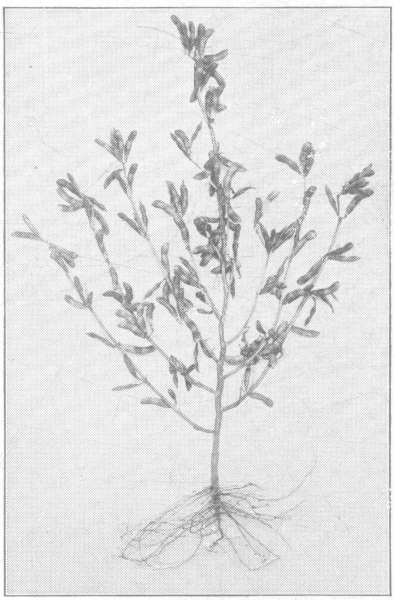
THE SOYBEAN IN OHIO

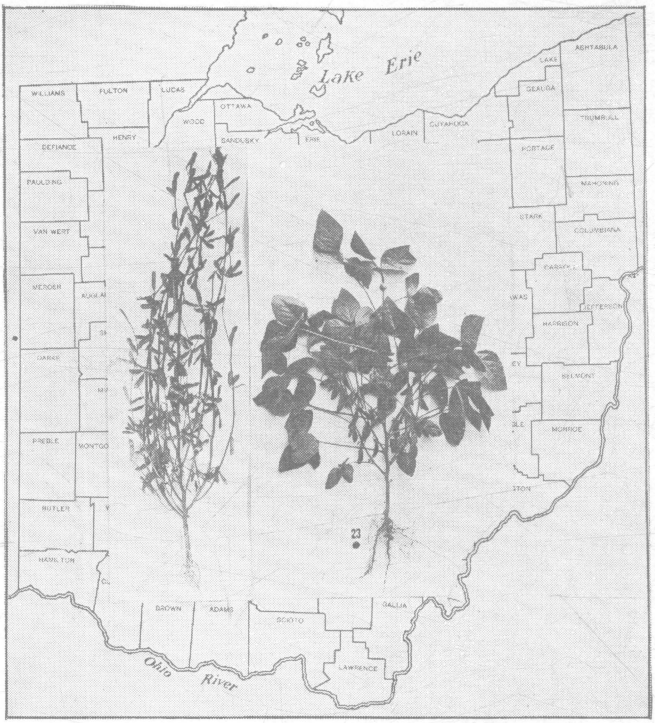
OHIO
Agricultural Experiment Station

WOOSTER, OHIO, U. S. A., MAY, 1925

BULLETIN 384



CONTENTS


Lake Erie
ASHTABULA
LAKE
GEAUGA
TRUMBULL
PORTAGE
MAHONING
STARK
COLUMBIANA
CARROLL
WAS
JEFFERSON
HARRISON
BELMONT
MONROE
WILLIAMS
FULTON
LUCAS
OTTAWA
WOOD
SANDUSKY
ERIE
LORAIN
CUYAHOGA
HENRY
DEFIANCE
PAULDING
VAN WERT
MERCER
AUGLAIZE
DARKE
PREBLE
MONTGOMERY
BUTLER
HAMILTON
BROWN
ADAMS
SCIOTO
GALLIA
LAWRENCE
Ohio River

BULLETIN
OF THE
Ohio Agricultural Experiment Station
NUMBER 384 MAY, 1925

THE SOYBEAN IN OHIO

L. E. THATCHER

The soybean crop in Ohio has rapidly increased in importance. The acreage in 1923 was 128,000, or twenty-six times that of the 4,921 acres in 1916.[20]* In the seven years it has advanced from a position of minor to one of major importance. Formerly soybeans were grown occasionally and as a substitute crop when clover or some other crop failed; now they are grown regularly for hay, grain, hogging off, or with corn for silage, on an increasingly large number of Ohio farms.

That soybeans are replacing oats on many farms in Ohio is indicated by statistics collected by the Agronomy Department in 1922, and published in the Monthly Bulletin for March-April, 1923.[17] These statistics show that about 52 percent of Ohio soybean growers were following a rotation of corn, soybeans, wheat, and clover, and that soybeans most often replaced oats either wholly or in part. Other popular rotations reported were corn, soybeans, and wheat (sometimes sweet clover being seeded in the wheat and plowed under as a green manure crop); soybeans, wheat, and clover; and corn, soybeans, oats, and clover.

Soybeans are grown in ten of the rotation experiments begun at the Station in 1916.[12] These experiments include continuous cropping and two-, three-, four-, and five-year rotations. Altho a few more years will be needed to bring out the full effect of the soybeans in the rotation, some lessons are now plainly indicated. The continuous growing of soybeans and the two-year rotations have returned smaller yields of crops than the longer rotations. Those rotations which include potatoes and clover with corn or wheat have proved the most favorable for soybeans as well as the most profitable as a whole. Soybeans have done well following a clover crop—much better than after corn. Wheat has yielded higher after potatoes than after soybeans.[21]

*The small figures refer to "Literature Cited" on page 56.

The following are suggested as satisfactory rotations in which to grow soybeans:

Soybeans, potatoes, and wheat, with a legume green manure crop seeded in the wheat;

Soybeans, wheat or oats, and clover—the clover may be alsike, common red, mammoth, or sweet clover, as local conditions warrant;

Soybeans, potatoes, wheat, and clover;

Corn, soybeans, wheat or oats, and clover;

Corn, soybeans, potatoes, wheat, and clover.

Table 1 gives the yields of crops in several of the rotations at Wooster. The soybean yields all average low. They were very low at first, but have been larger in later years.

TIME-OF-HARVEST AND SOIL NITRATES

As the soybean approaches maturity, the store of nitrogen in the roots is rapidly lowered and that of the soil itself may be similarly exhausted. Investigations at the Ohio Station[16] gave the results indicated in Table 2. The soybeans were drilled solid and produced a full crop. The roots were well supplied with nodules, indicating complete inoculation. The experiment was in triplicate and four soil samples were taken from each plot. Altho definite conclusions cannot be drawn from two years' work, the results secured to date are probably indicative of the effect upon the soil of harvesting soybeans for hay at different dates. When the soybean crop was removed in late summer or early fall, soil nitrates accumulated as long as moisture and temperature relations were favorable. The yield of wheat was largest both years following the removal of the soybean hay on August 15 and declined gradually as the hay harvest was made later in the season.

THE RESIDUAL EFFECT ON SOIL FERTILITY

There is much evidence to show that the soybean crop when removed cannot compete with the clovers and alfalfa in returning organic matter and nitrogen to the soil. This is because of certain fundamental differences between the root systems of the biennial and perennial legumes and that of the annual soybean. The root system of the soybean is small compared with its top growth; there is no second growth or aftermath with it as with clovers; and its roots do not have an organic reserve in anticipation of a period of future development as have the biennial and perennial legumes.

The amount of dry matter in the roots of the soybean is only about 17 percent of that in the tops. Brown and Stallings[1] report 36 percent of growth of red clover and 48 to 53 percent of alfalfa in the roots at maturity. Altho soybeans, when inoculated, secure part of their nitrogen from the air, the greater part of it is stored in the tops.[8] C. D. Woods, Connecticut Agricultural Experiment Station,[27] reports that an acre of soybeans contains 165 pounds of nitrogen in the crop and 9 pounds in the roots and stubble; red clover, 134 pounds of nitrogen in the crop and 44 pounds in the roots and stubble.

Investigations by Ames[12] of the Ohio Station show that the weight of soybean roots and stubble was only 10 percent of that of the hay crop removed. The nitrogen left in the roots and stubble was 6 pounds per acre; that removed in the hay, 178 pounds. These plants were cut closer to the ground than is the common farm practice, but some leaves were lost by shattering which added some nitrogen to that left by the roots and stubble.

Investigations at the Station in 1923 indicated that the ratio of roots to tops decreased as the plants approached maturity (See Table 3). In these tests the weight of roots per acre increased up to the beginning of seed formation after which it decreased rapidly as the plants matured the seed crop. The nitrogen per acre in the roots reached its maximum with the maximum weight of roots and the percentage of nitrogen in the roots decreased from blossoming to maturity, showing that as the soybean plant approaches maturity, the roots are drawn upon heavily for their supply of nitrogen. Piper and Morse[14] report the following percentages of nitrogen in the soybean roots at different stages of growth: plants in full bloom, 1.40 percent; pods one-half grown, 1.05 percent; pods full grown, 0.96 percent; plants mature, 0.64 percent.

When the entire soybean crop is plowed under for green manure very large amounts of nitrogen are returned to the soil. Wiancko and Cromer,[23] at Purdue University, report that soybeans grown as a catch crop after wheat returned, when plowed under in the fall, a four-year average of 92.7 pounds of nitrogen per acre, of which 10.9 pounds was in the roots and stubble, and 81.8 pounds in the tops. This is about the amount returned by an average red clover sod together with the aftermath.

In any system of farming where soybeans are used for building up the fertility of the soil, progress can be made by feeding the crop and returning the manure to the land. Soybean straw carries

about 18 pounds of nitrogen, 2½ pounds of phosphoric acid, and 18 pounds of potash per ton, and should be either worked into manure or spread on the land and plowed under.

The percent of nitrogen, phosphorus, potassium, calcium, and magnesium for soybean hay in the date-of-harvest tests for 1922 and 1923 (Table 3), as analyzed by R. H. Simon, assistant chemist at this Station, are given in Table 4.

It is noted that as the plant matures there is a movement of nitrogen, phosphorus, and potassium from the various parts of the plant to the seeds. The leaves and pods remain relatively high in calcium and magnesium thruout the life of the plant.

