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SOILS OF PENDER COUNTY, NORTH CAROLINA: A PRELIMINARY REPORT.

GENERAL DESCRIPTION OF THE AREA.

In June, 1909, preliminary examinations were made of the soils at a number of points in Pender County, North Carolina, for the purpose of determining the character and agricultural possibilities of the important types.

Pender County, North Carolina, lies in the southeastern part of the State, entirely within the Atlantic Coastal Plain. It borders on the Atlantic Ocean, with a water frontage of 12 miles, and extends inland a distance of 35 miles. Burgaw, situated near the center of the county, is 23 miles north of Wilmington, the important export town of North Carolina. The county embraces 883 square miles, or 565,120 acres.

Topographically Pender County presents the appearance of a plain interrupted by slight surface unevenness due to erosion. In a general way the lay of the land would be described as flat to gently undulating, varied here and there by comparatively shallow valleys of streams that cross or have their sources within the county. There is no very perceptible slope in any direction. In fact, the surface is so flat that there are large areas on which water stands for a considerable time after a heavy rain. The highest determined elevation, 66 feet, is that of the Atlantic Coast Line roadbed at Edgecombe, in the central-eastern part of the county. The elevation at Willard, in the northwestern part of the county, is 51 feet; at Burgaw, near the center, 57 feet; at Atkinson, in the central-western part, 63 feet; while Castle Hayne, near the southern boundary, is 20 feet above sea level.

As the sources of streams are approached their valleys gradually become shallower, until the drainage ways present merely wet depressions marked by a thick growth of water-loving shrubbery. There are a number of extensive areas into which no well-developed drainage ways enter. The most notable of these are the savannas—open flat lands without tree growth or supporting only a scattering growth of trees—as, for instance, the "Big Savanna" north of Burgaw. The most important streams are the Cape Fear and North East rivers. Other important though smaller water courses are

Holly Shelter, Swamp, Doctor, Sills, Cypress, Bee, and Long creeks. The bottom lands in the valleys of some of these streams are only a few feet above sea level. A conspicuous feature of the county is seen in the numerous "bays," or wet areas, which usually support a dense growth of shrubbery and trees, as bay, pine, black gum, sweet gum, and gallberry bushes. The better drained lands support a growth of pine, with a sprinkling of oak and hickory and an undergrowth of wire grass and huckleberries; while the poorly drained soils support mainly pine and a thick undergrowth of gallberry bushes, bay, pitcher plants, etc. Probably less than a third of Pender County is under cultivation.

The population of the county in 1900 was 13,381. There has been some increase, especially in the towns, but there are a number of rural districts so sparsely settled that agricultural development has not made anything like the headway warranted by the productivity of the soils. The white population is largely of English and Scotch descent. There are a number of Italians in a recently established colony at St. Helena, and a relatively large number of negroes throughout the county.

Three branches of the Atlantic Coast Line Railroad cross the county. These, together with the usually good public roads, give the area excellent transportation facilities. Fast freight is offered to northern markets, Burgaw being within thirty-six hours of New York by refrigerator express freight.

CLIMATE.

The climate of Pender County is mild and pleasant throughout most of the year. The summers are long, but the temperature is moderated by sea breezes. The winters are marked by moderate cold, with an occasional light snow. With a mean temperature of 48° F. for the months of December to February, inclusive, a number of vegetables can be grown throughout the winter, especially with a little protection, such as an occasional covering with cheese cloth, bagging, or some material like pine needles. A good idea of the climate is conveyed by the fact that such crops as Irish potatoes and radishes are planted in January and February. The average season free from killing frosts is seven months and nineteen days. The frost line moves northward in the spring at the rate of about 13 miles a day, so that following this recession vegetables and berries average about a day later in maturity for every 10 to 15 miles traveled northward. This section is nearly intermediate between Charleston, S. C., and Norfolk, Va., in date of vegetable and berry shipments.

