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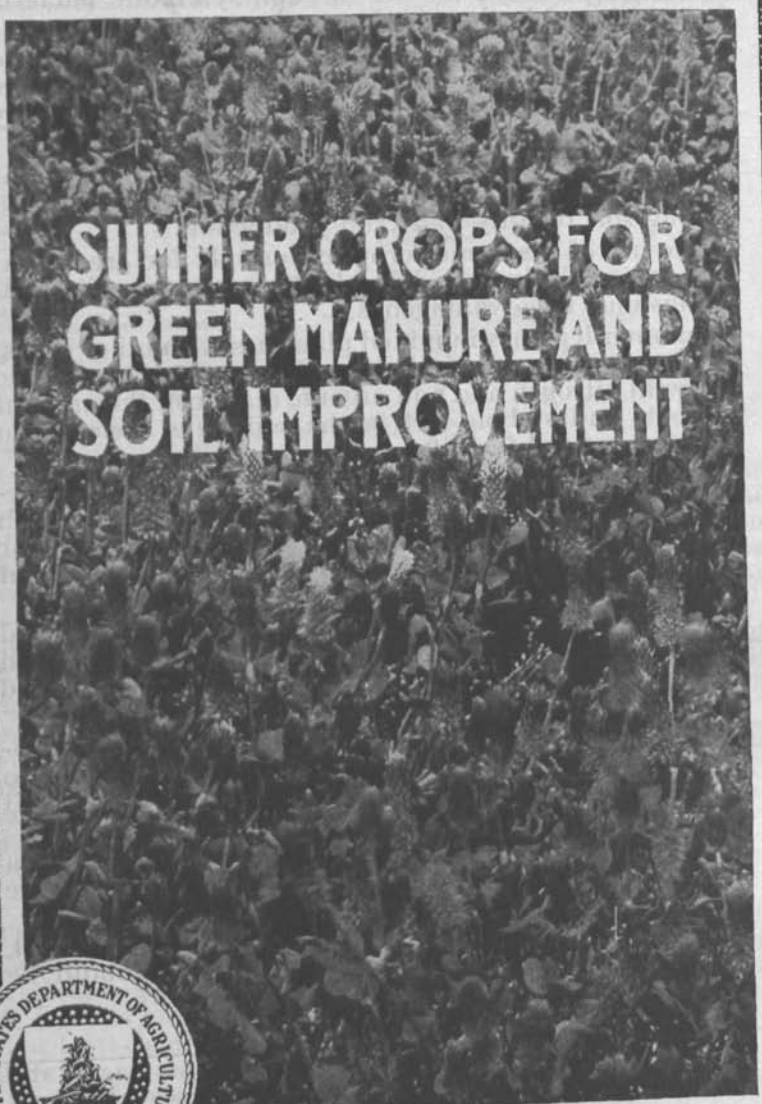

THE CROPS most commonly used for summer green manure and soil improvement are alfalfa, red clover, soybeans, cowpeas, velvetbeans, sweetclover, crotalaria, and lespedeza. These are all legumes, which take nitrogen from the air through symbiotic bacteria that are found in the nodules on the roots.

When the object of green manuring is primarily to supply organic matter, nonlegumes such as Sudan grass, mustard, sorghum, or other plants which make heavy yields may be particularly serviceable.

The use of legumes in rotation as one of the regular cash crops is one of the most economical ways of maintaining soil fertility and crop production.

The use of a summer crop exclusively for green manure generally is not advisable, but under special conditions may be advantageous.

Summer legumes in mixed plantings with other crops, and in rotations where they are used as hay, enrich the soil with nitrogen and add organic matter in the amount of roots and stubble left in the soil, thus assisting in maintaining soil fertility.

A crop turned into the soil during warm weather decomposes rapidly, and the plant food liberated by such decomposition may be carried away by leaching or escape as gas if a growing crop is not present to prevent such loss.

A summer green-manure crop should not be plowed down in late summer or early fall unless it is followed with a winter crop to prevent the loss of the plant food liberated during decomposition.

When a winter crop does not follow a summer green-manure crop the summer crop should be allowed to stand through the winter or should be mowed and left on the ground as mulch.

Ordinarily 2 weeks, at least, should elapse after a heavy green-manure crop has been turned down before the succeeding crop is planted.

When hard seed is present in an appreciable amount, as in crotalaria and sweetclover, the seed should be scarified before it is planted.

Washington, D. C. Issued September 1935

SUMMER CROPS FOR GREEN MANURE AND SOIL IMPROVEMENT

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INTRODUCTION

THE USE of summer crops for green manure is not as common a practice as the use of winter crops for that purpose. This is for the simple reason that the summer season is the time when most cash crops must be grown. To use the land exclusively for a summer green-manure crop would preclude the possibility of growing a regular summer cash crop. Winter green-manure crops occupy the land at a time that interferes but little, if any, with the regular cash crop and, therefore, ordinarily can be used more economically than summer crops. The use of summer green-manure crops, however, is to be recommended under certain conditions.