FERTILIZING THE SOYBEAN CROP

Soybeans respond to applications of manure, acid phosphate, and lime on land that is thin or acid. In the absence of manure or of a green manure crop, a fertilizer containing 12 to 14 percent phosphoric acid and 2 to 4 percent of potash is generally recommended. If the soybeans are inoculated, no nitrogen need be added in the fertilizer. If manure and acid phosphate are applied in generous amounts to other crops in the rotation, they may be omitted for the soybean crop.

LIMING THE LAND

Soybeans are able to produce fairly good yields on soils that are slightly acid and under other conditions that make the growing of red clover, sweet clover, and alfalfa impracticable. They will respond to liming, however, and on acid soils lime should be applied when it is possible to do so at moderate cost. A number of investigators have found that liming acid soils increases the formation of root nodules and the nitrogen content of the plants.[10] Soybeans grown on limed land at Wooster contained 17.2 percent protein and on unlimed land 14.5 percent. The seed on limed land contained 42.8 percent protein and on unlimed land 39.6 percent.[12]

INOCULATION

Soybeans that are grown on soils deficient in available nitrogen respond to inoculation. The best inoculation occurs when the soil is neutral or slightly alkaline. It is worthy of note, however, that the nitrogen gathering bacteria of the soybean will grow in a more acid medium than will those of other legumes. Löhnis and Fred[11] have shown that alfalfa-sweet clover, pea-vetch, clover, bean, soybean, and lupine strains of bacteria are sensitive to an acid medium in the order named. This is one reason why it is possible to grow soybeans successfully in soils too acid for many other legumes.

If the soil is abundantly supplied with nitrates, the soybean will secure most of its nitrogen from the soil rather than from the air. This accounts for an occasional failure of inoculated soybeans to produce nodules when grown on rich land. However, Smith and Robinson[15] of the Michigan Station have shown that, on soil of good productivity, inoculation increases the protein content of the plants even tho the yield was not measurably increased, and other investigators[2,4,26] have shown that inoculation increases the protein content of the plants.

After a soil has become thoroly inoculated, no further artificial inoculation is necessary if a crop of soybeans is occasionally grown on the land. Under favorable soil conditions, the bacteria have been known to live for 18 years[5] without the presence of the soybean plant. In acid soils the bacteria disappear in a few years unless the crop is grown on the land.

Seed and soil may be inoculated by means of cultures of the bacteria or by infected soil from a soybean field. The commercial cultures are generally satisfactory and for small acreages are decidedly convenient. Directions should be followed carefully for best results. The so-called soil-transfer method, which is frequently used with good results, consists of taking soil from a field that is known to be inoculated and scattering it over the new soybean seed bed. The inoculated soil may be sifted and applied at the rate of 100 or 200 pounds or more per acre with the fertilizer drill. Another method consists of sticking a small amount of inoculated soil to the soybean seed by means of a solution of glue or sugar in water or by mixing inoculated soil with water to form a thin mud.

Directions for use of glue or sugar method.—Dissolve 3 ounces of glue or sugar in 1 quart of water; spread the soybean seed out on a tight floor and sprinkle with the solution, stirring the seed until every bean is very slightly wetted. Do not put on enough of the solution to loosen the seed coats. Mix with the slightly moistened seed about 4 quarts of sifted inoculated soil to the bushel of seed. Spread out to dry. A small amount of soil should stick to each bean when dry. A galvanized bushel measure or tub may be used in which to treat small lots of seed with the glue or sugar solution. Exposing the inoculated soil or seed to strong sunlight or to excessive drying lowers the vitality of the bacteria.

A thin soup of inoculated soil and water may be applied to the soybean seed by stirring, following the directions as given above for the glue or sugar solution.

Soil for inoculating soybean seed may be dug in the fall, dried and stored for spring use. Inoculated dry and sifted soil is sometimes mixed and drilled with the soybean seed in about equal amounts. Fairly good inoculation is secured, but the soybeans are likely to be planted uneven.

PREPARATION OF SEED BED

As a general rule the ground should be plowed for soybeans. There are a few exceptions to this general rule, however, as when the soil is naturally loose and when a good seed bed can be prepared by disking. At Wooster in 1924 Manchu soybeans, seeded at the rate of three pecks per acre in 24-inch rows, gave a yield of 10.58 bushels of grain and 1895 pounds of straw on disked corn stubble land and 15.79 bushels of grain and 2,052 pounds of straw on plowed corn stubble. Early plowing is usually best as it gives time for the seed bed to settle and opportunity for killing a crop of weeds before planting. Late plowing in a dry season may leave the soil so loose and dry that germination will be poor and the early growth of the plants stunted. Many growers prepare the seed bed for soybeans before that for corn, but do not plant them until after the corn is planted. The weed seeds in the surface of the soil, which thus have a chance to sprout, may be killed with the harrow or light disk just before the soybeans are planted. The soybeans will make considerable growth before the next crop of weeds come on. This method is recommended where the seed is drilled solid at a light rate.

A firm seed bed should be prepared as for corn with enough loose soil to cover the seed well but not too deep. Sufficient moisture should be present to sprout the seed promptly.

TIME OF PLANTING

Soybeans should be planted at about the average time for planting corn. At Wooster, they have been planted on different dates with the following results:

Date planted	May 7	May 19	May 31	June 12
Yield of seed, bushels	24.02	24.75	21.67	17.12
Yield of straw, pounds	2,137	2,195	2,280	2,392

Early planting is accompanied by early ripening, altho the early planted crop requires a longer growing period than the late. Long-season varieties should be planted early if grown for a seed or grain crop.

About half of the plants in a plot of the Peking variety planted at the Station, April 25, 1923, were above ground and the rest pushing thru on May 10 when the temperature dropped to 29 degrees, freezing the ground and forming ice ¼ inch thick. There was no injury apparent, the stand was perfect and the yield equal to that of the same variety planted May 22. A frost late in the spring following good growing weather will damage soybeans in about the same degree as corn.

However, soybeans may be planted much later than corn with fairly good results. If planted very late in the spring, early or medium early varieties should be used, and, if a seed crop is wanted, these should not be planted later than the middle of June in Ohio under average conditions.

RATE OF PLANTING

No exact rule can be given for the rate of planting, since this can fluctuate markedly without materially affecting the yield. The best rate depends upon a number of factors, such as size of seed, date of planting, habit of growth, size of plant, productivity of land, distribution of rows, and the purpose for which the crop is being grown. In Table 5 rates of planting of fourteen varieties under normal conditions are suggested.

On a seed bed relatively free from weeds and when all conditions are favorable to securing a good stand, the lower rate given in the table may be used. When conditions are less favorable and when seed is relatively cheap, the higher rates are recommended.

Bulletin 312,[25] "Soybeans, their culture and use", shows the yields of soybeans when planted at different rates. The Guelph (Medium Green) variety was used. A summary of the results is given in Table 6.

ROW SEEDING VS. SOLID SEEDING

For seed production larger yields are usually obtained by planting in rows and cultivating than by drilling solid. The yields of soybeans seeded in rows vs. seeded solid in 1922-1923 are given in Table 7.

The plots seeded solid in 8-inch rows were not cultivated by harrowing or weeding with the rotary hoe as is the custom in some soybean sections of the corn belt. Weeds were not troublesome in these plots. The plants in the cultivated rows in both years had a darker green color and larger leaf development than those seeded

Fig. 1.—Above—Soybeans drilled in rows and cultivated for seed Below—Soybeans drilled for hay, almost ready for harvest, August 25

solid; but the difference might not have been striking had the solid seedings been cultivated, as this soil has a tendency to run together after a rain making frequent stirring necessary to induce aeration.

METHODS OF PLANTING

Soybeans are planted either in rows wide enough to permit cultivation or they are drilled solid. Formerly the rows, in a majority of cases, were 36 to 42 inches wide to permit cultivation with the ordinary corn cultivator. But experience has shown that the varieties grown in Ohio for seed production give best results in rows 24 to 30 inches apart as now generally planted. Rows 14 or 16 inches wide, made by stopping up every other hole of a 7- or 8-inch grain drill, have some advantage for both hay and grain over the solid seeding of 7 or 8 inches. Twice as many beans fall in each row with the wider spacing, and as twice as much force is thus exerted in breaking thru the crust, fewer beans break their necks. The 14- or 16-inch rows permit early cultivation with weeder or harrow and the plants soon occupy the ground so that late cultivation is not necessary.

In Ohio, soybeans are usually seeded with the ordinary grain drill using the oats feed. For drilling in rows for cultivation, only part of the feed cups are used, those not needed being stopped by some means, such as a tight-fitting board fastened over them in the bottom of the hopper or by partition boards. A home-made marker may be attached to the drill to aid in spacing the rows. It is advisable to calibrate the drill for soybeans by jacking up one wheel, turning off a certain fraction of an acre and weighing or measuring the soybean seed delivered. If a corn planter is used, special plates may be had and adjusted so as to drop 6 to 8 soybeans per foot. A sugar-beet drill may also be used for drilling soybeans in rows.

DEPTH OF PLANTING

A frequent cause of failure to get a stand of soybeans is that of planting the seed too deep. The depth of planting needs to be governed by the character of the soil and the amount of moisture present. In rich loose loams and sandy soils, the seed can be covered 3 inches—much deeper than on clays that are likely to crust after rains. On clay soils the seed should be covered lightly with about 1 inch of soil and the seed bed leveled over with a smoothing harrow or light drag to fill up the drill rows. Otherwise the drill rows may become puddled with the first rain and, upon drying, form a hard crust in the bottom thru which the tender plants

cannot push their way. In case a crust forms before the plants get above ground, it should be broken up with a harrow or weeder, or with an empty disk grain drill by lowering the disks just enough to penetrate the crust without stirring much soil and disturbing the sprouting seed.