The following tables give the normal monthly and annual temperature, rainfall, and frost records for Wilmington, N. C., and, for the sake of comparison, for Charleston, S. C., and Norfolk, Va.:

Normal monthly, seasonal, and annual temperature and precipitation at Wilmington, N. C.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.
December	49	78	10	3.1	3.3	7.1	0.1
January	47	80	9	3.6	1.4	2.4	.1
February	49	80	5	3.4	3.3	1.6	1.0
Winter	48			10.1	8.0	11.1	1.2
March	55	87	20	3.6	3.6	4.5	.1
April	61	90	28	2.8	1.6	6.6	.0
May	70	97	38	4.0	2.3	2.4	.0
Spring	62			10.4	7.5	13.5	.1
June	77	100	51	5.6	3.2	7.5	.0
July	80	103	58	6.7	3.0	9.4	.0
August	79	99	56	7.0	2.4	10.5	.0
Summer	79			19.3	8.6	27.4	.0
September	74	96	42	5.4	3.6	20.1	.0
October	64	92	32	3.9	3.2	6.7	.0
November	55	83	20	2.4	3.8	4.9	Trace.
Fall	64			11.7	10.6	31.7	Trace.
Year	63	103	5	51.5	34.7	83.7	1.3

Average date of last killing frost in spring, March 27; of first in fall, November 15. Date of latest in spring, May 1; and of earliest in fall, October 16.

Normal monthly, seasonal, and annual temperature and precipitation at Norfolk, Va.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.
December	43	75	6	3.4	2.3	0.8	2.7
January	41	80	6	3.4	3.3	4.9	2.0
February	43	81	2	3.8	2.8	4.2	3.8
Winter	42			10.6	8.4	9.9	8.5
March	48	88	14	4.6	4.3	7.6	.4
April	56	95	24	3.9	2.2	11.9	.0
May	67	98	38	4.3	2.5	4.6	.0
Spring	57			12.8	9.0	24.1	.4
June	74	102	49	4.1	2.6	4.8	.0
July	79	102	57	5.9	3.9	10.7	.0
August	77	100	56	5.9	7.7	5.9	.0
Summer	77			15.9	14.2	21.4	.0
September	71	100	40	4.2	3.8	5.4	.0
October	61	89	31	3.6	.2	7.6	.0
November	51	80	18	2.9	.4	2.6	.5
Fall	69			10.7	.4	2.6	.5
Year	59	102	2	50	36	71	9.4

Average date of last killing frost in spring, March 27; of first in fall, November 12; date of latest in spring, April 26; earliest in fall, October 15.

Normal monthly, seasonal, and annual temperature and precipitation at Charleston, S. C.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	°F.	°F	°F.	*Inches.*	*Inches.*	*Inches.*	*Inches.*
December	51	78	13	3.2	1.8	5.8	Trace.
January	50	80	10	3.6	2.2	.6	Trace.
February	52	80	7	3.4	3.6	2.4	Trace.
Winter	51	.....	.....	10.2	7.6	8.8	Trace.
March	58	86	24	3.8	2.4	2.5	Trace.
April	65	89	32	3.2	1.6	4.9	0.0
May	73	98	45	3.6	4.3	3.8	.0
Spring	65	.....	.....	10.6	8.3	11.2	Trace.
June	79	100	51	5.4	1.2	15.0	.0
July	82	104	64	7.4	5.5	11.3	.0
August	81	100	62	7.3	5.0	5.1	.0
Summer	81	.....	.....	20.1	11.7	31.4	.0
September	76	95	49	5.5	.4	11.3	.0
October	67	93	39	4.0	.9	14.3	.0
November	58	83	23	3.0	.8	1.4	.0
Fall	67	.....	.....	12.5	2.1	27.0	.0
Year	66	104	7	53.4	29.7	78.4	Trace.

Average date of last killing frost in spring, March 3; of first in fall, November 30; date of latest in spring, April 2; of earliest in fall, November 9.

The normal rainfall is sufficient and properly distributed for all crops suited to the region. Certain crops, however, are liable to injury from lack of moisture on the more sandy soils during protracted dry seasons, and from soggy conditions on the flat, heavier types in wet spells. Damage from these sources can be considerably reduced by frequent shallow cultivation, by keeping up the organic matter content, and in the case of flat land by proper ditching.

AGRICULTURE.

The native heavy growth of longleaf pine encouraged an early development of the naval-stores industry in this general region. This industry began to decline with the later inception of lumbering, and at the present is of little importance. Large old-field pines are frequently seen on the rimlike mounds of long-neglected tar pits. The turpentine, tar, and lumber industries in their time occupied a considerable share of attention on the part of the citizens of the county, but with the practical disappearance of the first two and the decline of the last, agriculture has been marked by a slow but steady development. General farming, including the production of cotton, corn, and rice, had attained considerable importance in this section long before the organization of the county in 1876.

