Your FARM

A Digest of Agriculture and Farm Management for Progressive Farmers

VOLUME 2 APRIL, 1944 NUMBER 6

Do Farmers Plow too Much?

Condensed from Better Crops With Plant Food

By Wm. A. Albrecht

THIS question comes to the fore now because of recent economic disturbances. When natural power in the form of concentrated sunshine collected on the farm and released locally through horses was replaced by machinery using imported liquid power collected in the ages past and stored in the great depths of the earth, the war's disruption of the far-flung distribution of fuels and oils and its deletion of our sources of rubber were not anticipated.

These disturbances, both in terms of mechanics and economics, have led some to believe that high costs of plowing would be best relieved if plowing were discarded altogether as a farm practice. This belief is reinforced by successes under reduced plowing in some areas.

In the face of such a rising belief, the practice of plowing deserves a review of both its vices and its virtues. It deserves more searching thought than attention merely to those aspects that are psychological and economic. It deserves more than tabulation of its values.

Productivity and plowing had many interactions and interrelations for the welfare of humans long before psychology and agricultural economics obtained academic classification, or a place as controlling forces in national policies. Production and plowing will, in all probability, still be basic when impending international changes bring many of us back to a much closer relation to the soil than we now believe we have.

We need to plow less on some soils. We need to plow more and deeper on others. We need to learn that the differences in degree of soil development according to climatic differences are factors in determining how important the plow is. The farmers in Ohio haven't invested so

much in clod-breaking machinery without provocation. The "one-way" land preparer of Kansas is not so successful purely because of its unusual mechanical design. The soil physical conditions, premised on chemical aspects controlling them, have some role in these differences between the forest-bearing soils and those of prairie-grass growing areas.

There is need to call out against excessive plowing if it occurs, but it is well to note whether it is the advent of the plow or the exit of the soil fertility that needs correction in improved soil conservation thinking.

Certainly soil conservation is more than simple mechanics, simple physics, and simple psychology. It calls for some real friends of the land who will try to understand soil and crop production in their fundamental connections, to say nothing of the tillage of the soil in all of its ramifications.

Fortunately, the plow is merely a tool in this whole matter under discussion. The concern about the practice of plowing is one that brings into question the judgment of him who is using the tool, and the purposes he has for it in relation to the soil as a national as well as an individual asset. One cannot condemn the rifle or the pistol as tools because these are now being used in war, when they can render so many more desirable services. Nor would we condemn the mechanics of the automobile when in its human destruction the fault is not one of the machine but rather one of "the nut that holds the wheel."

Our knowledge about plowing and our understanding of soils and not the combination of simple moldboard, share, and beam, as handiworks of the engineer, are on trial.

Have you ever thought that plowing may be different as the soils, the vegetation, and even the animals are different? A few wild turkeys and a few squirrels were the population limit in the forest for the Puritans. Those same soils, cleared of the forest and cultivated were soon abandoned as agricultural land by the pioneers who were willing to face the hazardous movement westward.

All of these facts have not commonly been related to the low nutrient delivery by those soils of the lime, the phosphorus, the nitrogen, and other chemical elements needed to make nourishing vegetation.

Soils that had come down to the low fertility delivery represented by the forest level of vegetation before man plowed them are offering so little for animal body-building that the plow must stir them. Every possible help is needed to encourage rapid release of the essential mineral nutrients from the meager stock of organic matter within them. Woody vegetation and a woody composition of any plant species, including farm crops, are characteristic of "the underprivileged vegetation," on such soils unless they are plowed and stir-

red to increase the rate of decomposition within the soil of residues of plant generations gone before, or are treated by fertility uplifters in chemical fertilizers and other manures.

On the prairies, where lesser rainfalls have not developed the soil into what is old age, or maturity, so far as leaching and nutrient losses are concerned, the vegetation is richer in protein. It is also more concentrated in minerals. The soil itself and not the plowing of it determines these conditions.

