livestock not only devoured the hay and silage, but gave back gratifying returns.

American farmers will probably be more than a little surprised to learn, for instance, that the detested bindweed, when cured into hay, gave returns from dairy cows considerably above either alfalfa or clover. Many weed experiments were carried on at one of England's leading experiment stations, where the weeds, of course, were under control.

Thistles of several kinds, when treated correctly, were also found to rank high as stockfeed. Thistle ensilage is not entirely unknown in the United States. Stinging nettles, a European weed that is now established in many parts of our own country, the English investigators found to be excellent feeding, when cured, for both dairy cattle and poultry. These nettles are rich in protein, and laying hens, fed the cured leaves and stems as a major part of their ration, showed a marked increase in egg production. With dairy cows, nettle hay produced a very noticeable increase in milk and butterfat.

How well I recall those dense patches of stinging nettles that we had to wade through bare-legged to reach the best fishing places! We could have made an abundance of chicken feed and cow feed from those nettles had we only known. Mother knew the nettles made good greens, but never dreamed of drying them and feeding them to her hens. Acres of those weeds, growing along the creek and in uncultivated bottoms, went to waste every year -- and are probably still going to waste.

The searching English scientists also discovered that many other weeds

needed only a bit of special treatment to bring out their value as food for livestock. The rough-leaf pigweed was found to make excellent hay. Pigweed hay and thistle hay brought returns only slightly below those received from bindweed hay.

Any weed that gave the least promise as human food was tested thoroughly with the aim of helping out the limited ration of a hungry people. Rural America today is more or less familiar with the common yellow dock, one of the most famous greens of the South. Many southern housewives will tell you that no potherb can excel the dock in richness. And they are right. The yellow dock stands near the top of all potherbs in food value. Every garden should have a patch of this dock, especially since it requires no care once it has become established in a fairly damp spot. During spring and early summer a few square feet of these weeds will give an abundance of solid nourishment.

Dandelion

As a general thing, American farmers have given little thought to the curing of weeds for hay. It has long been known that sunflowers make excellent ensilage. And I have seen several other weeds used in the

same manner. Giant ragweeds for one. One farmer told me he obtained his best ensilage when he mixed weeds with his cultivated legumes in the silage trenches. The stock seemed to prefer this ensilage to all others. Wild hay always contains a percentage of weeds. As a rule these weeds have passed beyond their valuable food stage before the grass is ready for cutting, but stock will go for many of them after the weeds have passed through the sweat in a stack.

But not all Americans are unaware of the value of weed hay as a forage for livestock. Lately I have had some very interesting reports on ragweed hay, and from widely different sections of the country. In every case the farmer was enthusiastic about the results he had obtained from this much-maligned weed: "Cattle preferred it to alfalfa and did well on it," one said. Another wrote me, "This hay is not bitter when cured and stacked right, like green ragweeds are. My cattle seem to like ragweed hay better than any other forage."

These farmers indicated that they were using identical methods for making the hay: the weeds are cut when lush and green, but before they become too woody. The hay is left in the swath or shock for a short period, the same as alfalfa, but when stacked it is given a bit of salt now and then as the stack goes up. These farmers seem to think that the salt in some way improves the value of the hay other than to perk up its flavor.

It goes without saying that the seed problem will enter in until somebody comes along with a satisfactory solution to it. The annual ragweeds must of course be planted each year save where a crop is permitted to go to seed on the land. Since no farmer has written me about planting ragweeds, I take it that all depended on natural seeding, or they were making hay from the common perennial which is found in many sections. However, annual ragweeds are heavy seed producers, and gathering and threshing the seed should not be difficult. A few years hence ragweed hay may well be filling an important forage niche on many American farms.

If a weed makes better hay than alfalfa or clover, then that weed *must* be good. Now, we have proof that many weeds will come close to doing that if they are cut at the right time and cured correctly. But any farmer who does not wish to make weed hay can turn his weeds into high-class ensilage. For making silage, weeds can be cut almost any time so long as they are not completely dry.

Why so many wild plants are repulsive to white people is difficult to understand, especially since many of these same plants have been ranked as nourishing food by our Indians as well as other primitive people since the beginning of time. One such plant is the common milkweed, a native perennial found generally throughout the United States. When the tender stems are boiled in two or three waters so as to remove the milky sap, the resulting product is a fair substitute for the

best spinach. The small pods when cooked resemble okra -- some who have tried it consider the milkweed pod more savory than okra, though the milkweed is not so easily cooked. And the milkweed roots are not bad "potatoes" -- once you remove the original bitter taste.

Then there is the wonderful ground cherry. The ground cherry, a valuable weed in any field, has been ignored too long. Its fruit, produced in a husk, is most delicious whether eaten raw or made into preserves or pies. This weed should be a companion in every garden where it can be made to grow. One member of the goldenrod tribe has long been known among the Indians as a favorite tea plant. This variety, often listed as the "sweet goldenrod," can be distinguished from the other strains by crushing and smelling the leaves, which have a delightful aroma, resembling anise. It is a tall, slender plant and grows along the edges of fields or near the forest where the soil is a bit sandy. The beverage made from the cured leaves is very pleasing.

Now *my* favorite beverage: sumacade. Gather the common sumac panicles in late summer when the berries are brilliant red and sour. Then squeeze out the juice in any manner you like, strain, add water, a bit of lemon, sugar to taste -- and drink ice-cold.

A research botanist remarked to me not long ago: "Rare is the weed that is not edible. I have eaten almost everything in the weed line in every community where I have lived, and have seldom found one that was not pleasing to the taste; most were delicious." As Indian John used to say: "All wild plants good. Indian eat 'em and live long time!" It used to seem to me, when I was a lad in the Indian country, that Indians did outlive white folks. I don't know how much weeds had to do with it. Old John may have been speaking with more wisdom than I at the time suspected.

I remember how as a boy I enjoyed digging and eating raw the roots of the evening primrose, but I did not know that those roots were cooked and served as a root vegetable until I had traveled in Europe. Though the primrose is native to America, it was the Europeans who first discovered that the roots were highly nutritious. This weed is commonly grown as a choice vegetable in both England and Holland. It should also be given a place in American gardens along with other favorite root vegetables.

And finally, I would put in a word for the lowly sheep sorrel, a weed found throughout most of our country in cultivated as well as neglected fields, or along the edges of woods. This sorrel has pink flowers and thick juicy leaves, all of which are pleasingly acid. While most folks know that sheep sorrel is edible, few know that it is delicious when served in a salad, or when used as pie filling. Those sorrel pies my mother used to make! No, I don't know how she made them, but she probably applied her good cook's ingenuity to a rhubarb recipe.

There is evidence that "weeds" are creeping back into the civilized man's diet. For much information about weeds as human food, we owe a real debt to some European and American biologists and chemists. There are now a few excellent publications which treat of weeds as food, giving the latest discoveries in considerable detail. Skeptics would do well to get hold of one of these books and then go weed foraging. I'll guarantee him some pleasant surprises. Probably the best all around book on the subject is: *Edible Wild Plants of Eastern North America* by Fernald and Kinsey (Idlewild Press).

11. Weeds and Wildlife

IGNORANCE of wildlife values on the farm is no more excusable than are our prevalent weed superstitions. Even the songbirds are resented by many, although the birds are among our best friends. Were it not for the helpful birds, insects would soon drive us poor humans off the earth completely, despite our sprays and other bug killers. Then there are the nonvenomous snakes. The childish fear perpetually manifested for these harmless creatures is hard to understand. One garter snake or one whip snake or one gopher snake will catch more mice and rats than sixteen cats. Even a small house snake will put to rout a giant rattler or copperhead -- and get a kick out of doing it. I have watched them. Venomous snakes are cowards and usually have a strange terror of their nonvenomous cousins. As long as there are a few nonpoisonous snakes around the house or barnlot, rattlesnakes are likely to make themselves scarce.

Even skunks are generally looked upon as odorous enemies of respectable folk. More need of understanding. Did you ever watch a skunk digging for insects in a pasture or meadow or orchard? The number of grubs and adult insects that skunks destroy each year is enormous. In the orchard the skunk is especially valuable, since the larvae of many injurious insects are commonly found around the base of fruit trees. Skunks, if not disturbed too often, will frequent orchards continuously and thus do a lot of good by digging up and destroying these fruit pests.

And there is no more ideal sanctuary for all such wild friends than rich coves of annual weeds growing in sheltered spots not too far from the house or barnlot. As I found in that weed cove of my boyhood, our friendly varmints prefer a weed patch to any other kind of cover, especially during the summer and autumn months.

