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# GREEN MANURING AND SOIL FERTILITY

AGRICULTURAL EXPERIMENT STATION  
IOWA STATE COLLEGE OF AGRICULTURE  
AND THE MECHANIC ARTS

AGRONOMY SECTION

Soils



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# GREEN MANURING AND SOIL FERTILITY

By P. E. Brown

Green manuring puts humus into the soil and that makes it an important farm practice, because humus is absolutely essential for the best growth of crops. Humus may be added in another way, by applying barnyard manure, but that method alone will not keep the soil from losing fertility from year to year. Even though it is saved with the utmost care, the manure produced on the farm will not return to the soil all the fertility removed by the crops. Circular No. 9, "Farm Manures," Iowa Agricultural Experiment Station, shows furthermore, that there are certain unavoidable losses in the storing of manure and that they may involve not only the valuable mineral constituents, but also the organic matter. As agriculture is now generally practiced in Iowa as well as elsewhere, the soil is being gradually worn out.

It is clear, therefore, that some other means must be employed to keep up the humus content of soils and this may be accomplished by turning under green manure crops.

## *THE VALUE OF GREEN MANURES*

Any crops grown and plowed under green to improve the condition of the soil are called green manure crops. When such crops are used in addition to a regular rotation and occupy the land for only a part of the season, they are known as "cover" crops or "catch" crops.

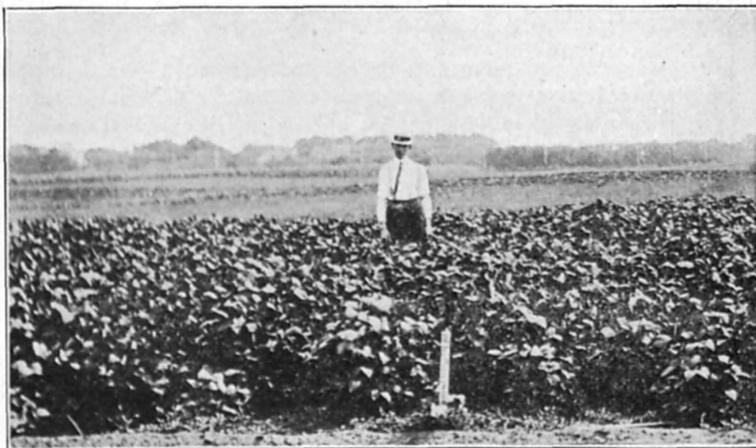
The value of green manures as a means of improving soil conditions has been known for centuries and in the light of past experience it is somewhat surprising that their use is not more common now.

Green manuring is not enough in itself, of course, to keep a soil from wearing out. There are other practices that must be followed also. Crop rotation must be practiced. The amount of moisture in the soil must be regulated. Proper tillage must be employed. Steps must be taken to keep soils from becoming acid. The supply of the mineral plant foods, especially nitrogen, phosphorus and potassium, must be kept up. This may be done in the case of nitrogen by growing legumes that take nitrogen from the air. Potassium is not likely to be deficient in Iowa soils for centuries. Phosphorus must be applied as it is needed. These factors are all important in keeping a soil fertile, but not more important than green manuring.

In general, it may be said that green manures improve poor soil because of their action on the physical, chemical, and bacteriological conditions pertaining to the soil.

## *THE PHYSICAL EFFECTS OF GREEN MANURES*

The character of a soil very largely determines the physical effects of a green manure upon it. If light, and sandy, it will be affected quite differently than if heavy and clayey. In general, however, green manures influence the moisture conditions, the temperature, the aeration, and the



Soy Beans on the Iowa Agricultural Experiment Station Plot.

sourness of soils. Through these physical effects, the chemical and bacteriological conditions are considerably altered.

#### MOISTURE

On light, sandy soils, green manure prevents rapid drying out, which so often occurs, by cutting down the losses of moisture due to evaporation and percolation. Green manures make the soil more compact by uniting the fine particles into larger masses, and the humus or organic matter, itself acts like a sponge in holding water. Thus by the use of green manures, sandy soils, otherwise infertile, may be made to hold enough moisture for crop production.

Green manures have the opposite effect on heavy clay soils. The organic matter opens them up, admitting air, and preventing extreme moisture conditions. It also makes them less stiff and more crumbly when dry. Thus not only is the mechanical conditions of the soil made better, but the chemical and bacteriological conditions are also much improved. Green manuring may exert certain mechanical effects on both heavy and light soils in particular cases, as in protecting hilly soils against washing and sandy soil against blowing.

