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Experiments with Corn, Forage Crops and Spring Cereals

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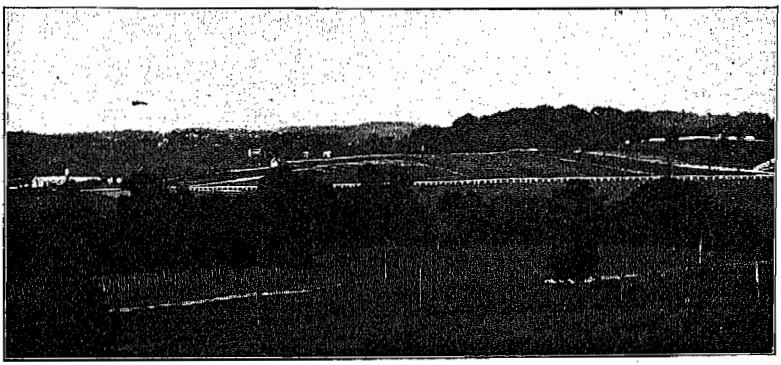

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Experiments with Corn, Forage Crops and Spring Cereals

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EXPERIMENTS WITH CORN, FORAGE CROPS AND SPRING CEREALS

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INTRODUCTION

In spite of the fact that corn is one of the oldest of the cultivated cereals, there is much to be learned concerning its production and general management. Its successful culture determines the relative development of several of the most important branches of our agricultural industries. Its abundance means an increase in animal production, especially of beef and pork, and hence greater prosperity for the farmer. The utility of various forage crops should be studied because from this source must be derived the additional roughness that will best combine with corn for the feeding of live stock, while the successful growth of spring cereals will furnish supplemental concentrates to balance the ration.

The immediate investigation of some of the problems relating to the culture of corn is important for the following reasons: Every year a number of apparently new varieties are placed upon the market with the hope of inveigling the farmer into buying some of them. They are but one or two crosses removed from the parent plant that have no fixed characteristics and their culture generally proves unsatisfactory. Thus, while there are innumerable varieties of this plant, one approaching perfection for a specific use or a certain locality has rarely been produced. It is true that many persons have worked conscientiously in the endeavor to establish a better variety of corn and the results accomplished taken on the whole are highly satisfactory, but it can not be said that a variety of corn best adapted for cultivation with the pea crop for the production of ensilage or shredded fodder has been determined as yet. Then, the best distance to plant in our climate, the proper rate of seeding, the correct methods of preparing the land and the after cultivation of the crop are still in a measure unsolved problems. The treatment of the soil so as to insure an ample and uniform growth of the roots is a subject which has not received much attention from the farmer, and yet the root development measurably determines the ultimate yield of the crop. The correct depth of seeding to most firmly establish the plant in the ground and the conservation of soil moisture in the ensuing cultivation are problems for serious consideration and about which we are at present not well informed. The food requirements of Tennessee soils for the best growth of this plant have not been carefully studied, and probably no class of experiments with corn will be more interesting or valuable than those which will determine the best relative rate of seeding. With many virtues to its credit and an almost uni-

versal adaptation to our soil and climate, corn is an unbalanced food product of itself. The excess of carbohydrates and the deficiency of protein entering into its composition require its combination with some other form of provender or concentrates for the most satisfactory and economic gains in stock feeding. The importance of blending the desirable feeding constituents of this plant in more suitable proportions is thus a question of vital concern to the farmer, and though the task will be a long and tedious one, it is quite possible of accomplishment through the medium of cross fertilization, seed selection and improved methods of cultivation. In future this work will form one of the principal lines of investigation at this station.

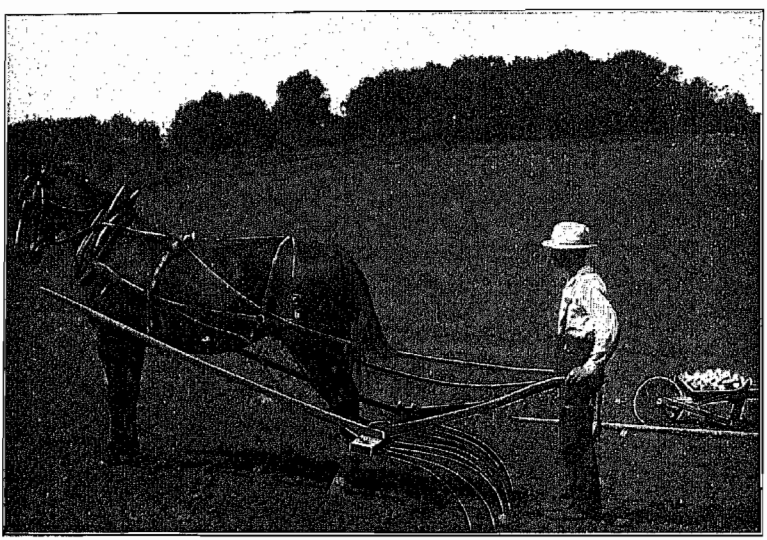
To the uninitiated some of these ideas may seem far-fetched, and there may be some who are even bold enough to assert that we understand very well the best distance at which to plant corn, etc., but for all this, the composition and the growth of the corn plant and the development of the ear and grain are all affected by the thickness of planting in various climates. The angle of the sun's rays, their intensity, and the amount of light furnished influence materially the composition and nutrients furnished by the crop, and certainly these are important though tedious problems to solve. It is not surprising that the farmer should disregard the value of such investigations for the many forms of culture often fail to show "evident effects" of what has really taken place in the internal economy of the crop. At the same time, the results obtained will in the aggregate be of great value, enabling the farmer to appreciate and correct many vagaries that now exist in his practice with regard to the care and handling of this crop.

The work reported in this Bulletin is preliminary in nature as it has been impossible in the first year's effort to commence investigations with many of the real problems relating to corn culture. Some interesting results have been obtained this year and the experiments will be materially enlarged another season and made commensurate with the importance of the corn crop in Tennessee agriculture.

PREPARATION OF LAND

The land for the corn experiment was plowed and subsoiled to a depth of 15 inches in November, 1899, and left in the roughest possible condition through the winter season. As most of the subsoils of Tennessee are red clay, the texture is tenacious and it is difficult for plant roots to penetrate into this area. It is important that this part of the soil be broken up for several reasons. First, it increases the water storage capacity of the soil and better insures its ability to withstand drought. Second, it materially increases the feeding area of the roots, thus aiding in the crop's ultimate development and allowing it to secure considerable quantities of its nourishment from a portion of the soil that is not usually drawn upon. Some of our soils have been greatly injured by the use of shallow feeding plants which have robbed the upper stratum of all its available fertilizing elements, and the importance of breaking up the sub-soil so as to get the roots as deep down as possible can not be urged too strongly.

Fall plowed land is important for the corn crop as it enables it to be seeded earlier than if the land is left unbroken during the winter and has to wait until sufficiently dried out for plowing in the spring. Then, in spring plowing it is necessary to have the land pulverized finely so as to have a good seed bed, but in the fall the idea is to leave the land as rough as possible so that that great physical force of nature, namely, frost, may do its powerful part in the disintegration of the soil particles and in rendering free latent plant food, in fining the soil to increase its capillary power etc. The question of thorough preparation of the land is one that can not be too strongly urged upon the farmers. The importance of culture and the influence of culture on setting free plant food by simply fining the soil and the immense value of a fine physical condition in the soil are questions not generally appreciated on the farm.



PRESERVING THE DUST BLANKET

SPRING CULTURE AND SEEDING

It may be proper here to state that the land for all the crops mentioned in this report was fall plowed and treated in precisely the same way with the objects stated above. On March 29 the land was thoroughly plowed and harrowed and farm yard manure applied at the rate of 15 tons per acre. It should be stated that the land had been in grass for several years and was an upland red clay soil containing a great deal of chert of but indifferent texture to commence with and evidently deficient in plant nutrients and humus. After the application of the manure, the corn was again cultivated to incorporate the manure with the surface soil. It was then rolled to compact it and to bring the moisture to the surface and immediately followed with the harrow to break off capillary connec-

tion with the atmosphere and prevent the escape of soil moisture. The corn was planted on April 26 in hills five links apart each way. It was planted rather thickly to insure a perfect stand so that the experiments might not be vitiated in any way. After it was well up it was thinned down to three plants in a hill. As soon as the corn was up in the rows, it was harrowed with the Breed's weeder and cultivated each succeeding week as long as feasible. The plats used in these experiments were 10x100 links, or 1-100 of an acre in area.