Summer crops at once assume great importance when legumes or other crops in rotations for soil improvement are considered, and such practice is recognized as a means of maintaining soil fertility and insuring increased crop yields.

CROPS COMMONLY USED

The summer crops commonly used for green manure and soil improvement are such legumes as alfalfa, red clover, soybeans, cowpeas, velvetbeans, sweetclover, crotalaria, and lespedeza. Other crops, both legumes and nonlegumes, are used to a lesser extent under special or local conditions, as indicated under the several crop headings.

Alfalfa and red clover are used in rotations as cash crops, as crops to turn under for green manure, and as permanent cover crops in orchards; soybeans, cowpeas, and velvetbeans are used in rotations as cash crops, as crops to turn under for green manure, and as crops to grow in combination or intermixed with corn. Sweetclover is used in rotations as a cash crop and as a crop to turn down for green

manure; lespedeza (fig. 1) is used as a cash crop in rotations and, to a limited extent, for green manure. Crotalaria (fig. 2) is used exclusively for green manure.

NONLEGUMES FOR GREEN MANURE

While legumes are generally recognized as the most desirable green-manure plants, under certain conditions nonlegumes may be used more profitably. When the period is very short during which the green-manure crop can occupy the land, as is usually the case in

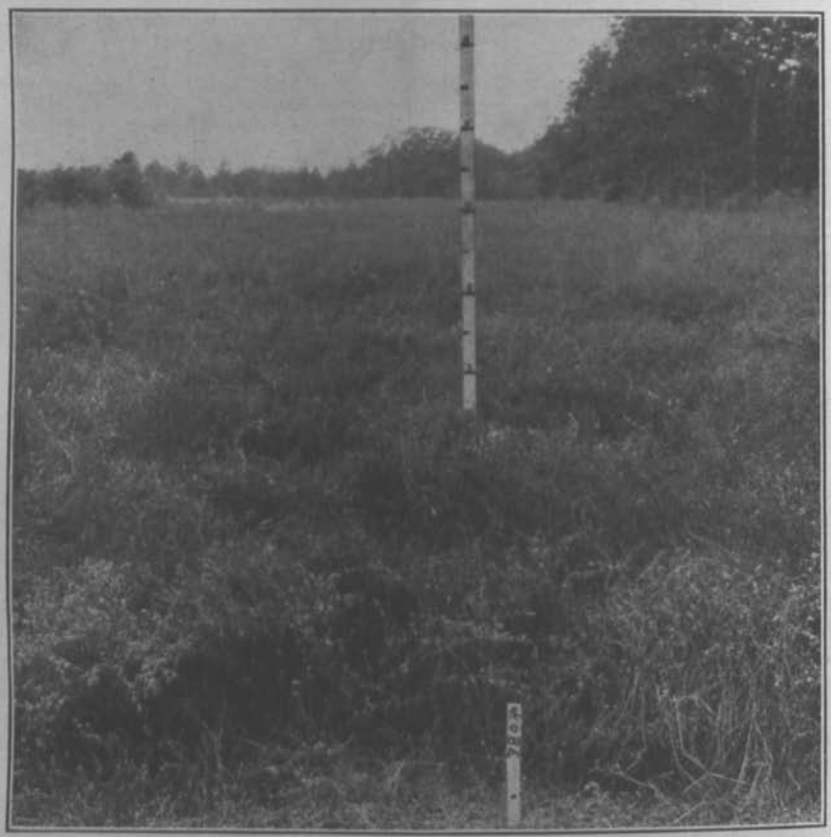

FIGURE 1.—Kobe, a variety of common lespedeza.

truck growing, it is desirable to plant a crop that will make the most growth in the time available. Under such circumstances, Sudan grass (fig. 3) or one of the sorghums often can be used to advantage; or, in certain parts of the South, pearl millet might be a serviceable crop.

In improving poor or worn-out soils, a nonlegume, such as buckwheat, sometimes serves better than any legume. When the objective is to supply organic matter to the soil, the crop that will produce the most growth in the time available should be chosen, whether a legume or a nonlegume.

INOCULATION

Artificial inoculation should be supplied when planting legumes on land that previously has not grown the crop, unless it is definitely known that the soil carries the necessary inoculating organism.

FIGURE 2.—*Crotalaria spectabilis* planted in wide rows.

Whenever possible, a small amount of soil from a local field that has grown a well-inoculated crop the previous year should be mixed with the seed, or 500 pounds per acre of such soil should be spread over the field prior to seeding. It is also advisable to use commercial

cultures which can be purchased through seed dealers. Directions for the use of such cultures will be found on the packages.

Florida beggarweed, cowpeas, Deering velvetbeans, crotalaria, lespedeza, and common sesbania usually are naturally inoculated in regions to which they are climatically adapted, and all are inoculated by the same organism.

