CAN WOOD CONTRIBUTE TO SOIL IMPROVEMENT?

A. C. McIntyre
Soil Conservation Service
Upper Darby, Pennsylvania

The title of this paper, "Can Wood Contribute to Soil Improvement?" was purposely worded as a question. I think the answer is a positive "yes" but I realize there is need for more research before full answer can be given to the obvious corollary question, "how?"

When Mr. Bruto asked me to present a paper I mentally declined because of apprehension about being considered an authority on the subject. I am not an authority. My research on the subject has been confined to the library, and talking to many who have done field or laboratory research or with farmers who have learned by trial and error and who have successfully used wood in one way or another.

As a forester I have been concerned with the multiple uses of wood. Sawdust and shavings have been used in many ways but no listings include agronomic recommendations. The question of possible use was impressed on me when a farmer, referring to wood, said "that's the cheapest organic matter I can get." This farmer was plowing down scrub oak stems along with associated vegetation such as blue berry, sweet fern, and laurel. He had the resultant soil mixture analyzed and was told that samples ran about ten percent organic matter. The soil was DeKalb, derived from sandstones and shales. It was light and droughty, a soil type representative of hundreds of abandoned farms. Farming, (plowing and cultivation), had burned out the virgin organic matter. With declining productiveness fields were abandoned and woody vegetation began to re-establish itself on the land.

It is the usual practice, when reclaiming abandoned and wooded fields, to remove all trees and shrubs before again plowing the soil. This accepted routine was not followed by W. P. Starkey of Buck Hill Falls, Pa. He disced and plowed the thickets of scrub oak into the soil and immediately planted spinach and snap beans. He used only one thousand pounds of 4-8-6 fertilizer per acre. The pay-off can be judged only by the fact that each year he has increased his acreage by following the same procedures.

A neighbor of Mr. Starkey's, observing results, acquired comparable acreage and has grown potatoes and snap beans. This farmer, A. T. Blakesley, of Blakesley, Pa., plowed out a new 100-acre field last fall. He dressed the field twice with lime, using one thousand pounds to the acre each time. When potatoes were planted last May a thousand pounds per acre of 5-10-10 was applied. These two instances, where large quantities of wood were directly incorporated into the soil, are cited only because they are dramatically illustrative of the fact that wood used as organic matter has had no toxic or detrimental influence.

This needs emphasis because there is prevalent an old wife's tale that wood sours soil or makes it acid and should not be used. College professors and many farmers have told me for a "hear-say fact" that wood makes soils sour and should not be used. They had no personal experience but accepted the statement as being true.

This false belief that wood is injurious to soil may account for its not having been more generally used on farms as a mulch, or plowed in to increase or maintain organic content.

The farmer's comment that wood was cheap organic matter, and the fact he followed this up with the statement he planned to plow down more scrub oak when the humus in the older fields was down to 3 or 4 percent, prompted me to seek what research had established for the agronomic uses of wood. I, too, had heard that wood soured the soil. I was skeptical of its use. At the library I found that the number of published research reports on the possible agronomic use of wood was limited. Most surprising of all was the limited scope of the studies, most of them being confined to determining fertilizer values and establishing that the lack of nitrates during decomposition of the sawdust was primarily responsible for poor growth of plants in pots or plots. Nearly all of the reports seemed to establish the fact that wood could be used, even as hay, straw or any other vegetative material, to add humus to the soil.

Before we could begin to evaluate wood in terms of its possible contribution to farming, some basic facts needed to be learned. First, we would need to know just what was meant when the words soil organic matter or humus were used. It is accepted that there are two kinds of humus: nutrient humus and long life humus. Those names are descriptive. Nutrient humus is what the farmer draws upon when he turns down a cover or green manure crop. It is the short lived form of organic matter lasting but a few summer weeks after being plowed down. Long life humus, as the name implies, is that form of organic substance most desired. It is the humus that results from a combination of lignin with bacterial proteins. Wood, of course, is high in lignin. It is the high lignin form of humus that farmers should strive to build up on their soils.

Soil scientists and agronomists recognize that American methods of farming are depleting the humus content of our soils. Not only has it been found that the amount of humus over the years has been materially and critically reduced, but the quality of this essential constituent to productive soils has been lowered. It is being accepted that one of the most important tasks confronting research is to determine how to enrich our soils to the highest degree with the most valuable organic materials.

Dr. Firman E. Bear has contributed a great deal to our knowledge of soil organic matter. He has summarized the values of organic matter as follows (1):

It serves as food for various types of desirable soil micro-organisms.

It supplies essential elements for re-use by succeeding plants.

It aids in improving the physical qualities of soils.