TABLE I Experiments with Varieties of Field Corn, 1900

Number	Name of Variety	Average height of crop—inches	Date of maturing	Number of days maturing	Weight of whole crop per acre, tons	Color of grain	Yield per acre of ears		Yield of grain per acre—bushels	Per cent of grain in whole crop
							Green, tons	Dry, tons		
			Aug.							
1	Florida	160	23	119	18.0	White	2.82	1.77	50.89	7.90
2	No. 3389	155	18	114	14.7	White	3.80	2.42	72.09	13.70
3	Ellis	144	20	116	14.7	White	2.13	1.28	37.96	7.23
4	Huffman	155	23	119	14.5	White	1.55	1.00	29.23	5.64
5	Improved Golden Beauty	130	13	109	14.0	Yellow	3.87	2.36	68.07	13.61
6	White Rockdale	155	20	116	13.5	White	3.47	2.13	65.18	13.52
7	Va. Ensilage	144	21	117	13.5	White	2.61	1.83	56.25	11.66
8	Va. Horsetooth	136	17	113	12.3	White	2.20	1.43	39.95	9.12
9	Wild Goose	144	18	114	12.0	White	2.83	1.50	44.86	10.46
10	Watson	138	16	112	12.0	White	2.87	1.81	54.00	12.60
11	Early Leaming	125	9	105	11.6	Yellow	3.35	2.01	58.48	14.18
12	Champion White Pearl	128	9	105	11.5	White	3.51	2.08	61.60	15.00
13	Chester Co. Mammoth	135	18	114	11.5	Yellow	2.40	1.52	45.75	11.13
14	Yellow Creole	146	21	117	11.5	Yellow	2.11	1.28	34.59	8.42
15	Nameless Beauty	116	6	102	11.0	Yellow	2.50	1.60	41.96	10.67
16	Hickory King	130	16	112	11.0	White	3.41	2.26	71.20	18.12
17	Improv'd Early Mastodon	124	6	102	11.0	Yellow	2.60	1.46	46.19	11.75
18	Cox Prolific	140	17	113	10.8	White	1.67	1.03	29.85	7.77
19	Henderson's Eureka	124	6	102	10.7	Yellow	2.07	1.10	30.12	7.88
20	Improved Leaming	118	6	102	10.5	Yellow	3.40	2.08	56.69	15.11
21	Cornucopia	134	13	109	10.5	White	2.46	1.75	37.50	10.00
22	Iowa Silver Mine	124	6	102	10.0	White	2.90	1.80	51.55	14.43
23	Pride of Nishna	120	8	104	9.9	Yellow	2.40	1.35	38.84	11.04
24	Golden Superb	130	13	109	9.5	Yellow	2.40	1.40	42.18	12.43
25	Wis. Early White Dent	106	4	100	8.8	White	3.25	1.93	57.36	18.24
26	Pride of the North	104	1	97	8.8	Yellow	2.67	1.55	53.12	17.00
27	Large White Flint	110	3	99	8.0	White	2.40	1.33	39.00	13.60
28	Iowa Gold Mine	108	3	99	7.4	Yellow	2.18	1.38	36.37	13.76
29	White Cap Yellow Dent	104	1	97	7.3	Yellow	2.58	1.42	40.00	15.44
30	Three Eared	86	1	97	7.2	White	2.85	1.78	52.67	20.48
31	New Klondike	120	6	102	6.5	Yellow	2.40	1.40	41.74	17.72

RESULTS OF VARIETY TESTS

Table I shows the results of the experiments with varieties of field corn for 1900. This shows that 30 Dent varieties and one flint variety were tested, and also that 17 varieties were white and 14 were yellow. The seed was secured from various sources, both north and south. The length of

the plants varied from 86 inches with three eared to 160 inches with Florida. Corn No. 3389 from the United States department of agriculture and Huffman were each 155 inches high. There was considerable difference in the date of ripening which varied from August 1 to 23; the number of days required for ripening running between 97 with Pride of the North, White Cap, Yellow Dent and Three Eared and 119 with Florida. The seed for the first three was from the north, while the Florida seed was grown in the Sweetwater Valley, about forty miles below Knoxville.

VARIETIES OF CORN

The difference in ripening would be explained by the source of the seed, and one point here may be emphasized with advantage, that as the northern corns will mature from 15 to 25 days earlier than those of southern origin, the seed from that source can often be used with advantage when it is desired to follow wheat with corn. This will allow ample time for the corn to mature, whereas, if a southern variety were used it would often be overtaken by frost before reaching its full development.

Some very remarkable results are shown in the column of yields, Florida corn leading with a total yield of 18 tons per acre, followed by corn No. 3389, Ellis, Huffman and Improved Golden Beauty, ranging between 14 and 14.7 tons per acre. The best varieties yielded more than twice as much as the poorer varieties, such as Iowa Gold Mine, White Cap, Yellow Dent, Three Eared and New Klondike. The most remarkable difference is apparent in the yield of ears per acre, both green and dry. Here it is seen that some of the poorest producing varieties when gross weight alone is considered yielded as many ears, both green and dry, as some of the coarse growing varieties. For example, Florida yielded 2.82 tons of green ears and 1.77 tons of dry ears per acre, while Three Eared yielded 2.85 and 1.78 respectively. This shows that a large stalk is not indicative of a heavy yield of grain, and its only advantage would be where the stalk is to be shredded or used in making ensilage. Even here it is not always clear that the largest stalk is best, for, as a rule, the smaller stalks are relatively more productive of nutrients than the larger ones. The best yield of grain per acre was secured from corn No. 3389, namely, 72.09 bushels. Following this came Hickory King with 71.20, and Improved Golden Beauty and White Rocksdale with 68.07 and 65.18 respectively. These are all white corn of northern origin. Florida, which made the immense gross weight of 18 tons per acre, only yielded 50.89 bushels of grain, about the same as Three Eared, Iowa Silver Mine, etc.

The per cent of grain in the whole crop exhibits many interesting results, and it is here that the crops producing the smallest gross weight showed to the best advantage, and especially the corns of northern origin. Three Eared led with 20.48 per cent; Wisconsin Early White Dent second with 18.24; New Klondike third with 17.74; and Pride of the North fourth with 17 per cent. The varieties making a high yield of grain, such as corn No. 3389, Improved Golden Beauty, White Rocksdale, etc., showed between 13 and 14 per cent of grain in the whole crop, while Florida and Ellis showed between 7 and 8 per cent.

From these results it is apparent that there are many interesting problems concerning the utility of various varieties of corn which are not clearly understood. It is also certain that the best varieties for the uplands and lowlands in Tennessee have not yet been determined, and it is evident that there is room for improvement in some particular in nearly every variety mentioned in the list. Among the most promising are corn No. 3389, White Rocksdale and Virginia Ensilage for late maturing and large total yields. For medium early to early maturing and a large per cent of grain, Hickory King, Champion White Pearl, Improved Golden Beauty and Early Leaming are probably among the best.

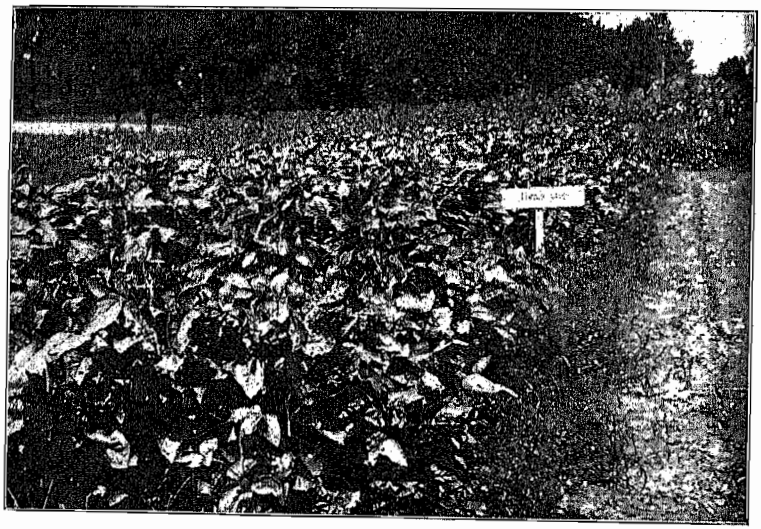
RESULTS OF EXPERIMENTS WITH CORN FROM DIFFERENT PARTS OF THE EAR

Of all the work of the agricultural department none is considered of greater general importance to the farmer than the endeavor to demonstrate the importance of seed selection. The work was barely commenced this year with an experiment in which the seed from the butt, middle and

TABLE II Selection of Seed from Different Parts of the Ear, 1900

Selection	Yield of Whole Crop Tons	Yield of Ears Tons
Butt end	15.56	2.76
Middle	15.74	2.20
Small end	14.00	2.10

small end of the ear of corn was selected and planted in duplicate plats on the 27 of April under conditions similar to those previously described. The importance of seed selection can hardly be over estimated as by this means the dominant characteristics of a variety may be maintained for many years and the so-called "running out" prevented. In addition, the yields of nutrients per acre both in the stalk and in the grain can be favorably influenced, and while this influence may not be marked as shown by the chemical analysis of a single plant, when the yield over a large area is considered the increased value of the feeding nutrients secured will be quite surprising. By means of selection, the size, composition and total



VARIETIES OF LEGUMES FOR FORAGE

yields produced by a variety may be manifestly altered, and as this character of work can be practiced on every farm with some success, its importance will commend itself to the consideration of every thinking farmer. This experiment slightly favors the use of the corn from the butt end of the ear. The corn was grown for ensilage and hence no attempt was made to determine the dry weight of the ears or the fodder. The experiment noted here is simply a suggestive one and marks the beginning of a special line of investigation with reference to seed selection at this station.