CULTIVATION

Soybeans respond profitably to cultivation, whether in solid seedings or in wider rows. Solid seedings for hay or grain should be given a surface cultivation with the weeder or harrow a few days before the plants break thru the ground. The plants are very easily broken off just as they are coming up and it is not best to harrow or weed at that time unless necessary to get them thru the crust. A second and third cultivation with the weeder or harrow may be given when the plants are 3 to 8 inches high. A rotary roe is a good tool with which to cultivate the solid seedings and it might be introduced into Ohio with profit. If cultivated during the heat of the day when the plants are tough, very little damage will be done to the stand.

Rows are cultivated to destroy weeds until the soybean plants make shade enough to keep them from making much growth. Ordinarily two or three cultivations are sufficient. The sugar-beet two-horse hoe or cultivator is a good tool for cultivating in narrow rows. Three or four rows are cultivated at a time, but only as many, and the same rows, as were planted at one time. Wide rows may be cultivated with the ordinary corn cultivator. The one-horse one-row cultivator used on many farms will cultivate 3.5 acres;[17] the two-horse corn plow, 5.5 acres; the beet cultivator 10.5 acres; and the weeder or harrow 17 acres a day. For economy of production, the tool should be used which will cultivate the largest number of acres with the least use of man and horse power. Cultivation should be shallow and level at all times, and carried on with caution after the plants begin to bloom, to prevent injury to the flower clusters and the setting of seed.

HARVESTING AND THRESHING THE GRAIN CROP

Time of harvest.—The soybean harvest may begin when a few of the pods have begun to ripen and a few of the leaves have fallen, and may continue until the leaves have all fallen and the seeds rattle in the pod. The time of harvesting should be governed by the weather and the variety.

Varieties such as Guelph (Medium Green), Elton, and Ito San which shatter badly as they become mature should be cut for seed at the earliest stage and allowed to ripen in the swath, windrow, or cock.

When the production of a grain crop is the first consideration, the soybeans should be allowed to reach full maturity before harvest, if shattering is not a serious factor. Some varieties such as Manchu, Blackeyebrow, Midwest, Hamilton, Wilson, Peking, and Virginia do not shatter seriously even when allowed to become fully ripe before cutting. Fully ripe soybeans, with no leaves, are harvested easily and may be threshed at once if the weather be dry. Soybeans cut before they are fully ripe should be well cured before threshing.

Cutting before the leaves fall gives the straw a higher feeding value; however, harvesting too early results in a small loss in amount of seed, since the yield increases up to the time the crop reaches full maturity.

Methods of harvesting.—The mowing machine is used in a large number of cases for harvesting the seed crop in Ohio, and about one-third of the mowers are equipped with a side delivery attachment as for handling the clover seed crop. This delivers the soybeans in a windrow behind the mower, so that the horses and the mower wheels do not damage them on the next round. A six- or seven-foot cutterbar gives plenty of clearance for the horses and machine. An extra man with a fork is usually necessary in order to keep the cutterbar from choking and to keep the windrower working.

It is desirable to leave as long stubble as possible and yet harvest all the lower branches, for a long stubble helps to keep the side delivery working and the swath from close contact with the ground. Soybeans drilled solid may be cut with a longer stubble than those in rows for cultivation.

A small proportion of growers use the self-rake reaper and find it very satisfactory. The chief objection to it is in the narrow swath cut, 5 to 5½ feet. Tall-growing varieties and solid seedings are easily harvested with a binder if there is not too much lodging. The beans should not be fully ripe if harvested with a binder, otherwise some of them will be lost thru shattering. As a rule, the bundles should be loosely bound in order to permit good circulation of air in curing. Frequently the twine is omitted and the crop cured in bunches.

The ordinary field-bean harvester may be used, but it is less satisfactory for soybeans than for ordinary field or garden beans.

In the southern states combination harvesters and threshers thresh the soybeans from the standing stalks. A few of these machines are used in the north with fairly good results. They are not well adapted to the narrow rows, and cannot be used for harvesting soybeans drilled solid, and, too, the loss from shattering is considerable.

Curing and handling.—Soybeans cut for seed are usually cured in small cocks, requiring several days. During protracted wet weather, the cocks should be turned occasionally to prevent molding next to the ground. If the weather is especially favorable, the soybeans may be allowed to cure in the swath and be taken up with the hay loader. The web-type loader is best to prevent shattering. If the crop has been harvested with the binder, eight or ten sheaves are put in a shock without a cap sheaf.

Storing.—Growers who have tried stacking soybeans report satisfactory results. Stacks or ricks are thatched with corn fodder or covered with a tarpaulin. Soybeans stored in mow or stack may be threshed at any convenient time during late fall or winter.

Threshing.—The ordinary grain thresher can be adjusted to thresh soybeans by substituting a set of thin concaves or by removing a number of ordinary ones and reducing the speed of the cylinder to about 300 revolutions per minute by the use of pulleys that run the separator at ordinary speed. Manufacturers are now equipping their grain separators with special adjustments for threshing soybeans. A small sized pea-and-bean thresher will be found very satisfactory, as it does clean work and splits practically no seed; or, in an emergency, the corn husker can be used.

Care of seed.—If the seed is tough when threshed, it should not be stored in a large bulk, because of danger of heating and molding. The beans may be spread on the barn floor until sufficiently dry, or sacked loosely in burlap sacks. By upending the sacks every few days, the beans will be stirred and drying hastened. After they are thoroly dry or if they have gone thru a sweat in the mow or stack, they may be stored in bulk with safety.

MAKING SOYBEAN HAY

Time of cutting.—The time to cut soybeans for hay will be determined by weather conditions, the press of other farm work, and whether quality or quantity is most desired. If weather conditions be favorable, harvesting the early maturing varieties may

begin by the first of September before corn harvest and silo filling. At this time many of the varieties will be in full pod, with the seed beginning to form. With a little more care, good hay can be made later in the fall. On the average, weather conditions become less favorable for curing hay as the season advances. Evaporation data at the Ohio Station indicate that one day of the first week in September is equal in drying power to two days of the first week in October.

Stage of maturity.—Soybeans may be harvested for hay at any stage of growth, but when in full bloom the crude protein content is very high—one-third higher than that of average alfalfa—and the tonnage per acre relatively small (See Table 3). As they approach maturity the percentage of protein decreases and the tonnage increases. Investigations at the Station show that, when quality and yield are both considered, the best time to cut for hay is when the pods are fully formed, but before the seed has made much growth.

As a result of four years' work on the development of the soybean plant, C. J. Willard of the Ohio State University,[24] finds, "In practice, soybeans should be cut for hay from the time the beans are well formed until the beans are half-grown."

The palatability of soybean hay decreases as the plants approach maturity. Hay made from plants that have partly ripened their seed may contain almost as much protein as hay made at a little earlier stage of maturity; but the protein will be largely concentrated in the seed, having been drawn from the leaves and stems, leaving them much poorer in feeding value. A considerable loss in feeding overripe soybean hay may result from the loss of beans either thru shattering or the refusal of livestock to eat all the beans and woody stems. Mills which will grind the entire plant are now on the market. The finely ground product may be eaten with less loss than the whole hay; whether or not any gain in feeding value is secured by grinding remains to be determined.

Curing soybean hay.—Soybeans are somewhat more difficult to cure than the clovers and grasses that are harvested earlier in the season. With a little more care, however, a high quality product can be obtained. As a general rule, soybeans should remain in the swath longer than is the case with clovers and grasses. After curing in the swath for a few days, the side-delivery rake may be used to pile the crop in light windrows. This is best done when the leaves are still tough with dew. If the weather is clear and drying, a few days in the swath will complete the curing and the hay can be taken up with the hay loader.

If the weather threatens to be cloudy or rainy, it may be best after partial curing to pile the hay from the windrows into small well-built cocks. Here the curing will go on to completion almost regardless of the weather. Well-built cocks will stand much wet weather with little damage to the hay, and they are sometimes left out in the field until snow flies. A great deal of spoilage is caused by putting soybean hay into the mow or stack before sufficiently cured. Plenty of time should be allowed for the hay to cure in the windrow or cock.

If slings are used for unloading the hay, care should be taken not to overload them, as a given bulk of new soybean hay is usually heavier than clover or timothy, and the hay fork does not handle soybeans as well as it does clover or timothy.

SOYBEAN SILAGE

If soybeans alone are used for filling the silo, they should be allowed to get as ripe as possible without appreciable loss of leaves. At this stage some of the leaves will be yellow, the pods filled with immature seed, and the moisture content about right for making a sweet, aromatic, palatable silage. If necessary to harvest early, the plants should be allowed to lie in the field a day or two until thoroly wilted so as to reduce moisture; otherwise the silage will be strong, ill-smelling, and unpalatable.

VARIETIES

Soybeans have been grown in China, Japan, and other eastern countries for centuries. More than 800 varieties, mostly from these countries, have been brought into the United States by the Department of Agriculture. Of this large number of varieties, fewer than 50 are adapted to conditions in the United States. A few varieties have been produced in this country by breeding and selection carried on by the department and some of the experiment stations.

The Ohio Station has been growing soybeans in an experimental way since 1893,[7] has tested many varieties, and by selection has developed several new sorts. Table 8 gives a description of 23 of the more important of these old and new varieties. Those designated as Ohio 9016, Ohio 9100, etc. are pure line selections developed by the Station. The Hamilton, formerly called Ohio 9035, originated at the Station.

Varieties differ in many characteristics, chief of which are yield, habit of growth, size, color, and composition of seed, number

of days required to reach maturity, and freedom from shattering of seed. Minor differences are color of flowers, size of leaves, color of pubescence, and shape of pods. The habit of retaining the leaves after the seed has ripened is a characteristic of a few varieties, as the Wisconsin Black and Ohio No. 20173, a selection from the Manchuria.