Alfalfa and sweetclover likewise have a common inoculating organism but, unlike the previous group, often need artificial inoculation when being grown for the first time. This is especially true in the eastern half of the United States.

FIGURE 3.—A heavy growth of Sudan grass.

Red clover and soybeans require distinctive inoculating organisms different from those required by any of the other crops mentioned. None of the common legume crops are inoculated by the same organism as the soybean. When this crop is being grown on land for the first time it always requires artificial inoculation. Red clover requires a different organism from the other crops but seldom requires artificial inoculation because of the wide distribution of wild and cultivated clover.

FERTILIZER

Whether commercial fertilizer should be used on a summer green-manure crop can usually be determined by observing the local practice with the same crop when grown for immediate cash returns. Ordinarily heavy growth is desired in a green-manure crop, and

when at least a fair growth cannot be attained without the use of fertilizer an amount sufficient to give a good yield should be used.

HARD SEED

Many summer legume crops contain a high percentage of hard seed or seed that will not germinate readily without scarification. All such seed should be scarified before it is planted, if prompt germination is desired. A number of scarifying machines, all based on the principle of scratching or breaking the seed coat, are on the market. Scarification is accomplished in part when seed is threshed or hulled. Hullers with rasp cylinders and concaves usually scarify a high percentage of ordinarily hard seed.

A barrel, as described in Leaflet 107, The Barrel Seed Scarifier, or a concrete mixer has proved to be quite effective and often can be used conveniently when other means of scarifying are not available. Equal parts by volume of seed and stones about three-fourths of an inch in diameter should be placed in the barrel or concrete mixer and revolved slowly for about 1 hour. If the amount of gravel is increased, the time required for scarifying will be lessened. Each year before planting time, seed tests should be made to determine the amount of hard seed and the percentage of germination of the seed that is to be planted. Such tests will indicate in a few days whether or not scarification is necessary.

SEEDING

General information regarding seeding is given in table 1. More specific information is given under each crop heading. Under time of seeding, the designations are necessarily general. Most of the spring-sown plants are summer annuals and should not be planted until all danger of frost is past. The few plants that require late-winter planting are fairly hardy and should be well established before warm weather. The rate of seeding will vary with climatic and soil conditions, but usually should be within the limitations given.

Common lespedeza, Korean lespedeza, alfalfa, sweetclover, and red clover should be seeded in late winter or early spring. The other crops listed in table 1 should not be seeded until all danger of frost is past.

TABLE 1.—*Rate of seeding summer crops for green manure and soil improvement*

Crop	Quantity needed to plant 1 acre		Crop	Quantity needed to plant 1 acre	
	Broadcast or in close drills	In 3-foot rows		Broadcast or in close drills	In 3-foot rows
	Pounds	*Pounds*		*Pounds*	*Pounds*
Alfalfa	15 to 20	3	Red clover	15 to 20	3
Florida beggarweed	15 to 20	3	Common sesbania	25 to 30	4 to 5
Buckwheat	35 to 50	8	Soybeans	60 to 100	20 to 25
Cowpeas	80 to 100	20	Sudan grass	20 to 25	4 to 5
Crotalaria striata	15 to 20	4	White sweetclover	15 to 25	3 to 4
Crotalaria spectabilis	20 to 30	6	Yellow sweetclover	15 to 25	3 to 4
Common lespedeza	15 to 20	3	Deering velvetbeans	100 to 120	25 to 30
Korean lespedeza	15 to 20	3½			

DECOMPOSITION

A green-manure crop decomposes readily when incorporated with moist soil. In warm weather with moisture present almost complete decomposition may take place in less than 6 weeks. Young, succulent material decomposes much more readily than older or mature plants.

Fertility liberated in the process of decomposition should be utilized immediately by growing plants, or it will be lost by leaching or escaping into the air in the form of gas.

These facts should be kept in mind in utilizing green-manure and cover crops or any kind of crop residue.

TURNING UNDER

A green-manure or cover crop may be left on the surface, or it may be incorporated with the surface soil by disking or plowing. When it is incorporated with the soil, care should be taken not to leave the green-manure material in bunches or layers that will not decompose readily. Large quantities of undecomposed material will tend to make the surface soil dry and result in a poor seed bed and a condition unfavorable for good crop growth. When ample moisture is present, a crop completely turned under ordinarily will decompose more rapidly than one left on the surface or only partially turned under. Whether a green-manure crop should be completely turned under, partially incorporated, or left on the surface of the soil should be considered further in connection with (1) maturity of the crop, (2) time of year, (3) length of time that will elapse before the growth period of the succeeding or cash crop, (4) nature of the succeeding or cash crop, (5) type of soil, and (6) moisture supply.

A young succulent plant will decompose more readily than mature material.

In hot weather, decomposition is most rapid and, conversely, in cool weather, is retarded. A green-manure crop turned down in late winter will not decompose so rapidly as one turned down in late spring.