According to the census reports, Pender County produced in the year of 1879, 159,064 bushels of corn, 2,269 bushels of oats, 835 bales of cotton, 248,622 pounds of rice, 116,559 bushels of sweet potatoes, and 7,851 bushels of cowpeas. The census of 1900 gives the following figures for the important agricultural products for the year 1899: Corn, 194,060 bushels; cotton, 776 bales; peanuts, 85,425 bushels; Irish potatoes, 14,552 bushels; sweet potatoes, 107,256 bushels; sorghum sirup, 4,208 gallons; peas, 10,448 bushels; and strawberries, 1,965,690 quarts. There were 470 acres in miscellaneous vegetables and a considerable acreage in oats, cowpeas for hay, and a small area in rice and tobacco. Farm live stock, valued at $144,234 in 1879, had increased in valuation to $211,674 in 1899.

Aside from the production of general farm crops a great many farmers are interested in the growing of strawberries and truck crops—industries which have been marked by rapid development within the last fifteen to twenty years, especially in the vicinity of Burgaw. This was long one of the most important strawberry sections of the South. The crop proved profitable from the beginning, though there were occasional bad years, the result of poor markets, and years of small production, due to unfavorable weather conditions. The producers, as a rule, however, find strawberries a paying crop. On account of two successive bad crop years a number of berry growers became so discouraged that in the last few years this industry has been somewhat checked. Present indications, however, point toward renewed activity in the production of this crop. Strawberries are usually grown in matted rows. The plants are hoed, runners cut, and the middle plowed out two or three times during the summer. It is usually the better plan to replant after the third crop.

The important truck crops are tomatoes, cucumbers, peppers, radishes, and Irish and sweet potatoes. Many other vegetables could be successfully grown. Lima beans, eggplant, garden peas, snap beans, cantaloupes, beets, turnips, cabbage, collards, kale, okra, squash, onions, and watermelons do well.

The well-drained Norfolk soils are admirably adapted to the general farm crops, such as cotton, corn, oats, forage, peanuts, and tobacco, and to a great variety of vegetables. The Portsmouth soils, especially the fine sandy loam, are, when drained well, suited to the production of corn, forage, cabbage, strawberries, lettuce, onions, and flower bulbs. In the adjacent county of Duplin there is, on the Portsmouth fine sandy loam, one of the largest flower-bulb farms in the world.

Two or three crops a year are frequently grown in the same field. Radishes and turnips planted in January are usually shipped, respectively, from the 10th to the 15th of March and from late March

to early April. These can be followed by either cotton, corn, or forage crops. Radishes may be followed by peppers, with cotton, corn, cowpeas, or other crops planted between the rows, thus admitting the growing of three crops on the same land. This year (1909) four crops were grown in the same field in the vicinity of Burgaw, in which instance radishes were followed by tomatoes, a crop of volunteer crab grass was cut, and the land seeded to cowpeas.

A good rotation is to follow spring lettuce by early snap beans and then collards or fall cabbage, and in January or early February by Irish potatoes to be dug in late spring or early summer and followed by cowpeas, these in turn to be followed by fall lettuce. Another excellent rotation is spring lettuce, cowpeas, Irish potatoes, sweet potatoes, and fall lettuce. Beets followed by cucumbers can be grown advantageously after fall lettuce. Numerous other combinations or rotations are common. Long-period rotations should be practiced in connection with the production of the general farm crops and vegetables. It is especially important in all rotations to introduce occasionally a legume, such as velvet beans, soy beans, cowpeas, crimson clover, or vetch, and on the sandy types one of these, preferably crimson clover, vetch, or cowpeas, should be plowed under to supply needed organic matter. The water-holding capacity and general structural condition of most of the soils are very greatly improved by turning under a partly matured or green crop.

Some trouble is had with lettuce by damping off or rotting, but it is believed that injury from this source could be materially lessened or avoided by practicing some of the above or similar rotations. Tomatoes have been injured in some instances by blight or other disease. It would be advisable for some farmers to acquaint themselves with modern methods of combating plant diseases by the use of fungicides.

Large quantities of commercial fertilizers are used. Of the general farm crops cotton and, to a less extent, corn are given applications of the lower grades of complete mixtures—generally those analyzing from 8–2–2 to 10–3–3. The acreage application for corn usually ranges from 250 to 350 pounds, while that for cotton varies from 300 to 500 pounds. Heavier applications of higher grades are generally made for vegetables. Frequently a ton per acre is used. With such an application usually two or three truck crops are grown, followed by cotton, corn, peanuts, or forage, the fertilizer being entirely adequate for good yields of several crops. Brands analyzing from 8–3–4 to about 8–6–7 are commonly used for vegetables. Various home mixtures and special commercial brands, however, are used to meet the requirements of different crops, different types of soil, and not infrequently the convenience or fancy of the grower.

