DEPARTMENT OF THE INTERIOR,
CENSUS OFFICE.

FRANCIS A. WALKER, Superintendent,
Appointed April 1, 1879; resigned November 3, 1881.

CHAS. W. SEATON, Superintendent,
Appointed November 4, 1881.

REPORT

ON

COTTON PRODUCTION IN THE UNITED STATES;

ALSO EMBRACING

AGRICULTURAL AND PHYSICO-GEOGRAPHICAL DESCRIPTIONS

OF THE

SEVERAL COTTON STATES AND OF CALIFORNIA.

EUGENE W. HILGARD, Ph. D.,

Professor of Agriculture, University of California, former Professor at the University of Mississippi, and State Geologist,

SPECIAL AGENT IN CHARGE.

PART I.

MISSISSIPPI VALLEY AND SOUTHWESTERN STATES.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1884.

SUBJECTS OF THIS REPORT.

PART I.

COTTON PRODUCTION IN THE MISSISSIPPI VALLEY AND SOUTHWESTERN STATES.

PART II.

COTTON PRODUCTION IN THE EASTERN GULF, ATLANTIC, AND PACIFIC STATES.

APPENDIX.

LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
CENSUS OFFICE,
Washington, D. C., October 1, 1883.

Hon. H. M. TELLER,
Secretary of the Interior.

SIR: I have the honor to transmit herewith the report upon Cotton Culture, forming the fifth and sixth volumes of the final report upon the Tenth Census.

I have the honor to be, very respectfully, your obedient servant,

C. W. SEATON,
Superintendent of Census.

INTRODUCTORY LETTER.

BOSTON, MASS., *June* 9, 1883.

Under the provisions of the eighteenth section of the act of March 3, 1879, authorizing the Superintendent of Census to "employ experts and special agents to investigate in their economic relations the manufacturing, railroad, fishing, mining, and other industries of the country", it was thought that the cotton culture of the South had a very strong claim to be considered among the most important subjects of such special investigation: first, because of the vast contribution made therefrom to the aggregate production of wealth; second, because this crop is so largely exported, which fact would give the widest possible interest to all information relating to the conditions of its production; third, because of the great and almost revolutionary changes in the system of cultivation which during the past fifteen or twenty years have been in progress throughout the cotton region, making the present a peculiarly appropriate time for a thorough survey of this industry; fourth, because, while other sections of the country afforded many subjects for extended special investigation in the census, cotton culture was the main interest of a group of eleven or twelve states.

In setting on foot the proposed investigation into the cultivation of cotton the Census Office was peculiarly fortunate in securing the services, as chief special agent, of Professor Eugene W. Hilgard, now of the University of California, but for many years a professor in the University of Mississippi, and the head of the geological and agricultural survey of that state. Besides rare powers of mind and high scientific attainments, coupled with the advantages derived from long and careful study of the subject-matter of the investigation, Professor Hilgard possessed the commanding qualification of being the author of that method of soil investigation which, after protracted debate, has been fully established to the approval of the agricultural chemists of the United States.

It is scarcely a matter of wonder that so great a work as was undertaken three years ago in this direction should be found, in the result, somewhat altered from its projected dimensions. In a word, the work, as it is now sent to press, contains vastly more of local and particular descriptions of the cotton lands of the South and somewhat less of general discussion and of historical and comparative matter than was first contemplated. This has been due to an increasing sense of the importance of the former element of the report, and also to the failure of the chief special agent to obtain all the assistance which was anticipated, and to the consequent necessity imposed upon him of doing with his own hands much of the local work. This, combined with the effects of grave and persistent ill-health, has caused Professor Hilgard to abridge that general discussion of the cotton-growing industry in the past as well as in the present, in other countries as well as in the United States, which formed so prominent a feature of the original plan.

No words could exaggerate the sense I have of the zeal, intelligence, and spirit of devotion with which this work has been pursued by Professor Hilgard under the gravest disadvantages. His regretted failure to obtain the services of *collaborateurs* in certain important cotton states has been in no small degree compensated by his exceptional good fortune in securing the assistance of Dr. R. H. Loughridge, first as a reporter upon the great states of Georgia and Texas, and subsequently as a general assistant upon the entire work.

FRANCIS A. WALKER.

GENERAL DISCUSSION

OF THE

COTTON PRODUCTION OF THE UNITED STATES;

EMBRACING

THE COTTONSEED-OIL INDUSTRY, METHODS AND UTILITY OF SOIL INVESTIGATION,

AND

TABLES OF COTTON FIBER MEASUREMENTS.

E. W. HILGARD, PH. D.,
SPECIAL AGENT IN CHARGE.

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PART II.

MAPS AND ILLUSTRATIONS.

LETTER OF TRANSMITTAL.

UNIVERSITY OF CALIFORNIA, *May* 31, 1883.

In submitting to the public the series of reports on cotton production the editor deems it not unnecessary to explain briefly the causes leading to their present form, and particularly to the great predominance of the special descriptive over the general part.

As originally outlined by ex-Superintendent Walker, the report was to embrace, besides the merely statistical matter, a measurably complete discussion of cotton production, not only in the United States, but elsewhere, and in the past as well as in the present, "the results themselves being used to indicate the probable movement in the immediate future. In a word, the figures of the returns should be set into a philosophical discussion of the subject-matter to which they relate. In regard to the cotton of the South, the field of actual culture should be defined, and within that field the soils treated of, as far as possible, mapped, the methods of culture discussed, the labor system described, and the American cotton botanically considered and compared as to its adaptations to the uses of the manufacturer with the cotton of other countries. So far as might be, it would be agreeable to the general plan that the discussion should outrun the field of actual present cultivation and take up the question as to the regions of the United States to which the culture might profitably be extended. Historical matter might be introduced to the extent that should appear desirable. Previous official reports and the literature of the subject could be brought under contribution, though the work should in the main consist of fresh, original matter."

Although feeling considerable hesitation in regard to his physical ability to carry out this programme successfully from his distant point of location, the writer, upon finding several gentlemen prominently identified with the agricultural interests of their respective states willing to lend their aid in the premises, finally accepted the general charge of the work, including the elaboration of such portions as might not find other hands.

In pursuance of this general arrangement, the several states were placed in charge of the following gentlemen: North Carolina, Professor W. C. Kerr, state geologist and member of the board of agriculture; Tennessee, Professor James M. Safford, professor of geology at Vanderbilt University, Nashville, and state geologist; South Carolina, Major Harry Hammond, of Beech Island, formerly of the State University of Georgia, and prominently identified with agricultural progress in his state; Alabama, Professor Eugene A. Smith, professor of chemistry and geology in the University of Alabama, and state geologist. The latter also took charge of the state of Florida, while Professors Safford and Kerr added to their respective states such portions of the contiguous states of Kentucky and Virginia, respectively, as could be considered cotton-producing. Georgia was placed in charge of Dr. R. H. Loughridge, formerly assistant in the Georgia geological survey, and thoroughly familiar with that state; and he was also charged with a rapid exploration of the state of Texas, of which he had long been a resident, as well as of the Indian territory, in which his boyhood was spent. Subsequently, the elaboration of a description of the state of Arkansas, from the reports of Dr. David Dale Owen and other sources, and likewise of the cotton-growing part of Missouri, also fell to him. In all cases the materials furnished by the geological surveys of the states were first utilized, and the existing gaps filled, so far as means would allow, by exploration, and essentially by the further analysis of representative soils, mostly carried out in the laboratory of the University of Alabama. Numerous samples of cotton were also obtained, and the measurements of their respective dimensions, strength, etc., were undertaken by Professor J. M. Ordway, of the Massachusetts Institute of Technology. The results of this part of the investigation will be found tabulated in the following pages.

The writer originally hoped to restrict his own state work to Mississippi, of which state he was geologist for a number of years; but in the course of time Louisiana and California were added to his share, from the difficulty of finding other persons qualified by previous acquaintance with these states. This cumulation of special work upon his hands, added to that of general supervision and regular professional duties, must be held accountable for the deviation from the original plan in cutting short to an unfortunate extent the general and, in some respects, most important portion of this report. Moreover, as the answered schedules came in, it was found that they contained a large amount of information regarding the agricultural features and capacities of the cotton states such as is needed by immigrants and investors, yet cannot be found in a connected and authentic form in any publications now extant. It was then concluded to add to the more general description of each state brief descriptions of each of its counties, with such abstracts from the schedule reports as might add to the practical interest. Had it been foreseen how great an increase of labor was involved in this expansion of the original plan the decision might have been against it. But it is believed that if the consequent abridgment of the general part has somewhat diminished the interest of this volume for those directly concerned in the world's cotton trade and production, as well as for the general student, its direct value to the states concerned, and to those who are to seek their homes and fortunes in their inviting climates, has been materially increased. The general discussion can reach those interested through the columns of the periodical press, while the facts wanted by the intending settler can ordinarily be ascertained by him only through personal observation or through the reports of interested parties, mostly very vague as regards the natural features, while profuse in examples of individual cases of well-doing, and in business advertisements. The latter feature is of course rigorously excluded from the contents of this volume; and however desirable it might have been to go somewhat beyond the mere statement of the means of communication and give some data regarding the chief towns, the rapid mutability of such matters in the United States, and the difficulty of avoiding *ex parte* statements and invidious comparisons, with their train of wounded sensibilities, rendered such additions clearly inexpedient. It should therefore be distinctly understood that this omission is intentional and general, and that the descriptions are intended to include only such matter as in the nature of the case is immutable or subject to slow change only, such as the natural features and the predominance of industries or industrial practice that have been found adapted to them.

It is not claimed, nor under the circumstances can it be reasonably expected, that mistakes have been entirely avoided and no important omissions made. The time and means at command were wholly inadequate for a work making such claims. But it is believed that in using the utmost diligence to secure the assistance and co-operation of the men whose life study has been given to the objects in view, and whose past or present official position has enabled them to gain the most comprehensive view of the natural and industrial features of their respective states, it has been possible to bring within this volume a larger foundation of solid and well-digested facts than could have been obtained by any of the ordinary methods of transient commissions or traveling observers, with their almost inevitable sequence of superficial observations and hasty generalizations and conclusions. If the merits as well as the faults of the work shall result in a fuller appreciation by the state and federal governments, as well as by the public, of the benefits to be derived from a closer attention to the study and intelligent as well as intelligible description of the agricultural features and peculiarities of the several portions of the United States, the object of our somewhat arduous labors will have been attained. It is but bare justice to say that these have been materially lightened by the uniform and appreciative courtesy and helpfulness of ex-Superintendent Walker, under whose administration the bulk of the work was done.

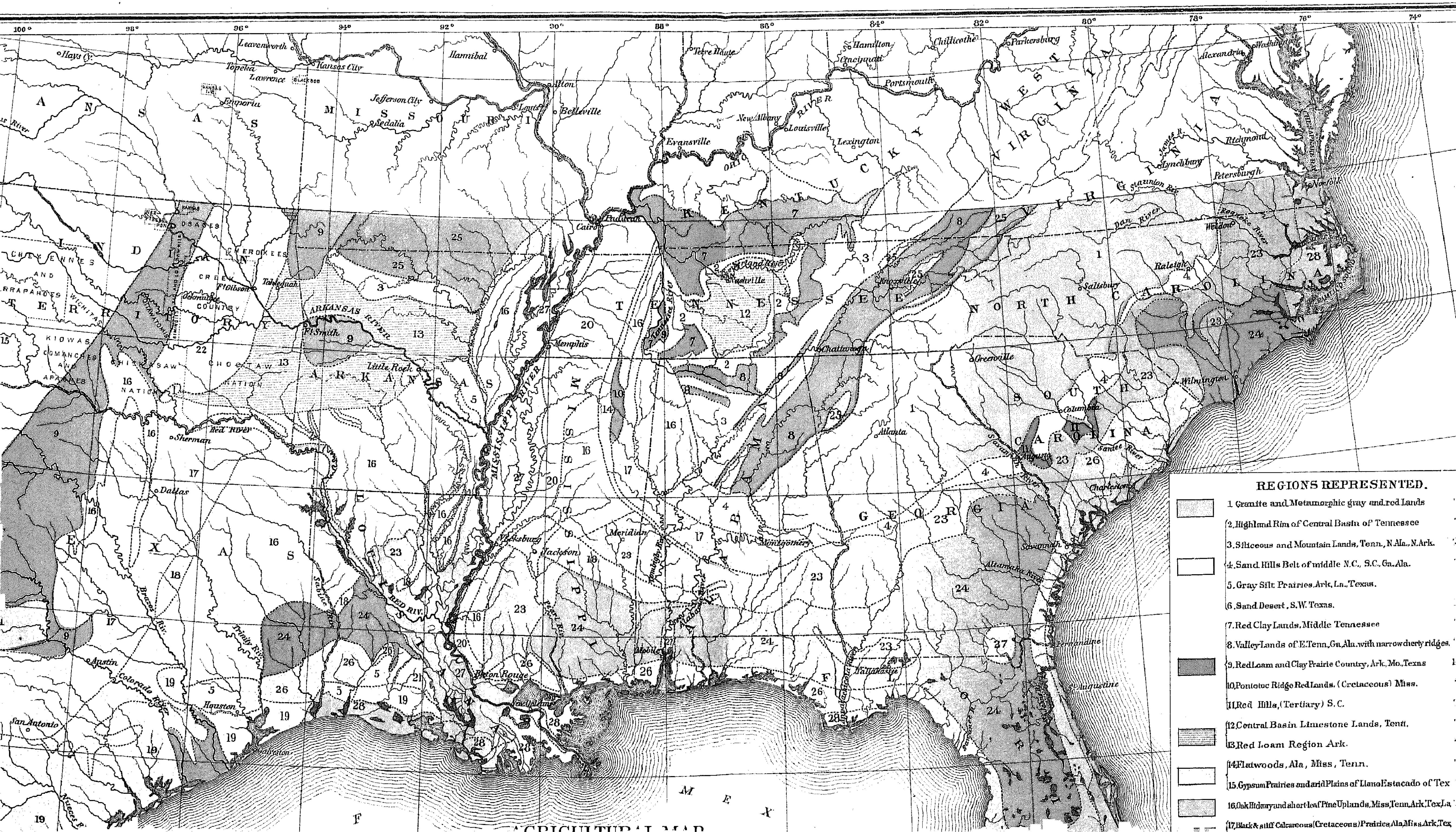
EUGENE W. HILGARD,
Chief Special Agent.

PART I.

STATISTICS AND GENERAL DISCUSSION

OF

COTTON PRODUCTION IN THE UNITED STATES.


REGIONS REPRESENTED.
1 Granite and Metamorphic gray and red Lands
2. Highland Rim of Central Basin of Tennessee
3. Siliceous and Mountain Lands, Tenn., N. Ala., N. Ark.
4. Sand Hills Belt of middle N.C., S.C., Ga. Ala.
5. Gray Silt Prairies Ark, La., Texas.
6. Sand Desert, S.W. Texas.
7. Red Clay Lands, Middle Tennessee
8. Valley Lands of E. Tenn., Ga. Ala. with narrow cherty ridges.
9. Red Loam and Clay Prairie Country, Ark., Mo., Texas
10. Pontotoc Ridge Red Lands, (Cretaceous) Miss.
11. Red Hills, (Tertiary) S.C.
12. Central Basin Limestone Lands, Tenn.
13. Red Loam Region Ark.
14. Flatwoods, Ala, Miss, Tenn.
15. Gypsum Prairies and arid Plains of Llano Estacado of Tex
16. Oak Hickory and short-leaf Pine Uplands, Miss, Tenn. Ark. Tex. La.
17. Black & stiff Calcareous (Cretaceous) Prairies Ala. Miss. Ark. Tex.
KANSAS
MISSOURI
KENTUCKY
WEST VIRGINIA
VIRGINIA
TENNESSEE
NORTH CAROLINA
SOUTH CAROLINA
ARKANSAS
MISSISSIPPI
ALABAMA
GEORGIA
TEXAS
INDIAN TERRITORY
AGRICULTURAL MAP

STATISTICS AND GENERAL DISCUSSION.

REVIEW OF THE GENERAL SOIL MAP OF THE COTTON STATES.

[It was intended to present under this head a general review and summary of the agricultural features and statistics of cotton production in the southern states, but the necessary closing of the census work at a fixed date precludes any extended comments.]

This map represents, so far as the smallness of the scale will permit, the chief soil regions of the cotton-growing states in thirteen colors, most of which are made to represent several distinct features, belonging, however, to districts so widely separated that no confusion can arise from this joint use, the meanings of which are indicated in the legend. (*a*) Since differences of soil necessarily find their expression in the vegetation covering the ground, the designations of the regions are largely based upon the characteristics in regard to tree growth.

It is apparent at a glance that in the coastward portion of the cotton states the agricultural divisions (Nos. 28, 26, 24, 23, 4) form, roughly speaking, belts more or less conforming or parallel to the present coast-line, while inland they are measurably governed on the east by the location and trend of the Alleghany range (Nos. 1, 3, 8), and farther west by the great northward prolongation of the Gulf of Mexico that existed at the end of the Cretaceous period, and was gradually filled up nearly to the present shore-line during the succeeding Tertiary period (Nos. 17, 14, 16, 18, 27). In the axis of this great embayment, which had its head near Cairo, Illinois, lies the alluvial plain of the Mississippi river, bordered and underlaid mostly by early Quaternary deposits lying in a Tertiary trough several hundred feet in depth. The greater part of Texas belongs to the western portion of the ancient embayment, and we find there, only in inverted order (as regards east and west), the same or corresponding formations and soils as those met with east of the Mississippi river in traveling toward the southern end of the Appalachian region; that is, we pass first from the recent to the older *alluvium*, consisting largely of heavy calcareous or "prairie" soils; thence again across calcareous black prairies derived from the *Tertiary* formations (18) to a broader belt of *Cretaceous* black prairies (17), which in their turn are followed, in part at least, by black calcareous prairie soils, derived from the *Carboniferous* limestones. Between these several prairie belts there intervene east of the Mississippi more or less of sandy or loam uplands, not of prominently calcareous character (16, 23), while in Texas the prairies corresponding to the four ages of limestones mostly adjoin each other directly.

It thus appears that, from the Chattahoochee west to the Nueces river of Texas, calcareous soils are widely prevalent; and the parallel map of intensity of cotton production shows a marked increase of the cotton culture whenever one of these calcareous belts is reached.

East of the Chattahoochee, and northeastward to the James, few prominently calcareous soil areas are met with, and all such are rather local and of small extent. The soils here, being derived from the eastern slope of the Alleghanies, are prevalently of a light siliceous character, and below the break of the highlands into the coast plains (or what is popularly known as "the falls of the rivers") they are but rarely influenced by the underlying Tertiary marls. They are mostly what, in a wide application of the term, might be termed "alluvial" soils, chiefly of early Quaternary origin; and, aside from the narrow "live-oak belt" of the immediate coast, the long-leaf pine is their characteristic tree. This pine, as analysis shows, is everywhere an indication of soils poor in lime; and experience shows that until the use of fertilizers becomes part of the agricultural system only the bottom lands of a long-leaf pine area are usually utilized for cotton production. Hence the great pine belts of the Gulf coast produce but very little cotton, while on the Atlantic border, with the use of fertilizers, the culture is more extended.

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a Owing to the failure of the printer to furnish proof-sheets of the map before striking off the edition, the following erratum requires notice:

The region along the Rio Grande river in Texas should have the same color as the coast and southern prairie region No. 19, on the east of the "Desert".

Discrepancies are apparent in some instances between this general map and the several state maps, which are in part due to differences in depth of color, and in part to the fact that changes were made in some of the state maps by their authors *after* the entire edition of this general map was printed. The most apparent among these occur in North Carolina, where the *sand-hills region* (of the general map) have in the state map been merged into the oak uplands or metamorphic region; and the region of *long-leaf pine hills*, which is very prominent here, is there narrowed down and shows its limits more in detail and with a different shade of color.

Inland the proportion of lime in the soils usually increases, and correspondingly the long-leaf pine gradually gives way to the short-leaf species and an increasing proportion of oaks and hickories, until finally the latter alone occupy the ground. With local modifications, this order of things holds good pretty generally from Virginia to eastern Louisiana, but by far most strikingly so in the Gulf states east of the Mississippi. In the bottom plain of the latter, near the line between Arkansas and Louisiana, we find the maximum of cotton production on natural soils (see page 14) on the highly calcareous and otherwise also profusely fertile "buckshot" soils of the great valley, with which only some of those of Red River bottom can dispute precedence. Under their influence cotton culture is carried far into Missouri, while in the hill country to the eastward and westward, in Kentucky and in northwestern Arkansas, it forms but a subordinate feature. In Texas again the Tertiary and Cretaceous prairie regions (Nos. 16 and 17) produce the bulk of upland cotton, while in the coast prairie region the river bottoms are almost alone employed in its production thus far; and westward of the Cretaceous prairie region, where the rainfall becomes more scanty, it has not yet had time to establish itself on a permanent footing, save locally.

While natural advantages thus clearly point to the Mississippi valley and regions immediately adjacent as the natural and future center of cotton production in the United States, it is interesting to notice to how great an extent these advantages are at present balanced by a more rational, thorough, and systematic culture of the less fertile soils of the Atlantic cotton states. The following table shows the total production of the several soil regions given on the map, as well as the partial production of each in the Atlantic cotton states on the one hand, and of the states west of the Chattahoochee on the other. The figures are, of course, only approximate, being based upon the returns by counties, which very often embrace within their areas small sections of other regions outside of the chief region to which each county is referred:

TABLE I.—APPROXIMATE AREA AND COTTON PRODUCTION OF EACH OF THE AGRICULTURAL REGIONS OF THE COTTON-PRODUCING STATES.

Agricultural regions.	Approximate land area.	COTTON PRODUCTION.				
		Total.	Atlantic states.	Mississippi valley and Gulf states.	Seed-cotton product per acre.	
					Claimed for fresh land.	Average yield for 1879.
	Square miles.	*Bales.*	*Bales.*	*Bales.*	*Pounds.*	*Pounds.*
Total	710,265	5,755,359	1,801,179	3,954,180	....	567
Metamorphic region	66,605	957,720	886,435	71,285	500–800	498
Siliceous and mountain lands	22,770	25,590	....	25,590	600–800	498
Sand- and red-hills region	6,660	53,355	53,355	....	300–500	561
Gray-silt prairies of Arkansas	1,535	27,189	....	27,189	1,000	855
Central basin of Tennessee	5,450	48,778	....	48,778	1,000	570
Valley lands of east Tennessee, northwestern Georgia, and Alabama	16,340	99,855	46,619	53,236	800–1,000	600
Red-loam region of Arkansas	18,520	144,864	....	144,864	1,000	828
Pontotoc ridge of Mississippi	590	23,768	....	23,768	1,000–1,600	555
Red-loam region of northwestern Texas	27,000	10,931	....	10,931	500–800	360
Valley of the Tennessee	5,080	94,067	....	94,067	1,000–1,500	471
Oak and short-leaf pine uplands	87,190	944,517	....	944,517	500–1,000	612
Black prairie region	39,225	753,552	....	753,552	800–1,000	456
Coast prairies of Texas and Louisiana	51,135	136,269	....	136,269	600–1,000	585
Brown-loam table-lands, bluff region, and cane hills	13,950	558,232	....	558,232	1,000–1,200	684
Magnesian limestone lands of Arkansas and Missouri	12,460	49,758	....	49,758	1,000–1,200	798
Oak, hickory, and long-leaf pine uplands	52,980	908,353	658,501	249,852	400–700	486
Long-leaf pine hills	74,478	100,717	77,213	23,504	400–600	372
Pine flats, savannas, and coast lands	48,499	79,850	79,056	794	500–1,000	543
Mississippi river alluvial lands	29,467	616,063	....	616,063	1,500–2,000	1,068
Other alluvial lands	5,557	104,931	....	104,931	1,500–2,000	783
Indian territory	3,400	17,000	....	17,000	1,800–1,900	969
Marsh lands	7,837	....	....	....	....	....
Flatwoods of Mississippi, Alabama, and Tennessee (*a*)	2,030	....	....	....	....	....
Gypsum region of Texas	17,490	....	....	....	....	....
Llano Estacado of Texas	93,927	....	....	....	....	....

a A narrow belt, and its cotton production not separately ascertained.

TABLE II.—TOTAL POPULATION, TILLED LAND, COTTON PRODUCTION, AND AVERAGE PRODUCT PER ACRE FOR THE UNITED STATES.

States in the order of cotton production.	Total land area.	Approximate area over which cotton is planted.	POPULATION.			TILLED LAND.			COTTON PRODUCTION.										Percentage of total production of the states.
			Total.	White.	Colored.	Acres.	Per cent. of area.	Acres per square mile.	Per cent. of tilled land.	Acres.	Bales.	Rank in product per acre.	Average product per acre: Fraction of a bale.	Average product per acre: Seed-cotton.	Average product per acre: Lint.	Average product per acre: Seed.	Total in tons: Lint.	Total in tons: Cotton-seed.	
		2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
	Sq. mls.												Lbs.	Lbs.	Lbs.	Lbs.			
Total	905,305	547,065	16,807,316	11,022,857	5,784,459	70,496,877	13.72	88	18.21	14,480.019	5,755,359	....	0.39	567	189	378	1,383,849	2,770,417	100.00
Mississippi	46,340	46,340	1,131,597	479,398	652,199	4,924,630	16.60	106	42.77	2,106,215	963,111	7	0.46	657	219	438	228,739	457,478	16.73
Georgia	58,980	*a* 57,680	1,542,180	816,906	725,274	7,690,292	20.37	130	34.03	2,617,138	814,441	13	0.31	444	148	296	193,429	386,858	14.15
Texas	262,290	*b* 108,000	1,591,749	1,197,237	394,512	7,628,536	4.54	29	28.56	2,178,435	*c* 805,284	11	0.37	555	185	370	201,321	402,642	13.99
Alabama	51,540	51,540	1,262,505	662,185	600,320	6,134,198	18.60	119	37.99	2,330,086	699,654	14	0.30	429	143	286	166,168	332,336	12.16
Arkansas	53,045	53,045	802,525	591,531	210,994	3,431,000	10.11	65	30.31	1,042,976	*c* 608,256	4	0.58	831	277	554	152,064	304,128	10.57
South Carolina	30,170	30,170	995,577	391,105	604,472	3,736,090	19.35	124	36.52	1,364,249	522,548	12	0.38	546	182	364	124,105	248,210	9.08
Louisiana	45,420	*d* 37,820	939,946	454,954	484,992	2,507,935	8.63	55	34.48	864,787	508,569	3	0.59	840	280	560	120,785	241,570	8.84
North Carolina	48,580	*e* 42,880	1,399,750	867,242	532,508	5,926,087	19.06	122	15.07	893,153	389,598	9	0.44	621	207	414	92,520	185,058	6.77
Tennessee	41,750	*f* 37,750	1,542,359	1,138,831	403,528	7,700,041	28.82	184	9.38	722,562	330,621	7	0.46	651	217	434	78,522	157,044	5.74
Florida	54,240	*g* 47,840	269,493	142,605	126,888	887,472	2.56	16	27.67	245,595	54,997	15	0.22	318	106	212	12,092	26,902	0.96
Missouri	68,735	15,000	2,168,380	2,022,826	145,554	13,203,756	30.02	192	*h* 0.24	32,116	*c* 20,318	2	0.63	900	300	600	5,079	10,158	0.35
Virginia	40,125	4,000	1,512,565	880,858	631,707	7,358,030	28.65	183	*h* 0.61	45,040	19,595	9	0.44	621	207	414	4,654	9,308	0.34
Indian territory	64,090	2,000	....	....	....	....	......	....	......	35,000	17,000	6	0.49	699	233	466	4,037	8,075	0.30
Kentucky	40,000	13,000	1,648,690	1,377,179	271,511	8,367,910	32.69	209	*h* 0.03	2,667	1,367	5	0.51	729	243	486	325	650	0.02
California (*i*)	155,980	....	864,694	767,181	....	6,606,102	6.62	42	......	*j* 375	*j* 295	1	0.79	1,125	375	750	70	140	......

a Omitting counties north of the Blue Ridge.
b Omitting western Texas.
c 500-pound bales.
d Omitting marsh lands.
e Omitting the mountain division.
f Omitting Unaka and Cumberland region.
g Omitting Everglades.
h Of tilled land in the cotton region.
i This state is not included in the general summary.
j These do not represent the acreage or number of bales actually produced in the state, but from one locality only. The enumeration schedules sent to this state did not include cotton.

TABLE III.—COUNTIES IN EACH STATE HAVING THE HIGHEST COTTON PRODUCTION.

States in the order of average product per acre.	Average product per acre (fraction of a bale).	COUNTIES HAVING HIGHEST TOTAL PRODUCTION.					COUNTIES HAVING HIGHEST PRODUCT PER ACRE. (*a*)				
		Name.	Rank in product per acre in the state.	Cotton acreage.	Bales, 475 lbs.	Product per acre, fraction of a bale.	Name.	Rank in total production in the state.	Cotton acreage.	Bales.	Product per acre, fraction of a bale.
	1	2	3	4	5	6	7	8	9	10	11
California (*b*)	0.79	Merced	......	375	295	0.79	Merced	1	375	295	0.79
Missouri	0.63	Dunklin	2	11,100	7,361	0.66	Pemiscot	3	3,787	2,848	0.75
Louisiana	0.59	Tensas	2	50,555	41,859	0.83	East Carroll	2	40,167	38,160	0.95
Arkansas	0.58	Jefferson	4	45,426	34,588	0.76	Chicot	3	26,941	25,338	0.94
Kentucky	0.51	Graves	4	869	417	0.48	Hickman	3	451	254	0.56
Tennessee	0.46	Shelby	8	92,620	46,388	0.50	Lake	23	3,249	2,412	0.74
Mississippi	0.46	Washington	2	63,409	54,873	0.87	Issaquena	22	18,293	16,150	0.88
North Carolina	0.44	Wake	7	59,916	30,115	0.50	Brunswick	61	385	244	0.63
Virginia	0.44	Southampton	3	11,500	5,200	0.45	Greenville	2	8,500	4,100	0.48
Texas	0.37	Fayette	33	58,353	24,766	0.42	Bowie	41	11,509	7,958	0.69
South Carolina	0.38	Edgefield	18	93,797	35,894	0.38	Marlborough	10	41,251	23,785	0.58
Georgia	0.31	Burke	54	87,359	29,172	0.33	Polk	41	16,774	8,126	0.48
Alabama	0.30	Dallas	45	115,631	33,534	0.29	Baldwin	62	1,384	638	0.46
Florida	0.22	Jefferson	4	37,500	10,368	0.28	Levy	10	3,665	1,251	0.34

a Omitting those counties whose production is less than 100 bales, except in the case of California.
b Merced was the only county in California producing cotton during the census year.

It should be kept in mind that in the case of the cotton crop the data collected by the enumerators during June, 1880, necessarily refer to the cotton crop of 1879, at least so far as the product is concerned. It may be questioned whether the same is in all cases true (as should have been the case) of the acreage reported; for, unless specially admonished by the enumerators, the producers would be very likely to give them the acreage of 1880, which would be most readily present to their minds. Since the acreage of 1880 was doubtless greater than that of the preceding year, this error would tend to depress the calculated average production per acre to some extent.

In Table II the cotton-producing states are arranged, in the order of their rank, according to total production in 1879. The first column gives the state areas; the second the approximate areas of each state over which cotton is planted; the three following the population of these states, divided according to color, as bearing upon the question so much and contradictorily discussed as to "who produces the cotton". The next group of three columns gives the number of acres of tilled land, the percentage of these as referred to the total areas, and the number of acres tilled per square mile. Columns 9 to 19 give details of production; No. 9, the percentage of tilled land devoted to cotton culture; 10, the corresponding number of acres in cotton; 11, the number of bales produced; 12, the number indicating the rank of each state among the fifteen as to the average product per acre; 13, the fraction of a bale (of 475 pounds) produced per acre; 14, the corresponding product in pounds of seed-cotton; 15 and 16, the corresponding amounts in pounds of lint and cottonseed, (*a*) respectively. Columns 17 and 18 give the totals in tons of 2,000 pounds of lint and cottonseed produced, and 19 gives the respective percentages contributed by each state to the grand total.

From the reports received in answer to schedules sent, as well as from statements received from the prominent cotton-shipping ports, it appears that, outside of Texas, Arkansas, and Missouri, the average weight of the "bale" may be assumed to have been 475 pounds in 1879. Upon this basis, and upon the commonly-accepted average proportion of one part of lint to two of seed in the "seed-cotton" as it comes from the field, are based the data given in columns 14 to 19. In the case of other states, the number of bales given is that reported by the enumerators; but as their average weight was about 500 pounds, this figure has served as the basis of all others concerning these states.

In Table III the states are arranged in the order of rank according to average product per acre, as given in column 12, Table II. In the ten columns following are given the names, acreage in cotton, total production in bales, and average product per acre of the "banner counties" of each state, considered, first, in relation to total production, and then in respect to highest product per acre. The rank of counties according to the first point of view is, of course, largely accidental, on account of their unequal areas; yet it is the one most commonly looked to by the producers. The figures under the second head, however, are of the greatest intrinsic significance, the last column showing irrefragably the effect of the fertility of the soil, of intelligent culture, or of both combined.

SUMMARY DISCUSSION OF COTTON PRODUCTION IN THE UNITED STATES.

The accompanying map, compiled from the several state maps (which may be found in the respective state reports), gives a general view of the regions of varying intensities of cotton acreage as compared with the total land area throughout the cotton states.

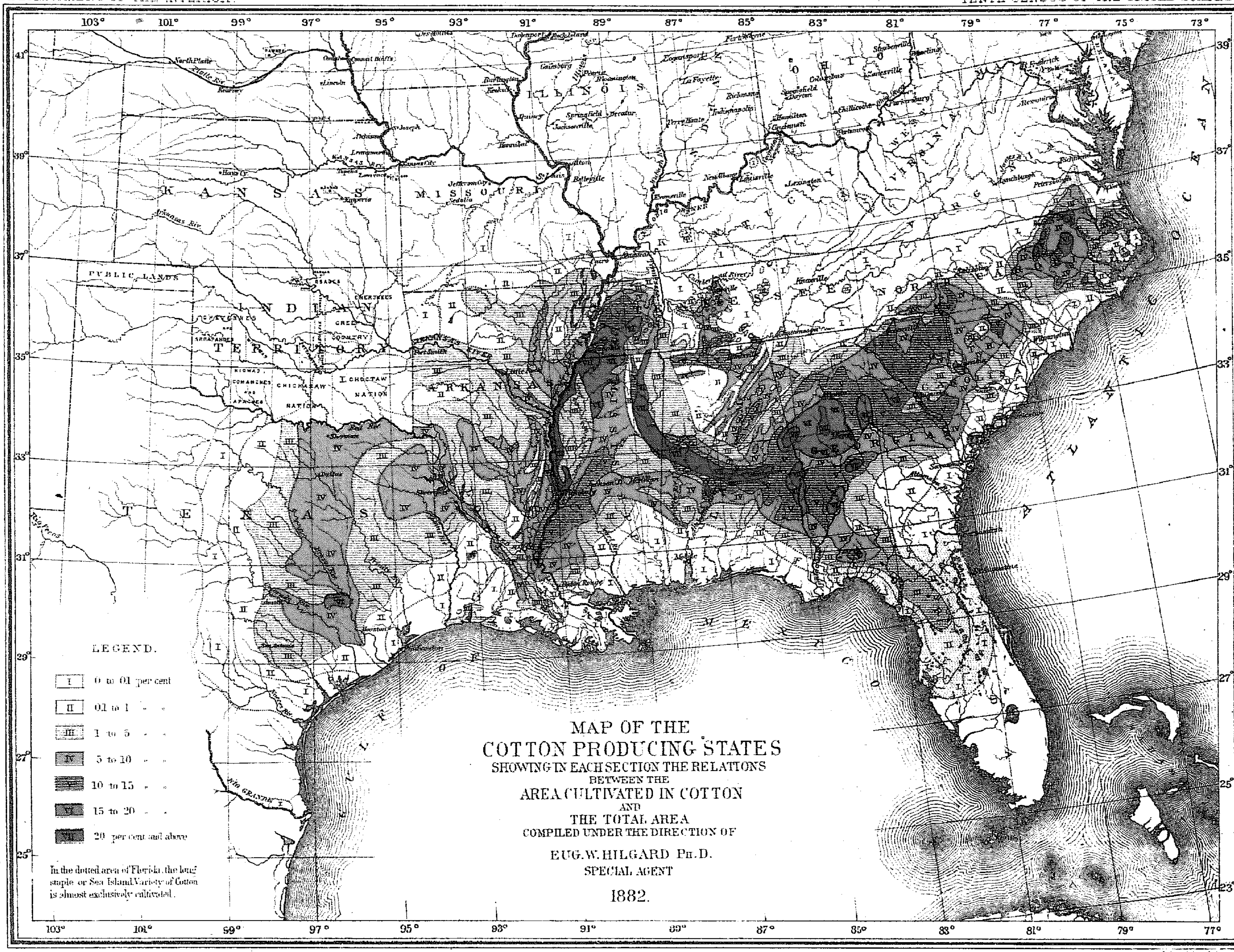
The regions of high percentage devoted to cotton (10 to 20 per cent. of the total area) are confined almost exclusively to the central portions of Mississippi, Alabama, and Georgia, the cotton acreage averaging above 65 acres per square mile within the respective areas. Small patches (representing counties) of the same occur in North Carolina, Tennessee, and Texas.