There is an old story of a miserly farmer who possessed extensive orchards and gardens, the only orchards and vegetable gardens for miles in any direction. It was natural for the birds to move into those orchards in droves every spring -- valuable birds and orchards were made for each other. At first the miser only grumbled as the birds went about their business of nest building. But as he grew older, his grumblings became more threatening. He didn't like the noisy chatter of those birds. Still, so long as the birds didn't disturb his fruit, he'd tolerate them -- and birds were not very troublesome in apple and pear orchards.

To add to his income, the miser planted a cherry orchard. The cherry trees at last came into bearing. The miser was counting a lot on the dollars he would get from those cherries. He visited his cherry orchard

daily. The trees blossomed, put on the young fruit -- and the fine cherries began to ripen.

Then the miser received his terrible shock. He went out one morning to find that the birds were pecking his cherries. They had eaten only a few of them, but the miser raged at what he saw. He swore then and there to drive every bird from his orchard. He'd destroy every nest and break every egg.

And he did. It took his laborers several days to destroy all of the birds' nests, for there were many of them. Then the miser kept one man busy for several more weeks, keeping the birds from rebuilding their nests. Finally the birds gave up; went in search of new nesting grounds.

A grim silence settled down upon the orchards and garden then. The miser gloated over his victory -- and the extra dollars he had gained by driving the birds away. He gloated over that grisly silence too. He liked the stillness. He gloated until ...

Until one day he was startled by new and different sounds coming from his orchards and gardens; sickening noises they were -- noises that kept up right through the darkness of the night. Now he was hearing the sounds of gnawing insects! The rasping, crackling sounds caused by insect mandibles! The insects stripped the miser's garden and orchards; then they began on the miser himself. The worms gnawed him; the bugs stabbed him and chewed him. They drove him mad. The miser went out screaming.

There are plenty of adults who need this lesson. Especially those adults who destroy or permit the destruction of valuable birds and their nests, who kill every harmless snake they see simply because it wriggles; or those who think that all the good that skunks do is to stir up a stink. Yes, and those folks who insist on destroying all weeds just because -- they don't happen to understand and appreciate weed values.

Once a very admirable man moved into our Kansas neighborhood. This man bought a sort of run-down farm and then proceeded to improve it not only agriculturally, but also by turning it into a haven for wildlife. And what a contrast was Uncle Les Mason, as we called him, to that miserly farmer! Uncle Les was kind to everybody and everything. He went out of his way to prove to us that wild things did appreciate human friendship. He often told us that the wild things always reciprocated human friendship by helping them at every turn. Why, Uncle Les knew a whole brigade of toads as individuals and called each toad by its name. I remember one jolly-looking toad that Uncle Les called Charley. I was certain that Charley always blinked more excitedly whenever he heard his name. Uncle Les used to say it was a lot better to have a bevy of toads around to catch the flies than to be bothered with sticky flypaper.

It was Uncle Les's flock of birds that no boy could forget. Uncle Les surely knew his birds and their value as insect catchers in his orchards and fields. But it was the homey things that he made so interesting to us when he was talking; the idiosyncrasies of birds -- or toads or harmless snakes or skunks -- as they went about their daily businesses.

It seems but yesterday when I was trotting at the side of Uncle Les Mason, listening with open ears and open mouth as he pointed out to us the thickets and weed patches that were inhabited by his happy birds; his birds, which he considered as necessary in his very successful farming as were his fat team, his farm implements, and his dog, Rover. I have since wondered why Uncle Les's appreciation of weeds didn't sink home with me at that time. It must have been that I was always too interested in the antics of the birds themselves. Weeds were ordinary, whereas Uncle Les's birds were not.

I can still hear Uncle Les talking weeds, with his fluttering and chirping birds in the dim background. "Fish anywhere you want to along my creek, boys, except at the bends where the weeds are thick," he would tell us. "Don't go into those patches for your grasshoppers -- those yellowlegs are for my birds. They need them to go along with the bugs and worms they harvest in my orchard and garden."

A fair-size creek angled across Uncle Les's farm, and the bends were numerous. In all of those bends were briar and weed patches that during the summer were alive with noisy birds. If Uncle Les ever planted weeds, I didn't know it; but I do know that he guarded his weed patches as carefully as he protected his small patches of grain planted especially for the birds.

Uncle Les Mason is an example of the value of a too-often-neglected side of most theories advanced relative to wildlife preservation: love and understanding for all wild things. The miserly farmer illustrates the value, too, in contrast.

It goes without saying that there must be scientific planning and well-directed procedure, else accomplishments may result in little more than the sentimental hysteria which a bit of superficial knowledge about Nature seems to arouse in so many people. Folks gush over the sublime beauty of redbuds, for instance, then proceed to mutilate the shrubs while gathering the blossoms. Such people haven't the least comprehension of Nature. But stern science, without a measure of sentiment -- true Nature-sentiment -- swings the pendulum too far in the opposite direction. Such naturalists know toads scientifically; they never see the jolly Charleys. They possess the letter of Nature, but too much of the soul is lacking. Anyone who thinks that he must kill a bird in order to study it thoroughly is not a naturalist. He is an anatomist who should work in a museum.

With the present interest in wildlife preservation, we need practical

biologists in our schools who can interpret the biology of field and stream and forest -- who are able to read Nature's books. We need a few textbooks or guidebooks that tell the full story about wildlife habits and habitats. While I have not scrutinized all books written on wildlife preservation, I have yet to discover a book or bulletin or pamphlet that gives weeds the place they merit as wildlife feeding grounds and covers. Rabbits or quail or other birds of many kinds -- a weed jungle is an ideal hideout for them. It provides them with protection and food and, in winter, warmth. Of the covers usually found on any farm where there are timber and brushy draws, shrubbery and vine thickets rank first and heavy weed growth second. Grass makes a good cover, but more wild things prefer weed coves or weedy fields than open prairie lands, however dense the grass.

For two seasons I kept check on a covey of quail which for years have made their home near the barnlot. These quail are not often disturbed and have easy access to a dense grass area, a field of either oats or wheat, a spread of fairly thick timber, and a patch of vigorous annual ragweeds. The quail seem to know they are as safe in one place as another, but during the many months I have been watching this flock, rarely have I routed the birds out of the grass. In the hot part of the day in June, July, and August, the birds usually spend several hours in the woody thickets. They also feed part of the day in the grainfields after the grain has begun to ripen, but considerably more than half of the time is spent in the ragweed patch. This, too, when there are no ripe seeds on the weeds. I attribute this conduct of the quail to something more than a partiality for ragweed feeding.

Rugel's Plantain

Quail are partial to ragweed cover because of some benefit they get from the soil where ragweeds grow. Ragweeds do enliven the soil. The soil where thick prairie grass grows is also richer than that found in most cultivated fields, but in sod it is not so easy for the birds to get close to mother earth.

Which brings us to one of the most tragic causes of wildlife depletion in many parts of our country: soil sterility. The garden toad, once so familiar around the doorsteps almost everywhere, or in the kitchen garden, or milk house near a cool spring, is now rare. A short time ago I visited my early childhood home in Kansas. I went first to the now-deserted cottage; the little house that had been home to me so long ago. I remembered the toads that had lived in or near our cool cellar and around our wonderful oaken-bucket well. I searched for them, but there was not a toad to be found.

Then I went to call on a friend of those yesteryears, a friend whom I had not seen since those days of my early youth; those years when we both cut weeds for Sol Benson and others. And I mentioned not finding any toads in the spots where they had once been so numerous.

A reminiscent shadow slid across my friend's face. "Toads! I recollect how thick they used to be when we were kids. Fly-catchers, we used to call 'em! I don't remember seein' hardly any toads for thirty years or more -- "

The everyday life of the humble toad is tied in with soil fertility. The toad is more dependent on fertile soil than many other wild things familiar to us: rabbits, gophers, skunks, and snakes. Toads haven't a great many enemies among other wildlife. Even snakes don't care much for toads. But toads soon disappear from land that is weak in organic substances, though the insects on which they feed may be plentiful. Earthworms and toads -- their absence spells weak or depleted land.

Throughout the United States some species of birds have become rare for the same reason: our eroded or exhausted soils are not providing birds the nourishing foods which for many of them are essential. On eroded land even weeds do not produce high-quality seed for the seed eaters. Granted that many other factors share responsibility for the depletion of our valuable birds, low-quality grains and the persistent destruction of weeds have, either directly or indirectly, taken a heavier toll than is usually recognized.

