

Oregon Agricultural College

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IMPROVING SANDY SOILS BY THE USE OF GREEN MANURE CROPS

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IMPROVING SANDY SOILS BY THE USE
OF GREEN MANURE CROPS

BY

R. W. ALLEN, Superintendent

AND

W. K. DEAN, Assistant

Improving Sandy Soils by the Use of Green Manure Crops

The arid soils of Oregon tend to be deficient in organic matter and nitrogen. This deficiency has a marked effect on the duty of water and the productiveness of such soils. Silt loams, volcanic ash, and fine sandy loams are not so greatly in need of this organic matter and nitrogen as are coarse sandy loams. These latter, in order to insure a high duty of water, must be abundantly supplied with such organic matter.

The initial cost of water rights and the development of irrigated land render immediate returns necessary to most farmers. The deficiencies of the coarse sandy loams require rapid and economical correction. Such effective improvement can be brought about by use of green manure crops or stable manure.

Green manure crops are those grown and worked into the soil for the purpose of improving its condition. Any crop that makes a large growth can be used to advantage for green manuring. Legumes are of the greatest value, especially for soils deficient in nitrogen, owing to the fact that through them this element, nitrogen, is gathered from the air and supplied to the soil, and in turn to the organic matter which the soil nourishes. Non-nitrogenous crops, such as rye, millet, etc., do not increase the supply of nitrogen, the most expensive element of soil fertility, which is procured in the cheapest manner by growing legumes. Stable manure is unobtainable in sufficient quantity for general use in the arid regions of Oregon, especially by orchardists. Hence the search for a profitable green manure crop.

To determine the cheapest and most rapid means of fertilizing land for which stable manure is not available, a large number of crops and methods of handling them have been tried. The cheapest manure crop is one that will grow at low temperatures; since it is thus capable of using winter precipitation to advantage. Moreover, it does not interfere with the production of cash crops, since it is plowed under in the spring

and leaves the land available during the summer. Our experiments in this work have shown hairy vetch (*vicia villosa*) to be the most valuable green manure crop for Eastern Oregon.

NEEDS OF ARID SOILS

The undeveloped arid lands of this region require an adequate supply of nitrogen and decaying organic matter (humus), before they are brought to the highest stage of productivity. The shortage of nitrogen in arid soils is due largely to the lack of humus, the media in the soil in which practically all the nitrogen is found. The process of growth and decay of vegetation in a soil materially increases the availability of important elements required in plant growth, such as phosphoric acid, potash, lime, etc. Organic matter, being sponge-like in nature, retains moisture effectively, thereby increasing the duty of water applied to the land; it forms a medium necessary for the growth and activity of bacteria, which hasten decay and make available for other plants the fertilizing materials contained in the humus; it assists in the liberation of mineral plant food from the soil particles; it serves as a retainer of soluble elements of fertility; and it diminishes erosion by wind and irrigation water. Where organic matter is present in sufficient quantity, commercial nitrogen can usually be applied without sustaining heavy losses through leaching.

Another great function of organic matter in coarse soils is to increase their water-holding capacity, thus preventing rapid fluctuation from a saturated condition to the wilting point. Again, less frequent irrigation is necessary, and thereby the labor required for irrigating is diminished. The conveyance losses of irrigation water are reduced; the rapid movement of water under the influence of gravity is prevented; and the loss by deep percolation is lessened.

The purchase of land and water rights and the improvement of such lands mean a considerable cash outlay before a revenue can be realized. It becomes highly desirable, therefore, that such raw lands be so treated that they will produce profitable crops in the shortest time possible. To accomplish

this, steps to increase the productivity of the soil must be taken at once. The most feasible and effective means of increasing soil fertility is either by the growing of green manures or the addition of stable manure. The cheaper method, which can usually be followed at a profit, is to grow and feed forage on the farm, returning the vegetable matter to the land. The growing of green manure crops is of the greatest importance in orchards and other places where the combined industry of dairying and hog raising is usually not considered feasible. Succulent green crops decay much more readily than stable manures, and supply available plant food for succeeding crops planted on the land.

The time required to grow green manure crops is an important factor. Some require one or more summers in which to attain sufficient size to be of use, others grow large enough in one season to be of value, while a number grow at low temperatures and will produce a vegetation sufficient for a manure crop after the harvest of the cash crops one year and before seeding time the next; that is, winter green manure crops. The production of summer green manure crops is more expensive, since they require the use of the land during the growing season, and prevent the growing of summer cash crops. In addition, the summer green manure crops require more labor and water for irrigating.