FORAGE CROPS

It is not necessary to explain to the farmers of Tennessee the admirable conditions found in this state for the pursuit of animal industries. The climate, soil, water privileges, and the variety of crops that may be grown all point this out in an emphatic manner. The summer drought which prevails in all sections of the country makes it imperative where stock industries are conducted on a profitable basis (especially those pertaining to dairying) that some provision be made for a succession of soiling crops. But comparatively little study has been given to this subject. The number and variety of crops that can be grown, their nutritive value, and the areas that must be planted to furnish sufficient food for a given number of cattle for a given length of time are all questions still requiring solution. This kind of work is therefore considered to be of particular importance to all those interested in stock husbandry in the state. While it is true that much of the stock is not fed in the summer time and it is imagined by some that it will not pay, this is a fallacy and the sooner it is corrected, the greater will be the economic gain to the farmer. It has been urged by some that Tennessee is not legitimately a dairy state, because while having all the natural advantages, it can not produce those grasses that do well in the north. On the other hand, the climate is capable of producing an admirable variety of forage plants as the preliminary experiments here described indicate, which can be depended on for feeding purposes for several months of the year. While soiling is more expensive than pastures, there are few sections of the country where these can be counted on at all times and where it must be practiced, it is to the dairyman's material advantage to have a great variety of forage crops which he can produce cheaply and easily and have to feed whenever needed. This being true, the state of Tennessee offers splendid opportunities for this character of work. The preparation and treatment of the land for these experiments was practically the same as for corn.

TABLE III RESULTS OF EXPERIMENTS WITH FORAGE CROPS FOR 1900.

This table shows that the forage crops were grown in 20 different combinations. The date of seeding, the rate of seeding, the method of seeding, the date of harvesting, the height of the crop, and the yield of the green crop per acre in tons are therein incorporated. The highest yield obtained from any crop was with teosinte, which unfortunately will not mature seed in this state. This militates against its successful use. The seed costs 75 cents per pound and when planted at the rate of two seeds per hill and four feet apart each way, a pound will seed from one to two acres. It produced a tremendous growth this year and was highly relished by our stock. The ensilage made from teosinte kept well and was greedily eaten by the dairy cows. It seemed more acid than sorghum or corn ensilage. Rape was second in point of yield, and as a forage crop for cattle, sheep and swine is unexcelled. It can not be fed, however, with immunity to dairy cows, as it is likely to taint the milk. Corn alone and corn and cowpeas combined gave practically the same yield. This was also

true of rape when sown alone and combined with cowpeas, and millet alone and combined with cowpeas. The table shows that a fine succession of forage crops can be grown in the state so as to furnish feed from June 20 to October 12. This does not include the winter cereals, such as rye, oats, barley, vetch, etc., which should be fall sown, and which would all be ready for use as soiling crops before the 20 of June.

TABLE III Experiments with Forage Crops, 1900

Number	Name of Crop	Date of seeding	Rate of seeding (Lbs.)	Method of seeding	Date of maturing	Average growth of plants, in.	Yield of green crop per acre (Tons)
1	Teosinte.....	May 2.....	2 seeds per hill	*5 links wide.	Oct 12.	85	26.25
2	Rape.....	April 24....	1 lb. per acre..	*3½ links wide	July 2.	24	18.50
3	Corn.....	April 24....	.....	*5 links wide.	Aug. 21	126	17.60
4	Cowpeas	May 1.....	.....	*3½ links wide	July 31	70	14.10
5	Velvet Beans.	May 2.....	.....	*5 links wide.	Oct. 25	175	8.75
6	Millet.....	May 3.....	40	Broadcast	July 3.	34	7.00
7	Sorghum	May 2.....	.....	*5 links wide.	Aug. 20	78	11.85
8	Soja Beans...	May 1.....	.....	*3½ links wide	Oct. 12	36	5.94
9	Canadian Field Peas.	April 9.....	2½ bus.	Broadcast	July 3.	30	3.87
10	Oats	April 24....	2 bus.	Broadcast	June 20	20	3.70
11	Hairy Vetch.	April 23....	2 bus.....	Broadcast	July 31	30	2.00
12	Cowpeas and Corn	May 2.....	.....	*5 links wide.	Aug. 21	Not taken	17.70
13	Cowpeas and Rape.....	May 2.....	.....	*3½ links wide	July 16		16.50
14	Cowpeas and Millet.....	May 3..	Cowpeas 56 lbs. Millet 28 lbs. ..	Broadcast .. Broadcast ..	July 10		10.25
15	Cowpeas, Millet, and Sorghum	May 3..	Cowpeas 37 lbs. Millet 18 lbs.... Sorghum 12 lbs.	Broadcast .. Broadcast .. Broadcast ..	July 10		9.87
16	Cowpeas and Sorghum ..	May 2.....	....	*5 links wide.	Aug. 31		8.25
17	Oats and Rape	April 24..	Oats 34 lbs..... Rape 2 lbs.....	Broadcast .. Broadcast ..	July 5.		7.87
18	Oats, Canadian Field Peas	May 24.	Oats 1 bus..... Peas 2 bus.....	Broadcast .. Broadcast ..	June 20		4.00
19	Oats and Tares	May 24.	Oats 1 bus..... Tares 2 bus....	Broadcast .. Broadcast ..	July 3.		2.25
20	Oats, Canada Peas, and Tares	April 9.	Oats 1 bus..... Peas 1 bus..... Tares 1 bus....	Broadcast .. Broadcast .. Broadcast ..	July 3.		2.00

* In rows.

There was not such a decided advantage in the use of any particular mixture as might be supposed. It is true that some show a much higher yield than others and where eaten with equal relish they should be used. One peculiarity was observed, that is, that the cowpeas and rape, cowpeas and corn, and cowpeas and millet, when sown separately and in com-

bination, gave practically the same yields per acre. There is a disadvantage in the mixture in that it is difficult sometimes to get two crops that combine well together and mature at the same time. On the other hand, it is a great advantage to combine these crops occasionally as some deficiency in the composition of one is offset by that of the other, and thus a better balanced food is secured from the combination. Thus, it is an open question as yet as to whether it is an advantage to combine many of the leading forage crops or not. Cowpeas and millet can be handled well together and make an excellent hay. Cowpeas and sorghum make an immense yield of forage of the finest feeding quality, but the sorghum being so much younger and sappier than the peas, the two can not be successfully cured into hay. Canadian field peas and oats make a most satisfactory soiling crop. The cost of the seed for use in combinations is very often against this system, as will be observed by referring to the rate of seeding as shown in Table III. A further study of the best succession of soiling crops, the date of ripening, and the approximate area of land to sow to each will be made next year. It should be noted that these crops can all be seeded with the drill and were only broadcasted on the plats as a matter of convenience.

There was no advantage in sowing more than two crops together, and it is especially important to be careful in selecting two equally vigorous growing crops for combinations, such as cowpeas and sorghum, for if the cowpeas once obtain a start, they are likely to crowd out any fine growing crop. While velvet beans produce a very good yield, they are not equal to the cowpea. They are more difficult to handle and it would be almost an impossibility to cure them into hay owing to the tangled nature of the vines and the watery condition of the plants; besides, they have as yet failed to mature seed in this climate. Soja beans are excellent in a soiling rotation, but they are much coarser in texture than the cowpea, have not as yet equaled it in yield, and can not be used for so many purposes or under so many circumstances as the cowpea. The hairy vetch, oats and tares have but a questionable value for use in Tennessee at the present time. With mixtures of rape, corn, cowpeas, millet, sorghum, Canadian field peas, oats and teosinte, a good selection of soiling crops can be had all through the season, and these are about the only crops as yet that can be used with safety by the farmer. Giant beggar weed, spring tares, etc., were entire failures this year. The sorghum did not germinate well in these particular experiments—that probably accounts for its not making a better showing.

TABLE IV RESULTS OF EXPERIMENTS WITH VARIETIES OF SORGHUM, KAFFIR CORN, ETC.

The importance of securing a variety of sorghum and kaffir corn that can be used in combination with cowpeas for the production of ensilage is clearly evident to the thoughtful farmer. Sorghum is a plant that stands the drought of summer with apparent immunity. It is a heavy yielder and produces an excellent quality of ensilage if properly prepared. It is also one of the very best of our summer soiling crops and can be cured and

make a fair quality of hay. A number of the varieties tested this year are quite promising. Some of those showing the best yields were from seed secured from the United States department of agriculture. The results of this work are given in table IV. The treatment of the soil, its preparation, fertilization, etc., were similar to those described under corn. Planting was done on April 30. The best yields were secured with sorghum No. 4312, No. 4310, and Early Orange sorghum, the yield varying between 11 and 11½ tons. The saccharine sorghums made much better yields than the non-saccharine and seem to be much better adapted to this climate than the other varieties. It might be thought that this would be so ap-

SORGHUM AND COWPEAS FOR FORAGE

parent that the experiment would not be worth making, but the difficulty of making sorghum into ensilage in the south when used alone, owing to the amount of sugar it contains, is one of vital importance to the farmer, and it has been found that by combining Kaffir corn with this crop that this difficulty can be largely overcome. The Kaffir corn seemed to be better adapted to our conditions than the Durra corn. The broom corns as grown made a fair yield. It was thought well to make this investigation because of the general interest shown in the preservation of broom corn in the

silo after the heads have been pulled and stripped. The analysis of broom corn is as follows:

Water	Protein	Fat	Nitrogen Free Extract	Fiber	Ash
9.41	3.87	1.85	42.37	36.76	5.74

This, of course, includes the grain which could easily be scraped from the broom head and incorporated with the balance of the stalk in the silo, thus making a good quality of ensilage and providing not only a considerable quantity of valuable feed, but making a second profit possible with this crop. The volunteer crop may then be plowed under to enrich the soil and provide additional humus. The seeding for this crop took place on April 30 and the cultivation was the same as for corn. Some of the seeds did not germinate well. This might have been due to change of climate and it is possible that another year they may show better results. The yields of