Regions of maximum intensity of cotton culture above 20 per cent. of the total area form two prominent belts (shown by the deepest shade of color), one lying along the Mississippi river within the alluvial region, while the other embraces the black prairie region from northeastern Mississippi, southeastward nearly through the central portion of Alabama. The cotton acreage within these belts averages 130 acres per square mile, and upon them was produced in 1879 about 753,550 bales of cotton. A penumbral region of very sparse culture is seen almost to surround, both inland and along the coast, the cotton-producing portion of the states, while outlying areas (representing isolated counties) occur in Kentucky.

A comparison of the total population of the states of the cotton belt proper, from North and South Carolina to Texas, shows in all but two cases an approximation to the proportion of one bale for every two inhabitants. These exceptional states are Mississippi and Arkansas, in which the ratio is from two-thirds to over three-fourths of a bale per head. No obvious relation between the total production and the number, or the ratio to the total number of the colored population, is discernible in the footings by states. Such a relation, however, can be shown in the detailed discussion of the agricultural subdivisions of each state.

I now proceed to discuss the determining causes of the position occupied by each of the states in the column of total production (No. 11 of Table II), as well as in that showing average product per acre (No. 1 of Table III).

a I venture upon the innovation of spelling "cottonseed" as one word, as is done in the case of flaxseed or linseed, moonseed, etc., in order to obviate the occurrence of such grammatical monstrosities as "cotton seed oil cake meal", and similarly constituted expressions that can hardly be avoided unless such a change is made. In the above case, "cottonseed-oilcake meal" will be understood at a glance.



Julius Bien & Co. lith.

1.—THE COTTON STATES PROPER.

Mississippi stands first in total production, while sixth in population, among the cotton states, thus bringing up its product to 0.85, or over eight-tenths of a bale *per capita*. At first blush, in view of the great fertility and large area of the Mississippi ("Yazoo") bottom within the limits of the state, the inference would be that the high position of the state's production is due to these fertile lowlands; but a detailed discussion of the areas of production shows that a little over one-fourth (25.5 per cent.) only of the cotton product of the state comes from the Yazoo bottom, while over one-half of the whole is produced in what might be termed the first-class uplands, viz, the table-land belt bordering the Mississippi bluff and the two prairie belts. The remaining one-fourth is grown scatteringly over the sandy uplands, bearing more or less of the long- and short-leaf pine, that form about one-half the area of the state.

It thus appears that the high production of Mississippi is due to the fact that quite one-half of its territory is occupied by soils of exceptional fertility, coupled with the circumstance that cotton culture is the one pursuit to which the population devotes itself.

Table III, columns 5 and 11, shows that Washington county, fronting on the Mississippi river and extending east to the Yazoo river, is the county of the state, as well as of the United States, having the largest total production, but the adjoining county of Issaquena exceeds Washington by 1 per cent. in product per acre, having 0.87 of a bale, or 413 pounds of lint, equal to 1,239 pounds of seed-cotton per acre. Issaquena stands third in this respect in the United States, East Carroll, Louisiana, and Chicot county, Arkansas, ranking above it. Even with the imperfect tillage and incomplete picking of the crop now prevailing in the Yazoo bottom the present average product per acre is over three-quarters of a bale; and, estimating the lands reclaimable by simple exclusion of the Mississippi overflows at only three millions of acres, the annual production could thus readily be raised to 2,250,000 bales in the Yazoo bottom alone without any change in the methods of culture. With improved cultivation the production could easily be brought up to 5,000,000 bales; and thus, with a similar improvement in the culture of the uplands, it is evident that the state of Mississippi alone could produce the entire crop now grown in the United States. (*a*)

Georgia stands second in total production, but examination shows that the causes which place the state so near to the highest in position are widely different from those obtaining in Mississippi. With half a million more inhabitants than Mississippi, the cotton product of Georgia is a little over half a bale (0.53) *per capita*, and the average product per acre is but two-thirds of that of Mississippi (0.31 to 0.46). A detailed examination of the soils of Georgia shows that her area of what in Mississippi are considered first- and second-class soils is very limited—far more so than is the case in the neighboring state of Alabama; yet Georgia stands slightly ahead of Alabama in the average cotton product per acre, and is only a trifle behind in production per capita (0.53 to 0.55). In other words, the high position of Georgia is due, not to natural advantages, but to better cultivation of the soil, the use of fertilizers, and the thrift of an industrious population. Reports also show a considerable extension of the area of cotton culture to and even beyond the Blue Ridge.

The geographical position of *Alabama* between the states standing at the head of the list gives double interest to the question regarding the causes of her position in the same, which would be the third place but for the enormous area of Texas, where the sparse population has thus far picked the best lands. Alabama is a newer state than Georgia, and there reach into it from Mississippi the two belts of rich prairie lands which terminate short of the Chattahoochee. Northern Alabama is almost identical in its agricultural features with northern Georgia, and we should therefore expect to find a much more marked difference in favor of Alabama than is shown in the figures quoted. The inference seems irresistible that, while Mississippi is still partly within the period of the first flush of fertility and Georgia has reached the stage when the use of fertilizers is renovating her fields, the soils of Alabama have passed the first stage, and her population has not yet realized the necessity of sustaining the soil's powers by fertilization.

Cotton culture in *Florida* is chiefly confined to that part of the state lying adjacent to Georgia. This is mostly pine land, and is cultivated without manure; hence the low product of less than a quarter of a bale per acre. Notwithstanding this, there has been a respectable increase in production since 1870, though not so large as that of the population; a circumstance doubtless due to the prominent position which the culture of tropical fruits has assumed during the past decade, and to which most of the new-comers have given their attention. No cotton is returned from that portion of the state lying south of Tampa bay, and but little from the coasts, as well as from the extreme western part. The cotton-growing counties show an average product of 0.26, or a little over a quarter of a bale per inhabitant. A considerable proportion (15,532 bales, or 28.2 per cent.) of this product is long-staple or sea-island cotton, of which the state produces nearly the entire supply at present. It should be kept in mind that the bales of long-staple cotton have an average weight of 350 pounds only, and that the proportion of lint to seed is reckoned as one to three, instead of one to two, as in the uplands cotton.

Tennessee presents the striking fact of a total production of less than half of that of Alabama, but with an average product per acre one-half greater, equal even to that of Mississippi. The cause of this state of things

a So far from being an overestimate, the above statement does not adequately state the possibilities within reach of careful culture. Fully 1,000 pounds of lint has repeatedly been picked off an acre of the "buckshot" soil of the Yazoo bottom.

becomes apparent when we circumscribe the regions of production in accordance with the natural divisions of the state. It then appears that the portion of Tennessee lying east of the "central basin", (*a*) from the eastern highland rim to the line of North Carolina, and comprising about one-third of the area of the state, produces only about 1 per cent. of the total amount of cotton, while 84 per cent. of this total is produced in the country lying between the Tennessee and Mississippi rivers, on the extreme west. More than this, within this region the average production *per inhabitant* is 0.57 of a bale and a little less (0.47 of a bale) *per acre*, while the average for the entire state per inhabitant is only 0.21 of a bale. Again, of the above 84 per cent., 70 belongs to the two tiers of counties lying nearest to the Mississippi river. Of these only a small portion is bottom land of the Mississippi river, the greater part by far being gently rolling uplands ("table-lands"), such as form also a large body in northwestern Mississippi, and extend, gradually narrowing, as far south as Baton Rouge, Louisiana.

It thus appears that the cotton production of Tennessee is concentrated upon a comparatively small area of highly productive lands, the rest being devoted preferably to grain, grasses, tobacco, and other industries, to which the soils and climates are more specially adapted; while in the other cotton-growing states cotton is very generally grown as a matter of course, regardless of other cultures, of which the partial pursuit, at least, would in the end be more profitable than exclusive cotton-planting.

Arkansas produces its 608,000 bales (in round numbers) on somewhat over a million of acres, making the average product per acre 0.58 (slightly lower than that of Louisiana) and the average per inhabitant 0.76 of a bale. A cursory examination shows that by far the greater portion of the cotton produced comes from the eastern and southern portions of the state, which contain a large proportion of bottom lands, while in the extreme northern and northwestern counties but little cotton is grown. The form of the returns makes it difficult to segregate the production of the uplands and lowlands in this case; but the product per acre of the bottom county of Chicot stands second to the highest on the list, and it is safe to assume that, on detailed discussion, the average production of uplands and lowlands will be found, respectively, to be about the same as in Louisiana. In both states alike the use of fertilizers in the large-scale production of cotton may be regarded as wholly insignificant in its influence on the general result.

In the case of *Louisiana*, as in that of Tennessee, a considerable portion (about one-fourth) of the state is devoted mainly to other cultures than that of cotton, the sugar-cane gaining precedence in the lowland country lying south of the mouth of Red river, in which only about 6 per cent. of the total amount of cotton is produced, but at the average rate of 0.80 bale per acre. Nearly the same or a slightly higher average per acre is obtained in the alluvial lands north and west of the mouth of Red river, and in the Red river valley itself. The small parish of East Carroll, in the northeastern corner of the state, has the highest average product per acre of any county in the cotton states (0.95 of a bale), and stands second in total production within the state. It will be noted that East Carroll lies opposite Issaquena county, Mississippi, and adjoins Chicot county, Arkansas, both representing maxima of product per acre in their respective states; and there can be no doubt that were the riverward portion of Washington county, Mississippi, segregated from the less productive interior portion its product per acre (0.87) would equal that of Issaquena (0.88). *We have here apparently the center of maximum cotton production on natural soils in the United States, and probably in the world.*

The average product per acre in the uplands of Louisiana (0.41) is approximately half that of the lowlands; and as the average for the state is 0.59, it follows that somewhat more than half the acreage in cotton belongs to the uplands, while the lowlands yield nearly two-thirds of the entire amount. This predominance of lowland cotton explains the higher average product per acre in Louisiana as compared with Mississippi, where less than one-third of the cotton production comes from the Yazoo bottom lands. Within the cotton-growing region proper the average production is approximately 0.95 of a bale *per inhabitant*, but as this figure excludes the entire population of the city of New Orleans, so largely interested in cotton, it is not fairly comparable with the proportion existing in other states. If one-half the population of the city be taken as mainly interested in cotton, the *per capita* proportion would stand 0.80 bale.

The great state of *Texas*, while first in population, stands third in the list of total cotton production among the cotton states. The fact shown by the figures of acreage and total production, viz, that in the average product per acre (0.37) it stands eleventh in rank, will be a surprise to most persons, and is doubtless in part to be accounted for as an accident of the season, the year 1879 having been an unusually dry one, and therefore especially unfavorable to a country having a scanty rainfall, and in which so large a proportion of the staple is grown on upland soils. Among these the heavy black-prairie soils, so highly productive in favorable seasons, are notoriously the first to suffer from drought. It is probable that in ordinary seasons the average product per acre in Texas would approach more nearly that of Mississippi or South Carolina.

A discussion of the returns shows that 52 per cent. of the cotton product of Texas is grown in the northeastern portion of the state, north of the thirty-second parallel and east of the ninety-eighth meridian, and that within this region the production is highest in the counties adjoining Red river, the product averaging 0.54 bale per acre. South of the thirty-second parallel the average yield is 0.34 bale per acre. The coast counties produce but little cotton; inland, between Red river and San Antonio, about 35 per cent. of the total product is grown on black-

a The "central basin" includes the valleys of the Cumberland, Duck, and Elk rivers, with tributaries.

prairie land, the average product per acre on such land being (in 1879) 0.34 bale per acre. A comparison of the returns of the present census with those of the preceding one shows that within the last decade the region of cotton production has extended westward 75 miles. On the south but very little cotton is grown south and west of the Nueces river.

Compared to the area of fertile lands susceptible of cotton culture, the present cotton acreage of Texas is almost insignificant.

The cases of the two *Carolinas* with respect to cotton production are nearly alike, and may as well be considered together. In both states the average cotton product per acre is high as compared with that of Georgia and Alabama, and in the case of North Carolina approaches that of Mississippi itself. Without entering into details on the subject of the distribution of cotton production in these states, it may be broadly stated that the culture of cotton is reported to have greatly extended of late, even up the slopes of the Blue Ridge itself. Among the causes leading to this gratifying result reports received show that the use of fertilizers, and, with it, better methods of culture, are foremost. In other words, these two members of the original union of thirteen have been the first to place cotton culture upon a permanent foundation by adopting a system of regular returns to the soil; and the high product per acre, as compared with Georgia and Alabama on the one hand and with Mississippi on the other, exhibits tellingly the tide-wave advancing westward, the ebb of the first native fertility in Alabama and Florida, the rising tide of restored productiveness in the Carolinas, with Georgia on the westward slope of the wave, on which it is rising and showing distinctly a higher product per acre in its eastern than in its western portion, where the use of fertilizers is much less extended.

2.—THE BORDER COTTON STATES.

The concentration of cotton culture upon the most fertile lands, already so apparent in Tennessee, becomes even more so in *Missouri*, the most northerly region of large-scale cotton production. It appears from Table III that Missouri stands at the head of the list for cotton product per acre cultivated in that crop, and it seems singular that this should be the case at the extreme northern limit of cotton culture; but the anomaly disappears when we locate the area of production, and it becomes apparent that it embraces almost exclusively the highly fertile lowlands lying at the head of the great "Saint Francis bottom", in the southeastern corner of the state. Their product per acre must therefore be compared with that of others of a similar character, *e. g.*, that of the Yazoo bottom; here, as is partly shown in Table III, the average product ranges between 0.80 and 0.88 of a bale per acre, to offset the 0.66 to 0.75 shown by the Missouri cotton area. Assuming the soils to be similar in average fertility in either region, the difference is manifestly due to the comparatively short season for the development of the cotton-plant in the latitude of the Missouri cotton region; and for the same reason cotton is there grown only on those lands whose high fertility insures the most rapid development. Taking these points into consideration, the product per acre seems high, owing, perhaps, to careful cultivation by white labor.

The cotton production of *Kentucky* pertains, in the main, to what has been appropriately styled the "penumbral" region of that industry. The bulk is produced in the counties lying adjacent to western Tennessee and to the Mississippi river, the latter embracing portions of the rich bottom, with an average product per acre of from 0.48 to 0.56 of a bale. Eastward the cotton is grown in small patches, mostly for home consumption. Such small tracts being well cultivated, the product per acre is comparatively high, even so as to reach the average of the counties bordering on the Mississippi river, doubtless through the use of manure.

In *Virginia* the cotton-producing region is confined to ten counties lying in the southeastern portion of the state, adjacent to North Carolina, and corresponding in their surface features and soils to the chief cotton-producing portion of the latter state. Accordingly the average product per acre of both states is the same, viz, 0.44 bale or 621 pounds of seed-cotton. A comparison with the returns of the census of 1870 shows a material increase of area as well as of total production of cotton in Virginia within the last ten years, as cotton was then produced in fifteen counties, with a reported product of 183 bales, as against 19,595 bales now shown from ten counties. The change indicates a tendency to the concentration of cotton culture in the southeastern portion of the state.

In the *Indian territory* the area of cotton production extends as far north as Tahlequah, in the Cherokee nation, and a few miles north of Muscogee, Creek nation; but the great bulk of the crop is produced south of the Canadian river, and in the Red River region from the Arkansas line as far west as Caddo, on the Missouri, Kansas and Texas railroad.

In the case of *California* no cotton was reported by the enumerators, but a special examination showed that cotton was grown during the census year in one locality, viz, on the bottom lands of the Merced river, to the extent shown in the table, the yield having been about a 400-pound bale per acre. The staple has at various times, however, been successfully grown in localities scattered throughout the Sacramento and San Joaquin valleys; but the limitation of the local market, and the great distance from the centers of manufacture, has thus far restricted production. The culture is, however, on the increase, since not only the excellence of the staple, but other natural causes, more specially referred to in the report on the state, seem to point to it as a promising industry in the future.

In *Arizona* successful experiments in cotton culture have been made, but not as yet to the extent of marketing the product. The perennial character which the plant assumes there, as well as in southern California, may ultimately turn the balance in favor of its cultivation.

MEASUREMENTS OF COTTON FIBER,

MADE UNDER DIRECTION OF

JOHN M. ORDWAY,

PROFESSOR OF METALLURGY AND INDUSTRIAL CHEMISTRY AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY, BOSTON.

MEASUREMENTS OF COTTON FIBER.

[NOTE.—The cotton samples of which measurements have been made were received in response to a circular sent out by the Census Office, through the special agents in charge of the subject of cotton production in the several states, to the same persons who had responded to the schedule questions regarding cotton culture. It was requested that one or several good average bolls should be sent with their seed-cotton still adherent; that the variety of the cotton should be stated, as well as the kind of soil on which it had been grown; whether manure has been used, and if so, what kind, and how much; whether the land was fresh or had been cultivated for some length of time, etc.

The extent of the response made is shown in the tables. Four hundred and fifty samples were received in time for the measurements, the proper means and appliances for which were devised by Professor Ordway and used under his personal supervision. Details regarding these, as well as the difficulties encountered, are given by him in the subjoined communication. A brief discussion of the results is added by the editor.

It is to be regretted that, in consequence of a misunderstanding, the state of Tennessee is but very scantily represented among the samples examined.—E. W. H.]

Professor EUGENE W. HILGARD:

DEAR SIR: For making trials of the *length* of cotton fibers we used at first a microscope with a "mechanical stage", whose right and left sliding-piece had been graduated and furnished with a vernier, so as to read to hundredths of a millimeter. The single fiber was spread out straight on a glass slide with the help of a camel's-hair pencil wet with water, and it was then covered with another strip of thin glass having an up and down line ruled in the middle of its length. This cross-line was needed to divide the fiber, so that half of the length could be taken at a time, as the stage allowed a motion of only about 20 millimeters at once.

It requires patience and practice to straighten the fibers properly, and absolute exactness is hardly attainable. After acquiring some experience in handling the fibers, the young ladies, who performed most of the work, found it possible to make pretty nice determinations by direct measurement with a pair of dividers and a scale graduated to twentieths of a millimeter. So a part of the lengths were obtained with the microscope and a part by the direct method.

Most of the samples had not been picked or ginned, and so, in most cases, the fibers were detached directly from the seed at the time of trial.

In determining the *widths* (*a*) several fibers at a time were compressed dry and measured in different parts with a Jackson eye-piece micrometer, the value of the divisions, for the one-fifth inch objective used, being determined by reference to a standard stage micrometer made by Rogers, of the Harvard College observatory. The figures of width given in the table are averages of four fibers, each measured in five places.

Width alone does not indicate the fineness of the flattened cells, and tensile strength ought, in strictness, to be referred to the area of the cross-section. I therefore desired very much to measure also the thickness of the fibers, but hitherto I have been unable to get an apparatus for untwisting the fibers under the microscope, and without such an apparatus it seems hardly possible to see and determine the natural thickness. It is exceedingly difficult to make exactly transverse sections of such fibers as cotton, and if sections are made with the help of paraffine or gelatine the original size is not likely to remain unaltered. The stage twister would probably enable one to find the comparative amount of twist in fibers, and no doubt the practical value of cotton depends, in no small measure, on the number of turns per millimeter.

a It should be understood that the fiber of cotton is, when young, a thin, hollow cylinder filled with liquid. In ripening the liquid disappears and the cylinder contracts into a flat band, with thickened edges (looking in cross-section somewhat like two commas placed points together), and assumes more or less of a twist. It is this peculiar form that allows even very short cotton fiber to be easily spun, a good deal depending upon the extent of the twist, the width, and the form of the upturned edges.—E. W. H.

I could devise no means of making trustworthy, comparable determinations of *tensile strength* except with single fibers. As the breaking strain of a single fiber is at best but a very small force, rarely exceeding 12 grams, after a due consideration of possible methods it seemed best to resort to the simplest, that of direct weighting. But to get clamps light enough for such fine work is not so very easy. I made very small forceps of hickory wood, with a hinge of thin brass, secured by brass hoops, the points being covered with thin wash-leather, glued on. The grip was tightened by a brass link with a wooden wedge. For the upper stationary holder a wooden clothes-pin with a strong spring was whittled to a narrow point and the tips were covered with wash-leather. The fiber being securely clamped, it was hung vertically, and to the spring hinge of the lower clamp was hooked a scale-pan of thin cardboard with hangers of fine wire. Weights were very carefully added, a tenth of a gram at a time, till the fiber broke. No account was made of such ruptures with a light strain as showed that the fiber was cracked or otherwise defective.

In finding the *relative amounts of fiber and seeds* five average seeds were weighed, with their coats, in a balance sensitive to tenths of a milligram; the fibers were then pulled off, and the remaining furzy or smooth seeds were weighed. Of course the seeds were taken as they came, air-dried. They were mostly about a year old, and the kernels were not as yet very much shrunken.

Respectfully yours.

JOHN M. ORDWAY.

EXPLANATION OF TABLES.

In the following tables the first column of figures shows the reference numbers of the specimens, running consecutively through the states and counties, arranged in alphabetical order.

The arrangement of specimens in each state is, as far as possible, according to soil classification; in some instances, however, the nature of the land on which certain samples of cotton were grown was either not given at all by the sender or was stated in an indefinite manner by reference to a soil number described by him in the county reports. Fertilizers were probably used on many of the soils in the states east of Mississippi, though not generally reported.

Samples collected at different times of the season may exhibit differences independent of the nature of the soil, especially when taken late, under the possible influence of frosts and early rains.

The measurements are recorded in both the English and metric measures and weights. The first and sixth columns give the average length of five fibers; the minimum and maximum are shown by the columns on the right. The second and ninth columns contain the average width of four fibers, measured each in five places, making the average of twenty measurements. These measurements are given in thousandths of an inch and in millimeters. The minimum and maximum of the twenty observations are also given in millimeters.

The third and twelfth columns represent the weight in grains and grams required to break single fibers. The number in each case is the average of either ten or five good results, doubtful trials not being recorded. Minima and maxima are given at the right.

The fourth and fifteenth columns express the weight in grains and grams of five seeds with the lint on.

The fifth column makes known the percentage of lint which was picked from the five gross seeds.

ALABAMA.

Number of sample.	Character of soil.	County.	Cotton variety.	Sender.
	SANDY LANDS.			
6	Sandy upland, unmanured	Bullock		W. M. Stakely
12	Sandy upland	Clarke		S. Forwood
14	Sandy upland, unmanured	Coffee		M. G. Stoudenmer
10	Sandy, gravelly upland	Clarke		S. Forwood
27	Fine sandy land	Marion		M. Nesmith
46 a	Gray sandy soil, yellow-pine land, fertilized	Wilcox		Felix Tait
46 b	Gray sandy soil, yellow-pine or scrub post-oak land, fertilized	do		do
48 a	Coarsest sandy pine upland, new, no fertilizers	Washington		R. M. Campbell
48 b	Old gray soil, Vivion place, no fertilizers	do		do
48 d	Piny woods, poor sandy land, no fertilizers	do		do
48 c	Piny woods, poor sandy land, with yard manure	do		do
48 e	Piny woods, gray sandy land, with composts	do		do
1	Gray sandy lands (flats of creeks), poor	Barbour		H. D. Clayton
15	Light sandy soil	Crenshaw		G. W. Thagard
9	Black-jack land	Bullock	Hunt and Dixon	M. L. Stinson
17	Gray "barrens" land	Jackson		W. F. Hunt
24	Fine sandy "barrens" land, with 200 pounds of guano per acre	Madison		T. B. Kelly
30	Gray gravelly upland, manured	Saint Clair		J. W. Inzer
31	do	do		do
28	Black sandy land	Marion		M. Nesmith
11	Sandy land, clay subsoil	Clarke		S. Forwood
13	Gray gravelly land	Cleburne		J. H. Bell
21	Gray gravelly land, lightly manured	Lee		J. T. Harris
34	Gray gravelly land, manured	Tallapoosa		D. A. G. Ross
	HEAVY AND CALCAREOUS LANDS.			
7	Black land, unmanured	Bullock		W. M. Stakely
26	Black and loose soil	Marengo	Early bolls	W. A. Stickney
49 a	Stiff prairie soil	Washington		R. W. Campbell
49 b	Black prairie or lime land, loose and mellow	do		do
49 c	Red prairie soil	do		do
47 a	Slough prairie soil	Wilcox		Felix Tait
47 b	Ridge prairie soil	do		do
3	Light gray lime lands, Cowikee uplands	Barbour		H. D. Clayton
	BOTTOM LANDS.			
44	Brown loam of creek bottoms	Winston		F. C. Burdick
33	Bottom lands	Talladega		H. M. Bart
5	Lowland	Barbour		H. Hawkins
4	Best Cowikee bottom land	do		H. D. Clayton
36	Bottom land, fertilized	Tallapoosa		D. A. G. Ross
37	Stiff river bottom land	Tuscaloosa	Long staple	J. R. Maxwell
39	do	do	Ramesses	do
40	do	do	Golden Prolific	do
50	Big Black river bottom land	Washington		R. M. Campbell
45 b	First quality Alabama river bottom land	Wilcox		Felix Tait
29	Swamp or marsh land	Marion		M. Nesmith
	RED AND CLAY LANDS.			
8	Clay uplands, unmanured	Bullock	Hunt and Dixon	M. L. Stinson
22	Red land	Lee		J. T. Harris
25 a	Post-oak or mulatto soil, "cedar soil"	Marengo		W. A. Stickney
25 b	do	do		do
35	Red land, fertilized	Tallapoosa		D. A. G. Ross
38	Red clay upland	Tuscaloosa	Ramesses	J. R. Maxwell
41	do	do	Golden Prolific	do
45 a	Red land, oak, hickory, and short-leaf pine	Wilcox		Felix Tait
2	Coarse, red sandy land, clay subsoil	Barbour		H. D. Clayton
16	Red-clay lands	Jackson		W. F. Hunt
19	Table-lands, newly cultivated	Lauderdale		J. H. Simpson
18	Table-lands, old lands cultivated 75 years	do		do
20	Table-lands, fine red, sandy, gravelly soil	do	First picking	J. W. Morgan
23	Red limestone land, partly manured	Madison		T. B. Kelly

ALABAMA.

LENGTH, IN INCHES.	WIDTH, IN $\frac{1}{1000}$ OF AN INCH.	BREAKING WEIGHT, IN GRAINS.	Weight of 5 seed with the lint, in grains.	Percentage of lint.	LENGTH, IN MILLIMETERS.			WIDTH, IN $\frac{1}{1000}$ OF A MILLIMETER.			BREAKING WEIGHT, IN GRAMS.			Weight of 5 seed with the lint, in grams.	Number of sample.
Average of 4 fibers.	Average of 4 fibers.	Average of 10 or 15 results.			Average of 5 fibers.	Minimum.	Maximum.	Average of 4 fibers.	Minimum.	Maximum.	Average of 5 or 10 results.	Minimum.	Maximum.		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
1.043	0.791	148.8	....	....	26.51	21.9	20.8	20.1	10.0	30.0	9.64	7.9	11.5	....	6
0.847	1.004	132.3	11.11	31.25	21.52	21.0	22.1	25.5	10.6	33.3	8.57	7.4	10.6	0.720	12
1.004	0.906	103.4	13.66	35.59	25.50	23.7	27.2	23.0	16.6	26.6	6.70	5.9	7.6	0.935	14
1.214	1.035	132.4	11.42	30.40	30.84	25.1	32.7	26.3	16.6	33.3	8.58	7.2	12.6	0.740	10
1.015	0.744	196.1	14.89	32.12	25.80	21.2	29.3	18.9	13.3	28.3	10.07	8.4	10.6	0.965	27
1.266	0.906	142.3	10.57	28.47	32.16	25.7	37.5	23.0	16.6	26.6	9.22	7.3	13.6	0.685	46 *a*
1.057	0.878	172.5	12.42	31.08	26.84	25.3	29.2	22.3	16.6	26.6	11.18	8.9	14.7	0.805	46 *b*
0.925	1.031	192.0	13.74	33.14	23.50	20.6	27.8	26.2	20.0	33.3	12.44	8.8	7.4	0.890	48 *a*
0.931	1.086	123.8	9.41	36.06	23.64	22.4	26.1	27.6	23.3	30.0	8.02	6.3	11.2	0.610	48 *b*
0.789	0.827	143.4	9.49	35.77	20.04	19.0	20.9	21.0	13.3	26.6	9.29	8.6	10.1	0.615	48 *d*
0.922	0.819	114.2	13.04	26.62	23.42	20.9	26.1	20.8	16.6	23.3	7.40	5.7	9.2	0.845	48 *c*
1.023	0.866	147.5	12.35	31.87	26.00	25.0	26.7	22.0	16.6	26.6	9.56	7.7	13.8	0.800	48 *e*
0.990	0.890	142.6	11.73	38.16	25.14	22.9	29.3	22.6	20.0	26.6	9.21	8.0	11.2	0.760	1
1.048	0.760	149.4	13.97	34.80	26.62	26.0	28.6	19.3	13.3	23.3	7.68	7.1	9.0	0.905	15
0.963	0.839	115.8	10.65	34.78	24.46	24.1	25.3	21.3	13.3	26.6	9.45	7.7	11.7	0.690	9
0.996	0.768	145.5	13.50	31.48	25.30	23.7	27.5	19.5	16.6	26.6	9.43	7.7	12.0	0.875	17
1.083	0.878	142.3	11.73	34.87	27.52	25.2	34.6	22.3	16.6	26.6	9.22	7.4	12.7	0.760	24
1.076	1.153	152.6	....	....	27.34	26.6	28.8	29.3	20.0	43.3	9.88	8.0	10.9	......	30
1.156	1.027	184.5	12.73	35.75	29.36	26.1	34.2	26.1	30.0	46.6	8.72	5.1	11.4	0.825	31
0.984	0.882	120.1	14.43	28.87	25.00	21.5	27.1	22.4	16.6	33.3	7.78	6.1	12.0	0.935	28
0.848	0.772	140.1	12.50	30.25	21.54	19.5	23.7	19.6	16.6	26.6	9.08	7.2	11.2	0.810	11
0.966	0.764	113.0	8.26	27.10	24.54	22.4	25.8	19.4	13.3	23.3	7.33	5.2	8.9	0.535	13
0.961	0.913	140.0	10.11	36.79	24.42	22.4	29.3	23.2	10.0	33.3	9.10	6.7	12.8	0.655	21
0.864	0.913	168.1	13.73	31.46	21.94	20.8	22.9	23.2	13.3	33.3	10.89	9.6	12.5	0.890	34
1.123	0.988	127.8	....	....	28.54	25.6	31.8	25.1	16.6	30.0	8.28	6.5	12.0	....	7
1.104	0.949	115.8	14.04	28.02	28.04	27.2	29.5	24.1	16.6	26.6	7.57	6.0	8.9	0.910	26
1.178	0.862	123.2	15.90	33.49	29.94	26.4	34.1	21.9	16.6	33.3	7.98	7.1	9.5	1.030	49 *a*
1.114	0.893	122.2	14.74	30.36	28.30	26.5	32.1	22.7	10.0	30.0	7.92	7.1	9.5	0.955	49 *b*
1.023	0.961	153.1	10.96	30.30	26.00	25.1	26.7	24.4	13.3	30.0	9.92	8.1	14.3	0.710	49 *c*
1.137	0.713	144.5	12.42	36.64	28.74	25.9	30.1	18.1	10.0	26.6	9.36	7.3	11.0	0.805	47 *a*
0.917	0.768	138.3	13.35	32.37	23.30	22.0	26.1	19.5	10.0	26.6	8.96	7.1	10.4	0.865	47 *b*
0.990	0.669	121.3	12.04	34.61	25.16	22.0	26.6	17.0	10.0	23.3	7.86	6.9	9.0	0.780	3
0.943	0.811	129.5	11.50	39.60	23.95	23.8	25.8	20.6	16.6	30.0	8.30	7.1	10.0	0.745	44
0.974	1.047	130.6	11.42	31.08	24.74	22.7	25.8	26.6	20.0	33.3	8.46	7.2	12.2	0.740	33
1.075	0.925	87.3	12.27	30.82	27.31	24.6	29.0	23.5	16.6	30.0	5.66	4.4	8.2	0.705	5
1.039	0.728	138.7	14.20	36.41	26.40	25.0	28.7	18.5	13.3	23.3	8.99	7.1	10.5	0.920	4
0.958	0.626	136.4	14.04	37.36	24.34	21.0	27.1	15.9	10.0	26.6	8.84	6.8	12.1	0.910	36
1.109	0.866	124.2	11.96	32.90	28.16	26.2	29.1	22.0	16.6	26.6	8.05	6.2	12.3	0.775	37
1.039	0.937	140.4	13.58	34.66	26.40	25.0	27.9	23.8	20.0	33.3	9.10	7.6	13.3	0.880	39
1.016	1.074	208.7	10.11	41.98	25.80	22.3	29.7	27.3	16.6	36.6	13.52	10.6	17.0	0.655	40
1.301	0.740	141.1	13.19	28.65	33.06	20.4	35.6	18.8	13.3	23.3	9.14	7.7	10.9	0.855	50
1.177	0.669	156.5	11.81	35.94	25.90	24.5	28.3	17.0	10.0	26.6	10.14	8.6	14.4	0.765	45 *b*
0.990	1.051	151.4	11.03	32.86	25.14	23.0	28.7	26.7	10.0	36.6	9.81	9.2	12.3	0.715	29
1.006	0.803	123.0	14.97	30.92	25.56	23.4	27.3	20.4	13.3	26.6	7.97	6.2	9.9	0.970	8
1.007	0.724	128.6	13.35	30.64	25.58	21.5	28.3	18.4	6.6	26.6	8.51	6.8	12.6	0.865	22
0.860	1.181	118.7	11.42	35.78	21.84	20.4	23.0	30.0	23.3	40.0	7.69	6.8	10.3	0.740	25 *a*
0.920	0.906	132.7	13.58	30.00	23.38	22.3	24.6	23.0	16.6	36.6	8.60	6.7	11.8	0.880	25 *b*
1.101	0.902	162.8	15.28	31.31	27.98	26.0	32.5	22.9	16.6	26.6	10.55	8.5	14.4	0.990	35
0.961	0.748	85.3	9.49	30.08	24.40	24.0	25.7	19.0	16.6	23.3	5.53	5.0	6.6	0.615	38
1.408	0.870	124.2	12.35	38.75	35.92	31.6	39.9	22.1	16.6	26.6	8.05	6.7	9.6	0.800	41
0.945	1.308	146.1	13.19	34.50	24.02	21.8	27.2	34.0	13.3	36.6	9.47	8.2	12.1	0.855	45 *a*
0.968	0.988	100.4	10.73	30.20	24.60	21.1	27.8	25.1	20.0	33.3	6.74	5.5	7.9	0.710	2
1.175	0.791	117.3	16.76	29.03	29.78	26.8	34.2	20.1	16.6	30.0	7.60	6.2	8.7	1.085	16
0.875	1.004	197.8	10.96	34.08	22.22	19.1	25.9	25.5	16.6	30.0	12.78	10.3	15.3	0.710	19
0.872	1.016	197.8	10.96	33.80	22.14	20.0	25.1	25.8	20.0	33.3	12.82	10.9	15.3	0.710	18
1.058	0.913	139.0	12.73	32.72	26.89	25.2	29.4	23.2	13.3	36.6	9.01	7.0	12.8	0.825	20
1.045	0.799	137.8	10.96	32.40	26.54	25.6	27.8	20.3	10.0	30.0	8.93	7.3	10.4	0.710	23

ALABAMA—Continued.

Number of sample.	Character of soil.	County.	Cotton variety.	Sender.
	RED AND CLAY LANDS—continued.			
32	Red loam valley land	Talladega		H. M. Burt
42	Uplands	Winston		G. W. Hogg
43	do	do		do
	Average of all			

Longest, No. 43; shortest, No. 48 *d*. Widest, No. 45 *a*; narrowest, No. 36. Strongest, No. 40;

ARIZONA.

51	Valley lands, Hayden's Ferry	Maricopa		C. T. Hayden
52	Valley lands	Pima	Chinese	W. A. Cunningham
53	do	Yuma	Second-year plant	Lieut. J. M. E. Hyde, U. S. A.
54	Valley lands, Salt River valley			R. A. Loughridge
	Average of all			

Longest, No. 51; shortest, No. 53. Widest, No. 52;

ARKANSAS.

56	Timbered upland, sandy	Arkansas		J. H. Moore
57	Black gravelly loam	Boone		
58	Sandy loam, ridge land	do		
61	Black sandy land, flat	Crittenden		A. A. Brewer
62	Dark loam	do		do
66	Sandy upland, clay subsoil	Grant		W. W. Cleveland
59	Brown clay loam bottom land	Boone		
55	Arkansas river alluvial land	Arkansas		J. H. Moore
60	do	Conway		W. C. Stout
64	Dark sandy alluvial land	Garland	Third picking	J. J. Sumpter
65	Light sandy bottom land	do	do	do
67	Lowland	Grant		W. W. Cleveland
63	Buckshot land	Crittenden		A. A. Brewer
	Average of all			

Longest, No. 66; shortest, No. 56. Widest, No. 56; narrowest, No. 55. Strongest, No. 60;

CALIFORNIA.