#### TEMPERATURE

The presence of humus produced from decomposition of green manures tends to lessen extremes of temperature in the soil. Thus it will make it cooler in summer and warmer in winter; cooler in the daytime and warmer at night.

Extremely high temperatures in sandy soils in summer are prevented and the loss of valuable constituents which may result from such high temperatures is restricted. Very low temperatures in "cold" clay soils are likewise prevented and the transformation of mineral plant food into available form which might be restricted considerably is permitted to continue at a normal rate.

#### AERATION

Since green manures open up clay soils and make sandy soils more compact by adding organic matter, or humus, they have an important influence on the amount of air present in the soil. Humus acts beneficially on light, open soils in which too much air is apt to be present and in which destruc-

tive fermentative processes may occur with loss of valuable constituents. It restricts the entrance of air and reduces the destructive processes and consequently the losses. In heavy, tight, clay soils, on the other hand, fermentative processes are apt to be too slow. In these the organic matter from green manures opens up the soil, admits air, and permits the more rapid production of plant food. The subsoil is also opened up to a considerable extent and the unavailable plant food there is brought up and made available.

#### *REACTION OR "SOURNESS"*

The turning under of a crop of green manure adds a large amount of organic matter to the soil. In its decomposition, acids may be produced in considerable amounts and the soil become acid or "sour" in reaction. As is well known, sour soils are somewhat infertile, so when green manures are employed the reaction of the soil should be carefully tested. If it is acid, limestone should be applied in amounts depending on how "sour" the soil is and the crop to be grown.

### *THE CHEMICAL EFFECTS OF GREEN MANURES*

Although the main effects produced in a soil by adding the organic matter contained in a green manure crop are physical, the chemical and bacteriological conditions are also influenced to a considerable extent, as well as the plant food production which is governed by these conditions.

#### *THE CONSERVATION OF PLANT FOOD*

Humus not only absorbs and retains moisture, but it also absorbs plant food which might otherwise be lost. It retains nitrogen in the form of ammonia, and it absorbs soluble potassium compounds which might be leached out of the soil and retains them for plant nourishment.

Nitrogen may be lost from the soil not only by passing into the air as ammonia, but also by the leaching of soluble nitrates into the drainage water and by the escape of nitrogen gas from nitrates into the air. There is very little plant food in the drainage water from soils under crops, while on fallow soils as much as 40 lbs. of nitrates may be lost annually. Hence the presence of green manure crops on the soil at times when it would otherwise be bare prevents the loss of nitrates as these are taken up by the plants and so stored in the soil for the succeeding crop. Furthermore, the period of most active nitrification in soils, that is, the time at which the greatest production of nitrates occurs, is during July and August and consequently if the soil is left bare following a small grain crop all the nitrates produced in the soil may be lost in the drainage water. It has been estimated that this loss of nitrogen from soils on which wheat is grown continuously amounts to 4 to 6 lbs. of nitrogen for each pound used by the crop.

The late summer and early fall is not only the period of greatest activity of the nitrifying bacteria, but also of many other species. Consequently, many other soluble plant food constituents are produced which might be lost by leaching if no crop were present to absorb and retain them.

#### *THE CONCENTRATION OF PLANT FOOD*

The green manure crops, especially the legumes, may act as collectors of plant food, building themselves up by drawing their nourishment from the lower soil layers. When such a crop is plowed under, all the food contained in it is stored near the surface for the benefit of succeeding crops. The roots of alfalfa, for instance, may extend from 12 to 30 feet downwards and much of its food is thereby brought up from the subsoil. This food is stored in the crop itself and in the large tap roots of the plants

near the surface. When the plants are turned under, this food is retained near the surface for the use of succeeding crops.

#### *THE INCREASE IN AVAILABLE PLANT FOOD*

When a green manure crop is turned under in a soil, moisture conditions being favorable, many species of bacteria begin to act on its mass of organic matter. They change the proteins, the complex, insoluble compounds which contain the nitrogen, into soluble proteins, then into amino acids, then into ammonia, and finally into nitrates, in which form the nitrogen is taken up by plants.

The non-nitrogenous matter in the green manure is also acted upon by various groups of bacteria which decompose the carbohydrate and cellulose materials more or less completely into carbon dioxide, organic acids, etc. This carbon dioxide and the organic acids act on the insoluble phosphorus and potassium compounds in the soil and change them into soluble, available forms. Thus the destruction of a green manure crop in the soil not only transforms the nitrogen in the crop into a form that plants can use but it also makes the plant food in the soil soluble.