TABLE IV Experiments with Varieties of Sorghum, Kaffir Corn, Etc., 1900

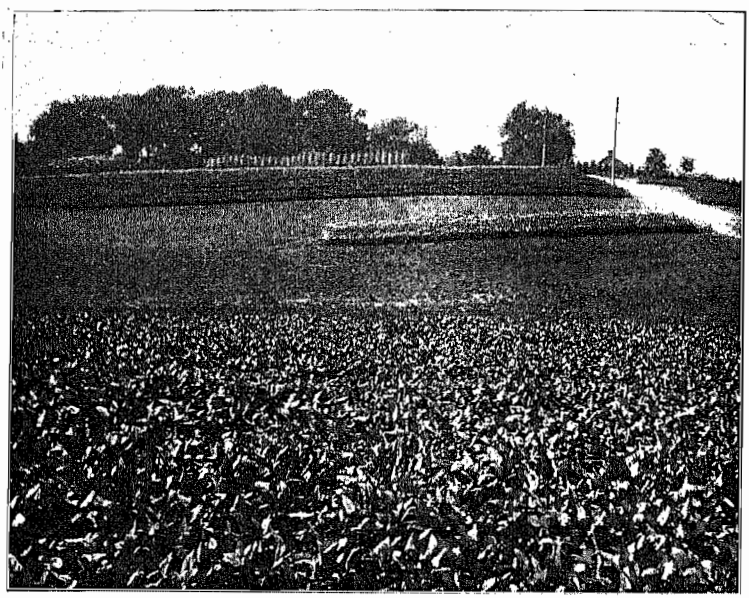
No.	Name of variety	Average height of crop Inches	Date of cutting	Yield per acre Tons
1	Sorghum, No. 4312	88	Sept. 6	11.85
2	Sorghum, No. 4310	98.5	Sept. 6	11.80
3	Early Orange	102	Oct. 30	11.00
4	Sorghum, No. 4309	89	Sept. 6	9.50
5	Sorghum, No. 4311	98.5	Sept. 6	9.00
6	White Kaffir Corn	63.5	Oct. 30	8.01
7	Early Amber	100	Oct. 30	8.00
8	Rural Branching "Durra" Corn	68.5	Sept. 6	7.70
9	Sorghum, No. 4308	79	Sept. 6	7.40
10	Red Kaffir Corn	55	Oct. 30	6.50
11	Improved Evergreen Broom Corn	111	Sept. 6	6.37
12	Brown "Durra" Corn	68.5	Sept. 6	4.63
13	White African Sorghum	84	Sept. 6	2.37

sorghum shown in these experiments are not considered the maximum by any means, but are very excellent for the character of land on which the crop was grown, it being a cherty upland soil of inferior texture.

TABLE V RESULTS OF EXPERIMENTS WITH VARIETIES OF COWPEAS FOR HAY.

The peas in this experiment were seeded on May 3. They were planted in rows three and one-half links apart, the seed being four inches apart in the row. The germination was good and the cultivation commenced as soon as the horse could follow between the rows. They were cultivated weekly thereafter to conserve the moisture until the vines commenced to run. The object of the experiment was particularly to determine the merits of a few of the leading varieties of peas for hay. The green yield made by the varieties was very heavy indeed, ranging between 22,500 and 13,000 pounds per acre. The dry weight varied from 3,500 to 6,200 pounds. The smallest yield of hay was from Large Purple Eye, being less than two tons per acre,

while the best was shown with Taylor, three and one-tenth tons per acre. Wonderful, Clay, Blackeye and Whip-poor-will all made good yields of hay. It will be observed from this table that the cowpea when green contains an immense volume of water, as with the Taylor variety, for example, there was a shrinkage of seven tons of green weight for one ton of dry weight. The peas sown on May 3 and cut on August 7 made a fine volunteer growth. The grain was gathered from the volunteer crop of the Taylor variety and yielded at the rate ot eight bushels per acre. This is an excellent showing, considering it was the second crop. Frost was unusually late in falling this year, thus making the season especially favorable. This indicates that two crops of peas can be secured in a season, namely, one for hay and one for grain. In our experiments this year, the second crop has



COWPEAS AFTER WHEAT

not made a very large growth but has fruited unusually well. Investigations looking to the possibility of securing two crops of cowpeas will be continued another year. In order to do this the land must be fall plowed and the peas seeded as early as danger of frost in the spring is passed. The possibility of growing one crop for hay and another for seed is not so doubtful as some may imagine, for generally the farmer is busy in the spring with other crops and knowing the peas will grow and thrive well during the warm weather, they are as a rule not put in from two to three weeks later than they could be planted, thus cutting off the possibility of a second crop or aftermath for hay, grain, etc. Where it is hoped to cut two crops a season, the dates of maturing of the several varieties must be carefully

considered, for by reference to table V it will be seen that the dates when the several varieties were ready for hay-making varied from July 31 to September 4.

TABLE V Yield of Hay from Leading Varieties of Cowpeas, 1900

No.	Name of Variety	Average length of plant Inches	Date of cutting	Green weight Lbs.	Dry weight Lbs.	Yield of hay per acre Tons
1	Taylor	60	Aug. 7	22500	6200	3.1
2	The Wonderful	50	Sept. 4	21400	5200	2.6
3	Clay	55	Sept. 4	20700	4900	2.5
4	Black Eye	70	Aug. 7	18000	5150	2.3
5	Whippoorwill	68	Aug. 14	16500	4800	2.4
6	Black	45	Aug. 7	15600	4350	2.2
7	Warren's Extra Early	42	July 31	15600	4250	2.1
8	BlackEye(homegrown)	70	Aug. 7	15000	4000	2.0
9	Large Purple Eye	48	Sept. 4	13600	3500	1.8

The value of cowpea vine hay is being appreciated more thoroughly by Tennessee farmers. Two or three tons per acre can be secured on well prepared land. The feeding value is very high and it is almost a sure crop, withstanding the hot, dry weather of summer with immunity and growing finely all the time. It is a crop that is well adapted to the feeding of horses, cattle, sheep and swine, and is highly relished by all of them. In addition, it has the great advantage of being able to draw large supplies of atmospheric nitrogen from the air and store this in the soil. It is one of the most powerful soil restorers that can be used, and in this way the farmer can avoid buying large quantities of nitrogen which is the most expensive fertilizing element he has to supply the soil, and in which the soils of Tennessee as a rule are deficient. More cowpeas should be grown as they fit in as a catch crop after almost any system of cultivation. In our experiments the medium growing varieties have been more satisfactory for the making of hay because the vines do not tangle so badly. For hay making it is preferable to grow the peas in drills 15 inches apart and cultivate during the first stages of growth, leaving the ground as smooth as possible. By the use of a hay tedder and a little straw, the field curing of this crop if put up in large cocks has not been a difficult matter with us. Table V shows that for every ton of cured hay there was a green weight of 7000 pounds, and it is not surprising that to get rid of 5000 to 6000 pounds of water per ton of cured hay should require skillful management.

A series of fertilizer experiments were undertaken with cowpeas in which no fertilizer, 150 pounds nitrate of soda, 300 pounds Tennessee acid phosphate, 75 pounds muriate of potash and 50 bushels of lime per acre were used singly. The following combinations were also used: 75 pounds nitrate of soda and 150 pounds Tennessee acid phosphate; 75 pounds nitrate of soda and 50 pounds muriate of potash; 150 pounds Tennessee acid phosphate, 50 pounds muriate of potash and 75 pounds nitrate of soda; 150 pounds Tennessee acid phosphate and 50 pounds muriate of potash. One of the objects was to determine the value of using a nitrogenous

fertilizer with leguminous plants that have the power of taking supplies of nitrogen from the air, and also to determine the value of acid phosphate and muriate of potash alone and in combination for this crop. It is well known that the cowpea draws heavily on these two constituents of the soil. It has long been held that it would be an advantage to add these to the soil. The experiment this year, however, was negative as to the use of 150 pounds of nitrate of soda, and muriate of potash only increased the green yield one ton per acre. Lime was equally effective and shows the value of this fertilizer when judiciously applied to our soils. Nitrate of soda had apparently no effect whatever on the growth and yield of the crop.

VELVET BEAN

TABLE VI THE RESULTS OF EXPERIMENTS WITH SOJA BEANS FOR HAY

Most of these varieties were imported and secured through the United States department of agriculture. They were sown the same as the cowpeas on May 4. The yield of grain could not be determined as the beans were grown to determine their yields for green food, and they will only mature one crop in this climate. The best yield secured was 5.94 tons of green material. The beans stand erect, do not run so much, are easier to handle than the cowpea and can be cultivated for a longer time, but they are coarser, do not make as great yields, though they are less watery in substance than the cowpea. The soja beans No. 4912, No. 4914 and

No. 4913 made satisfactory yields and are the most promising varieties yet tested at this station. Most of the varieties of soja beans matured earlier than the cowpeas, but they failed to produce any volunteer crop this year. It seems possible that some of the ranker and coarser growing varieties

TABLE VI Experiments with Soja Beans for Green Food, 1900

Number	Name of variety	Average height of crop Inches	Date of cutting	Yield of gross crop per acre Tons
1	Soja Bean, No. 4912.....	34	July 31	5.94
2	Soja Bean, No. 4914.....	29	Oct. 5	5.70
3	Soja Bean, No. 4913.....	30	July 31	5.25
4	Medium Green Soja Bean.....	32	July 31	5.10
5	Common Soja Bean.....	25	July 24	3.60
6	Medium Early Soja Bean.....	23	July 23	3.30
7	Extra Early Dwarf Soja Bean..	16	July 10	1.29

might be cut and bound with the corn harvester, making the handling of the crop quite simple. This crop is not nearly equal in general utility to the cowpea for Tennessee conditions.