Whenever I visit a weed cove, which is one of my chief outdoor sports, I inevitably compare it with that one particular cove of my youthful years. That cove was wildlife at its best. In summer or winter the cove was activity plus. In it, many wild things found food, either insects or seed, and protection and warmth, preferring it to the surrounding rich fields and meadows and forest in which food was abundant.

Such weed coves are not often found now. Where there is continuous erosion the water often sweeps through the coves and disturbs the soil-mellowing work of the weeds. Either poor soil is washed into the coves, or the dead plant bodies are carried away. The weeds may struggle along and make a fair growth, but they are not able most of the time to build up a rich, mellow earth.

Dense shrub thickets provide a bit better cover than weeds, since these thickets are more permanent and enemies cannot penetrate them so easily. A wise farmer, instead of destroying his thickets, will encourage them to grow in all places where land can possibly be spared. And not all of the thickets should be located in pastures. The best wildlife thickets are those completely isolated from all farm activities, located where domestic animals cannot browse in or near them. Permanent weed coves should be left as undisturbed jungles.

An ideal setup for many species of wildlife is a dense, well-shielded thicket that stands near a small field that has been released to weeds. I know an almost impenetrable plum thicket situated near such a weed patch. The weeds in the small field have been permanent fixtures for only a few years, but even when that field was under cultivation there usually was a good growth of weeds in it late in the summer after crops had been laid by. This plum thicket and field have long been a favored spot for migratory birds. Many species have for many years spent a

part of each year here, some for only a few days, while others have come down from the north to remain for the winter.

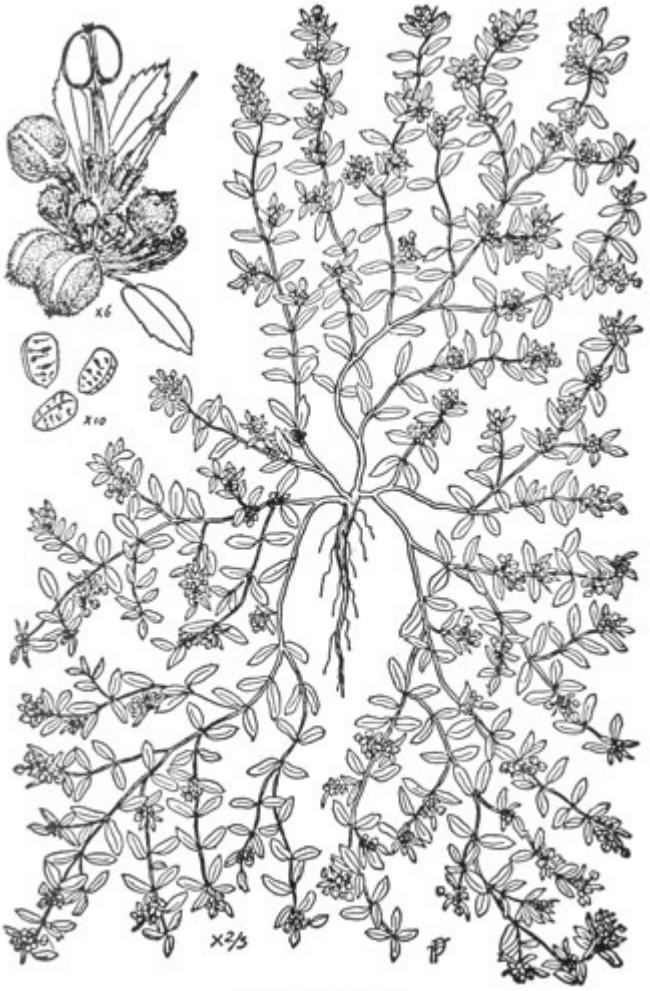
During late years, though, the bird population of this thicket has shrunk to a mere fraction of what it formerly was. I am quite certain that the birds haven't shifted their course. The birdlife has vanished in direct proportion to the depletion of the farmlands.

Just lately I watched from a concealed spot the activities in and around this thicket. I had seen some migratory birds near the house, which immediately brought the thicket to mind. I found a few migrants in the thicket in addition to the two or three species of small birds that make the thicket their permanent homes. But the migratory birds were few. In an hour I saw only two species, and I could have counted all of those on the fingers of my two hands and had a finger or two left. I decided to go out into the weed patch, hoping I could in that way add more visitors to my count. But at that same moment I caught sight of something that caused me to change my mind: a wild house cat. The cat was easing its way towards the thicket, bird hunting, of course.

The prowling beast soon disappeared into the brush. Immediately birds came fluttering out. I ran to the thicket and routed the cat, after which I said a few uncomplimentary things about people who cast off their cats to hustle for themselves. One can't blame the starving cats. But why can't people put the cats out of their misery and thus save a very large number of valuable birds?

Cats may be questionable pets; they don't help to produce and conserve food -- save for an occasional worthy mouse catcher. Birds do. One spring I kept a record on a pair of friendly wrens that had built their nest in an old bucket near my garage, which stood near the garden fence. For four uninterrupted hours I checked the number of worms the birds brought from the garden to their five young: every forty-five seconds one of the birds returned from the garden with a worm! I know, because I timed them carefully with my watch. I was a wreck when I finally gave up. And that wasn't all: those faithful little laborers had been at it since daylight. I have no doubt they continued their work until dark. Where those tiny nestlings put all those worms is still a mystery to me. But I am very certain those two wrens were largely responsible for some excellent cabbage in our garden that summer.

While wrens as a rule do not frequent weed patches, many other valuable birds do: for seed or for insects -- or just for cover when they are not busy elsewhere. If two wrens in a few hours could do so much valuable work, think of the good all birds taken together must do. Then add to this the joy they bring us in friendship and song.



Spotted Spurge

The 4-H club work, dealing with wildlife preservation, is a grand movement and should receive hearty support from everyone. However, there is danger of this work's becoming too mechanical. Boys and girls should be taught in school and in club meetings that the first step in learning how to preserve the wildlife is to learn to love the outdoors -- and to understand the outdoors. They should be taught how to study the wild things in the fields and forests -- and weed patches. In this way they can best learn the relationship that exists between the birds, for example, and man's well-being. In this way it will be possible to present to the boys and girls the sentiment factor more realistically, for to see wildlife in action in the field will teach more than whole libraries of books.

As the young naturalist systematically studies his wild friends -- and they should be looked upon as friends even though they do scamper away when he approaches them -- he will often find his path leading straight toward a weed patch. And he may be a bit surprised to discover that so many of the inhabitants of the big outdoors depend upon weeds for food and shelter. From then on, as a true naturalist, he will see weed coves in a new light. Weed patches, with their seeds for his valuable bird friends; weed patches for cover for other wild things -

- they all belong together. And all are man's trustworthy friends.

12. Sponge Structure versus Dams

PROBABLY no other region of the United States has experienced such evolutionary changes as has the Mississippi Basin. And practically all of these changes have come about since the arrival there of the white man. To the Indian, that vast expanse of territory drained by the Mississippi and its tributaries was second only to the Happy Hunting Ground. And the early explorers agreed. At any rate, they sent word back to their friends and relatives in the original colonies that they had indeed found a paradise on earth: rich land without measure for all who wanted to come.

And they came. The machine-minded white man pillaged the wealth of the Valley: forests went into lumber -- or up in wasteful flames and smoke. In due time the prairie lands and erstwhile forests were pouring forth food crops beyond anything believed possible when the land was first broken.

More decades went by. The day arrived when the Great Basin came to be called the granary of the world. Cities, as if they too were growing from planted seed, sprang into being to process and utilize in various ways the soil's wealth. Major interest began swinging from the *production* end to the *factory* part of agriculture. The making of good flour was more important than growing superior wheat.

Even so, during most of this second phase of the Great Basin's history, farming methods were basically sound, save in one vital respect. The inexhaustibility of the soils of the new continent was still taken for granted, as it had been since the landing of the Pilgrims back there in New England. Science entered into farming in a grand way -- above ground. We built our agricultural superstructures efficiently. Livestock was developed to meet every special need; farm machinery by now was coming from the factories in an endless parade, each machine an improvement over its predecessor, and each machine improving the *mechanics* of farming.

It was during this period, too, that plant scientists performed wonders for the Great Valley. Among these wonders were disease-resistant grains that also gave double yields; fruits that the Pacific Coast alone could excel in; protein-rich forage crops adapted to almost every type of soil and climatic condition. Though little thought was given to land conservation, the land continued to produce bountifully -- and we harvested. We mined our soils to the limit. We ignored Nature's law of return compensation, though even at that period Nature sounded her warning.