#### *THE INCREASE IN NITROGEN*

When leguminous crops are used as green manures there may be an increase in the nitrogen content of the soils.

Legumes are independent of the nitrogen in the soil if their roots have so-called nodules, or swellings, which contain bacteria. These bacteria take the nitrogen from the atmosphere and supply it to the plants and thus there is no draft on the nitrogen in the soil. If the entire crop is turned under there is an addition of nitrogen to just the extent to which the nitrogen from the air is stored in the plants. For this increase of nitrogen in the soil to occur, the legumes must be inoculated; that is, if the proper bacteria are not already present in the soil, they must be put there. This is called "inoculation" and may be accomplished by the use of inoculated soil or by pure commercial cultures of the proper organisms. Further details concerning the inoculation of legumes may be obtained in Circular No. 8 of the Iowa Agricultural Experiment Station.

Green manures also bring about an increase in the nitrogen content of soils by encouraging the activities of the non-symbiotic, or free-living bacteria, supplying them with energy so they can fix nitrogen from the atmosphere in the soil.

#### *THE BACTERIOLOGICAL EFFECTS OF GREEN MANURES*

The bacteriological effects of green manuring depend so closely on the physical and chemical changes caused that it may be said that they are the direct result of those changes. The variations in moisture content, temperature, aeration, and reaction or "sourness" of soils caused by green manuring affect the bacteria very considerably.

Bacteria require water for their growth just as the higher plants do and they are similarly affected if there is too little or too much moisture. If the water content of a soil is very high, beneficial bacteria will be checked in their growth and the production of plant food, which is the main function of bacteria in the soil, will be reduced. So also if the soil becomes too dry, bacteria will be reduced in numbers and efficiency. Temperature has a certain effect on bacteria, some species growing best at moderately high temperatures and others preferring lower ones, and the activities of many beneficial species are reduced by extremes of temperature.

The amount of air present will determine to a large extent the kind of bacterial activity going on in the soil. If abundance of air is present then the aerobes, the bacteria needing air for their growth, will flourish and a large production of available plant food may occur. If the entrance of air

is restricted then the anaerobes, those bacteria growing without air, will prevail and the production of available food is restricted. The sourness of the soil also has an important influence on its bacterial activities. Bacteria generally prefer a soil which is not sour and if acids accumulate to any extent the numbers will grow considerably less and the production of available plant food will be correspondingly decreased.

Thus it is evident that as the use of green manures improves the physical condition of soils along these lines, beneficial bacterial activities are encouraged and likewise the production of plant food. In other words, improved physical conditions lead to greater bacterial action. Those bacteria which attack proteins and transforms them through the various stages already enumerated, into nitrates are encouraged. Those organisms also which attack purely non-nitrogenous compounds are more active; greater amounts of organic acids and carbon dioxide are formed and the transformation of insoluble phosphorus and potassium compounds into soluble form is increased.

We find therefore, that the chemical effects of the use of green manures which have already been discussed are the result of bacterial action. Available plant food in the soil is increased through the action of bacteria and the increase in nitrogen content by the use of legumes is the direct result of bacterial inoculation. A further increase in nitrogen in the soil may be brought about by the non-symbiotic nitrogen-fixing organisms which are encouraged to fix more nitrogen in the soil by the energy supplied in the organic matter of the green manure.

### *THE CROPS WHICH MAY BE USED FOR GREEN MANURES*

There are two classes of crops which may be used as green manures, "nitrogen consumers" and "nitrogen gatherers." The "nitrogen consumers" prevent the loss of valuable constituents and improve the physical and absorptive power of the soil but add no nitrogen directly and the "nitrogen gatherers" have the same effects but in addition they put nitrogen into



**Cowpeas on the Iowa Agricultural Experiment Station plots.**

the soil. Among the first group we find the cereals, the grasses, buckwheat, turnips, rape, etc. Because of their time of growth and period of rapid development it is often desirable to grow them for green manures when the chief purpose is to save plant food and it is of only minor importance to add nitrogen to the soil. The second group includes all the legumes, such as the clovers, peas, beans, vetches, alfalfa, lupines, etc. The great advantage from the use of legumes for green manures is that they may be grown absolutely independent of the nitrogen in the soil. The nitrogen which a legume takes from the air is added to the soil when it is plowed under and that increases considerably the nitrogen content of the soil. As nitrogen is the essential plant food most apt to be lacking in soils, this adding it by plowing under legumes is quite an important consideration.