Its presence as living or dead material on or in the soil aids in the control of erosion by wind and water.

In mulch form it increases water intake, reduces water loss and lowers soil temperature.

The chemical composition of wood is slightly variable, depending on tree species. It can be generally accepted as an organic substance composed of 40 percent lignin and 60 percent cellulose, with some waxes, tannins, and resins. The N-P-K values are low, about 4-2-4.

Several comprehensive studies have been made on the value of wood as organic matter. Viljoen and Fred (2) studied the effects of different kinds of wood on the growth of oats and clover. They found the unfavorable action of wood on plant growth was due to a lack of available nitrogen in the soil. Using wood-pulp cellulose as a check, the same results were obtained as with wood. They concluded it was unlikely there is any toxic action on plants due to such wood constituents as oils, resins, and tannins. They found the lack of nitrate due to a reduction rather than an inhibition of nitrification, and this reduction was caused by a group of organisms that make use of cellulose. (The same organisms and nitrogen deficiencies appear when other organic materials decompose.) Their work appears to have established that the reduced growth of plants following the application of wood is closely connected only with a tie-up of nitrates and that this depressive action soon passes off and is almost without effect the following season.

Turk (3) drew similar conclusions. He reported: "Experiments . . . indicate that the depressive action of sawdust on plant growth is the result of a deficiency of soluble nitrogen, in soils higher in nitrogen, no depressive effect is likely to occur, well rotted sawdust usually has no detrimental effect."

Butterfield (4) reports: "If the sawdust is supplemented with some readily available source of nitrogen, it can be added to soils without fear of harmful effects. In all the greenhouse experiments, nitrogen, whether in the form of dried blood, inorganic nitrogen, or manure, overcame the detrimental (nitrogen grab) influence of sawdust . . . nitrogen added in sufficient quantities to give the sawdust the equivalent of about 2 percent N will overcome the detrimental effects of the sawdust in soils very low in available nitrogen." Turk (3) said, "On the average, perhaps one-third of a pound of ammonium sulphate per cubic foot of fresh sawdust will meet the nitrogen demand . . . 500 pounds of ammonium sulphate should be used with each 10 tons of dry sawdust."

Midgley (5) found that shavings and sawdust supply active energy material and raise the temperature of manure to the same extent as does mature hay. Thus wood acts like other carbonaceous materials.

Wood does not produce excessive soil acidity. Pine or other softwood sawdust contains less basic material than that from hardwoods. Upon decay most of the organic acids are used by organisms or lost into the air, leaving a neutral or alkaline residue. Sawdust from tree species like oak contains large amounts of tannins and terpenes but the latter seldom hold over in soil because soil organisms destroy them. Data indicate that pH will be affected by not more than two-tenths. Locally recommended liming programs will suffice to meet requirements.

These studies and others lead to the conclusion that wood itself does not produce a toxic soil condition, and the incorporation of fresh wood in the soil results in a nitrogen grab that is reflected in decreased plant growth. If the nitrogen requirement is met, no depressive effects should be observed. Research on

nitrogen requirements under varying conditions of size of wood fragment, or physical nature of soil medium, is lacking. Studies seem to establish that if nitrogen is added with the wood, beneficial effects, as measured by crop yields, will occur.

It is accepted that a beneficial physical effect accrues to soils by mixing sawdust with them. Adding sawdust to heavy soil has improved its structure, as reflected by ease of tillage and infiltration rates. Aeration is improved. Sawdust and shavings have a high water-absorbing capacity and contribute this quality to both heavy and sandy soils. One pound of sawdust can absorb two to four times its own weight; shavings about twice their weight.

While there is no reported research on the use of chips - small fragments or wood chunks - it is reasonable to assume the incorporation in soil of wood in any form will improve its physical properties.

There is no reason to assume that wood could not make as great a contribution to the control of wind and water erosion as many other sources of humus material. It is well established that there is a direct correlation between the erodibility of a soil and its organic matter content. One of the values of a crop rotation is to maintain or build up the percentage of organic matter. Wood, readily available in the woodlots of thousands of farms, might be used to aid conservation programs.

Sawdust and shavings have been used as a mulch. They have given the same beneficial effects - increased water intake, reduced water loss, and low soil temperature - as have other organic materials. That heavy soil can be improved by adding sawdust is interestingly reported in a memorandum from which I quote (6):

"Mr. T. C. Corn (Medford, Oregon) has used fir sawdust in his pear orchard for the past three years. He is very enthusiastic about the results obtained on the heavy soils that were giving him water penetration problems. He applies 2 to 3 inches of sawdust on the soil surface, grows a heavy cover crop of rye and legume, and chops it down by discing once each direction, leaving a fine surface mulch. He applies 200 pounds of nitrogen in three applications per acre and about 100 pounds of P_2O_5. He claims fine yields, good water penetration, and the saving of one irrigation. We checked the soil structure and found a great improvement in tilth which increased with the age of the treatment. The three-year-old mulch still showed considerable remains, indicating the possibility of benefits extending over five to ten years from a single application."