TABLE VII RESULTS OF EXPERIMENTS WITH MILLETS FOR HAY

Millet hay is largely cultivated in this state, and in order to determine the value of some of the important varieties, an experiment was conducted with this crop. The millets were seeded at the rate of 40 pounds per acre on May 10. Japanese is rather a coarse growing variety and therefore not quite so good in quality as Golden or Hungarian, or so well

TABLE VII Experiments with Millets for Hay, 1900

Number	Name of variety	Average height of of crop Inches	Date of cutting	Green weight Lbs.	Dry weight Lbs.	Yield of hay per acre Tons
1	Japanese	45	July 21	10750	5250	2.62
2	Golden.....	43	July 21	12000	5000	2.50
3	Hungarian	32	July 21	8000	3500	1.75
4	Millet No. 2797	19	July 21	2250	1150	.57
5	Millet No. 2795	18	July 21	1150	500	.25
6	Millet No. 2794	13	July 21	700	300	.15

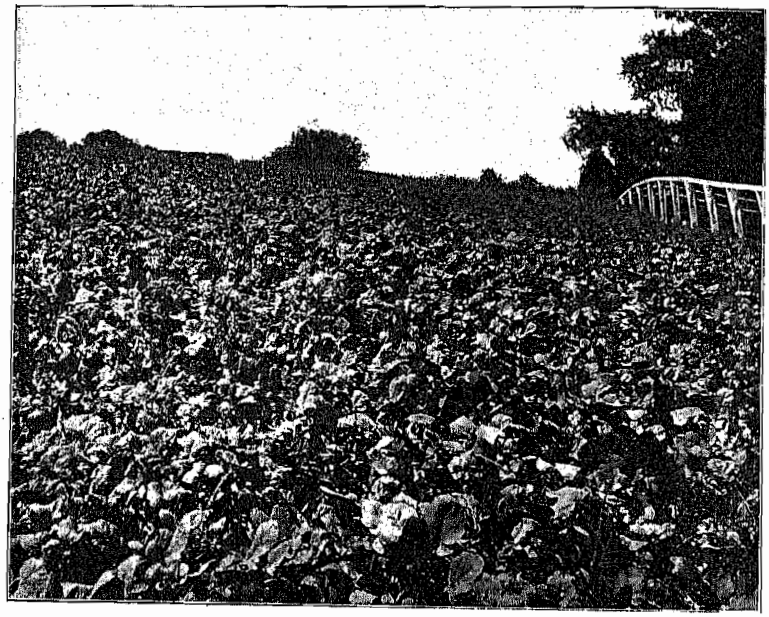
adapted for making into hay, and while it makes a greater yield its coarse texture makes it unsatisfactory. The Japanese millets imported and grown here for the first time this year were but indifferently successful, and unless they show better results another year are not the equal of Golden or Hungarian for use by Tennessee farmers.

TABLE VIII Spring Seeding of Rape at Different Dates, 1900

No.	Name of Variety	Date of seeding	Average height of plant Inches	Date of cutting	Yield of green crop per acre Tons
1	Dwarf Essex rape.....	March 31	21	July 10	8.5
2	Dwarf Essex rape.....	April 16	21	July 10	7.0
3	Dwarf Essex rape.....	April 30	19	July 20	6.0
4	Dwarf Essex rape.....	May 14	16	July 20	3.9
5	Dwarf Essex rape.....	June 15	Failed	Failed	.....
6	Dwarf Essex rape.....	July 16	Failed	Failed	.....

TABLE VIII RESULTS OF EXPERIMENTS WITH RAPE

Rape is a forage plant offering considerable promise in the state of Tennessee. It is admirably adapted for the spring feeding of lambs, hogs and cattle, except those intended for dairy purposes, and then the only



FIELD OF RAPE

objection would be the tainting of the milk. Excellent results can be secured with rape if planted on spring plowed land very early in the season, as shown from the accompanying table. Of the six seedings made by us, the earliest sown was the most successful. Quite a volunteer crop was obtained from that seeded on March 31 and April 16 and cut on July 10. Owing to the scarcity of land this year, it was impossible to continue to

seed rape all through the season, but owing to the favorable showing it has made this year and its recognized value as a pasture crop for farm live stock, the work with this plant will be conducted on a much larger scale next year. The mistake of cutting the rape too late in the season was made this year. It is believed that another year by pasturing and not allowing it to be eaten down too closely that it will lay dormant through the summer and come on again in the fall. A number of fields have been seen in the state where this practice has been successfully carried on. For fall pasture, if sown in August or September, it will be available until Christmas. It thus furnishes an immense amount of green forage through a long period of the year whose value is greatly superior to that shown by the chemical analysis of this plant. The seed was sown in drills three and one-half links apart at the rate of one pound per acre.

CANADIAN FIELD PEAS

The experiments with Canadian field peas this year were only measurably successful. This was due to the fact that the seed could not be sown quite early enough on account of wet ground. It is believed that this plant will do better when seeded in the fall and experiments looking to the determination of this point are being conducted this year. Of the five varieties tested all made a fairly good growth, but a small yield of grain and straw. They matured from the 7 to the 14 of July. Of the varieties tested, Tall White Marrowfat and Prussian Blue offer the most promise.

TABLE IX Experiments with Varieties of Spring Oats, 1900

No.	Name of Variety	Average height of crop Inches	Date of ripening	Yield of grain per acre Bushels	Yield of straw per acre Tons
1	Texas Rust Proof	21	July 10	42.26	1.88
2	Big Four	32	July 11	36.38	1.93
3	Shotilof, No. 1178	32	July 13	35.29	1.75
4	Holstems Prolific	35	July 12	34.45	1.91
5	Mortgage Lifter	37	July 2	34.11	1.87
6	Clydesdale	31	July 10	31.50	1.21
7	White Russian	36	July 12	30.50	1.28
8	Lincoln	33	July 11	29.41	1.50
9	Oat No. 2788	36	July 10	28.29	1.36
10	Welcome	31	July 11	24.61	1.28

TABLES IX AND X RESULTS OF EXPERIMENTS WITH SPRING OATS

These plats were seeded on March 12 at the rate of two bushels per acre. They were not much injured by rust, although White Russian, Big Four and No. 2788 were affected the most. Clydesdale was the only variety that had any smut. All the varieties were possessed of good straw, while Texas Rust Proof gave the greatest weight per measured bushel. If winter grown oats are seeded early in the fall on well prepared land they

will generally produce a good crop. But occasionally they fail and in certain sections of the state it is exceedingly important to be able to produce a good crop of spring oats, which furnish such excellent feed for a great variety of farm stock, both in straw and in grain. One of the important points about growing spring cereals in Tennessee is to get them in the ground as early as possible so that they will mature before the hot weather comes on. If this is accomplished they will fill well and will not likely be injured by rust, smut or other fungous diseases. In order to do this it is necessary to fall plow the land as described in the beginning of this report.

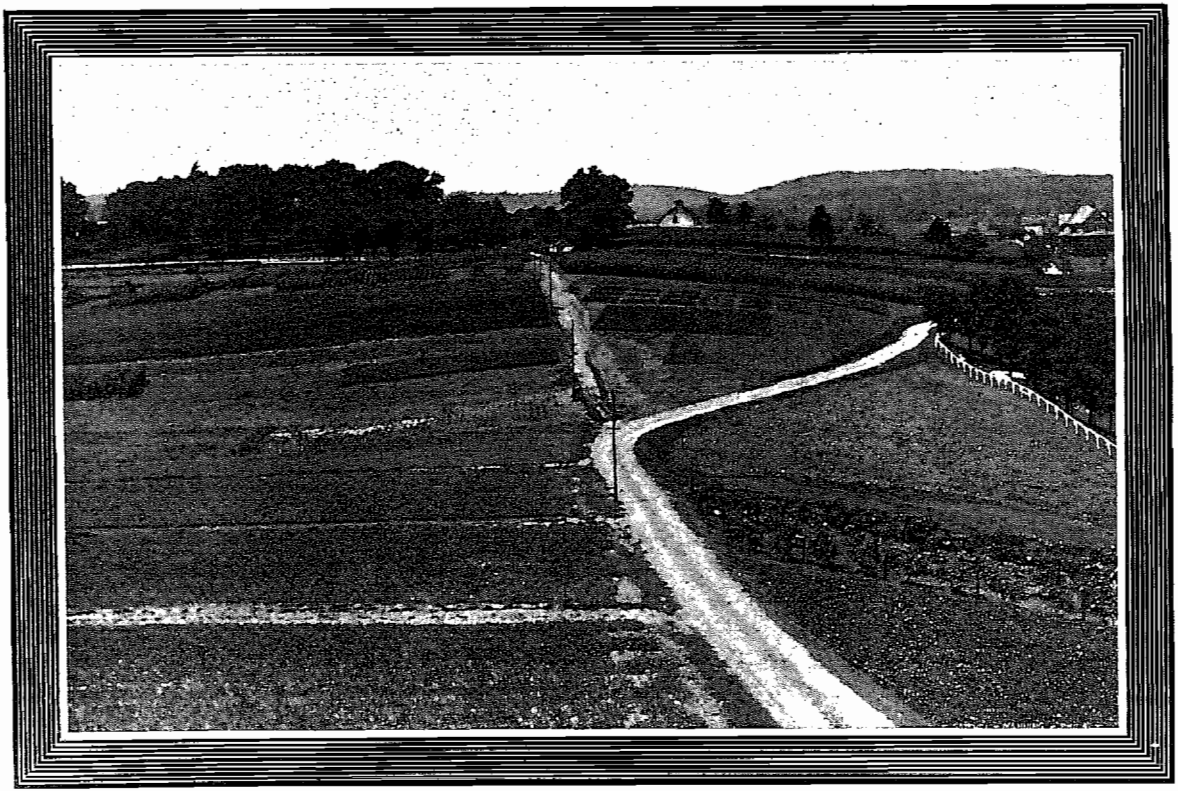
TABLE X Seeding Spring Oats and Barley at Different Dates, 1900