82	Red gravelly bench land, National ranch	San Diego	2-year old plant	F. H. Kimball
81	Red plateau soil, 2,000 feet altitude	Napa		H. Kimball
68	Alluvial loam, alkaline	Kern	Texan smooth seeds	
69	do	do	Golden Prolific	
70	do	do	Dickson smooth seeds	
71	do	do		
72	Alluvial loam	Merced	Peeler	
73	Alluvial loam, Buckley's ranch	do	do	
74	do	do	do	
75	Alluvial loam	do	Mexican	
76	Alluvial loam, Peck's ranch	do	Dickson	
77	Alluvial loam, Wilcox place, Mariposa creek	do	do	
78	do	do	Alabama	
79	Alluvial loam, Hopeton	do	Dickson	W. A. Grado
80	Alluvial loam, Mariposa creek	do		J. L. Strong
83	Alluvial loam	Tulare	Seed from Saint Louis prize bale	do
84	do	do	Excelsior	do
85	do	do	Matagorda	do
86	Alluvial loam, Mussel Slough	do		
	Average of all			

Longest, No. 86; shortest, No. 70. Widest, No. 70; narrowest, No. 86. Strongest, No. 79;

ALABAMA—Continued.

Length, in inches. Average of 4 fibers.	Width, in 1/1000 of an inch. Average of 4 fibers.	Breaking weight, in grains. Average of 10 or 15 results.	Weight of 5 seed with the lint, in grains.	Percentage of lint.	Length, in millimeters. Average of 5 fibers.	Length, in millimeters. Minimum.	Length, in millimeters. Maximum.	Width, in 1/1000 of a millimeter. Average of 4 fibers.	Width, in 1/1000 of a millimeter. Minimum.	Width, in 1/1000 of a millimeter. Maximum.	Breaking weight, in grams. Average of 5 or 10 results.	Breaking weight, in grams. Minimum.	Breaking weight, in grams. Maximum.	Weight of 5 seed with the lint, in grams.	Number of sample.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
0.883	0.858	130.5	11.88	33.11	22.42	20.4	25.2	21.8	16.6	26.6	8.85	7.9	10.4	0.770	32
1.049	0.808	111.3	12.73	33.94	26.64	25.0	35.3	22.8	16.6	26.6	7.21	6.3	8.5	0.825	42
1.427	1.279	144.8	11.11	37.50	36.25	30.3	47.5	32.5	20.0	46.6	9.38	7.2	12.8	0.720	43
1.027	0.896	137.8	12.38	32.90	26.09	19.0	47.5	22.75	6.6	46.6	8.93	4.4	17.4	0.803	

weakest, No. 38. Heaviest, No. 16; lightest, No. 13. Most lint, No. 40; least lint, No. 48 c.

ARIZONA.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Number of sample.
1.192	0.965	140.7	....	....	30.28	28.3	32.9	24.5	17.4	33.9	9.12	7.9	9.7	....	51
0.904	1.103	143.7	....	....	22.96	17.7	27.5	28.2	17.4	35.6	9.30	8.4	11.8	....	52
0.745	0.972	138.6	11.50	24.16	18.93	16.3	22.9	24.7	17.4	31.3	8.98	7.8	10.7	0.745	53
1.034	0.779	115.1	12.42	31.67	26.28	25.0	28.7	19.8	13.3	26.6	7.46	6.8	8.2	0.805	54
0.969	0.957	133.7	11.96	27.91	24.61	16.3	32.9	24.3	13.3	35.6	8.71	6.8	11.8	0.775	

narrowest, No. 54. Weakest, No 54; strongest, No. 52.

ARKANSAS.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Number of sample.
0.965	1.154	132.3	11.88	31.17	24.52	23.0	26.0	29.3	23.3	46.6	8.59	7.2	9.8	0.770	56
0.983	1.008	103.5	14.27	29.19	24.92	19.6	29.8	25.6	16.6	30.0	6.71	6.2	9.2	0.925	57
1.026	0.984	134.3	13.12	38.23	26.06	23.8	28.3	25.0	16.6	30.0	8.70	7.1	11.8	0.850	58
1.088	0.795	121.0	9.42	32.78	27.65	25.8	28.7	20.2	10.0	30.0	7.84	6.2	10.0	0.610	61
0.972	0.803	132.9	13.19	33.92	24.69	26.0	31.0	20.4	10.0	30.0	8.61	6.8	11.0	0.855	62
1.143	0.807	128.4	11.57	37.33	29.04	28.2	30.6	20.5	16.6	23.3	8.32	7.4	9.4	0.750	66
1.039	0.854	117.6	14.81	28.64	26.40	20.8	31.4	21.7	13.3	30.0	7.62	6.7	9.9	0.960	59
1.050	0.732	131.8	14.35	30.10	27.30	24.0	31.8	18.6	13.6	26.6	8.54	7.5	10.5	0.930	55
1.031	1.035	185.2	22.14	35.89	26.21	23.0	28.8	26.3	13.3	36.6	12.00	10.1	16.6	1.435	60
1.124	0.989	122.2	11.19	35.86	28.54	24.3	30.9	25.1	20.0	30.0	7.92	7.2	9.8	0.725	64
1.033	1.004	162.1	13.27	29.05	26.23	23.6	28.8	25.5	20.0	30.0	10.50	9.6	12.3	0.860	65
0.998	0.787	142.6	11.73	33.55	25.35	23.8	27.8	20.0	16.6	30.0	9.24	8.5	11.8	0.700	67
0.992	0.996	125.0	12.81	30.72	25.13	23.7	26.7	25.8	20.0	33.0	8.10	7.5	8.6	0.830	63
1.036	0.917	134.7	13.86	32.85	26.31	19.6	31.8	23.3	10.0	46.6	8.67	6.2	16.6	0.860	

weakest, No. 57. Heaviest, No. 60; lightest, No. 61. Most lint, No. 58; least lint, No. 59.

CALIFORNIA.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Number of sample.
0.902	0.906	174.9	14.35	39.78	22.01	20.4	25.9	28.0	17.4	33.0	11.83	9.5	14.1	0.930	82
1.307	0.984	163.6	9.67	33.87	33.20	26.8	37.7	25.0	17.4	29.6	10.60	8.6	12.4	0.620	81
0.908	0.957	161.7	15.13	35.20	25.30	21.4	28.9	24.8	17.4	34.8	10.48	9.9	11.3	0.890	68
0.961	1.016	122.8	13.19	35.08	24.40	22.2	27.9	25.8	17.4	32.2	7.96	7.5	8.7	0.855	69
0.827	1.083	125.3	10.03	28.46	21.01	18.2	25.0	27.5	18.4	43.5	8.12	7.0	9.7	0.650	70
1.122	0.925	145.1	12.96	35.71	28.50	22.4	32.6	23.5	20.0	30.0	9.40	7.7	11.3	0.840	71
0.879	0.854	112.9	....	....	22.32	16.8	28.0	21.7	11.3	26.1	7.32	6.7	8.4	....	72
0.978	0.913	132.7	....	....	24.83	21.2	29.4	23.2	17.4	29.6	8.60	7.6	9.8	....	73
1.431	0.953	172.5	15.82	23.90	36.35	32.6	39.3	24.2	16.5	35.6	11.16	9.0	13.5	1.025	74
0.943	0.996	168.2	....	....	23.96	17.5	29.6	25.3	19.2	29.6	10.90	8.2	13.9	....	75
0.965	1.059	171.9	9.96	32.56	24.52	22.4	27.7	26.9	17.4	34.8	11.14	10.1	12.7	0.645	76
0.853	0.957	163.0	10.72	33.81	21.66	18.4	28.3	24.3	13.0	33.0	10.56	9.0	12.2	0.695	77
1.114	0.906	110.8	11.19	23.45	28.30	24.3	31.3	23.0	13.0	33.0	7.18	5.6	9.4	0.725	78
1.053	1.004	175.6	....	....	26.75	22.7	32.5	25.5	17.4	33.0	11.38	8.8	13.9	....	79
0.969	0.909	151.8	....	....	24.62	22.6	26.5	20.1	16.6	23.3	9.84	7.7	11.3	....	80
1.154	0.779	121.0	13.97	34.81	29.31	27.1	31.0	19.8	13.3	26.6	7.84	7.0	10.0	0.905	83
1.182	0.858	142.3	16.28	33.64	30.02	26.5	32.5	21.8	16.6	26.6	9.22	8.8	10.2	1.055	84
1.143	0.846	112.6	12.58	30.06	29.04	27.0	32.5	21.5	13.3	26.6	7.30	6.5	8.2	0.815	85
1.669	0.756	118.5	10.26	27.81	42.38	40.0	44.0	19.2	16.6	23.3	7.68	6.2	10.0	0.665	86
1.079	0.921	144.6	12.58	32.01	27.40	16.8	44.0	23.4	11.3	43.5	9.37	5.6	14.1	0.815	

weakest, No. 78. Heaviest, No. 84; lightest, No. 81. Most cotton, No. 82; least cotton, No. 78.

FLORIDA.

Number of sample.	Character of soil.	County.	Cotton variety.	Sender.
87 *a*	Old pine lands, sandy, manured with 300 pounds of phosphate per acre	Alachua	Sea island	P. B. Turpin
87 *b*	Old pine lands, sandy, not manured	do	do	do
88 *a*	do	do	do	do
88 *b*	Old pine lands, sandy, manured with 12 bushels of cottonseed per acre	do	do	
90 *a*	Sandy pine lands, manured	Clay	do	L. D. Wall
90 *b*	Sandy pine lands, unmanured	do	do	do
89 *a*	Sandy pine lands, clay subsoil, commercial fertilizers	do	do	do
89 *c*	Sandy pine lands, clay subsoil, barn-yard manure	do	do	do
89 *b*	Sandy pine lands, clay subsoil, no manure	do	do	do
92 *c*	Sandy, "pepper and salt" land, no manure	do	do	do
93	Sandy, gray soil, new land	Columbia	do	G. B. Smithson
94	Sandy, gray soil, cultivated 30 years, no manure	do	Smooth seeds	do
95	Sandy, gray soil, cultivated 30 years, manured	do	do	do
96 *a*	Light gray soil, with clay subsoil, old land	do	Worth 35 cents per pound	do
96 *b*	do	do	Worth 25 cents per pound	do
96 *c*	do	do	Worth 7 cents per pound	do
96 *d*	do	do	Worth 5½ cents per pound	do
97	Light gray soil, old land	do	"Rattoon" or "Stand over" cotton of two years' growth. Sprouts from root and produces second crop.	do
101	Rolling pine land, fine sandy loam, clay subsoil	do		T. R. Collins
102	Yellow sandy soil, clay subsoil	do		do
98	do	do		J. D. Zackey
99	do	do		do
107	Common pine land, rather poor, lightly fertilized	Hillsborough	Sea island	W. F. White
109 *b*	Gravelly pine land	Marion	do	I. S. Binnecker
110 *a*	New pine land	do	do	do
111	"Salt and pepper" sandy land	do	do	do
113 *a*	Coarse gravelly soil, not manured	Suwannee		G. E. Deale
113 *b*	Light gray, sandy, not manured	do	King	do
114 *a*	Level piny woods, sandy	Volusia	Coarse or old cotton	D. J. McBride
114 *b*	Level piny woods	do	Bolter, or finest	do
115	Light brown soil	do	Sea island	W. A. McBride
116	Dark brown soil	do	do	D. J. McBride
117	Light sandy soil	do	do	William Arnett
92 *a*	Pine land, clay subsoil	Clay		O. Budington
92 *b*	do	do		do
91	Hummock land	do		L. D. Wall
103	do	Columbia		T. R. Collins
109 *a*	Light sandy hummock land	Marion		I. S. Binnecker
110 *b*	Red hummock land	do		do
100		Columbia		J. D. Zackey
104	Sandy upland	Gadsden	Short staple	Jesse Wood
105	Clay upland	do	do	do
112	Mahogany land, manured lightly	Santa Rosa		J. M. McGehee
106	Red clay hummock	Gadsden		Jesse Wood
108	Low hummock land	Hillsborough	"Florida Cecil hemp"	W. F. White
	Average of all			

Longest, No. 96 *d*; shortest, No. 104. Widest, No. 100; narrowest, No. 106. Strongest, No. 98;

GEORGIA.

Number of sample.	Character of soil.	County.	Cotton variety.	Sender.
118	Sandy, long-leaf pine and wire-grass land	Appling	First boll to open	Benjamin Miliken
122	Poor sandy upland soil, no manure	Burke	Herlong	W. B. Jones & Sons
123	Sandy upland soil	do	Jones upland, long staple	do
124	do	do	Jones upland, long staple, prolific.	do
125	Sandy coast lands	Camden		
144	Sandy, pine, and wire-grass land	Lowndes		P. T. Graus
146	Sandy pine land, not manured	Muscogee		J. C. Cook
156	Old gray sandy land, cultivated 40 years, manured	Stewart	Bahamian bolls at joints; 48 bolls a pound of lint, 5 locks per boll.	J. B. Latimer

FLORIDA.

LENGTH, IN INCHES. Average of 4 fibers.	WIDTH, IN 1/1000 OF AN INCH. Average of 4 fibers.	BREAKING WEIGHT, IN GRAINS. Average of 10 or 15 results.	Weight of 5 seed with the lint, in grains.	Percentage of lint.	LENGTH, IN MILLIMETERS. Average of 5 fibers.	LENGTH, IN MILLIMETERS. Minimum.	LENGTH, IN MILLIMETERS. Maximum.	WIDTH, IN 1/1000 OF A MILLIMETER. Average of 4 fibers.	WIDTH, IN 1/1000 OF A MILLIMETER. Minimum.	WIDTH, IN 1/1000 OF A MILLIMETER. Maximum.	BREAKING WEIGHT, IN GRAMS. Average of 5 or 10 results.	BREAKING WEIGHT, IN GRAMS. Minimum.	BREAKING WEIGHT, IN GRAMS. Maximum.	Weight of 5 seed with the lint, in grams.	Number of sample.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
1.554	0.732	89.0	12.81	31.32	30.48	36.8	43.2	18.6	13.3	23.3	5.64	5.4	6.0	0.830	87 *a*
1.514	0.590	99.4	15.20	29.95	38.48	33.4	42.0	15.0	10.0	16.6	6.44	4.6	7.3	0.985	87 *b*
1.441	0.791	168.2	12.27	32.07	36.60	33.4	37.9	20.1	13.3	23.3	10.90	9.7	11.7	0.795	88 *a*
1.268	0.890	84.3	12.19	25.82	32.22	29.3	34.6	22.6	16.6	26.6	5.46	4.7	6.6	0.790	88 *b*
1.014	0.909	115.1	12.47	29.01	25.76	22.9	29.6	23.1	16.6	30.0	7.46	7.2	8.3	0.810	90 *a*
1.046	0.724	123.4	13.03	26.62	26.58	22.7	32.6	18.4	13.3	26.6	8.00	6.7	9.0	0.845	90 *b*
1.664	0.831	103.1	12.88	31.73	42.28	46.8	49.3	21.1	16.6	30.0	6.68	6.2	7.0	0.835	89 *a*
1.246	0.866	151.6	15.20	32.48	31.66	29.9	35.0	22.0	13.3	30.0	9.82	8.7	11.4	0.985	89 *c*
1.189	0.827	147.9	14.03	28.02	30.20	27.7	32.2	21.0	16.6	28.3	9.58	9.2	10.4	0.910	89 *b*
1.110	0.752	157.4	21.14	23.35	28.20	26.1	30.1	19.1	16.6	26.6	10.20	8.7	11.0	1.370	92 *c*
1.552	0.929	132.3	14.43	32.08	39.36	36.5	43.0	23.6	16.6	30.0	8.57	6.5	10.6	0.935	93
1.594	0.799	118.2	14.28	16.75	40.50	36.0	47.0	20.3	13.3	30.0	7.66	6.9	9.9	0.925	94
1.586	0.732	120.0	13.12	30.58	40.28	30.2	47.3	18.6	16.6	30.0	8.36	7.7	9.8	0.850	95
1.609	0.933	118.2	....	....	40.86	36.4	52.5	23.7	16.6	26.6	7.66	6.5	8.4	....	96 *a*
1.576	0.810	140.1	....	....	40.04	37.8	42.7	20.8	13.3	23.3	9.08	7.8	10.4	....	96 *b*
1.194	0.728	106.1	....	....	30.32	30.0	35.6	18.5	13.3	23.3	6.88	6.4	7.1	....	96 *c*
1.910	0.547	105.2	....	....	48.52	47.6	49.5	13.9	10.0	16.6	6.66	5.3	8.1	....	96 *d*
1.367	0.917	126.5	14.12	24.04	34.74	32.0	36.2	23.3	20.0	30.0	8.20	6.9	8.9	0.915	97
1.368	0.747	135.8	12.81	27.71	34.74	33.7	36.3	19.0	13.3	30.0	8.80	8.5	10.4	0.830	101
1.493	0.811	135.5	10.80	35.71	37.92	34.1	40.4	20.6	16.6	26.6	8.78	8.0	10.4	0.700	102
0.980	0.977	175.0	15.12	35.71	24.90	22.0	28.5	24.8	20.0	33.3	11.34	10.1	13.9	0.980	98
1.080	0.866	117.3	13.43	32.18	27.48	25.5	29.5	22.0	16.6	26.6	7:60	7.1	7.9	0.870	99
1.340	0.846	98.5	9.03	30.76	34.05	31.2	39.2	21.5	16.6	23.3	6.38	6.2	6.5	0.585	107
1.673	0.701	162.7	10.42	30.37	42.50	39.5	47.2	17.8	13.3	23.3	10.54	9.2	13.0	0.675	109 *b*
1.681	0.787	101.8	10.11	11.45	42.70	37.5	51.3	20.0	16.6	26.6	6.60	5.0	8.0	0.655	110 *a*
1.429	0.689	125.9	14.35	29.03	36.30	34.5	38.5	17.5	13.3	20.0	8.16	7.2	9.2	0.930	111
1.868	0.677	80.1	13.80	27.78	47.44	39.7	56.5	17.2	10.0	23.2	5.24	4.2	6.4	0.900	113 *a*
1.596	0.886	117.6	12.81	25.30	40.54	35.8	46.8	22.5	13.3	23.3	7.62	7.2	8.5	0.830	113 *b*
1.700	0.701	86.7	10.49	30.88	45.70	39.9	49.0	17.8	13.3	23.3	5.62	5.3	5.9	0.680	114 *a*
1.739	0.799	102.5	11.88	28.57	44.18	39.2	50.2	20.3	16.6	23.3	6.64	6.0	7.4	0.770	114 *b*
1.489	0.831	137.7	13.11	25.88	37.84	32.6	41.3	21.1	13.3	26.6	8.92	6.4	15.7	0.850	115
1.381	0.811	113.1	11.42	19.59	35.08	30.2	39.9	20.6	13.3	26.7	7.33	6.0	12.0	0.740	116
1.527	0.819	138.0	12.58	33.12	38.80	37.5	40.5	20.8	13.3	26.6	8.94	7.3	10.6	0.815	117
1.609	0.728	124.4	13.50	25.73	40.88	37.4	45.6	18.5	13.3	23.3	8.06	7.5	8.4	0.875	92 *a*
1.187	0.630	115.7	11.96	29.04	30.16	28.3	32.0	16.0	13.3	20.0	7.50	5.9	8.9	0.775	92 *b*
1.372	0.900	....	....	....	34.84	28.8	38.7	23.1	16.6	26.6	....	....	....	....	91
1.344	0.661	120.0	13.04	28.90	34.14	30.9	37.1	16.8	13.3	20.0	7.78	7.1	8.7	0.845	103
1.118	0.732	138.9	11.50	20.80	28.40	25.9	30.5	18.6	13.3	23.3	9.00	8.6	9.5	0.745	109 *a*
1.598	0.740	120.1	10.80	36.43	40.60	36.2	43.8	18.7	13.3	23.3	7.78	7.2	8.6	0.700	110 *b*
1.141	1.213	112.7	14.12	35.51	28.98	24.0	32.1	30.8	23.3	33.3	7.30	6.4	8.2	0.915	100
0.854	0.839	166.4	10.49	36.76	21.70	20.9	23.3	21.3	13.3	36.3	10.78	9.1	12.7	0.680	104
0.907	0.980	155.4	10.43	36.56	23.04	19.0	27.0	24.9	16.6	33.3	10.07	8.9	12.9	0.670	105
0.904	0.760	126.6	10.72	31.88	22.96	20.9	26.4	19.3	16.6	23.0	8.20	8.0	8.4	0.695	112
1.081	0.480	121.9	10.88	34.75	27.46	25.3	29.0	12.2	3.3	26.6	7.90	7.3	9.0	0.705	106
1.305	0.760	118.2	9.18	31.93	33.14	26.6	35.5	19.3	13.3	23.3	7.66	6.6	10.1	0.595	108
1.384	0.793	124.1	12.64	29.14	35.16	19.0	56.5	20.2	3.3	36.3	8.04	4.2	15.7	0.819	

weakest, No. 113 *a*. Heaviest, No. 92 *c*; lightest, No. 107. Most lint, No. 104; least lint, No. 110 *a*.

GEORGIA.

1.019	0.945	180.2	13.77	41.57	25.90	24.3	27.4	24.0	20.0	26.6	11.68	10.6	12.9	0.890	118
1.050	1.224	131.2	12.04	28.84	26.68	24.8	29.7	31.1	20.0	46.6	8.50	7.4	11.0	0.780	122
1.380	1.101	116.5	15.20	28.93	35.06	27.6	37.7	20.5	23.3	33.3	7.55	6.7	9.0	0.985	123
1.572	0.886	113.9	11.58	29.10	39.94	31.4	45.3	22.5	16.6	26.6	7.38	6.7	9.0	0.945	124
1.253	0.681	81.5	10.42	25.92	31.82	28.4	35.3	17.3	13.3	20.0	5.28	4.4	6.5	0.675	125
1.040	0.889	127.5	11.78	28.28	26.66	23.5	28.1	21.8	16.6	26.6	8.26	7.6	9.1	0.760	144
1.069	1.043	163.9	13.58	38.52	27.15	22.3	30.7	26.5	20.0	33.3	10.62	8.9	11.9	0.880	146
1.108	0.898	....	18.60	36.10	28.14	26.2	29.1	22.8	16.6	33.3	....	....	....	1.205	156

GEORGIA—Continued.

Number of sample.	Character of soil.	County.	Cotton variety.	Sender.
157	Gray sandy lands	Sumter		S. S. Bird
162	Gray sandy pine lands	Tattnall		John Hughey
163	Sandy pine lands	do	Bahamian bolls at joints; 48 bolls a pound of lint, 5 locks per boll.	do
	LANDS WITH CLAY SUBSOILS (METAMORPHIC).			
119	Gray sandy land	Bibb		W. D. W. Johnson
126	Sandy granitic soil	Campbell	Matagorda	Georgia Department of Agriculture.
127	Gray sandy soil	Carroll		R. H. Springer
131	do	Coweta	Improved cluster and sea island.	R. N. Carmichael
132	do	do	Barnes' Improved	Georgia Department of Agriculture.
133	do	De Kalb	Cheatham and Dixon Improved.	W. B. Frances
134	do	Gwinnett		R. D. Winn
139	do	Henry	Petit Gulf	Georgia Department of Agriculture.
140		Jackson	Herlong	W. J. Colquitt
141	Gray sandy soil, first quality	Lincoln		N. A. Crawford
143	Coarse and gravelly, third quality	do		do
147	Oak and hickory upland, not manured	Muscogee		J. C. Cook
148	Coarse sandy upland, manured with 250 pounds guano and 600 pounds of stable manure per acre.	Newton		J. P. Walker
149	Coarse sandy upland, cultivated 32 years, manured with 400 pounds of guano and 1,000 pounds of compost per acre.	do		do
152	Gray sandy upland, first grade, manured with 55 pounds of old dry stable manure per acre.	Paulding		J. R. Prewett
150	Gray sandy upland, second grade, manured with 300 pounds of barn-yard manure per acre.	do	Green-seed	do
159	Gray sandy land, with 500 pounds of dissolved bones and 1 ton of compost of cottonseed and manure per acre.	Talbot		W. R. Gorman
165	Gray sandy land	Troup		W. P. Beasley
166	do	do		do
167	do	do	Jones' Improved	J. F. Jones
	CLAY LANDS (METAMORPHIC).			
120	Red or mulatto land	Bibb		W. D. W. Johnson
121	Red or mulatto land (new land)	do	Frost-bitten	do
135	Chocolate or yellow soils	Gwinnett		R. D. Winn
136	Red clay land	do		do
137	Mulatto land, good, fertilized	Hancock	Hunt's Prolific, 185 bolls per stalk of 4 feet.	Georgia Department of Agriculture.
138	Mulatto land, poor, fertilized	do	Stalk 2 feet high	do
142	Clay land, second quality	Lincoln		N. A. Crawford
151	Red upland, fertilized with 300 pounds of night-soil manure per acre	Paulding		J. R. Prewett
160	Red clay land	Talbot		W. R. Gorman
164	do	Troup		W. P. Beasley
158	Red land (buhr-stone, Tertiary)	Sumter		S. S. Bird
	LANDS OF NORTHWEST GEORGIA.			
128	Gravelly ridge lands (Quebec)	Chattooga		A. R. McCutchen
129	Upland soil	do		A. P. Algood
130	Gray gravelly land	do	Third picking	C. D. Hill
168	Gray sandy soil, red-clay subsoil, no manure	Walker	Late picking	F. M. Young
153 b	Gray gravelly land	Polk	Jones' Improved	S. M. H. Byrd
153 a	Red land	do	do	do
	Bottom lands.			
145	River bottom lands, fertilized with 200 pounds of phosphate per acre	Muscogee		J. C. Cook
154	Brier creek bottom land, sandy	Scriven	Dixon Prolific	G. R. Black
155	Brier creek bottom land, alluvial	do	Rio Grande	do
161	Creek bottom land	Talbot		W. R. Gorman
	Average of all			

Longest, No. 124; shortest, No. 148. Widest, No. 134; narrowest, No. 135. Strongest, No. 160;

GEORGIA—Continued.

LENGTH, IN INCHES.	WIDTH, IN 1/1000 OF AN INCH.	BREAKING WEIGHT, IN GRAINS.	Weight of 5 seed with the lint, in grains.	Percentage of lint.	LENGTH, IN MILLIMETERS.			WIDTH, IN 1/1000 OF A MILLIMETER.			BREAKING WEIGHT, IN GRAMS.			Weight of 5 seed with the lint, in grams.	Number of sample.
Average of 4 fibers.	Average of 4 fibers.	Average of 10 or 15 results.			Average of 5 fibers.	Minimum.	Maximum.	Average of 4 fibers.	Minimum.	Maximum.	Average of 5 or 10 results.	Minimum.	Maximum.		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
0.942	0.839	123.8	10.57	35.76	23.92	19.5	25.9	21.3	10.0	26.6	8.02	7.0	9.4	0.685	157
0.887	0.866	152.1	11.50	35.57	22.52	19.0	31.4	22.0	16.6	30.0	9.86	8.1	11.6	0.745	162
1.342	0.976	129.6	10.80	30.00	34.10	30.6	36.6	24.8	13.3	36.6	8.40	7.5	9.8	0.700	163
1.098	0.858	151.7	9.40	39.02	27.90	26.8	29.6	21.8	16.6	26.6	9.83	8.1	14.0	0.615	119
0.934	1.126	126.8	10.65	35.50	23.72	20.7	26.9	28.6	20.0	33.3	8.22	7.4	10.1	0.690	126
1.052	0.732	140.7	11.19	36.55	26.72	25.3	28.2	18.6	10.0	26.6	9.12	7.6	10.7	0.725	127
1.372	0.767	123.8	15.59	25.24	34.86	32.0	35.9	19.5	16.6	23.3	8.02	6.2	11.7	1.010	131
0.870	1.051	115.3	11.11	37.50	22.10	18.6	24.4	26.7	23.3	33.3	7.47	6.4	9.8	0.720	132
1.140	1.003	119.0	12.65	34.14	28.96	26.9	30.1	27.0	20.0	43.3	7.71	6.2	9.5	0.820	133
1.245	1.299	145.4	15.66	29.55	31.64	26.5	35.4	33.0	23.3	40.0	9.42	8.0	11.2	1.015	134
1.156	0.795	131.5	13.35	32.20	29.38	26.4	32.9	20.2	13.3	30.0	8.52	6.7	10.3	0.885	139
0.901	0.768	140.6	10.65	35.50	22.88	19.5	25.8	19.5	13.3	23.3	9.11	7.3	11.1	0.690	140
0.924	0.862	158.1	12.81	36.10	23.46	20.0	25.4	21.0	10.0	30.0	10.25	9.1	12.0	0.830	141
1.040	0.909	167.1	12.04	29.41	26.42	22.2	28.2	23.1	10.0	33.3	10.83	9.6	12.1	0.780	143
1.334	1.059	137.7	12.81	31.92	33.90	31.9	36.2	26.9	20.0	36.6	8.92	7.4	11.1	0.830	147
0.806	0.831	147.5	11.50	34.89	20.48	10.0	22.5	21.1	13.3	23.3	9.56	8.0	13.1	0.745	148
0.983	0.748	120.1	10.34	31.34	24.97	21.3	31.0	19.0	10.0	26.6	7.78	7.1	9.5	0.370	149
1.026	0.760	126.7	11.65	33.77	26.06	23.0	28.8	19.3	16.6	23.3	8.17	6.5	9.7	0.755	152
1.183	1.004	119.7	13.10	31.58	30.06	28.4	31.1	25.5	20.0	33.3	7.76	6.7	9.8	0.855	150
1.115	0.870	144.8	15.90	33.98	28.33	24.0	32.2	22.1	16.6	30.0	9.38	7.8	10.9	1.030	159
1.071	0.909	149.4	12.65	34.14	27.20	25.4	29.5	23.1	20.0	26.6	9.68	8.8	10.5	0.820	165
0.881	0.770	140.8	11.42	33.11	22.38	21.4	23.2	19.8	13.3	26.6	8.96	7.9	10.4	0.740	166
0.934	1.004	157.4	18.21	33.90	23.72	21.1	25.7	25.5	20.0	30.0	10.20	8.5	13.9	1.180	167
1.114	1.141	125.0	13.58	30.11	28.31	25.4	31.8	29.0	23.3	33.3	8.10	6.9	9.3	0.880	120
1.025	0.760	110.2	....	....	26.04	23.6	29.9	19.3	13.3	23.3	7.14	5.9	8.1	....	121
0.906	0.614	164.5	13.89	35.00	23.00	20.0	25.6	15.6	13.3	23.3	10.66	9.3	12.7	0.900	135
1.112	1.220	150.1	15.66	33.00	28.24	26.4	30.7	31.0	20.0	43.3	9.73	8.4	13.3	1.015	136
0.819	1.153	124.5	11.65	31.12	20.80	18.6	23.3	29.3	23.3	33.3	8.07	6.3	10.8	0.755	137
0.952	0.921	125.3	9.88	34.37	24.18	23.3	27.4	23.4	13.3	33.3	8.12	7.1	12.3	0.640	138
0.919	0.945	170.2	13.50	36.36	23.34	20.6	25.6	21.0	16.6	33.3	11.61	9.0	13.7	0.856	142
1.007	0.917	140.7	12.81	39.77	25.58	22.8	27.7	23.3	16.6	33.3	9.70	8.8	10.4	0.830	151
1.076	0.878	193.8	11.11	36.80	27.34	22.8	29.5	22.3	13.3	30.0	12.56	9.1	13.1	0.720	160
1.207	0.968	102.1	12.58	24.54	30.64	28.7	34.2	24.6	20.0	26.6	6.62	6.1	7.0	0.815	164
0.999	0.850	119.8	10.34	32.83	25.38	24.5	27.1	21.6	13.3	30.0	7.76	7.2	8.4	0.670	158
1.105	0.839	130.0	18.13	32.76	28.08	25.5	36.0	21.3	16.6	23.3	8.42	7.1	10.0	1.175	128
1.119	1.051	157.1	14.35	32.79	28.42	26.9	30.6	26.7	20.0	33.3	10.18	8.4	13.6	0.930	129
0.970	0.820	125.0	11.73	35.52	24.62	20.5	29.5	20.6	16.6	26.6	8.10	7.1	8.8	0.760	130
1.172	0.713	116.7	12.58	30.61	29.78	27.5	32.0	18.1	13.3	20.0	7.56	6.8	9.3	0.815	168
0.816	0.693	131.5	17.44	36.28	20.72	19.8	21.4	17.6	16.6	23.3	8.52	7.6	9.7	1.130	153 *b*
1.012	0.858	148.1	10.19	34.85	25.70	23.5	28.4	21.8	16.6	26.6	9.60	7.3	11.3	0.660	153 *a*
1.208	0.949	129.3	11.96	27.74	30.68	26.0	35.6	24.1	20.0	30.0	8.38	6.8	9.5	0.775	145
1.142	0.917	121.0	7.95	37.86	29.02	27.1	35.5	23.3	16.6	30.0	7.84	6.1	10.1	0.515	154
0.985	0.728	134.1	11.11	31.04	25.02	23.6	27.2	18.5	13.3	28.3	8.69	7.6	9.9	0.720	155
1.063	1.025	147.5	16.90	35.16	27.00	25.3	29.0	28.6	13.3	36.6	9.56	7.3	14.3	1.095	161
1.066	0.913	136.9	12.80	33.18	27.09	18.6	37.7	23.2	10.0	46.6	8.85	4.4	14.3	0.830	

weakest, No. 125; heaviest, No. 156; lightest, No. 154. Most lint, No. 118; least lint, No. 164.

INDIAN TERRITORY.

Number of sample.	Character of soil.	County.	Cotton variety.	Sender.
170	Alluvial land, first class	Pottawatomie		E. A. Carnbrow
169	Alluvial land, old-land class	...do		...do

LOUISIANA.

		PARISH.		
171	Light sandy soil	Bienville		T. J. Butler
175	Hill land	Catahoula	McClendon's Prolific	M. Dempsey
176	Hill land, side of hill	...do	...do	...do
178	Upland sandy soil	De Soto	Dixon's Cluster, late	A. V. Roberts
179	...do	...do	Peeler, late	...do
183	Light sandy loam	Saint Tammany		W. C. Warren
185 b	Land sloping toward bottom, cultivated 30 years, manured	Tangipahoa		W. H. Garland
186	Table-land, not manured	...do		B. L. Gullett
187 a	Table-land, long-leaf pine, red and white oaks, subsoil red or yellow loam, manured.	...do		...do
187 b		...do		...do
190	Light sandy upland loam	Vernon		R. T. Wright
173	Red soil	Bienville		T. J. Butler
188	Black prairie upland	Vernon		R. T. Wright
172	Bottom land	Bienville		T. J. Butler
174	Creek bottom land	Catahoula	McClendon's Prolific	M. Dempsey
177	Dark sandy bottom land	De Soto	Peeler	A. V. Roberts
180	Hummock land	Morehouse	Boyd's Prolific	A. S. Keller
181	Gum lands	...do	African	...do
182	Red river alluvial land	Red River	Peeler	B. W. Marston
184	River bottom	Saint Tammany		W. C. Warren
191	Bottom land	Winn	Petit Gulf	W. T. Jones
192	Sandy hummock	...do	Herlong	...do
189	Dark clay loam, lowland	Vernon		R. T. Wright
185 a	Creek bottom land	Tangipahoa		W. H. Garland
	Average of all			

Longest, No. 179; shortest, No. 187 b. Widest, No. 186; narrowest, No. 183. Strongest, No. 185 a

MISSISSIPPI.

		COUNTY.		
193	Gravelly hill land, sandy subsoil	Amite	Heavily manured	J. R. Galtney
201	Light sandy loam	La Fayette	Fresh	P. Fernandez
202	...do	...do	Old land, not manured	...do
200	...do	...do	Old land, highly manured	...do
203	Dark sandy loam	...do		Ira B. Orr
209	Dark loam or hill land	Warren	Cultivated 3 years	L. Wailes
208	...do	...do	Cultivated 25 years	...do
204	Sandy bottom lands	Lee	First picking	H. L. Holland
205	...do	...do	Second picking	
206	...do	...do	Third picking	
207		Panola		D. B. Stewart
196	Clay loam soil	Hinds		H. O. Dixon
197	...do	...do	Manured; cultivated 20 years	...do
198	...do	...do	Cultivated 22 years	...do
194	Black prairie soil	Clarke	Cultivated 10 years	J. W. Wilbourn
195	...do	...do	Cultivated 40 years	...do
199 a	...do	Jasper	New ground	S. G. Loughridge
199 b	...do	...do	Cultivated 20 years	...do
	Average of all			

Longest, No. 200; shortest, No. 202. Widest, No. 200; narrowest, No. 198. Strongest, No. 200; weakest, No. 193.

INDIAN TERRITORY.

LENGTH, IN INCHES.	WIDTH, IN 1/1000 OF AN INCH.	BREAKING WEIGHT, IN GRAINS.	Weight of 5 seed with the lint, in grains.	Percentage of lint.	LENGTH, IN MILLIMETRES.			WIDTH, IN 1/1000 OF A MILLIMETER.			BREAKING WEIGHT, IN GRAMS.			Weight of 5 seed with the lint, in grams.	Number of sample.
Average of 4 fibers.	Average of 4 fibers.	Average of 10 or 15 results.			Average of 5 fibers.	Minimum.	Maximum.	Average of 4 fibers.	Minimum.	Maximum.	Average of 5 or 10 results.	Minimum.	Maximum.		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
1.023	1.043	126.2	12.50	31.48	25.98	24.2	28.1	26.5	23.3	30.0	8.18	6.8	12.0	0.810	170
1.140	0.768	112.4	14.35	32.26	28.96	23.3	31.1	19.5	10.0	26.6	7.28	6.6	8.5	0.930	169

LOUISIANA.