Table 9 gives the average annual yields of seed of 21 varieties grown at Wooster. The highest averages for the period of 10 to 12 years were those of Elton, Ohio 9016, Manchuria, Hamilton, and Habaro; for the shorter period of 6 to 8 years, Ohio 13177, Ohio 13163, and Blackeyebrow. For the 4 years in which it has been grown in the test, Manchu ranked third highest in average yield.

Variety tests have also been conducted in ten other counties of the State. Table 11 gives a summary of these tests. For the long time test, Hamilton, Midwest, Ohio 9016, and Elton; and for the shorter period, Ohio 13177 and Manchu averaged high. Table 12 gives the yield of 15 varieties grown for hay at Wooster. The high yields for the period of 6 to 8 years were those of Shingto, Medium Green, Peking, Hamilton, and Cloud; for the last 2 or 3 years, Peking, Midwest, Virginia, Wilson, and Cloud. On the County Experiment farms (Table 13) the Cloud, Auburn, Virginia, Peking, and Ito San made the best averages.

J. B. Park, head of the department of farm crops of the College of Agriculture, Ohio State University, at Columbus reports a 7-year variety test with soybeans for seed on the University farm. The results are given in Table 9. In this test the Manchu lead in yield five times in seven and had the highest 7-year average yield.

The comparative value of the several varieties for hay is not fully shown by their average yields. As a rule, the early maturing varieties will not yield as much when cut at the proper stage for hay as the varieties which are a few days later. But the earlier sorts are desirable if the hay crop is to be cut in late summer or early fall, or if the planting is made very late in the season. For maximum hay production, the later maturing varieties should be grown if they can be planted early in the season and harvested late.

Varieties differ greatly in habit of growth and fineness of stem. The fine-stemmed sorts make the best quality of hay but are likely to lodge badly in some seasons, making it difficult to cut the crop. A notable exception is the Peking, which has an upright habit of growth, and fine stems.

In Ohio, very late maturing sorts, such as Mammoth Yellow, Biloxi, Laredo, Mammoth Brown, Tarheel Black, and Tokio should

be avoided as they will not reach the best stage for hay in time for harvesting. Very early sorts, such as Mandarin, Minsoy, Ogemaw, Pinpu, Early Brown, and Wisconsin Black should not be used except when necessary to plant very late or harvest very early.

The following varieties are recommended for Ohio. New introductions and new varieties developed by breeding may change the list from time to time.

SOYBEAN VARIETIES BEST FOR

Grain crop for feed or seed	Hogging off with corn	Silage with corn
NORTHERN OHIO		
Manchu	Manchu	Peking
Ito San	Ito San	Midwest
Blackeyebrow		Medium Green
CENTRAL OHIO		
Manchu	Manchu	Peking
Midwest	Midwest	Midwest
Ebony	Hamilton	Hamilton
Elton	Elton	
SOUTHERN OHIO		
Midwest	Midwest	Peking
Hamilton	Hamilton	Hamilton
Peking		Virginia
Virginia		Wilson
Wilson		

SOYBEAN VARIETIES BEST FOR HAY

Early maturing	Medium early	Late
Blackeyebrow	Midwest	Peking
Ito San	Hamilton	Wilson
Ebony	Cloud	Virginia
Manchu		
Medium Green		

The Guelph, or Medium Green, is a good variety for hay and is used very extensively for that purpose. It has a bad habit of shattering the seed as the pods ripen, making it a very poor sort to grow for seed or grain. For this reason its culture should not be encouraged. Ito San has been a standard variety for many years and seed is usually plentiful. Its popularity is decreasing, however, and it is being replaced very largely by Manchu, a comparatively new sort that has given large yields of seed and that does not shatter seed on ripening.

SOYBEANS AS AN EMERGENCY CROP

Soybeans are frequently used for planting as an emergency crop when a regular crop fails. When clover does not catch in winter wheat, soybeans may be planted immediately after wheat harvest and a good crop of hay cut in the fall. It is usually best to

Fig. 2.—Soybeans and corn for silage at harvest time, showing end of rows, above, and side of rows, below

plow the wheat stubble rather shallow as soon after harvest as possible, disk thoroly, and drill the soybeans solid not later than July 15. Under favorable weather conditions, a ton to a ton and a half of hay can be made in the late fall, or the crop may be plowed under for green manure, returning a relatively large amount of nitrogen to the soil.

Soybeans may be used to replace corn when the latter is killed by late frost or when the stand late in spring is poor. In the sugarbeet section of the State, it is sometimes advisable to plant soybeans rather than to replant a poor stand of sugarbeets late in the season. Soybeans for hay may follow early potatoes, canning peas, and other crops that are harvested by the first week in July.

CORN AND SOYBEANS AS A MIXED CROP

The combination cropping of corn and soybeans for hogging off or for silage is a common practice on a large number of Ohio farms. In 1923, 57 percent of the soybean acreage in the State was grown in a mixture with corn; and in 1924, 49 percent.[22]

The advantages and disadvantages of this combination may be considered from two standpoints. First, has the combination a larger market value or a larger feeding value than corn or soybeans alone? Second, is the combination crop produced with less draft on the elements of soil fertility, especially nitrogen, than that of either crop alone?

Experimental evidence and general observations indicate that the addition of soybeans to corn results in a reduction of the yield of corn, especially of the grain. The degree of reduction depends largely upon the thickness of planting of both corn and soybeans. The reduction in the yield of corn may be partly compensated for by the yield of the soybeans in the more favorable rate of planting. In the mixed crop at the Missouri Agricultural Experiment Station,[3] the loss in yield of corn over a 5-year period amounted to about an average corn crop for one year, and the yield of soybeans occasionally was greater than the loss in corn, but more frequently equalled ½ to ¾ of the loss in pounds of grain per acre. Planting the crop on rich bottom land did not increase the effectiveness of mixed planting. At the Kentucky Station[9, 19] the most favorable rate of planting, 2 corn and 3 soybean plants per hill, gave as a 6-year average, a loss of 5.7 bushels of shelled corn and a yield of 3.5 bushels of soybeans per acre. In a 4-year test at the Tennessee Station[19] a loss of 618.2 pounds of shelled corn was replaced by 724.5 pounds of soybeans or cowpeas. At the Illinois Station[19] there was a 4-year

average loss of from 10.1 to 12.5 percent shelled corn due to the presence of the soybeans. The production of soybean seed did not quite equal this loss except in one instance when the combination grain crop was 146.4 pounds greater than the corn alone. At the West Virginia Station[19] the 2-year average loss was 11.23 bushels of corn from the best rate of planting, 2 corn and 2 soybean plants per hill. The highest yield in bushels of corn was obtained from 3 corn plants per hill and the highest yield of dry matter per acre from corn drilled 7 inches apart in the row.

In experiments at the College of Agriculture, Columbus, Ohio[13, 19] the 5-year average yield of corn and soybeans at a medium rate of planting, corn 12-14 and soys 4-5 inches apart, was 34.93 pounds more of grain than medium planting of corn alone, and consisted of 16.46 percent soybean seed in the grain mixture. In the silage test corn and soybeans at a medium rate gave 1120 pounds more dry matter per acre than medium-planted corn alone. Of the mixture 22.76 percent was soybean plants. Soybeans in corn at the Iowa Station[19] decreased the yield of corn 6.76 to 25.15 percent depending upon the rate of planting. In no case did the yield of soybean seed equal the loss in yield of corn. However, the combination planting, on the average, in the grain series, produced 28.25 percent more protein than corn alone. At the Nebraska Station[19], as an average of 3 years, the total yield of cured forage for the mixture averaged 4.11 tons, and for corn alone 4.13 tons.

The Ohio Station has compared Clarage corn, a variety maturing a grain crop in a normal season, and Blue Ridge corn, a late silage variety, with and without soybeans for silage during a 7-year period.[18] Clarage corn alone averaged 8.28 tons of silage per acre, and Clarage corn and soybeans 7.96 tons, Blue Ridge alone 12.57 tons, and Blue Ridge and soybeans 12.23 tons. The corn was planted at the usual rate for silage and the proportion of soybeans in the mixture was small. In 1917 the two varieties of corn were planted alone and with soybeans in hills and drills, the hills containing 4 corn plants and 3 soybean plants, and the drills equal numbers of corn and soybean seed 6 inches apart in the rows. Drilling gave larger yields than checking in hills, and corn alone larger yields than corn and soybeans together. In 1920 corn and soybeans planted at the same time gave a larger yield than when the soybeans were planted two weeks later than the corn. The largest yield of soybeans was secured when planted half way between corn hills, thus reducing the amount of competition with

the corn. In 1921 comparisons were made between corn alone, sunflowers alone, corn and soybeans together, and sunflowers and soybeans together in the hill. The average weight per plant of both corn and sunflowers decreased as the stand of plants increased. As the stand of corn and sunflowers increased, there was a very marked decrease in the average size of the soybean plants. That this reduction was greater with sunflowers as the companion than with corn may be accounted for by the fact that the sunflower requires twice as much water per pound of dry weight produced as does corn.

In 1923 a test was conducted at the Ohio Station in which corn alone was compared with corn and soybeans for grain and silage. The plots were triplicated, 1-4-7, having one corn plant every 16 inches and one soybean plant every 8 inches (one soybean 4 inches on each side of a corn plant); 2-5-8, one corn plant every 16 inches; and 3-6-9, two soybean plants every 8 inches in the row. The rows were 42 inches apart with 4 rows to the plot and the plots 1-36 of an acre in size. Plots were hand planted thick and thinned and the plants accurately spaced in the row. Clarage corn and Manchu soybeans were the varieties used.

In the silage experiments the above series was duplicated, (Table 15) except that Peking soybeans were used instead of Manchu. The stand of corn and soybeans was very uniform. Each row has harvested and the corn and soybeans weighed separately.