In going from more rainfall to less rainfall or from eastern to western Kansas, for example, the protein concentration in the wheat goes up. We call it "hard wheat" because, as we commonly say, it grows in regions of lower rainfall. More properly it is "hard wheat" because it is grown on those soils that have more nutritional minerals for the micro plants within, and for the macro plants above them.

These mineral supplies are producing not only protein-rich forages in legumes like alfalfa, but also protein-rich grain in non-legumes like wheat. Such soils have lime and other minerals nearer their surface where plants can get them to make vegetation rich in calcium, encouraging nitrogen fixation, protein production, and other mineral contributions. We surely cannot subscribe to the belief that all "principles valid for the forest are valid for the fields," when the soils differ as widely as they do under forest and under prairie.

Mineral provisioning of the plants by the soils is now more clearly understood. The ideas coming from the soil mineralogists, the colloid chemists, the plant physiologists and other fundamentals of netural laws are helping us to visualize the processes whereby plant nutrition is brought about and what plowing does for it.

It was once believed that plant nutrients were coming from the soil minerals in true solution and were caught up as the plant was taking in and passing on this solution. Studies in plant physiology have recently given us the concept that the nutrient ions move according to physico-chemical laws dealing with the kinds and concentrations of the nutrients on the clay; with the different nutrient ions within the roots in terms of concentration, absorption, and the elaboration into the plant compounds; and with a root membrane interposed between the clay colloid of the soil and the complex colloid within the root.

Plowing has been much confused with water movements from the soil through the plant, possibly more by imagination than by actual demonstration. Water moving into the root follows its laws of ionic and molecular behaviors. These are quite different from those of capillary movements. These laws seem to suggest that there is little travel by

water as a liquid and that the plant has little to do in the way of control.

The concept of the plant as the channel by which soil forces holding the water are balanced against air conditions dissipating it seems to be logical when we remember that plant stubbles and such dead plant parts transpire water from the soil. Plowing has not been connected with the newer concept that nutrient movement from the soil to the plant may be occurring independently of these wanderings of soil water.

Plant nutrient ions, like calcium, magnesium, potassium, and others, are held on the finer clay part of the soil in an adsorbed form against loss by water. They are, however, exchangeable by other ions, particularly hydrogen.

That hydrogen is the main item, which the plant exchanges to the clay for what ions the clay offers in trade as plant nourishment, is now fairly well understood as the mechanism of plant feeding. This occurs through a most intimate contact by plant roots with the soil particles. Plant roots extend themselves through the soil to get their nourishment by means of this trading process. Little credence can be placed in the belief common only a decade ago, that the soil gives nutrients to the plant. The performance fits more nearly into the country boy's understanding of how we get milk from cows, when he said, "our cows don't give milk, we take it from them."

The effects by the root as a nutrient gatherer may extend through a distance from the root of but a few layers of clay particles. This is limited probably to distances in millimeters. The root systems' effects as nutrition are also commensurate with the total root surfaces.

Accordingly, then, the densely matted collection of roots under bluegrass takes more total nutrients from the colloidal part of the soil than does the sparsely rooted crop, like soybeans.

Each root leaves the soil in its immediate zone of activity exhausted to a very low level. The advent of the root has opened channels by which nutrients could go out and energy compounds come in. In fact, it brings about, either directly or indirectly through its own decay and bacterial activities, a reduction of the compounds of the soil about its area of penetration. This reduction may be indicated by a color change from the customary reddish to the drab gray soil, much like we know it to be brought about by waterlogging.

One might expect roots of the next crop to follow successively in these old exhausted root channels, if the soil were not stirred. Plowing serves as a mixing agent to redistribute this reduced clay amongst those clay portions that were not so nearly ex-

hausted of their supplies of nutrients.

That plowing is more essential for this purpose than we commonly believe is indicated by the increasing report of observations of deficiency symptoms suggesting plant diseases of some crops, such as cereals and some legumes in such a close sequence as to reduce the amount of plowing.