Farm Journals have published farmer experiences on the use of sawdust as a mulch in orchard or berry patch. These farmers have learned by trial and error. Their comments are comparable to the following quoted from The Minnesota Fruit Grower (10): ". . . a heavy sawdust mulch about 10 inches deep (was applied) to some 20-year-old apple trees about 5 years ago. The mulch has not been disturbed since that time but the trees have received annual applications of about 6 to 7 pounds of nitrate of soda or ammonium sulphate. The owners are well pleased with the results. Experience indicates that the normal nitrogen application should be increased at least 50 percent for the first year or two when fresh sawdust is used. After decomposition is well started it is probable that extra amounts of nitrogen would not be needed."

A brief item in Horticulture interested me because it reports an extreme amount of sawdust used. I quote: ... "Mr. Washburn has applied no less than 640 tons of wet sawdust around the trees in a three acre apple orchard. The young trees which were not doing very well have made good growth since being mulched with the sawdust."

A story about a Maine farmer who for the past 31 years has successfully used sawdust appeared in the July 10th issue of the New England Homestead. These years of experience have taught Mr. James G. Chadbourne that "hardwood is best because it decays quicker in the soil." White birch is best because "it rots in about a year." Pines take about twice as long to rot.

In treating a piece of land, Chadbourne harrows 4 to 6 inches of sawdust into the ground. The land is planted to a leguminous crop which absorbs nitrogen from the air, and the crop is plowed under in the autumn. The sawdust land is ready to use the following year upon addition of a fertilizer high in nitrate.

Is empirical research ahead of planned research? If wood is making a real contribution to the farming practices of a few, can it not also aid others? Of course economics and costs must be considered. Millions of tons of sawdust are wasted. Sawmill men usually find sawdust and shavings a costly handling item and welcome removal. A few mills have installed "hoppers" as an invitation to farmers to remove it. However, if agriculturists were to advocate the use of sawdust, or more farmers learn by trial that wood can contribute to farming, there would not be enough sawdust to meet the demand. Because of demand for shavings as bedding in some areas, they are competitively priced. Volume is largely dependent on planing mill operations. A few mills have installed hogs or hammer mills for the conversion of lumber waste into bedding materials. Again volume is limited.

Light portable wood chippers are available. Designed to convert chunk or pole wood into chips acceptable for bedding, these machines can be used in the farm woodlots to produce chips.

A Study (8) of production of hogged wood for fuel in 1942 indicated that pole wood in 8 to 12 foot lengths could be converted to chips at a cost of $1.15 a cord. It is estimated that today's cost would be about $2. This includes all items of conversion from the pole pile to the mound of chips. A cord of wood weighs about 2 tons. Thus, the cost of converting chunk wood to chips would be $1.00 per ton.

The U. S. Forest Service has recently carried out some cost studies on the hogging of wood in the farmers' woodlots (9). Depending on the size of the trees or chunks fed into the machine costs varied from one to two dollars per cord for machine operation.

It is recognized that woodland is producing at least 2 tons of wood per acre, that is cellulose and lignin, organic matter, each year. If this wood is not harvested from normally stocked woodland it is lost to farmer use. It can be harvested without reducing productive capacity. Census data show that in most States east of the Mississippi about 25 percent of farm land is woodland. Thus there would be available each year per average farm about 50 tons of wood that might be converted

to chips and used as mulch, bedding, or added directly to the soil. This might be an answer to the question so often asked by foresters: "Where is there a market (or use) for low grade material in woodlots that should be removed to improve growing stock, and how can logging waste be economically utilized?"

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(6) Hockensmith, R. D. Memorandum June 1948.

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(8) Horticulture, January 15, 1942.

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(10) The Minnesota Fruit Grower. March, 1944.

COMMENTS

The following analysis was made of advantages and disadvantages of sawdust and wood chips as mulch materials as described by Mr. McIntyre.

Advantages of Wood Mulch Materials

1. Cheap (less than $5 per ton estimated).
2. Easy to obtain.
3. Easily applied.
4. No need for anchoring on slopes.

Disadvantages of Wood Mulch Materials

1. Small size of particles.
2. Application of heavy amounts nitrogen in fertilizer form required.
3. Difficult to manufacture without complicated mechanical equipment.