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TESTS OF SOY BEANS, 1916.

(NOTE ON THE PLANT FOOD IN A CORN CROP.)

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



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TESTS OF SOY BEANS IN 1916.

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

During 1916 a considerable number of field tests of soy beans have been made by farmers in this State. The County Agents of the Extension Department of the Agricultural College have placed and superintended these tests, and the two Stations have coöperated in making water determinations and, in some cases, chemical analyses of the crops.

This Station also provided most of the seed and furnished artificial cultures for inoculation.

The results of these farm tests may be reported separately.

The purpose of this bulletin is to record the results of the Station's tests at Mount Carmel in 1916 and certain other data which concern the soy bean crop.

There are four products derived from this crop, one or more of which give it importance in different sections of the country. These are the oil, the oil cake or meal, the seed, and the forage, which is used either for hay, ensilage, soiling cattle, or as a green manure.

SOY BEAN OIL.

Among the thirteen varieties of soy beans grown at this Station in 1914, the yield per acre ranged from 15 to 32½ bushels (of sixty pounds) and averaged 25 bushels. This is a larger yield than was obtained in the two succeeding years. The percentage of oil in the seed ranged from 14.5 to 19.0 and averaged 16.6.

The average quantity of oil contained in the seed per acre was therefore about 249 pounds, three-quarters of which, or

* Mr. C. D. Hubbell, the farm manager, has had charge of the field work and has taken 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.

about 186 pounds, equivalent to 24 gallons, could have been obtained by crushing and pressure with suitable machinery. The present quotation (Feb. 16, 1917) of soy bean oil in New York is eleven to thirteen cents per pound or from 84 cents to \$1.00 per gallon.

This oil is semi-drying and is used as a partial substitute for linseed oil in paints, as well as in the manufacture of soaps, enamels, linoleum and waterproofing material. To some extent it doubtless finds its way into butter substitutes and salad oils.

At present North Carolina leads in the growing of soy beans and in soy bean oil production.

Large quantities of the oil are imported yearly and its production in this country is rapidly increasing in several of the southern states, where cotton-oil mills can be profitably used for its extraction from the seed, but it does not seem likely that this industry can be established in this part of the country.

SOY BEAN MEAL.

The 1,500 pounds of seed per acre which we raised in 1914 would have yielded, after the extraction of oil, about 1,200 pounds of cake or meal.

This meal contains about 7.4 per cent of nitrogen (equivalent to 46.2 per cent of protein), 1.4 per cent of phosphoric acid and 1.8 per cent of potash.

It is an excellent cattle feed, is richer in protein than is cotton-seed meal, and is used in the Orient for human food also.

At present the output of southern mills is chiefly used in the manufacture of fertilizers.

SOY BEAN SEED.

Soy beans are quoted in our local market, in bushel lots, at \$2.75 to \$3.75, depending on the variety. Mammoth Yellow is quoted at \$2.75, Hollybrook at \$3.00, and Ito San and Black are quoted at \$3.75 each.

At these rates, a yield of 25 bushels of seed per acre would sell at prices ranging from \$68.75 to \$93.75. The beans can be threshed by hand or, with less loss from splitting the seed, in a bean thresher, and the leaves and trash can be plowed under.

or composted with manure. The seed should be well dried before storage, otherwise it is quite subject to damage from heating.

If the scarcity of food in this country increases, it is likely that soy beans will be in demand for human food.

SOY BEAN FORAGE.

At present the soy bean will be grown in this State chiefly for hay, ensilage, soiling, or hog pasture.

In our previous bulletins, 185 and 191, which are still available, these uses were discussed, and our own field tests in 1914 and 1915 and twenty others made by farmers in different parts of the State, as suggested by the Station, were also given.

In 1916 the work was continued at Mount Carmel, and the results are given in following pages. In the table are given the names of the varieties grown, the yields per acre, and the composition of the crops.