#### *NITROGEN CONSUMING CROPS*

**Rye** has many advantages as a green manure crop. It may be seeded late and will make a good growth during the late fall. It withstands cold winters well and makes an early spring growth and consequently may be plowed under for early crops. The cost of seeding rye is small and all farmers are familiar with the method of preparing for the crop and handling it. It absorbs the plant food which might be lost in the fall and it adds a large amount of humus to the soil, but it does not add nitrogen. The chief value attached to rye is its hardiness in withstanding cold winters and its early spring growth.

**Wheat** is less satisfactory than rye as a green manure for the reason that, although it is somewhat the same, it is not so hardy and does not make as early a spring growth. Furthermore, much more care must be taken in preparing the soil for wheat than for rye and the seed is more expensive. The value of wheat as a grain crop is too great to warrant its extensive use as a green manure crop.

**Buckwheat** makes a valuable green manure on poor lands. Its season of growth is during July and August and it is valuable therefore in keeping the soil covered during the hot weather of those months, preventing the loss of plant food which would otherwise occur. It also adds a considerable amount of humus to the soil.

**Turnips** are frequently used for green manures because of their rapid appropriation of plant food in cool weather. They make a large accumulation of organic matter in the late fall and if deep rooted varieties are employed, much plant food is brought up from the lower soil layers and stored in the crop for the benefit of succeeding crops.

**Dwarf Essex Rape** is occasionally employed to serve as a cover crop during the winter, as it may be grown in the late fall. It possesses no particular advantages over rye or the other nitrogen consuming crops.

#### *NITROGEN GATHERING CROPS*

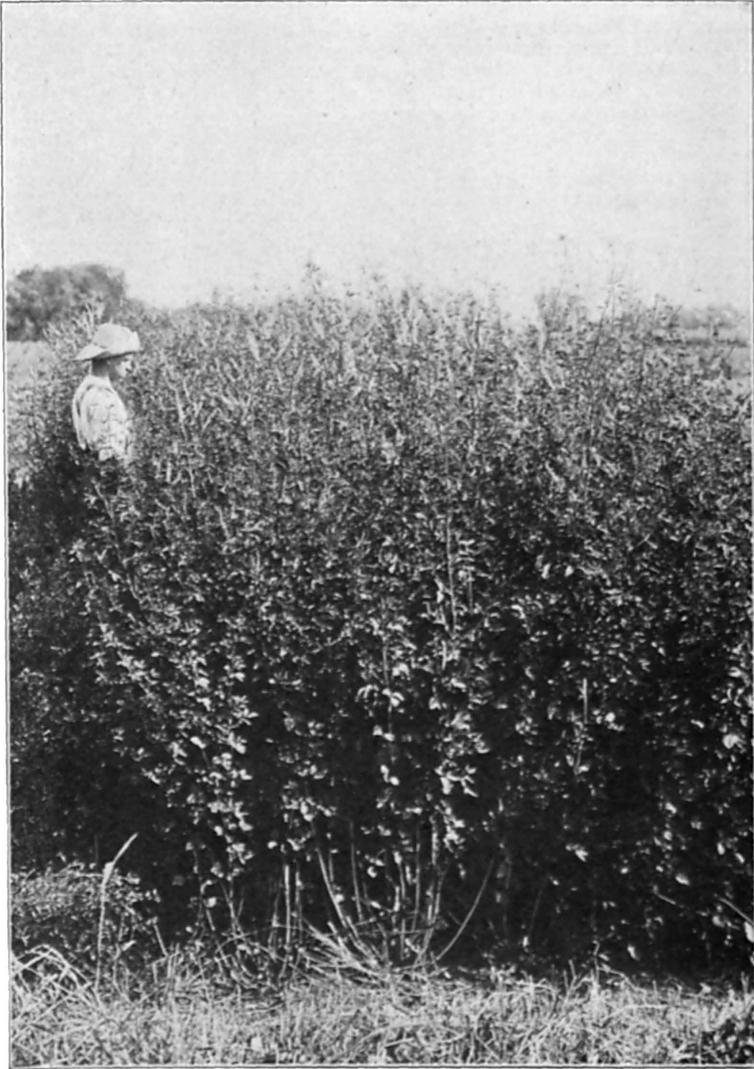
Clovers are the most common and best known legumes and the good effects of their use as green manures is a matter of common knowledge.