The sandy soils for most crops need more potash than the heavier soils, while larger quantities of phosphoric acid are usually necessary to hasten maturity on those lands where the clay subsoil comes near the surface. The poorly drained Portsmouth soils are greatly benefited by applications of lime to correct acidity or other unfavorable conditions developed through lack of proper aeration. The well-drained soils may need lime occasionally, but as a rule the dark-colored, poorly drained types and newly cleared lands are more in need of this material. A good method of applying lime is to make a broadcast surface application following the plowing under of a green crop of vegetation. The well-drained soils, particularly the light-colored, sandy types, are very often deficient in organic matter. For best results with these it is necessary that the supply of organic matter should be replenished at intervals varying according to textural and structural conditions. Soil well supplied with organic matter always possesses a more loamlike tilth than that deficient in organic matter, conserves moisture better, and is less subject to baking and crusting. Fertilizers are usually more beneficial and lasting on the soils with favorable organic matter content.

Notwithstanding that excellent ready-mixed brands can be bought, a more general practice of home mixing of fertilizers can not be too strongly urged. Farmers should keep careful records of mixtures used upon various crops, taking also into account the weather conditions, the soil, and the soil treatment. It is not necessary to make plot tests, although this could be easily done in a small way for experimental purposes, but the growing of every crop should be considered an experiment, the results of particular manurial applications, crop rotations, methods of soil preparation, and cultivation being recorded for future guidance. Too many farmers change from one fertilizer or method of soil treatment to another fertilizer or method of soil treatment without taking into consideration or making any allowance for variations in season or the use of different types of soil.

A considerable portion of the flat areas of the Norfolk soils and all of the Portsmouth types need artificial drainage. This can be done effectively and economically by straightening and deepening the drainage ways, supplementing these with canals to receive drainage from main ditches and sublaterals. The requisite number of laterals for a field will depend largely upon its evenness of surface, permeability, and nearness of the subsoil to the surface. Some of the flat savanna lands and considerable timbered areas having either a very flat or somewhat hummocky surface should have laterals placed at intervals of not over 100 feet. Most of the land, however, can be effectively drained by ditches at intervals of from 50 to 100 yards, while a great many small depressions or bays simply need a good out-

let ditch. Open ditches in the great majority of cases should have a slope of from 1 to 2 inches per hundred feet. Much trouble is experienced in those areas having a "quicksand" subsoil, on account of the tendency of the latter to wash out, causing the overlying soil to cave. Experience has shown that the sides of ditches in this character of land should have a decided slope.

With the establishment of a thorough system of drainage there is but little land in the county that can not be made to produce profitably. There has been too little effort to direct the attention of outsiders toward the wonderful productiveness and comparative cheapness of the lands of Pender County, which are not only adapted to general farming but to the production of special crops, such as strawberries and a great variety of vegetables. More tillers of the soil are needed in order to bring about substantial and widespread development commensurate with the agricultural possibilities of the region. There is an abundance of good, well-drained land and poorly drained land easily reclaimable to agriculture, but there are too few farmers to undertake the task of fully developing them. There is no lack of evidence as to the profitableness of agriculture upon the various grades of land, for good farms can be seen throughout the county. To the man of small means or to one seeking a mild climate or land suited to the production of special crops the county offers very attractive inducements.

A colony of Italians at St. Helena has, within a period of about three years, established itself upon a very substantial and promising basis, having cleared and drained considerable land and brought the same into a good state of productiveness. There are at present something like 300 individuals in this colony; and that they are prospering in a new country upon soils with which they in the beginning had limited acquaintance attests the agricultural capabilities of the region.

SOILS.

The soils of Pender County have been derived from materials which were washed down from the Piedmont country and deposited in the sea that formerly covered this Coastal Plain region. These sediments, subjected to the action of waves and tides, were reworked and assorted into sand, sandy loam, fine sandy loam, and silt loam. Since the recession of the ocean they have been further modified by erosional processes, organic life, and chemical changes. Streams have cut their channels farther and farther inland, and in places along the slopes good drainage conditions, with consequent better aeration, have induced more complete oxidation than elsewhere, giving rise to reddish subsoils. In other localities the fine particles

have been washed out, leaving mantles of the coarser soil constituents as the medium and fine grades of sand.

