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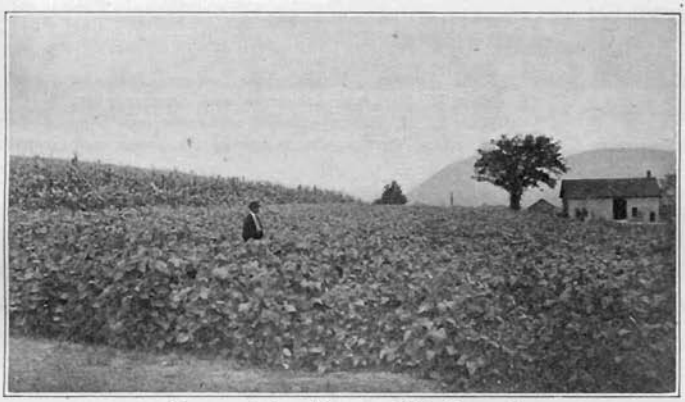
TESTS OF SOY BEANS, 1915.

By E. H. JENKINS, JOHN PHILLIPS STREET AND C. D. HUBBELL.



Corn and Soy Beans at Mt. Carmel.

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TESTS OF SOY BEANS IN 1915.

By E. H. Jenkins,* John Phillips Street
and C. D. Hubbell

This Bulletin is a continuation of the study of the soy bean under Connecticut conditions, which has been carried on for some years and has been described in part in Bulletins 179 and 185. It presents the data gathered in 1915.

Yield of Seed From New, Unnamed Varieties.

Twenty varieties, chiefly new introductions, as yet unnamed, were grown in 1915 in cooperation with the Bureau of Plant Industry of the U. S. Department of Agriculture, to determine their period of growth and yield of seed. It was not possible to determine their yield of forage. The results are given in Table I.

These varieties were planted May 26 in rows 30 inches apart, plants standing about 4 inches apart in the row. The calculated area for each variety was 250 square feet or only $\frac{1}{174}$ of an acre. Soy beans had been grown on this same land for two years previously, between the trees in an apple orchard five years old. This land was dressed in 1915 with 45 pounds of nitrogen and 95 pounds of phosphoric acid in form of nitrate of soda, acid phosphate and tankage. No potash was applied because of its scarcity and high price.

Table I. Unnamed Varieties of Soy Beans Grown in 1915.

No.	Date of Blossom.	Days to Maturity.	Yield per Acre in Bushels.
37063	July 12	97	19.6
36914	" 14	97	18.6
36919	" 18	100	26.1
36653	" 14	100	22.9

*Mr. C. D. Hubbell, the farm manager, has had charge of the field work and gathering the field data, the chemical work has been done under the direction of Mr. J. P. Street, chief chemist, and the results have been arranged and discussed by the director.

No.	Date of Blossom.	Days to Maturity.	Yield per Acre in Bushels.
36915	July 18	107	24.1
30744	" 18	109	21.6
28050	" 20	109	19.3
30600	" 18	111	19.3
30601	" 18	111	19.3
37062	" 20	111	29.6
37571	" 18	111	21.6
37572	" 18	111	28.0
30594	" 18	114	19.7
36916	" 18	119	23.2
30747	" 25	121	19.0
30599	" 20	126+	31.2
37573	" 20	126+	30.6
30746	" 20	130+	28.7
36829	Aug. 12	142+	19.7
30593	" 15	152+	....

The last variety did not mature seed, being killed by frost. Four others, marked +, did not mature their seed uniformly at one time but it was dry when threshed and lost no weight during a month's storage. The average yield of all varieties was at the rate of 23.3 bushels per acre. No comparison of the yields of these varieties is attempted because of the small size of the plots and lack of duplication. We are advised that No. 30744 is Black Eyebrow. Fifteen of these 20 varieties could be grown for forage and even seed production in the southern part of the state, and fully half of them would give a crop of forage anywhere in Connecticut.

Report on Named Varieties Grown in 1915.

In Table II are given the data regarding named varieties grown by the Station, being the same as those grown in 1914 and described in Bulletin 185. Quebec 92 and Quebec 537 obtained from Macdonald College, Quebec, appear to be selections of Ito San.

Kentucky is a mixed variety from Manchuria, grown one year in Kentucky and one year in Connecticut.

The beans were planted May 19th in the same orchard and with the same treatment as those already described. They were cultivated a few times but not after July 1.

The figures given in the table are chiefly interesting in comparison with those for the same varieties grown last year and given in Bulletin 185.