1.116	0.846	123.2	15.28	34.85	28.34	24.0	32.0	21.5	13.3	26.6	7.98	7.2	9.3	0.990	171
1.077	0.953	112.0	11.65	31.12	27.35	23.4	30.7	24.2	16.6	33.3	7.26	4.9	11.7	0.755	175
1.106	0.917	84.6	12.19	36.08	28.08	20.9	40.6	23.3	20.0	26.6	5.48	6.5	8.6	0.790	176
1.003	0.819	100.9	12.42	33.54	25.48	22.5	30.0	20.8	16.6	20.0	7.12	6.2	8.1	0.805	178
1.267	0.795	82.1	13.50	29.14	32.18	30.4	34.4	20.1	13.3	26.6	5.32	4.1	7.0	0.875	179
1.151	0.634	142.4	....	....	29.25	22.7	36.9	16.1	6.6	26.6	9.23	7.3	11.9	....	183
1.075	0.716	141.1	12.04	30.13	27.30	24.5	30.5	18.2	13.3	26.7	9.14	7.9	11.4	0.780	185 *b*
0.902	1.263	120.1	13.12	38.23	22.92	21.5	24.4	32.1	26.6	36.6	7.78	6.0	10.5	0.850	186
1.152	1.146	149.4	13.50	32.00	29.26	26.2	31.9	29.1	20.0	40.0	9.68	8.7	12.2	0.875	187 *a*
0.862	0.831	115.6	13.74	29.21	21.90	19.5	26.2	21.1	16.6	23.3	7.49	6.1	10.8	0.890	187 *b*
1.028	0.996	120.3	12.27	33.96	26.12	24.0	28.5	25.3	13.3	33.3	7.80	7.1	9.1	0.795	190
1.214	0.846	131.8	11.19	33.10	30.84	28.4	32.7	21.5	16.6	26.6	8.54	7.9	10.7	0.725	173
1.001	1.004	173.5	12.89	32.33	25.44	22.8	29.0	25.5	20.0	30.0	11.24	9.4	13.3	0.835	188
1.104	0.799	132.4	10.88	35.46	28.04	24.5	31.6	20.3	16.6	23.3	8.58	6.8	9.6	0.705	172
1.084	0.693	135.5	16.36	32.07	27.53	24.7	31.6	17.6	13.3	23.3	8.78	7.8	10.2	1.000	174
1.220	0.878	151.9	15.66	28.57	30.98	25.8	34.7	22.3	16.6	26.6	9.84	8.6	11.4	1.015	177
1.011	0.807	117.4	11.11	34.02	25.68	23.3	27.2	20.5	6.6	33.3	7.61	5.5	11.7	0.720	180
1.039	0.783	69.0	12.35	34.37	26.40	21.9	31.3	19.9	13.3	30.0	4.47	3.0	6.1	0.800	181
1.014	0.850	94.4	13.19	20.46	25.76	33.0	37.3	21.6	16.6	26.6	6.12	5.7	6.8	0.855	182
1.059	0.657	123.0	....	....	26.91	21.2	30.3	16.7	6.6	26.6	7.97	6.8	10.2	....	184
1.094	1.008	123.7	9.03	35.04	27.80	24.9	31.9	25.8	16.6	33.3	8.02	6.7	10.4	0.585	191
0.987	0.917	138.0	11.80	43.79	25.08	22.7	27.5	23.3	16.6	36.6	8.94	7.4	11.9	0.705	192
1.029	1.008	157.0	16.28	31.28	26.15	24.2	29.3	25.8	13.3	33.3	10.04	8.3	12.3	1.055	189
1.032	1.004	214.5	15.74	39.21	26.22	22.0	31.6	25.5	16.7	40.0	13.90	11.0	18.2	1.020	185 *a*
1.069	0.882	127.5	13.01	33.08	27.15	19.5	40.6	22.4	6.6	40.0	8.26	3.0	18.2	0.843	

weakest, No. 181. Heaviest, No. 174; lightest, No. 191. Most lint, No. 192; least lint, No. 182.

MISSISSIPPI.

1.041	1.020	109.9	....	....	26.45	22.2	32.7	25.9	17.4	33.9	7.12	6.2	7.8	....	193
1.055	0.909	125.3	....	....	26.80	20.7	32.6	23.1	17.4	31.3	8.12	7.2	9.7	....	201
0.810	0.929	117.6	....	....	20.58	17.7	26.5	23.6	13.0	30.1	7.62	6.0	9.3	....	202
1.282	1.081	161.4	....	....	32.56	30.1	38.0	27.4	20.8	36.5	10.46	8.4	12.4	....	200
1.069	0.933	134.6	....	....	27.16	22.9	29.6	23.7	17.4	30.4	8.72	6.7	11.0	....	203
1.012	1.016	144.8	....	....	25.43	23.2	27.6	25.8	17.4	36.5	9.38	8.2	10.6	....	209
0.994	0.980	147.5	....	....	25.25	21.2	28.8	24.9	19.2	34.8	9.56	8.1	10.8	....	208
0.986	1.027	130.2	11.11	31.94	25.00	20.4	29.1	26.1	19.1	30.0	8.44	6.9	9.3	0.720	204
1.022	0.941	146.3	9.11	35.50	25.95	24.0	27.3	23.9	17.4	30.4	9.48	8.0	12.7	0.590	205
1.009	0.968	125.0	11.57	33.33	25.62	20.5	30.9	24.6	15.7	34.8	8.10	6.4	10.5	0.750	206
1.170	0.945	139.5	....	....	29.72	22.8	36.6	24.0	17.4	33.9	9.04	7.0	11.0	....	207
1.098	0.984	156.2	13.94	33.25	27.90	24.1	30.6	25.0	17.4	36.5	10.12	8.9	12.4	0.845	196
1.080	0.890	142.9	11.27	32.87	27.44	25.0	28.5	22.6	13.3	26.6	9.26	7.5	11.0	0.730	197
1.210	0.768	145.4	12.73	34.54	30.74	30.1	31.6	19.5	16.6	23.3	9.42	7.3	11.8	0.825	198
0.922	0.902	113.8	12.58	39.26	23.42	17.1	31.6	22.9	11.3	39.1	7.34	6.6	8.3	0.815	194
1.015	0.965	116.7	12.35	31.87	25.80	22.6	29.6	24.5	17.4	31.3	7.56	6.1	10.5	0.800	195
0.996	0.933	116.4	14.82	33.33	25.30	22.0	27.5	23.7	20.0	26.7	7.54	7.0	8.6	0.960	199 *a*
1.098	1.039	145.1	12.65	34.13	27.90	26.0	32.0	26.4	23.3	30.0	9.40	8.0	11.3	0.820	199 *b*
1.047	0.957	134.3	12.11	34.01	26.61	17.1	38.0	24.3	13.0	39.1	8.70	6.0	12.7	0.785	

Heaviest, No. 199 *a*; lightest, No. 205. Most lint, No. 194; least lint, No. 195.

MISSOURI.

Number of sample.	Character of soil.	County.	Cotton variety.	Sender.
	MISSISSIPPI ALLUVIAL LANDS.			
212	Dark sandy loam, cultivated 30 years, no manure	Dunklin	Java Prolific	E. J. Langdon
215	Dark sandy upland	Stoddard		J. P. Walker
210	Dark prairie loam, cultivated 10 years, no manure	Dunklin	Matagorda Silk	E. J. Langdon
211	Dark prairie loam, cultivated 20 years, no manure	do	Red River	do
213	Lowland	Stoddard		J. P. Walker
214	do	do		do
	Average of all			

Longest, No. 210; shortest, Nos. 215 and 213. Widest, No. 214; narrowest, No. 210. Strongest, No. 210;

NORTH CAROLINA.

Number of sample.	Character of soil.	County.	Cotton variety.	Sender.
	SANDY UPLANDS.			
220	Sandy loam of coast region, fertilized with compost	Beaufort	Dickson's Early Cluster	R. W. Wharton
221	Sandy, somewhat clayey loam, with compost of muck, cottonseed, ashes, and phosphate.	do		do
230 a	Upland soil, with barn-yard manure	Craven		C. Duffey, jr
230 b	Upland soil, with compost of cottonseed and phosphate	do		do
231 a	Light sandy soil, barn-yard manure	do		do
231 b	Light sandy soil, with cottonseed and phosphate compost	do		do
234	Sandy soil	Cumberland		W. G. Hall
235	Sandy loam	Duplin		J. A. Bryan
238	do	Greene		R. C. D. Braman
241	Sandy, piny woods	Halifax	Braswell	J. M. Smith
242	Gray sandy loam	do		J. H. Parker
243	Light sandy loam	do		do
245	Gray sandy loam, piny woods, manured with cottonseed	do		do
246	Gray upland soil (near creeks), manured with 100 pounds of sea-fowl guano and 25 bushels of cottonseed per acre.	Harnett	Not well grown	H. C. McNeill
247	Dark gray loam, little sand, yellow-clay subsoil	do		do
249	Gray sandy, pine, oak, and hickory land, sandy-clay subsoil	Johnson		E. J. Holt
250	Light sandy land, clay subsoil, oak and hickory	Jones		H. C. Foscue
255	Dark gray soil, clay subsoil	Martin		J. R. Lanier
271	Gray sandy loam	Pasquotank		
272	Piny woods, sandy land	Bitt		F. Joyner
273	Light sandy soil	do		do
274	Sandy, gravelly soil	Richmond		R. L. Steele
275	Sandy soil	do		do
285	Upland soil	Wilson		G. W. Stanton
225	Light sandy loam, pine, oak, etc	Carteret		A. Oaksmith
260 a	Sandy, gravelly pine upland, manured	Moore		M. McQueen
260 b	do	do		J. H. McDonald
260 c	do	do		J. W. Johnson
260 d	Sandy, gravelly pine upland, manured with 200 pounds of guano per acre.	do		J. C. Fergerson
260 e	Sandy, gravelly pine upland	do		William Blue
261	Sandy uplands	do		J. C. Campbell
262	Lands of Pocket creek	do		do
263	Sandy uplands	do		N. R. Bryan
264	Lands of Governor's creek	do		N. M. Fergerson
265	Sandy uplands	do		S. M. Carter
266	do	do		E. J. Harrington
267	Sandy pine, oak, and hickory flats, with clay subsoil	New Hanover		A. R. Black
	BOTTOM LANDS.			
219	Dark alluvial soil, slightly manured with guano	Beaufort		R. W Wharton
232 a	Lowland soil, manured with cottonseed and phosphate compost	Craven		C. Duff, jr
232 b	Lowland soil, manured with cottonseed and barnyard manure	do	Stalk matured 94 bolls	do
239	Sandy land, Roanoke river	Halifax	Peeler	J. M. Smith
240	do	do	Johnson	do
256	Light sandy creek lands	Martin		J. R. Lanier
257	Low bottom lands	do	Opens late	do
284	Bottom land, no manure	Wayne	Picked late	J. Robinson
277	Light sandy loam, yellow-clay subsoil	Tyrrell		Eph. Leigh
233	Stiff clay hummock land	Craven		J. Humphrey
259 c	Dark gray soil, second bottom Crawley creek, no manure	Moore		John C. Campbell

MISSOURI.

LENGTH, IN INCHES.	WIDTH, IN $\frac{1}{1000}$ OF AN INCH.	BREAKING WEIGHT, IN GRAINS.	Weight of 5 seed with the lint, in grains.	Percentage of lint.	LENGTH, IN MILLIMETERS.			WIDTH, IN $\frac{1}{100}$ OF A MILLIMETER.			BREAKING WEIGHT, IN GRAMS.			Weight of 5 seed with the lint, in grams.	Number of sample.
Average of 4 fibers.	Average of 4 fibers.	Average of 10 or 15 results.			Average of 5 fibers.	Minimum.	Maximum.	Average of 4 fibers.	Minimum.	Maximum.	Average of 5 or 10 results.	Minimum.	Maximum.		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
1.075	0.811	137.0	12.73	33.93	27.30	22.5	32.4	20.6	16.6	26.6	8.88	8.0	9.4	0.825	212
0.907	1.047	131.2	11.50	29.51	23.04	22.6	24.3	26.6	23.3	30.0	8.50	6.6	10.2	0.745	215
1.260	0.779	183.3	15.82	28.30	32.02	24.5	37.1	19.8	13.3	23.3	11.88	10.0	13.5	1.025	210
1.240	0.886	100.9	14.12	31.14	31.50	28.4	37.1	22.5	16.6	30.0	6.54	5.1	8.2	0.915	211
0.980	0.905	132.1	11.73	34.21	24.88	23.1	26.1	23.0	16.6	30.0	8.56	7.4	10.9	0.760	213
1.130	0.909	134.0	10.65	32.61	28.69	25.4	41.6	23.1	20.0	26.6	8.68	7.3	9.6	0.690	214
1.098	0.890	136.4	12.76	31.62	27.90	22.5	41.6	22.0	13.3	30.0	8.84	5.1	13.5	0.827	

weakest, No. 211. Heaviest, No. 210; lightest, No. 214. Most lint, No. 213; least lint, No. 210.

NORTH CAROLINA.

1.048	0.795	141.4	12.11	33.75	26.62	24.1	28.4	20.2	16.6	26.6	9.16	7.2	10.9	0.785	220
1.045	0.661	136.4	10.73	35.97	26.54	25.1	29.6	16.8	10.0	26.6	8.84	7.2	11.4	0.695	221
1.041	0.878	145.4	11.81	26.79	26.44	21.1	30.4	22.3	16.6	30.0	9.42	7.9	13.4	0.765	230 *a*
1.040	1.027	159.6	13.04	26.03	26.64	25.3	29.1	26.1	20.0	33.3	10.34	8.6	11.7	0.845	230 *b*
0.906	0.909	121.0	8.87	34.78	25.29	24.1	26.6	23.1	20.0	26.6	7.84	6.4	8.4	0.575	231 *a*
0.841	1.067	124.7	11.73	40.13	21.36	17.2	24.6	27.1	16.6	36.6	8.08	6.1	9.8	0.700	231 *b*
0.886	0.988	145.0	14.82	37.50	22.51	20.9	24.8	25.1	20.0	30.0	9.40	8.0	11.2	0.960	234
1.040	0.929	161.1	....	....	26.42	25.2	29.8	23.6	13.3	30.0	10.44	9.5	11.4	....	235
0.921	0.839	172.5	14.04	34.06	23.40	20.7	27.6	21.3	20.0	23.3	11.18	8.9	13.0	0.910	238
0.956	1.057	116.3	13.12	35.29	24.28	23.1	25.4	26.8	20.0	33.3	7.54	5.9	8.8	0.850	241
1.033	0.760	131.7	....	....	26.24	21.1	30.2	19.3	13.3	23.3	8.53	6.7	10.1	....	242
1.063	0.827	129.6	13.12	29.41	27.00	25.1	28.7	21.0	16.6	26.6	8.40	7.0	9.8	0.850	243
1.077	0.760	176.6	14.43	32.62	27.36	24.6	29.6	19.3	16.6	23.3	11.44	6.9	12.4	0.935	245
1.018	1.220	152.2	13.10	35.79	25.86	25.2	26.6	31.0	23.3	40.0	9.86	8.1	11.1	0.855	246
1.005	0.874	164.3	....	....	25.52	23.8	26.6	22.2	13.3	30.0	10.65	8.6	14.7	....	247
1.208	0.752	106.6	13.12	28.23	30.68	29.3	33.2	19.1	16.6	23.3	6.91	5.3	10.0	0.850	249
1.015	0.626	171.3	....	....	25.78	22.8	28.5	15.9	6.6	23.3	11.10	10.0	11.7	....	250
1.023	0.984	147.5	11.50	36.24	25.98	21.5	25.4	25.0	13.3	30.0	9.02	8.2	11.1	0.745	255
....	1.024	....	....	....	....	....	....	26.0	20.0	30.0	....	....	....	....	271
1.019	0.898	160.2	12.50	37.03	25.88	24.0	29.5	22.8	16.6	30.0	10.38	9.1	11.6	0.810	272
1.045	0.787	120.1	14.43	33.15	26.54	21.7	32.8	20.0	10.0	26.6	7.78	6.8	9.3	0.935	273
0.998	0.728	139.5	....	....	25.36	21.3	29.1	18.5	13.3	23.3	9.04	8.2	10.0	....	274
1.042	0.748	149.1	....	....	26.46	23.1	29.0	19.0	13.3	26.6	9.66	7.0	12.7	....	275
1.017	1.071	119.8	....	....	25.82	23.8	27.9	27.2	16.6	33.3	7.76	7.1	9.0	....	285
0.695	0.787	107.4	10.03	33.84	17.66	15.4	18.8	20.0	10.0	26.6	6.96	6.1	7.7	0.650	225
1.190	1.067	130.5	12.10	38.61	30.24	29.3	33.1	27.1	20.0	33.3	8.46	7.6	10.5	0.790	200 *a*
1.162	0.945	118.2	12.10	36.07	29.52	25.6	31.5	24.0	20.0	30.0	7.66	6.9	8.1	0.790	200 *b*
1.332	1.181	119.1	12.81	25.30	33.58	30.8	37.8	30.0	26.6	33.3	7.72	6.4	11.1	0.830	200 *c*
1.038	1.165	103.7	12.42	33.54	26.36	25.1	27.5	29.6	23.3	36.6	6.72	5.9	8.8	0.805	200 *d*
1.138	0.886	130.6	14.51	35.13	28.90	26.0	30.8	22.5	16.7	30.0	8.46	6.3	11.9	0.940	200 *e*
1.079	0.984	154.6	....	....	27.42	21.2	32.1	25.0	16.6	33.3	10.02	8.6	11.5	....	261
1.093	1.003	133.3	....	....	27.76	27.0	28.9	25.5	20.0	33.3	8.64	7.1	9.5	....	262
1.225	1.004	132.1	....	....	31.12	27.7	35.7	25.5	20.0	33.3	8.56	7.6	9.8	....	263
1.103	1.043	133.2	....	....	28.02	24.7	33.9	26.5	20.0	33.3	8.64	6.8	11.0	....	264
1.034	0.791	142.9	....	....	26.26	24.0	28.2	20.1	10.0	26.6	9.26	8.3	10.1	....	265
1.129	0.906	126.2	10.40	32.35	28.68	27.4	31.0	23.0	20.0	26.6	8.18	7.0	10.7	0.680	266
0.915	0.906	123.3	13.50	29.71	23.24	22.0	25.1	23.0	20.0	26.6	8.64	7.4	12.1	0.875	267
1.226	0.909	107.1	12.88	20.94	31.14	29.5	32.6	23.1	20.0	26.6	6.94	5.1	8.9	0.835	219
1.076	1.027	113.6	10.11	35.87	27.34	25.7	30.1	26.1	13.3	33.3	7.36	5.9	8.8	0.655	232 *a*
1.131	1.067	116.7	12.81	31.32	28.72	25.7	31.9	27.1	20.0	33.3	7.50	6.0	9.4	0.830	232 *b*
1.048	0.988	176.2	12.19	32.27	26.62	19.9	28.0	25.1	20.0	26.6	11.42	10.1	12.9	0.700	230
0.912	0.886	114.6	9.65	38.40	23.16	21.6	25.0	22.5	16.6	30.0	7.48	6.8	9.5	0.625	240
0.985	1.015	108.9	9.88	32.81	25.03	22.2	27.3	25.8	20.0	30.0	7.06	6.1	10.3	0.640	256
0.902	0.634	128.4	9.96	37.21	24.02	23.1	25.8	16.1	13.3	20.0	8.32	7.4	9.3	0.645	257
0.931	0.929	118.2	10.26	37.59	23.10	20.1	27.5	23.6	16.6	33.3	7.66	6.5	10.1	0.665	264
1.078	0.858	176.0	16.67	35.18	27.40	25.5	29.3	21.8	16.6	26.6	11.40	7.9	13.8	1.080	277
0.965	1.051	126.8	15.43	19.50	24.52	22.6	26.8	26.7	20.0	30.0	8.22	6.6	12.1	1.000	233
1.272	0.910	123.1	14.66	34.20	32.32	20.1	37.0	22.6	20.0	26.6	7.98	6.1	11.3	0.950	259 *a*

NORTH CAROLINA—Continued.

Number of sample.	Character of soil.	County.	Cotton variety.	Sender.
	RED OR CLAYEY LANDS.			
244	Heavy clay soil, manured with cottonseed and guano	Halifax		J. H. Parker
269	Stiff land (coast)	Pamlico		J. S. Lane
270	Clay soil	Pasquotank		C. W. Hollowell
282	Clay uplands, manured with guano	Wayne		J. Robinson
283	Clay uplands, no manure	do		do
248	Dark loam upland, little sand, yellow-clay subsoil, manured with 30 bushels of cottonseed per acre.	Harnett	Not fully grown	H. C. McNeill
258 a	Red and dark gravelly upland, manured with 250 pounds of guano per acre	Moore		A. H. Cameron
258 b	Red and dark gravelly upland soil	do		D. M. Sinclair
258 c	do	do		R. M. McRaes
258 d	do	do		M. Fergerson
258 e	do	do		J. C. Campbell
259 a	Red and dark gravelly upland soil, no manure	do		R. McDonald
259 b	Red and dark gravelly upland soil, manured with 200 pounds guano per acre	do		B. F. Clegg
259 d	Red and dark gravelly upland soil, no manure	do		F. Campbell
259 c	Red and dark gravelly upland soil, manured with 200 pounds guano per acre	do		A. B. Harrington
	OAK UPLANDS HAVING CLAY SUBSOILS.			
216	Sandy upland	Alamance		J. A. Graham
217	Sandy and gravelly upland	Anson		W. E. Smith
218	do	do		do
222	Sandy upland	Caldwell	Edwards	
223	do	do	do	
224	do	do	do	
226	Sandy loam, pine, hickory, poplar	Chatham		J. W. Scott
227 a	Gray and sandy land	Cleaveland		J. R. Logan
227 b	do	do		do
227 d	do	do		do
227 c	Red and gray sandy land	do		do
227 e	do	do		do
228 a	Gray sandy land	do		do
228 b	do	do		do
228 c	do	do		do
228 e	do	do		do
228 f	Red and gray sandy land	do		do
229	Gray and sandy land	do		do
236	Gray and gravelly land	Franklin		W. F. Greene
237	Sandy loam	Granville		J. B. Hunter
252	Gray sandy land	Lincoln		W. A. Graham
251	Upland soil	do		Elisha Ballard
253	do	do		John J. Phifer
268	Gray sandy land	Orange		C. W. Johnson
276	Gray gravelly land	Stanley		M. T. Waddill
280	Gray sandy loam	Union		H. M. Houston
279	Gravelly land	do		do
281	Upland	do		do
228 d	Red land	Cleaveland		J. R. Logan
254	Red-clay land	Lincoln		W. A. Graham
278	Coarse, gravelly mulatto upland, oak, black-jack, and pine growth	Union		H. M. Houston
	Average of all			

Longest, No. 258b; medium, No. 228a; shortest, No. 225. Widest, No. 246–227b; medium, No. 258b–284; narrowest, No. 250. Strongest, No. 251; medium, No. 228d;

SOUTH CAROLINA.

290	Sandy highlands, Edisto island	Charleston		I. J. Mikell
293 a	Light sandy land, James island	do		W. G. Hinson
293 b	do	do		do
294	do	do		E. L. Rivers
295	Light sandy land, John's island	do	Sea island	W. E. Trip
296 a	Light sandy land	do	Santee long-staple	J. S. Porcher
296 b	do	do		
296 c	do	do		
299	High sandy pine land, clay subsoil	Colleton		G. Varn
301	Sandy pine lands, clay subsoil	Hampton		H. H. Peeples
286	Light sandy loam, clay subsoil	Aiken		P. F. Hammond

NORTH CAROLINA—Continued.

LENGTH, IN INCHES.	WIDTH, IN 1/1000 OF AN INCH.	BREAKING WEIGHT, IN GRAINS.	Weight of 5 seed with the lint, in grains.	Percentage of lint.	LENGTH, IN MILLIMETERS.			WIDTH, IN 1/100 OF A MILLIMETER.			BREAKING WEIGHT, IN GRAMS.			Weight of 5 seed with the lint, in grams.	Number of sample.
Average of 4 fibers.	Average of 4 fibers.	Average of 10 or 15 results.			Average of 5 fibers.	Minimum.	Maximum.	Average of 4 fibers.	Minimum.	Maximum.	Average of 5 or 10 results.	Minimum.	Maximum.		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
1.241	0.850	121.6	11.96	32.90	31.54	26.8	35.6	21.6	16.6	26.6	7.88	7.1	8.7	0.775	244
1.128	0.894	98.2	12.19	26.58	28.60	28.1	30.2	22.7	16.6	30.0	6.36	5.4	7.2	0.790	269
0.852	0.900	125.3	12.96	29.97	21.64	20.1	22.6	23.1	20.0	26.6	8.12	6.4	10.2	0.840	270
0.965	0.866	165.5	11.57	37.33	24.50	20.1	28.0	22.0	16.6	30.0	10.72	8.1	15.8	0.750	282
1.023	0.984	148.5	11.50	36.24	25.98	21.5	25.4	25.0	13.3	30.0	9.62	8.2	11.1	0.745	283
1.084	1.023	139.5	10.96	35.91	27.54	23.7	31.8	26.0	23.3	33.3	9.04	7.8	10.3	0.710	248
1.037	0.984	117.6	11.57	30.67	26.34	25.1	29.8	25.0	16.6	30.0	7.62	6.1	9.0	0.750	258 *a*
1.357	0.929	112.4	13.27	31.39	34.46	30.0	34.0	23.6	16.6	26.6	7.28	6.2	8.5	0.860	258 *b*
1.195	1.035	157.7	15.97	31.40	30.36	27.0	33.1	26.3	16.6	36.6	10.22	7.3	12.5	1.035	258 *c*
1.251	0.925	110.8	14.20	38.58	31.78	27.0	34.5	23.5	16.6	26.6	7.76	6.4	9.2	0.920	258 *d*
1.174	0.701	163.3	13.97	32.04	29.14	26.0	32.6	17.8	13.3	23.3	10.58	8.8	11.6	0.905	258 *e*
1.347	0.835	138.0	12.27	33.96	34.22	31.8	36.2	21.2	13.3	26.6	8.94	6.4	11.2	0.795	259 *a*
1.328	0.949	130.5	11.65	33.77	33.75	31.0	36.5	24.1	20.0	30.0	8.46	6.7	10.1	0.755	259 *b*
1.010	0.878	139.8	13.81	32.40	25.66	24.0	28.3	22.3	13.3	26.6	9.06	7.1	11.4	0.895	259 *d*
1.220	0.669	127.8	14.74	30.89	30.98	25.6	35.3	17.0	13.3	23.3	8.28	7.1	9.8	0.955	259 *e*
1.178	1.023	150.6	....	....	29.92	28.6	31.9	26.0	20.0	36.6	9.76	8.1	11.1	....	216
0.970	0.925	110.8	....	....	24.64	21.8	29.5	23.5	20.0	26.6	7.18	6.1	8.0	....	217
0.950	0.850	115.4	10.03	33.84	24.12	22.3	26.4	21.6	16.6	26.6	7.48	5.7	8.6	0.650	218
0.875	0.941	147.7	11.42	29.73	22.22	20.4	24.6	23.9	16.6	33.3	9.57	7.7	16.2	0.740	222
1.135	0.870	133.9	11.73	30.26	28.82	24.8	33.8	22.1	16.3	30.0	8.68	7.5	11.3	0.700	223
0.946	0.898	100.5	10.03	36.15	24.04	23.2	25.4	22.8	13.3	33.3	6.51	4.9	8.1	0.650	224
1.005	0.787	124.4	10.96	36.62	25.54	21.4	27.7	20.0	10.0	26.6	8.06	6.6	10.4	0.710	226
0.895	0.906	126.7	....	....	22.74	19.8	23.9	23.0	13.3	33.3	8.21	7.0	9.9	....	227 *a*
1.086	1.220	93.8	....	....	27.60	24.3	29.1	31.0	26.6	36.6	6.08	3.9	8.9	....	227 *b*
1.064	0.929	138.7	....	....	27.04	25.0	29.0	23.6	16.6	30.3	8.99	7.0	10.1	....	227 *d*
0.895	1.050	133.1	....	....	22.74	20.0	27.4	26.9	20.0	33.3	8.63	7.1	10.4	....	227 *e*
0.911	1.086	113.1	....	....	23.14	21.7	25.4	27.6	20.0	33.3	7.33	4.7	8.2	....	227 *e*
1.060	1.126	140.7	....	....	26.92	24.6	29.3	28.6	20.0	40.0	9.12	6.7	12.7	....	228 *a*
1.011	1.020	114.5	....	....	25.70	23.3	27.6	25.9	16.6	40.0	7.42	5.6	9.2	....	228 *b*
1.050	1.138	100.1	....	....	26.66	25.5	28.6	28.9	13.3	36.6	6.49	4.2	13.5	....	228 *c*
1.131	0.980	158.1	....	....	28.72	26.0	31.5	24.9	20.0	30.0	10.25	8.6	12.2	....	228 *e*
0.919	0.890	140.7	....	....	23.34	21.1	25.4	22.6	13.3	33.3	9.12	7.5	12.2	....	228 *f*
1.016	0.831	121.6	....	....	25.81	24.9	27.3	21.1	16.6	26.6	7.88	6.6	10.6	....	229
0.995	0.886	107 7	....	....	25.28	22.7	28.3	22.0	13.3	30.0	6.98	5.0	8.2	....	236
1.165	1.035	145.3	....	....	29.60	27.2	34.2	26.3	23.3	30.0	9.42	8.1	10.9	....	237
1.048	0.945	104.3	13.66	36.16	26.62	23.5	27.0	24.0	13.3	26.6	6.76	5.3	9.3	0.885	252
1.078	1.035	179.9	14.66	37.89	27.33	23.7	29.2	26.3	16.6	33.3	11.66	9.1	13.3	0.950	251
1.111	1.122	117.9	11.03	32.16	28.24	27.5	29.4	28.5	13.3	30.3	7.64	5.2	15.1	0.715	253
0.972	0.807	132.2	....	....	24.70	20.9	28.4	20.5	16.6	23.3	8.57	7.3	11.7	....	268
1.335	0.866	117.6	11.19	28.27	33.90	32.1	37.2	22.0	13.3	30.0	7.62	6.5	8.6	0.725	276
1.017	0.898	163.9	....	....	25.83	24.0	28.6	22.8	16.6	33.3	10.62	9.0	12.5	....	280
0.971	0.949	139.2	....	....	24.67	21.4	28.5	24.1	20.0	26.6	9.02	7.2	12.2	....	279
1.126	0.744	151.3	....	....	28.62	26.4	32.8	18.9	10.0	30.0	9.80	6.8	12.4	....	281
1.115	0.992	132.7	....	....	28.32	25.4	31.3	25.2	20.0	36.6	8.60	7.1	10.4	....	228 *d*
1.083	1.047	105.2	12.27	33.96	27.50	25.4	30.3	26.6	20.0	30.0	6.82	6.2	7.4	0.705	254
1.003	0.968	105.3	....	....	25.47	22.9	27.7	24.6	13.3	33.3	6.82	5.4	8.7	....	278
1.058	0.920	132.7	12.55	33.21	26.87	15.4	37.2	23.6	6.6	40.0	8.60	3.9	16.2	0.813	

weakest, No. 269. Heaviest, No. 277; medium, No. 272; lightest, No. 240. Most lint, No. 231*b*; medium lint, No 273; least lint, No. 233.

SOUTH CAROLINA.

1.996	0.878	110.5	13.89	27.77	49.94	45.1	53.0	22.3	16.6	30.0	7.16	5.6	9.3	0.900	290
1.780	0.720	72.2	11.42	29.05	45.20	43.0	52.0	18.3	16.6	23.3	4.68	3.0	7.5	0.740	293 *a*
1.429	0.850	99.2	10.65	37.68	36.30	31.5	39.8	21.6	16.6	26.6	6.43	4.5	10.0	0.690	293 *b*
1.431	0.882	103.1	9.42	31.91	36.36	28.5	44.3	22.4	16.6	30.0	6.68	5.2	7.7	0.610	294
1.820	0.945	98.8	11.19	32.10	46.22	42.0	49.4	24.0	20.0	33.3	6.40	5.2	10.6	0.725	295
1.666	0.909	104.3	11.96	29.03	42.32	40.8	44.2	23.1	13.3	30.0	6.76	5.3	8.0	0.775	296 *a*
1.732	0.799	112.0	11.42	28.38	44.00	41.6	47.0	20.3	13.3	26.7	7.26	5.6	9.3	0.740	296 *b*
1.932	0.866	80.3	10.73	30.94	49.08	46.0	53.2	22.0	16.7	26.7	5.20	4.1	6.6	0.695	296 *c*
1.218	0.984	123.1	14.20	28.80	30.94	29.6	32.0	25.0	16.6	33.3	7.98	7.2	8.7	0.920	299
1.023	1.086	157.1	12.03	31.41	25.99	22.1	24.9	27.6	23.3	36.6	10.18	8.2	13.6	0.780	301
1.045	0.898	111.4	7.95	31.06	26 54	24.6	27.8	22 8	20.0	26.6	7.22	6.1	9.6	0.515	286

SOUTH CAROLINA—Continued.

Number of sample.	Character of soil.	County.	Cotton variety.	Sender.
305	Light sandy soil	Marlborough		C. S. McCall
308	Light sandy soil, clay subsoil	Orangeburgh	Long staple	O. N. Bowman
288	Gray sandy pine lands	Barnwell		W. B. Rice
289	Light and poor sandy pine lands	...do		...do
302	Gray uplands, clay subsoils, with 160 pounds of manure per acre	Lexington		F. J. Harman
304	Red or mulatto lands manured with 125 pounds of fertilizer per acre	...do		...do
287	Mulatto land	Barnwell		W. B. Rice
307	Stiff reddish soil	Marlborough		C. S. McCall
300	Red-clay lands	Fairfield		G. H. McMaster
297	Dark red bottom lands	Colleton		G. Varn
306	Blackish soil	Marlborough		C. S. McCall
303	Dark loam soil of rivers, lightly manured	Lexington		F. J. Harman
298	Light and sandy hummock land	Colleton		G. Varn
291	Lowlands of Edisto island	Charleston		I. J. Mikell
292	Marsh or salt land of Edisto island	...do		...do
	Average of all			

Longest, No. 290; shortest, No. 303. Widest, No. 304; narrowest, No. 293 *a*. Strongest, No. 289;

TENNESSEE.

309 *a*	Table-land, no manure	Madison		E. C. Harbent
310 *b*	Table-land, old, with barn-yard manure	...do		...do
310 *a*	Table-land, cultivated five years, no manure	...do		...do
311 *c*	Hill land, no manure	...do		...do
311 *b*	Hill land, manured	...do		...do
311 *a*	Hill land	...do	Rusty cotton	...do
309 *b*	Second bottom land	...do		...do
	Average of all			

Longest, No. 310 *b*; shortest, No. 311 *a*. Widest, No. 311 *b*; narrowest, No. 309 *a*. Strongest, No. 309 *a*;

TEXAS.

	TIMBERED SANDY UPLANDS.			
312	Sandy lands	Angelina	Worm-proof cotton	E. L. Robb
313	Sandy upland soil	Bastrop		
321	Sandy loam soil	Dallas		J. F. Cole
324	Light sandy soil	Denton		J. W. Evans
323	Dark sandy soil	...do		...do
328	Very light sandy soil	De Witt		A. G. Stevens
327	Light sandy soil	...do		...do
340	Sandy upland soil	Gonzales		
341	...do	Gregg		J. D. Woodward
345	...do	Grimes		R. D. Blackshear
353	Sandy pine land of rivers	Kendall		C. H. Claus
351	Sandy pine land	Jasper	Hybrid cotton	L. C. White
357 *a*	Sandy post oak, manured	Lee	Schubach, or storm proof	R. H. Flaniken
357 *b*	Sandy post oak, manured	...do	...do	...do
358 *a*	Sandy post oak, not manured	...do	...do	...do
358 *b*	Sandy post oak, manured from cowpen	...do	...do	...do
354	Sandy post oak and prairie	...do		C. B. Longley
362	Sandy timbered land	McLennan		
372	Sandy land	Walker		J. F. Fisher
348	Stiff sandy land	Harrison		W. J. Caven
359 *a*	Stiff post oak sandy land	Lee		R. H. Flaniken
	PRAIRIES.			
359 *b*	Brown prairie land	Lee		R. H. Flaniken
364	Brown loam prairie land	Navarro	Schubach, or storm proof	
373	Upland prairie	Walker	Smooth seeds	J. F. Fisher
329	Black sandy prairie soil	Ellis		
330	...do	Erath		J. G. O'Brien
331	Lighter sandy prairie soil	...do		...do

SOUTH CAROLINA—Continued.