Poor drainage conditions in flat and depressed areas have favored the growth of water-loving plants and shrubbery, the organic remains of which have accumulated in the soil in varying quantities, resulting in the formation of the dark-colored Portsmouth and Muck soils. In the Angola Bay, in the northeastern part of the county, there has been formed in this way a deep mucky soil containing large quantities of organic matter in varying stages of decomposition. On the other hand, the soils of the less poorly drained open savannas or nearly treeless areas are black only in the upper few inches, as organic matter has accumulated here through the decay only of sedges and other grasses and weeds. The subsoils in the poorly drained areas are usually light gray or drab in color and frequently mottled yellowish or reddish yellow, as a result of poor aeration and consequent incomplete oxidation of the soil components.

The soils having intermediate drainage conditions and lying between the better drained lands on the slopes of streams and the poorer drained lands in the depressed and flat areas having immature drainage systems, are gray to dark gray in the upper portion and bright yellow to yellow slightly mottled with drab or reddish colors in the subsoils. These soils belong to the Norfolk series, and in their present condition comprise the best all-round agricultural lands of the area.

The upland sedimentary materials which have given rise to the Norfolk and Portsmouth soils belong to that formation geologically known as the Columbia. The strictly alluvial soils of the stream bottoms belong to a more recent period. These last have been formed by deposition from overflow water and along some of the larger streams consist of materials washed down from local soils and commingled with that transported from more remote areas occurring in the drainage basins of such streams.

In this preliminary investigation no attempt was made to outline the different areas of the individual types, as is done in case of the regular soil survey. The more important types were examined with the purpose of ascertaining the general characteristics of the lands of the county, their crop adaptations, and capabilities. The most extensive and important types are described in detail in the following pages.

NORFOLK FINE SANDY LOAM.

The Norfolk fine sandy loam is the most extensive and, on account of its good natural drainage, the most used soil type in Pender County. Notwithstanding the large area of this type and its admirable adaptation to a wide range of crops, a considerable proportion is yet

undeveloped. This is true not only in Pender County, but over a very large part of eastern North Carolina. There were mapped in the adjoining county of Duplin 180,032 acres of the Norfolk fine sandy loam, representing 34.2 per cent of the area of that county. The soil conditions in Pender County are quite similar to those of Duplin, and the relative extent of this type is probably about the same in the two counties.

There are two distinct phases of this soil, the result largely of difference in drainage conditions brought about by variations in topography. The type is found along or near stream slopes, in flat to undulating areas favored by wide reaching drainage systems, and on the slight ridges is a rather loose grayish loamy fine sand to fine sandy loam. There is a gradual increase in the content of fine material, as well as a gradual change to yellow color downward, until at a depth of about 8 to 20 inches, or at an average depth of 16 inches, a bright yellow comparatively friable fine sandy clay is reached. There are occasional areas in which clay is encountered at a greater depth or anywhere above 36 inches. The better drainage condition obtaining along or near the slopes of streams has in places given rise to a decidedly reddish cast in the subsoil, the result of the better oxidation arising from more thorough aeration. Such areas are always more productive than the average of the type. The color of the soil under timber and in newly cleared fields averages much darker than that which has been under cultivation for several years. This difference in color is due to the more rapid depletion of the dark-colored organic matter with the better aeration brought about by cultivation, and also to the commingling of the darker upper soil with the lighter colored lower material brought up by plowing.

Both the texture and structure of the subsoil are well suited to the conservation of moisture, and with proper management, particularly the maintenance of a favorable supply of organic matter and frequent shallow cultivation during dry seasons, crops are enabled to draw from this reservoir enough moisture for continuous and steady growth even during protracted droughts. On those areas, however, where the clay lies at a depth much below 18 inches crops like corn, melons, and cowpeas are apt to be injured by dry weather unless there is a high organic matter content.

The timber growth is mainly shortleaf and longleaf pine, with here and there, especially near streams and on the ridges, a sprinkling of oak, hickory, and other hardwoods. Huckleberries and wire grass are common.