It is desirable to have the crop turned down a sufficient length of time before an annual crop is planted to enable the material to pass through the first stages of decomposition in order that the plant food thus liberated may be available to the growing crop during its early development and rapid-growth period. Seeding a crop immediately after turning under a green-manure crop will sometimes result in injury to the young seedlings. In experimental planting it has been found advisable to let 2 weeks elapse before planting corn and 3 weeks before planting cotton. In the case of permanent crops, such as trees, exact information is lacking, but it is assumed that the green-manure or cover crop should be decomposed if possible just before the rapid-growth period of the permanent crop.

Whether a green-manure crop should be plowed under or worked into the soil lightly when used in orchards depends somewhat on the activity of root growth of the trees at the time of such plowing or cultivation. If the roots are in active growth they should be disturbed as little as possible, but if dormant, deeper cultivation may be given.

Organic matter usually can be incorporated into heavy clay soils without serious danger of loss from leaching, since leaching in such soils takes place slowly. In the case of sandy or porous soils, leaching is rapid, and it is important to have the green-manure material nearly mature and to leave it at the surface so that decomposition and leaching may not be too rapid.

When ample moisture is present and the temperature is sufficiently high for plant growth, decomposition goes on rather rapidly under almost any soil condition. In general, however, decomposition is retarded by leaving the green-manure material on the surface or working it in but lightly or partially.

Other factors, too, are involved, such as the effect on crops of plowing or working the soil at certain times of the year, and these must be given some consideration in handling the green-manure crop.

TYPES OF SUMMER GREEN MANURING

The use of summer green manure should be considered not only from the standpoint of increased crop yields, but also with reference to cash returns in connection with the crop that it is to precede or supplement. If a green-manure crop is to have exclusive use of the land for an entire season its use must be justified by the returns from increased crop yields in subsequent years. Sometimes it is possible to grow a green-manure crop and a cash crop the same season, but more often when a cash crop is grown every year it is necessary to obtain the green manure by interplanting with the main crop or merely by using the residue of the main cash crop to supply the organic matter. The use of the words "green manure" in this way somewhat broadens the usual meaning, but the addition of organic matter to the soil in any way is in effect green manuring and must be considered in a discussion of the subject.

Under this broader definition of the term, there are four types of summer green manuring that need consideration, viz: (1) Using the crops exclusively for green manure, that is, the green-manure crop occupies the land the entire season to the exclusion of any other crop; (2) growing a green-manure crop intermixed with the main crop but subsidiary to it; (3) growing a green-manure crop in midsummer or late summer following a cash crop; (4) using legumes in rotation with other crops and treating the stubble or aftermath of the legume as a green-manure crop.

These several types or kinds of summer green manuring can best be discussed separately.

General experience and the limited experimental data available indicate that the giving over of the entire crop season to the exclusive use of a green-manure crop is seldom profitable. This practice perhaps is justifiable only when the succeeding crop is more or less permanent and the establishment and good growth of the seedlings or young plants are of prime importance. Where early fall seeding of lawns can be practiced or is advised, a summer green-manure crop of soybean, cowpea, or other legume can well be used to prepare the land to receive the grass seeding.

In the South when a summer legume is plowed down in early fall it should be followed with rye or some other winter-growing crop

to prevent the leaching of the plant food released in the decaying of the turned-under crop. When a summer green-manure crop is not followed by a winter crop, the summer green manure should not be plowed under green but should be cut in the fall and allowed to remain on the surface as a mulch or should be lightly worked into the soil, so as to delay decay and prevent loss during the winter months.

In northern latitudes there is relatively little leaching during the winter period; consequently it is seldom profitable to grow a crop merely to prevent this relatively small loss. In the case of abandoned or worn-out lands a legume might well be sown to occupy the land more or less permanently, and where seed of a satisfactory