Soils put under full-pastured barley as nurse crop for summer-pastured lespedeza to be disced and to go to barley again in another annual cycle with only this limited tillage are showing nutrient deficiencies that are not prevalent under plowing.

Plowing serves to shuffle the exhausted soil surface into contact with other surfaces not so depleted. It is apparently significant for crop nutrition that such soils be plowed between even two successive crops.

It may be true that the farmer cannot appreciate the colloid chemistry and low levels of nutrients in the soil concerned with the crop disease symptoms, but he does appreciate the improvement in the crops after he plows.

Plowing serves for nutritional improvement of the crop by mixing the different clay areas in the soil. Dr. Graham's researches at the University of Missouri have recently pointed out that plowing may be instrumental for better plant nourishment because it shifts the connection between the surfaces of the clay and surfaces of the silt, or the larger mineral particles of the soil not commonly considered so active as exchange performers.

He demonstrated that the nutrient ions in the mineral silt moved to the clay in the absence of plants, and that plants picked them from there to their better growth advantage than from the minerals directly. Periodic shuffling of the clay in contact with the surfaces of the silt particle, or after the clay has become saturated during the period of contact for a few months, is the means of keeping more of the clay loaded with nutrients to be passed on to the plant root.

Plowing is the means whereby enough clay in the soil picks up enough nutrients from the silt, and other original reserve supplies of fertility, in active forms and in amounts sufficient to give us the quality and the quantity of crops we need to produce.

This then is the picture of plant nutrition as we visualize nutrient elements coming from the soil. It is a chemical performance within the soil to which plowing and other similar mechanical measures contribute speed. The nutrient ions adsorbed on the clay move into the root in exchange for hydrogen ions coming from the plant root to take their place on the clay.

The clay on becoming more extensively saturated with hydrogen ions — the active producers of soil acid-

ity — passes them on to the silt and to other mineral soil particles as the means of weathering the nutrients out of these original rock forms. Thus, by means of plowing, the clay is rapidly reloaded with a stock of nutrients, or is buffered against what we have been viewing as dangerous, excessive acidity, but which is in reality dangerous soil fertility exhaustion.

As has been demonstrated by Dr. Carl E. Ferguson at the University of Missouri, this exhaustion of the clay's nutrient supply would occur in but a few crops were it not for the silt. It is through these steps — rock to clay, clay to plant — that the nutrients pass. It is in the reverse direction — root to clay, and clay to mineral — that the weathering effects travel for soil depletion of its mineral nutrient supply. Plowing increases both of these reciprocal movements of the chemical elements, and thereby facilitates food production.

Plowing merely hastens many of the same processes that are occurring more slowly when "the land is resting." When land must be allowed to rest in order to boost its productivity back to economic levels again, this is merely proof that the fertility supply on the clay is exhausted so nearly to completion and the mineral reserve of fertility has fallen so low that the interactions between the clay and the minerals are too slow to move enough nutrients on to the clay surface.

Plowing isn't the cause of the depletion of the fertility supply. Depletion occurs because of the fertility removed within the crop hauled off. The plow is not the exploiter; rather, it is the farmer. The plow is merely the tool that facilitates his exploitation at a faster rate and over more acres than before the plow was given him. The plow has helped him to feed many of us too far removed from the land to appreciate its exploitation.

Some of our plains have been exploited to such an extent that even the plow can't substitute for the time needed to restock the clay from the mineral reserve. These soil processes are too slow in rate, and too limited in amounts of fertility mobilized, to finish, for example, one wheat crop in June and to germinate to a good start another crop by the succeeding October, even with the help of plowing.

Here is a suggestion that any accusation of the plow as a responsible agent for soil deterioration is a misplaced and unfair condemnation. Such accusation would still seem just, even if by the best of science we should lay bare every principle of physics that plowing of soil involves. Even if we should dispel the belief that "the exact physical effects that follow the operation of the plow have never been subjected to

scientific scrutiny," the plow might still be listed for its exit as an implement.