No.	Name of variety	Average height of crop Inches	Date of seeding	Yield of grain per acre Bushels	Yield of straw per acre Tons
1	White Russian	37	March 12	29.41	1.2
2	White Russian	35	April 2	22.80	.89
3	Texas Rust Proof	19	April 2	29.41	.95
4	Early Ripe	19	April 2	23.53	.75
5	White Russian	33	April 23	18.00	1.02
6	Mandscheuri Barley	29	March 12	40.62	1.02
7	Mandscheuri Barley	29	April 2	32.02	1.10
8	Mandscheuri Barley	25	April 23	21.35	1.20

Of the 12 varieties tested this year Texas Rust Proof led with a yield of 42.26 bushels. Big Four and Shotilof also made good yields. The best yield of straw was from Big Four with 1.93 tons, but as in the case of corn, there was apparently no relation between the yield of straw and the yield of grain. White Russian oats were sown at different dates, March 12, April 2 and April 23, to determine the influence of early seeding on the yield of the crop. The plats sown on March 12 yielded 29.41 bushels of grain and 1.2 tons of straw; those sown on April 2, 22.08 bushels of grain and .89 tons of straw; April 23, 18 bushels of grain and 1.02 tons of straw, emphasizing most emphatically the importance of early seeding of spring oats. The seed of oats secured from the north made very satisfactory yields this year. How they will do when used a second season remains to be determined. One of the best ways to avoid the ravages of the Hessian fly is by means of crop rotation and the successful culture of spring cereals will materially aid in this work. Whenever possible it is advisable to cultivate oats because of their superior feeding value. When combined with corn they make an unrivaled food for horses and sheep, and when ground are most excellent for calves and young stock.

SPRING BARLEY

Mandscheuri barley was also sown on the same dates as White Russian oats. That sown on March 22 yielded 46.2 bushels of grain and 1.02 tons of straw; April 2, 32.06 bushels of grain and 1.10 tons of straw;



General View of Experimental Plats, University Farm

April 23, 21.35 bushels of grain and 1.20 tons of straw. This indicates that spring barley can also be grown advantageously in Tennessee if put in the ground sufficiently early in the spring.

TABLE XI Experiments with Varieties of Spring Wheat, 1900

No.	Name of variety	Average height of crop Inches	Date of ripening	Yield of grain per acre Bushels	Yield of straw per acre Tons
1	Wellman Fyfe	30	June 30	17.91	1.21
2	Lamonia	33	July 2	15.83	1.27
3	Nicaragua	32	July 2	15.2	1.20

TABLE XI RESULTS OF EXPERIMENTS WITH SPRING WHEAT

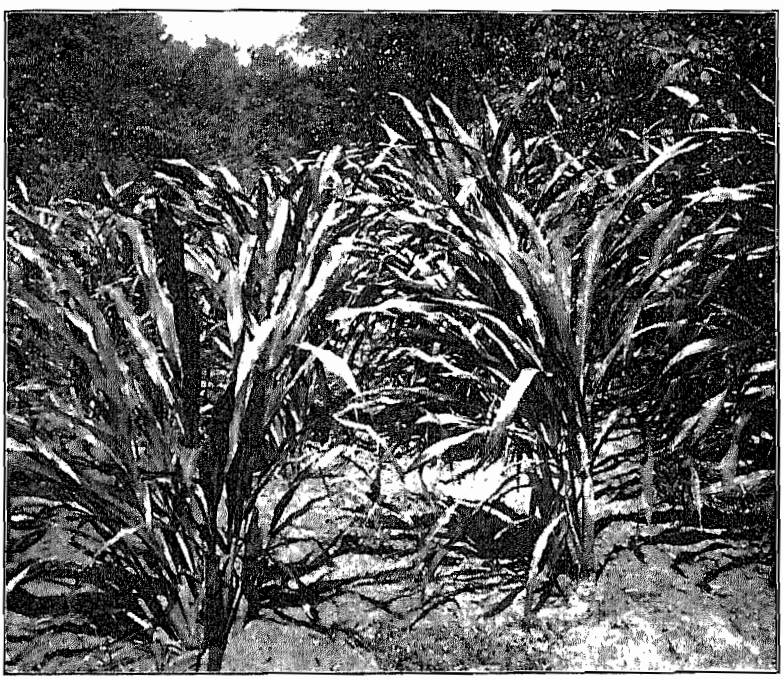
Three varieties of spring wheat were grown, which seeded on March 12. The yields secured were less than one-half of those made by the leading varieties of fall wheat, indicating that spring wheats have little value in Tennessee. Wellman Fyfe yielded 17.91 bushels of grain and 1.21 tons of straw; Lamonia yielded 15.83 bushels of grain and 1.27 tons of straw; Nicaragua, 15.2 bushels of grain and 1.20 tons of straw. The spring wheats did not seem to be affected by the fly and if this rule should hold it might be that this crop would offer greater advantages than now anticipated.

TABLE XII Showing the Digestible Nutrients and Fertilizing Constituents Contained in Some Leading Farm Crops

No.	Name of crop	Yield per acre of green crop 1900 Lbs.	Digestible Nutrients			Fertilizing constituents		
			Protein Lbs.	Carbohydrates Lbs.	Fat Lbs.	Nitrogen Lbs.	Phosphoric acid Lbs.	Potash Lbs.
1	Cowpeas	28002	504	2436.2	56	75.6	28	86.8
2	Soja Beans	11880	380	1306	59.4	84.5	17.8	62.9
3	Corn	35200	352	4088	140	144.3	52.8	116.2
4	Sorghum	23700	142	2891	94.8	54.5	21.3	54.5
5	Millet	14000	280	2240	56	54.6	22.4	77.2
6	Oats — Grain	1237	113.8	585.1	52	25.5	10.2	7.7
	Oats — Straw	3860	46.3	1490.0	30.9	23.9	7.7	47.9
	Oats — Total	5097	160.1	2075.1	82.9	49.4	17.9	55.6
7	Barley — Grain	1950	169.6	1279	31.2	29.4	15.4	9.4
	Barley — Straw	2000	14	824	12	26.2	6	41.8
	Barley — Total	3950	183.6	2103	43.2	55.6	21.4	51.2
8	Spring Wheat — Grain	1075	109.6	743.6	18.3	25.4	8.5	5.4
	Spring Wheat — Straw	2420	9.7	878.5	9.7	14.3	2.9	12.3
	Spring Wheat — Total	3495	119.3	1622.1	28.0	39.7	11.4	17.7

TABLE XII DRAFT OF FARM CROPS ON THE SOIL

In Table XII is given a summary of the digestible nutrients and fertilizer constituents produced and extracted from the soil by the principal crops reported in this Bulletin. This is done in order that the reader may be better familiarized with the feeding value of the different crops and the draft on the soil of the same. It will help him to appreciate the necessity of growing a variety of crops and combining these for feeding purposes in order to secure the best results, and it will also show him the importance of a rotation of crops and how soon his soil must of necessity be exhausted by the continuous cropping of one or two crops and the return of nothing to the land. The digestible nutrients and fertilizer



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constituents presented in the table are based on the average analysis of many samples of these plants. The yield shown is the maximum yield secured by any crop with the different varieties mentioned in this Bulletin. This is taken because it will probably show the maximum food value produced on an acre of farm land in this state and the maximum draft on the soil by any of the crops mentioned in the table. It will be seen from the table that cowpeas produce the most protein, followed closely by soja beans and corn. Sorghum is lower in this element than any other crop except spring wheat. Cowpeas are fairly rich in carbohydrates and fat,

superior in this respect to soja beans, but not at all equal to corn. Sorghum shows considerably more fat than cowpeas or soja beans, but much less than corn. The carbohydrates and fat of millet and sorghum are about the same. Oats and barley about equal millet in these constituents. It is thus evident that better results in feeding will be secured by combining the excess of protein in cowpeas with the excess of carbohydrates in corn, thus balancing the food up, and so other very interesting comparisons might be made if space permitted. The digestible nutrients shown by a crop must not be taken as a sole measure of its utility on the farm, for the winter cereals, oats, barley and wheat, will make equal if not better yields than those sown for green crops and especially so in the case of wheat, and in addition, they will do their growing and act as a soil cover at a season of the year when other crops are dormant, so they have a material advantage in this respect that must be considered.