**Red Clover** is perhaps the crop most generally used for this purpose. Its advantages are very largely due to the extensive root system which not only opens up the soil but also enables the plant to draw its food from the deeper soil layers and then store it in the surface soil. Furthermore, red clover is a very vigorous gatherer of nitrogen from the atmosphere. If the crop is well inoculated and the soil is poor in nitrogen subsequent crops may be benefited even when only the roots and stubble are left in the soil. When the whole crop is turned under for a green manure the addition of nitrogen to the soil may be very considerable.

**Mammoth clover** is very similar to red and possesses no particular advantages except that it grows better on wet land and produces a larger and

coarser plant and provides more green material to be turned under for a green manure.

**Alsike clover** is better adapted to cold, moist soils than the other clovers and it is much hardier, withstanding cold winters much better. It is a creeper and is preferably sown with some other crop, such as red or mammoth clover, to hold it up.



**Sweet Clover**

**Crimson clover** has been used with considerable success in the eastern states but it is affected by severe weather and is particularly sensitive to drought. It is essentially a cool weather plant, grows late in the fall and makes an early spring growth. Great care must be observed in preparing for this crop. Because of the difficulty in getting a good stand, it cannot be recommended for Iowa.

**Sweet clover** has been little used for green manuring but it has advantages which will certainly make it an important green manure crop in the future. It makes a rank growth and has a deep root system which enables it to bring up food from sources not reached by many other legumes. It grows best on soils rich in lime and it has been claimed that its roots decay much more rapidly than those of other legumes. Sweet clover grows readily in Iowa where the soils seem to be practically universally inoculated, leaving no doubt of the plant's ability to utilize the nitrogen of the atmosphere. It is easily grown and requires no more than the usual care in the preparation of the seed bed. As a whole, the use of sweet clover for green manuring purposes in Iowa is strongly to be advocated.

**Alfalfa** may be employed for green manuring but it is not very satisfactory. It is a perennial and reaches its best stage of growth in the second or third year. The expense of seeding is considerable and much difficulty is often experienced in securing a good stand.

**Canada field peas** are used considerably in Canada and in the northern states. They are well adapted to cool, moist weather, making early spring and late fall growth under such conditions.

They may be seeded when it is too late for other legumes and will make enough growth before frost to serve as a mulch during the winter, preventing losses from the soil.

**Cowpeas** are particularly adapted for warm climates but some varieties do well in cool climates also. They make a rapid and large growth during the hot summer months, when it is very desirable to have the soil covered. They possess considerable ability in the fixation of nitrogen and when well inoculated may add a large amount of this valuable constituent to the soil. They may be plowed under green in the fall or left on the surface as a mulch during the winter and plowed under in the spring.

**Soybeans** resemble cowpeas in many ways but they are more difficult to handle and they are more sensitive to cold. They should not be seeded until the soil is warm. While their yields are not so heavy as cowpeas, the plants contain more nitrogen in the dry matter.

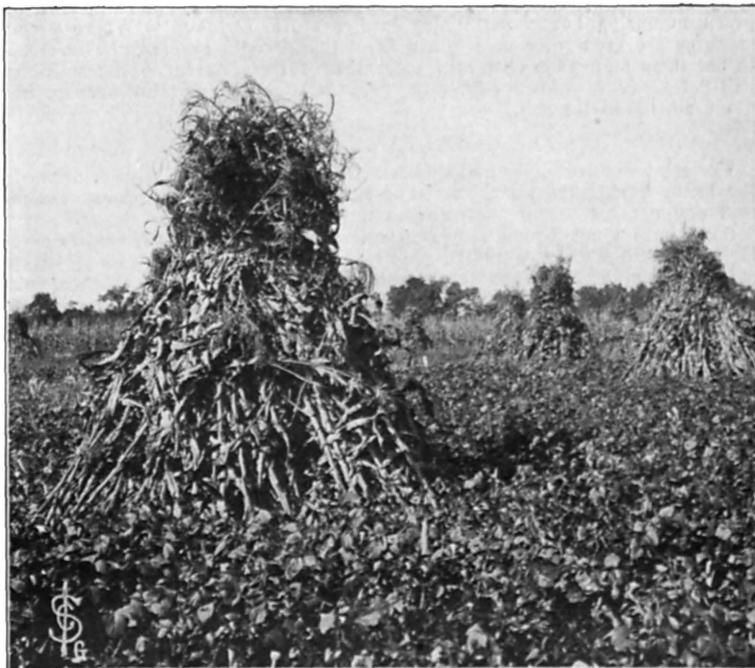
**Vetches**, winter and spring varieties, are used for green manures with considerable success but the seed costs too much to make their use pay. They are superior to cowpeas or soybeans on light soils, and they may also be sown in the early spring or in the fall.