Under present conditions of drainage this is the best all-round soil in the county, needing only to be cleared and broken to be in readiness for agriculture. It is well adapted to cotton, corn, pea-

nuts, cowpeas, velvet beans, soy beans, crab grass for hay, crimson clover, bright tobacco, sorghum, strawberries, and a great variety of vegetables, such as tomatoes, turnips, peppers, radishes, lettuce, melons, cucumbers, beets, collards, cauliflower, eggplant, asparagus, English peas, lima beans, snap beans, onions, and spinach. Rye, oats, and vetch can be grown with a fair degree of success, especially after a crop of velvet beans or other rank leguminous growth. Cotton, strawberries, Irish potatoes, tomatoes, and spinach give better yields where the clay comes within 8 or 10 inches of the surface. A number of crops, vegetables particularly, mature earlier where the soil is deeper. Corn, melons, and sweet potatoes succeed best in those areas having a moderately deep soil. A bale of cotton, from 30 to 50 bushels of corn, 150 to 250 bushels of Irish potatoes, and 250 bushels or more of sweet potatoes can be counted upon as reasonable yields, provided proper rotations and cultural methods are practiced and moderate applications of good fertilizers are used.

Away from the influence of streams there are flat, rather poorly drained areas of the Norfolk fine sandy loam, the surface soil of which is usually dark gray to nearly black. In these areas, as with the better drained phase, pale yellow material is encountered at a depth of a few inches. At from 8 to about 20 inches this pale yellow, fine sandy loam grades into a yellow, fine sandy clay, sometimes slightly mottled with grayish or reddish-brown colors. The subsoil frequently remains soggy for considerable periods after heavy rains.

There is usually less hardwood and more pine on this phase. Gallberry and huckleberry bushes are quite conspicuous. This poorly drained phase requires thorough ditching to be brought into proper condition for agricultural use. Open ditches placed at intervals ranging, according to local conditions, from 150 to 300 feet and having a head depth of about 2 feet and a slope of 1 inch to 100 feet have been found sufficient to give soil of this character excellent drainage. When thoroughly drained this phase of the type is especially suited to strawberries, onions, cabbage, and corn.

The Norfolk fine sandy loam can be easily cultivated and with careful treatment can be maintained in a relatively high state of productiveness. Rotations should be practiced which include an occasional crop of crimson clover, cowpeas, vetch, or rye to be turned under green, as a means of replenishing the supply of organic matter. Nitrogen should be largely supplied to the general farm crops by growing the legumes. In the use of commercial fertilizer experience would seem to indicate that within certain limits the requirement of potash increases with increase in soil depth, while on the other hand more phosphoric acid is needed to hasten maturity where the clay comes nearer the surface. This seems particularly true with

cotton and tobacco. It might be said in this connection that there is need for experimentation along this line not only on this type but on most of the other important soils.

There is wide variation in the quantity applied as well as in the quality of fertilizer used. Acreage applications range from 250 pounds of an 8–2–2 brand for corn to a ton of high-grade material for certain vegetables. In some sections a brand analyzing approximately 10–3–5 has been used on this soil with much success for cotton, corn, oats, and vegetables. An 8–2–10 brand at the rate of 500 to 1,000 pounds to the acre gives good results with sweet potatoes. Early Irish potatoes require relatively heavy applications of nitrogen. Something near a 7–5–7 mixture would probably give excellent results. Heavy applications of cotton-seed meal are advisable on the deeper, sandier phases, especially for Irish potatoes. Liberal quantities of stable or barnyard manure with 1,000 pounds per acre of a 9–4–4 fertilizer should give good results with cabbage, collards, cauliflower, and watermelons.

The proper fertilizer for a given soil can best be ascertained through actual experience. The above figures simply represent mixtures that have given good results on this type of soil, and it is not meant that they represent the exact manurial requirement of the type, for still better results can possibly be secured with other mixtures. It is often advisable for farmers to buy the fertilizer ingredients and, as far as possible, do their own mixing, as in this way the proportions can be changed to suit the conditions. Home mixing will prove the cheaper and better plan in the long run.

Lettuce could be made a very important crop on this type of soil. In the adjoining county of New Hanover the production of lettuce has been accompanied with much success. The report on the soil survey of that county contains the following in regard to the growing of this crop:

> The plants are grown from the seed and transplanted on a very slight ridge in a cold frame which is provided with a cloth cover for protection against frosts. These are used only on nights when there is danger from this source and are removed during the day to admit the full rays of the sun unless the day be exceptionally cold. The preparation of the soil receives careful attention, and while as much as 100 loads of well-rotted manure is necessary, it is found that the best lettuce can not be grown with this alone. From 500 to 2,000 pounds per acre of high-grade commercial fertilizer is applied when the soil is being prepared, or better, half then and the remainder as a top dressing later between the rows. Some money could be saved by the growers by using home-mixed fertilizers. The following formula has been recommended by the North Carolina Experiment Station for this crop: Acid phosphate, 900 pounds; dried blood, 600 pounds; muriate of potash, 400 pounds. This should be applied at the rate of from 500 to 1,000 pounds per acre. Owing to the large quantity of potash in this mixture it is advised that it be thoroughly incorporated in the soil several days before setting the plants, since it is apt to

burn the roots otherwise. If special forcing is desired, a top dressing of sodium nitrate is sometimes given. The most successful growers never use cotton-seed meal, as it is believed to be conducive to rot, which often seriously damages the crop.

About three months are required for lettuce to mature, which permits of two crops being produced each year. The fall crop is set out from the last of August to the middle of September, and is ready for shipment about the last of November or the middle of December. The spring crop is set out in December and is ready for market the last of February or early in March. The spring crop is usually of more importance and brings the best prices. The fall crop is often seriously affected by dry weather, unless provision for irrigation has been made.

More than two or three crops can not be successfully grown on the same land in succession, and it is thought better by some to grow only one. Many short rotations or successions of crops might be suggested in connection with this vegetable product. Spring lettuce may be followed by early snap beans and later by collards. About January 15, or a little later, a crop of early Irish potatoes may be planted on the same ground and dug by June 1, which will leave three months for the growing of cowpeas before setting to fall lettuce. Another rotation is spring lettuce, followed by cowpeas for hay, then by a late crop of Irish potatoes, in the spring by sweet potatoes, and in the fall by lettuce. Another excellent rotation is fall lettuce, followed by beets, these by cucumbers, and these in turn by a crop of late Irish potatoes, which may be dug in time to permit the ground to be planted in spring lettuce. The frames in which spring lettuce has been grown the year before can be planted in fall lettuce after gathering the crop of cucumbers, the late potatoes being omitted in this case. While most of the older growers of the area believe in growing three and even four crops of lettuce in succession, followed by one or two other crops, and then "turning the land out to rest" for a year or so, yet rotations such as are given above have proved a success in other trucking sections, and it is believed that the growers of this area might well give them a test. Such rotations will prove beneficial to the different crops and will doubtless diminish the damage by rot in the lettuce. The diversity of crops will insure a more certain income, and greater returns can be had from a smaller acreage.

Asparagus also can be successfully grown on well-drained areas of the Norfolk fine sandy loam, from crowns set to a depth of 6 to 8 inches during the winter season. The rows should be about 5 feet apart and the plants spaced at least 2 feet. A thousand pounds an acre of a mixture of 900 pounds of acid phosphate, 600 pounds of cotton-seed meal, 400 pounds of muriate of potash, and 100 pounds of nitrate of soda, has been used quite successfully with this crop.

Irish potatoes offer attractive inducements on this quality of land. Planted between the middle of January and the middle of February the crop can be harvested under ordinary weather conditions by the 25th of May to the 1st of June. A fall crop should be grown for local use and for seed.

The production of sweet potatoes, it would seem, could be extended upon a profitable basis by growing particular varieties for particular markets, paying careful attention to assorting and packing. (See Farmers' Bulletin No. 324, U. S. Department of Agriculture.)

Alfalfa has been successfully grown on a well-drained field of the Norfolk fine sandy loam in the vicinity of Burgaw. After turning down a crop of cowpeas with a two-horse turning plow running about 10 inches deep, the land was thoroughly disked and then given a heavy application of stable manure. The manure was turned under to a depth of 5 or 6 inches, the field redisked and lime applied at the rate of 1,000 pounds to the acre. This was followed by another harrowing and an application of 700 pounds per acre of an 8–5–7 fertilizer. The field was then seeded (September 28) following a good rain. The seed was inoculated and in addition soil from a well-established field of alfalfa applied. After several cuttings the stand was injured in an attempt to get rid of crab-grass, whereupon the field was plowed again and reseeded. Four cuttings averaging 1,000 pounds each were secured in 1908. Three cuttings had been made at the time of this investigation (June, 1909), and two others expected.

There would be less danger from injury to a stand of alfalfa were the land cultivated to an intertilled crop the year before seeding. Such a field should be kept scrupulously free from grass throughout the spring and summer. Inoculation can be done to the best advantage by an application of 400 or 500 pounds of soil from a well-established field of alfalfa. (See Farmers' Bulletin No. 339, U. S. Department of Agriculture.) Good underdrainage to a depth of at least 3 feet should be secured before attempting to grow alfalfa. Those areas should be selected in which the clay subsoil comes near the surface.