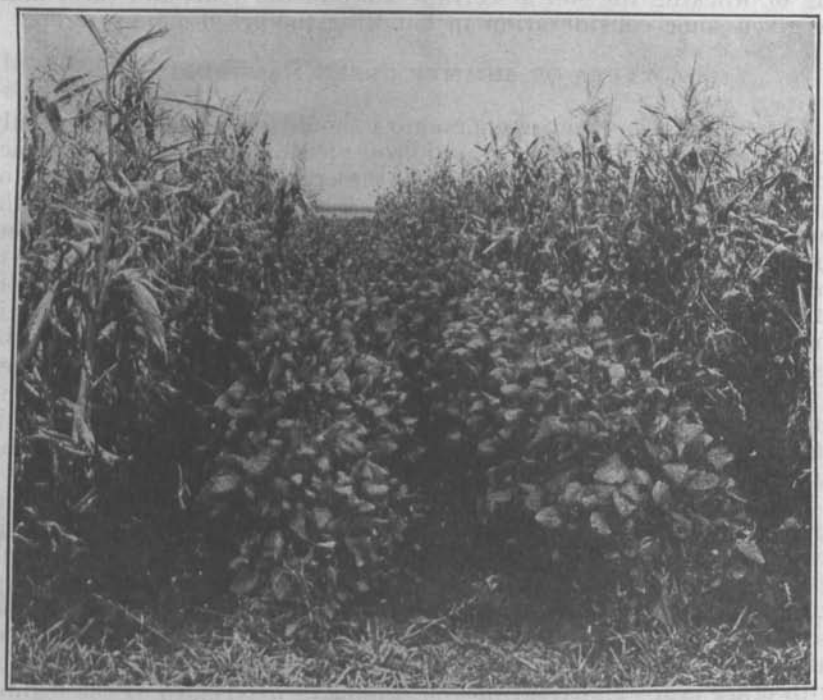

FIGURE 4.—Corn interplanted with soybeans.

legume is available at a reasonable price such a procedure is to be advised. In certain parts of the South lespedeza and crotalaria can be used in this way.

When a nonlegume, such as corn, is the main cash crop the use of a legume intermixed in the planting, or interplanted, will furnish valuable organic matter and in part have the effect of a crop rotation. Soybeans and velvetbeans are commonly planted with corn in this way in the Cotton Belt, and the practice is to be recommended (fig. 4).

Sometimes a green-manure crop can be planted in late spring or midsummer following an early cash crop such as wheat, oats, or some truck crop. As to whether a crop thus grown can best be used exclusively for green manure or in part for forage and part for green

manure will have to be determined by the probable cash value to the succeeding crops and the value of the forage that might be obtained. Where crotalaria is well adapted it can be used to advantage in this way for a green-manure crop. A good green-manure crop can be assured by broadcast seeding the crotalaria in oats in late spring, which will in no way interfere with the growth of the oats or harvesting them. The seeding of the crotalaria should be fairly late; if the oats are sufficiently small to permit of a light harrowing to cover the crotalaria seed, this is a good practice.

The use of legumes in rotation as one of the regular cash crops is a common practice and one of the most economical ways of maintaining soil fertility and crop production. The stubble of the legume returns to the soil considerable organic matter that is high in nitrogen and that costs practically nothing (fig. 5).

FIGURE 5.—Crimson clover and grain stubble being turned under for soil improvement.

In the South, especially on light soils, if maximum results are to be obtained, when stubble or other crop residue is plowed under in early fall, rye should follow as a winter crop to prevent leaching and loss of the plant food liberated by decomposition.

COMMON ALFALFA

Common alfalfa (*Medicago sativa* L.), a long-lived upright perennial, while primarily a hay crop, is valuable in crop rotation and is used effectively as a green-manure and cover crop. In the irrigated apple orchards of the Rocky Mountains and the Pacific Coast States, it is being used with excellent results as a cover crop, and in the truck-crop areas of the Southwest it has been found to be one of the best crops to precede or rotate with lettuce, cantaloup, or similar crops. When common alfalfa is grown in an orchard, the entire crop should be allowed to remain for mulch or cover. It can

be cut at intervals, or allowed to stand and mat down without being cut. Disking the orchard during the fall and winter months is a common practice. This reduces the fire hazard from accumulated dry material, incorporates some of the organic matter with the soil, destroys hiding places or nests of insects and rodents, and puts the ground in shape to facilitate furrowing for irrigation.

In growing common alfalfa in orchards with trees under 4 years old, care should be exercised to see that the trees get sufficient water and plant food. When the trees are older and more deeply rooted there is less danger in this connection. When common alfalfa is grown in orchards or elsewhere for green manure or cover, the time, rate, and method of seeding are the same as when the crop is grown for hay or other purposes.

BUCKWHEAT

Buckwheat (*Fagopyrum esculentum* Moench.) is a very old crop, having been used in Asiatic and European countries from very early times. In the United States, it is grown mostly in the Northeast, Pennsylvania and New York having half the total acreage. Not being exacting as to soil conditions, it can be grown on poorer soils than most crops. It does well on acid soils, and liming for the crop is seldom necessary. For these reasons, it can sometimes be used in preference to other crops for adding organic matter to the soil. Buckwheat is very sensitive to cold and is very easily killed by freezing. Plantings in the northeastern United States should be made the latter part of June or early in July for best results. The rate of seeding should vary with the fertility of the soil. On rich soils 35 pounds per acre is ample, but on poor soils as much as 60 pounds per acre may sometimes be needed.

COMMON SESBANIA

Common sesbania (*Sesbania macrocarpa* Muhl.) is native to North America and extends as far north as Alabama, Georgia, and Arkansas. In the southwestern part of the United States it occurs in abundance on the overflow lands of the Colorado River, and in Louisiana it is common in the rice fields. In recent years this species has come into commercial use as a green-manure crop and is commonly known in the trade under the name "sesbania." Occasionally it is referred to as wild hemp, but this name should not be used, as the name hemp is commonly used for another class of plants. It is an upright annual legume attaining a height of from 6 to 8 feet. In thin stands it is moderately branched, but in thick stands the lower branches either fail to develop or are shed very early and the upper branches are rather light and leafy.