## *THE USE OF GREEN MANURES*

Many important questions arise in the use of green manures. In the first place it is necessary to determine when green manuring should be practised and whether under the conditions a legume or a non-legume should be chosen. Then there must be careful preparation of the soil, and consideration must be given to the factors that influence the crop. Also, the farmer must take into account the effect of green manures on succeeding crops and the conditions governing the plowing under of the crop.

### *WHEN GREEN MANURING SHOULD BE PRACTISED*

Green manuring should not be used without good reason any more than any other agricultural practice, for even the most commonly beneficial operation may sometimes injure the soil. Thus while general principles and



Cowpeas in Corn

directions governing the use of green manures may be given, local soil, climatic and other conditions are of so much importance that definite advice cannot be given without knowledge of these particular conditions.

In grain farming, where the produce is sold from the farm, there is a rapid decrease in fertility. The soils become poor not only in the essential plant food constituents but also in organic matter, while their physical condition becomes unsatisfactory for crop growth. An ample supply of humus is one of the essential requisites for the maintenance of soil fertility and in grain farming the only logical way to insure this supply is by the use of green manures. When a leguminous green manure crop is introduced as an addition to the regular rotation, the humus content of the soil is maintained and besides much nitrogen may be added.

Just where to introduce the green manure in the rotation will depend entirely on the rotation. If that contains corn, then a green manure crop may be sown in the corn, allowed to remain on the ground during the winter and turned under in the spring. Thus in the common Iowa rotation, which consists of corn, corn, oats, and clover, green manures may be used in connection with both corn crops if it is deemed necessary. It should be used in at least one crop. The fact that the soil is kept covered during the winters following the corn crops is an important point in favor of the use of clover crops in such case.

In live stock farming, much of the fertility removed from the soil by the crops may be returned by the proper storing and use of the manure produced on the farm, assuming of course that all the produce of the farm is fed on the place. Even under the best conditions, however, all the fer-

tility removed by the crops cannot be returned in the manure and hence green manuring has a place also in live stock farming. Where green manures are used twice on a grain farm there would probably be no need to use them more than once on a stock farm. Here, again, local conditions will determine to a large extent the need and frequency of the need of organic matter in the soil.

#### *THE CROPS TO BE EMPLOYED*

The relative advantages of legumes and non-legumes have been mentioned, the latter having the same effects as the former to a large extent except that non-legumes do not put nitrogen into the soil.

Sometimes a non-legume may accomplish just as satisfactory results as a legume at a less expense and in such cases there is no question as to which should be employed. Thus rye may sometimes be used as a cover crop on soils following the corn crop with as much beneficial effect as a clover. If the soil is rich enough in nitrogen and it is desired only to add organic matter, improve the physical condition of the soil, and prevent the loss of valuable constituents, then a non-legume may be cheaper than a legume and just as good. Again, the local conditions, including the apparent needs of the soil, must aid in the selection of a crop for a green manure.

The value of sweet clover as a leguminous green manure crop for Iowa soils has already been pointed out and tests of its use as a means of maintaining the fertility of the soils of the state cannot be too strongly urged.

#### *THE CONDITIONS GOVERNING THE CHOICE OF A CROP*

Certain conditions should be observed in the choice of a crop. Among these are the cost of seed, the suitability of the crop to the particular climate, and the character and need of the soil. The ease with which the crop may be plowed under is another point of importance and the ability of the plant to choke out weeds is also of interest if the crop is to be used for that purpose on soils permitted to remain bare during the late summer and fall.

When legumes are grown, the ability of the plant to secure nitrogen from the atmosphere must in addition to the above then be considered. Some legumes seem to have more power of utilizing atmospheric nitrogen than others. How deep the plant's roots go is another point of interest, for the deeper the root system the greater the feeding district of the plant and the more plant food will be brought up from the deeper soil layers and stored near the surface. Furthermore, the deeper the roots go into the subsoil, the more it is opened up, and the greater is the admission of air. Increased aeration is followed by increased bacterial activities and greater plant food production.