In the grain series, (Table 14) the presence of the soybeans increased the number of nubbins, and decreased the weight of stover, shelled corn, and cobs. The total yield of grain of both corn and soybeans was about equal to that of corn alone. The total air-dry matter was slightly in favor of the combination. Of the grain mixture, 13.47 percent was soybean seed.

In the silage series, the presence of soybeans decreased the weight of the corn. There was a slight increase in the percentage of protein in the corn when grown with soybeans, altho this was of doubtful significance. The total dry matter and protein were greater for the combination than for the corn alone, but the soybeans alone yielded a larger amount of protein per acre than either corn alone or the combination. The moisture content of the combination silage, 24.2 percent soybeans, was about 3 percent greater than that of corn silage alone, due to the higher moisture content of the soybeans. The percentage of protein in the Peking soybeans grown alone was higher than when grown in competition with corn.

A method suggested by Etheridge and Helm[3] of growing alternate rows or pairs of rows of corn and soybeans is worthy of consideration. A 3-year test showed that corn alone yielded 37.8 bushels; soybeans alone, 14.1 bushels; average grain per acre, 1481.4 pounds. Corn and soybeans in alternate rows gave 25.4 bushels of corn and 8.5 bushels of soybeans, or a total of 1932.4 pounds per acre. Alternate pairs of rows gave 22.2 bushels of corn, 9.6 bushels of soybeans, or a total of 1819.2 pounds per acre. Estimating corn at 9.6 percent protein and soybeans at 36.5 percent[6], ½ acre each of corn and soybeans grown separately would yield 252.34 pounds of protein per acre; alternate rows, 322.70 pounds of protein; and alternate pairs of rows, 329.58 pounds of protein per acre.

Table 16 brings out the following points: Soybeans alone are more efficient producers of protein than corn alone; corn is a much more efficient producer of total digestible nutrients than soybeans alone; the mixed crop of corn and soybeans compares favorably with corn alone in total digestible nutrients, a larger proportion of which is protein in the mixture, making the nutritive ratio theoretically a little more desirable than corn alone. From the cropping standpoint, therefore, if our assumptions are approximately correct, the mixture of corn and soybeans is the most efficient producer of well balanced total digestible nutrients. It should be understood, however, that the final test of its efficiency as a feed for animals, will have to be made in the feed lot itself. If a mixture of corn and soybeans is to be fed, either in the field or after harvest the question resolves itself into one of the relative value of the added protein per acre furnished by the soybeans. That vegetable proteins differ largely in nutritive value is no longer a disputed question.

The mixed planting for silage production, where the total yield of nutrients in the entire plant is of first importance, gives promise of more frequently outyielding corn alone than it does when grown for grain. The total dry matter in the grain series is in favor of the mixed planting. It should be pointed out, however, that seldom have tests been conducted in which the stand of corn alone has been increased until, within practical limits, a maximum production of dry matter per acre has been reached. Whether or not the mixed planting of corn and soybeans will outyield corn alone in grain or total dry matter depends upon the choice of the right rate of planting both corn and soybeans. This will vary with the season, the earliness or lateness of the varieties of both corn and soybeans, and

the productivity of the land. A general average based on present information would be two corn plants and two to four soybean plants per hill or, if drilled, one corn plant every 12 to 16 inches and one soybean plant every 6 to 8 inches in the row. For silage the rate may be somewhat thicker than for grain production. The final answer to the question of the relative feeding value of corn alone as compared with the mixture of corn and soybeans will need to await the outcome of numerous feeding trials being conducted at several experiment stations.

SUDAN GRASS AND SOYBEANS FOR HAY

A mixture of Sudan grass and soybeans was drilled solid on July 3, 1924 and harvested for hay in September. Table 17 gives the rate of seeding and average yield of cured hay on duplicate plots in 1924 at Wooster.

The largest yield of hay was secured from a full seeding of soybeans, 60 pounds per acre, plus 10 pounds of Sudan grass seed. The mixture of Sudan grass and soybeans stood up well and was cured easily for hay. Soybeans alone at the rate of 60 pounds per acre yielded almost as much as the best mixture. When the soybean seed was reduced to 30 pounds per acre and the Sudan grass kept at 10 pounds the tonnage was less than soybeans alone, and only 70.6 percent of the hay was soybeans. The feeding value of the mixture containing the larger amount of soybeans was the higher.

Aside from the greater ease in curing for hay the mixture of Sudan grass and soybeans has little to recommend it over soybeans alone. The above statement applies equally well to a mixture of millet and soybeans.

HABIT OF GROWTH IN CORN

Varieties of soybeans that stand up only fairly well when grown in the open are likely to lodge when grown in the shade of the corn; the normally viney sorts become weak and prostrate, and certain ones of the stiff, bushy sorts develop a slender twining habit of growth. Certain varieties have been planted with corn with the following results.

LABOR COST OF PRODUCING SOYBEAN HAY AND SEED

The relative profitableness of the soybean crop depends somewhat upon its labor costs as compared with those of other crops which it supplements or replaces in the rotation. These costs are high, as indicated by the limited number of field trials for which we

GROWTH HABIT OF SOYBEAN VARIETIES IN CORN

Variety	Habit	Amount of growth
Manchu	Semi-erect	Good
Ebony	Weak, prostrate	Good
0-13185 Cloud	Erect	Very good
Johnson No. 4	Semi-erect twining	Fair to good
Ito San	Upright	Fair to good
Wilson	Semi-erect twining	Fair to good
Medium Green	Semi-erect to upright	Poor to fair
Peking	Upright	Fair to good
Blackeyebrow	Semi-erect to upright	Fair to good
Midwest	Upright	Good to very good
Hamilton	Upright	Good
Virginia	Prostrate	Good

have data. Table 18 shows an average labor of 14 man hours, 16.9 horse hours, and 1.8 tractor hours per acre, which returned an average of 1.62 tons of hay. If man hours are estimated at 34 cents, horse hours at 17 cents, and tractor hours at $1.25, the average labor cost per ton of soybean hay in the eleven tests would be $6.10, and the average labor cost per bushel of seed in the five tests $1.19. It is probable that the yields of hay and seed reported for year under test were lower than the average for a period of years. It is obvious that the labor cost per unit of product decreases with an increase in yield per acre. It is evident also that if the cost of fertilizer, manure, seed, equipment charges, interest on land value, etc., which together will probably be more than the labor cost itself, be added, the cost of production will be relatively high.

The substitution of disking for plowing when practicable, the use of multiple row cultivators or wide harrows and weeders, the reduction of man labor in the hay field thru the use of the side-delivery rake and hay loader are suggested as means toward this end. Increasing the yield per acre of hay or seed is in itself a means of reducing the cost per ton or bushel.

LITERATURE CITED

[1]Brown, P. E., and J. H Stallings, Inoculated legumes as nitrogenous fertilizers, Soil Science XII, 365-407.

[2]Eastman, M. G., Soybean inoculation N. H. Agr. Exp. Sta. Report 1921 (Bul. 203).

[3]Etheridge, C. W. and C. A. Helm, 1924, Corn and soybeans, Mo. Agr. Exp. Sta. Bul. 220.

[4]Fellers, C. R., The effect of inoculation, fertilizer treatment, and certain minerals on the yield, composition and nodule formation of soybeans. Soil Sci. 6, 81-129.

[5]Fred, E. B. and Audrey Davenport, 1922, Bacteria for legumes, Wis. Col. of Agr. Exp. Sta. Cir. 143, p. 18.

[6]Henry, W. A. and F. B. Morrison, 1922, Feeds and Feeding, The Henry-Morrison Co.

[7]Hickman, J. F. Ohio Agr. Exp. Sta. Fifteenth An. Rep., 1896, p. 85.

[8]Hopkins, Cyril G. Soil fertility and permanent agriculture, Ginn & Co., p. 222.

[9]Kinney, E. J., Soybeans Ky. Agr. Exp. Sta. Bul. 232, 1921.

[10]Lipman, J. G., and A. W. Blair, The influence of lime upon the yield of dry matter and nitrogen from different varieties of soybeans, N. J. Agr. Exp. Sta. Report 1918, 189-193.

[11]Löhnis, F. and E. B. Fred. 1923, Textbook of Agricultural Bacteriology, McGraw-Hill Book Company, p. 260.

[12]Ohio Agr. Exp. Sta. Forty-first Annual Report, 1921-1922.

[13]Park, J. B., C. J. Willard, and H. L. Borst, 1922, Growing soybeans in corn, experiments on Ohio State University Farm, Columbus, Ohio Agr. Exp. Sta. Mo. Bul. VII, p. 75.

[14]Piper, C. V., and W. J. Morse, The soybean, McGraw-Hill Book Company.

[15]Smith, C. D., and F. W. Robinson, Observations on the influence of nodules on the roots upon the composition of soybeans and cowpeas. Mich. Agr. Exp. Sta. Bul. 224, 1905.

[16]Thatcher, L. E., and J. W. Ames, Unpublished data. Ohio Agr. Exp. Sta.

[17]Thatcher, L. E., The status of the soybean crop in Ohio, Ohio Agr. Exp. Sta. Monthly Bul., March-April, 1923, VIII, pp. 59-64. [18]Corn and soybeans for silage, Ohio Agr. Exp. Sta. Mo. Bul. May-June, VII, p. 79. [19]Ohio Agr. Exp. Sta. A summary of some unpublished data on growing corn and soybeans together for grain and silage. Mimeograph report of data from several state experiment stations.

[20]U. S. Dept. Agr., 1924, Crops and Markets, I, Supplement 1, p. 10.

[21]Welton, F. A., and V. H. Morris, Yields of wheat following potatoes and the relation of nitrates in the soil to these. Jour. Am. Soc. Agron. Vol. 16, No. 8, August, 1924.