YIELD AND COMPOSITION OF VARIETIES OF SOY BEANS GROWN AT MT. CARMEL IN 1916.

Variety.	Days to Maturity.	Yield, pounds per acre.		Analysis of crop as harvested.					
		Fresh.	Water-free.	Water.	Ash.	Protein.	Fiber.	Extract.	Fat.
Ito San	105	10,367	2,615	74.8	2.0	4.4	6.7	10.8	1.3
Cloud	127	9,409	2,574	72.6	2.0	4.2	7.8	11.9	1.5
Swan	127	12,893	3,213	75.1	1.8	4.1	6.3	11.6	1.1
Morse	121	10,890	2,824	74.1	1.9	3.2	6.6	13.0	1.2
Hollybrook	121	10,019	2,630	73.8	2.2	3.7	6.2	13.0	1.1
Wilson	116	11,326	2,515	77.8	1.6	3.7	5.7	9.9	1.3
Ohio 7496	113	8,668	2,406	72.2	2.1	3.9	6.7	13.3	1.8
Manchuria	113	7,362	2,249	69.5	2.5	6.4	6.5	12.2	2.9
Arlington	127	8,407	2,431	71.1	2.0	4.7	7.5	12.8	1.9
O'Kute	116	13,590	3,152	76.8	1.8	3.6	5.5	10.5	1.8
Wing's Mongol ..	116	8,015	1,992	75.2	2.0	4.0	6.6	10.7	1.5
Medium Green ..	121	10,237	3,325	67.5	2.2	6.6	7.6	13.0	3.1
Ebony	113	8,494	2,459	71.0	2.3	5.7	7.5	11.3	2.2
Kentucky 10	116	12,806	3,173	75.2	2.0	4.5	6.0	10.4	1.9
Kentucky 11	116	8,276	2,410	70.9	2.3	5.1	6.3	13.0	2.4
Kentucky 24	116	8,015	2,010	74.9	2.0	5.2	5.4	10.2	2.3
Black Eyebrow ..	116	8,494	2,226	73.8	2.0	4.8	6.7	10.7	2.0
Average		9,839	2,600	73.3	2.0	4.6	6.6	11.7	1.8

The yields in almost all cases are disappointing. Thus, the average yields in pounds per acre of twenty varieties at Mount

Carmel in 1916, compared with the yields of the thirteen varieties grown in 1914 and 1915, are as follows:

Year.	Fresh Forage.	Dry Matter.
1914	17357	5275
1915	16941	4056
1916	9918	2602

The average yield of six of the seven tests of soy beans grown elsewhere this year, referred to above, was 10,580 pounds of green forage, with 3,315 pounds of dry matter.

We apprehend that the small yields on our own field were due to a variety of causes. The beans were grown where they had never been grown before and the land may not have been fully inoculated, although abundant nodules were found on the plants which were specially examined. They were planted late, and scarcity of labor made timely tillage and weed destruction impossible. Moreover, our previous experience has indicated that the first crop of soy beans on new land is likely to be disappointing. There is also to be considered perhaps the possibility of the inferiority of home-grown seed although the laboratory tests of the seed showed almost perfect germinating power.

Of the crops grown elsewhere, that from N. S. Stevens, East Canaan, yielding 9 tons per acre, with 2.3 tons of dry matter, is very satisfactory. Two others, yielding 5 and 6 tons of fresh forage, are fair. The others, like all of our own, are quite inferior in quantity.

The composition of the dry matter of the Mount Carmel crops in 1914 and 1916 shows that the latter is richer in protein, fat and carbohydrates, but this difference does not nearly compensate for the much smaller yield.

PERCENTAGE COMPOSITION OF DRY MATTER IN THE CROPS OF
1914 AND 1916.

	1914.	1916.
Ash	8.8	7.7
Protein	16.4	17.1
Fiber	29.3	24.9
Carbohydrates	40.0	43.7
Fat	5.5	6.6

Twelve varieties have been grown at Mount Carmel for three years in succession. For two years the seed planted was from the crop raised on the same land the year before.