While common sesbania is primarily a subtropical plant, it will mature seed as far north as Washington, D. C. Where sufficient soil moisture is available or when irrigation is supplied, it does exceptionally well in the Southwest, where the atmospheric humidity is very low. It does not thrive so well in the Southeast, where the rainfall is comparatively heavy and the atmospheric humidity high. This difference may, however, be due more to soil difference than to climatic difference, as the soils of the Southwest are very fertile.

Common sesbania makes but little growth in cool weather but grows very rapidly in high temperatures. In northern latitudes slow growth and small yields are to be expected. It is strictly a summer-growing plant.

Available information indicates that common sesbania does best on rich loam soils. It will grow on poorer lands, but it has done rather poorly in limited tests on poor sandy soils.

The only use made of common sesbania is for green manure. It seems to be disliked by livestock and, so far as known, has no value as forage. In the Imperial and Coachella Valleys of California and in the Yuma and Salt River Valleys of Arizona, common sesbania is used for green manure in connection with winter truck crops. It has also proved adapted to the irrigated lands of the lower Rio Grande in Texas. On account of its rapid growth and the heavy tonnage produced, this crop seems well suited for green manure where the land can be given over to this purpose during the midsummer season.

The seed of common sesbania is comparatively small, and 20 pounds per acre should be sufficient under average conditions. The seeding may be done by broadcasting or drilling; the latter method is more economical and usually gives better stands.

It is not uncommon to find nematodes in the roots of common sesbania, but they do not seem to do serious damage to the plant. In fact, plants with nematodes are often strong and vigorous. While little or no damage may be done to common sesbania, succeeding crops may be attacked by the nematodes, and this must be considered in growing any crop that may be subject to nematode attack.

As the organism that inoculates common sesbania seems to be rather commonly distributed throughout the South, artificial inoculation is unnecessary.

COWPEAS

Cowpeas (*Vigna sinensis* (Torner) Savi) are one of the summer crops most commonly used for green manure in the Southern States. The plants are viny or semiviny, depending on the variety, and are fairly leafy. Under most conditions, cowpeas make a good yield of green manure in comparison with other crops and are also valuable both as a forage and seed crop. Adapted to a wide range of soils, they apparently do as well on sandy soils as on clays. Among the best varieties for use in the South are Iron, Victor, Brabham, and Groit. Seeding should not be done until the ground is thoroughly warmed, as all varieties are susceptible to cold. When planted in rows 3 feet apart, about 20 pounds of seed per acre are required; when sown broadcast, 80 to 100 pounds per acre are needed. Cowpeas are subject to attack by nematodes and a bacterial wilt, both of which often may do considerable damage.

If cowpeas have been grown in a locality for many years, the inoculating bacteria are plentiful, and inoculation usually is not necessary. In new regions, however, especially in the North and West, when cowpeas are grown for the first time, the soil should be inoculated from an outside source.

CROTALARIA

Two species of *Crotalaria* have been used for green manure in the United States, *C. spectabilis* Roth and *C. striata* DC. Other species with similar habits have value for this purpose and are used in other parts of the world.

Both *Crotalaria spectabilis* and *C. striata* behave as annuals in the United States except under almost frostless conditions. They are upright and attain a height of from 3 to 6 feet. A warm season is necessary for their best development. They do not start growth until late and make most rapid growth during July and August. Crotalaria is especially adapted for sandy land. The seed should be planted in late spring, from 15 to 30 pounds of seed being used per acre. The latter quantity should be used, especially when the seed is not scarified or when seeding conditions are unfavorable.

Artificial inoculation seems not to be necessary under ordinary conditions. Crotalaria has been used most extensively in the citrus and tung-oil plantings in Florida, but it has also been used in pecan orchards of the Gulf coast area and for general plantings elsewhere. The yield of green manure is comparatively heavy, the plants decompose readily, and the crop seems well adapted for cover and green-manure purposes. As the percentage of hard seed is usually high the seed should be scarified before being planted.

In the lower South, crotalaria can be seeded in oats in late spring and allowed to grow subsequent to the harvesting of the oats; in this way a good green-manure crop is assured at little expense. The crotalaria will make but little growth before the oats are mature and will in no way interfere with harvesting. The oats serve as a nurse crop, keeping down weeds that otherwise would be in competition with the crotalaria during the early and most critical period of its growth.

FLORIDA BEGGARWEED

Florida beggarweed (*Meibomia purpurea* (Mill.) Vail.), an annual, upright, herbaceous plant, attaining a height of 4 to 7 feet, is a native of tropical and subtropical America, occurring as far north as the southern part of the United States, especially in cultivated lands. The plant is leafy above but sparingly so below, and the main stem is sparsely branched. In thick stands the branches are greatly reduced or fail to develop.