Finally, in the choice of a green manure crop, its forage value and the quality and quantity of hay or pasture it may produce must be considered. Thus in some cases it may be more profitable to use the crop for forage or hay or to pasture it than to turn it under for a green manure. It must be remembered that the roots and stubble of legumes make an important addition to the soil, even although no decided gain in nitrogen is accomplished. The nitrogen content of the soil need not be depleted to any extent by the growth of legumes if proper inoculation is performed. If the humus content is not seriously reduced and it is not necessary to make large additions of organic matter or nitrogen to the soil to bring it to a fertile state, the use of the crop for feeding purposes may be more profitable.

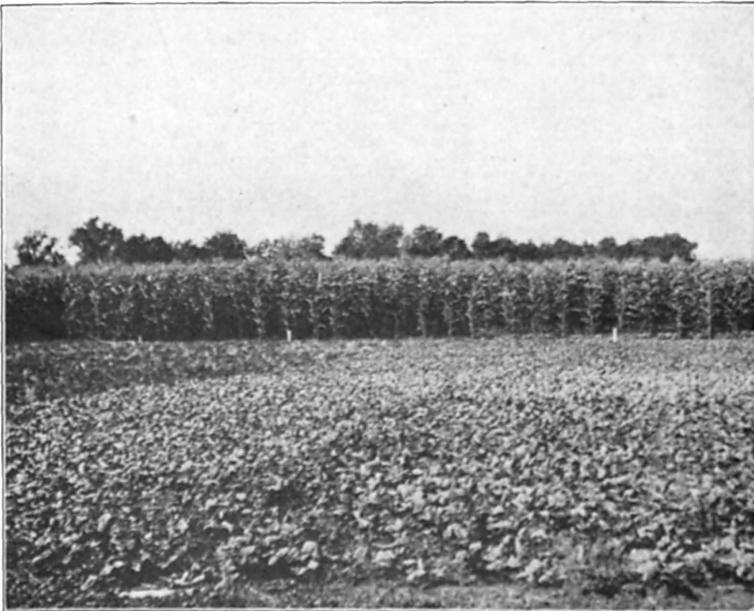
#### *THE PREPARATION FOR A GREEN MANURE CROP*

The soil must be put in as good a state for the growth of a green manure crop as for any other crop. The seed bed must be just as carefully prepared as if the crop were to be harvested. The soil must have the necessary plant food, except that in the case of legumes no nitrogen is necessary, pro-

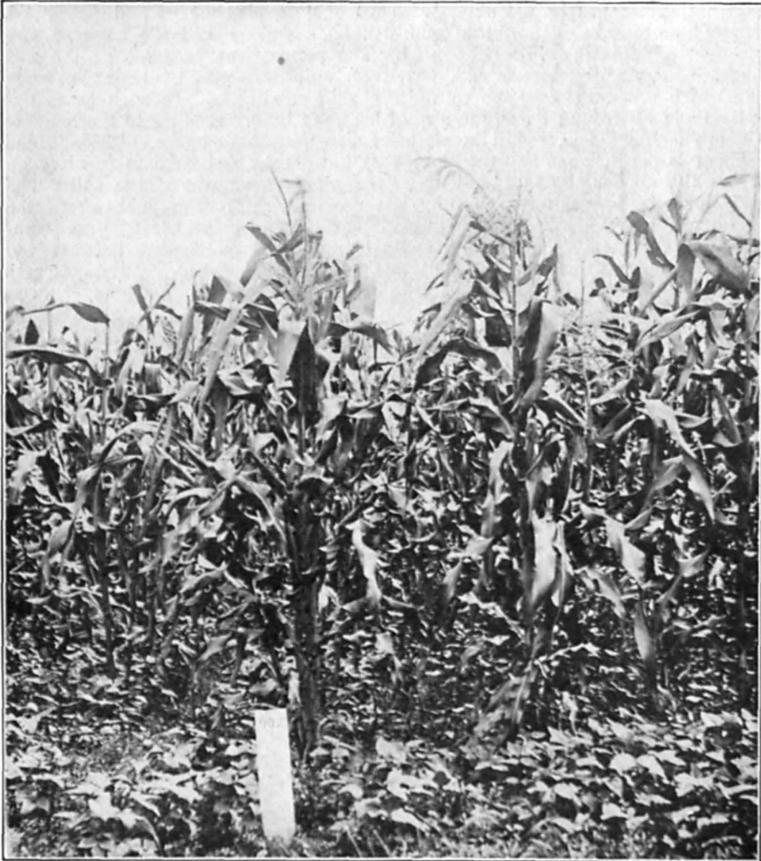
vided there is proper inoculation. Thus enough phosphorus and potassium must be present; if not, the crop will be a failure and the expense and trouble of planting will be wasted. The reaction or sourness of the soil must be carefully determined, particularly in the case of legumes, some of which are very sensitive to slightly acid conditions. In such cases applications of ground limestone should be made before seeding to the legume. Where legumes are used it is essential also that there be inoculation. The proper bacteria must be present so that the plants may take their nitrogen from the air and be independent of the nitrogen supply of the soil. The soil may be inoculated either by the use of soil from a field where the legume has previously been successfully grown or by the use of pure, commercial cultures. The former method is still recommended because the latter is not yet certain. Inoculation by using from 300 to 500 lbs. per acre of soil from a well inoculated field of the same legume have never been known to fail.