These varieties are here given with their *average yearly yield* in pounds per acre of dry matter in the forage, and the average number of days from planting to maturity.

The yield of Kentucky and O'Kute are uncertain. One variety suffered in one year from unfavorable position, and in the other, dry matter was estimated from the weight of green forage.

AVERAGE YIELD OF SOY BEANS FOR THREE YEARS.

	Pounds of Dry Matter per Year.	Days from Planting to Harvest.
Wilson	3,329	122
Medium Green	3,281	122
Swan	3,276	130
Ebony	3,230	117
Cloud	3,201	134
Arlington	3,114	128
Kentucky	3,039 ?	118
O Kute	2,849 ?	120
Hollybrook	2,698	132
Ito San	2,609	112
Morse	2,680	126
Mongol	2,406	122

Of these, Wilson, Ebony and Cloud have small black seeds. Cloud is distinctly twining; Ebony is erect but falls easily.

SOY BEANS AS GREEN MANURE.

The very unsatisfactory yield of soy beans this year, to which reference has been made, greatly reduces the value of the 1916 crop as a green manure. It is only about four-sevenths of the average value of the two previous crops. The crops of the last three years, exclusive of roots, contained per acre:

Organic matter	3,637 pounds
Nitrogen	111 "
Phosphoric acid	20 "
Potash	79 "

and would add or return these quantities to the soil when turned under.

The potash and phosphoric acid were simply taken by the crop from the stock in the soil. A very considerable part of the nitrogen, however, variously estimated from one-half to two-thirds,

is a dividend on this stock, having been gathered from the air and fixed in forms available to crops.

This is not the only dividend. The organic matter, derived wholly from air and water, supplies a lodging and food for soil bacteria, which in turn liberate carbonic acid and other solvents of plant food within the soil. The importance of easily decomposing organic matter in the light sandy soils of the State is not often sufficiently considered.

Five and seven-tenths tons of stable manure would supply the same amount of organic matter, 25 pounds more of phosphoric acid, but 33 pounds *less* of nitrogen and somewhat less potash than a rather low yield of soy beans.

Two varieties of cow peas were grown in 1916 in the same field as the soy beans, on land which had been differently treated but was considered well adapted for either crop.

No close comparison between soy beans and cow peas is possible here, but the data may be recorded as of interest.

YIELD OF COW PEAS IN POUNDS PER ACRE

	Whippoorwill.	Brahman.
Organic matter	2,542	2,160
Nitrogen	54	50

AVERAGE COMPOSITION OF THE DRY MATTER OF SOY BEANS AND COW PEAS GROWN AT MOUNT CARMEL. 1916.

	Soy Beans.	Cow Peas.	
		Whippoorwill.	Brahman.
Ash	7.7	11.6	9.8
Protein	17.1	11.8	13.0
Fiber	24.9	21.5	21.1
Extract	43.7	53.0	54.3
Fat	6.6	2.1	1.8
	100.0	100.0	100.0

SUGGESTIONS FOR THE GROWING OF SOY BEANS.

The following hints may be helpful to any who plan to grow soy beans *this year*.

Soil. A rich soil is not necessary. The crop has done well on rather light sandy soil. A good seedbed is essential.

Fertilizers. If land is in fair condition of fertility, use no fertilizer. On poor land, 200 to 300 pounds of acid phosphate

may be applied. Liming is an advantage, but generally not essential if the soil is not very acid.

Inoculation. By all means inoculate, either with 500 pounds of soil from a field where soy beans have been lately grown, or with a commercial culture. If inoculating soil is used, spread soon after digging it, and harrow in as soon as possible.

Time of planting. To get the best yield of forage, plant immediately after corn. Planting for soiling or for green manuring may be done as early as May first and as late as July first.

Rate of seeding. For raising seed, drill in rows 28 to 30 inches apart, dropping the seed three to four inches apart, and cover about an inch deep.