LENGTH, IN INCHES. Average of 4 fibers.	WIDTH, IN $\frac{1}{1000}$ OF AN INCH. Average of 4 fibers.	BREAKING WEIGHT, IN GRAINS. Average of 10 or 15 results.	Weight of 5 seed with the lint, in grains.	Percentage of lint.	LENGTH, IN MILLIMETERS. Average of 5 fibers.	Minimum.	Maximum.	WIDTH, IN $\frac{1}{1000}$ OF A MILLIMETER. Average of 4 fibers.	Minimum.	Maximum.	BREAKING WEIGHT, IN GRAMS. Average of 5 or 10 results.	Minimum.	Maximum.	Weight of 5 seed with the lint, in grams.	Number of sample.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
0.869	0.976	126.8	9.34	32.23	22.08	20.0	23.7	24.8	20.0	33.3	8.22	6.6	9.1	0.605	305
0.901	1.102	127.8	11.73	28.94	22.88	20.2	24.8	28.0	16.6	33.3	8.28	7.4	12.0	0.760	308
1.008	1.142	146.3	12.66	34.14	27.14	26.5	30.3	29.0	23.3	33.3	9.48	8.3	10.9	0.820	288
0.992	0.776	160.3	14.12	31.14	25.10	22.2	26.1	19.7	10.0	30.0	10.39	8.5	14.3	0.915	289
1.020	1.126	155.5	11.81	33.33	25.92	23.0	31.1	28.6	23.3	46.6	10.08	7.5	13.2	0.705	302
0.779	1.181	143.5	11.27	32.19	19.78	16.7	24.9	30.0	26.6	36.6	9.30	7.7	10.3	0.730	304
0.931	0.846	125.3	12.42	31.02	23.65	22.1	25.6	21.5	16.6	23.3	8.12	6.9	9.3	0.805	287
1.063	1.141	113.0	14.35	29.57	27.00	24.2	29.2	29.0	20.0	36.6	7.32	6.3	9.4	0.930	307
0.956	1.146	99.7	10.03	33.84	24.28	20.2	28.6	29.1	23.3	33.3	6.46	4.2	9.5	0.650	300
1.000	0.972	115.7	12.89	31.73	24.08	21.5	34.3	24.7	13.3	40.0	7.50	5.2	9.4	0.835	297
1.094	1.047	131.8	12.03	29.48	27.80	26.5	29.3	26.6	13.3	40.0	8.54	8.0	9.1	0.780	306
0.706	1.102	142.7	13.12	35.88	19.46	17.6	21.3	28.0	23.3	33.3	9.25	8.7	10.9	0.850	303
1.000	0.807	143.1	13.04	35.38	25.40	20.1	28.0	20.5	16.6	23.3	9.27	6.9	12.1	0.845	298
1.163	0.949	108.8	11.04	32.16	29.54	21.8	42.5	24.1	16.6	30.0	7.05	5.5	8.9	0.715	291
1.460	0.740	92.0	12.42	32.91	37.08	31.7	42.9	18.8	13.3	26.6	5.96	4.6	7.9	0.805	292
1.234	0.957	120.3	11.80	31.62	31.34	16.7	53.2	24.3	13.3	46.6	7.79	3.0	14.3	0.765	

weakest, No. 293 *a*. Heaviest, No. 307; lightest, No. 286. Most lint, No. 293 *b*; least lint, No. 290.

TENNESSEE.

0.868	0.764	180.7	11.96	35.48	22.06	20.7	23.6	19.4	6.6	30.0	11.71	7.7	15.5	0.775	309 *a*
1.131	0.882	115.3	12.73	29.69	28.74	27.3	30.4	22.4	16.6	30.0	7.47	6.9	8.7	0.825	310 *b*
0.986	0.894	133.8	12.18	31.64	25.04	21.2	29.4	22.7	13.3	30.0	8.67	7.1	11.6	0.790	310 *a*
0.841	0.890	151.1	10.57	36.62	21.36	19.0	22.9	22.6	16.6	26.6	9.79	7.1	12.7	0.685	311 *c*
0.898	1.189	139.5	12.19	30.37	22.80	21.3	23.9	30.2	16.6	46.6	9.04	7.1	11.2	0.790	311 *b*
0.821	0.776	79.6	11.96	37.41	20.86	17.4	22.9	19.7	13.3	33.3	5.16	3.6	8.1	0.775	311 *a*
1.036	0.882	133.0	14.66	30.52	26.33	23.6	29.4	22.4	16.6	30.0	8.62	7.0	12.1	0.950	309 *b*
0.992	0.808	133.3	12.33	33.10	25.21	17.4	30.4	22.8	6.6	46.0	8.64	3.6	15.5	0.790	

weakest, No. 311 *a*. Heaviest, No. 309 *b*; lightest, No. 311 *c*. Most lint, No. 311 *a*; least lint, No. 311 *b*.

TEXAS.

1.148	0.744	156.5	18.25	32.91	29.16	27.2	32.5	18.9	16.6	23.3	10.14	8.5	12.3	1.185	312
0.994	0.709	113.6	8.26	33.43	25.24	22.0	24.6	18.0	13.3	23.3	7.36	6.7	8.0	0.535	313
1.157	1.063	160.8	14.12	32.24	29.38	26.2	33.9	27.0	23.3	36.6	10.42	7.7	14.7	0.915	321
1.088	0.854	176.4	14.66	34.21	27.63	25.0	32.4	21.7	16.6	26.6	11.43	9.2	14.2	0.950	324
1.094	0.732	136.7	14.43	32.51	27.78	25.5	30.7	18.6	13.3	23.3	8.86	7.7	10.5	0.935	323
0.998	0.799	127.1	14.12	26.21	25.34	22.2	27.8	20.3	10.0	26.6	8.24	6.9	8.9	0.915	328
0.996	0.897	188.9	14.82	31.77	25.30	23.4	25.6	22.8	16.6	30.0	12.24	10.1	14.7	0.960	327
1.114	0.917	61.1	9.03	29.91	28.30	25.1	31.0	23.3	16.6	26.6	3.96	3.7	4.4	0.585	340
1.005	0.791	128.1	12.35	32.30	25.52	22.9	28.5	20.1	16.6	23.3	8.30	7.8	9.2	0.800	341
1.075	0.811	121.9	10.11	33.58	27.30	25.0	28.8	20.6	16.6	26.6	7.90	6.7	10.2	0.655	345
1.155	0.787	121.3	....	....	29.34	25.6	32.0	20.0	13.3	23.3	7.86	6.1	9.2	....	353
1.163	0.886	158.1	....	....	29.56	27.1	30.6	22.5	16.6	26.6	10.22	7.5	11.8	....	351
1.153	0.858	138.0	17.21	32.73	29.30	27.5	33.0	21.8	16.7	30.0	8.94	7.7	10.4	1.115	357 *a*
1.374	0.736	142.3	17.13	28.82	34.90	32.0	39.3	18.7	16.7	23.3	9.22	8.0	11.3	1.110	357 *b*
1.075	0.791	136.4	18.13	31.01	27.30	23.5	31.4	20.1	13.3	26.6	8.84	7.7	11.0	1.175	358 *a*
1.147	1.260	134.6	17.50	27.10	29.14	29.1	30.2	32.0	20.0	43.3	8.72	8.0	9.7	1.140	358 *b*
1.085	1.063	153.4	15.05	29.74	27.56	24.8	29.9	27.0	23.3	33.3	9.94	8.1	12.9	0.975	354
1.032	0.909	125.9	9.65	28.80	26.22	25.4	27.8	23.1	20.0	30.0	8.16	7.2	10.2	0.625	362
0.819	0.909	146.6	5.71	32.43	20.80	16.0	24.3	23.1	20.0	30.0	9.50	6.1	14.8	0.370	372
1.380	0.827	127.9	14.04	31.87	35.06	32.7	36.5	21.0	13.3	33.3	8.29	7.3	9.1	0.910	348
1.036	0.976	135.8	15.74	28.92	26.33	23.3	30.0	24.8	20.0	30.0	8.80	8.2	9.5	1.020	350 *a*
1.075	0.819	154.0	15.66	37.93	27.32	27.0	28.8	20.8	16.7	26.7	9.08	8.7	10.8	1.015	359 *b*
1.138	0.988	108.0	13.27	37.20	28.92	27.6	30.2	25.1	16.6	30.0	7.00	5.5	8.5	0.860	304
1.097	0.811	123.5	14.20	32.60	27.88	26.5	29.1	20.6	16.6	26.6	8.00	6.4	9.8	0.920	373
1.065	0.768	141.7	10.34	36.56	27.06	24.9	29.1	19.5	13.3	23.3	9.18	8.3	10.0	0.670	329
1.116	0.874	109.7	12.35	33.12	28.34	26.5	29.9	22.2	16.6	33.3	7.11	4.8	10.4	0.800	330
0.879	0.941	145.2	12.88	32.93	22.34	19.8	28.6	23.9	16.6	33.3	9.41	8.4	12.2	0.835	331

TEXAS—Continued.

Number of sample.	Character of soil.	County.	Cotton variety.	Sender.
	STIFF LANDS, MOSTLY PRAIRIES.			
360	Red land (timbered)	Lee		Mrs. E. R. Wilson
315	Stiff black prairie soil	Bell	Hofley's Golden Leaf	M. Maedgen
316	......do	...do	Planted late	......do
317	......do	Bosque		T. W. Archibald
320	Stiff black prairie land	Dallas		J. F. Cole
322	.... do	...do	Storm-proof cotton	F. Hensley
325	......do	Denton		J. W. Evans
326	......do	De Witt		A. G. Stevens
332	......do	Erath		J. G. O'Brien
333	Stiff black prairie, valley	...do		......do
334	Stiff black prairie land	Falls		E. P. Lea
339	......do	Fayette	Late picking	
346	Stiff black prairie, hog-wallow soil	Grimes		C. H. Ehinger
347	Stiff black prairie land	Harris		S. P. Christian
349	......do	Hood	Cheatham Prolific	
352	......do	Kendall		C. H. Clauss
365	Stiff black prairie land, valley	San Saba		
367	Stiff black prairie land	Travis	Matagorda Silk	J. J. Wheeler
369	......do	...do	5-lock Silk	......do
370	......do	Victoria		
371	Stiff black prairie land	Walker	Nankin	J. F. Fisher
	BOTTOM LANDS.			
336 *a*	Red river bottom sediment land	Fannin		Gideon Smith
336 *b*	......do	...do		......do
337 *c*	Red river bottom sandy land	...do		......do
337 *d*	......do	...do		......do
338 *e*	Red river valley, cultivated 30 years	...do		......do
338 *f*	......do	...do		......do
344	Brazos river bottom lands	Grimes		R. D. Blackshear
350	Brazos river second bottom soil	Hood		
361	Brazos river second bottom sandy soil	McLennan		
335	Brazos river black sandy hummock	Falls		E. P. Lea
314	Colorado river valley soil	Bastrop		
319	Colorado river dark alluvial soil	Colorado		
368	Colorado river valley soil	Travis	5-lock cotton	
318	Oyster creek red soil	Brazoria		J. M. Kirkland
374	Rio Grande valley soil		From stalk, first year growth	Rev. J. G. Hall
375	......do		From stalk, second year growth	......do
376	......do		From stalk, fourth year growth	......do
342	Second bottom land	Gregg		J. D. Woodward
343	......do	...do		......do
355	Yegua creek bottom soil	Lee		C. B. Longley
356	......do	...do		......do
363	Chambers creek valley soil	Navarro	Schubach, or storm proof	
366	Bottom land	Shelby		
377	Coast lands		Sea-island cotton	
	Average of all			

Longest, No. 377; shortest, No. 372. Widest, No. 358 *b*; narrowest, No. 313. Strongest, No. 327;

VIRGINIA.

Number of sample.	Character of soil.	County.	Cotton variety.	Sender.
380	Sandy soil and subsoil, manured as in No. 378	Southampton	Williams	W. H. Doughty
383	Light gray sandy soil	Sussex		J. D. Thornton
384	Medium upland	...do		...do
378	Gray sandy loam, red sandy clay subsoil, manured with 30 bushels of cottonseed meal, 100 pounds of guano, 100 pounds of kainit, and 50 pounds of plaster per acre.	Southampton	Williams	W. H. Doughty
379	Gray sandy loam, bluish clay subsoil, with 200 pounds of superphosphate per acre.	...do	Mixed, third picking	...do
381	Light sandy soil, red sandy clay subsoil	...do		J. D. Pretlow
382	......do	...do		...do
385	Stiff bottom land	Sussex		J. D. Thornton
	Average of all			

Longest, No. 380; shortest, No. 383. Widest, No. 379; narrowest, No. 385. Strongest, No. 380;

TEXAS—Continued.

LENGTH, IN INCHES.	WIDTH, IN 1/1000 OF AN INCH.	BREAKING WEIGHT, IN GRAINS.	Weight of 5 seed with the lint, in grains.	Percentage of lint.	LENGTH, IN MILLIMETERS.			WIDTH, IN 1/100 OF A MILLIMETER.			BREAKING WEIGHT, IN GRAMS.			Weight of 5 seed with the lint, in grams.	Number of sample.
Average of 4 fibers.	Average of 4 fibers.	Average of 10 or 15 results.			Average of 5 fibers.	Minimum.	Maximum.	Average of 4 fibers.	Minimum.	Maximum.	Average of 5 or 10 results.	Minimum.	Maximum.		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
1.074	0.988	91.4	5.86	42.10	27.29	22.9	28.9	25.1	20.0	30.0	5.02	5.0	7.3	0.380	360
1.170	0.787	171.4	12.89	32.93	27.92	22.3	30.4	20.0	16.6	26.6	11.11	8.4	14.6	0.835	315
0.865	0.977	120.2	17.44	33.62	21.97	20.4	23.2	24.8	20.0	30.0	8.18	7.5	9.0	1.130	316
0.945	0.831	101.0	12.11	29.93	24.02	22.7	25.5	21.1	16.6	26.6	6.54	4.2	9.5	0.785	317
1.026	0.976	120.7	20.32	32.57	26.06	25.6	26.5	24.8	20.0	36.6	7.82	6.6	10.0	1.320	320
0.927	0.811	115.4	11.96	33.40	23.54	23.0	24.5	20.6	16.6	26.6	7.48	5.5	9.6	0.775	322
0.961	1.075	131.8	16.74	40.09	24.42	22.8	26.3	27.3	23.3	33.3	8.54	8.0	10.6	1.085	325
1.365	0.839	114.8	8.72	31.84	34.68	32.3	36.3	21.3	16.6	30.0	7.44	5.6	10.2	0.565	326
0.857	1.071	118.8	11.42	35.13	21.78	19.6	22.9	27.2	23.3	36.6	7.70	6.6	10.5	0.740	332
1.046	0.898	113.2	7.18	33.33	26.56	24.3	29.1	22.8	16.6	26.6	7.34	6.0	7.9	0.465	333
1.006	1.035	154.9	10.88	38.29	25.57	23.3	27.6	26.3	20.0	33.3	10.06	7.5	11.5	0.705	334
1.165	0.760	90.4	13.81	31.84	29.58	26.8	31.6	19.3	13.3	23.3	5.80	4.7	6.7	0.895	339
0.991	0.827	109.3	13.07	30.93	25.18	24.3	27.2	21.0	16.6	26.6	7.08	6.2	7.9	0.905	346
1.031	0.843	128.2	15.82	28.29	26.18	24.2	28.4	21.4	10.0	30.0	8.31	7.7	10.0	1.025	347
1.116	0.917	144.2	10.95	30.09	28.36	26.3	30.5	23.3	20.0	30.0	9.34	7.0	12.0	0.710	349
1.059	0.850	125.4	....	....	26.90	25.3	30.7	21.6	16.6	26.6	8.13	6.4	13.1	....	352
1.094	0.894	167.7	13.50	34.97	27.78	25.9	29.9	22.7	16.6	30.0	10.88	8.2	14.4	0.875	365
1.200	1.165	144.2	11.88	31.16	30.48	28.2	33.9	29.6	20.0	30.0	9.34	8.4	10.8	0.770	367
1.058	1.015	146.3	....	....	26.87	24.2	29.5	25.8	16.6	33.3	9.48	7.9	10.6	....	369
1.150	0.827	129.0	13.58	28.40	29.22	28.8	29.8	21.0	16.6	23.3	8.36	7.9	8.8	0.880	370
0.979	0.890	137.0	11.96	23.16	24.88	22.3	28.6	22.6	20.0	26.6	8.88	7.8	10.5	0.775	371
0.941	1.212	73.2	16.28	31.75	23.90	22.7	28.7	30.8	23.3	43.3	4.74	4.1	5.2	1.055	336 *a*
0.984	1.047	152.5	13.35	32.35	25.00	21.0	27.8	26.6	16.6	40.0	9.88	9.0	10.8	0.865	336 *b*
1.102	0.949	154.3	12.35	37.50	27.98	27.3	28.5	24.1	16.6	33.3	10.00	8.7	11.3	0.800	337 *c*
0.880	0.929	140.7	12.50	30.86	22.36	19.0	26.0	23.6	16.6	30.6	9.12	8.4	11.0	0.810	337 *d*
0.994	0.850	91.4	11.57	31.33	25.26	22.7	26.8	21.6	13.3	30.0	5.92	5.6	6.4	0.750	338 *e*
1.020	0.968	102.8	11.57	32.66	25.90	21.9	27.2	24.6	13.3	33.3	6.66	6.0	8.3	0.750	338 *f*
1.001	0.894	141.7	10.40	30.14	25.42	21.1	28.6	22.7	16.6	30.0	9.18	7.4	11.7	0.680	344
1.056	0.839	154.6	9.18	37.81	26.82	21.6	35.1	21.3	16.6	26.6	10.02	8.9	12.2	0.595	350
1.009	0.866	114.2	13.50	32.57	25.64	24.5	27.9	22.0	16.6	26.6	7.40	7.1	7.7	0.875	361
1.016	0.866	140.1	11.96	32.25	25.80	20.3	30.0	22.0	16.6	30.0	9.08	8.2	10.1	0.775	335
1.187	0.791	111.4	12.19	27.21	30.14	26.5	33.5	20.1	10.0	26.6	7.22	6.8	7.6	0.700	314
1.104	1.008	127.4	14.51	32.97	28.05	25.4	29.4	25.6	20.0	33.3	8.26	6.7	9.7	0.940	310
1.130	0.909	182.4	10.57	33.57	28.72	25.7	32.1	23.1	16.6	30.0	11.82	8.8	15.0	0.685	368
1.163	1.094	141.7	14.51	35.85	29.54	25.7	32.3	27.8	6.6	36.6	9.18	7.7	11.4	0.940	318
1.174	0.909	157.7	12.04	30.70	29.83	27.6	33.0	23.1	20.0	30.0	10.22	8.5	11.6	0.780	374
1.117	0.732	143.2	12.26	31.44	28.38	23.3	31.2	18.6	10.0	26.6	9.28	8.1	11.3	0.705	375
1.115	0.957	118.2	13.35	34.10	28.34	25.6	30.4	24.3	20.0	30.0	7.66	7.1	8.7	0.805	376
1.000	0.831	144.6	....	....	25.40	20.6	28.9	21.1	16.6	26.6	9.37	8.5	10.5	....	342
1.133	0.878	140.9	....	....	28.78	22.3	31.9	22.3	10.0	33.3	9.13	7.6	9.4	....	343
1.053	0.831	122.2	15.13	27.04	26.76	24.5	29.2	21.1	16.6	26.6	7.92	7.0	10.1	0.980	355
1.043	0.827	159.9	15.36	28.64	26.50	22.2	31.4	21.0	16.6	26.6	10.36	9.0	13.0	0.995	356
0.856	0.835	141.7	13.27	26.74	22.24	20.1	26.1	21.2	10.0	30.0	9.18	7.3	12.6	0.860	363
1.109	0.866	145.7	13.58	33.51	28.16	25.1	31.0	22.0	20.0	26.6	9.44	7.5	12.8	0.880	366
1.717	0.913	112.2	....	....	43.62	36.7	48.1	23.2	16.6	30.0	7.27	6.2	9.0	....	377
1.075	0.897	132.8	13.07	32.34	27.13	16.0	48.1	23.0	6.6	43.3	8.60	3.7	15.0	0.855	

weakest, No. 340. Heaviest, No. 320; lightest, No. 372. Most lint, No. 360; least lint, No. 371.

VIRGINIA.

1.366	1.004	142.3	13.43	30.45	34.70	31.0	43.3	25.5	20.0	30.0	9.22	7.0	12.0	0.870	380
0.883	0.886	124.7	13.27	38.95	22.42	18.6	27.1	22.5	16.6	26.6	8.07	6.6	9.4	0.860	383
1.069	0.791	127.6	11.88	32.47	27.16	26.1	28.3	20.1	13.3	26.6	8.27	7.1	10.1	0.770	384
1.003	1.008	117.6	15.74	29.90	25.48	23.5	27.2	25.6	13.3	33.3	7.62	5.4	11.5	1.020	378
1.067	1.114	127.2	15.50	35.63	27.11	25.1	29.9	28.3	23.3	40.0	8.24	7.0	9.5	1.010	379
0.946	1.094	139.8	14.12	34.97	24.04	22.0	26.0	27.8	20.0	33.3	9.06	7.0	14.1	0.915	381
1.116	1.004	132.0	16.05	31.25	28.36	27.4	33.0	25.5	20.0	33.3	8.56	7.5	11.0	1.040	382
0.964	0.669	97.2	11.96	41.93	24.48	23.7	26.0	17.0	10.0	26.6	6.30	5.6	8.3	0.775	385
1.060	0.945	126.1	14.00	34.44	26.94	18.6	43.3	24.0	10.0	40.0	8.17	5.4	14.1	0.907	

weakest, No. 385. Heaviest, No. 382; lightest, No. 384. Most lint, No. 385; least lint, No. 378.

TABLE SHOWING MAXIMA AND MINIMA OF THE POINTS INCLUDED IN THE MEASUREMENTS FOR THE SEVERAL STATES.

LENGTH OF FIBER.

State.	Longest.				Shortest.			
	No. of sample.	County.	Character of soil.	Inches.	No. of sample.	County.	Character of soil.	Inches.
Alabama	43	Winston	Upland soil	1.427	48 d	Washington	Old land, pine woods, poor, not manured.	0.789
Arkansas	66	Grant	......do	1.143	56	Arkansas	Timbered upland	0.905
Arizona	51	Maricopa	Valley land	1.192	53	Yuma	(Boll from plant two years old, not cultivated.)	0.745
California	86	Tulare	Dark alluvial loam, light, somewhat alkaline.	1.669	70	Kern	Alluvial loam, somewhat alkaline.	0.827
Florida	96 d	Columbia	Light gray soil, old land (sea-island cotton).	*1.910	104	Gadsden	Sandy table-land	0.854
Georgia	124	Burke	Sandy uplands (Jones' long staple)	1.572	148	Newton	Coarse sandy upland, fertilized	0.806
Indian territory	169		Alluvial lands	1.140	170		Alluvial lands	1.023
Louisiana	179	De Soto	Upland sandy land (late)	1.267	187	Tangipahoa	Table-land, long-leaf pine and oak, manured.	0.862
Mississippi	200	La Fayette	Light sandy upland, old land, highly manured.	1.282	202	La Fayette	Light sandy upland, old land, unmanured.	0.810
Missouri	210	Dunklin	Dark prairie loam, cultivated ten years, not manured.	1.260	215	Stoddard	Lowland	0.907
North Carolina	258 b	Moore	Red and dark gravelly upland soil.	1.357	225	Carteret	Light sandy loam	0.695
South Carolina	290	Charleston	Sandy highland, Edisto island (sea island).	*1.996	303	Lexington	Dark loam river soil, manured	0.766
Tennessee	310 b	Madison	Table land (old land manured)	1.131	311 a	Madison	Hill land	0.821
Texas	348	Harrison	Stiff sandy land	1.380	372	Walker	Sandy land	0.819
Virginia	380	Southampton	Sandy soil and subsoil, manured	1.366	383	Sussex	Light gray sandy soil	0.883
All the states	86	Tulare, Cal	Dark alluvial loam, Mussel Slough.	1.669	225	Carteret, N. C	Light sandy loam	0.695

* Sea-island cotton omitted from the averages of the United States.

WIDTH OF FIBER.

State.	Widest.				Narrowest.			
	No. of sample.	County.	Character of soil.	Inches.	No. of sample.	County.	Character of soil.	Inches.
Alabama	45 a	Wilcox	Red land, oak, hickory, and pine	1.308	36	Tallapoosa	Stiff river bottom land	0.626
Arkansas	56	Arkansas	Timbered upland	1.154	55	Arkansas	Alluvial of Arkansas river	0.732
Arizona	52	Pima	Valley land	1.103	54		Salt river valley	0.770
California	70	Kern	Alluvial loam, alkaline	1.083	86	Tulare	Dark alluvial loam, alkaline	0.750
Florida	100	Columbia		*1.213	106	Gadsden	Red clay hummock	*0.430
Georgia	134	Gwinnett	Gray sandy land, clay subsoil	1.299	135	Gwinnett	Chocolate or yellow soil (clayey)	0.614
Indian territory	170		Alluvial lands	1.043	169		Alluvial lands	0.708
Louisiana	186	Tangipahoa	Table-land, not manured	1.263	183	Saint Tammany	Light sandy loam	0.634
Mississippi	200	La Fayette	Light sandy upland, old land, highly manured.	1.081	198	Hinds	Clay loam, cultivated 22 years	0.708
Missouri	215	Stoddard	Lowland	1.047	212	Dunklin	Dark sandy loam, cultivated 30 years, not manured.	0.811
North Carolina	246	Harnett	Gray upland soil, fertilized	1.220	280	Union	Gray sandy loam	0.808
	227 b	Cleaveland	Gray sandy soil					
South Carolina	304	Marlborough	Light sandy soil	1.181	293 a	Charleston	Sandy land, James island	0.720
Tennessee	311 b	Madison	Hill land, manured	1.189	309 a	Madison	Table-land, not manured	0.704
Texas	358 b	Lee	Sandy post-oak soil, unmanured	1.260	313	Bastrop	Sandy upland soil	0.700
Virginia	379	Southampton	Gray sandy loam, clay subsoil, manured.	1.114	385	Sussex	Black stiff bottom land	0.669
All the states	45 a	Wilcox, Ala	Red land	1.308	135	Gwinnett, Ga	Chocolate or yellow soil (clayey)	0.614

* Sea-island cotton omitted from the averages for the United States.

MAXIMA AND MINIMA OF THE POINTS INCLUDED IN THE MEASUREMENTS FOR THE SEVERAL STATES—Continued.

STRENGTH OF FIBER.

State.	STRONGEST.				WEAKEST.			
	No. of sample.	County.	Character of land.	Breaking weight.	No. of sample.	County.	Character of land.	Breaking weight.
				Grains.				*Grains.*
Alabama	40	Tuscaloosa	Stiff river bottom land	208.7	38	Tuscaloosa	Red clay upland	85.3
Arkansas	60	Conway	Arkansas river bottom land	185.2	57	Boone	Black gravelly loam	103.5
Arizona	52	Pima		143.7	54		Salt river valley	115.1
California	79	Merced	Alluvial loam	175.6	78	Merced	Alluvial loams	110.8
Florida	98	Columbia		*175.0	113 *a*	Suwannee	Coarse gravelly soil, not manured.	*80.1
Georgia	160	Talbot	Red clay lands	193.8	125	Camden	Coast lands (sea-island cotton)	81.5
Indian territory	170		Bottom lands	126.2	169		Bottom lands	112.4
Louisiana	185 *a*	Tangipahoa	Creek bottoms	214.5	181	Morehouse	Gum lands	69.0
Mississippi	200	La Fayette	Light sandy loam, old, and heavily *manured.*	161.4	193	Amite	Gravelly hill land, heavily *manured.*	109.9
Missouri	210	Dunklin	Dark prairie loam, cultivated 10 years, not manured.	183.3	211	Dunklin	Dark prairie loam, cultivated 20 years, not manured.	100.9
North Carolina	251	Lincoln	Sandy upland soil	179.9	260	Pamlico	Stiff land	98.2
South Carolina	289	Barnwell	Poor, light, sandy pine lands	160.3	293 *a*	Charleston	Sandy land, James island	72.2
Tennessee	309 *a*	Madison	Table-land, no manure	180.7	311 *a*	Madison	Hill land	79.6
Texas	327	De Witt	Light sandy land	188.9	340	Gonzales	Sandy upland	61.1
Virginia	380	Southampton	Sandy soil and subsoil, manured	142.3	385	Sussex	Stiff black bottom land	97.2
All the states	185 *a*	Tangipahoa, La.	Creek bottoms	214.5	340	Gonzales, Tex.	Sandy upland	61.1

* Sea-island cotton omitted from the averages for the United States.

WEIGHT OF FIVE SEEDS WITH LINT.

State.	GREATEST.				LEAST.			
	No. of sample.	County.	Character of land.	Weight of 5 seed with lint.	No. of sample.	County.	Character of land.	Weight of 5 seed with lint.
				Grains.				*Grains.*
Alabama	16	Jackson	Red clay land	16.76	13	Cleburne	Gravelly land	8.26
Arkansas	60	Conway	Arkansas river bottom land	22.14	61	Crittenden	Black sandy land	9.42
Arizona	54		Salt river valley	12.42	53	Yuma	(No cultivation; from plant of second year.)	11.50
California	84	Tulare	Alluvial loam	16.28	81	Napa	Red plateau land (altitude of 2,000 feet).	9.57
Florida	92 *c*	Clay	Sandy, "pepper and salt" land, no manure.	*21.14	107	Hillsborough	Rather poor pine land	*9.02
Georgia	156	Stewart	Gray sandy land, 40 years' culture, manured.	18.60	154	Screven	Sandy bottom land	7.95
Indian territory	169		Bottom lands	14.35	170		Bottom lands	12.50
Louisiana	174	Catahoula	Creek bottom land	16.36	191	Winn	do	9.03
Mississippi	199 *a*	Jasper	Black prairie, new land	14.82	205	Lee	Sandy bottom land	9.11
Missouri	210	Dunklin	Dark prairie loam, cultivated 10 years, not manured.	15.82	214	Stoddard	Lowland	10.65
North Carolina	277	Tyrrell	Light sandy loam, clay subsoil	16.67	240	Halifax	Sandy river land	9.65
South Carolina	307	Marlborough	Red stiff soil, clay subsoil	14.35	286	Aiken	Light sandy loam, clay subsoil (long staple upland).	7.05
Tennessee	309 *b*	Madison	Hill land, manured	14.66	311 *c*	Madison	Hill land, not manured	10.57
Texas	320	Dallas	Black prairie land	20.32	372	Walker	Sandy land	5.71
Virginia	382	Southampton	Light sandy soil, red subsoil	16.05	384	Sussex	Medium upland soil	11.88
All the states	60	Conway, Ark.	River bottom land	22.14	372	Walker, Tex.	Sandy land	5.71

* Sea-island cotton omitted from the averages for the United States.

MAXIMA AND MINIMA OF THE POINTS INCLUDED IN THE MEASUREMENTS FOR THE SEVERAL STATES—Continued.

PERCENTAGE OF LINT ON THE SEED.

State.	GREATEST.				LEAST.			
	No. of sample.	County.	Character of land.	Per cent.	No. of sample.	County.	Character of land.	Per cent.
Alabama	40	Tuscaloosa	Stiff river bottom land	41.98	48 c	Washington	Piny woods land, fertilized	26.02
Arkansas	58	Boone	Sandy loam ridge land	38.23	59	Boone	Brown clay loam	28.64
Arizona	54		Salt river valley	31.67	53	Yuma	(From boll of plant of second year)	24.16
California	82	San Diego	Red gravelly bench land, cotton of 2-year old plant.	39.78	78	Merced	Alluvial loam	23.45
Florida	104	Gadsden	Sandy table-land	36.76	110 a	Marion	New pine land, sandy	*11.45
Georgia	118	Appling	Sandy pine woods and wire-grass land.	41.57	164	Troup	Red clay land	24.54
Indian territory	169		River bottom land	32.26	170		River bottom land	31.48
Louisiana	192	Winn	Sandy hummock	43.79	182	Red River	Red river alluvial land	20.46
Mississippi	194	Clarke	Black prairie soil, cultivated 10 years.	39.26	195	Clarke	Black prairie soil, cultivated 40 years.	31.87
Missouri	213	Stoddard	Lowlands	34.21	210	Dunklin	Dark sandy loam, cultivated 30 years, unmanured.	28.30
North Carolina	231 b	Craven	Light sandy soil, manured	40.13	233	Craven	Stiff clay hummock land	19.50
South Carolina	293 b	Charleston	Light sandy soil (James island)	37.68	290	Charleston	Highland, sandy (Edisto island)	27.77
Tennessee	311 a	Madison	Hill land	37.41	311 b	Madison	Hill land, manured	30.37
Texas	360	Lee	Red land upland	42.10	371	Walker	Black prairie soil	23.16
Virginia	385	Sussex	Stiff black bottom land	41.93	378	Southampton	Gray sandy loam, clay subsoil, manured.	29.90
All the states	192	Winn, La	Sandy hummock land	43.79	233	Craven, N. C	Stiff clay hummock land	19.50

* Sea-island cotton omitted from the averages of the United States.

AVERAGES FOR EACH STATE.

State.	No. of samples.	Length.	Width, $\frac{1}{1000}$ inch.	Breaking weight.	Weight of 5 seed.	Percentage of lint.
		Inches.		*Grains.*	*Grains.*	
Alabama	60	1.027	0.896	137.8	12.38	32.96
Arkansas	13	1.036	0.917	134.7	13.36	32.85
Arizona	4	0.969	0.957	133.7	11.96	27.91
California	19	1.079	0.921	144.6	12.58	32.01
Florida*	45	1.384	0.793	124.1	12.64	29.14
Georgia	52	1.066	0.913	136.9	12.80	33.18
Indian territory	2	1.081	0.905	119.3	13.42	31.87
Louisiana	24	1.069	0.882	127.5	13.01	33.08
Mississippi	18	1.047	0.957	134.3	12.11	34.01
Missouri	6	1.098	0.890	136.4	12.76	31.62
North Carolina	94	1.058	0.929	132.7	12.55	33.21
South Carolina	26	1.234	0.957	120.3	11.80	31.62
Tennessee	7	0.992	0.808	133.3	12.33	33.10
Texas	72	1.075	0.897	132.8	13.07	32.34
Virginia	8	1.060	0.945	126.1	14.00	34.44
Total	450					

* Mostly sea-island cotton.

SUMMARY.

The following table shows the number of samples which have the given respective fiber lengths in the several states.

"Short" staple signifies under 0.98 inches, or 25 millimeters; "medium" means from 0.98 to 1.17 inches, or 25 up to 30 millimeters; "long" staple denotes 1.18 to 1.57 inches, or 30 to 40 millimeters; "extra" includes those that are 1.58 inches, or 40 millimeters or more.

State.	Short.	Medium.	Long.	Extra.	All.
Alabama	22	33	5	....	60
Arizona	2	1	1	....	4
Arkansas	3	10	....	....	13
California	9	6	3	1	19
Florida	4	7	20	14	45
Georgia	16	26	10	....	52
Indian territory	....	2	....	....	2
Louisiana	2	19	3	....	24
Mississippi	2	14	2	....	18
Missouri	2	2	2	....	6
North Carolina	22	58	14	....	94
South Carolina	7	9	4	6	26
Tennessee	4	3	....	....	7
Texas	11	55	5	1	72
Virginia	3	4	1	....	8
Total	109	249	70	22	450

GENERAL AVERAGES FOR THE UNITED STATES.

		Least.	Medium.	Most.	Extra.	All.
Length	inches	0.91	1.07	1.32	*1.72	1.10
	millimeters	23.03	27.09	33.44	43.63	27.80
Width	$\frac{1}{1000}$ inch	0.93	0.91	0.88	0.80	0.91
	$\frac{1}{1000}$ millimeter	23.60	23.20	22.40	20.40	23.00
Strength	grains	134.30	122.80	126.50	109.90	125.60
	grams	8.70	7.96	8.20	7.12	8.14

* Sea-island cotton.

PERCENTAGES OF DIFFERENT LENGTHS.

Short, or under 0.98 inches long 24
Medium, or from 0.98 to 1.17 inches long 55
Long, or from 1.18 to 1.56 inches long 16
Extra, or 1.57 inches and more 5

The "extra" and the "long" appear, from the character of the seeds, to have come mostly from what Todaro describes as *Gossypium maritimum* (sea-island cotton). The "short" and "medium" correspond to *Gossypium hirsutum* and *Gossypium herbaceum*. Florida makes the best show as to quality, sea-island cotton being predominantly grown.

REMARKS ON THE FIBER MEASUREMENTS.

BY E. W. HILGARD.

Several unforeseen difficulties present themselves in the attempt to deduce general truths from the results of the measurements. First among these is the uncertain nomenclature of the varieties grown. It soon became evident also, as the samples came in, that the same variety of cotton occasionally received different names, and different varieties the same name, so that an element of uncertainty was introduced into the comparison designed to elicit the influence of different soils and climates upon the quality of the staple to the extent to which different varieties might differ in these respects. It was attempted to obtain, through correspondence, accurate and authentic descriptions of the prominent varieties; but from a variety of causes the success was not encouraging, it being evident that the subject requires a thorough sifting by a competent person in the cotton-fields themselves. Again, it was not always possible to obtain samples grown on the soil-varieties that had been accurately studied, and perhaps in the majority of cases the exact nature of the soil had to be inferred from the description of its natural plant or timber growth and of the region of country in which it occurred. It would, of course, have been feasible to supplement these data afterward, and it may perhaps still be done; but want of farther means compels for the present the publication of the data as they are with but little comment.

It is well known that of all experimental studies those referring to agriculture must guard most carefully against hasty conclusions based upon scanty premises and short experience. In the present case, so many factors present themselves as possibly influencing the several points ascertained in the processes of measurement that sweeping inferences regarding any one of them cannot be safely made. But what can be done is to deduce probable indications of the proper direction to be given to future researches, which should be conducted on a uniform and well-elaborated plan, at the several agricultural colleges or experiment stations in the cotton states.