[22]West, C. J., agricultural statistician, Ohio Dept. of Agr., Letter, Dec. 5, 1924.

[23]Wiancko, A. T., and C. O. Cromer, 1920, Purdue University Agr. Exp. Sta. Bul. 238, p. 6.

[24]Willard, C. J., The time of harvesting soybeans for hay and seed, Jour. Am. Soc. Agron. Vol. 17, March, 1925.

[25]Williams, C. G., and J. B. Park, 1917. Soybeans: their culture and use, Ohio Agr. Exp. Sta. Bul. 312.

[26]Woll, F. W., and G. A. Olson, The effect of soil inoculation on the distribution of the fertilizer ingredients in soybeans, Wis. Agr. Exp. Sta. Twenty-fourth An. Rep., 1906-7.

[27]Woods, C. D., Fertilizing ingredients in crop and roots of legumes. Conn. Agr. Exp. Sta. (Storrs) Bul. No. 6.

TABLE 1.—9-YEAR AVERAGE YIELDS OF CROPS IN VARIOUS ROTATIONS—WOOSTER 1916-1924, INCLUSIVE

	Corn first crop	Oats	Wheat	Soybeans	Potatoes	Clover	Timothy	Corn second crop	Potatoes second crop
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Lb.*	*Lb.*	*Bu.*	*Bu.*
Soybeans, continuous culture				12.35					
Two-year rotations:									
Soybeans, wheat			30.07	13.54					
Corn, wheat	58.86		29.90						
Potatoes, wheat			35.64		99.24				
Corn, soybeans	49.41*			15.18*					
Three-year rotations:									
Soybeans, wheat, clover			38.99	16.63		3,764			
Potatoes, wheat, clover			39.71		125.11	4,042			
Corn, wheat, clover	63.22		36.67			3,757			
Soybeans, potatoes, wheat			37.96*	17.00	97.99				
Four-year rotations:									
Potatoes, soybeans, wheat, clover			35.00	15.70	129.13	3,409			
Potatoes, corn, wheat, clover	56.56		34.63		137.60	3,753			
Corn, soybeans, wheat, clover	66.52		32.20	14.88		3,244			
Corn, oats, wheat, clover	62.79	65.51	35.09			3,839			
Five-year rotations:									
Corn, corn, soybeans, wheat, clover	70.17		30.27	15.30		3,321		61.38	
Corn, potatoes, soybeans, wheat, clover	71.48		32.49	16.13	169.97	3,770			
Potatoes, soybeans, potatoes, wheat, clover			38.89	16.84	118.83	3,885			76.40
Corn, oats, wheat, clover, timothy	65.77	64.26	37.21			3,485	3,984		

*5 years only.

TABLE 2.—SOIL NITRATES, SOIL MOISTURE, AND WHEAT YIELDS FOLLOWING SOYBEAN HAY CUT AT DIFFERENT DATES

Date of harvesting soybean hay	On date of harvest		On date of seeding wheat, October 1 or 2		Yield of wheat following soybean hay
	Soil nitrates	Soil moisture	Soil nitrates	Soil moisture	
	*P. p. m.**	*Percent*	*P. p. m.*	*Percent*	*Bu.*
August 1, 1922	4.21	5.64	10.26	7.35	31.75
August 1, 1923	6.21	8.15	8.73	12.90	23.34
Average	5.21	6.89	9.49	10.12	27.54
August 15, 1922	2.44	5.77	10.03	6.17	32.41
August 15, 1923	1.55	13.51	8.97	13.03	27.34
Average	1.99	9.64	9.50	9.60	29.87
August 31, 1922	1.96	6.64	5.94	7.59	31.00
September 1, 1923	2.22	10.50	5.93	13.43	24.83
Average	2.09	8.57	5.93	10.51	27.91
September 16, 1922	2.41	7.34	3.04	5.88	27.25
September 15, 1923	2.61	9.84	5.87	13.43	21.25
Average	2.51	8.57	4.45	9.65	24.25
October 1, 1922	3.39	4.57	3.39	4.57	27.25
October 1, 1923	3.20	14.43	3.20	14.43	18.17
Average	3.29	9.50	3.29	9.50	22.72

*P. p. m.=parts per million.

TABLE 3.—COMPOSITION OF SOYBEANS HARVESTED FOR HAY AT DIFFERENT DATES, WOOSTER

	1922					1923				
	Aug. 1, Plants in full bloom	Aug. 15, Pods forming	Aug. 31, Small seeds forming	Sept. 16, Seeds two-thirds formed	Oct. 1, Seeds ripe, leaves falling	Aug. 1, Plants in full bloom	Aug. 15, Pods one-half formed	Aug. 31, Seeds forming	Sept. 15, Seeds one-half formed	Oct. 1, Seeds ripe, many leaves fallen
Yield per acre, pounds										
Hay (air-dry)	4631	6026	7128	6896	6434	2353	3675	4622	5318	4609
Leaves (oven dry)	2821	3319	3673	2772	2006	1467	2221	2119	2135	733
Stems	1116	1803	2386	1932	1907	533	903	1152	1148	688
Pods				604	670			463	618	1130
Seeds				553	887			195	619	1367
Roots						258	364	441	430	247
Percent of top weight										
Leaves	71.64	64.80	60.63	47.29	36.67	73.34	71.10	53.94	47.24	18.71
Stems	28.36	35.20	39.37	32.95	34.86	26.66	28.90	29.32	25.40	17.56
Pods				10.31	12.25			11.79	13.68	28.85
Seeds				9.45	16.22			4.95	13.68	34.88
Roots						12.90	11.65	11.22	9.51	6.30
Percent protein, (N. × 6.25)										
Hay (air-dry)	14.39	13.04	13.70	12.75	12.25	12.74	10.41	9.10	8.75	12.14
Leaves (oven dry)	19.89	18.50	18.89	14.11	11.87	17.18	14.49	11.17	8.93	8.58
Stems	9.46	9.50	11.88	8.56	6.31	8.94	6.75	5.06	3.39	2.70
Pods				15.03	10.01			10.30	4.62	3.74
Seeds				41.87	40.94			40.17	33.54	31.92
Percent nitrogen										
Roots (oven dry)						1.20	1.08	0.92	0.84	0.78
Pounds protein per acre										
Top growth	666	785	977	879	788	300	383	421	466	55.9
Pounds nitrogen per acre										
Roots						31	39	41	36	19

TABLE 4.—NITROGEN, PHOSPHORUS, POTASSIUM, CALCIUM, AND MAGNESIUM CONTENT OF SOYBEAN HAY AND ROOTS. DATE-OF-HARVEST TEST AT WOOSTER, 2-YEAR AVERAGE PERCENT, 1922-23

	Nitrogen	Phosphorus	Potassium	Calcium	Magnesium
August 1, cutting					
Leaves	2.966	0.267	1.077	1.618	1.079
Stems	1.471	0.231	0.858	0.795	0.752
Total	2.560	0.256	1.017	1.394	0.992
Roots (1923)	1.200	0.162	0.454	0.473	0.480
August 15, cutting					
Leaves	2.619	0.272	0.987	1.574	1.001
Stems	1.290	0.195	0.607	0.666	0.673
Total	2.188	0.246	0.864	1.280	0.898
Roots (1923)	1.080	0.193	0.340	0.522	0.646
August 31, cutting					
Leaves	2.395	0.249	0.830	1.875	1.072
Stems	1.349	0.156	0.472	0.563	0.587
Pods (1923)	1.630	0.290	1.528	0.999	0.834
Seeds (1923)	6.300	0.814	2.312	0.395	0.401
Total	2.137	0.236	0.787	1.335	0.863
Roots (1923)	0.920	0.181	0.311	0.473	0.572
Sept. 15–16, cutting					
Leaves	1.829	0.171	0.553	2.061	1.178
Stems	0.954	0.123	0.343	0.553	0.600
Pods	1.563	0.223	0.919	0.972	0.789
Seeds	5.986	0.695	2.004	0.295	0.327
Total	2.004	0.225	0.707	1.372	0.865
Roots (1923)	0.840	0.146	0.267	0.455	0.533
October 1, cutting					
Leaves	1.607	0.176	0.679	1.787	1.043
Stems	0.714	0.075	0.265	0.645	0.648
Pods	1.100	0.123	0.990	1.064	0.828
Seeds	5.785	0.751	1.836	0.282	0.343
Total	2.252	0.296	0.960	0.994	0.788
Roots (1923)	0.78				

TABLE 5.—RATE OF SEEDING VARIETIES OF SOYBEANS IN POUNDS OF SEED PER ACRE

Variety	In cultivated rows	Drilled solid	
	For seed	For seed	For hay
	Lb.	*Lb.*	*Lb.*
Mammoth Yellow	.....	.....	120—135
Hamilton	60—75	90—100	120—135
Elton	45—60	75— 90	100—120
Blackeyebrow	45—60	75— 90	100—120
Medium Green	45—60	75— 90	100—120
Manchu	45—60	75— 90	100—120
Ito San	45—60	60— 75	80—100
Midwest	30—45	60— 75	80—100
Habaro	30—45	60— 75	80—100
Ebony	30—45	50— 65	75— 90
Cloud	25—30	50— 65	75— 90
Virginia	25—30	50— 65	75— 90
Peking	15—25	45— 60	60— 75
Wilson	15—25	45— 60	60— 75

TABLE 6.—RATE OF PLANTING SOYBEANS IN 28-INCH ROWS AND 6-YEAR AVERAGE YIELD PER ACRE

Seed per acre	Yield per acre		
	Grain	Straw	Grain, net
Pecks	*Bu.*	*Lb.*	*Bu.*
1	20.16	2,027	20.01
2	20.31	2,032	19.81
3	22.49	1,801	21.74
4	22.05	1,257	21.05
8	19.68	3,200	17.68