And it has been our persistent ignoring of that law of return compensation that has brought us to the third phase of the Basin's history: the period of rapid soil depletion. We are deep in that phase now. Long since have vanished those streams, almost clear even in flood, which were common in pioneer days; no longer do we have unsilted riverbeds. Instead we find ourselves with all rivers

and all smaller streams overflowing with soupy-thick water after every moderate rain. Now we have broad stretches of denuded slopes and upland farms with weak and unbalanced surface soils. Much of our once-fertile bottom land is now spread with mediocre soil, and that soil is still pouring down from the poor uplands.

And then there is the harvest! Unbalanced food products are now being gathered from most of the food-producing land in the Basin. Many food specialists and other scientists tell us that such a large percentage of our farms are now turning off unbalanced foods that deficiency diseases, once rare, are more and more lowering the health standard of our nation.

Erosion, the chief cause of land depletion, is still going on, and savagely. Where erosion is not a serious menace, we have mined our soils instead of farming them intelligently. Blindly we have destroyed the original sponge structure. Blindly we have refused to recognize Nature's law of return. Today the Great Valley as a whole presents a superficial picture of opulence and progress; internally, from the standpoint of a stable agriculture, the foundation is tottering.

There is enough sediment resting on the floor of the Gulf of Mexico to build a sizable continent. Where did it come from? Practically all of that sediment came from the farms of the Great Basin. What has not gone on to the Gulf has been deposited in riverbeds, or has gone into building swampy deltas. Our riverbeds, once deep, are shallow. Overflows are inevitable. River-bottom lands, once among the most dependable food-producing areas of our country, are practically valueless in many sections.

The fact that there are areas in the Great Basin where constructive land management is being carried on, does not change the drab picture to any degree. The small amount of improvement that is being accomplished here and there is insignificant compared with what needs to be done.

In traveling across the country one now and then comes to a region where, at first sight, practically all of the land seems to be under improvement. A friend told me about such a situation where he was so impressed by the amount of conservation work being done he decided to go back and make a thorough recheck in order to be sure he hadn't misjudged. He received a shock. Actually, not more than a fourth of the land was being given constructive treatment. He was there during a heavy rain, when he had a chance to see erosion at its worst: neglected pastures almost carried off in chunks, he said; abandoned fields dissolving before his eyes; small, inconspicuous spots tumbling into the deeper gullies -- and vanishing as red water. All of this added up to three times the land under improvement. If such was the case in a progressive area like that -- what must be the picture of our country as a whole!

But the very fact that we can rebuild -- are rebuilding to a degree -- gives reason for considerable encouragement. I have seen some very satisfying illustrations of what can be done in the way of transforming stiff subsoil into a

new and highly productive surface soil. I have seen land approaching the original prairie soil in fertility, all rebuilt solely by adhering strictly to Nature's laws of land building: by filling the soil with the right kinds of organic materials and in the right way. I have watched the rain pour down on such land -- *on a slope*. The rain immediately went into the ground. That soil had its dams -- a tiny dam for each drop of water. It had its *sponge structure*, which is the only logical reservoir for controlling erosion.

A true soil is one that is so friable and mellow it absorbs rainfall much as a blotter takes up ink. When a soil is properly filled with organic materials -- disintegrated and disintegrating weeds and other herbaceous plants, fallen tree leaves, decaying straw, and so on -- the whole soil mass becomes a huge sponge. Such a soil can drink any except the heaviest rain as fast as it falls. That is why there is little erosion where Nature's virgin soils are still found, unless the land is extremely steep. Even in the latter situations the runoff is normally not great. And all because the land has the essential sponge structure developed through the inculcation of organic materials.

Only through the refiberization of our lands on the slopes can we hope to protect the lowlands. Small frog-pond reservoirs up near the sources of the streams, or near the mouths of the smaller tributaries, should do considerable good; but river embankments and dikes, though necessary in places, are as a rule only temporary expedients. They are just a continuous enlargement of the trough to hold more of the runoff silt. And the runoff will continue to pour down its silt until the runoff is checked before it starts. Raising riverbanks higher and higher and thus lifting the river higher and higher above the bordering lands, may be good engineering -- it is not logical soil conservation.

I cannot help feeling that if the people in our Great Basin were brought to see how serious our soil situation is, they would respond with greater determination than has been the case up to now,. It is true that most folks do not like unpleasant facts; but here is one important fact that directly affects all of us: at our present rate of land waste, there will be little productive soil left on the Great Plains forty years from now. This statement is not a guess; it is backed up by reliable soil surveys, Dams, no matter how colossal, will never stop runoff . And they will not build back what we have already lost.

Only an aroused public can stem the erosion tide! One important way we can help is by getting solidly behind the soil-conservation service of the United States Department of Agriculture, which is doing some excellent work -- although it isn't in all cases building sponge structure as rapidly as might be desired. Erosion and incorrect farming methods are tearing down faster than the conservationists are building. We need more conservationists on the job. We can use more spade work and a little less show and tongue work. We need to take a few lessons from the subtle agents of erosion themselves: ceaseless persistence, and silence. Depend on it, we'll never lick erosion by any other means.

There seems to be no valid reason why every county shouldn't be organized as a unit, with everybody given a chance to become a part of the unit. Where

counties are already organized -- as a great many are -- the county organization should be expanded to include everybody who will agree to help build soil, and then given a bit more efficient directing than is the case in some places. Let's get everybody on the job. Then let's make sure that the major issue is putting sponge structure back into the land -- in a practical manner. Let us build sponge structure until every acre in the country drinks the rain as it falls. That'll call for sweat and a lot of it -- but an acre healed will mean an acre gained; possibly several of them.

And every little bit does help! I had a good illustration of this not long ago. A man who had listened to me discuss weed values on several occasions decided to try out weeds on a tiny bit of eroded land that lay behind his house. This area of only a few square rods was peeled and gullied -- about as poor, he told me, as land could be. His original plan was to help weeds get a start on the piece, then thin the weeds and use them as a mother crop for something, I don't recall what, that he aimed to plant with the weeds.

He scratched the surface a bit, then scattered over it some rotted manure that he gathered up from a part of his corral, where an assortment of weeds had grown luxuriantly for several seasons. This manure, of course, contained an abundance of weed seed, and the weeds popped up, he said, like all get out. Then something happened to prevent his getting round to planting his companion crop; the weeds were left to go it alone and without any disturbance.

One day when it was pouring rain, he decided to go down and see whether or not his weeds were holding back the runoff. The man admitted he was skeptical when he left the house, for it was really raining. And he remembered how many years the water had been gushing off that little slope. But when he reached the lower edge of the slope, he found, much to his surprise, that only a small fraction of the water he knew was falling was making it through the weed patch and pouring into the small brook. The weeds had already built up a sponge structure efficient enough to catch and hold the rain.

Fortunately there are many ways by which the sponge structure can be put back into our hungry and depleted soils. The case just described was simple, yet a good one. These sponge-building operations would seem to fall logically under three heads, each more or less demanding its own system of treatment. First, there are those tiny areas which, at first thought, would not appear to amount to much: the eroded nooks and washed spots on most farms, like the one mentioned above; the small garden areas, including town and city gardens. The sum total of these small areas adds up to a much larger acreage than one would at first suspect. While most gardens are fairly well cared for and are not affected seriously by erosion, many gardeners do have the erosion problem, even in town.

Establishing a good sponge in garden soils not only assures water absorption, but it also enhances soil balance and guarantees quality produce. To fill the soil with barnyard manure or well-built compost or green manure of any sort; to fiberize the lower soils with deep-diving weeds is always good business.

Then there are those discarded or semi-discarded areas that now spread across our country: abandoned farms or parts of farms; denuded forest land; rocky sections;. countless sloping acres which as they now stand are next to worthless. A large percentage of the wild pastures falls into this class. Someone has said that if we could stop erosion from these eye-sore areas, our erosion problem would be well on its way to solution.

Apparently about the only way we have of getting such land covered with holding vegetation is for state and national governments to take over completely. It seems impossible for farmers to take personal interest in such projects, with the exception of a pasture now and then. Most farmers figure that they have all they can do to look after the land that must fill their breadbaskets. Maybe a cooperative scheme between government and farmer can be worked out that will get the job done. Certain city and town organizations might well get in some constructive licks here -- for erosion is very decidedly a menace to all of us. Going to the country and helping farmers to build sponge structure could hardly be called philanthropy. Anything that any of us can do to get our unused land covered with vegetation will be stabilizing our own future as well as that of the other fellow. And the fine part about it is that this work could practically all be done without technical skill. All it needs is progressive leadership.