Number of Days to Maturity—The number of days to maturity was slightly greater this year than last. Hollybrook and Peking were 15 days later, Quebec and Arlington 10 days later in 1915, and the other thirteen varieties were not more than 6 days apart in time of maturity in the two years.

The crops in 1915 were perhaps a little less mature when cut for forage. They contained 7.1 per cent more water than those of 1914.

Comparison of Average Yields in 1914 and 1915—Further comparison of average yields follows, based only on those varieties which were grown for two years until harvest without accident, and expressed in pounds per acre.

	Forage.	Dry Matter.	Protein.	Seed.
Thirteen varieties in 1914	17357	5275	902	1438
Same varieties in 1915	16941	4056	739	1408

The average, maximum and minimum yields per acre in the two years (of those varieties only which were successfully grown in both years) are as follows:—

	Fresh Forage.			Dry Matter.			Protein in Pounds.		
	Max.	Min.	Av.	Max.	Min.	Av.	Max.	Min.	Av.
1914	10.6	6.5	8.6	3.1	1.6	2.6	1,116	624	902
1915	9.9	5.9	8.4	2.6	1.3	2.0	1,001	475	739

	Nitrogen in Pounds.			Seed in Bushels.		
	Max.	Min.	Av.	Max.	Min.	Av.
1914	178	99	144	30.9	14.8	23.9
1915	160	76	119	29.0	18.6	23.4

The average yield of dry feed was about 1200 pounds less in 1915 than in 1914. The dry feed was however somewhat richer in protein in 1915, containing about 18.2 per cent, whereas *the same varieties* in 1914 contained 17.1 per cent.

TABLE II. YIELD OF SOY BEANS AT MT. CARMEL FIELD, 1915.

Variety.	Data regarding yield of forage.						Yield of seed per acre.	
	Days to maturity.	Water.	Protein.	Yield of fresh forage per acre.	Yield of dry matter per acre.	Yield of protein per acre.		
		per cent	per cent	pounds	pounds	pounds	pounds	bushels
Ito San	114	78.55	4.46	17,249	3,699	769	1,313	21.9
Quebec No. 537	114	75.07	5.70	14,985	3,736	854	1,629	27.1
Medium Yellow	114	78.58	4.84	15,856	3,396	767	1,307	21.8
Quebec No. 92	*114	63.26	9.51	5,672	2,084	539	1,368	22.8
Manhattan	114	78.82	4.52	16,030	3,395	725	1,246	20.8
Kentucky	119	76.46	3.87	19,863	4,676	769	1,368	22.8
O'Kute	119	.....	....	19,341	.....	....	1,594	26.6
Ebony	119	73.07	5.86	17,076	4,598	1,001	1,742	29.0
Medium Green	126	73.11	5.42	17,076	4,592	926	1,237	20.6
Wilson	126	73.78	4.63	19,689	5,162	912	1,307	21.8
Mongol	126	78.23	4.24	18,992	4,135	805	1,464	24.4
Morse	126	77.93	4.01	11,848	2,615	475	1,272	21.2
Mikado	126	77.86	4.20	17,947	3,973	754	1,316	21.9
Arlington	134	73.98	3.35	14,985	3,899	502	1,307	21.8
Swan	134	77.08	3.63	22,477	5,152	816	1,220	20.3
Peking	139	77.29	3.52	14,288	3,245	503	1,115	18.6
Cloud	139	75.77	3.09	18,818	4,560	581	749	12.5
Hollybrook ...	145	75.38	4.82	16,901	4,161	815	1,072	17.9

From this it appears that the average harvest of green forage and also of seed was but little smaller in 1915 than in the previous year.

But when cut for forage in 1915 only about three-quarters as much dry matter and protein were harvested as in 1914. The crops of green forage in 1914 contained an average of only 69.0 per cent of water when cut, whereas those in 1915 contained 76.1, a difference of 7.1 per cent.

Soy beans have been grown on the same land for three years in succession, which may account in part at least for the somewhat smaller yields in 1915.

Comparison of Varieties—The results of two years' tests of those varieties which grew successfully in both years, indicate that the Wilson, Ebony and Cloud were in both years among the six which yielded most dry matter in the green forage. These are small, black seeded varieties, Cloud is distinctly twining, Ebony is erect but falls easily. We consider Manhattan, Arlington and Kentucky to be excellent kinds also.

* Past maturity, leaves falling.

Kentucky is a mixture of similar strains. By selection, these have been separated this year and two of the most promising are to be propagated.

The soy bean appears to cross fertilize sparingly.

The early, medium and late varieties which we have grown are given below, and in each group the varieties are in the order of their maturing, the earliest first.