#### *THE EFFECT OF GREEN MANURES ON SUCCEEDING CROPS*

Many experiments have been carried out showing the effects of green manures, notably legumes, on succeeding crops. While of course these effects vary with the crop employed, as well as with the local conditions, they have in most cases been very striking. For instance, red clover has been shown to increase the succeeding crop of corn to the extent of 20 bushels per acre, and the following crop of oats to the amount of 10 bushels per acre. Potatoes have shown a 30 bushel increase when grown following red clover as a green manure. Cowpeas have given similar increases under certain conditions and other legumes have caused varying increases in subsequent crops. Occasionally some crop may be unfavorably affected by the use of green manures. The large amount of organic matter sometimes leads



• Cowpeas in Oat Stubble



Cowpeas in Standing Corn

to the extensive production of nitrates which may cause the increased development of leaves, and delay the ripening of some fruits, or cause the lodging of some grains. With these few rare exceptions, however, green manures have been shown to increase the yields of subsequent crops to a profitable extent.

#### *THE PLOWING UNDER OF GREEN MANURES*

The time of plowing under green manure crops will be determined by various factors, among which are the season of growth of the plant, the condition and character of the soil, and the weather and other seasonal conditions. The crop should be plowed under in a green condition when it is full of moisture as then the decomposition processes are favored and its destruction takes place more rapidly.

If the plants are matured, they have become woody in structure and decompose very slowly and may cause drying out of the soil by the increased evaporation which they cause. If a heavy green manure crop is plowed un-

der when the soil is dry, and in warm, dry weather, the soil may be injured by the reduction of the moisture content and succeeding crops may suffer for lack of water. On the other hand, if green manures are turned under in the late fall, the decomposition processes are very slow and acid conditions may be developed in the soil. In short, the ideal conditions for the decomposition of green manures are abundance of moisture and a moderately high temperature. When fall sown crops are to follow green manures the green manure should be turned under at least four weeks prior to the planting of the crop and the soil thoroughly harrowed and compacted to insure proper decomposition of the green matter.

### CONCLUSION

In conclusion, the importance of green manuring in all systems of permanent agriculture cannot be too strongly emphasized. In no other way can the humus content, and therefore the fertility, of a soil be as cheaply maintained.

The manure produced on the live stock farm, although it does constitute a means of returning to the soils of such farms a portion of the fertility removed by crops, is insufficient to keep the soil fertile. In grain farming, when the produce is sold, there is absolute necessity of some means of returning valuable constituents, for on these farms the manures produced are of little significance, representing as they do such a small portion of the crops grown. It makes no difference therefore, whether grain farming or live stock farming is practised, no rotation of crops which does not permit of the introduction of some "cover" or "catch" crop should be considered satisfactory.

The wearing out of Iowa soils is no idle prophecy, it is a reality, which is now close upon us. Already some Iowa soils are beginning to decline in fertility as evidenced by decreasing crop yields and the reason is that proper methods of farming are not practised.

Every farmer should consider well the essential factors influencing soil fertility, which have been enumerated in this circular. He should use all precautions that his soils do not become infertile because of improper rotations, poor drainage, lack of care in the preparation of the seed bed and the cultivation of the crop, insufficient plant food, the development of acid conditions, or deficiency in humus content. Observing all these precautions there is no need of Iowa soils wearing out; and neglecting them there is no doubt but that such a wearing out will occur.