Keep Your Farm Fertile!

1. Fertile, high-yielding acres are most apt to produce a profit.

2. This generation is using and wasting more than its share of our soil resources.

3. There is very little undeveloped "West" to go to. A farmer remarked, "The Greatest remaining undeveloped agricultural territory now lies just under the hat."

4. Increased acreages of crops are being produced and sold to pay the cash cost of operating trucks and tractors, and machines do not produce barnyard manure.
COLORADO STATE COLLEGE
EXTENSION SERVICE
F. A. ANDERSON, DIRECTOR
FORT COLLINS

Keep Your Farm Fertile

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Soil Is More Than Just Dirt

The most valuable thing in all the world is a fertile soil—the fertile few inches which cover our farms and ranches. Imagine the difficulty of making a living in a city or country without a productive soil!

From a farmer’s viewpoint, soil is mineral matter from broken and weathered rock, together with organic material in which crops, grass, trees, and other plants grow. Weathering agencies such as freezing and thawing and wetting and drying help to break down rock to form soil material. Rock is ground into soil material in running water or under sheets of ice and snow on the mountainsides. Blowing sand will wear down the hardest of rock surfaces. Tree roots sometimes force rocks to break open.

Water in the soil combines with gases of the air, such as carbon dioxide which we force out of our lungs when we breathe. The water and gas form a weak acid which helps to dissolve rock particles in the soil or layers of rock underneath.

A long time ago, Mother Nature experimented with grass, trees, shrubs, and other plants, and discovered one or more plants most suitable for each soil whether above timberline, on the plains, or at sea level. When these plants died, the roots decayed in the soil. Broken stems and leaves became mixed with the soil each year through the activities of earthworms, rodents, or by dropping into cracks, as the soil dried after a rain. This organic matter, or humus as it is called, may be in sufficient amounts to make the topsoil black or dark in color.

Sometimes Mother Nature’s forces, working day and night, required nearly 1000 years to break down rock material and add the humus in each inch of topsoil.

Plants have no teeth—they cannot chew up particles of soil and humus. Plants cannot grow unless their food is dissolved in water. Roots absorb the different materials needed for growth of the plant from a sort of “soil soup.” If one or more of the eleven essential plant-food materials which come from the soil—for example, phosphorus—is missing from the soil soup, then the plants cannot grow properly.
Plants Need Balanced Ration

Every farmer understands that livestock must be fed a variety of feeds—a balanced ration—for best results. Plants need a balanced ration of minerals in the soil in liquid form. Successful crop production is simply the management of the soil so that a liberal supply of soil soup containing all of the materials needed for plant growth is available to plant roots, together with protection of the crops from disease and insect pests.

When a small rock is dropped into a glass of water, it may not dissolve in 50 years because pure water itself is not a very good solvent. Humus is essential in a high-producing soil because its decay forms acids which help to dissolve and release the tiny bits or traces of mineral which are carried by water into the roots of growing crops, causing growth.

600,000,000 Little Germs!

The topsoil is alive. It breathes with the changes in temperature during the day and night. In a thimble full of fertile topsoil, it is estimated that there may be 600 million little germs of decay tearing down the humus, creating juices and solutions which help to dissolve soil particles. These little germs die and their bodies supply materials for a part of the plant sap. This death and decay and release of plant food from soil particles occurs mostly in the topsoil and is essential in order that we may have new life and growth, new plants and growth of humans or animals who eat the plants.

The supply of humus or organic matter which is rapidly used up through decay must be regularly renewed if the soil is to continue to be productive.

Someone said: "If all of the accumulated soil-management information and wisdom of a hundred generations of Master Farmers were boiled down to just three sentences, one of these sentences would certainly be: 'Provide for regular and frequent renewal of the supply of organic matter in the soil.'"
Why Low-Producing Fields and a Run-Down Farm?

Everyone knows what a bank account is. Also, everyone knows what happens if one keeps writing checks without making some deposits. Trouble begins with a notice of overdraft.

The soil is the farmer’s bank account. Instead of dollars being deposited in this bank account, there is a deposit of plant-food materials to be drawn upon and converted into dollars as crops are produced. Deposits of essential plant-food minerals may be lost through erosion. Erosion means that the soil bank, together with the deposits of plant food, are lost from the field. Topsoil lost in erosion cannot be replaced very easily.