It is greatly to be regretted that, as it now appears, the material received and examined was little adapted to the definite determinations of the questions mooted, being composed of such samples only as chanced to be sent by persons responding to the circular. Had it been feasible to collect samples systematically from the several soil regions, such as the great bottom, the prairie belts, sandy pine lands, etc., of the several states, much more definite conclusions could have been reached, and perhaps could be eliminated even now did time permit. As it is, the best form in which the results foreshadowed can be presented is that of tables showing the maxima and minima of length, width, strength, etc., for the several states. These certainly afford much food for reflection, and show how well a closer investigation of this interesting and important subject would be rewarded. It is true that (as was pointedly remarked by Mr. Edward Atkinson in a letter to the editor on this subject) the commercial grading of the staple, as at present practiced, takes but little account of anything save the length and color, and, to a limited extent, of the luster and fineness of the fiber, the determining points being, first, freedom from trash, and, next, the greater or less injury done to the staple in ginning. The latter point especially is coming to be more and more appreciated, and it is getting to be understood that the high velocities of the saw cylinder, adopted for the sake of an increased output of lint, are seriously detrimental to the quality and especially the strength of the fiber—that a considerable proportion of the fibers is actually cut in two, while a still larger one is sharply bent and thereby weakened at or near the middle, greatly diminishing the aggregate strength of thread made of such material. This is among the considerations that have so strongly recommended the use of the "Clement attachment", with its gently-acting wire brush, instead of the saws; there being no occasion to hasten the ginning beyond the immediate requirements of the carding-machines, the cutting or tearing as well as the sharp bending ("knicken") of the fiber is altogether avoided, and the same cotton will make a stronger thread. It is sometimes thought that the substitution of the Macarthy (cylinder) gin for the saw gin would obviate the greater part of the damage done in ginning; but the experiments made in India and England show that, with an equal output of lint, the knife of the Macarthy gin does nearly or quite as much damage to the staple as the teeth of the saw gin.

So long, then, as the grading and commercial value of cotton depends less upon its natural quality than upon the greater or less care with which it is prepared for market the points of which the measurements are here recorded are only contributory, and not governing, as regards the commercial value of a given product. Yet it is obvious that even thus a knowledge of the peculiarities of the cotton from the several soil regions and varieties is of great importance; for it is manifest that a long and weak fiber must be ginned more slowly than a short and strong one, in order to give the product the highest market value compatible with what may be considered a reasonable output of the gin. The cotton-grower will then know how to balance his operations as between speed and output of the gin, in order to secure the best pecuniary returns in each particular case. At present few pay any attention to these points, and cottonseed cotton having a staple of extra length is ginned at the same speed as, and perhaps even mixed with, short staple from poor pine lands.

The following points are suggested by even a cursory inspection of the preceding tables:

1. *Length of fiber.*—The maximum of all cottons necessarily falls to South Carolina (1.966) and Florida (1.910) as the representatives of the long-staple or sea-island variety. Limiting comparisons to the upland or short-staple cottons, California stands first (1.669), Georgia second (1.552), Alabama third (1.427), and Texas fourth (1.380);

while Virginia and North Carolina come in almost equal for the fifth place. A rapid review discovers no obvious relation of these maxima to upland or lowland soils, and so far as the imperfect testimony goes the upland cottons seem to be longer than those from the lowlands, except in the case of California. The minimum of length (0.695) comes from North Carolina, from a light sandy loam soil. The next shortest comes from a plant bearing in its second year, at Yuma, Arizona, that was growing among weeds in an abandoned garden. Another two-year-old plant, growing near National City, San Diego, also yields a somewhat short, yet respectable fiber. It should be noted that, with the exception of the sample from California (No. 70), all the shortest samples were grown on uplands.

2. *Width of fiber.*—The widest fiber comes from Alabama "red land"; it is at the same time quite short (0.945 inch). With the exception of California and Missouri, all the widest fibers come from uplands, and the width of those from the two excepted states is quite low. Among the minima Florida, with its fine and long sea-island staple, stands foremost. Outside of this the lowest minima are from bottom lands, and it would therefore seem pretty well shown that the river-bottom staple is narrower, and therefore probably finer, (*a*) than that of the uplands.

3. *Strength of fiber.*—The strongest fiber comes from Tangipahoa parish, Louisiana, and was grown on creek-bottom land, of which nothing is known in detail except that it is very sandy, and, for such soil, rich in vegetable matter. The next strongest comes from "stiff river-bottom land" in Tuscaloosa county, Alabama, and a very weak one, oddly enough, from red-clay upland of the same state and county. As all the Alabama samples were strictly new cotton, this is a remarkable result not to be explained by a possible deterioration of the fiber. Fortunately, the two soils referred to have been analyzed and show a remarkable difference in their percentages of phosphoric acid, the latter being very high in the bottom land and extremely low in the upland soil. Time has not permitted the verification of a similar relation in other cases, but the general "run" of soils appears to point that way. It would be curious to find that the strength of cotton fiber depends materially upon the same substance whose presence or absence determines the strength of the bony fabric of animals.

4. *Weight of five seeds with lint attached.*—The maximum weight (22.14) comes from the rich bottom land of the Arkansas river; the next in weight (21.14), curiously enough, from the poor sandy pine upland of Florida; the third heaviest (20.32), from the black prairie land of Texas. It seems difficult to reconcile this diversity of origin with the idea of any common cause; still, inspection of the table shows that the light weights or minima are nearly all from sandy land, both upland and lowland, while the heavier weights come prevalently from heavy and mostly very productive soils. The contrast between the third heaviest weight from Dallas and the lightest (5.71) from Walker county, Texas, is telling, the one being from prairie land, and the other from light sandy upland. It is well known to cotton-growers that the bolls are usually largest on the fertile bottom lands, and it is currently supposed that the seeds are there the heaviest; but nothing is known regarding the number of seeds carried by each, or whether these are usually more numerous in the lowlands or the uplands. These points acquire the greatest practical interest in connection with the next item.

5. *Percentage of lint and seed.*—The proportion commonly assumed to exist between these is that the lint forms about one-third (33.3 per cent.) of the weight of the seed-cotton. The average shown in the table is considerably higher than this, for the natural reason that the gin is not as effective in making a complete separation as the hand, and that a good deal of cotton remains with the seed. Another cause is the dry condition of the seeds when weighed, they having in part been over a year from the picking; while the weight to which the planter refers his product of lint is that obtained in weighing the pickers' daily gatherings, when the seed-cotton is fresh, and in many cases moist or partly wet from dews or showers. The lint alone being always weighed dry, all the losses in drying as well as in ginning tend to lower the lint percentage obtained in practice. Comparing the data in the table, we find the maximum lint percentage (43.79) to come from a sandy creek hummock land in Winn parish, Louisiana, and the minimum (11.45) from new sandy pine land in Marion county, Florida. This is so far below the rest that it must be supposed to have been long-staple cotton, to which in practice the proportion of one of lint to three of seed is assigned; but it is exceedingly low even for that. This sample was not very long, and broke with 101 grains—a very weak fiber. Of the rest, the lowest percentage occurs in stiff clay hummock land from Craven county, North Carolina; and next to this stands a sample from Red river alluvial land from Red River parish, Louisiana. This is one of the best cotton-growing regions of the South, where as much as a thousand pounds of lint per acre has been grown on fresh land; and it confirms the current impression that in the seed-cotton from the great bottoms the seed is heavier than elsewhere. In the case before us it implies the gathering of fully 5,000 pounds of seed-cotton per acre—a somewhat startling figure. There can be no doubt that a close and more extended investigation of this point would lead to important practical results.

Influence on soil and location on cotton fiber.—In regard to the influence of soils and location on the dimensions, strength, and relative abundance of the cotton fiber in seed-cotton Texas seems to offer the best opportunity for a comparison from which at least the element of diversity of climate is sensibly eliminated. It offers, moreover, the advantage of a considerable diversity of soils, strongly characterized and rather numerously represented among those analyzed, as well as a uniform absence of any method of soil improvement calculated to modify the nature of

a "Fineness," properly speaking, involves not only the width but the cross section, *i. e.*, width multiplied into thickness. As the latter has not been measured, it cannot be taken into account; and practically what is here designated as "width" is the measure of commercial "fineness" and "coarseness".

the soil, such as manuring, underdraining, etc. The subjoined table presents the results of a classification of Texas cotton samples and corresponding measurements, upon the basis of the soils upon which they were grown, into four divisions. Of these, the first, that of "black prairie soils", represents soils in general of a rather heavy clay nature, black with humus, in part at least highly calcareous, and in all cases moderately so, and possessing from fair to high percentages of mineral plant-food. In the second class, "sandy uplands," the texture of the soil is generally light, the amount of humus only moderate, the supply of lime low to deficient, but the supply of phosphoric acid and potash fair to high. The soils of the "river bottoms" differ from the prairie soils mainly in that they are lighter and usually less calcareous, but few being very decidedly so; the supply of humus is rather less, as is also that of potash, but phosphoric acid is mostly high. As to the fourth class, "creek bottoms," the four samples falling into this class seem to represent the alluvial soils of the sandy uplands—sandier than the bottom soils of the large rivers, usually lighter in texture, and with smaller percentages of phosphoric acid, potash, and lime, and mostly also of humus:

Character of lands.	No. of samples.	Length.	Width.	Breaking weight.	Weight of 5 seeds, with lint.
		Inches.	*Inch.*	*Grains.*	*Grains.*
Stiff black prairie lands	20	1.040	0.921	125.7	12.64
Sandy upland soils	16	1.059	0.855	138.4	12.85
River bottoms (alluvial)	12	1.048	0.975	136.2	12.61
Creek bottoms (dark loams)	5	1.017	0.840	141.8	14.59

The result of these comparisons may be thus stated: The fiber from the creek bottoms is the shortest, finest, and strongest, and the one yielding the largest weight of seed. That from sandy uplands is the longest, and next in fineness, strength, and weight of seed to the creek-bottom staple. The fibers from the prairie lands and the great alluvial bottoms are of the same length, and are considerably greater than that of the creek-bottom product, but decidedly less than that of the uplands. The river-bottom fiber is the widest of all and in strength is slightly behind that of the uplands. The prairie cotton is somewhat finer, but its strength is considerably behind that of all the rest.

Should these results be substantiated by further comparisons, they would be of very considerable practical importance in the grading of cotton for manufacture. Two factors, however, are lacking, viz, the thickness of the cotton bands, as well as the relative twist, a matter discussed by Professor Ordway on page 18. The determination of these, however, would require appliances to be constructed for the specific purpose.

The comparison of averages of measurements by states must of course be taken with a great deal of allowance for the accidental predominance of the products of certain districts from which the larger number of samples was obtained, as, *e. g.*, in the case of South Carolina and Florida, where long-staple cotton predominates. In the older states it is, moreover, vitiated by long cultivation and the occasional use of heavy manuring, the influence of which is very apparent in some cases where manured and unmanured ground of the same character can be compared. Cases in point are given in the table below:

No. of sample.	Character of lands.	Length.	Width.	Breaking weight.	Weight of 5 seeds, with lint.	Percentage of lint.
	ALABAMA.	*Inches.*	*Inches.*	*Grains.*	*Grains.*	
48 c	Pine-woods soil, fertilized with yard and fowl-house scrapings	0.922	0.819	114.2	13.04	20.02
48 e	Pine-woods soil, fertilized with compost of cottonseed, lime, and lot scrapings	1.023	0.866	147.5	12.35	31.87
48 d	Pine-woods, old land, not fertilized	0.789	0.827	143.4	9.48	35.77
	MISSISSIPPI.					
201	Light sandy loam, fresh	1.055	0.909	125.3	....	....
202	Light sandy loam, old land, unmanured	0.810	0.929	117.6	....	....
203	Light sandy loam, old land, highly manured	1.282	1.081	161.4	....	....
209	Dark loam or hill land, cultivated three years	1.012	1.016	144.8	....	....
208	Dark loam or hill land, cultivated twenty-five years	0.994	0.980	147.5	....	....
199 a	Black prairie land, fresh	0.996	0.988	116.4	14.82	33.93
199 b	Black prairie land, cultivated twenty years	1.098	1.039	145.1	12.65	34.13
194	Black prairie land, cultivated ten years	0.922	0.902	113.3	12.58	30.26
195	Black prairie land, cultivated forty years	1.015	0.965	116.7	12.35	31.87
	TEXAS.					
358 a	Sandy post-oak land, unmanured	1.075	0.791	136.4	18.13	31.91
358 b	Sandy post-oak land, manured from cow-pen	1.147	1.260	134.6	17.59	27.10
357 a	Sandy post-oak land, manured	1.153	0.858	138.0	17.21	32.73
357 b	Sandy post-oak land, manured	1.374	0.736	142.3	17.13	28.83

In the case of the Alabama pine-woods soil, No. 48, the shortness of the fiber, the small weight of the five seeds, and the large percentage of lint are eloquent of the difference between this product and that from fresh or manured land, both in quantity and quality. The same inference as to length of fiber is apparent in the first group of Mississippi samples, Nos. 201, 202, and 203, in which the fiber from unmanured land is one-fifth shorter than that from the fresh land and one-third shorter than that from the highly manured land; and the comparison in the case of Nos. 208 and 209 points in the same direction. In the case of the black prairie land the reverse occurs; the comparison of the fresh land, No. 199 *a*, with the same cultivated twenty years, and that of Nos. 194 with 195, each show an increased length of fiber with longer cultivation, with a nearly corresponding increase of width. This is quite intelligible in so far as rich, heavy prairie land really improves by cultivation for some time, becoming more friable and affording better opportunity for full development; while the sandy uplands soon become "tired", and yield a short and indifferent fiber.

THE PRODUCTION AND USES OF COTTONSEED

AND THE

COTTONSEED-OIL INDUSTRY,

BY

E. W. HILGARD.

THE COTTONSEED-OIL INDUSTRY.

The following circular was sent by the Census Office to all cottonseed-oil mills then known to exist, as well as to a number of prominent cotton-planters, for the purpose of obtaining data regarding the cottonseed-oil industry and the uses of cottonseed:

DEPARTMENT OF THE INTERIOR,
CENSUS OFFICE,
Washington, D. C., April 5, 1880.

SIR: The subjoined schedule of questions, relating to the cottonseed-oil industry, is transmitted to you, with the request that you fill the blanks as far as possible, and return them, at as early a period as convenient, in the inclosed envelope.

In order that the object of these questions may be fully understood, it is desirable to call attention to the high importance of the development of the cottonseed-oil industry with reference to its influence upon the production of cotton itself.

Since cottonseed constitutes on an average somewhat more than two-thirds by weight of the crop taken from the cotton-field, it is obvious that the progress of soil exhaustion, or the maintenance of fertility, must depend mainly upon the use made of cottonseed itself. As a matter of fact, however, it is proved by chemical analysis, corroborated by the experience of the older cotton-growing states, that the importance of cottonseed to the soil is far greater than is indicated by its proportion to the lint crop; for out of 45 pounds of mineral plant-food withdrawn from the soil by the seed-cotton required to make a 400-pound bale but a little over four pounds are contained in the lint, the rest remaining in the seed. In other words, the withdrawal of one crop of cottonseed from the soil is equivalent to the drain created by *ten* crops of lint. Practically, cotton lint could be grown indefinitely upon most of the better class of soils without other return than the cottonseed itself.

The oil extracted from the seed, however, contains little that is of any consequence to the soil. The seed-cake and hulls would be nearly as good as the whole seed. The seed-cake *without* the hulls would be equivalent to more than three-quarters of the seed when returned to the field as a manure.

The cottonseed-oil manufacture, therefore, does not only not detract necessarily from the returns to the soil, but puts the most important portion of the crop into a far more convenient shape for use, both for feed and manure, than the raw cottonseed.

It is desired, by the aid of the data furnished by you, to place this important subject clearly and authentically before the cotton-growers, showing them by the irresistible logic of figures that the cottonseed-oil mill is to them the means of utilizing a waste product, increasing materially their home supply of available stock feed, and at the same time of maintaining the fertility of their soil, instead of paying heavy tolls to manufacturers of chemical fertilizers, transportation companies, and provision merchants.

Late experiments having appeared to indicate that among the most available and profitable modes of returning cottonseed or its oil-cake to the fields is the feeding of sheep, thus producing cotton and wool on the same field, as it were, any data you may be able to furnish on this and related points will be especially welcome.

Many persons to whom this circular may be sent, who are not manufacturers of cottonseed-oil, will be able to reply to all the questions in respect to the use of the seed, hulls, and meal for feed and for manure, and they are urgently requested to give such replies, especially as to the feeding of sheep and the effect of cottonseed thus used upon the production of wool.

Respectfully,

FRANCIS A. WALKER,
Superintendent of Census.

In response to the above circular replies were received from twenty cottonseed-oil mills, about double that number being in existence at the time. The substance of the replies is given partly in tabular form and partly under the head of the schedule questions. In some of these is apparent a scantiness of definite data regarding the manufacture; but, fortunately, such data can mostly be supplemented from the statements of others on the same points. The industry has now so far passed beyond the experimental stage that few important technical secrets can lie within the scope of the information asked for.

A number of letters from planters addressed on the subject were also received, and of these abstracts are hereinafter given.

The accompanying table exhibits, in a convenient form, the answers received to a portion of the inquiries; while another portion is of necessity placed under the heads of the respective questions.

COTTONSEED-OIL MILLS—REPLIES TO QUESTIONS.

	Names.	Location.	Working capacity. Tons of seed used. Daily.	Working capacity. Tons of seed used. Yearly.	Working capacity. Estimated gallons of oil. Daily.	Working capacity. Estimated gallons of oil. Yearly.	Hullers.	Presses of boxes. Presses.	Presses of boxes. Boxes.
							No.	No.	No.
1	Crescent City Oil Company	New Mechanicham, La	150	....	5,550	....	4	12	240
2	Maginnis Oil Works	New Orleans, La	....	3,500	....	115,500	6	13	200
3	Planters' Oil Company	do	....	20,000	....	640,000	6	14	84
4	Iberia Oil Mill	New Iberia, La	10	....	320	....	1	2	12
5	Hamilton Oil Mills	Shreveport, La	60	....	1,920	....	3	3	63
6	Yazoo Oil Works	Yazoo City, Miss	....	....	1,100	....	1	6	32
7	Refuge Oil Works	Refuge, Miss	40	....	1,240	....	2	4	60
8	Friar's Point Oil Mill	Friar's Point, Miss	....	....	1,260	....	2	3	45
9	Augusta Oil Company	Augusta, Ga	20	....	600	....	1	4	....
10	Savannah Oil Company	Savannah, Ga	30	....	900	....	1	8	32
11	Galveston Oil Company	Galveston, Tex	....	....	....	....	5	10	150
12	Calvert Oil Company	Calvert, Tex	....	....	800	....	2	2	30
13	Bryan Manufacturing Company	Bryan, Tex	....	5,000	....	102,500	1	4	104
14	Brenham Oil Mill (burned)	Brenham, Tex	....	....	....	....	....	....	....
15	Callahan Oil Works	Hempstead, Tex	40	....	1,280	....	....	....	....
16	Schumacher Oil Mill	Navasota, Tex	20	....	600	....	1	4	....
17	Cottonseed-Oil Mills	Raleigh, N.C	(a)	....	50	....	....	....	....
18	Southern Oil Works	Memphis, Tenn	60	....	1,820	....	....	....	....
19	Panola Oil and Fertilizing Company	do	75	....	2,400	....	2	6	96
20	Hope Oil Company	do	....	....	....	....	1	8	....

a Three hundred bushels of seed per day.

COTTONSEED-OIL MILLS—REPLIES TO QUESTIONS.

PRODUCT PER TON.				Cottonseed used in a season.	Source of supply.	Average price.	COTTONSEED-CAKE.				
Kernels.	Hulls.	Oil-cake.	Crude oil.				Amount sold at home to farmers.	As cake or meal.	Uses. Feed.	Uses. Manure.	
Lbs.	*Lbs.*	*Lbs.*	*Galls.*	*Tons.*							
1,000	1,000	775	37½	12,726½	Mississippi River valley, Texas, and a little from Alabama.	$10	25 per cent	Meal	Some (*b*)	Chiefly	1
....	....	700	30-35	17,000	Mississippi, Louisiana, Texas, Alabama, and Florida.	$12-$15	10 per cent	Meal	Yes	Yes	2
Various	Various	Various	Various	20,000	Mississippi River and tributaries, Alabama, and Texas.	Various	Small	Meal	Small	Chiefly	3
c 615	1,385	720	32	1,200	Bayou Teche and Opelousas	$6	All	Meal	Not much	Mostly	4
1,000	1,000	About 700	32	12,000	Bayou Wincey and Red river to Kiamitia; eastern and northern Texas.	$9	Very little	Meal	Little (*d*)	....	5
1,000	1,000	720	30-35	2,500	Yazoo and Tallahatchee rivers	$7 50 to $8 50, delivered.	None	Meal	Yes	No	6
1,000	1,000	770-785	30-32	Half season lost. 7,000	Mississippi river from Vicksburg to Helena.	$9 50, or $7 net to farmers.	None	Some meal	Yes	Yes	7
....	....	700-720	34-36	3,500	Vicksburg to Memphis	$9 to $9 50	None	5 per cent. meal.	Yes	None	8
1,000	1,000	730-740	25-35	867	Georgia and South Carolina	$9 to $11 50	Half	Meal	....	....	9
....	....	....	....	First season.	Georgia, South Carolina, and Florida	....	....	....	....	....	10
Not yet in operation.				....	Texas	$6 at railroad stations.	....	....	....	....	11
500	1,500	763⅓	30	2,378	Robertson county	$5	Small amount.	Meal	Yes	....	12
1,240	760	850	32½	2,244 Short supply.	Brazos, Burleson, and Robertson counties.	$7	Small	Meal	Mostly	Some	13
....	....	....	....	....	....	$4 50, delivered	Most of it is shipped to Liverpool.				14
900	1,100	750	28-35	3,000	Immediate vicinity and stations on the Houston and Texarkana railroad.	$6	Small am't, 50 tons per year.	Meal	Yes	Yes	15
1,000	1,000	750	30	2,000	Neighborhood	$6 to $9	Very small	Meal	Mostly	Some	16
1,000	1,000	1,100	22	400	East and Middle North Carolina	$10	All	Meal	Yes	Yes	17
....	....	....	....	10,000	Southern states	....	None	....	Yes	Yes	18
1,000	1,000	Varies	Varies	10,000	Neighboring states	$7 to $12	Two-thirds	Meal	Yes	Yes	19
....	....	....	....	....	Tennessee, Mississippi, and Arkansas.	$9	2 per cent	Meal	Yes	None	20

b Increasing demand for this purpose.

c The huller does nothing but grind or cut the seed; the shake divides or separates the kernels from the hulls; 1 to 2¼.

d Increasing; dairymen use it liberally and profitably.

The above partial statement of the seed worked and products marketed by the cottonseed-oil mills is supplemented by a summary given by Hon. Henry V. Ogden, of New Orleans, in a lecture delivered at Atlanta, Georgia, May 26, 1882. He says:

Taking my estimate of the consumption of seed by the forty-one oil-mills this season, the proportion and value of the total product may be summed up as follows:

410,000 tons seed, yielding 35 gallons crude oil to the ton, is 14,350,000 gallons, worth 30 cents per gallon.	$4,305,000
Same amount of seed, yielding 22 pounds cotton lint to the ton, is 9,020,000 pounds cotton, worth 8 cents per pound	721,600
And yielding also 750 pounds oil-cake to the ton, is 137,277 tons (*a*) of cake, at $20 per ton	2,745,540
Makes the total value of the manufactured products	7,772,140
Deduct the sum paid for the seed, say	4,100,000
And there remains for value gained in manipulation of seed	3,672,140

Other oil-mills (from which no reports have been received) are located as follows:

Louisiana: 2 in New Orleans and 1 in Baton Rouge.

Mississippi: 1 each in Columbus, Greenville, Natchez, Meridian, Jackson, and Vicksburg.

Texas: 1 each in Dallas and Sherman.

Arkansas: 2 in Helena, and 1 each in Pine Bluff and Little Rock.

Alabama: 1 each in Selma and Montgomery.

Tennessee: 4 in Memphis, 2 in Nashville, and 1 in Jackson.

Missouri: 2 in Saint Louis.

OTHER ANSWERS TO SCHEDULE QUESTIONS.

1. Do you refine your oil yourself, or is there a growing tendency to the establishment of separate refineries?

The oil is refined in *Crescent City, Maginnis, Planters, Panola, Hope, Southern* and *Refuge* mills. In the others the crude oil is shipped to refineries. *Maginnis:* We purchase crude oil from other mills. *Iberia:* The mills of New Orleans do the refining. *Refuge:* We know of no tendency to establish separate refineries. *Friar's Point:* We sell the oil in the crude state. *Calvert* and *Bryan:* There is a tendency to the establishment of refineries. *Callahan* and *Panola:* The tendency is for oil-mills to refine their own oil.

2. What knowledge have you of the use of cottonseed or meal as a manure for sugar-cane, and of its effect on the production of sugar?

Bryan: It causes the cane to grow rapidly and mature quickly, giving a longer time to sweeten; 400 pounds of meal per acre has been known by a number of planters to increase the yield from 50 to 100 per cent. per acre. *Friar's Point:* We consider it one of the best fertilizers for sugar-cane, and sell large quantities for that purpose. *Refuge:* We are told by buyers that it is the finest that can be found; it also applies to cotton and corn. *Yazoo:* Sugar-planters in the Lower Mississippi region prefer it over any other fertilizer. *Hamilton:* Sugar-planters claim an increased yield of 33⅓ per cent. from its use. *Iberia:* Very beneficial, and is extensively used on cane, particularly stubble cane. *Maginnis* and *Planters:* Meal for sugar-cane is good. *Panola:* Have been told by sugar-planters that in some years (cold seasons) it increases the yield 100 per cent.

3. Do you use any process or machine prior or subsequent to the hulling process for removing lint left by the gin or the short fur of the seed?

The "linter" or gin, usually the Carver patent, is used in all of the mills except the Shreveport mill, which uses only a screen for removing trash, etc.; the Raleigh mill uses nothing at all.

4. Do you find it a paying process, whether as to the value of the shoddy produced or the increased yield of oil?

Crescent Mills: It pays about $1 25 per ton and facilitates hulling, which otherwise would be almost impossible. *Maginnis Mills:* Depends on the price of the seed. *Planters:* It forms part of the product procured from seed. *Iberia:* Not only necessary, but pays. *Hamilton:* Protects machinery from breaks. *Yazoo:* Adds to receipts and facilitates hulling. *Refuge:* The value of the lint we get. *Augusta:* Not very profitable after deducting labor and extra machinery. *Calvert:* In both respects. *Bryan:* The value of the lint, the most profitable part of the business. *Callahan:* It is profitable because of the lint. *Schumacher:* It is essential to free the cake from lint. *Panola* and *Hope:* It only enables us to hull easier.

5. Do you find any sale for cottonseed hulls for packing, stock feed, or any other purpose?

Crescent City: For stock feed entirely. *Planters:* For packing and stock feed. *Iberia:* For fuel. *Hamilton:* For stock feed. Think it would make paper; and would make a fine absorber for making manures. *Yazoo:* No; cannot give them away; planters would not move them for their value. *Refuge:* For stock feed and fertilizers. *Friar's Point* and *Augusta:* No use. *Calvert:* For packing and for stock feed. *Bryan:* To some extent for packing; a good demand for stock feed and for fuel. *Brenham:* Were used as fuel in the oil-mill. *Callahan:* For packing, stock feed, fuel, and manure; stock prefer them to the seed. *Schumacher:* To a small extent; some for packing, but mostly for stock feed. *Raleigh:* Some as manure for corn and potatoes. *Hope:* Some for food. *Southern* and *Panola:* For food and for fuel.

a 2,240 pounds each.

6. Please state what, according to your best information, are the merits or demerits of cottonseed-meal for either food or manure.

Maginnis: Good for both. *Planters:* Its value as cattle food is well established, and English statistics show it as being the best flesh and fat former known. For fertilizers its use is increasing every year. *Iberia:* All that we make is used by the sugar-planters on the Teche for fertilizing, and is considered a necessity. On stubble cane the effect is good, warming the ground and giving the plant an early start. *Hamilton:* Our practical experience proves it a nutritious, cheap, and valuable food for cattle and sheep, and creates the richest and largest flow of milk from cows than any other food ever used. It cannot be surpassed as a fertilizer. *Yazoo:* Excellent for either; is a good flesh former and also a cooling food; is superior to any other for milch cows, sheep, and working cattle. *Refuge:* It fattens cows, and is also a fine milk-producing food. *Calvert:* Good for food; as a manure I don't think it will do in a dry climate. *Bryan:* Has no superior as food for cattle and sheep in producing flesh. A Texas cow will quite often yield one-half more milk if fed on this meal, and at all times will increase her milking capacity fully one-third. The finest looking crops of cotton and corn on the uplands in this county are where about 400 pounds of meal were used per acre. *Callahan:* Good for both, especially as food for milch cows. *Raleigh:* Nothing can be better as a food to produce milk or for work oxen; it has been used with great success for seven years on cotton land, mixed half and half with good acid phosphate. *Panola* (Memphis): It is the equal of any food known; as a fertilizer for some crops it is unsurpassed. *Hope* (Memphis): Best product known for food; recommended as a fertilizer by all who have tried it.

7. What patent or style of huller is preferred?

Crescent City, Hamilton, Refuge, Friar's Point, Savannah, Calvert, Callahan, Hope and *Panola* prefer Wells' patent of Memphis, Tennessee. *Planters'* and *Galveston* prefer the Keihmuller patent. *Maginnis* and *Yazoo* prefer either Wells' or Keihmuller's patent. *Iberia* and *Augusta* prefer Callahan's patent, Dayton, Ohio. *Bryan:* Callahan's for a small and Wells' for a large mill. *Raleigh:* Old style Stone and Demond mill, of Cincinnati, Ohio.

8. Please give such other information or suggestions regarding possible and desirable improvements in this industry as may be pertinent to the object of these inquiries.

Iberia: We are anxious to have all cultivators of the soil and cotton producers give us the seed and take the meal therefrom for fertilizers. We would like to convince them that the cottonseed, divested of its lint and oil, is a better fertilizer than the raw seed; and it will pay us to work the seed for the oil and lint (extra), giving to the farmer the meal; resulting from his seed; 100 tons of seed gives 40 tons of meal; this is a fair average. *Yazoo:* Refined cottonseed-oil is superior to lard for cooking; not only for salad oil, but for all purposes for which lard is used. In taste it is superior and sweeter, and, being vegetable, is easier digested, less heat producing, and therefore, principally in this climate, a healthier food. *Bryan:* We are using a double mat of our own make for pressing the oil out of the seed, which has increased our working capacity fully 50 per cent. Instead of making six cakes, weighing 8 pounds each, we make twelve cakes, weighing 8 pounds each, at each pressing, without any additional labor save that of packing the cakes in sacks for shipment. *Panola:* We think our home farmers and dairymen stand in their own light in not using the meal or cake more extensively. Nearly the whole of the product is exported to Europe for cattle feed. *Hope:* Much more care should be exercised by planters to preserve their seed in good condition, *so that it may not become heated;* the value is nearly destroyed by heating.

9. Do you use the hulls for fuel? If so, are they sufficient to make all the steam you need?

They are not used in *Raleigh*. In all other mills they are used, and make all the steam needed. *Crescent City:* Also sell a great many. *Hamilton:* On grate-bars, longer than for wood. *Yazoo:* 33½ per cent. left. *Refuge:* Use only one-half of what is made. *Brenham:* Four hullers will make hulls sufficient for fuel. *Southern:* Depends on the amount of machinery to be run.

10. Are the ashes of the hulls valued as a manure? If so, for what cultures chiefly, and what price is paid for them?

No use is made of the ashes as a manure in *Calvert, Callahan,* or *Brenham* mills. In others they are usually valued, but in *Iberia, Hamilton* (Shreveport), *Yazoo, Friar's Point,* and *Bryan* no price is put on them. *Crescent City:* Price $12; mixed with cottonseed meal for sugar-cane. *Maginnis:* From $8 to $14 per ton. *Planters:* Sugar-cane. *Iberia:* We don't sell any. Usual price, $12. *Hamilton:* Don't use them. Give them to friends as manure for vegetable and flower gardens. *Refuge:* Price, $9 per ton. Used for sugar-cane. *Augusta:* From $18 to $20; for most field crops. *Bryan:* But little demand; good for corn; washerwomen use them in preference to wood ashes for making soap. *Hope* and *Panola:* Price, $10 per ton.

ABSTRACT OF LETTERS REGARDING USES OF COTTONSEED.

W. C. STOUT, HAWKSTON, CONWAY COUNTY, ARKANSAS.—The introduction of small cottonseed-oil mills (if profitable) in the interior owned by joint-stock companies would most likely lead to a greater appreciation of the value and uses of cottonseed and its products. At no time and in no place have the farmers ever realized one-half the value of their seed. Fed in the raw state, as from the gin, cottonseed is worth to the farmer half as much as corn. As manure it is worth much more than the price obtained. From $8 to $10 per ton have been paid for seed at the mills. Taking from this the cost of shipping, etc., it is safe to say that the farmer realizes not more than $4 per ton for what is worth to him at home 18 bushels of corn. The sale of the seed at present prices is a ruinous exhaustion of the soil without an adequate return.

JOSEPH B. JONES, HERNDON, GEORGIA.—A very large percentage of cottonseed is still returned to the soil for manure, either in its pure or natural raw state or in the form of a compost. Perhaps 85 to 90 per cent. of all the seed (except what is reserved for planting) is thus used, the remainder being used for food for stock. I have been familiar with its use as food for cattle and sheep for the past fifty years, and know it to be excellent for fattening both; but they must be fed with care and in moderation. The seed has never been regarded as reliable and safe for hogs unless fed in combination with other food, nor have I ever been able to get horses to eat it kindly in any form, either alone or in combination. The cottonseed-meal (free from oil) is, however, the best for all purposes; and, if the hulls remain with it, it is especially good for fertilizers. I prefer, however, the natural seed, in compost, as a fertilizer.

DR. M. W. PHILLIPS, OXFORD, MISSISSIPPI.—Experience has shown that cattle fed on cottonseed, and a very little, are kept in excellent condition during the winter; thirty or forty years ago I fed my cows on boiled cottonseed, cooked until easily crushed between forefinger and thumb. There was a demand for all the butter I could spare, and no one complained of *white butter*.

Since 1831 all of my cottonseed was used for manure, except that for planting. I had been taught to let the seed rot in the rains and sun; but after about forty years I determined to let the seed rot in the earth. As an experiment I hauled out sound seed in January to the field and drilled it in the row intended for cotton and turned two furrows on it. I bedded on this in April and planted cotton. This covered 20 acres. Another 20 acres I manured with the rotted seed, most of it as compost. Visitors pronounced the cotton crop from the first to be the best.

I am of the opinion that cottonseed used in stables as litter for stock, to be crushed under foot in part and to be mixed with the dung and saturated with urine, would enhance its value from two to four fold.

On land lying well, cultivated well, all seed and stalks returned to it, the crops will not decline (or very slowly); but to let land become exhausted and then try to bring it back will take more than the seed.

D. L. PHARES, WOODVILLE, MISSISSIPPI.—There is nothing better for food than cottonseed-meal in small quantities, say one or two pounds per day, mixed with hay, etc., and fed to a cow or horse. For manure it is the most valuable known to me. Its use is profitable for crops, except, perhaps, winter oats. Cottonseed sown broadcast and plowed in with winter oats increases the crop from 200 to 400 per cent.

I. H. MOORE, OAKLEY, ARKANSAS.—I know nothing practically of feeding oil-cake to sheep, as the raw seed is cheaper, and has so far been satisfactory. There is no doubt that if the seed from 100 bales of cotton (47 tons) was fed to 500 sheep, running on 100 acres of land, the land would be better and more evenly manured than if the seed in the raw state was plowed in. Cow-pease also raised and sheep pastured on them would be very highly beneficial and restore the old cotton lands of the south. My own experience this winter with feeding sheep on cottonseed has been successful. My flock now consists of 31 old ewes, 16 ewe lambs one year old, and 43 lambs. Three-fourths of the ewes had twins. Last year there were only 31 lambs. Some of the ewes this winter had so much milk that I had to milk them to keep the bag from spoiling. I have fed more seed this year than last. I now feed about two pounds per day to each sheep, or about one ton of seed for each 10 sheep for the winter. The seed is worth at the gin about $3 per ton, or 30 cents for each sheep, and their manure is fully worth the seed.

I am satisfied that the south can, with cottonseed and winter pasture of rye, oats, barley, or wheat, winter 75,000,000 sheep and still have seed sufficient to plant. The more I see of Bermuda grass the more I am satisfied that it will yet prove a great blessing to the south.

PROSPECTIVE MAGNITUDE OF THE COTTONSEED-OIL INDUSTRY AND INFLUENCE UPON SOIL FERTILITY.

The following table shows, for 1879, the amount of cottonseed not needed for seed, and which might have been used in the manufacture of the oil. The second group of columns gives the possible products of such manufacture for the year, assuming that each ton of cottonseed is divided half-and-half into hulls and kernels after the removal of 22 pounds of adherent cotton, and that each ton yields 35 gallons of crude oil. The third group of columns gives the market value of these products, as well as the total for all, the hulls being valued, weight for weight, like pine cord-wood, at $5 per cord, and the ashes at $10 per ton for manurial purposes. The fourth group gives the selling value of the raw cottonseed which would be received by the producer at an average of $7 per ton. In the last column is placed the valuation of the cottonseed, or its equivalent in cottonseed-cake, according to the customary valuation of the ingredients of commercial fertilizers, as deduced from the best analyses. For the percentage composition of cottonseed ash and the ammonia equivalent of the seed the data given in the report of the North Carolina experiment station for 1882 have been adopted; for the ash percentage of the seed the figure 4.0 has been adopted, instead of 3.67, as given on page 95 of that report for the dry substance, but, making an allowance of 7.7 per cent. of moisture, makes the actual figure used 3.70. This increase is justified by the results of ash determinations made by myself with Mississippi uplands cottonseed and by Anderson with seed from South Carolina. The average of the Mississippi seed was 4.2 for the dry substance. Anderson's determinations run even higher than this.