In Florida and as far north as southern Georgia and Alabama, it has been used as a regular and volunteer crop. Attempts to grow the crop at a few northern experiment stations indicate that under favorable conditions it will make a fair growth as far north as the Great Lakes States but in northern latitudes it can seldom compete with summer weeds.

Florida beggarweed does best on a rich sandy loam soil but is not exacting in its requirements. It is of particular interest and value on account of its ability to grow on soils that are moderately acid. A moderate rainfall is essential to good growth even though the plants will stand as much drought as the average farm crop. On extremely poor sandy soil, it will do but little unless supplied with commercial fertilizers; on cotton and corn lands that have been regularly ferti-

lized, little or no fertilizer is needed; on lands not previously fertilized, 200 pounds of superphosphate, 75 pounds of muriate of potash, and 50 pounds of sodium nitrate or sulphate of ammonia can be used to advantage.

For green manure, Florida beggarweed serves best on sandy loam soils in rotations where a volunteer crop can be handled. When once established it will volunteer from year to year if seed is allowed to mature. Volunteering can be accomplished by permitting strips through the field to go to seed each year and then harrowing crosswise to scatter the seed, relying on subsequent plowing and cultivating to cover the seed. While good stands will not always result from this method of procedure, it may often be an economical practice. Florida beggarweed does not reseed well except on cultivated land. Cotton growers sometimes object to this volunteering habit, as the mature seed of Florida beggarweed adheres to the lint of the cotton.

Seeding of Florida beggarweed should be delayed until all danger of frost is past. From May 15 to June 20 is recommended for the extreme South. Seed can be sown in early corn at the time of the last cultivation. Hulled seed should be used for seeding when an immediate stand is desired. Unhulled seed will not germinate readily on account of the high percentage of hard seed it contains. When hulled seed is used, from 15 to 20 pounds per acre of scarified seed is sufficient on a good seed bed. If unhulled seed is used, this should be increased to 30 to 40 pounds per acre. As the organism that inoculates Florida beggarweed seems to be present in most southern soils, artificial inoculation is unnecessary.

LESPEDEZA

Common lespedeza (*Lespedeza striata* (Thunb.) Hook. and Arn.) is an annual, spreading or upright leguminous plant attaining a height of 6 to 12 inches on poor soils and of 12 to 18 inches or sometimes more on fertile soils. The stems are small, branch freely in thin stands, and are quite leafy. It is well adapted to the Southeast and is found as an escape throughout the Piedmont and Coastal Plains areas, extending north to and beyond the Ohio River and west beyond the Mississippi River. It is in this general region that the crop is most valuable.

For soil improvement, common lespedeza offers great possibilities. It may be used for green manure, for hay, or for rotating with other cash crops.

While common lespedeza makes but little growth until warm weather and continues growth until fall, it must be seeded early to get good stands. The seed should be sown either broadcast or in close drills, between January 15 and March 15 at the rate of 15 to 20 pounds per acre. When the plants are allowed to stand sufficiently late to mature seed, a volunteer growth will be maintained from year to year. While the root-knot nematode has been reported as attacking common lespedeza, it is practically immune. The organism that inoculates common lespedeza seems to be rather widely distributed, and artificial inoculation will seldom be required.

There are two improved varieties of common lespedeza, known as Kobe and Tennessee No. 76, both of which grow larger than the common form and are to be preferred for use under cultivation.

Korean lespedeza (*Lespedeza stipulacea* Maxim.) is like common lespedeza in general, but differs in its range of adaptation, season of development, and minor plant characteristics. It cannot be used successfully as far south as can common lespedeza, but it has a somewhat farther northern range. It is an earlier maturing, slightly larger growing plant than common lespedeza, with practically identical utilization.

RED CLOVER

Red clover (*Trifolium pratense* L.) has long been known as a valuable crop for soil improvement. Using it in crop rotations is a common practice and often it is used as a summer green-manure crop. It is also used as a combination hay and green-manure crop, which seems to be very practical. The early or first growth is cut for hay and the later or second growth used for green manure. Another way of handling it is to cut the first crop for hay, then harvest a seed crop and return the straw to the land. When only the stubble is returned to the soil, there will be a benefit to the soil from the nitrogen gathered by the nodule-forming bacteria that live on the roots. The fact that red clover has upright growth and heavy yields, together with its fitting so readily into rotations with other crops, makes it one of the best crops for soil-improvement purposes.

In most regions red clover is seeded in the spring, 15 to 20 pounds of seed being used per acre. Because red clover has been grown over such a wide area, the organism that inoculates it is usually in the soil. In new areas, however, artificial inoculation should be practiced.