The third and, of course, the most urgent need right now is the building up of our food-producing soils. We should be pouring into this land green manures, barnyard manures -- every type of organic material that will decay in a reasonable time. The method of getting this stuff into the soil and getting it at work will vary with almost every locality. No set rule can be given that will apply to all sections -- except that the materials should be poured into the land as fast as conditions will permit, and that we should keep pouring them in until the sponge is there, much as it was when the land was broken up.

In most of our soils it will require enormous amounts of the right kinds of materials before there will be any noticeable betterment of conditions. It will be wise to keep that in mind. There must be many crops of lush legumes, the latter inoculated in most instances. The green stuff should be thoroughly broken up and then wilted before being turned under. That will hasten their transformation into fiber. Green manure will need to be grown on the land every possible season of the year, even though that may at times mean the sacrifice of some other crop. Lime will often be necessary and rock phosphate advisable -- but high-powered stimulants will not help build sponge structure except where the land is so poor it needs a quick perk-up to start things off. We need the help of the active soil life in maintaining our sponge, and stimulants are likely to kill or drive out that life.

So much for our surface soil. It will take something more to care for our subsoils completely, and those deeper soils need fiber also. We need to establish as large a sponge volume in the soil as we can. To do that we will need to employ our deep-diving weeds. Too much is at stake for us to permit weed superstition to rule our actions. The weed roots will build little dams

down in the deeper soils -- millions of little dams placed exactly where they should be. A regular weed crop in a well-planned rotation will convince anyone of that -- if he is willing to be convinced.

If the cost of just one colossal dam could be used to build sponge structure in the areas where the erosion menace is worst! We should bombard our senators and congressmen with demands that the huge dams be postponed -- save possibly in the Far West, where irrigation water is vital and the silt in the feeding streams no serious menace -- until we get the sponge structure job well under way. Let's work for more support for the conservation division of the USDA. This support should be something more than what the government is able to do financially, however. We have no moral right to expect the government to bear the whole burden. We have a lot to do individually in every community. We need to get out and reveal the old American spirit that seems to be vanishing from our blood. Our forefathers were builders, even if they did shoot off at the wrong tangent here and there. Again let us manifest that building spirit; let us all become soil builders, even if some of our individual parts may be only a few square yards!

Then let's give our farm youth a chance to carry on sponge-building projects; offer worthwhile prizes. Rebuilding a piece of sloping land may not be as simple or as thrilling as growing and finishing a prize-winning steer or hog, but rare is the farm lad who would not be willing and ready to take on the job if his leaders were ready to direct him. Every dollar spent in this manner would accomplish more than every hundred spent in building large silt-holding reservoirs.

There is no argument against dams and reservoirs at the right time and in the right place. Irrigation water in many parts is vitally essential, and hydroelectric power has become indispensable to all of us. Of course, it is a bit difficult to reconcile oneself to the valuable acreage buried beneath some of the large reservoirs -- with our uplands depleted as they are. But runoff is a danger which great dams do not prevent -- even though the dams may be built where little cultivated land is lost. And stopping wasteful runoff is our number one agricultural problem. We must stop that runoff before it starts, by putting the sponge back into our soils. Naturally, it will take a much longer time to fill a reservoir when the soil sponge is returned, but when full the reservoir will contain water and not one-time farms.

En fin: the good farms buried by the lake will not loom so large in importance -- *if we first rebuild our food-producing uplands before we build our dams*.

13. Here and Yon

I ONCE received some valuable weed knowledge from a former secretary of state of the first Philippine Republic. The old Don's hacienda, where I first met him, lay very near the land on which we were establishing an experiment station, and he owned some land which we wished to annex to the station. This land was already planted to young coconuts, and was just the thing, we thought, on which to demonstrate the *right* way of growing coconuts. We Americans out there at that time didn't know much about the right methods of growing this famous palm, but the ex-secretary was considerate of my lack of coconut wisdom, as he was most graciously patient with my limited Spanish.

After the usual bit of courtesy talk with the Don, my native assistant, acting as interpreter, delivered to me the good news that we were to be given the lease on the land for a period of ninety-nine years.

"Fine! " I said, gasping at the ninety-nine-years part. "Thank our generous friend -- now what are his terms?"

Then after a few more minutes of excited palaver -- "The Don say we may have the coconut plantation to do with as we wish, except he ask that we do not cut the weeds that are growing with the palms!"

I really did gasp at that. But after answering for me a barrage of questions which I immediately began hurling at him, the ex-secretary revealed convincingly that he really did know his tropical weeds in their constructive relation to coconuts.

The roots of the palm, he explained, are long and slender and like to feed close to the surface of the ground. He said he had long ago learned that when the roots of the coconut palm are not able to feed very near the soil surface as well as deep in the soil, the trees do not make the growth they should during the earlier years. In the torrid zone, where the rains are extremely heavy, any except a very sandy soil, unless protected by vegetation, is likely to form a thick crust that will not permit the proper functioning of the coconut roots. For that reason, the Don did not like clean coconut plantations. Also, he said he had discovered that the palm roots grew well among the weeds, excepting where the weeds were very, very thick. Years of experience had convinced him that weed roots and coconut roots were not enemies of each other.

It was important to keep the ground clean for a meter or so out from the base of the young trees so the palms could get the necessary ventilation and sunlight, but it would be quite all right to cultivate a

strip of land midway between the palm rows. All that the ex-secretary was asking was that we permit the weeds to grow everywhere else.

I accepted the land under the stipulated conditions. But after the old Don had returned to the village and I had sent my assistant about his work, I kept right on sitting there under the mango tree, living over that long-ago talk back there in Sol Benson's cornfield.

Sol Benson and his pusley; the wise old Filipino Don and the weeds in his coconut plantation -- almost the same situation, though ten thousand miles apart. There were all sorts of weeds growing in that young coconut grove: annuals and perennials -- I cannot now recall the name of a single one of them. A matter of minor importance. But it was important that Sol Benson and the Filipino planter had talked to me about weeds in the same manner: what weeds would do when growing with farm crops.

And then I remembered: actually, corn roots and palm roots are very similar in their feeding habits. Sol Benson was certain the corn roots accompanied the weed roots into the lower soils. The palm roots were likely doing the same thing in the coconut plantation. The American farmer and the Filipino *hacendero,* though many years of time separated them, had each discovered a fundamental weed value: Sol Benson, that weed roots opened the soil so that crop roots could feed deeper; the Don, that unrelated root systems grow better together than when either is growing alone. Each had glimpsed one of Nature's vital laws that govern the soil world.

Some of our own weed friends work well as companion or mother crops, as the Don discovered with his tropical weeds, while others serve best as green manures. There are those that are good divers into stiff subsoils, and those that seem to prefer the loose gravelly subsoils. Then there are those weeds that make particularly good cover for most kinds of land. And the edible weeds: those that make the best livestock forage, and those that are good food weeds in general. Much must still be learned about the whole of weed values before any individual weed can be placed definitely where it will render the best service. Most of our common annuals seem to have several constructive uses. In the discussions that immediately follow, effort has been made to present a bit more information relative to the *specific* uses for most of our particular weeds, based not only upon my own findings, but also upon the findings of many others who have employed or are now employing these weeds successfully.

I usually think of the pigweed first as a general, all-round weed. There are several species of pigweeds, including the tumbleweed as well as our ornamental coxcomb. They are all annuals and native to America. I am here interested especially in the redroot, coarse-leaf variety, though there is a smooth-leaf strain that is about as good. This weed may be found growing in cultivated fields as well as in waste places. It is deep

rooted and an excellent soil improver if correctly managed. Aside from being a first-class mother weed and an excellent green manure, it is a worthy potherb and good for making hay or ensilage. Its scientific name is *amaranthus retroflexus*.

Lamb's quarter is also a good weed, fitting into about as many niches as the pigweed. It is an annual and a native of Europe. As a general rule, lamb's quarter may be found wherever pigweeds grow, and often as a companion of giant ragweeds. This weed is a good diver and brings up much food material to the surface soil. It is an excellent green manure and makes an ensilage second to none when mixed with legumes. It is also a good mother weed if controlled, and one of the best potherbs of the whole group (*chenopodium album*).