COTTONSEED PRODUCTION OF 1879, THE POSSIBLE OIL-MILL PRODUCTS, WITH THEIR MARKET VALUATIONS, AND THE MANURE VALUE OF SEED IN EXCESS OF THAT REQUIRED FOR PLANTING.

States.	I.			II.				III.						IV.	
	COTTONSEED OF 1879.			POSSIBLE OIL-MILL PRODUCTS FROM EXTRA SEED OF 1879.				MARKET VALUE OF PRODUCTS.						Selling price of seed.	Manure value of the seed or respective oil-cake.
	Total.	Reserved for seed. (a)	Convertible into oil and cake.	Crude oil.	Oil-cake.	Cotton from linter.	Hulls.	Crude oil.	Oil-cake.	Cotton from linter.	Hulls. Fuel.	Hulls. Ash.	Total.		
	Tons.	*Tons.*	*Tons.*	*Gallons.*	*Tons.*	*Tons.*	*Tons.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*
The United States	2,270,417	238,718	2,531,699	88,609,465	949,387	27,848	1,238,001	26,582,839	18,987,740	4,455,680	4,419,664	247,600	54,692,523	17,721,893	46,076,922
Alabama	332,336	38,446	293,890	10,286,150	110,209	3,233	143,712	3,085,845	2,204,180	517,280	513,052	28,740	6,349,097	2,057,230	5,348,798
Arkansas	304,128	17,209	286,919	10,042,165	107,594	3,156	140,303	3,012,649	2,151,880	504,960	500,882	28,060	6,198,431	2,008,433	5,221,926
Florida	26,902	4,052	22,850	799,750	8,569	251	11,174	239,925	171,380	40,160	39,801	2,240	493,596	159,950	415,870
Georgia	386,858	43,181	343,677	12,028,695	128,879	3,780	168,058	3,608,609	2,577,580	604,800	599,967	33,610	7,424,566	2,405,739	6,254,021
Indian territory	8,075	412	7,663	268,205	2,873	84	3,748	80,461	57,460	13,440	13,380	750	165,491	53,641	139,407
Kentucky	650	44	606	21,210	227	7	296	6,363	4,540	1,120	1,056	50	13,129	4,242	11,029
Louisiana	241,570	14,269	227,301	7,955,535	85,238	2,500	111,150	2,386,661	1,704,760	400,000	396,806	22,230	4,910,457	1,591,107	4,136,878
Mississippi	457,478	34,720	422,758	14,796,530	158,534	4,650	206,729	4,438,959	3,170,680	744,000	738,022	41,350	9,133,011	2,959,306	7,694,196
Missouri	10,158	530	9,628	336,980	3,610	106	4,708	101,094	72,200	16,960	16,808	950	208,012	67,396	175,230
North Carolina	185,058	14,736	170,322	5,961,270	63,871	1,874	83,287	1,788,381	1,277,420	299,840	297,335	16,660	3,679,636	1,192,254	3,099,860
South Carolina	248,210	22,510	225,700	7,899,500	84,638	2,483	110,367	2,369,850	1,692,760	397,280	394,010	22,070	4,875,970	1,579,900	4,107,740
Tennessee	157,044	11,922	145,122	5,079,270	54,421	1,596	70,965	1,523,781	1,088,420	255,360	253,345	14,190	3,135,096	1,015,854	2,641,220
Texas	402,642	35,944	366,698	12,834,430	137,512	4,034	179,315	3,850,329	2,750,240	645,440	640,155	35,800	7,922,024	2,566,886	6,673,904
Virginia	9,308	743	8,565	299,775	3,212	94	4,189	89,932	64,240	15,040	14,955	840	185,007	59,955	155,883

a The estimates of tons of cottonseed in this and all of the state reports are based upon the generally accepted ratio of two of seed to one of lint; whereas the majority of correspondents place the proportion of seed much higher. This would therefore give a greater weight of seed actually produced than above tabulated, and this excess, with the amount given in the second column of figures, would make a reserve of more than two bushels per acre for planting.

The figures of the table are sufficiently eloquent. Assuming as the nearest approximation to the actual amount of seed worked in 1879–'80 by the forty-one mills the figures given by Mr. Ogden, we find that somewhat over one-seventh of the available seed has been actually worked. Had all been similarly treated, the cotton-planters would have received something over $17,000,000 for the raw seed, which would have been converted into products worth about $54,000,000. But not the least significant item is found in the last column, viz: That *in order to replace the drain upon their fields resulting from the sale of the seed the planters would have had to purchase commercial fertilizers of the estimated value of over forty-six millions; they could have purchased back the oil-cake itself* (*nearly equal to the fertilizers required*) *by paying for it about a million more* (*or* $18,987,740) *than what they originally could have obtained for their seed* ($17,721,893), *a saving of* $27,089,182 *over the value of the commercial fertilizers*, thus showing the oil-cake to be by far the cheapest fertilizer in the market.

Considering that, on account of its better keeping qualities and better adaptation for feed, the oil-cake is more valuable than the seed it represents, the cotton-grower can afford this advance of about 40 cents per ton; and the near balancing of the aggregate values in the home market is a curious instance of the self-adjustment of values under the laws of trade. Still, as regards his soil, the cotton-grower loses the ingredients contained in the hulls; whereas, had he retained the seed and returned it directly to the soil, the replacement would have been so nearly complete as to relieve him entirely from the need of purchasing fertilizers, at least for cotton production. (*a*)

From the pecuniary standpoint of the maintenance of fertility by a direct return of the cottonseed alone to the soil, as against the need of purchasing, instead, commercial fertilizers (with all the cost of manufacture, transportation, commissions, etc., heaped upon them), the sale of cottonseed at ruling prices is a transaction too absurd to be tolerated for a moment. For although the valuations attached by the chemists to the ingredients of fertilizers are (in the case of the better class at least) usually somewhat above the price paid by the farmer, yet such difference is insignificant compared to that between the seventeen and three-quarter millions received for the seed and the forty-six millions to be paid for fertilizers in order to replace the drain upon the soil. If the cottonseed-oil industry involved such an alternative, it could not stand for a moment so soon as the state of facts became generally known.

But such is far from being the case; and the near equality of the market values of the totals of cottonseed and seed-cake suggests at once the utmost simplicity of transactions between the oil manufacturer and the producer, such as was suggested by me in the southern press years ago. It is that, since the producer is interested in having his surplus cottonseed transformed into the convenient cottonseed-cake, he can afford to let the manufacturer take the remaining lint, oil, and hulls as toll, provided the cake be integrally returned to him, and by him either directly,

a See the circular on page 43 and the table of "soil ingredients withdrawn by various crops," page 50.

or through his cattle, to the soil. The return thus made will still leave cotton one of the least exhaustive crops known, and give the farmer the benefit of a manufacturing industry at home that reacts in many ways to increase the prosperity of the whole. It is true that, in order to render this simple condition of barter possible, cottonseed-oil mills should be established in all large cotton-growing districts; perhaps best as joint-stock concerns, so as to reduce the expense of transportation, as well as the intervention of middlemen, to a minimum. Few more important steps toward the maintenance of fertility in the cotton states could be taken; for as matters stand at present the sale of cottonseed to the oil-mills is on the increase, and yet, as will be seen from the schedule answers from the several states, the use of cottonseed cake or meal within the cotton states is altogether insignificant. Almost the whole of it flows out in a steady stream from the oil-mills to Old and New England, while a costly return stream of commercial fertilizers sets in the reverse direction. When once the full bearing of this matter is understood by cotton-growers, few can have doubts as to the course to be pursued for the preservation of their fields. Either the seed as a whole or the corresponding seed-cake must in common sense go back to the soil.

The following table, based upon data obtained from the investigation of the question in the state of Mississippi, has often been used by the writer to make plain to audiences of farmers the peculiar advantages enjoyed by the cotton-grower as regards the maintenance of the productiveness of his soil. Potash and phosphoric acid, being the most valuable of the mineral ingredients contained, are segregated from the rest of the ash ingredients. The figures refer to the product of an acre of good upland soil as commonly obtained in Mississippi:

Soil ingredients withdrawn by various crops.

	Potash.	Phosphoric acid.
One bale of cotton:	*Pounds.*	*Pounds.*
1,350 pounds of seed-cotton: 400 pounds of lint make 4 pounds of ash, containing	1.6	0.5
1,350 pounds of seed-cotton: 950 pounds of seed make 41 pounds of ash, containing	14.7	15.2
Total seed-cotton	16.3	15.7
Of the 41 pounds of ash in the seed—		
The hulls, weighing 475 pounds, contain 9.5 pounds of ash.		
The oil-cake, weighing 368 pounds, contain 31.0 pounds of ash.		
The oil, weighing 107 pounds, contains 0.5 pounds of ash.		
950 — 41.0		
Fifteen bushels of wheat:		
The grain makes 18 pounds of ash, containing	5.5	9.0
Two tons of straw make 200 pounds of ash (silica, 128 pounds), containing	8.0	3.0
Total	13.5	12.0
Thirty-five bushels of corn:		
The grain makes 25 pounds of ash, containing	6.0	13.0
Two tons of stalks, etc., make 200 pounds of ash (50 pounds silica), containing	15.0	16.0
Total	21.0	29.0

One lesson conveyed by this table, viz, that the removal of one crop of cottonseed depletes the soil to the same extent as that of ten crops of cotton lint, has already been referred to in the introductory circular. The comparison with other crops shows that none approaches cotton in respect to the slight exhaustion caused by the sale of the chief merchantable product, the lint, the relation being somewhat as if, in the case of corn, the shucks were only removed while returning the stalks and ears integrally; a proceeding under which most soils would improve instead of deteriorating indefinitely. That this is not only theoretically but practically true, and that the conscientious return to the soil of each field of the cottonseed produced on it *from the beginning of cultivation* will, in the case of all soils of fair natural strength, maintain their cotton production undiminished almost indefinitely, has been repeatedly shown by actual experience in the older states. Of course the same is not true of soils that, through long-continued cropping without returns, have been carried to the verge of exhaustion, *i. e.*, of unprofitableness in cultivation. When this has been done, much more than the simple return of the cottonseed is needed for the time being; yet when the land has once again been placed in good condition, so that it would produce full crops without manure for several years, the rule that holds good for fresh soils would again apply to them. (*a*)

a See the writer's discussion of this subject in the *Rural Carolinian* for November and December, 1869.

RETURN OF COTTONSEED TO THE SOIL WITHOUT THE INTERVENTION OF OIL-MILLS.

A.—DIRECT.—It is well known that cottonseed is readily killed by "heating" when kept in large, and especially wet, piles; that the kernels shrink and become brown, and that finally a strong odor of ammonia announces that a large proportion of this most valuable fertilizing substance is escaping. Intelligent farmers have therefore long since been in the habit of letting the seed heat and "kill" in the ground, so as to let the earth absorb the ammonia, or else to compost the pile with muck, plaster, or other proper absorbents. In the former practice it has been found that the use of fresh cottonseed, and still more that of seed-cake meal, is liable to kill seedlings in the immediate neighborhood. This has been attributed to the excessive evolution of ammonia; but some observations having led me to doubt this explanation, I made, in 1871 and 1872, a series of observations and experiments at the University of Mississippi as to the best methods of using these fertilizers and the causes of the occasional bad effects. The latter became abundantly apparent upon submitting a quantity of fresh oil-cake meal to fermentation with a moderate amount of water. Within twenty-four hours a pungent odor, but not of ammonia, became very perceptible in the heated mass; and upon distillation I obtained a not inconsiderable quantity of a very ill-flavored alcohol. The deadly effects of this substance upon the delicate rootlets of seedlings is easily understood, and also the simple method that may be adopted to avoid all trouble from this source, by a "heating" of the seed or seed-cake meal previous to putting in the ground; provided, of course, that the fermentation is stopped short by drying or other means before the evolution of ammonia begins. This confirms the soundness of the long-established practice of "killing the seed" before using it in close connection with other seeds. Meal not previously heated may be used with impunity, provided it is thoroughly mixed with a large proportion of earth. In connection with the same experiments it was found that when the wetted meal is first composted with plaster to absorb the ammonia, and then allowed to sour, it acts most energetically upon bone-meal, and even bone-ash, in rendering them efficacious as fertilizers; thus replacing in a very good measure the effect of sulphuric acid in performing the same service under the hands of the manufacturers of fertilizers, but at nominal expense and at home.

Decomposition of whole seed in the soil.—Another series of experiments was made to test the progress of the decomposition of whole cottonseed buried in the soil. Seed that had been used abundantly under a "seed-bed" of sweet potatoes was examined six months afterward. By far the greater proportion of the seeds were still whole, a number having been perforated either by the rootlets or by insects. The whole seeds were very light, and contained a brown, shrunken kernel, which, upon analysis, was found to contain fully 75 per cent. of the mineral ingredients of the original seed, of which a similar number from the same lot was examined. It was plain that the sweet potatoes and the weeds following them had during all that time been unable to extract from the oily seeds more than a small proportion of their plant-food, but had been benefited chiefly by the ammonia that was given off in the shape of gas at first, and that subsequent crops would get the chief benefit of the mineral plant-food in succeeding years. This result is in accordance with the oft-repeated assertion of cotton-growers that cottonseed put in the ground whole benefits corn more than cotton during the first year. Corn will bear a heavy application of ammoniacal manures, whereas cotton is liable to run to weed and boll poorly under their influence. After the corn has taken up the ammonia during the first season, cotton gets the full benefit of the phosphates and potash the next year.

The experiment shows, in addition, the benefit of the removal of the oil from the seed when desired for manure. The "whole" kernel is completely "preserved in oil" during the first season, and resists the decay which would render its ingredients accessible to plants; whereas, when freed from the oil, as in oil-cake meal, the process of decomposition is unchecked, and the entire stock of plant-food goes to the use of the crop the first season. This is an additional reason for converting the spare seed into oil-cake meal, even for manurial purposes.

B.—INDIRECT RETURN THROUGH THE MANURE OF ANIMALS FED WITH SEED OR SEED-CAKE.—It should be kept in mind that the manure of cattle fed with cottonseed or oil-cake is of especial value as a fertilizer for cotton and should be carefully preserved from waste. By far the safest method of obtaining complete returns to the soil is, in this as in other cases, the use as feed for sheep, which distribute the fertilizer in the most perfect manner, at the same time producing another fiber—wool—from the refuse of the same field that grew the cotton. The plan of "growing cotton and wool on the same field", so strongly advocated by Mr. Edward Atkinson, has been successfully tried by several persons, among them Mr. I. H. Moore, of Oakley, Arkansas, whose experience is given in a preceding page. There seems to be no valid reason why the advantages obtained by him through the feeding of sheep with cottonseed should not be realized by others; but it is true that to do so would involve a material change of policy in southern farming: first, as regards the growing of pasture grasses for the season when the seed is not available (although cake-meal would always be), and second, as regards the raising of the numberless dogs that infest the southern states, each laborer being allowed to keep as many curs as he pleases; and dogs are shown, statistically, to be more numerous, and, according to the shows and valuations made of them, to be more highly valued in some of the states than the useful but unattractive sheep. Southern farmers will soon, however, have to make a serious choice between the two races of domestic animals.

SOIL INVESTIGATION.

INTRODUCTION

TO THE

DESCRIPTION OF STATES,

BY

E. W. HILGARD.

SOIL INVESTIGATION.

A full and accurate knowledge of the agricultural features and other industrial resources of a state is of the most direct and obvious importance to every one concerned in industrial pursuits. It is wanted by the immigrant or settler seeking a new home suitable to his tastes and resources, as well as by the large farmer and capitalist desiring to locate and invest to the best possible advantage. Most of the older states have long ago satisfied this demand in some form; mostly in connection with the public surveys, usually named, from their fundamental feature, geological surveys, but commonly charged as well with the full investigation of the other industrial features of the state. The demand for this kind of information is shown by the publication of numerous pamphlets and newspaper articles, describing more or less fully and correctly certain regions recommended for settlement; but the fact that these publications emanate largely from interested parties, and are compiled by persons unused to accurate observation of natural phenomena and not possessed of the means for thorough investigation, greatly reduces the usefulness of the large amount of correct information thus conveyed. Even the more ambitious class of publications in book form, purporting to give full descriptions of regions, states, or territories, are largely compilations from this class of literature, and, apart from the climatic, commercial, and general topographical data, rarely convey much of that specific, technical, and local information that is so necessary to the seeker for a permanent home, and which he must usually, after all, obtain at the expense and trouble of a personal visit.

Of the state surveys that have given close and specific attention to the agricultural features the first survey of Kentucky and that of Arkansas, by Dr. David Dale Owen, stand first in order of time. Dr. Owen was profoundly impressed with the advantages that a closer and more rational knowledge of the peculiarities of their soils would give those desiring to cultivate them rationally; and his assistants were instructed to gather from the mouths of the inhabitants all information extant in regard to the production, peculiarities, merits, and demerits of the several soils, and also to collect carefully samples of the same, noting all details as to depth, subsoil, drainage, "lay," natural vegetation, etc. These soil samples were afterward subjected to chemical analysis according to a definite and uniform method, and from a comparison and discussion of these Dr. Owen hoped to gain important data, not only with regard to these particular soils, but also with respect to the general functions of soils in vegetable nutrition, the cheapest and most needful modes of improving each one, and of maintaining its productiveness. These views are set forth in the text, especially of the first volume of the Kentucky report, and the effort to carry them into effect is apparent throughout these volumes. Dr. Owen's early death prevented him from entering upon a more general discussion of the subject and of the results deducible from the entire work.

When placed in charge of the geological and agricultural survey of the state of Mississippi the writer earnestly endeavored to carry out more fully the views suggested to him on the occasion of a personal visit by Dr. Owen; and finding before him a field containing an unusually great variety of strongly characterized soils, offering a wide and most interesting scope for comparison, he soon found himself engaged on a field of research almost unexplored and with but few landmarks left by previous investigators; most of the latter, too, pointing away from it, as being hopelessly intricate and beyond the power of our present means of research. But as the work progressed there came glimpses of light and results quite in accord with the general presumptions upon which the hope of ultimate success rested; and with these before him, in the face of much indifference and adverse criticism, much of his life-work has been given to this speciality of physical and chemical soil investigation.

In the "report on the geology and agriculture of the state of Mississippi", printed in 1860, but not published until after the war, the writer adopted the express segregation of the subject into a "geological" portion, into which scientific facts and discussions are freely introduced, and an "agricultural" one, containing a description of the agricultural features of the state, subdivided into "regions", which of course conform more or less to the geological divisions, but at the same time correspond to well-defined and popularly recognized areas of similar agricultural conditions. In this second part of the report, intended for popular comprehension and use, all more recondite scientific or technical language is avoided as much as possible. The soil analyses made up to the time of its going to press are communicated in connection with the descriptions of the several regions concerned, and their

meaning is interpreted in accordance with the still somewhat dim understanding then acquired upon such a slender basis of well-observed facts. Subsequently this basis was much enlarged by a number of additional analyses made as the survey work progressed; but these, in consequence of the stoppage of the work and the removal of the writer from the state, were never published. They are now given in full in the report on the state of Mississippi.

The plan adopted of giving, in connection with the census reports on cotton production, a more or less detailed description of the agricultural features of the cotton states, regarding which but little definite information had thus far been accessible to the general public, afforded an excellent opportunity for enlarging the scope of the comparisons of soil composition beyond that afforded by the state of Mississippi. A limited number of analyses of the more important soils of each of the states concerned was, at the writer's request, authorized by the Superintendent; and with the co-operation of state surveys and the utilization of such material as was already extant the field of comparison has thus been extended over the cotton states from North Carolina to Texas, as well as to California, as will be noted in the several reports.

REMARKS ON THE METHODS OF SOIL INVESTIGATION AND ON THE INTERPRETATION AND PRACTICAL UTILITY OF CHEMICAL SOIL ANALYSES.

In view of the emphatic condemnation of chemical soil analysis, as a practically useless expenditure of energy and money, that has in the past been pronounced by a number of prominent scientists, both in this country and in Europe, it is not superfluous to advert in this place to the causes of these opinions, and to point out the extent of their truth and fallacy in connection with a presentation of the methods pursued in the present work, by which these objections are measurably done away with. In the absence of such a discussion, much that follows would be unintelligible, and might seem baseless or arbitrary assumption. (*a*)

The claim of soil analysis to practical utility has always rested on the general supposition that, "other things being equal, productiveness is, or should be, sensibly proportional to the amount of available plant-food within reach of the roots during the period of the plant's development;" provided, of course, that such supply does not exceed the maximum of that which the plant can utilize when the surplus simply remains inert.

The above statement has been, either tacitly or expressly, admitted as a maxim by those who have attempted to interpret soil analyses at all; it being thoroughly in accordance with the accumulated experience of agriculturists, and with their cry for "enough manure", that has been so potent a factor in the development of agricultural science and of rational agriculture itself. Its acceptance is implied in the search for the solvent that shall represent correctly the action of the plant itself on the soil ingredients; and I shall take it for granted in this discussion, while strongly emphasizing the importance of concomitant physical conditions, that it is universally admitted that the *ultimate* analysis of soils affords little or no clew to their agricultural value. Such agents as fluohydric acid and alkaline carbonates go by far deeper than the solvents naturally acting in soils bearing vegetation will go within the limits of time in which we are interested.

Many attempts have been made to find solvents whose action on soils would so nearly represent the agents subservient to the needs of vegetation that conclusions as to the present agricultural value of a given soil could be deduced therefrom. It is needless to recite the long list of such solvents suggested since soil analysis attracted attention. From fluohydric acid to water charged with carbonic acid (the latter extensively employed by Dr. D. D. Owen) the acid solvents have all signally failed to secure even an approximation to the result desired, viz, a consistent agreement between the quantitative determinations, or the percentages of plant-food found in the several soils, and the actual experience of those who cultivate them.

It has been attempted by the German experiment-stations, under Wolff's initiative, to gain an approximation to the relative availability of parts of the soil's store of plant-food by consecutive extractions with acid solvents of different strength, beginning with distilled water, and ending with boiling oil of vitriol or fluohydric acid. It can hardly be wondered that this laborious process, with solvents arbitrarily chosen, and without any known relation to the solvent action exerted by roots, should have found so little acceptance, and has, on the contrary, perhaps rather served to confirm the common impression of the uselessness of soil analysis, especially when contrasted with the huge amount of work, ending after all in mere guesses. We vainly seek in the recorded results of such investigations for any such ray of light on the functions of the several soil ingredients as would even remotely justify the labor involved. They rather tend to justify the remark of a distinguished American agricultural author, that he "would rather trust an old farmer to tell him about the value of a soil than the best chemist alive".

The old farmer, however, is not always at hand, especially in the newer portions of the United States, where such *prima facie* judgment is most especially needed, since upon it depends so largely the future of the settler for weal or woe. And even when the old farmer is at hand, he is very frequently sadly at fault when asked such simple but pregnant questions as these: Is the soil likely to be durable? What crops adapted to the climate will bring the highest returns and insure the longest duration of fertility under rational treatment? In which direction

a In the following discussion the language adopted is largely that of an article on the subject, published in the *American Journal of Science* for September, 1881.

will the natural defects or the impending exhaustion of the soil first make themselves felt, and how can they best be countervailed? However, if the old farmer can train his judgment in this matter so as to make shrewd guesses, the agricultural chemist ought to be able to do a great deal better, for he should know all that the farmer does, and a great deal more beside. In addition, he should bring to bear on the whole subject a well-trained mind, accustomed to accurate observation and logical reasoning; but this cannot possibly be accomplished without bringing to bear upon the study of soils the best resources of chemical and physical examination combined—a subject that has too long been put aside upon the mere assertion, based upon imperfect methods of investigation, that its pursuit led to no practical results.

Assuredly, the chemist who does no more than to give the farmer a column of figures summing up to one hundred or nearly so, opposite another column of unintelligible names, acts simply as an analytical machine; and even to the best of such machines the remark above quoted will most truly apply. Soil analyses do not, like the assay of an ore, interpret themselves to the layman; and it is a matter of history that the attempt to so interpret them in the analyses made under the auspices of the German experiment-stations was chiefly instrumental in the rejection of this method of investigation, the results being altogether discordant with the indications of practice upon the basis of a mere comparison of percentages of plant-food.

One great difficulty in the way of definite conclusions from the analyses of European soils is that virgin soils are there practically non-existent, the arable soils having nearly all been at some time subjected to cultivation, and, concurrently, to the use of fertilizers, thus veiling their original characteristics and rendering extremely difficult, to say the least, the taking of any sample of soil that shall represent correctly, in all respects, the whole of any large field or district. In the United States it is our special privilege to be still able to secure specimens of the soils of by far the greater portion of the country that even the plow has never yet touched, and where manure, outside of the flower and vegetable garden, is an unknown quantity. We can find on these soils their original vegetation, which is so largely used by the settler as a means of diagnosing the actual productiveness of the land he proposes to clear and of prognosing its durability, and there can be no doubt that in so doing he is thoroughly right. The virgin soil and its vegetation are the outcome of long ages of coadaptation by the processes of natural selection, and they present to us an array of ready-made culture experiments whose cogency can rarely be approached by those of our experiment stations within less than a life-time. The observant farmer or settler attaches to each tree or herb a more or less definite significance, based upon experience as regards the character and productiveness of the parent soil. A soil naturally timbered with a large proportion of walnut, wild cherry, or, as at the south, with the "poplar" or tulip tree, is at once selected as sure to be both productive and durable, especially if the trees be large. He knows well that the black and Spanish oaks frequent only "strong" soils, and that an admixture of hickory is a welcome addition; while the occurrence of the scarlet oak at once lowers the land in his estimation, and that of pine still more so. However much opposed to the cocklebur in his fields, he welcomes it as a sure sign of a good cotton soil, as much as though he had seen the latter itself growing for a series of years.

It is this sound empiricism that at present gives the old farmers the advantage over "the best chemist alive" in judging of the value and adaptations of soils. But it is certainly the chemist's fault if he fails to avail himself of these long observed facts, and to expand them into something more definite and thorough than intuitive empiricism.

Taking for granted the soundness of the principle involved in judging the productiveness and other peculiarities of soils from their natural vegetation, and having gained a large array of additional data from personal observation in the field, I have then sought to ascertain, by close chemical and physical examination of the soils in their natural condition, the causes that determine this natural selection on the part of certain species of trees and herbaceous plants, while at the same time observing closely the behavior of such soils under cultivation, their special adaptations, etc. It goes without saying that this can be done most successfully where, as in the western and southern states, virgin soils are still obtainable, where the use of manure is unknown, and where the simple history of each field can easily be gathered from the lips of the settler who first broke the sod.

It is evident that when used in this connection, and made uniformly and systematically, with a definite problem in view, each soil analysis becomes an equation of condition; and that by the proper treatment of a large number of such analyses, by a logical process of elimination, the problem of the function and value of each soil-ingredient or soil-condition can be approached with a better prospect of a solution in accordance with *natural* conditions than can be expected from cultures upon artificial soils or in solutions.

My first trials of the efficacy of this method of investigation were made upon the soils of the state of Mississippi, which, fortunately, present extreme variations in character in almost every direction and upon every key, so to speak, of the soil scale. Some of the conclusions reached in that work have been given in published papers; but the wider scope afforded in the work embodied in the present volumes has served to extend and rectify the first conclusions, and gives them a definiteness which renders it desirable to sum up the present condition of the investigation with the record of facts now published.

The *taking of representative soil specimens* is, of course, a matter of first importance, and sometimes of no little difficulty. All those analyzed under my direction have been taken in accordance with printed directions hereinafter given, with care in the selection of proper localities, the discrimination between soil and subsoil, a

record of depth, natural vegetation, behavior in cultivation, etc. As heretofore stated, I find that with such care it is perfectly practicable to obtain samples representing typically soil areas of many thousands of square miles, especially so when the subsoils are taken as the more reliable indices. On the other hand, a collection of soil samples taken without such discrimination, care in selection, and accompanying statements regarding "lay", depth, subsoil, etc., is as hopeless a riddle as can be placed before an investigator, so far as practical utility is concerned.

DIRECTIONS FOR TAKING SOIL SPECIMENS.

First. Do not take samples indiscriminately from any locality you may chance to be interested in, but consider what are the two or three chief varieties of soil which, *with their intermixtures*, make up the cultivable area of your region, and carefully sample these first of all.

Second. As a rule, and whenever possible, take specimens only from spots that have not been cultivated, and are otherwise likely to have been changed from their original condition of "virgin soils"—*e. g.*, not from ground frequently trodden over, such as roadsides, cattle-paths, or small pastures, squirrel holes, stumps, or even the foot of trees, or spots that have been washed by rains or streams, so as to have experienced a noticeable change, and not be a fair representative of their kind.

Third. Observe and record carefully the normal vegetation, trees, herbs, grass, etc., of the average land; avoid spots showing unusual growth, whether in kind or quality, as such are likely to have received some animal manure or other outside addition.

Fourth. Always take specimens from more than one spot judged to be a fair representative of the soil intended to be examined as an additional guarantee of a fair average.

Fifth. After selecting a proper spot, pull up the plants growing on it and scrape off the surface lightly with a sharp tool, to remove half-decayed vegetable matter not forming part of the soil as yet. Dig a vertical hole, like a post-hole, at least 20 inches deep. Scrape the sides clean, so as to see at what depth the change of tint occurs which marks the downward limit of the surface soil, and record it. Take at least half a bushel of the earth above this limit, and on a cloth or paper break it up and mix thoroughly, and put up at least a quart of it in a sack or package for examination. This specimen will ordinarily constitute the "soil". Should the change of color occur at a less depth than 6 inches, the fact should be noted, but the specimen taken to that depth nevertheless, since it is the least to which rational culture can be supposed to reach.

In case the difference in the character of a shallow surface soil and its subsoil should be unusually great, as may be the case in tule or other alluvial lands or in rocky districts, a separate sample of that surface soil should be taken besides the one to the depth of 6 inches.

Specimens of salty or "alkali" soils should, as a rule, be taken only toward the end of the dry season, when they will contain the maximum amount of the injurious ingredients which it may be necessary to neutralize.

Sixth. Whatever lies beneath the line of change, or below the minimum depth of 6 inches, will constitute the "subsoil". But should the change of color occur at a greater depth than 12 inches, the "soil" specimen should nevertheless be taken to the depth of 12 inches only, which is the limit of ordinary tillage; then another specimen from that depth down to the line of change, and then the subsoil specimens beneath that line. The depth down to which the last should be taken will depend on circumstances. It is always desirable to know what constitutes the foundation of a soil down to the depth of 3 feet at least, since the question of drainage, resistance to drought, etc., will depend essentially upon the nature of the substratum. But in ordinary cases 10 or 12 inches of subsoil will be sufficient for the purposes of examination in the laboratory. The specimen should be taken in other respects precisely like that of the surface soil, while that of the material underlying this "subsoil" may be taken with less exactness, perhaps at some ditch or other easily accessible point, and should not be broken up like the other specimens.

Seventh. All peculiarities of the soil and subsoil, their behavior in wet and dry seasons, their location, position—every circumstance, in fact, that can throw any light on their agricultural qualities or peculiarities—should be carefully noted and the notes sent with the specimens. Unless accompanied by such notes, specimens cannot ordinarily be considered as justifying the amount of labor involved in their examination.

DETAILS OF SOIL INVESTIGATION.

PHYSICAL SOIL EXAMINATION.—The first step, after recording the aspect of the soil or subsoil under examination, is the separation of the coarser portions—gravel, coarse sand, and bog-ore grains—which cannot be accounted as exerting any important direct influence upon vegetation or the tilling qualities of the soil. I have drawn the limit of the "fine earth" at the diameter of half a millimeter, which is at the same time the upper limit of convenient use of the hydraulic method of mechanical soil analysis. Crushing with a rubber pestle and sifting are the ordinary preparations, but in the case of hard-baked clay soils boiling and passing the creamy magma through the sieve is sometimes necessary. The nature of the coarser portions is noted, and their proportion to the fine earth is determined by weighing.

The fine earth thus obtained is reduced to a condition of tilth, and then its "moisture-coefficient" determined by exposure to an atmosphere *fully* saturated with aqueous vapor at such uniform temperature as may be at command, in a layer not exceeding 1 millimeter in thickness, for a convenient time, not less than seven hours. As stated in a previous paper, I have in these determinations come to results differing materially from those obtained by Knop, Schübler, and others, probably because of the more complete fulfillment of the conditions of full saturation of air as well as of soil. I have found that for some soils the absorption-coefficient varies but little between 7° and 25° C. under these conditions, but always *increases* with the elevation of the temperature; while in others this increase is considerable, approximating to 0.1 per cent. for each degree Centigrade from 14° up to 35°, the highest limit thus far observed. With a *half-saturated* atmosphere the direction of change is reversed, the amount absorbed *decreasing* as the temperature rises, but to an extent varying with the degree of saturation. This general fact is in accord with Knop's observations, but it is evident that the law deduced by him can hold good only for a definite degree of undersaturation, which must be introduced as an essential condition, and which he has failed to establish definitely. (*a*)

Again, I find that, contrary to the conclusions reached by Adolph Mayer, this coefficient exerts an exceedingly important influence upon the agricultural qualities of soils. All those having at 15° C. an absorption-coefficient less than 2 per cent. are in practice droughty soils. The ordinary upland loams not easily damaged by drought have coefficients ranging from 4 to 8 per cent. Those ranging higher are mostly heavy clay soils, whose resistance to drought is very high when they are well tilled, but, from a variety of causes, very low when tillage is shallow and imperfect. Mayer's experiments on the wilting of plants in drying soils, from which he deduces as probable the maxim that the hygroscopic coefficient of soils is a matter of indifference to plants, are entirely nugatory. His plants *in pots* were not under the conditions in which field crops are when called upon to resist drought, whether from drying winds or hot sun. Here the continuous rise of moisture from the subsoil tends to keep up the supply to the water roots, while at the same time the nutrition of some plants, as is well-known, continues almost unabated in air-dry soils so long as there is no injurious rise of temperature in consequence of that dryness. But that is precisely the point where a high moisture-coefficient comes into play, by preventing, in consequence of evaporation, a rise of temperature that, under similar circumstances, would prove fatal to the surface roots of the crop in soils of low absorptive power. In fact, Mayer's conclusion is at variance with the ordinary experience of centuries, repeated every day in the droughty regions of the south and of the Pacific coast. It takes more than flower-pot experiments to invalidate the universal designation of soils of low hygroscopic power as "droughty".

A discussion of the numerous moisture determinations hereinafter given, in connection with the chemical analyses of the corresponding soils, shows that the moisture-coefficient depends essentially, in ordinary soils, upon one or more of four substances, viz (in the order of their efficacy), *humus*, *ferric hydrate*, *clay*, and *lime*. It varies in cultivable soils from about 1.5 to 23 per cent. at 15° C. in a saturated atmosphere. A pure clay rarely exceeds 12 per cent.; ferruginous clays show from 15 to 21 per cent.; some calcareous clay soils rise nearly as high, while peaty soils rise to 23 per cent. and even more. The efficacy of the ferric hydrate depends essentially upon a state of fine division. When merely incrusting the sand-grains or aggregated into bog-ore grains, it of course exerts little or no influence, although the analysis may show a high percentage. Sometimes soils highly colored show but a small iron percentage, while yet, on account of very fine diffusion, the advantages referred to are realized.

MECHANICAL ANALYSIS.—It would have been very desirable to extend farther the investigation of the physical constitution of a number of representative soils by the aid of the processes and instrument devised by me ten years ago, (*b*) but the limits of time and expense assigned to the soil-work under my charge forbade such expansion. The subject has, however, received some additional light from work done in the agricultural laboratory of the University of California on soils of that state, as well as (under the auspices of the Northern Transcontinental Survey) on those of Washington territory. These analyses, partly reported in their proper connection, only serve to confirm the conclusion, previously reached by me, that an intelligent understanding of the physical qualities of soils, their relation to tillage, moisture, and heat, cannot be reached without a more definite and intimate knowledge of the physical constitution of soils, and that to the attainment of such definite knowledge the precautions noted as necessary in the papers above alluded to are the very minimum. This is true, especially as regards the accurate determination of true plastic clay, as contradistinguished from the non-plastic but extremely fine sediments, with which it has always heretofore been weighed conjointly. In irrigation countries especially the facility with which the soil "takes" the water is of first importance, and this factor depends upon the presence or absence of a certain proportion of (true) clay and on certain ratios between the coarser and finer sediments, the ascertainment of which lies completely beyond the possibilities of the methods and instruments employed by the German experiment-stations, and in some cases as yet try severely the capabilities of those devised by me. The entire subject needs a close revision, involving no small amount of labor, but eminently worthy of the attention of the experiment-stations.

a See *Report of the California College of Agriculture* for 1882, p. 54; also *Trans. of the Am. Ass'n of Agr. Chemists*, vol. I, 1883.

b See articles on "The silt analysis of soils and clays" and "Silt analyses of Mississippi soils and subsoils", in *Proc. Am. Ass'n Adv. Sci.*, 1873; *Am. Jour. Sci.*, Oct. and Nov., 1873, and Jan., 1874. Also, article "On the flocculation of particles", *Am. Jour. Sci.*, Feb., 1879

CHEMICAL ANALYSIS—METHODS.—In the selection of the *solvent for making the soil extract* to be analyzed I have been guided by the consideration that minerals not sensibly attacked by several days' hot digestion with strong hydrochloric acid are not likely to furnish anything of importance to *agriculture* within at least a generation or two. If this assumption seems arbitrary, it at least commends itself to common sense. The heavy draught made upon the soil by the removal of crops cannot be sensibly affected by the minute additions made to the available plant-food by the atmospheric or root action on such refractory minerals.