SOYBEANS

The soybean (*Soja max* (L.) Piper) is an upright-growing legume native to northern China, from which region it was introduced into the United States early in the nineteenth century. While the crop is grown primarily for seed, it is used extensively for forage and soil-improvement purposes. In the United States, it is grown mostly east of the ninety-ninth meridian or a line passing through the middle of the Dakotas and south through central Texas. When soybeans are used for a green-manure crop, late-maturing varieties usually will give the largest yields; when used as a regular crop in rotations, varieties should be selected that will give high yields of seed or hay, as the grower may desire. For green-manure, the crop should be sown broadcast or in close drills, from 60 to 100 pounds of seed being used per acre, depending on the size of the seed, which varies with varieties. When soybeans are sown on land where the crop has not been previously grown, inoculation is advisable. Where the crop has been grown in previous years, inoculation is not necessary.

SUDAN GRASS

Sudan grass (*Sorghum vulgare sudanensis* (Piper) Hitchc.) is an easily grown nonlegume whose habit of rapid growth makes it a very suitable plant for green manure when the period in which such a crop can be used is very short. Sudan grass belongs to the sorghum group of plants, but it is only moderately coarse and is adapted to practically all parts of the United States. The culms or stems

are upright, attaining a height of from 3 to 5 feet and a diameter equivalent to that of an ordinary lead pencil or less. Such a plant is especially serviceable in connection with truck-crop growing where the summer period between crops usually must be short. The seed should be sown in close drills or broadcast, 20 to 25 pounds of seed being used per acre. The time of turning down should be determined with reference to the time of planting the succeeding crop and not with reference to the stage of development of the Sudan grass. Ordinarily very succulent Sudan grass will decompose rapidly, and a short period after its turning under, the soil will be in condition to receive the succeeding crop. When the plants are more mature, a longer time is required. Mature Sudan grass plants turned into the soil will reduce the available nitrates for a time, and such material should never be used except when ample nitrogen fertilizer is applied or when a long period can elapse before it is necessary to have available the nitrogen that already is present in the soil.

SWEETCLOVER

There are two species of sweetclover that are used as summer green-manure crops in the United States. These are white sweetclover (*Melilotus alba* Desv.) and yellow sweetclover (*M. officinalis* (L.) Lam.). These are upright-branching, leafy, biennial legumes, in thick stands having the appearance of alfalfa. The first year of seeding they make a growth of 12 to 24 inches, depending on moisture and soil conditions. In the second year a height of from 4 to 5 feet usually is attained. Both these species need lime and for this reason cannot be grown successfully in most parts of the eastern half of the United States unless this need is supplied. In the Corn Belt, white sweetclover has been especially useful as a soil-improving crop. Large increases of corn and other crops have followed its use as a green-manure crop and as a hay crop in rotations.

Inoculation is one of the important factors in success with both white sweetclover and yellow sweetclover. In the alfalfa region west of the Mississippi River, wherever alfalfa inoculates naturally, these crops will not need artificial inoculation, but in most areas east of the Mississippi River artificial inoculation is essential. The seed should be sown on well-prepared firm ground, 15 pounds of scarified seed or 25 pounds of unscarified seed being used per acre. Seeding can be done any time from fall to early spring. In the fall or winter unscarified seed should be used, but in the spring scarified seed gives the best results. Spring broadcast sowings should be covered with a harrow; fall or winter sowings should be broadcast and given no further treatment. The heavy top growth and large deep-penetrating roots make both these crops excellent for green manure.

DEERING (FLORIDA) VELVETBEANS

The Deering (Florida) velvetbean (*Stizolobium deeringianum* Bort.) is a vigorous-growing leguminous annual plant which, under favorable conditions, attains a stem length of 40 feet or more. Most varieties are viny, but a bush form has been developed. It is semitropical in its requirements and is adapted only to the southern part of the United States. While Deering velvetbeans make excellent feed

for livestock, when cut in bloom they are difficult to handle for hay and are seldom used for this purpose. However, they are grown for the seed crop and used in rotations to improve soil. Velvetbeans are one of the best crops for use on sandy lands and can be used to advantage to maintain fertility. Because velvetbeans are hardy, yield heavily, and decay readily, they make an excellent green-manure crop.

The Deering velvetbeans should not be sown until the soil is well warmed, or a little later than the time for planting corn. Seeding in wide rows is recommended and will require from 25 to 30 pounds of seed per acre. As the organism that inoculates Deering velvetbeans is present in the soils of the South, artificial inoculation is unnecessary. The root knot nematode does no damage to this crop, and so far as known all varieties are immune. When velvetbeans are grown for seed it is essential to plant them with a supporting crop such as corn, which insures a free circulation of air and prevents the flowers from decaying without setting seed.

WEEDS

Weeds usually are thought of as plants that should be destroyed, but it should be kept in mind that much of the vegetation that is commonly termed weeds contributes large quantities of organic matter to the soil. Whenever weeds can be utilized for green manure without sacrificing needed ground moisture and plant food, their presence may be an advantage rather than a detriment, a fact which should be kept in mind in handling weeds in connection with crop production.

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