Then there are the two annual ragweeds, both friends of the land wherever they grow. Both the giant (*ambrosia trifida*) and common (*ambrosia artemissifolia*) are native to America. The common ragweed needs no introduction to anyone -- it is almost everywhere. The giant ragweeds, or horseweeds of the middlewest, are a bit more exacting, preferring edges of cultivated fields, open forest areas, or sunny coves where they can grow unmolested. But this weed will also take hold in hard land. It often reaches a height of seven or eight feet where the soil is fertile, and it may be easily recognized by the abundance of pollen which it scatters when in bloom. The common annual ragweed will produce a crop on the poorest of land. Neither of these two valuable weeds is used as human food. The lower animals go for them, though. Cattle seem to eat green ragweeds as a "vitamin"; and quail and other birds relish the seed. Some farmers who have tried it consider ragweed hay excellent forage. The giant ragweed has been used successfully for making ensilage. It is probable that one of the most important uses of the giant rag is to provide seed for many kinds of birds during the winter season, when bird food is scarce.

Our native annual nightshade deserves a high rating. This nightshade may be recognized by its white flowers, which resemble those of the potato, and by its black, berrylike fruit. This is a clean weed and works well for most row crops as a mother. It has a penetrating root system that forages well in the lower soils, and its spreading habit of growth makes it a good soil protector (*solanum nigrum*).

Then there is the milkweed, shunned by most folks because of the weed's milky sap. I have just read a Johnny-come-lately article recommending milkweeds as superior potherbs; the Indians knew that before the arrival of the white man in America and taught our Colonial ancestors its value. The milkweed is a vigorous-growing perennial, with a root system that wanders far from the base of the mother plant. There are several strains of this weed, each more or less preferring its own soil and location. Rarely is there a field or pasture where a variety is not found. Milkweeds are not soil robbers! I have yet to find a case where these weeds gave even superficial evidence of being harmful to

the crop with which they were growing. Most milkweeds will take hold on extremely poor soil if assisted a bit, and do a good job of opening it up (*asclepias syriaca*).

And now the sow thistle -- which is not a thistle at all; it is a wild lettuce. And it is far from being the noxious weed that some weed books would have it. The sow thistle is a native of Europe and made its way over here very shortly after the Pilgrim fathers. It is now a common weed in gardens and fields and in waste places in most communities. It companions well with most row crops, since the roots feed deep after the plant is once established. The sow thistle will often grow a fine crop of green manure in the fall, a point especially in its favor (*sonchus aleraceus*).

And the pusleys. The succulent purslane of my boyhood years -- and Sol Benson's cornfield. Purslane is a wonderful soil covering, but not easy to induce to take hold on extremely poor land. It needs fairly good soil to start it off, and that is why most farmers familiar with purslane consider it an out-and-out robber. Once established thinly over a field, the roots of the purslane gather much rich food material in the subsoil and bring this to the surface. And as Sol Benson found, the pusley opens up the ground for the corn roots, or for any other crop with which the weed may be growing. Purslane can be readily recognized by its reddish succulent stems, which lie flat on the ground. It is a native of Europe and an annual (*portulaca oleracea*).

The other types of spreading weeds differ very materially from purslane. Most of these spreading weeds belong to the spurges, of which there are many. Spurge likes to grow in hard ground, often forming mats in a traveled path. I once made a study of some of this spurge that insisted on growing in the middle of a well-traveled road. It is amazing what the roots of spurge will do to hard soil. I found the soil for several inches out from the weed base to be soft down to a foot or more. Where there were none of these weeds, the soil was stiff, hard clay. On severely eroded land the spurge certainly has a place. It may be hard to get started, owing to the difficulty of collecting and planting the small seed, but once established it will go it alone. The common spotted spurge (*euphorbia supina*) is a native North American annual.

Here I must introduce a good friend, the annual ground cherry, not because it is a superior soil improver but because it is such a clean weed in either field or garden. There are many strains of ground cherries, a few of which are perennials and consequently do not fit well into the rotation nor grow well as mother crops, as do the annuals. All of these weeds produce their fruit in a sort of capsule. The annual ground cherry, because of its bushy habit of growth, is a good soil shade aside from the value to be derived from its deep-feeding roots -- and its fruits which make the *right* kind of pies. I have seen these ground cherries taking hold on the poorest kind of land, which indicates their possibilities as conservationists (*physalis subglabrata*).

And the goldenrod (*solidago*), good for either gravelly or heavy soils, depending upon the variety. Some goldenrods seem to prefer stiff soils, though as a rule the tribe seems partial to the sandier land. Not long ago I found a piece of very heavy land which the goldenrod was doing a good job of fiberizing. Since goldenrod produces an abundance of seed, it should not be overly difficult to put the weed to work on peeled land or along the brinks of gullies.

Then there is the despicable cocklebur, possessing, like some humans, a few virtues despite its many bad traits. The cocklebur is one of our most persistent native annuals. By including it in this list of perfectly decent weeds, I do not mean that it should be planted on any kind of land. But farmers often have cockleburs in their fields, whether they like it or not. And it is good sense to make use of them constructively. Cockleburs will often do wonders to obstreperous soil if they are thinned enough to permit normal root development. Whenever the plants are scattered thinly throughout the field, cockleburs are not bad companion crops. Many farmers can tell you that corn and cockleburs go it well together (*xanthium commune*).

The familiar sunflower is a weed whose value to the soil is rarely appreciated. Sunflower value comes not only from the weed's ability to forage well in the deeper soils but also from the fact that the stalks, when broken up and turned under, disintegrate rather quickly. The amount of fiber added to the soil by a heavy crop of sunflowers, not to mention the abundance of plant food which these plants provide, will come near doubling that of any other green-manure crop. The sunflower is an annual and as truly American as the Indian (*helianthus*).

There are times when a most insignificant weed is able to prove its worth to the soil in a very conspicuous manner. Not long ago I came upon such a case; a case where annual smartweeds (*polygonum hydropiper*) were doing a good job of draining land. Of course, I had always been familiar with smartweeds. Mother used them to make brine for her pickles -- and kept me on the jump hoeing them out of her Kansas garden. I had long known that this weed also grows where the land is boggy or poorly drained. The patch of smartweeds I refer to here was growing on a strip of very tight land; eroded land that had been crudely terraced and then left to go its own way. Because of the impervious condition of the soil, rain had formed pools back of the ridges, and most of this water remained there until it evaporated. But where the smartweeds had taken over, the smartweed roots fiberized the soil and thus provided for natural drainage. Many farmers have just such conditions scattered through their fields. I mean those low, tight spots where water stands for a long time after a rain. Smartweeds might come to their rescue here if they were to give the weeds a little help. Annual smartweeds are not difficult to eradicate once one is through with them.

And do not forget that the annual wild morning-glory (*ipomoea*) is not a bindweed (*convolvulus*), though the two are relatives. The annual morning-glory, another native American, is really not a pernicious weed. While these morning-glories should perhaps not be planted in fields that are regularly cropped, if they move in of their own accord they should be controlled and thus forced to serve as a valuable mother weed. And morning-glories will do a good job on extremely poor land; that is, land that is suffering from a lack of soil fiber. Many farmers know that corn and these morning-glories get along well together.

In addition to the weeds discussed, there are a few others that deserve mention, though they may not be outstandingly beneficial from a soil-building standpoint. One of these is the common wild lettuce (*lactuca canadensis*), a familiar roadside weed and one which has the ability to penetrate hard soil almost as well as the famous legume, sweet clover. And the shepherd's purse (*capsella bursapastoris*), a member of the mustard family. The shepherd's purse makes a fairly good winter green manure in some southern sections. Then there is the dandelion. The dandelion may be a pest in the lawn, and in some parts of our country in the field, but in most regions it makes a good mother crop in either the garden or field. In England dandelion is ranked high as a soil-improving weed.

There are many wild legumes, most of which are friends of the soil. These include some of the lupines, the button and burr clover, and the wild vetches and peas found in so many parts. Many of these will grow excellently with non-leguminous weeds, and in the weed-legume combination in land building they surely have a place.

"Yes, but supposing I decide to use weeds in building up some of my poor land -- how do I go about it? This land I'm thinking about is worn out -- dirt plumb gone. Most of it, anyway. Not many weeds on it either -- they won't grow there. Now how am I going to make 'em grow?

When folks start asking those questions, I know they are becoming weed conscious in the right direction. It is true that much of our once-rich farmland is so poor that practically all of our soil-building weeds refuse to make much of a growth on it. In most such situations the weed seeds are there and the seeds germinate, but the seedlings soon die or, because of a lack of nourishment, make little growth during an entire season. They are too weak to reach down into the lower soils.