TABLE 7.—SOYBEANS PLANTED SOLID VS. IN ROWS, FOR SEED, BUSHELS PER ACRE

Variety	Year	Solid	24-inch rows
Ohio 9016	1922	9.44	11.48
Manchu, mulch test	1923	17.28	21.87
Manchu, rate test	1923	23.00	29.78

TABLE 8.—DESCRIPTION OF SOYBEAN VARIETIES AS GROWN AT OHIO EXPERIMENT STATION

	Beans per bushel	Color of seed	Color of flowers	Habit of growth	Composition of seed, 1922 crop (15 % moisture)		Days to maturity
					Protein	Fat (Ether extract)	
	Thousand	*	†	‡	*Percent*	*Percent*	*No.*
Amherst	133	y	p	e, st	37.05	17.32	120
Auburn	193	bl	w	e, st	37.86	15.85	115
Blackeyebrow	149	br, bl, m	p, w	e, st	40.02	18.00	105
Cloud	234	bl	w	s-e, sl	39.34	14.13	128
Ebony	228	bl	p	s-e, sl	41.03	13.63	120
Elton	149	y	p	e, st	35.08	18.47	115
Hobaro	171	y	p, w	e, st	37.87	17.19	115
Hamilton	119	br	p	e, st	36.50	18.21	125
Ito San	157	y	p	e, st	38.58	17.20	110
Mammoth Yellow	.....	y	w	e, st	42.32	15.24	.....
Manchu	141	y	p, w	e, st	37.89	18.90	105
Manchuria	166	y	p	e, st	34.53	18.85	110
Medium Green	146	gr	p	e, st	37.29	18.56	115
Midwest	193	y	p	e, st	39.23	15.75	115
Ohio 9016	152	y	p	e, st	33.42	18.35	120
Ohio 9100	160	y	p	e, sl	41.34	14.86	110
Ohio 13163	201	bl	p	s-e, sl	40.14	14.51	115
Ohio 13177	179	y	p	e, st	35.24	18.70	115
Peking	353	bl	w	e, sl	34.57	16.27	128
Shingto	130	ol	p, w	e, st	34.90	18.32	125
Virginia	231	br	p	t, sl	38.48	15.67	125
Wilson	277	bl	p, w	t, sl	34.06	16.29	128
Yosho	127	ol	w	e, st	38.03	16.26	125

*y., yellow; bl., black; br., brown; gr., green; ol., olive; m., mottled.
†p., purple; w., white.
‡e., erect; t., twining; s-e., semi-erect; st., stout; sl., slender.

TABLE 9.—SOYBEAN VARIETIES GROWN AT OHIO STATE UNIVERSITY, YIELD PER ACRE

	1918	1919	1920	1921	1922	1923	1924	7-year average
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*
Ito San	13.43	29.37	23.16	24.78	25.29	25.58	13.14	22.11
Elton	11.55	27.93	19.17	22.23	23.35	31.80	12.25	21.21
Manchu	18.80	30.85	23.65	26.11	30.72	36.70	14.09	25.85
Medium Green	6.98	21.45	17.46	24.50	18.75	16.35	7.66	16.16
Midwest	6.18	19.72	18.44	24.60	19.03	22.29	6.87	16.73
Peking	10.41	20.01	16.01	22.48	23.05	17.70	9.16	16.97
Wilson	.....	.....	.....	22.98	24.90	22.54	10.55	20.28*
Virginia	8.59	23.29	22.55	25.65	31.45	24.83	11.52	21.13
Kentucky	11.55	27.36	20.71	22.87	26.92	25.08	13.39	21.13
Ebony	9.94	20.34	17.79	21.02	20.73	22.64	10.80	17.61
Arlington	8.86	20.01	16.01	21.33	22.42	19.15	8.30	16.59
Hamilton	5.05	22.96	23.01	28.16	21.54	19.55	9.01	18.47
Shingto	12.36	20.80	22.31	22.84	24.16	21.44	12.35	19.46

*4 years only.

TABLE 10.—SOYBEANS IN VARIETY TEST AT WOOSTER YIELD PER ACRE

Varieties	4-year average			12-year average		
	1910–1913	1915–1920	1921–24	Grain	Straw	Straw per bu. of grain
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Lb.*	*Lb.*
Medium Green	22.84	22.07	22.38	22.43	2,339	104
Ito San	19.53	21.38	22.18	21.03	2,291	109
Ebony	21.93	23.98	21.47	22.46	2,089	93
Amherst	24.01	22.61	18.55[3]	22.02[11]	2,585	117
Ohio 9016	26.54	24.05	21.54	24.05	2,296	95
Ohio 9100	19.80	18.33	23.33	20.48	2,317	113
Manchuria	22.18	24.16	25.48	23.96	2,077	87
Elton	24.65	25.73	23.04	24.48	2,116	86
Auburn	21.10	21.75	17.32	20.05	2,240	112
Hamilton	26.29	22.30	21.80	23.46	2,835	121
Habaro	22.16	24.38	21.55[3]	22.80[11]	2,388	105
Shingto	24.87	21.61	.....	23.25[8]	2,396	103
Cloud	19.97	14.12	12.70[2]	16.18[10]	2,588	160
Midwest	27.58[3]	21.10	19.03[3]	22.42[10]	2,521	112
Yosho	24.10[3]	16.46	.....	20.16[7]	2,587	128
Sable or Peking	17.63[3]	12.32	11.14[3]	13.56[10]	2,496	184
Ohio 13177	.....	25.54	25.74	25.64[8]	2,770	108
Blackeyebrow	.....	23.21	22.26	22.74[8]	1,967	86
Wilson	.....	20.16[2]	13.45[3]	.....	2,814	174
Ohio 13163 Ebony	.....	22.91[2]	24.15	.....	2,468	104
Manchu	.....	.....	24.64	.....	2,442	99

TABLE 11.—SOYBEAN HAY IN VARIETY TESTS AT WOOSTER, YIELD PER ACRE

	1912	1913	1914	1915	1916	1921	1922	1923	Average
	Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Tons*
Ito San	5015	6140	4340	6075	2700	.....	4900	3874	2.36
Medium Green	5856	6260	3830	6666	4400	6320	5060	3958	2.65
Ebony	5334	5280	4070	5400	3700	.....	4260	4158	2.30
Shingto	6099	5460	4440	4556	3700	7320	5820	.....	2.67
Hamilton	5129	4300	3470	5991	5200	.....	4320	5411	2.42
Cloud	5703	4800	3270	4894	5200	5180	4880	4810	2.42
Taha	4670	5180	3100	5231	4900	5720	4900	.....	2.41
Peking	5027	4800	3080	4894	.....	4820	4880	7465	2.50
Mammoth Yellow	4606	.....	2840	3712	4100	4060	2660	.....	1.83
Auburn	5972	5440	3820	4978	3900	.....	4560	.....	2.39
Midwest	.....	.....	.....	.....	.....	6370	4990	5828	2.86
Wilson	.....	.....	.....	.....	.....	5960	3440	6079	2.86
Virginia	.....	.....	.....	.....	.....	5640	4680	5661	2.66
Manchu	.....	.....	.....	.....	.....	.....	4620	4141	2.19
Elton	.....	.....	.....	.....	.....	.....	5120	4008	2.28

TABLE 12.—AVERAGE YIELD OF SOYBEAN SEED IN VARIETY TESTS ON EXPERIMENT FARMS OF THE STATE

County	Elton	Midwest	Ebony	Ito San or Selection 9100	Hamilton	Medium Green	Manchu	Ohio 9016	Ohio 13177	Wilson	Manchuria
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*
Miami[11]	22.47	21.35	22.75	17.41[10]	26.62	19.03	20.50[2]	16.37[9]	25.52[3]	... .	.....
Clermont[10]	8.45	10.43	10.14	7.64	8.11	6.39[8]	13.55[2]	.....	12.73[2]	.....	.....
Hamilton[11]	17.47	21.00	18.34	17.67	20.42	15.18	20.60[2]	18.17[10]	.....	13.15	.....
Meigs[6]	18.72	21.55	19.94	19.90	18.14	14.37[5]	20.95[2]	16.37	21.99[2]	.....	18.93
Trumbull[4]	13.31	13.30[3]	15.70	14.98	.....	12.87	.....	9.57	.....	.....	13.06[3]
Paulding[10]	19.43	.....	.....	17.10	.....	14.16[9]	25.94[3]	21.67[1]	23.12[2]	.....	.....
Washington[2]	15.84	14.70	12.25	14.97	16.73	10.35	.....	.....	.....	.....	.....
Belmont[2]	11.93	.....	8.37	10.28	7.63	11.87	.....	12.33	.....	.....	.....
Madison[1]	15.67	.....	13.87	17.65	12.06	14.67	.....	15.29	.....	....	.....
Union[2]	18.91	9.17	.....	26.75	.....	15.25	18.33	.....	25.66	.....	.....
Wayne[12]	24.48	22.42[10]	22.45	21.03	23.46	22.43	24.64[4]	24.05	25.64[8]	16.13[5]	23.96
Number tests	71	55	59	70	55	67	17	45	19	16	21
Average yield	18.12	18.39	17.97	16.70	19.08	15.48	21.43	18.13	23.61	14.08	20.96

*Small figures in the table give number of years tested.