Early Varieties—Mature in 104-118 days. Quebec 92, Quebec 537, Medium Yellow, Ito San, Kentucky, Manhattan, Ebony.

Medium Varieties—Mature in 120-124 days. Medium Green, Mongol, Mikado, Peking, O'Kute, Wilson, Arlington.

Late Varieties—Mature in 130-135 days. Hollybrook, Swan, Morse and Cloud.

As is to be expected, the earliest maturing varieties yield less dry forage than the others.

The latest varieties as a rule yield rather more than the earliest and the medium maturing varieties have been, in general, the most productive.

Comparison of the Yield of Feed of Soy Beans, Alfalfa and Ensilage Corn and of Mixtures—The tests made in the last two years fix with sufficient accuracy the approximate average yield of forage which may be expected from an acre of soy beans cut when the foliage is still green but mature.

There may fairly be expected *at least* 8½ tons of fresh forage having the following composition: For comparison is given in Table III the average yield of seven varieties of ensilage corn

TABLE III. YIELD AND COMPOSITION OF SOY BEAN FORAGE, ALFALFA AND ENSILAGE CORN.

	Mature Soy Bean Forage.			Alfalfa.		Ensilage Corn.	
	Percentage composition.	Pounds per acre.	Pounds digestible nutrients per acre.*	Pounds per acre.	Pounds digestible nutrients per acre.	Pounds per acre.	Pounds digestible nutrients per acre.
Water	73.0	12,410	....	....	....	....	....
Ash	2.4	408	....	....	....	....	....
Protein	4.6	782	602	1,360	1,006	559	347
Fiber	7.9	1,343	604	2,276	956	2,223	1,423
Nitrogen-free Extract	10.7	1,819	1,365	3,133	2,256	5,297	4,078
Fat	1.4	238	126	167	63	159	121
	100.0	....	2,697	6,936	4,281	....	5,969

* The coefficients of digestibility used in this bulletin are those given in Henry's Feeds and Feeding, 15th Ed.

grown in 1914, averaged 21½ tons of fresh fodder per acre, and of a year's yield from a measured acre of alfalfa.

A mixture of one part soy bean forage with three parts ensilage corn is recommended by several stations as making an excellent silage, and the Ohio Station states that a mixture of one to two may be used successfully.

The composition of such mixtures, based on the composition of the corn and soy beans as grown in our tests, is given in Table IV.

TABLE IV. NUTRIENTS (STATED IN POUNDS) IN ONE TON OF ENSILAGE CORN, SOY BEAN FORAGE AND MIXTURES OF THE TWO.

	One ton ensilage corn.	One ton soy bean forage.	One ton mixture 3 parts corn 1 " soy.	One ton mixture 2 parts corn 1 " soy.
Protein	16.12	70.80	29.8	34.4
Fiber	66.18	71.10	67.4	67.8
Nitrogen-free Extract	189.73	160.50	182.4	180.0
Fat	5.62	14.84	7.9	8.7
	277.65	317.24	287.5	290.9
Nutritive ratios	1:16.6	1:3.74	1:8.98	1:7.78

From this table it appears that the three to one mixture has in a ton 13.7 pounds more of digestible protein, and 2.3 pounds more of digestible fat and a much narrower nutritive ratio than ensilage corn alone. The two to one mixture has more than twice as much digestible protein and 1½ times as much digestible fat, with a still narrower ratio. At a time when concentrated feeds are very expensive it seems likely that soy beans may profitably be substituted for a considerable part of them. This is a question of farm economics which the station is not in a position to solve.

Note on Time of Planting—Our experience indicates that soy beans may be planted at any time after danger of frost is over and that a slight frost on the young plants is not absolutely destructive.

In 1915 seed of the Hollybrook was planted in small plots, each of 175 square feet, at three different dates, and harvested Oct. 11. The yields were as follows:

Date of planting.	Pounds of mature forage per acre.	Pounds of dry matter per acre.	Pounds of protein.	Pounds of seed.
May 5th	25,389	6,896	1,096	1,045
" 15th	19,415	4,902	811	1,120
" 29th	24,643	6,030	1,158	971

These tests are inconclusive and need to be repeated on a larger scale, but indicate no disadvantage from early planting.

Soy Beans as a Green Manure—In some cases it may be desirable to turn under soy beans as a green manure. Where sown for this purpose they may be drilled in rows seven inches apart, which may be done with an ordinary seed drill.

An average crop of soy beans such as we have grown at Mt. Carmel in the last two years may be expected to contain, exclusive of roots, per acre

Organic matter	4,255	pounds
Nitrogen	131	"
Phosphoric acid	23	"
Potash	93	"

What part of the nitrogen is taken directly from the air by the crop cannot be determined. It has been variously estimated from one-half to two-thirds and even more.