Here is one place where I heartily approve of the application of some strong stimulant to the land -- to give the weeds a boost during their early stages of growth. By working a small amount of some concentrate (almost any of those now being so highly advertised) into the soil, and then broadcasting the weed seed over the land after the soil is settled well, a good growth of weeds often may be obtained.

However, there are situations where even an elixir won't do much in the way of starting the young weeds off. But where it does work, it will keep the weeds going until they have strength enough to forage for themselves.

In planting weeds, a farmer must keep in mind that weeds are very decidedly *weeds.* Which is to say that their habits are wild. The seed should be scattered over the surface of well-packed or hard ground, not on land that has been freshly plowed. The best time to plant weeds is just before or during a rain in early spring, or in winter when there is snow on the ground. Scatter the seed over the snow and forget about them. While many weeds, such as sunflowers and lamb's quarter, plant easily, some of our best weeds are unpredictable. If they don't grow the first time, you may have to "try again" several times.

Bringing a piece of land back to permanent fertility is probably the most difficult of all farm operations. Too often the farmer fails to make a go of his soil building because he doesn't acquaint himself thoroughly, before starting, with all the adverse factors he is going to have to fight. He gets discouraged because he does not see the size of the job of remaking land that has been weakened for fifty or a hundred years. He has more than likely been schooled to expect the quick response that land makes to stimulants. He forgets that now he is *building* for permanency, not merely *stimulating*.

Remember: it takes Nature, working from scratch, from five hundred to a thousand years to build one inch of fertile, perfectly balanced soil. If the land builder would always keep that fact in mind, perhaps he would not want to give up so quickly when he cannot see the slightest progress in his labors. Not, of course, that he will have to struggle for years and years before seeing beneficial results. But to complete a good soil-building job calls for much sweat and time. The valuable work is going on under the surface, but signs of this are often slow in appearing above ground. Only stimulated land, as a rule, will reveal spasmodic responses.

There are really only two vital factors connected with land improvement once the mechanical work has been completed: lime application in practically all cases, and rock phosphate in many of them; and filling the soil with organic materials so that these may be in the soil at all times and at all stages of decay. On very poor land much of the first application of lime is going to be lost, and there isn't much the farmer can do about it. In depleted soils there is no sponge structure. Unless the soil happens to be extremely tight, a very large portion of the lime will be lost through leaching. Yet there must be ample lime at the beginning else not much of a green manure can be expected, especially where legumes are employed. And it is the green manure which must furnish the fiber to rebuild the soil sponge. The green crop also provides the food for the other agents of the soil world that are waiting to move in.

Getting the sponge structure may prove a difficult task, yet rebuilding that sponge structure is very close to the whole of land improvement in the United States today. Not uncommonly, even after two or three excellent crops have been turned into the soil, the land does not reveal any change for the better. At this point in his work it is well for the farmer to pause and try to recall just how long that particu.lar piece of land has been under cultivation. Maybe fifty, maybe a hundred years, and the soil has been deteriorating all of those years! A farmer can in many instances consider himself fortunate if he sees any marked change in such land short of six, eight, even a dozen green-manure crops, although there are often situations where the subsoil is such that it is possible to build a good surface soil from it with only three or four lush crops. Often it may be advisable to give a second and light application of lime after the land starts to show signs of real mellowness. That means there is probably now enough fiber in the soil to hold the lime.

The farmer will generally find that his best bet is to work with mixed green manures. He may have to try out several legumes before he finds the one or ones best suited to his situation. In all events, he should strive to keep a soil-improving crop on the land every growing month of the year. And don't forget that nothing can surpass inoculated legumes companioned with deep-foraging weeds.

Harvesting crops from poor land that is under specific treatment is as a general rule not advisable. Neither should such land be pastured until it is well on its way toward normal productivity. Best to put everything back into the land until normal fertility is restored.

14. Nature's Togetherness Law

ONE fundamental law governs inexorably every phase of organic life: Nature's law of the togetherness of things. This law of togetherness is as vital in practical agriculture as it is in the profoundest nature manipulation in which the human can play no part: for instance, in the manufacture of food in the leaf factory. This food factory is still beyond man's best ingenuity. Oh, man can help Nature in sundry ways by improving the environmental conditions of the plant; but he can take no part in the technical process of photosynthesis. Let there be the slightest interference with just one of the factors involved in the manufacturing of food, and the work of the leaf factory is slowed down; it may stop entirely.

That is why the law in operation there is the *togetherness law*. No matter where this law may be operating, there is certain to be a group of factors operating together. Often the number of these factors is close to legion, yet no matter how many there are, all must work together harmoniously. That is the heart of the law -- harmony. And that is why an understanding of the law in any specific case generally makes it possible to substitute *constructive harmony* where before there was baffling discord.

Though we may not be conscious of it or even wish to admit it, our success or failure depends very largely upon the understanding we have of Nature's law of togetherness, and our adherence to it. Every phase of agriculture is dependent upon the workings of this law. It is well enough to talk about the mechanization of crop production, but unless the machine is made to work in harmony with the togetherness law there will be trouble. The agricultural machine can be made to work with Nature instead of against her -- even those colossal machines employed in "building a farm in a day." It is not the machine that is at fault where this cooperation does not exist; it is the manipulator of the machine.

An ideal soil world, with all the factors functioning healthily and efficiently, is the togetherness law in superb manifestation. In such a soil there is supreme harmony: the necessary mineral elements are there, and the necessary gases. There is the indispensable fiber to regulate structure and to provide food and warmth for the live factors. These factors, along with a host of others all working together, furnish and prepare the ingredients that are to be sent up to the food factory of the leaf, where they will receive the final processing. Again, let anything interfere with the soil-world laboratory -- interfere with the togetherness law down there -- and discord becomes evident in many directions: the soil itself is thrown out of balance; the leaf factory may be forced to turn off an unbalanced food product. Animal life, which is

at the mercy of the plant world, finds itself responding with weakened body structures. The animal world gets sick -- and all because something interfered with the togetherness law in the soil world.

A few farmers or even a few nations ignoring this law of togetherness in maintaining soil fertility and in the production of food, will not upset the harmony of the world as a whole; but when the agriculture of the entire world is disturbed at the same time in this manner, you have a very different situation. And that is exactly where we are now. In America, in our frenzied efforts to take advantage of high prices for agricultural products, we are mining our soils instead of farming them. In the manipulation of our soils, save for a case here and there, little thought is given to the law of return compensation. In many European countries, before the late war, there were many farmers in every country who methodically recognized and practiced the law of return compensation. Since the war, however, few of them have resumed their constructive routine, being forced in many parts to soil stimulation in order to provide a quick supply of food. Japan and China, ancient models of some types of Nature farming, are also out of gear, either because of the inevitable aftermath of war, or because of the continuous effects of war.

It is a little difficult to get some American farmers to understand why or how the togetherness law of Nature can possibly mean anything in the business of farming. This is due largely to the fact that America is and always has been machine minded; always has been an industrial nation. *That includes her farmers*. Our colonial forefathers, with few exceptions, were industrialists. There were a few dirt farmers on the Mayflower and on subsequent ships, but as a rule the colonial settlers came from the small urban districts. They had been shopkeepers, small-business folk, preachers, teachers, lawyers.

In the New World for a lengthy period there was little place for the shop as it had been known in Europe; not much place for even small business. Preachers and lawyers and teachers there were who were engaged in their professions, but even they had to turn to the soil for much of their living,

And they looked upon their soil as little more than mechanical food factories. Machines of most kinds were primitive in those days, of course, but the machine mindedness was much like ours of today. Cultivated land must be as clean as a shop counter.

The Indians in a large measure were the agriculture teachers of our colonial parents. And the Red Man was a pretty keen agriculturist. The colonists declined to accept all of his "crude" wisdom, however.

It is true that the Indian's Nature wisdom was mixed with superstition, but even so his agriculture was sound. It was sound because he listened to the subtle voices of the earth. Our forefathers acknowledued their

God as the giver of gifts, but saw those gifts only in the abundant harvests. The Indian gave thanks to his Great Spirit for the land that gave him his corn; the white man gave thanks for his corn. The one was a naturalist, the other an industrialist. And across the decades from that day until this our farmers have ever had their eyes on the corn, not on the soil that is responsible for the corn.

Jim Lucas, an old college friend of mine, is a good example of industrial America. Jim has always had a machine mind. Never has he been able to see how this natural togetherness I talk about can have any connection with the efficient operation of farm machinery -- or in the production of livestock and grain. It was many years after we had both left college before we met again -- and those years hadn't changed Jim Lucas a bit.