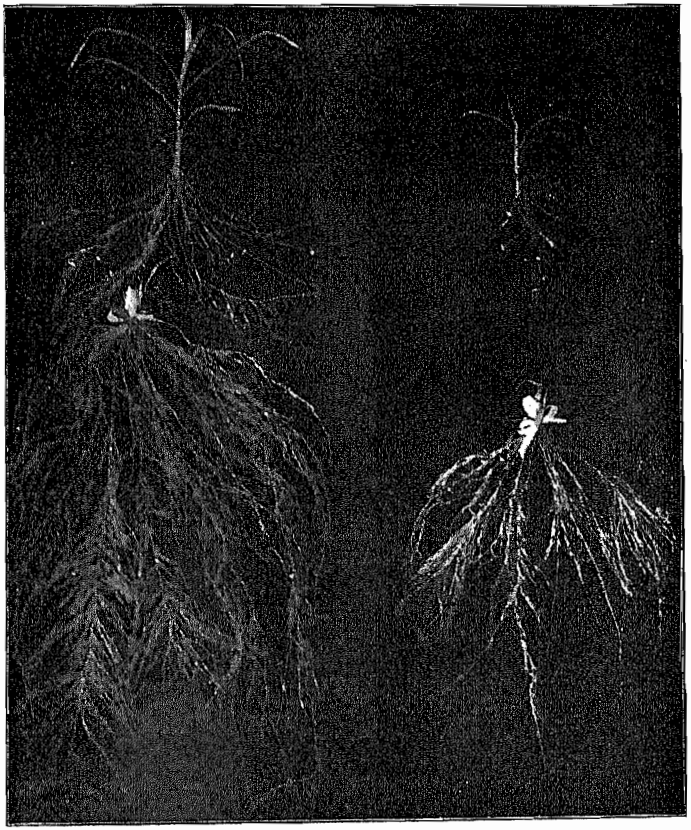
So far as draft on the soil is concerned, corn is the most exhausting of all the crops here shown, and yet sorghum and millet, not taking from the soil half as much nitrogen as corn in these experiments are generally counted as harder on the soil than this crop. This is at least partly due to the fact that sorghum and millet are surface feeders and exhaust the surface area very rapidly and apparently injure its productive power, while corn being a gross feeder and throwing its roots deep into the soil and taking in vastly more plant food does not seem to injure the land so much as the other crops. Corn, sorghum, millet, oats, barley and wheat are all harder on the soil in one sense than soja beans or cowpeas, as they draw all their nitrogen from the air and in addition enrich the soil by 20 to 30 pounds of nitrogen per acre stored in their roots and fallen leaves, etc., scattered upon the ground. The draft of phosphoric acid and potash made by these crops on the soil as shown by these results is not so great as often thought. In fact, it is not so great as that required by several other crops. It will thus be seen from a study of the fertilizing constituents in these crops that if they are fed and the manure carefully preserved and returned to the soil, the fertility of the land can be maintained with comparative ease, and that the best way to secure the supply of nitrogen in the soil and renew its humus, improve its tilth and mechanical condition is to incorporate a crop of legumes occasionally.

IMPORTANCE OF STUDYING ROOTS

The importance of studying the root development of farm crops under field conditions is apparent to all. In this way the various forces influencing the growth of the roots can be ascertained, and if they are objectionable, methods of cultivation looking to their correction can be instituted. To accomplish this, specimens of the roots of several of the principal farm crops were washed from the soil as they stood in the field rows. The results obtained are very instructive and should prove very helpful in the future cultivation of these crops.

The ground was a stiff and clayey loam with a very compact subsoil. It was broken with an ordinary turning plow to a depth of nine inches. The plats were planted in rows and given ordinary field cultivation. The

crops used were as follows: Corn—Cock's Prolific; sorghum—Amber; velvet bean; soja bean; clay pea and Dwarf Essex rape. These were all seeded on June 1. The first root of the corn plant was taken up on June 20. At that time the plant was about seven inches high. Sixteen roots originated from the base of the stalk. These varied from 3 to 18 inches in length. Five of the roots were quite bare; the others had a good number of fibrous or feeding rootlets on them. The roots and rootlets were of a fleshy character. The greatest depth at which the roots were found



ROOTS OF CORN AND SORGHUM—DIFFERENT STAGES OF GROWTH

was nine inches, where they struck the subsoil. The second corn plant was taken up on July 5. At this time the roots filled an area two feet deep and four and one-half feet square. These roots like the others were of a fleshy character, and they varied from within two inches of the top of the ground, running almost parallel with it down to the depth as before noted of two feet. Most of the roots set off in a downward direction. Some few went almost straight down. It was noted that wherever the roots struck

the subsoil or any other obstruction they became wavy. In most instances through the loose soil the roots did not have this wavy appearance; hence, the great importance of deep breaking and subsoiling for such crops.

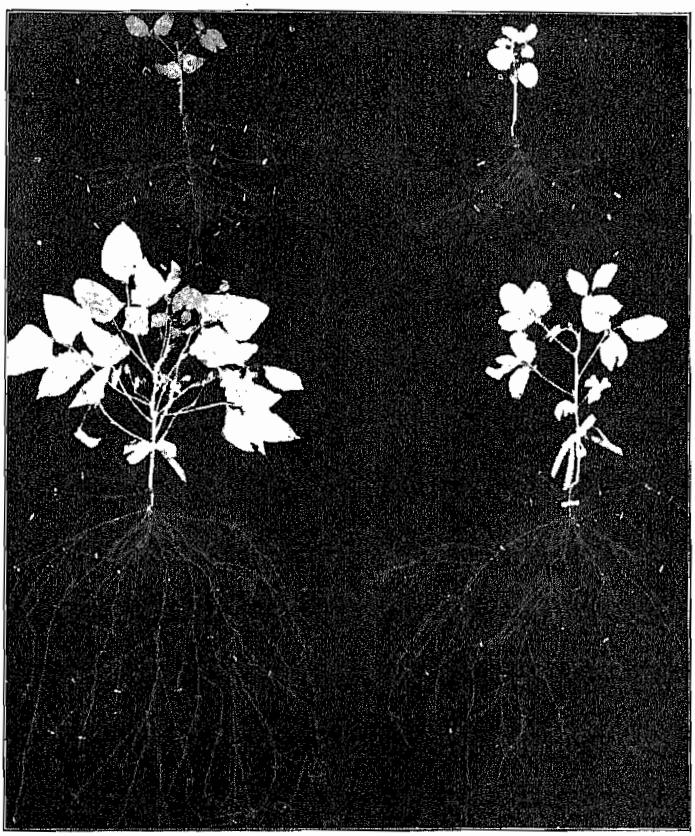
On June 22 the first sorghum plant was taken up. It did not present as vigorous a root development as the corn plant. The character of the root was altogether different, being fibrous rather than fleshy, with but a limited number of rootlets. The plant was seven inches high and the number of roots projecting from the base of the stalk was nine; five of these had several rootlets; the other four had very few, if any at all. They set off at the same angle as the corn. They did not grow at quite the same depth or attain the length or proportions of the corn roots. The second sorghum plant was taken up July 7, after 37 days growth. The character of the roots had changed but little in the interval. They occupied a cube of soil some 15 inches deep and 30 inches square. They branched off at a sharper angle than the corn roots.

The rape plant was taken up on June 20, and was 12 inches high. There were 22 roots branched from the tap root. The tap root was fleshy for a considerable distance and the remainder was like the branch roots, fine and thread-like. The branch roots varied from 1 to 10 inches in length and set off at nearly a right angle from the tap root. The second plant taken up did not show so many roots as the first. The greatest depth was two feet, and the greatest length was from the crown two and one-half feet. The longest root, however, was three feet long. This was hardly a fair specimen, however, as the ground and especially the subsoil had become so hard by this time that a great many of the rootlets were broken off. The main roots were much more fleshy than in the previous plant, but the branch roots were the same, fine and thread-like and very delicate.

The soja bean was taken up on June 22. The height of the plant was six inches. The tap root went down five inches. The 38 roots branching from the tap root varied from 1 to 11 inches long. These branches went downward from the tap root at a very slight angle. The roots near the top of the ground were rather short, growing longer as they descended the tap root. There were very slight indications of the nodules commencing to form. The second plant was taken up on July 6. The roots extended 15 inches deep and 15 inches from the plant. They were very tender and broke very easily. There were only eight nodules but these were of good size. The majority were on the small roots not far from the tap root. As in the corn plant, the longer roots were on the south side, or on the lower slope of the hill. The number of roots here was 15, having about the same angle as in the first root taken up.