Recent experience indicates that it is wise to turn under a legume crop ten days or two weeks before planting the land. If immediately planted on land filled with fresh legume forage germination may be retarded or prevented. We had one experience of this kind in 1915.

Results of Field Tests of Soy Beans—Accepting the offer made in Bulletin 185, twenty-one farmers received enough seed, chiefly of the Hollybrook variety, to plant a half acre in 1915.

With the seed was sent to each a culture (Farmogerm from the Earp-Thomas Co. of Bloomfield, N. J.) sufficient to inoculate the seed.

With one exception all made report of their results to the station. One was prevented from making the test; in several cases the crop was practically ruined by woodchucks or deer; in two cases weeds suppressed the soys.

One reports that cows did not take readily to the feed but "the soys were mixed with weeds which got ahead of them."

All the others got a good or excellent growth, full inoculation and satisfactory results.

Some of the reports are here given as a valuable supplement to the work in our experiment field:—

Harry S. Ferry, So. Glastonbury. On Sept. 14 the writer saw the crop, which stood 38-40 inches high and looked very vigorous. One-half of the piece was cut for hay but it moulded in the barn. The other half matured seed and was harvested Oct. 23. The estimated yield was 16 bushels per acre. He says "My driving horse will leave his hay to eat a small quantity of the threshed vines, the stems of which are as large round as a lead pencil."

Wm. Coleman, Westport, grew and fed it successfully.

W. C. Robinson, Columbia, planted on clay soil with a corn planter June 1st, and cut for silage Oct. 1st. The crop was three feet high and the roots well supplied with nodules.

Thomas H. Williams, Southington, planted May 28th after harrowing in 250 lbs. of acid phosphate; rows 2½ feet apart. Sept 15th the crop stood 44 inches high and from a measured rod yielded 150 lbs., which is equivalent to 24,000 pounds per acre, a very large yield. On Oct. 11 the seed was harvested but owing probably to difficulty of threshing he got only 9 bushels of seed per acre.

Albert T. Rowe, East Glastonbury, writes:

"I am satisfied that they are valuable for feeding green and a good soil improver. They grew very rapidly, had nodules, some of them ¼ inch in diameter. Planted 28 inches apart the vines met between the rows and showed an unbroken green field. Have tried alfalfa with poor success and if soy beans give me the satisfaction in future that they have this year I do not think I will try alfalfa again. The only objection to them is that the stems grew rather tough before I finished feeding them."

W. H. Brown, R. F. D., Easthampton:

"In answer to your inquiry of the 9th as to soy beans I beg to say I planted them May 25th in drills 30 inches apart and I commenced feeding them to my hogs July 24th and have fed every day since that date. The hogs like them and seem to do well on them.

I think soy beans might be a remarkable crop to grow; in fact I think they have done remarkably for me under the condi-

tions. I planted them on the poorest land I have, sandy river bank, and put no fertilizer on land at all. I cultivated them only once, and when they were about six inches up we had a heavy hail storm and cut them up very bad, and yet I have a good piece of beans. I think they will average about three feet high.

I expect to let part of mine go to seed so as to plant several acres next year for hay on this same land where I have never been able to grow anything at a profit. I can report more fully later on. I live just across the river from Higganum depot."

J. D. Kelsey & Son, Madison, used them successfully in a young orchard for a corn crop. They also sowed a small area broadcast. The beans grew well and the forage was fed green to two milch cows with excellent results. "We think they are great for milk."

Orrin Case, East Granby: "The soys could not be planted till June 16. They were planted in drills 2 feet apart on land quite free from weeds and cultivated once. They now, Sept. 15, stand over 4 feet tall and are very large and dark green in color. Pods are just forming."

N. E. Whiting, Norwich, planted the crop June 2d in drills 3 feet apart. On Sept. 9 the plants stood 3½ feet high and the lower leaves were beginning to mature. The roots were covered with nodules, and the crop, mixed with corn, was to be cut into the silo.

The following very interesting reports we copy entire:

"About one-third of our patch of ¾ acre was nibbled off by woodchucks before we were able to control these by methods suggested by the farm bureau agent, Mr. Wright. This happened when plants were six inches high, but these plants recovered and made a fine second growth of tops.

The inoculation was perfect. All roots were thickly covered with nodules, and the crop was a fine healthy green color and made a sturdy growth. We fed a small area green to some six month old heifers and these ate the plants eagerly, stripping the stalks and eating all the branches except a portion of the main stalk.