Plant production is more than applied physics and particular mechanics. It is a matter of delivery of the required plant nutrients. The soil processes providing nourishment within the soil are slowing down because of soil fertility exhaustion more than through bad mechanics.

Shifts in the kinds of nurse crops and in the kinds of legumes in order that we might accept substitute crops are very striking evidence of soil exhausted of its nutrient reserves. Not only is the slowing down reflected in grain crops by their alternation between a crop and a crop failure. Older apple trees become alternate-bearers. Older cows pastured on and fed products from many soils of declining fertility go on similar biennial schedules in reproduction.

Surely the plow isn't to be blamed for what happens in the subsoil under the apple trees or for nutritional irregularities on permanent sod pastures that come to light in terms of breeding troubles in cattle.

If we are to bring the plow into this picture of "the debacle into which our American soils have drifted," the case could not be rested on the contention that while the farmer's "reputation for smoothness and neatness of the plowed field was developing, no thought was given to the possible connection between smoothness of the land surface and exclusion of the rainwater from the soil."

Antediluvian ideas about water in the soil, about the wet subsoils under freshly incorporated green manure, interpreted as interrupted capillary rise rather than "sweat" from the respiring and decaying organic matter, don't convict the plow except for those unfamiliar with more recent soil science.

Plowing and crop production are more than water problems. No one will deny that even these are serious enough. Declining soil supplies of fertility are making the water problem worse as we allow the plants to starve for nutrients while they are wasting their water transpiration and carrying on within themselves little or no construction of the organic, nutritional complexes they are intended to synthesize.

Water will be the lesser of the soil troubles when we understand nutrition, and when we feed the plant so that what water we have will be used most effectively for crop production.

Starving plants do more damage than merely wasting water. They invite attacks of bacteria and fungi to cause much that is regularly called "plant disease." Starving plants are symptoms of soils that are no longer stable in their structural conditions, known as granulation. Their surfaces are hammered flat with the first dash of rain and are moved off as erosion.

To the eye and mind observing

soil fertility, numerous other plant and soil symptoms are clearly visible. For such an observer, the real debacle is that we continue to exploit our soil resources without giving thought to the fact that these unrecognized and unappreciated chemical changes within the soil are basic to erosion, to disturbed agricultural economics, to distorted national economy, and to a disturbed national health.

This larger problem is aggravated by the plow, but also by any tool, either mechanical or psychological, that encourages and permits continued exploitation of the fertility of the soil in the same manner as we mine and consume many other resources. The land is the basis for our existence. "Mining" performance has brought us to where it is difficult to change and to shift into using the soil only as a site for soil fertility "turnover" by putting in about as much of plant nutrients as we take out in crops.

This shift to letting land rest, to putting out the land to grow cover, to encouraging organic matter restoration, to purchasing fertilizers as a definite program of returning almost the ash equivalent of the crop removal demands more than that the farmer quit plowing.

This shift to squeezing out the charges assessed against an unearned increment, and to going back to an acre value of the soil as a producer after deducting costs of fertility maintainance, labor, and investment carriage even at the low rate acceptable to the man of the soil whose hope for security is still pinned to the land, is a change that calls for more than invention of a scapegoat in the form of the plow.

The understanding of the processes in the soil as a producer of our foods has become a challenge to an increasing number of people. Friends of the land are multiplying so that with a knowledge about and deep concern for the soil, they will not long leave unanswered the question, why plow?

* * *

Did You Know—

☆ THAT THE PRACTICE of planting four kernels of corn per hill descended from the red man who planted — one for the squirrel, one for the crow, one for the worm, and one to grow. — *Kentucky Farmer's Home Journal.*

* * *

☆ ABOUT half the growth of new saw timber in the South consists of four species of pine. — *Western Livestock Journal.*