For the large seeded varieties, one-half bushel will plant an acre.

For use as a green manure or pasturage, and probably also for hay or for soiling, the beans can be broadcast, or better, drilled with a grain drill, stopping every other hole so as to have the drill rows fourteen inches apart, using $1\frac{1}{2}$ bushels of seed per acre.

Tillage. When planted in rows 28 to 30 inches apart, for seed or forage, the crop should be cultivated until the plants are a foot high, when, on fairly clean land, the beans will not need further attention.

Time of harvest. Seed may be harvested after all the leaves have fallen—even after frost, if the pods do not shatter.

At present no special machinery is available for harvesting seed. We have pulled the plants, tied them in bunches, dried them in loose stacks and threshed them with flails, or better, with a Koger bean thresher.

The largest yield of hay or feed for soiling stock is obtained by cutting when the lowest leaves on the stalks are turning yellow. From that time on the crop loses its leaves, and with them its value, quite rapidly.

WHAT USE CAN BE MADE OF SOY BEANS IN CONNECTICUT?

To summarize briefly the discussion in previous bulletins:

1. As a catch crop following winter-killed grain or clover or a poor spring seeding. Can be sown *safely* from May first until the middle of June.

2. As a late summer crop for soiling cattle; furnishing concentrated roughage from the latter part of August to frost. It is scarcely inferior to alfalfa in feeding value, though its yield per acre is less. Choose the earliest maturing varieties for the first feeding, and sow at the same time later maturing kinds.

3. As an ensilage crop, either grown along with corn (a practice which is being studied by the Storrs Station) or grown separately and cut into the silo with corn, using about three tons of corn to one of soys.

4. As a nitrogen-gathering green manure; see the remarks on page 7.

5. As a seed crop.

HOW MUCH PLANT FOOD DOES A CORN CROP TAKE FROM AN ACRE?

The characters of soil, fertilizers and season, as well as the weight of crop, affect the amount of plant food removed. The following facts, however, make possible a fairly reasonable estimate.

In nine series of tests with husking, as well as silage, corn, most of them in the Northeastern states, the average amounts of nitrogen, phosphoric acid, and potash removed by the crop were the following, in pounds per acre:

	Highest.	Lowest.	Average.
Nitrogen	95.8	73.6	87.5
Phosphoric acid	61.0	23.0	42.0
Potash	99.7	36.2	67.1

Six tests this year at the Mt. Carmel field gave, for a crop of 15 tons of ensilage corn, the average figures under A below.

Several crops of husking corn, grown elsewhere in Connecticut, calculated to 75 bushels per acre, gave the average figures under B.

	A	B
Nitrogen	88	92
Phosphoric acid	37	34
Potash	100	74

HOW MUCH OF THIS MAY GO BACK IN MANURE?

Suppose 30 tons of ensilage corn from one acre are fed to cows in milk. Some 25-30 per cent of the nitrogen and phosphoric acid and a smaller proportion of the potash in the crop go into milk or flesh, and somewhere about 63 lbs. of nitrogen, 30 of phosphoric acid and 50-60 lbs. of potash are voided in dung and urine. More than half of the nitrogen and the most valuable part of it is in the urine, as well as more than two-thirds of the potash.

Every pound of the nitrogen which is in liquid form is worth at present 25 cents. That in the dung is probably worth not more than half as much.

With all care in keeping manure, a loss of 15 per cent of the nitrogen is unavoidable. Careless storage will result in wasting half of it, or more.

With such care as Mr. Southwick has suggested in the Extension Bulletin of December 20th, there may be returned to the field in manure from 30 tons of ensilage, perhaps 50 pounds of nitrogen, 25-30 of phosphoric acid and 45-50 of potash.

The above is only a general approximation. It does not include the fertilizing ingredients in the litter, nor the fermenting organic matter, which has great value as an amendment and, indirectly, as a solvent of plant food.