SEARCH FOR CROPS

A large number of plants, chiefly legumes, have been grown in this search for a profitable green manure crop. As a result of this work, which was begun in 1909, it has been found that hairy vetch is the most valuable crop for light soils under irrigation. It gave fair results the first year, and has been extensively grown on the farm since that time. Canadian field peas, if planted early in the spring, do fairly well on land that has been cropped for a time. Warm weather is detrimental to them, and if planted late they do not succeed. Soy beans are an excellent summer crop, but they require almost the entire summer season to make sufficient growth for use as green manure. Where rabbits are not under perfect

control, it is difficult to grow soy beans, for the small plants will be destroyed as soon as they appear. Figure 1 shows a maximum growth of soy beans, produced without inoculation.

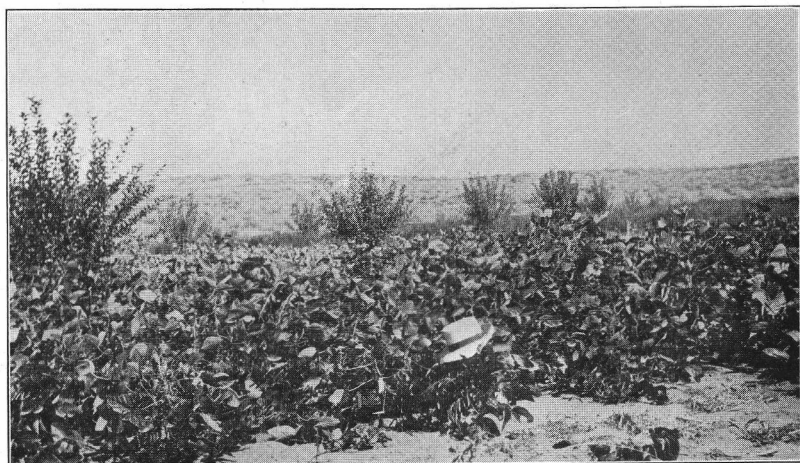


Fig. 1.—SOY BEANS SHOWING MAXIMUM GROWTH, SEPTEMBER 15, 1913, THIS IS A PROMISING SUMMER GREEN MANURE CROP.

Sweet clover (*Melilotus alba*), sown in April or May on fair soil will usually be large enough to plow under in the fall, but it is as difficult to start as alfalfa and is not an economical one-year crop. Red clover is also a very good crop, but it requires considerable time to develop. Rye, being very hardy, is the most successful crop to plant on shifting or exposed soils, to prevent erosion. As a green manure it is inferior to legumes, on account of the fact that it does not store nitrogen. A number of crops that have been tried and found unsuccessful are Crimson or Scarlet clover (*Trifolium incarnatum*), Alsike or Swedish clover (*Trifolium hybridum*), Burr clover (*Medicago maculata*), Japan clover (*Lespedeza striata*), Espercette or Sanfoin (*Onobrychis sativa*), Lentils (*Lens esculenta*), Fenugreek (*Trigonella Fenum-Groecum*), Velvet beans (*Mucuna utilia*), Cowpeas (*Vigna sinensis*), Niles peas, and Spring or Common vetch (*Vicia sativa*). Cowpeas made a fair growth and set a large amount of seed that ripened quickly, shattered, and were found to be shriveled; on fertilized soils cowpeas might be a successful summer crop.

HAIRY VETCH AS A GREEN MANURE CROP

Hairy vetch is variously known as sand vetch, winter vetch, Russian vetch, and common vetch. The first and most generally applied name is derived from the hairy appearance of the plant. From its adaptability to sandy soils it has derived the name of sand vetch. It was introduced from Russia, hence the name Russian vetch, while the name common vetch has evidently been attached to it in some locality where it has become more common than any other varieties. The last name is misleading and should never be used.

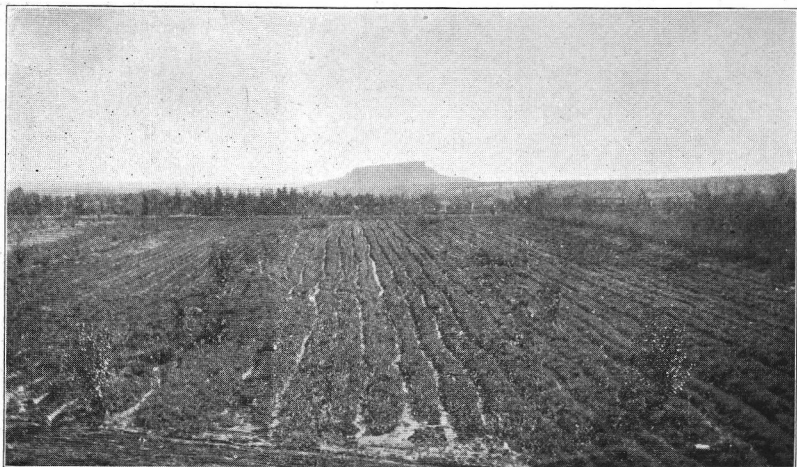


Fig. 2.—HAIRY VETCH, SOWN IN SEPTEMBER AND PHOTOGRAPHED OCT. 15, 1911, SHOWING MAT OF GROWTH MADE IN SHORT TIME.