NORFOLK FINE SAND.

Several areas of the Norfolk fine sand occur in different parts of the county. The type consists of a light-gray to dark-gray loose fine sand, underlain at a depth of a few inches by a light-gray to pale-yellow fine sand. The color is darker in the timbered areas and wet depressions. Where the drainage is poor the subsoil is often quite compact.

This is a warm-natured soil admirably adapted to the production of early truck, especially Irish and sweet potatoes, melons, garden peas, peanuts, and early cabbage.

The soil is rather inclined to be droughty, but this tendency can be reduced to a minimum by turning under some green crops, such as cowpeas, rye, or crimson clover, once every two years and by practicing rotations which include frequent crops of the leguminous family. Heavier applications of fertilizer are required than in case of the Norfolk fine sandy loam and more potash is needed.

PORTSMOUTH FINE SANDY LOAM.

The Portsmouth fine sandy loam is the second soil in point of areal extent and agricultural importance. It occurs in depressions and

flat areas, the drainage of which has been so poor as to favor the accumulation of black organic matter in the soil. The soil is a black fine sandy loam, high in organic matter, underlain at a depth of from 5 to about 15 inches by a pale-yellow to gray fine sandy loam, which quickly passes into a plastic, clammy, fine sandy clay, mottled drab, gray, and reddish-yellow, and usually saturated with water. In places the subsoil consists of a grayish, sticky, fine sand, locally styled "quicksand."

The timbered phase supports a growth of pine and bay, with a dense undergrowth of gallberry bushes. Much of the treeless or savanna phase is heavily sodded with native grasses.

For successful utilization the Portsmouth fine sandy loam requires thorough drainage. This can be accomplished by open ditches, placed at intervals of 75 to 150 feet, according to the texture of the subsoil. Water stands on this land, especially the savanna phase, for a considerable time after heavy rainfalls.

The Portsmouth fine sandy loam, when drained, is admirably adapted to corn, strawberries, and forage crops. A number of truck crops, as cabbage, onions, and probably celery, would do well. Cotton, potatoes, etc., can be grown with fair success.

Tuberose, dahlia, canna, caladium, and gladiolus bulbs are grown on this character of land in Duplin County. These plants require heavy fertilization. That phase of the type underlain by a fine sandy clay is the more productive.

Commercial fertilizer in moderate applications gives good results. Brands relatively high in potash and phosphoric acid seem to be the most effective. Applications of lime will aid in securing a favorable soil condition. An application of from 25 to 35 bushels per acre is generally sufficient for five or six years. As with the Norfolk soils, a crop rotation including the legumes, especially cowpeas and velvet and soy beans, is advisable, and after several years of cultivation it is necessary to plow under an occasional green crop in order to maintain favorable organic matter content.

LESS EXTENSIVE TYPES.

There are several other distinct types of soil in Pender County, among which are the Norfolk very fine sandy loam and Portsmouth very fine sandy loam. These types are so closely associated with and so near the corresponding coarser members of these series in their crop adaptations and requisite methods of cultivation that it is not considered necessary to describe them in detail. The Norfolk very fine sandy loam is generally a little better producer of the general farm crops than the Norfolk fine sandy loam and vegetables average somewhat later in maturity.

There is a considerable acreage of bottom land, much of which is nothing more than swamp. Some of this could be reclaimed and made to produce good crops of corn. No examination was made of the river-bottom lands. The "mud lands" of the North East River bottoms in Pender County are described in the soil-survey report of Duplin County as producing fine crops of corn.

The Angola Bay, in the northeastern part of the county, according to the Duplin County report, is a wet, mucky loam to sandy loam, filled with roots and vegetable fiber and underlain by a sticky sand or sandy loam. It supports an almost impenetrable growth of underbrush, bay, juniper, pine, etc. There is a good opportunity for reclaiming the land of this bay. The soil unquestionably would prove admirably suited to corn, forage crops, strawberries, cabbage, onions, and celery.

The Norfolk sand, a good early truck soil, is found to some extent in the southeastern part of the county. The Portsmouth fine sand, Portsmouth loam, Sandhill, Salt marsh, and Beach sand also occur in the county.

Other types probably would be encountered in making a regular detail soil survey, but the most important ones are described in this report.

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