Unmeasured deposits of soil elements are lost from many Colorado fields through the use of excess irrigation water which dissolves and carries the minerals away in seepage, or deep into the soil beyond the reach of plant roots.

When crops are harvested and removed from the field, fertility or plant-food elements are taken from the soil. The bank account of plant food is drawn upon. The rate of removal in crops of three important plant foods — nitrogen, phosphoric acid and potash—is shown below, together with the cost to replace these elements if commercial fertilizers had to be purchased at present prices.

The application of irrigation water usually hastens the decay of humus and increases yields of crops. Therefore, more of the plant-food minerals are taken from the soil on irrigated farms.

### Removal of Fertilizing Elements in Crop Production and Cost to Replace

<table>
<thead>
<tr>
<th>CROP</th>
<th>YIELD PER ACRE</th>
<th>NI-TROPGEN</th>
<th>NI-TROGEN</th>
<th>PO-TASH</th>
<th>PO-TASH</th>
<th>PHOS-PHOSGEN</th>
<th>PHOS-PHOSGEN</th>
<th>COSTS TO REPLACE *</th>
</tr>
</thead>
<tbody>
<tr>
<td>BARLEY</td>
<td>70 bu.</td>
<td>61.82</td>
<td>28.56</td>
<td>24.86</td>
<td>$7.02</td>
<td>1.57</td>
<td>1.36</td>
<td>$9.95</td>
</tr>
<tr>
<td>CORN, GRAIN</td>
<td>50 bu.</td>
<td>45.36</td>
<td>19.32</td>
<td>11.2</td>
<td>5.15</td>
<td>1.06</td>
<td>0.61</td>
<td>6.82</td>
</tr>
<tr>
<td>CORN, SILAGE</td>
<td>12 tons</td>
<td>81.6</td>
<td>38.4</td>
<td>105.6</td>
<td>9.26</td>
<td>2.11</td>
<td>5.80</td>
<td>17.17</td>
</tr>
<tr>
<td>BEETS</td>
<td>15 tons</td>
<td>78.0</td>
<td>24.0</td>
<td>96.0</td>
<td>8.86</td>
<td>1.32</td>
<td>5.28</td>
<td>15.46</td>
</tr>
<tr>
<td>WHEAT</td>
<td>30 bu.</td>
<td>35.64</td>
<td>15.48</td>
<td>9.54</td>
<td>4.04</td>
<td>0.85</td>
<td>0.52</td>
<td>5.41</td>
</tr>
<tr>
<td>ALFALFA</td>
<td>5 tons</td>
<td>238.0</td>
<td>54.0</td>
<td>223.0</td>
<td>27.03</td>
<td>2.97</td>
<td>12.26</td>
<td>41.26</td>
</tr>
<tr>
<td>POTATOES</td>
<td>300 bu.</td>
<td>63.0</td>
<td>21.6</td>
<td>95.4</td>
<td>7.15</td>
<td>1.18</td>
<td>5.24</td>
<td>13.57</td>
</tr>
</tbody>
</table>

*Prices: ammonium sulphate, $46.60 per ton; treble superphosphate, $49.75 per ton; potash, $55.00 per ton.
Notice of Overdraft

It is easy to understand that when crops are grown continually for 40 to 50 years, the bank account of some essential plant foods may become short. The notice of overdraft is: Reduced crop yields. Such a farm is commonly referred to as “a run-down farm.”
Sweet clover, pastured and plowed under, builds up fertility and farm profits.

Maintaining Fertility

When crops are produced and then plowed under, there is no loss of fertility from the soil except from seepage and some loss from erosion on sloping fields. If legume crops such as clovers, alfalfa, peas, and beans are plowed under, the soil is made more fertile because these crops have taken some nitrogen from the air and helped to fix it in the soil.

A farmer cannot afford to plow under all of the crops which he raises, but he can afford to plow under an occasional crop of sweet clover, cutting of alfalfa or other green manure crop for the purpose of helping to maintain the supply of humus in the soil.

Very little fertility is lost from a field when the crop is pastured off because only small amounts of the fertilizing materials remain in the bodies of hogs, cattle or sheep when they graze on grass, sweet clover, or alfalfa.