The value of hairy vetch for soil enrichment and forage purposes is not fully appreciated. The superior value of this vetch depends upon its habit of growth; the large amount of nitrogen it accumulates,—which, per unit of dry matter, is greater than any other legume grown in this locality; its ability to withstand alkali, temporary heat, drouth, and cold. It is very persistent if allowed to develop seed. This habit of persistence, however, is not frequently objectionable, since it renders reseeding of orchards and pastures unnecessary.

In some places vetch is highly prized as a pasture crop, but it is of greatest value in arid regions of Oregon to enrich new land, on which it grows very well. Vetch is not an objec-

tionable weed except in wheat fields, since it enriches rather than depletes the soil, and is not difficult to control. It prefers a fairly rich, well-drained soil, but thrives on either heavy or light soils where there is not too much or too little moisture.

The best success has been derived from sowing early in the fall, from August 15 to September 15. If irrigated at the



Fig. 3.—HAIRY VETCH SOWN IN SEPTEMBER, 1913, PHOTOGRAPHED MAY 15, 1914, SHOWING HEAVY GROWTH RESULTING FROM EARLY SEEDING AND LIBERAL IRRIGATION.

time of planting, and on some soils a few days later, vetch will make a strong growth and be in proper condition to withstand cold winter weather. Late seeding suffers some loss by severe winters and on very coarse soils, but the plants that survive make an early start and usually are ready to plow under by May 1 to 15, sometimes without irrigation, but usually with one and sometimes two irrigations.

A chain or rolling coultter will assist in turning under rank crops of vetch, and if the crop is very heavy, rolling it before plowing, so as to break it down the way the plow is to go, will be a great help. Where irrigation water is available, plowing should not be done until the crop is almost fully grown, or until it is as large as can be turned under satisfactorily, since drying out of the vegetation and the furrow slice can be prevented, and rapid decay accomplished by liberal use of water. Soon after plowing, the ground should be thoroughly



Fig. 4.—FIRST CROP OF VETCH GROWN ON FINE SANDY LOAM WITHOUT INOCULATION, MAY 13, 1913.

worked with a disk harrow, in order to settle it. When grown on firm ground, the crop should be cut up with a disk before plowing; this cannot be done on loose soils, as loosening of the surface soil prevents thorough turning.

An average crop of vetch on land that has been worked for a time will weigh three to three and one-half tons green, and one to one and one-fourth tons cured. A crop of nine tons of green material has been produced by an abundant use of water. The quantity of stubble and roots is about one-fourth as great as the tops.

Vetch hay contains 2.52% nitrogen, or 50.4 pounds to the ton; the stubble and root system contain 1.79%, which would equal 35.8 pounds to the ton, making a total of 75.18 pounds of nitrogen for each acre of land producing $1\frac{1}{4}$ tons of hay. The quantity of nitrogen incorporated in the soil with a $1\frac{1}{4}$ ton crop of vetch would equal an application of 484.2 pounds of 15.32% nitrate of soda, which at \$66.10 a ton (the cost in quantities less than a carload at Hermiston) would cost \$16. A crop of vetch yielding $1\frac{1}{4}$ tons of hay that contains 74.18 pounds of nitrogen can be grown for \$10, or less. This makes a saving of \$6 an acre or more, in addition to the quantity of organic matter added, the value of which, although difficult to estimate, is considered to be great.

The real value of the vetch crop as an agent for increasing soil fertility, especially for the light soils of the Columbia River Valley, can hardly be overestimated. The fact that it is the most economical and the most effective fertilizer available recommends it for extensive use.

When vetch is sown on new ground, the growth is usually uneven, on account of the spotted condition resulting from grading. Vigorous, dark-colored plants will usually be found to have nodules on the roots, while those that are poorly colored and growing slowly have none. The extent of inoculation that occurs on new land without treatment will be found to vary with the quantity of organic matter in the soil. Vigorous growth and nodules are seldom found the first year, and frequently not the second year, where the surface soil has been removed by grading. Inoculation is of considerable advantage in starting vetch, and can be effectively and cheaply accomplished by applying from 200 to 500 pounds of soil from an inoculated field to each acre of new land.