On June 22 the first cowpea plant was taken up. The plant was seven inches high. The tap root was 12 inches long and the branch roots numbered 64, varying from 1 to 12½ inches long. These roots branched off at a right angle from the tap root. The rootlets and root hairs were very numerous; some of the rootlets being as long as three inches. There was no indication of nodules at this stage. On July 16 the second cowpea plant was taken up. The number of roots was 24. The tap root had decayed about seven inches below the top of the ground, and this was the case in

three plants taken up about this time. The first two were discarded, because it was thought the tap root had been broken off. The roots were at about the same angle as in the first noted. The greatest distance to the end of the roots was two and one-half feet at a depth of 18 inches. The root that was found at a depth of 18 inches made a turn and went out horizontally for 12 inches farther. The nodules on this were not nearly so large as on the soja bean, but were much more plentiful; 324 were counted,

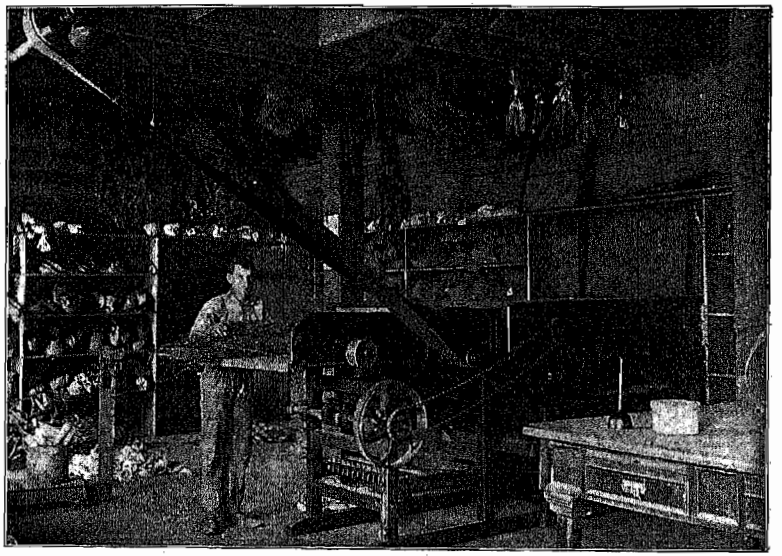


ROOTS OF THE COWPEA AND SOJA BEAN—DIFFERENT STAGES OF GROWTH

varying from one-half the size of a pin head to the size of a small pea. The upper roots contained the most nodules, but there were quite a few on those roots penetrating the subsoil. One root was found three and one-half feet long when it was straightened out, and branch roots with rootlets 18 inches in length. The vines were 16 inches high and it was a good, healthy, stalky plant.

The first velvet bean plant was taken up on July 23. It was seven and

one-half inches high with a tap root six inches long. Seven roots branched out from the tap root. The branch roots, as in the case of the cowpea and soja bean, formed a right angle with a downward trend. The branch roots varied from 4 to 16 inches long and contained many more rootlets than the plant previously examined. It was also more fleshy than any of the others, especially the rootlets. These roots began to turn black as soon as exposed to the air for an hour or so. The second velvet bean plant taken up was found to contain 10 clusters of nodules. These were mostly found from 6 to 8 inches from the stem. The roots were found as deep as 18 inches and at a distance of four feet from the plant. The longest root varied from two to six inches below the surface. There were eight branch roots. As in the case of the cowpea, the tap root was shorter in the last



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than in the first specimen taken up. The roots were very fleshy and contained quite a number of rootlets.

The following conclusions may be drawn from these results: That the roots of plants can not readily penetrate the texture of a heavy clay soil and in order to increase the feeding surface, it is necessary to plow deeply, nine inches, and subsoil from six to eight inches deeper occasionally. The deepening of the soil enlarges the feeding area of the plant and insures a larger growth as it brings the roots in contact with larger supplies of moisture and plant food. The larger the feeding surface at the disposal of the roots the less exhaustive is the crop on the soil because the food is not gathered from the surface area.

Shallow feeding crops, such as sorghum and millet, are hard on the soil

because the roots only occupy the shallow surface layer and thus this area is exhausted of plant food while the subsoil is untouched. The general direction of plant roots is as follows: During the first stages of development decidedly downward, thus enabling deeper cultivation to be practiced in the early stages of growth. After this there is a tendency for the roots to branch off at almost a right angle from the tap root or the crown, as the case may be, and to approach nearer the surface, hence the necessity of after cultivation with various crops being shallow. In order that crops may make a large and uniform growth and be insured against a drought, it is important that the soil be friable, fine of texture, deep, and well supplied with an abundance of available plant food. It is further apparent that deep and thorough culture of the soil not only renders available plant food and is less exhaustive on the surface soil because of the larger supplies of food gathered from the subsoil, but also in a well cultivated soil much less of the plant energy is used up in the vain effort to gather food from compacted subsoils. This is shown by the atrophy of the roots of certain plants washed up in these experiments and by the wavy and horizontal direction of the roots on approaching a hard surface. Corn and cowpeas are gross feeding plants. The roots occupy large areas of soil and for their best development, it is necessary that the subsoil be available for plant nutrition.

SUMMARY OF RESULTS

1 Of the 31 varieties of corn grown, Florida made the largest gross yield, namely, 18 tons. No. 3889 and Ellis and Huffman made over 14 tons. The smallest yield was made by New Klondike, 6½ tons.

2 The best yield of grain was made by No. 3889, 72.09 bushels. Improved Golden Beauty was second with 68.07, and Improved Leaming third with 56.69.

3 The highest per cent of grain in the whole crop was made by Three Eared with 20.48; followed closely by New Klondike with 17.72. No. 3889 showed 13.7 per cent and Improved Golden Beauty 13.61. Florida and Huffman, two of the corns making the largest gross yields, showed only 7.90 and 5.64 per cent respectively of grain in the whole crop.

4 It is observed that with the seed secured from the north the stalks were smaller, the gross yield less and the green yield and the per cent of grain in the whole crop better in proportion than with the southern grown varieties.

5 There was a difference in the extreme dates of maturing of 21 days with the several varieties of corn. Several of the northern corns matured in 97 days, while Florida, No. 3889, Ellis and Huffman varied between 114 and 119 days.

6 The highest yield of green crop per acre was with teosinte, 26.25 tons; rape second with 18.50 tons; corn third with 17.60 tons and cowpeas and corn fourth with 17.70 tons. Cowpeas alone yielded over 14.10 tons.

7 It was observed that cowpeas and rape, cowpeas and corn, cowpeas and millet when combined and sown alone made practically the same yields.

8 Table III shows that a succession of forage crops of spring growing cereals and legumes can easily be had from the middle of June until November 1 in this climate.

9 A combination of forage crops has the advantage of producing a better balanced food, but is found objectionable owing to the difficulty of getting two crops that mature at the same time.

10 The best yield of sorghum was 11.85 tons and the best yield of Kaffir corn 8.01 tons. As the Kaffir corns are non-saccharine, however, and drier, they combine well with sorghum in the making of ensilage.

11 The best yield of pea vine hay was with Taylor, 3.10; Wonderful, second, with 2.6. The Clay, Blackeye and Whippoorwill averaged between 2.3 and 2.5 tons.

12. Comparing the green weights with the yield of hay per acre it was seen that there was a loss of between 5000 and 6000 pounds of water for the production of a ton of hay.

13 By the early seeding of peas on fall plowed land it is possible to secure a large crop for hay and a second crop for grain or pasture, as may be deemed preferable.

14 The soja bean made a satisfactory growth. The best yield of green crop per acre was with No. 4912, 5.94 tons. The plants are more woody and tree like than the cowpea and did not produce a volunteer crop, or nearly equal the former in the yeild of green crop.

15 The best yield of millet made was secured with Japanese, 2.62 tons. The imported Japanese varieties did not make satisfactory yields.

16 Rape sown on fall plowed land made a very satisfactory yield of green crop, namely 8½ tons per acre. This plant promises well in the state and attention should be given to its culture by all interested in stock husbandry.

17 Of the 10 varieties of spring oats grown, Texas Rust Proof made the largest yield of grain, 42.26 bushels. Big Four was second with 36.38 bushels and also made the largest yield of straw, 1.93 tons.

18 The importance of the early seeding of oats and barley is evidenced by the facts brought out in Table X, where the yield gradually decreased with the later date of seeding. Mandscheuri barley seeded March 12, yielded 40.62 bushels, April 2, 32.02, and April 23, 21.35 bushels.

19 Spring wheat made a better growth and yield than was anticipated. Wellman Fyfe stood at the head with 17.91 bushels.

20 Considering the maximum yield of the several crops grown in these experiments the highest yield of digestible protein was made by cowpeas with 504 pounds; soja beans came second with 380 pounds; and corn third with 352 pounds. Corn, however, is richer in charbohydrates and fat than either of the above plants. Sorghum is inferior to any of the crops mentioned and almost to millet so far as its digestible nutrients are concerned.

21 The greatest draft on the soil was made by corn, namely, 144.3 pounds of nitrogen, 52.8 pounds phosphoric acid and 116.2 pounds potash. Cowpeas came second with 75.60 pounds nitrogen, 28 pounds phosphoric acid and 86.6 pounds potash. As this crop however gathers its nitrogen

from the air and improves the texture of the soil, it builds up the soil if judiciously used.

22 While sorghum and millet in these tests make about equal draft on the fertility of the soil, and do not draw so heavily on the fertilizing elements of the soil as corn, they are shallow feeders and they exhaust the surface foot of soil and injure its texture and are thus said to kill the soil.

23 Plates, pages 25 and 27, show the actual growth of the roots of corn, sorghum, soja beans and cowpeas as washed from the soil when growing under field conditions. An examination of their growth and development will show why certain methods of cultivation should be practiced with these crops.