Why Feed at Home?

When crops are harvested and fed to livestock, nearly 90 percent of the plant food contained in the crop remains on the farm in the form of barnyard manure. Several tons of grass, hay, silage or beet by-products and grain containing fertilizers which would cost $40 to $45 to replace may be fed to produce and fatten a 1000 lb. steer, but plant food worth only $4.02 is taken off the farm in the body of the steer. The bodies of 1000 lbs. of fat lambs contain fertility valued at $2.94, and 1000 lbs. of fat hogs remove about $1.71 in fertilizer when sold off the farm.

Knowing the amount of fertilizing elements removed by crops when harvested and the composition of average barnyard manure, it is possible
Contented cows in clover usually indicate a contented farm family.

to calculate fertilizer needs and approximately balance the deposit of fertility with the outgo from a farm. Generally, it is believed that 5 or 6 tons of Western manure, applied to each acre of cultivated crops in the rotation, together with plowing under a cutting of alfalfa and crop

Pigs on pasture—productive fields—profits—What more does a farmer want?
Barnyard manure is fertility that is not hauled away from the farm in the sale of crops. residues, will maintain the nitrogen and humus supply in the soil. This amount of manure will not replace the plant-food elements removed in high yields of crops on irrigated land. The difference will need to be made up by either of two methods:

1. By release from the soil par-

Yield and Composition of Manure from Farm Animals

<table>
<thead>
<tr>
<th>Composition of one ton of average manure</th>
<th>Value of Plant Food Which Remains on the Farm in Manure</th>
</tr>
</thead>
<tbody>
<tr>
<td>TONS PER YEAR</td>
<td>WATER lbs.</td>
</tr>
<tr>
<td>-----------------</td>
<td>-------------</td>
</tr>
<tr>
<td>Cow, 70 lbs daily</td>
<td>12</td>
</tr>
<tr>
<td>Steer, 60 &quot; &quot;</td>
<td>11</td>
</tr>
<tr>
<td>Horse, 44 &quot; &quot;</td>
<td>8</td>
</tr>
<tr>
<td>Hog, 9 &quot; &quot;</td>
<td>1.5</td>
</tr>
<tr>
<td>Sheep, 4 &quot; &quot;</td>
<td>.75</td>
</tr>
</tbody>
</table>

Table shows composition of solid and liquid manure as it comes from the animals.
articles through activity of the small germs of decay, together with annual applications of small amounts of commercial fertilizer.

2. By heavy applications of commercial fertilizers and organic matter when the farm becomes "run-down."

The problem of maintaining fertility on a farm where all crops are harvested and sold off the fields is emphasized by a calculated comparison with a farm where livestock feeding is practiced. Suppose we follow a seven-year rotation:

Alfalfa 3 years, yielding 4 tons per acre each year.

Corn 1 year, yielding 60 bu. per acre.

Beets 2 years, yielding 18 tons each year.

Barley 1 year, yielding 60 bushels.

If these crops are all sold off the farm, the average annual removal and value of nitrogen, phosphoric acid and potash from each acre in the rotation could be calculated as shown below.

Assuming that beet pulp, molasses, some cottonseed and additional grain would be fed to finish out the livestock, it is easy to understand that the actual fertility deposit on the farm could be made to equal the removal in beets and livestock sold.

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**Fertility Removal In 7 Years from Each Acre on a Cash Crop Farm**

<table>
<thead>
<tr>
<th>Crops In the Rotation</th>
<th>Total Yield</th>
<th>Total Lbs. of Fertilizing Elements Removed Per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nitrogen</td>
<td>Phosphoric Acid</td>
</tr>
<tr>
<td>Alfalfa, 3 yrs.</td>
<td>12 tons</td>
<td>571.2 lbs.</td>
</tr>
<tr>
<td>Corn, 1 yr.</td>
<td>60 bu.</td>
<td>57.43 lbs.</td>
</tr>
<tr>
<td>Beets, 2 yrs.</td>
<td>36 tons</td>
<td>93.6 lbs.</td>
</tr>
<tr>
<td>Barley, 1 yr.</td>
<td>60 bu.</td>
<td>53.0 lbs.</td>
</tr>
</tbody>
</table>

Average Annual Removal Per Acre in 7-Yr. Rotation: 7/775.23

Average Annual Cost Per Acre to Replace 3 Elements if Commercial Fertilizer is Purchased: $12.58 + $1.62 + $4.94 = $19.14
Which Is Better Farming?