Practically all of the seed of hairy vetch is imported and costs from 10 to 20 cents a pound. It is difficult to harvest on account of uneven ripening and shattering. Vetch planted for seed should not be mixed with rye, since the two are difficult to separate. The rye produces more seed, and if



Fig. 5.—HEAVY CROP OF VETCH AND RYE BEING CUT TO PIECES BEFORE BEING PLOWED UNDER, MAY 10, 1913.

sown in this way will predominate and crowd the vetch out. The amount of rye seed can be greatly diminished, where the two are growing together, by pasturing the field a short time when the rye is heading out. If this is done early enough, the vetch will not be injured. The seed of this vetch is relatively small. Its most common adulterant is the large gray seed of *Vicia sativa*, spring vetch, which can be easily detected. Spring vetch produces seed in abundance, is easily harvested, and costs about three cents a pound. This vetch, however, is killed by the extreme winter weather in Eastern Oregon, and

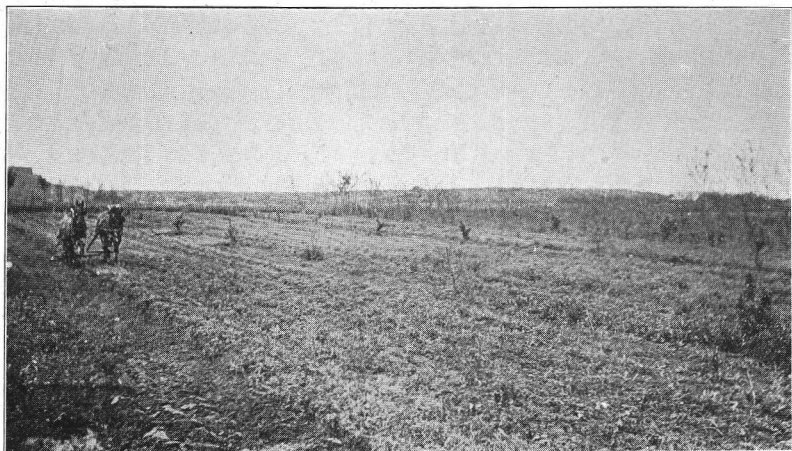


Fig. 6.—PLOWING CROP UNDER AFTER CUTTING IT UP WITH DISK HARROW, MAY 10, 1913.

is, therefore, not suitable for this climate, although considerable of it has been sold to purchasers unfamiliar with it.

The amount of hairy vetch to sow to the acre has been variously recommended as from 20 to 60 pounds. The high cost of seed prevents many from profiting by its use. This is unnecessary, however, as it reseeds readily, and if allowed to do so will last indefinitely from one planting. For gardens and for such other places as require being kept clean, annual seeding is necessary; but in orchards where a strip can be allowed to mature each year, it can be spread about and worked into the ground in the fall, irrigated, and started for the ensuing crop. This method prevents keeping the orchard



Fig. 7.—TURNING UNDER MAXIMUM CROP OF VETCH AND RYE WITH TWO-WAY PLOW, MAY 15, 1914.

clean, as many growers desire, but saves considerable expense, is very effective, and can be kept up indefinitely. Each succeeding crop grown on the land appears to be better than the previous one. The seed should be sown with a drill about two inches deep to insure even germination.

An experiment to determine the proper ratio of rye to vetch seed for a desirable crop shows that 10 or 20 pounds of rye and 20 pounds of vetch to the acre is sufficient if the seed germinates well. The rate of seeding should be increased in poor or coarse soils. A greater amount of rye frequently results in crowding out the vetch. When 30 or 40 pounds of rye was sown with 20 pounds of vetch, the latter was almost completely destroyed early in the spring.

EFFECT OF GREEN MANURE CROPS ON LAND

The growth and incorporation of a heavy crop of vetch and rye into a loose sandy soil for four successive years on the Umatilla Experiment Farm has made quite a perceptible change in the physical condition of the soil. It has rendered it less subject to blowing and washing, facilitated irrigation, appears to have increased the water-holding capacity of the soil, and has made a very noticeable increase in crop produc-

tion. One heavy, green manure crop is not sufficient to make a perceptible improvement in such a soil, but it appears that a continued practice of growing and plowing under a crop each year will accomplish and maintain a high degree of fertility, and by increasing the fiber content of the soil will raise the duty of water to a much more economical point.

An annual green manure crop supplemented with an occasional light application of fine or decayed stable manure appears to be more effective than the crops alone. Either stable or green manures require liberal irrigation to hasten decay.