"But, Joe -- you still don't seem able to see that now more than ever we're living in a *mechanical* age!" he chided me impatiently. "There is no longer any place for your small, half-neglected farm -- or your Nature business either! Large acreage with special machines to do the farm work -- that will be our agriculture of tomorrow. Two men doing the work that now requires twenty -- "

"Wait a minute, Jim! " I stopped him. "Are you still trying to tell me you can't understand how our very existence is dependent on some very definite laws of Nature -- "

"You and your Nature stuff ! That's all very well in theory, Joe -- I'm giving you cold-blooded facts! Starving people are looking to America for food. We've got to feed 'em. We've got to mechanize our agriculture on a large scale; make our land produce to its limit -- '

No; the Jim Lucases don't see or don't wish to see how the togetherness law functions in the most rudimentary agricultural operations, as well as in the most complex. The fact is that all of us unconsciously, through trial and error, if we have been growing things in dirt, are constantly discovering bits of the law. We learn that we must *do* certain things and *not* do certain things if we expect to harvest a crop of beans or potatoes -- or a crop of desirable pigs. We accept that much of the togetherness law without questioning it. But most of us are inclined to stop short. We aren't willing to admit that we can produce more and better beans and potatoes and pigs if we will learn and practice more of the togetherness law. We aren't willing to learn how we can improve our production in both quality and quantity, and improve our land at the same time, simply by following the mandates of the togetherness law. We aren't willing to admit that the law enters very directly into land preparation, natural soil fertilization, and into every phase of crop treatment from the planting of the seed until the harvest.

Not long ago I came face. to face with a proposition where a very

considerable knowledge of the togetherness law would be needed. I was examining a small area of abandoned land, to see if it could be brought back to production again economically. Superficially, at first glance, the land looked as if it never could be other than abandoned land, no matter what one might do to it. It was not merely sick; that land appeared to be completely dead. It was just a stretch of barren, gullied and cracked subsoil that had been uncovered by erosion. It was situated on a fairly steep slope, too, with a large number of pretty deep gullies.

Before I was half through with my exploring, I found signs aplenty that the land was far from dead. It was sick, but not too sick to be cured, and that only by giving the togetherness law a bit of the right kind of assistance. How did I know that? Simply by what the togetherness law had already done and what it was fighting desperately to do.

Even the worst of weed haters would have been forced to pay the despicable weed a measure of respect had he walked with me around the edge of that abandoned field. He would have been forced to see how hardy weeds were slowly eating their way into that stiff clay -- and completely transforming the soil as they went. The weeds were inching their way forward very slowly, but they were going forward and not fighting an unproductive battle. The present process of rebuilding was entirely too slow, of course; but the law was at work constructively and needed only man's help to bring about satisfactory accomplishment in a reasonable period of time.

After I had finished my survey, I went to an oak tree that stood a short distance from the eroded field, sat down in the shade, and imagined I had the weed hater there beside me as the owner of that land; or of any other similar piece of land in the country. There he could see how to bring that piece of land back to life simply by cooperating with Nature's togetherness law. And it wouldn't take a half century to do the job, either.

It would be helpful to call in a piece or two of build-a-farm-in-a-day machinery, to get rid of those gullies in short nonce. But that wouldn't be possible. But we could brush the large gullies; build brush dams in them. There was an abundance of brush not far from the field and growing so thick that a large portion of it could be removed without starting erosion there. Cutting and hauling the brush would be an off-season job; a winter task. Then there would have to be a few terraces of a sort where the land was steep. Nothing extensive; just a few strong ridges to help hold the soil until the fiber should be put back into it. There should always be the minimum of soil stirring on a slope like that; and all plowing, of course, should be done contour. Every move must be directed toward getting a cover back onto the land. Those weeds that were eating into the edges must be helped to spread over the entire surface. Simply gathering and scattering the weed seed wouldn't be sufficient. The land would have to have special treatment

before the weeds would take hold. That would mean an application of well-rotted barnyard manure, or a commercial stimulant, preferably one rich in nitrogen.

But first of all we would have to apply two or three tons of ground limestone per acre, and a fair dose of rock phosphate. On this particular piece of land it would be better to start work in the fall, provided there was sufficient moisture. Otherwise the beginning work should be done in late winter or early spring. The region will naturally govern the best seasons for such soil-building operations.

And we want to gather all weed seed we can get hold of, especially seed from those weeds that are already growing around the edges of our field, no matter where the field is located. If we begin the main work in the spring, it is still better to apply the lime and phosphate in the fall, though these also can be put on in the spring if necessary. Better to put the elixir on -- if we use one -- just before we plant our domestic legumes, which are going to be grown with our controlled weeds. Yes, we want at least one hardy legume to grow with our weeds, and that legume inoculated, of course; to provide some quick nitrogen. It doesn't make much difference when the weed seeds are planted, so long as they are there to start early spring growth. And remember that most weeds object to having the seed covered. Just scatter the seed over the surface of the ground.

That simple procedure should help us get a good weed growth started; help us get a soil-improving cover on the land. That was what we were after in the first place. We have a right to expect the project to succeed, because we are cooperating with the togetherness law. On an extremely poor piece of eroded land we may have to make our attack two or even three times. But once one gets several clumps of vigorous weeds along with some legume patches growing on the erstwhile dead slope, one can figure the problem more than three fourths solved. The togetherness law from then on will usually carry through alone. What is ultimately done with the land will depend on the location and the farmer's desires. In any case, it should not be permitted to lose its sponge structure.

Our understanding of the togetherness law can perhaps never be complete, but, fortunately, for reasonable success in agriculture our knowledge of the law need not be extensive. For instance, we can well leave to the expert the intricacies of animal breeding, but after the specialists have given us the new breeds of livestock, it is up to us to master the togetherness factors involved in propagating the new breeds and maintaining their high standards.. The same holds equally true with plants. Individual farmers don't need to go into the intricate details required to develop a new strain of wheat; but every wheat farmer should know how to grow and maintain the purity of the grain. The only difference is that the "breeder" in every case will need to have a deeper understanding of the law.

I doubt if any man of modern times -- or any other times -- ever had as clear an understanding of the law as had Luther Burbank, especially in the plant world. Burbank recognized the togetherness law and developed his marvelous creations by adhering strictly to it. Those seemingly impossible marvels that Burbank brought forth! As one of Burbank's several cooperators -- one of those fortunate people who were given the privilege of testing the new strains under varied conditions -- I always received a specimen or two or three of many of the new plants as soon as they were released: enormous Shasta Daisies; blackberries as white as snow and seedless, which would *really* melt in your mouth. I recall one particular plant whose leaves were fifty times as sweet (according to Burbank himself) as the most concentrated sugar. The father of these wonders was not Luther Burbank the "plant wizard," as he was commonly called, but Burbank the penetrating scientist and naturalist, who was able to prove that marvels could be brought about merely by understanding and practicing the law of "Nature Harmony," the togetherness law.

One of Luther Burbank's soundest convictions never appeared in print during his lifetime: that all agriculture learning should start with a clear-cut study of Nature as the basis of all agriculture. In other words, start with a thorough study of the togetherness law. Schools of agriculture would have scoffed at the idea then, as they would today. But Luther Burbank knew his practical agriculture, as he knew his Nature. He knew the relationship that must exist between the plant and the soil for success in crop production.

My claim for weed values rests entirely upon this basic law of the togetherness of things in Nature. It would be contrary to Nature's law of harmony, for instance, not to have any means of bringing back to the surface the food materials that constantly trickle into the lower soil regions. It is true that capillary water lifts much of this material back to the surface, but soil conditions must be right before capillarity can take place efficiently. Deep-foraging weeds will fiberize the lower soils and thus help capillarity. And weeds are not robbers, save in some instances where they are uncontrolled. Instead, they are Nature's most important means of preventing waste!

The fact that many common annual weeds can be put to work constructively does not by any means indicate they are constructively valuable in all situations. Such a claim would be ridiculous. But it is even more ridiculous to insist that all wild plants are injurious when growing with domestic crops -- simply because they are "weeds." A study of the togetherness law should convince any farmer -- or anyone else who is not too poisoned with bias -- just where and how the so-called weed can be useful in carrying out the law. To help him do that, I have written this book. Blind antipathy toward weeds will get us nowhere. But a sane study of the weed as a part of the law involved in the maintenance of soil fertility can be revealing to any open-minded

person.

THE END