7-Year Rotation—Everything Sold Off Farm

\[
\begin{align*}
\text{NITROGEN} & \quad \$12.58 \\
\text{PHOSPHORUS} & \quad 1.62 \\
\text{POTASH} & \quad 4.94
\end{align*}
\]

\[
\text{Average value of fertility removed per acre each year} = \$19.14
\]

7-Year Rotation Livestock Feeding—Only Sugar Beets Sold Off The Farm

\[
\begin{align*}
\text{NITROGEN} & \quad \$1.51 \\
\text{PHOSPHORUS} & \quad .23 \\
\text{POTASH} & \quad .91
\end{align*}
\]

\[
\text{Average value of fertility removed per acre each year} = \$2.65
\]

The cash value of fertilizing elements removed by crops as calculated are based on the composition of crop products. If a sufficient supply of these plant-food elements is made available for crops through proper soil management, an application of commercial fertilizer may have no value in increased yields.

It Is Easy to Keep the Farm Productive

The principle of maintaining soil fertility is simple:

"Return to the soil as needed the plant food which is lost in the sale of crops and livestock, in leaching and in soil erosion."

Soil fertility can be maintained by planning and carrying out a farm program which includes:

1. Rotating crops, including feed crops and soil-conserving crops in the rotation.
2. Livestock to consume all of the feed and pasture crops produced on the farm and the return of all of the manure and crop residues to the fields.
3. Proper use of irrigation water and rainfall to reduce leaching and soil erosion.
4. Application of commercial fertilizers to supply those plant foods which may be needed. The best way to find out what fertilizer is needed is to treat a small plot or strip across the field.
Some Cropping Systems Pay
And Some Do Not

The question is often asked: "Is a rotation or cropping system which encourages livestock production or feeding and the keeping of soil fertility on the farm most likely to be profitable?" The answer is found in a study of net returns per acre in crop-rotation experiments conducted for 23 years (1912-1934) under irrigation at Scottsbluff, Nebraska.

Comparative Value of Some Cropping Systems
Scottsbluff, Nebraska Field Station, 1912-1934

<table>
<thead>
<tr>
<th>Crops, Treatment and Sequences or Rotation</th>
<th>Relative Value or Net Return Per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oats (with sw. clover), sw. clover pastured (sheep), sugar beets, 2 yrs.</td>
<td>$ 24.26</td>
</tr>
<tr>
<td>Alfalfa (3 yrs.), potatoes, sugar beets (manure), sugar beets, oats</td>
<td>21.45</td>
</tr>
<tr>
<td>Oats (manure), sugar beets</td>
<td>21.32</td>
</tr>
<tr>
<td>Alfalfa (2 yrs.), potatoes, sugar beets</td>
<td>21.05</td>
</tr>
<tr>
<td>Potatoes, oats (manure), sugar beets</td>
<td>20.86</td>
</tr>
<tr>
<td>Alfalfa (3 yrs.), potatoes, oats (manure), sugar beets</td>
<td>20.44</td>
</tr>
<tr>
<td>Alfalfa (3 yrs.), potatoes, sugar beets, oats</td>
<td>19.15</td>
</tr>
<tr>
<td>Alfalfa (3 yrs.), potatoes, oats, sugar beets</td>
<td>13.11</td>
</tr>
<tr>
<td>Alfalfa (continuously)</td>
<td>7.60</td>
</tr>
<tr>
<td>Alfalfa (3 yrs), corn, oats, sugar beets</td>
<td>6.95</td>
</tr>
<tr>
<td>Oats, sugar beets</td>
<td>.13</td>
</tr>
<tr>
<td>Corn, oats, sugar beets</td>
<td>Loss. 1.26</td>
</tr>
<tr>
<td>Sugar beets continuously</td>
<td>Loss. 4.71</td>
</tr>
<tr>
<td>Corn continuously</td>
<td>Loss. 8.07</td>
</tr>
<tr>
<td>Potatoes continuously</td>
<td>Loss. 28.08</td>
</tr>
</tbody>
</table>

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