We intended to put the main part of the crop into the silo, but put only about 2½ tons in, as our silo got full before we finished the piece. This portion was cut on September 10th.

We have no report yet on the feeding value of the ensilage, as we do not open this silo until about January 15th. The ensilage looked very good and packed nicely.

We did not touch the remainder of the field until September 22d, when we moved it and cured it in cocks for hay. It was too late for best results as hay, I am afraid, as the stalks were woody, and the beans were almost full in the pod. The hay yielded us, by weight, after curing in the cock ten days, under covers,—101 pounds from 25 feet square plot, or 625 square feet." (This equals 3½ tons per acre.)

"The beans moulded slightly in the pod, but not much. We fed one large two-horse load of this cured hay to our milkers. This was used in the stable to supplement our late fall pasturage, and a slight increase of milk flow resulted all throughout the herd. The cows were eager at all times for the hay and cleaned up all but the stalks, which were used as bedding. The increased milk flow, however, was also maintained by following the soy bean hay with mixed hay rowen.

The rest of the soy beans were fed out of the cocks to the young heifers in pasture. They would all come running down the hill to the fence as soon as the beans were thrown over. They cleaned the hay up very well and seemed to make a perceptible increase in growth while the hay lasted. The soil used was a fairly rich piece of light loam. A big root development was made.

We were, in all, well pleased with the crop, and will use it next season as a forage crop for our milkers, cutting it earlier than we did this past season.

We also used a variety of soy bean, Harris's Medium Early Green. We planted this variety in the hills with our silo corn, also in the hills with our Evergreen sweet corn, for forage, and were much pleased with that arrangement and also with that variety. It blossomed and formed pods earlier than the Hollybrook, and although its height was less, its stalk was less woody. We expect our ensilage to be much better because of it.

We are convinced that soy beans are a valuable crop and one that can be grown to advantage on New England dairy farms.

We consider it a mistake to plant the soy beans in rows 26 inches apart. They should be from 32 to 36 inches apart, so that a horse cultivator can be used."

Directions for Planting Soy Beans.

Choose land in fair condition; poor rather than rich. Liming is not essential; 200 pounds of acid phosphate per acre may pay.

Inoculation is generally desirable, using 500 pounds of soil from a soy bean field or an artificial culture which can be bought.

Plant at corn planting time or not later than the first week in June.

For forage, drill in rows 28 inches apart, plants about 2 to 3 inches apart in the row and cover seed about one inch deep.

Keep weeds down by cultivation till the crop is a foot high.

Cutting for soiling may begin when the pods form, and for ensilage soy beans should be harvested before the lower leaves turn yellow and drop.

For seed, cut or pull plants after all leaves have fallen and the pods are brown.

SOY BEANS AS FOOD FOR DIABETICS.

Following is a very brief outline of a paper* by Messrs. J. P. Street and E. M. Bailey of this Station.

In recent years various soy bean preparations have come into quite extensive use as special foods for the diabetic. The soy bean is especially suited for such a dietary as it is very rich in protein and fat, and furthermore contains only traces of starch, although analysis shows from 20 to 25 per cent of "nitrogen-free extract."

The form of the carbohydrates, however, is vital to the claims of special value of soy beans as food for diabetics, for starch is not by any means the only carbohydrate which is objectionable in their diet.

The authors have therefore made a thorough study of the nitrogen-free extract and fiber of Hollybrook soy bean seed grown at Mt. Carmel and thoroughly ripe when harvested.

The proximate percentage composition of the beans was

Water	12.67
Ash	4.64
Protein	36.69
Nitrogen-free extract and fiber	31.08
Fat	14.92
	100.00

* Journal of Indust. and Engineering Chem., Vol. 7, No. 10, p. 853.

The analysis of nitrogen-free extract and fiber, by methods described in the paper, yielded

Galactan*	4.86
Pentosan	4.94
Organic acids (as citric)	1.44
Invert sugar	0.07
Sucrose	3.31
Raffinose	1.13
Starch	0.50
Cellulose	3.29
Undetermined hemicelluloses	0.04
Dextrin	3.14
Waxes, color principles, tannins, etc. (by diff.)	8.60
	31.32
Galactan from raffinose	0.24
	31.08

The organic acids, celluloses and waxes, etc., certainly cannot be regarded as objectionable, nor are galactans or the pentosans generally considered dangerous. This leaves only 8.15 per cent of "extract" which is considered objectionable in a strict diabetic diet. This is less, it is believed, than occurs in any other unmanipulated vegetable products having a considerable protein content.

* Including 0.24 per cent derived from raffinose.