TABLE 13.—AVERAGE YIELD OF SOYBEAN HAY IN VARIETY TESTS ON EXPERIMENT FARMS OF STATE

County	Ito San or Selection 9100	Elton	Ebony	Hamilton	Medium Green	Auburn	Cloud	Mammoth Yellow	Peking	Midwest	Virginia	Wilson
	Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
Madison[5]	3,576[3]	3,613[4]	3,573	3,593	3,412	4,100[1]	4,440[1]	2,420[2]	3,430[2]	3,100[2]	.....	.....
Clermont[4]	3,781[2]	3,231[1]	3,566[2]	2,760	2,889	.....	.....	4,064	3,974[1]	3,827[3]	4,037[3]	.....
Belmont[3]	3,768	.....	4,039[3]	4,280	3,116	.....	2,233[2]	.....	3,749	.....	2,772	2,635
Washington[7]	3,854	.....	3,616[6]	3,611	3,818	4,098[4]	.....	2,760[6]	.....	2,960[2]	.....	2,900[3]
Wayne[7]	4,721	4,564[2]	4,600	4,832	5,294[8]	4,778[6]	4,842[8]	3,663[8]	4,995	5,729[3]	5,327[3]	5,159[3]
Number tests	22	7	23	26	27	11	11	18	13	10	9	9
Tons per acre	2.04	1.91	1.97	1.94	1.98	2.23	2.16	1.66	2.19	2.04	2.01	1.78

TABLE 14.—CORN AND SOYBEANS (GRAIN), AVERAGE PER ACRE OF TRIPLICATE TEST PLOTS AT WOOSTER, 1923

	Corn and soybeans	Corn alone	Soybeans alone
Corn plants...Number..	9,226.8	9,180.0	
Soybean plants...Number.	16,308.0		
Ears...Number..	5,770.8	6,804.0	
Nubs...Number..	3,362.4	2,304.0	
Total	9,133.2	9,108.0	
Ears...Pounds..	3,474.00	4,421.88	
Nubs...Pounds..	1,154.88	876.24	
Total	4,628.88	5,298.12	
Stover...Pounds..	3,336.12	4,077.00	
Total corn and stover	7,965.00	9,375.12	
Shelled corn (15 percent moisture)...Pounds..	3,178.08	3,687.48	
Cobs (15 percent moisture)...Pounds..	608.40	694.08	
Soybeans and grain...Pounds.	495.00		1,446.12
Soybeans and straw...Pounds..	956.88		2,754.00
Total	1,451.88		4,200.12
Grain (corn and soybeans)...Pounds..	3,673.08	3,687.48	1,446.12
Straw and stover...Pounds..	4,243.00	4,077.00	2,754.00
Straw, stover and cobs...Pounds.	4,091.40	4,771.08	
Air-dry matter...Pounds..	8,574.48	8,458.56	4,200.12

TABLE 15.—CORN AND SOYBEANS (SILAGE), AVERAGE OF TRIPLICATE TEST PLOTS AT WOOSTER, 1923

	Corn and soybeans	Corn alone	Soybeans alone
Corn plants...Number..	9,167.66	9,275.76	
Soybean plants...Number..	17,604.00		29,664.00
Corn, green weight...Pounds..	14,077.08	15,406.92	
Soys, green weight...Pounds..	4,712.40		16,540.92
Corn, dry weight...Pounds..	4,978.44	5,413.68	
Soys, dry weight...Pounds..	1 204.92		3,982.32
Corn, dry matter...Percent..	35.53	35.95	
Soys, dry matter...Percent..	25.58		24.16
Protein, corn...Percent..	7.60	7.47	
Protein, soys...Percent..	12.20		14.67
Protein, corn...Pounds..	379.80	405.00	
Protein, soys...Pounds..	145.08		580.68
Total dry matter...Pounds..	6,183.36	5,413.68	3,982.32
Total protein...Pounds..	524.88	405.00	580.68

TABLE 16.—AVERAGE EXPECTANCY OF CORN AND SOYBEAN PER ACRE BASED ON 23 SEPARATE TESTS IN CORNBELT STATES

Crop	Yield		Protein			Total digestible nutrients	Nutritive ratio
	Corn	Soys	Corn	Soys	Total		
	Bu.	*Bu.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	
Corn alone	48.47	.....	262.03	.....	262.03	2,230.0	1:10.4
Soybeans alone*	.....	17.00	.....	372.30	372.30	959.8	1:1.8
Corn and soybeans mixed	41.41	5.79	222.64	123.71	346.35	2,221.7	1:6.7
Corn 23.6 and soybeans 76.4 percent of area	11.50	12.99	61.92	284.43	346.35	1,259.5	1:3.1

*Estimate based on Ohio survey.

TABLE 17.—EBONY SOYBEANS AND SUDAN GRASS MIXTURE FOR HAY, RATE OF SEEDING AND YIELD PER ACRE

Rate of seeding		Yield		Soybeans and Sudan grass in mixture	
Soybeans	Sudan grass	Air-dry hay	Protein	Soybeans	Sudan grass
Lb.	*Lb.*	*Lb.*	*Lb.*	*Percent*	*Percent*
60	10	3,800	712	80.02	11.98
30	5	3,100	.....	.....	.....
60	5	3,680	.....	.....	.....
30	10	3,560	668	70.60	29.40
60	.....	3,660	812	100.00	100.00
.....	10	3,000	200	.....	

TABLE 18.—LABOR AND YIELD PER ACRE OF SOYBEANS ON 16 WESTERN OHIO FARMS IN 1923

Farm	Acres	Plowing			Fitting			Drilling		Weeding and cultivating		Hoeing	Cutting		Making hay			Curing seed		Threshing		Total labor per acre			Yield per acre Tons or bu.
		M.	H.	T.	M.	H.	T.	M.	H.	M.	H.	M.	M.	H.	M.	H.	T.	M.	H.	M.	H.	M.	H.	T.	
	No.	Hr.	Hr.	Hr.	Hr.	Hr.	Hr.	Hr.	Hr.	Hr.	Hr.	Hr.	Hr.	Hr.	Hr.	Hr.	Hr.	Hr.	Hr.	Hr.	Hr.	Hr.	Hr.	Hr.	
Grown and harvested for hay																									
1	3.6	2.0	.....	2.0	3.1	2.7	1.7	1.0	2.0	0.8	0.8	.....	0.8	1.7	8.1	1.3	2.7	.....		.....		15.8	8.5	6.4	2.24
2	0.6	6.0	12.0	.....	3.0	4.0	1.8	1.8	3.6	.....	.....	....	2.5	5.0	12.2	3.6	.....	.....		.....		25.5	28.2	1.8	2.27
3	3.9	1.6	6.3	.....	4.4	12.0	.....	0.6	1.3	1.1	1.1	....	1.3	2.5	6.9	8.6	.....	.....		.....	....	15.9	31.8	....	1.77
4	5.1	2.3	.....	2.3	2.4	.....	2.4	2.0	3.9	.....	.....	.....	1.2	2.4	3.6	6.3	.....	.....		.....		11.5	12.6	4.7	1.97
5	3.9	1.5	.....	1.5	1.5	.....	1.5	1.0	2.0	3.8	7.7	....	1.0	2.0	2.3	2.6	.....	.....		.....		11.1	14.3	3.0	0.51
6	5.5	1.5	.....	1.5	3.2	4.0	1.2	0.8	1.5	0.9	1.8	1.4	1.1	2.2	18.4	10.5	.....	.....		.....		27.3	20.0	2.7	2.00
7	12.0	3.6	5.7	0.7	1.8	1.6	1.0	1.1	2.2	.....	.....	.....	1.1	2.2	7.7	8.1	.....	.....		.....		15.3	19.8	1.7	1.13
8	7.0	7.0	14.0	.....	6.5	13.0	.....	1.3	2.6	1.2	2.4	....	1.3	2.6	8.7	7.4	.....	.....		.....		26.0	42.0	....	1.50
9	10.0	1.5	.....	1.5	1.4	.....	1.4	0.6	1.8	.....	.....	....	0.7	1.4	4.1	3.7	.....	.....		.....		8.3	6.9	2.9	3.00
10	10.0	1.3	....	1.3	1.4	1.2	0.8	1.0	2.0	.....	.....	....	1.0	2.0	5.9	4.6	....	.....		.....		10.6	9.8	2.1	1.85
11	20.0	3.6	7.2	.....	1.1	2.2	.....	1.0	2.0	0.5	0.5	.....	1.0	2.0	4.0	2.8	. ...	.....		.....		11.2	16.7	.....	1.00
Av.	.....	2.8	4.2	0.8	2.2	2.5	0.9	1.0	2.1	0.5	0.9	0.1	1.0	2.0	6.4	5.2	0.1	....				14.0	16.9	1.8	1.62
Grown and harvested for grain																									
12	4.0	1.6	6.3	.....	4.3	11.9	.....	0.8	1.5	5.5	1.10	....	1.6	3.2	....			1.9	0.9	4.1	4.5	19'8	39.3	.....	12.5
13	3.3	4.0	8.0	.....	2.6	1.6	1.8	0.8	1.5	3.7	5.4	10.5	1.2	2.4	.....			2.1	1.5	2.1	3.0	26.0	23.4	1.6	8.0
14	18.0	2.5	14.2	.....	3.0	1.10	.....	1.4	2.8	4.9	9.8	.....	.....	.....	....			6.0	....	4.7	4.7	22.5	42.5	.....	10.0
15	1.5	1.5	.....	1.5	1.4	.....	1.4	0.6	1.8	.....	.....	.....	1.2	2.4	.....			.....	.....	6.3	2.6	11.1	6.8	2.9	18.0
16	20.0	4.0	6.7	0.7	2.5	0.1	2.0	0.9	1.8	1.9	1.9	.....	0.9	1.8	.....			2.2	.....	6.2	2.4	18.6	14.7	2.7	10.3
Av.	.....	3.1	6.8	0.3	2.8	5.4	1.0	1.0	2.1	3.3	5.9	0.7	0.6	1.2	....			2.7	0.2	5.1	3.5	19.3	25.1	1.3	10.4