Regarding the *strength of acid* to be used in the extraction of the soils, and the *time* necessary to secure the solution of the important substances, I have caused investigations to be made by Dr. R. H. Loughridge (*Am. Journal*, Jan., 1874, p. 20) on a subsoil selected for its representative position and derivation—a drift soil covering, probably, some 15,000 square miles in the uplands of western Tennessee and Mississippi, and one perhaps as fully "generalized" in its origin as can be obtained. The result of this investigation was that hydrochloric acid of about the specific gravity of 1.115 seems to exert the maximum effect, and that the extraction is practically complete after a water-bath digestion of five days. An excess of time of digestion results simply in higher percentages of alumina and soluble silica, or, what is equivalent, in a farther decomposition of kaolinite particles.

These conditions of digestion have been substantially maintained in all the soil analyses made under my direction. It may be said that what is true as regards the drift soil used in Dr. Loughridge's investigation may not be necessarily so in regard to other soils. I hope before long to test this point with regard to soils lying nearer, both in time and space, to their parent rocks, but it is obvious that much will depend upon the nature of the latter. In the case of soils derived from the close-grained and resistent basalts of Oregon and Washington, for example, the action is soon at an end and a plainly recognizable mineral powder is left, the acid acting apparently only on what has been prepared by atmospheric action; but in the case of argillites and other rocks, in which there has been more or less formation of zeolitic material of variable resistance, the extraction appears to be less prompt and its cessation less definitely marked. This, however, refers more especially to the dissolution of potash and alumina, while that of available lime and phosphoric acid seems to be very promptly accomplished far within the limits of the five days' digestion. As will be noted hereafter, these two ingredients really, as a rule, govern most largely the character and agricultural value of soils, variations in the potash percentages being of much less immediate concern. I therefore incline to consider the five days' term of digestion with acid of 1.115 specific gravity as adequate for all ordinary purposes to be gained by the determination of the mineral ingredients of soils, apart from the data derived from extraction of the humus according to the method of Grandeau.

The *methods of analysis* used by me are substantially those given in the *Kentucky Report*, volume I, by Dr. Robert Peter, with such changes as the progress of analytical chemistry suggested. It is substantially the usual course of a silicate analysis after "aufschliessung", using Bunsen's method of boiling with sal ammoniac for the separation of manganese from iron and alumina, and (at present) the permanganate process for the separation of the latter two. After the precipitation of lime, the ammoniacal salts are destroyed by aqua regia, finally using nitric acid in excess; after evaporation to dryness and filtering from silica floccules, sulphuric acid is precipitated by a few drops of baric nitrate, the precipitate being afterward purified; after filtration, the nitrates are decomposed by sublimed oxalic acid in a platinum dish and gently ignited, the alkalies leached out and determined as usual, excess of baryta removed, manganese and magnesia being separated in the residue from the alkali separation. In the insoluble portion of the soil the amount of silica soluble in sodic carbonate is also determined by difference after ignition.

Phosphoric acid is determined by means of ammonic molybdate in a separate portion of three to four grams of fine earth, which has first served for the determination of "volatile matter", or loss by ignition, consisting of organic matter and combined water. While this latter determination is necessary to the "summing up" of the analytical statement, it is not in itself very instructive, as it leaves the relative amounts of the two substances altogether indefinite. A determination of the organic matter by combustion, or by extraction with potash lye, is also unsatisfactory, because of the impossibility of excluding from these determinations a large amount of comminuted but altogether crude and unhumified vegetable matter, which becomes very obvious under the microscope or in the process of silt analysis. I have therefore adopted for the determination of active humus the admirable method of Grandeau, by the aid of which at least a uniform *minimum* determination becomes possible.

I have not devised any method for the direct determination of the *water of hydration*, although there are cases in which it would be very desirable to have this item for the determination of the condition of the alumina and ferric oxide.

I have in a few cases determined the amount of *silica soluble* in boiling solution of sodic carbonate in the *crude* soil. But this determination is often beset with almost insuperable mechanical difficulties, from the diffusion of the clay in the alkaline liquid. It does not appear to promise results of sufficient importance to justify such labor; the more as, by the method of Grandeau, the actual available amount of silica can probably be better determined.

As regards the determinations of *nitrogen* and its compounds in the virgin soils thus far analyzed, I have omitted them in part from want of time and proper appliances for these delicate determinations, and partly from a

doubt of their present usefulness. The constant variation and interconvertibility of nitrates and ammonia compounds renders their determination at any given time of interest for that time only; and as the nitrogen percentage of the mold of natural soils adapted to agriculture (*a*) is not likely to vary much, the humus percentage may probably be taken as roughly proportional to the total nitrogen of the soil. The tendency of natural soils rich in humus is notoriously toward the production of excess of foliage; the special effect of the excessive use of nitrogenous manures, and the use of the latter, very rarely produces any notable beneficial effect on naturally unproductive soils. While, therefore, a full investigation of this subject is of course called for, I have thought that among the many problems to be solved this could best afford to wait. The analyses have, however, made it abundantly obvious that a fulfillment of the *conditions of nitrification* is in all natural soils a primary condition of their thriftiness, as will be more specially noted hereafter.

It may not be unnecessary to state that scarcely in any case have reagents commercially obtainable been found sufficiently pure for the purposes of soil analysis. In the work done under my charge all the reagents have been especially prepared or purified in the laboratory itself. Porcelain beakers only have been used in the digestions, and generally every possible precaution has been taken to insure correctness in the determination of the minute percentages of the important ingredients. Numerous repetitions have in most cases confirmed the correctness of the work, which can, moreover, be measurably controlled by an experienced eye when once the general character of the region concerned is known. Errors are usually traced to omissions to protect the vessels and reagent bottles from dust and to the use of "old" chlorhydric acid or ammonia, these reagents being scarcely fit for use after standing for as much as a month in a glass vessel. They have therefore, as a rule, been currently prepared in small quantities. For the determination of humus, according to Grandeau, about 10 grams of fine earth are commonly used, the treatment with acidulated water being continued until the lime reaction ceases, then washing until the chlorine reaction stops, when the dilute ammonia water dissolves the true humus, leaving the unhumified organic matter untouched. After evaporation and weighing the residue is ignited and the ash weighed, and in it the "available phosphoric acid" determined by means of molybdate.

INTERPRETATION OF THE ANALYTICAL RESULTS.

Having obtained, as above outlined, the percentage composition of a soil, how are we to interpret these percentages to the farmer? What are "high" and "low" percentages of each ingredient important to the plant, whether as food or through its physical properties?

The first question arising in this connection is, naturally, whether all soils, having what experience proves to be high percentages of plant-food when analyzed by the processes above given, show a high degree of productiveness.

So far as my experience goes, this question can for virgin soils be unqualifiedly answered in the affirmative; provided only that improper physical conditions do not interfere with the welfare of the plant.

But it does not therefore follow, as was at first supposed, that the converse is true, and that low percentages necessarily indicate low production. This will be apparent from a simple consideration.

Suppose that we have a heavy alluvial soil of high percentages and producing a maximum crop in favorable seasons. We may dilute this soil with its own weight, or even more, of coarse sand, thereby reducing the percentages to one-half or less; and yet it will not only not produce a smaller crop, but it is more likely to produce the maximum crop every year, on account of improved physical conditions. If we compare the root system of the plants grown in the original and in the diluted soil, we will find the roots in the latter more fully diffused, longer, and better developed, not confined to the crevices of a hard clay, but permeating the entire mass, and evidently having fully as extensive a surface-contact with the fertile soil particles as was the case in the undiluted soil.

How far may this dilution be carried without detriment?—The answer to this question must largely be experimental, and must vary with different plants and soils, which is precisely what the farmers' experience has long since shown. A plant capable of developing a very large root-surface can obviously make up by greater spread for a far greater dilution than one whose root-surface is in any case but small. The former flourishes even on "poor, sandy" soils, while the latter succeeds, and is naturally found on "rich, heavy" ones only, although the absolute amount of plant-food taken from the soil may be the same in either case.

Now, the conditions here supposed are frequently fulfilled in nature, and more especially so in alluvial soils. Among many striking examples that might be given are the analyses of two soils about equally esteemed for the production of cotton, both equally durable, so far as experience has gone, and yet differing in their percentages of mineral plant-food to the extent of from three to five times. (See Nos. 390 and 68 in the subjoined table.) No. 88 is also a highly esteemed soil, while No. 214 is practically worthless; yet the percentage differences are only such as for many purposes would be considered neglectable. Again, No. 206, with higher percentages of most ingredients than the two preceding, is considered as being "of no account".

a Excluding therefrom "sour" soils.

Comparative table of some Mississippi soils.

	HIGHLY PRODUCTIVE.		MEDIUM.	ALMOST WORTHLESS.	
	Buckshot soil.	Middle Homochitto.	Shell hummock soil.	Pine meadow soil.	Pine hills soil.
	Issaquena county.	Franklin county.	Hancock county.	Jackson county.	Smith county.
	No. 390.	No. 68.	No. 88.	No. 214.	No. 206.
Insoluble matter	71.767	92.164	96.082	95.592	93.257
Potash	1.104	0.148	0.045	0.061	0.250
Soda	0.325	0.044	0.057	0.056	0.065
Lime	1.349	0.122	0.098	0.023	0.120
Magnesia	1.665	0.212	0.114	0.069	0.180
Brown oxide of manganese	0.119	0.284	0.053	0.045	0.146
Peroxide of iron	5.818	1.183	0.516	0.459	1.251
Alumina	10.539	3.219	0.464	0.848	2.356
Phosphoric acid	0.304	0.079	0.097	0.021	0.030
Sulphuric acid	0.024	0.045	Trace.	Trace.	0.024
Water and organic matter	7.369	2.097	3.018	2.277	2.330
Total	100.383	100.197	100.544	99.445	100.027

In cases like these, which are not at all infrequent, the mere percentage of plant-food in the soil showing the low figures would lead to a most erroneous estimate of its agricultural value, and the showing made by such comparisons as the above seems at first blush to be a desperate one for the practical value of soil analysis; yet it seems also as though the agricultural chemist could hardly shirk the responsibility of at least trying to account for such glaring anomalies before he declares himself incompetent.

Now, when, in addition to the above figures, we know the fact that in soils such as Nos. 68 and 88 the food-roots can exercise their functions to the depth of 3 or 4 feet, while in the richer soil (No. 390), with ordinary cultivation, they will rarely reach to a greater depth than 12 or 15 inches, the equal productiveness becomes much more intelligible, for it implies that in making the comparison we must multiply the percentages of the two former soils by three or four, which makes them quite respectable. As between soils Nos. 88 and 214, the chemist should know that below the 12 inches represented in the analysis of No. 214 there is nothing but a pure sand underlaid by an impervious clay. As to No. 206, nearly the same occurs, except that at about 20 inches depth there underlies a loam subsoil of fair resources. But such soils occupy thousands of square miles in Mississippi alone. It is a matter of no small consequence whether they can be made profitably cultivable; and, if so, how. If the agricultural chemist can do nothing to help the farmer in solving such problems, his practical utility will be limited, indeed.

From among the multitude of examples of close correspondence of plant-food percentages with the practical estimate of farmers, in cases where there is no material difference in the penetrability or other physical qualities of the soils compared, I select two analyses of Florida soils, known respectively as "first" and "second class", as deduced from the experience in cultivation.

Analyses of Florida pine lands.

	MARION COUNTY.	COLUMBIA COUNTY.
	First class.	Second class.
	No. 6.	No. 7.
Insoluble matter	94.460 } 96.125	95.630 } 96.509
Soluble silica	1.665 }	0.879 }
Potash	0.189	0.117
Soda	0.038	0.064
Lime	0.072	0.058
Magnesia	0.039	0.042
Brown oxide of manganese	0.055	0.049
Peroxide of iron	0.321	0.224
Alumina	0.915	0.473
Phosphoric acid	0.110	0.092
Sulphuric acid	0.091	0.058
Water and organic matter	1.884	1.807
Total	99.839	99.493
Hygroscopic moisture	2.138	1.643
absorbed at	26.1 C.°	24.5 C.°

Here the amount of inert matter in both soils is almost identical, though slightly greater in the second-class soil, in which, moreover, the loss shown in summation is probably chiefly attributable to mechanical loss (dusting) during ignition; but the difference in the important ingredients—potash, lime, and phosphoric acid—is striking and uniformly in the same direction, as is also the significant item of "soluble silica", which is farther discussed on page 73. The inferior soil is also more droughty, as is indicated by its low moisture coefficient. It is said to produce, when fresh, from 400 to 500 pounds of seed-cotton per acre, as against from 500 to 700 pounds in the case of the first. Both, however, soon fall below even this production unless sustained by fertilizers.

It is obvious, then, that without a knowledge of the respective depths and penetrability of two soils a comparison of their plant-food percentages will be futile. Nor is it feasible to agree upon a certain depth to which all soils analyzed should be taken. The surface soil, with its processes of humification, nitrification, oxidation, carbonic acid solution, etc., in full progress, must always be distinguished from the subsoil in which these processes are but feebly developed, and where the store of plant-food, in which it is generally richer than the surface soil, is comparatively inert. Hence the obvious importance of specimens correctly taken, and the necessity of intelligent and accurate observations on the spot.

I have attempted to make allowance for the cases of dilution, as above noticed, by combining the results of the mechanical with those of chemical analysis. In the investigation made by Dr. Loughridge of the several sediments obtained in the mechanical analysis of the typical soil above referred to it appeared that plant-food practically ceased to be extracted from sediments exceeding 5 millimeters hydraulic value; and in recalculating the percentages of soils *of the same general derivation*, after throwing out the coarser sediments, we often find very striking approximations to identity of percentage composition, as well as of proportionality *inter se*. It is obvious, however, that this cannot be generally true, since inert clay or impalpable silt must often come in as dilutents. Nevertheless, I consider the mechanical analysis of soils (carried out by the method heretofore described by me, and *not* in accordance with that of the German experiment-stations) as an almost indispensable aid in judging fully of the agricultural peculiarities of soils, especially when these cannot be personally examined in the field.

The concentration of the available portion of the plant-food of soils in their finest portions is almost a maxim already, scarcely needing the corroboration afforded by the investigation of Dr. Loughridge, above quoted. A "strong soil" is invariably one containing within reach of the plant a large amount of impalpable matter; although the reverse is by no means generally true. Striking corroborations of this maxim are afforded by the steady increase of certain plant-food percentages (notably that of potash) in the deposits of streams as we descend, and the proverbial richness of "delta soils" is exactly in point. Compare in this respect the composition of an alluvial "front-land" soil from Sunflower county, Mississippi, with that of corresponding "front-land" of Bayou Terrebonne, in the Houma country of Louisiana, and with that of a "back-land" soil from the latter locality, representing the slack-water deposits back from the bayou ridge.

Comparative analyses of highly fertile lands of Mississippi and Louisiana.

	SUNFLOWER COUNTY, MISSISSIPPI.	TERREBONNE PARISH, LOUISIANA.	
	Front-land.	Front-land.	Back-land.
	No. 376.	No. 239.	No. 240.
Insoluble matter	87.808 } 91.934	75.136 } 81.505	35.480 } 56.242
Soluble silica	4.036 }	6.369 }	20.762 }
Potash	0.226	0.767	1.031
Soda	0.116	0.089	0.131
Lime	0.158	0.631	0.720
Magnesia	0.256	0.552	0.884
Brown oxide of manganese	0.048	0.018	0.014
Peroxide of iron	1.848	3.822	7.101
Alumina	2.565	7.274	15.446
Phosphoric acid	0.162	0.105	0.146
Sulphuric acid	0.042	0.365	0.246
Water and organic matter	3.013	4.400	18.520
Total	100.363	99.528	100.481
Hygroscopic moisture absorbed at	4.070 14 C.°	8.510 12 C.°	18.820 13 C.°

The increase in the percentages of potash, lime, and alumina is sufficiently striking, the latter indicating the increase of fine clayey and easily decomposible material in the soils. As between the two Louisiana soils, the increase of phosphoric acid is also striking, but the easy solubility of the phosphates in marshy regions renders their distribution somewhat capricious when compared with upland or other soils not subject to long submersion.

But the chemist's task does not stop at these considerations of physical constitution. A comparison of the composition of soils of known productiveness, and characterized in their natural state by certain invariable features of plant-growth, soon reveals the existence of definite relations, not only to the *absolute amounts* of certain ingredients present in the soil, but also to their *relative proportions*. No ingredient exerts in these respects a more decided influence than *lime*, its advent in relatively large proportion, other things remaining equal, changing at once the whole character of vegetation, so as to be a matter of popular remark everywhere. Only it is not popularly known, nor has it been definitely recognized by agricultural chemists thus far, that it is the *lime* that brings the change.

FUNCTIONS OF LIME.—The evidence afforded of this fact by the analyses hereinafter recorded is overwhelming. It is very often obvious to the eye in the rich black "prairie spots" formed where a calcareous material approaches the surface so as to take part, exceptionally, in soil formation; and whatever may be the cause of the disabilities ascribed in Europe to the "poor chalk soils", in the United States the "rich limestone soils" are at least equally proverbial. Thus far he that runs may read, and the agricultural chemist who travels with his eyes open cannot fail to recognize the facts familiar to all farmers. But it is interesting to find that, even where the eye fails to see the effect on the aspect of the soil, analysis invariably corroborates the presumptive evidence afforded by the natural choice of certain trees and smaller plants. Almost all the trees which the "old farmer" habitually selects as a guide to a good "location" (*a*) are such as frequent calcareous soils, using the term, however, in a somewhat different meaning from that usually given it; that is, I find that, in order to manifest itself unequivocally in the tree-growth, the lime percentage should not fall much below 0.1 per cent. in the lightest sandy soils; in clay loams not below a fourth of 1 per cent., 0.25, and in heavy clay soils not below 0.5, and may advantageously rise to 1 and even 2 per cent. Beyond the latter figure it seems in no case to act more favorably than a less amount, unless it be mechanically.

These are mere statements of facts, amply exemplified in the analyses of soils accompanied by a statement of their natural vegetation. The subjoined analyses may serve as examples:

Table of Mississippi soils, showing relations between lime and clay.

	KEMPER COUNTY.		JASPER COUNTY.		PONTOTOC COUNTY.
	Stiff red soil.	Black prairie soil.	Hogwallow prairie soil.	Black prairie soil.	Flatwoods soil.
	No. 141.	No. 139.	No. 242.	No. 195.	No. 230.
Insoluble matter	54.565 } 67.784	67.078	76.758	77.488	77.854
Soluble silica	13.219 }				
Potash	0.431	0.699	0.525	0.384	0.753
Soda	0.277	0.136	0.190	0.059	0.106
Lime	0.540	1.371	0.424	1.728	0.178
Magnesia	0.836	1.003	0.074	0.881	0.831
Brown oxide of manganese	0.079	0.245	0.559	0.128	0.107
Peroxide of iron	7.089	6.748	4.121	3.890	5.800
Alumina	16.071	13.068	10.050	7.680	10.302
Phosphoric acid	0.187	0.033	0.063	0.104	0.052
Sulphuric acid	0.009	0.077	0.059	0.005	0.032
Water and organic matter	6.922	9.453	5.733	7.772	3.689
Total	100.225	99.911	99.165	100.128	99.803
Humus	0.781	1.277	0.729	....	0.806
Available inorganic	3.256	1.088	2.168	....	1.806
Hygroscopic moisture	13.100	11.500	6.830	13.780	9.330
absorbed at	11 C.°	8 C.°	Air-dried.	16 C.°	22 C.°

All these are very stiff soils, the first two from the Cretaceous prairie region, and lying in close proximity on hillsides; the third and fourth from the Tertiary prairie region, also not very far apart. The two black soils (Nos. 139 and 195) bear a most characteristic "lime" growth of trees, and are very productive, although No. 139 does not last well. The other soils bear only oaks. No. 141 is fairly productive in good seasons and with good tillage, but No. 242 is considered practically worthless, and bears a growth of scrubby black-jack oak only. No. 230 is very stiff gray clay soil, whose inferior lime percentage is indicated in the tree-growth by the addition of pine to the black-jack and post oaks. Comparing these with each other and with the sandy soils Nos. 68 and 88 of a previous table, which also bear the lime growth, the maxim above stated appears well established, being moreover corroborated throughout the series of analyses made. It is, besides, altogether in accord with the experience of agriculturists

a Of these, those most generally recognized in the Mississippi valley are the black walnut, wild cherry, sycamore, wild plum, crab-apple, the linden, *most* hickories, ash, chestnut, black, white, and *certain forms* of the other oaks; in the south, in addition, the tulip-tree or "poplar", hackberry, pecan, large, stout sassafras, large grape-vines, and others.

as to the effects of the use of lime as a fertilizer on clay soils, on which it can be advantageously used in large quantities, while small dressings will suffice on lighter ones. There can be no doubt that lime acts in these cases, partially at least, by its peculiar effect on the tillableness of clays, investigated almost simultaneously by Schloesing and myself in 1872, and to which I have applied the term "flocculation". A certain proportion of it is necessary to render the plant-food of heavy clay soils physically accessible to vegetation, and where there is little clay little lime is needed to secure this result; but, after making full allowance for this action, some very obvious chemical relations to other soil ingredients require consideration.

A chemical effect produced by the presence of large percentages of lime in the soils seems to be a kind of "aufschliessung", an energizing or rendering active of that which otherwise would remain inactive. This becomes evident at once in the smaller insoluble residues from the acid treatment yielded by such soils, there being then oftentimes a complete dissolution of the alumina, a large part of which ordinarily remains behind in the shape of clay (kaolinite particles). It would seem that, as regards the silicates, the carbonate of lime in soils performs gradually, in a measure, the same functions as the caustic lime in Lawrence Smith's method of silicate "aufschliessung", doubtless in consequence of the formation of zeolitic compounds readily attacked by solvents.

From the evidence afforded by the analyses, (*a*) I should summarize as follows: The advantages resulting from the presence of an adequate supply of lime in soils:

a. A more rapid transformation of vegetable matter into *active* humus (*matière noire*), which manifests itself by a dark or deep black tint of the soil.

b. The retention of such humus, against the oxidizing influences of hot climates; witness the high humus percentages of such soils, as against all others, in the southern states. (*b*)

c. Whether through the medium of this humus, or in a more direct manner, it renders adequate for profitable culture percentages of phosphoric acid and potash so small that, in the case of deficiency or absence of lime, the soil is practically sterile.

d. It tends to secure the proper maintenance of the conditions of nitrification, whereby the inert nitrogen of the soil is rendered available.

e. It exerts a most important physical action on the flocculation, and therefore on the tillability, of the soil.

f. In the same connection it tends to increase the absorption coefficients of soils for moisture and other gases.

g. The efficacy of lime in preventing "running to weed" in fresh soils, and in favoring the production of fruit, is conspicuously shown in a number of cases.

I may add that in the great majority of soils (excepting those that are extremely sandy) the lime percentage is greater in the subsoil than in the surface soil. This is doubtless the result of the easy solubility of calcic carbonate in the soil water, which carries it downward, and thus tends to deplete the surface soil. This fact is strikingly shown in the results of Loughridge's investigation on the composition of the several sediments into which the subsoil under investigation had been resolved. (*c*) In the summation of the percentages found in the sediments most of the substances determined appear nearly as in the original soil; but of 0.27 per cent. of lime in the latter, only 0.09 reappear in the summation, and a similar loss is shown in the case of phosphoric acid. These two important ingredients had to a large extent been dissolved out by the distilled water used in the process of sedimentation. Practically, the same observation has been made in the formation of crusts of lime carbonate in the drains laid in calcareous or marled soils.

This controlling influence of lime renders its determination alone a matter of no small interest, since its deficiency can very generally be cheaply remedied, avoiding the use of more costly fertilizers. To this extent at least the agricultural chemist can render the old farmer an undoubted service.

As to "*a*" and "*b*", the points mentioned therein are apparent upon a mere inspection of the humus determinations given in the last table and throughout the entire series of reports. Ordinary upland soils show from 0.4 to 0.75 per cent. of *matière noire;* the prominently calcareous soils, from 1 to 1.5, and even more. Their familiar black tint tells of the same fact, which is moreover altogether in accord with what we know of the effects of alkalies upon vegetable matter, and with the experience of manure-makers everywhere, only the carbonate of lime in the soil acts more slowly than the hydrate. As to point "*c*", we have an indication of the same action in the case of marls, whose small percentages of potash and phosphates act so energetically, and in which we so often find the potash in the highly available form of glauconite grains; also in the displacement of potash from zeolitic compounds by lime or lime salts. It is manifestly of the utmost importance for the interpretation

a It will be noted that these axioms regarding the effects of lime in the soil are largely those already recognized in agricultural science; but as they have here been arrived at by the process of direct soil investigation, they are summarily presented in that connection

b The contrary results obtained heretofore in experiments made with soils mixed with lime, which showed a more rapid oxidation of the organic matter than the unlimed soils, are not valid as against the case of soils in their natural condition. It was well known before that nitrification proceeded more rapidly under the artificial circumstances there created; but the *eremacausis* so induced tells largely upon the unhumified organic matter, while the black tint of calcareous soils is due to the efficacious and difficultly oxidable *matière noire*, to the formation of which lime, like potash, contributes so powerfully.

c See *Am. Jour. Sci.*, Jan., 1874, p. 18; also, *Proc. Am. Ass'n Adv. Sci.*, 1873, p. 80.

and utility of soil analyses; and while the reader of these reports will find the truth of the maxim abundantly exemplified in its pages, it may be desirable to adduce some prominent examples in its support. These of course have to be sought chiefly among the less productive soils, but can also be noted in the preceding table; as in the case of the black prairie soil of Kemper, whose very small phosphoric acid percentage suffices, in the presence of much lime, to render it at first more productive than No. 141, with over five times the amount of phosphates, the potash supply being ample in both cases. But before proceeding to discuss this issue a general summary of the usual percentages, as shown in the analyses, together with the general conclusions deduced therefrom, must be given.

PLANT-FOOD PERCENTAGES.—The *phosphoric acid* percentage is that which, in connection with that of lime, seems to govern most commonly the productiveness of our virgin soils. In any of these less than five-hundredths (0.05) must be regarded as a serious deficiency, unless accompanied by a large amount of lime. In sandy-loam soils one-tenth (0.1), when accompanied by a fair supply of lime, secures fair productiveness for from eight to fifteen years; with a deficiency of lime, twice that percentage will only serve for a similar time. The maximum percentage thus far found in an upland soil by my method of analysis is about a quarter of 1 per cent (0.25) in the splendid table-land soils of West Tennessee and Mississippi; in the best bottom ("buckshot") soil of the Mississippi, three-tenths (0.3); in that of a black prairie of Texas, 0.46 per cent., and in a red-clay soil from Tennessee, 0.563 per cent., this being the highest figure that has come under my observation. It implies the presence in each acre of soil taken to the depth of 6 inches of 11,000 pounds of phosphoric acid.

The *potash percentages* of soils seem in a large number of cases to vary with that of "clay"; that is, in clay soils they are usually high, in sandy soils low; and since subsoils are in all ordinary cases more clayey than surface soils, their potash percentage is also almost invariably higher. One and three-tenths (1.3) per cent. of potash is the highest percentage obtained by my method of extraction, and that from the same soil that afforded the second highest phosphate percentage also, the "buckshot" of the Mississippi bottom, noted for its high and uniform production of cotton. As the same soil contains 1.4 per cent. of lime, and is jet black with humus, it may well serve as the type of a fertile soil.

The potash percentage of heavy clay upland soil and clay loams ranges from about 0.8 to 0.5 per cent., lighter loams from 0.45 to 0.30, sandy loams below 0.3, and sandy soils of great depth may fall below 0.1 consistently with good productiveness and durability, the former depending upon the amounts of lime and phosphoric acid with which it is associated. Virgin soils falling below 0.06 in their potash percentage seem, in most cases that have come under my observation, to be deficient in available potash, its application to such soils being followed by an immediate great increase of production. Sometimes, however, a soil very rich in lime and phosphoric acid shows good productiveness despite a very low potash percentage; (*a*) and, conversely, a high potash percentage seems capable of offsetting a low one of lime.

Since but few soils fall below this minimum, my general inference has been that potash manures are not among the first to be sought for after the soils have become "tired" by exhaustive culture. The universal preference given to phosphatic and nitrogenous fertilizers in the west and south is in accord with this inference. In the older portions of the United States "kainit" is becoming more important, while in the alkali lands of California soluble potash salts often impregnate the soil water, and will probably never need to be supplied by manure.

In all soils not specially impregnated with sea or other salts the amount of *soda* extracted by the acid is considerably *below* that of potash in the same soil, varying mostly from one-eighth to one-third of the percentage of the latter. When much more is found in such soils a repetition of the determination will usually show that the separation from magnesia was imperfectly made. I can trace no connection between the soda percentage and any important property of the soil, any more than in the case of *magnesia* and *manganese;* albeit none of these is ever absent from ordinary soils. In the majority of cases the percentage of magnesia is greater than that of lime, frequently about double; but it does not seem capable of performing to any appreciable extent the general functions of lime in soil-making.

Sulphuric acid is found in very small quantities only, even in highly fertile soils. From two- to four-hundredths of one per cent. (0.02 to 0.04) seems to be an adequate supply, but it frequently rises to one-tenth (0.1) per cent., rarely higher.

Chlorine I have as a rule left undetermined, on account of its constant variability and universal presence in waters and acknowledged slight importance to useful vegetation.

Iron, in the shape of ferric hydrate finely diffused, appears to be an important soil ingredient on account of its physical, and partly also its chemical, properties. The universal preference given to "red lands" by farmers is sufficiently indicative of the results of experience in this respect, and I have taken pains to investigate its causes. The high absorptive power of ferric hydrate for gases is probably first among the benefits it confers. Red soils resist drought better than similar soils lacking the ferric hydrate.

a See, for example, soils Nos. 1 and 2, Florida, which are among the best upland soils in the state, producing, when fresh, as much as 1,500 pounds of seed-cotton.

From 1.5 to 4 are ordinary percentages of ferric oxide, occurring even in soils but little tinted. Ordinary ferruginous loams vary from 3.5 to 7 per cent.; highly colored "red lands" have from 7 to 12 per cent., and occasionally upward to 20 per cent. and more.

Of course, a large amount of ferric hydrate facilitates the tillage of heavy clay soils, and its color tends to the absorption of heat; but I incline strongly to the belief that the benefits of its presence are not confined to physical action. From the fact that highly ferruginous soils rarely have a high percentage of humus, it appears that the former acts as a carrier of oxygen to the latter, and thus probably favors, especially, nitrification.

On the other hand, such soils are the first liable to damage from imperfect drainage, overflows, etc. The reduction of the ferric hydrate to ferrous salts, most commonly in the subsoil, manifests itself promptly by the "blighting" of the crop. But under natural conditions this can rarely occur, because a frequent recurrence of conditions favoring reduction will inevitably result in a gradual bleaching of the soil and an accumulation of its iron in the subsoil in the form of bog-ore or "black pebble".

The percentages of *alumina* are but an imperfect indication of the amount of *clay* in the soil. As before remarked, they are always found larger in calcareous soils, other things being equal, and the amount dissolved continues to increase long after the rest of the important substances have been extracted if the digestion with acid be prolonged, doubtless in consequence of the slow action on the larger kaolinite particles. But the first portions are dissolved with great promptness; and if all were in combination as hydrous silicate, it is obvious that the amount of silica soluble in boiling solution of sodic carbonate should bear a certain ratio to that of the alumina. In all later analyses this determination of "*soluble silica*" in the residue remaining after digestion with acid and evaporation has been made. Curiously enough, it is but rarely that the amount of silica dissolved satisfies the requirement for combining with the alumina into kaolinite, and in a *very* few cases there is an excess of silica over that requirement. In numerous cases the silica falls so far below the amount corresponding to the alumina as to raise a serious question as to the combination in which the latter occurs in the soil, the *hydrate* (gibbsite) being almost the only possible one, apart from zeolitic minerals. Perhaps this fact may serve to explain some of the otherwise incomprehensible variations in the physical properties of soils whose chemical and mechanical analysis would seem to make them almost identical. In some of the Tertiary prairie soils of the southern states, moreover, there seems to occur still another amorphous mineral, related to or identical with *saponite*, which sometimes occurs in segregated masses, and imparts to these soils very peculiar and unwelcome properties in tillage. We are evidently as yet very far from a full understanding of the mechanical constitution of soils.

I have in a few cases determined the amount of *silica soluble* in boiling solution of sodic carbonate in the *crude* soil. But this determination is often beset with almost insuperable mechanical difficulties, from the diffusion of the clay in the alkaline liquid, and does not appear to promise results of sufficient importance to justify such labor; the more, as by the method of Grandeau the actual available amount of silica can probably be better determined.

As regards the *determination of humus*, I have not yet been able to extend the method of Grandeau for humus extractions over a sufficient number of widely-different soils of well known characteristics to consider the claim of its furnishing a definite measure of the available plant-food in the soil as definitely established. There can be no reasonable doubt that what *is* extracted by Grandeau's ammonia-water is at the command of the solvents employed by plants; the only question is, to what extent plants can readily go beyond. This, of course, requires extended culture experiments on a great variety of soils. The determination of the *phosphoric acid* and *silica in the residues* from the ignition of Grandeau's extracts have already furnished most important data concerning the cause of the productiveness of some soils having comparatively a low percentage of phosphates; and here again there is evidence of a direct connection with the more or less calcareous nature of the soils. The facts thus far elicited are not sufficiently numerous to prove or disprove definitely Grandeau's claim as to the direct connection of the results with the soil's present productiveness, and I hope to carry the study of the subject to a more definite conclusion hereafter. The figures given opposite the heading "available inorganic" in the analyses are often suggestive, but can justify no conclusions until they shall have been fully analyzed; a task involving no small amount of labor. Silica and ferric oxide seem ordinarily to form the bulk of this ash. There is a class of soils, poor in lime, in which the ammonia solution is of a pale yellow, instead of the usual dark tint, but darkens during evaporation, probably by oxidation of crenic into apocrenic acid.

As exemplifications (which might be indefinitely multiplied) of the *effects of increased lime percentages* in rendering soils thrifty, *i. e.*, productive for the time being, as the result of the increased availability of plant-food when present even in small quantities, I give the following instances:

Analyses of Louisiana soils.

	PINE WOODS SUBSOIL.	OAK AND HICKORY RED SUBSOIL.	ANACOCO PRAIRIE SOIL.
	Vernon parish.	Sabine parish.	Vernon parish.
	No. 134.	No. 165.	No. 171.
Insoluble matter	77.870 } 82.265	49.120 } 72.570	53.190 } 74.290
Soluble silica	4.395 }	23.450 }	21.100 }
Potash	0.247	0.202	0.332
Soda	0.083	0.065	0.064
Lime	0.097	0.268	1.398
Magnesia	0.380	0.290	0.735
Brown oxide of manganese	0.041	0.146	0.149
Peroxide of iron	3.214	5.324	4.520
Alumina	9.918	15.232	11.363
Phosphoric acid	0.072	0.038	0.047
Sulphuric acid	0.086	0.050	0.123
Water and organic matter	3.546	5.509	7.266
Total	99.908	99.694	100.287
Hygroscopic moisture	6.790	12.140	18.110
absorbed at	26.6 C.°	25.6 C.°	25.5 C.°

In these soils the potash percentage is only fair in Nos. 134 and 171; in No. 165, rather low, according to the usual run of soils of the state. The phosphoric acid is low in all, highest in the pine-hill soil, and deficient, according to the usual standard, in the other two. The pine-hill soil will produce about 500 pounds of seed-cotton per acre for a few years; the Sabine upland soil from 800 to 1,000 pounds, when fresh, but soon declining. The Anacoco prairie soil has yielded from 1,200 to 1,500 pounds per acre for fifteen years, and is still doing fairly well. Had the soil corresponding to No. 134 been analyzed in place of the subsoil, the percentages would have been somewhat diminished all around and the comparison would have been more striking. As it is, the lime percentages are respectively 0.097, 0.268, and 1.398.

Some examples from Mississippi are given in the first table of this paper; but the following are more particularly illustrative of the influence of lime, especially in counteracting a deficiency in the amount of phosphoric acid:

Analyses of Mississippi soils.

	BLACK PRAIRIE SOILS.		LONG-LEAF PINE SOILS.	
	Noxubee county.	Kemper county.	Smith county.	Pike county.
	No. 170.	No. 180.	No. 206.	No. 218.
Insoluble matter	64.644 } 75.704	67.078	93.257	89.801
Soluble silica	11.060 }			
Potash	0.366	0.699	0.259	0.218
Soda	0.074	0.136	0.065	0.076
Lime	1.254	1.371	0.129	0.034
Magnesia	0.716	1.003	0.180	0.306
Brown oxide of manganese	0.118	0.245	0.146	0.072
Peroxide of iron	4.557	6.748	1.251	2.402
Alumina	8.918	13.068	2.356	3.783
Phosphoric acid	0.068	0.033	0.030	0.038
Sulphuric acid	Trace	0.077	0.024	0.036
Water and organic matter	8.466	9.453	2.330	3.446
Total	100.241	99.911	100.027	100.212
Hygroscopic moisture	14.290	11.450	2.480	4.110
absorbed at	20 C.°	8 C.°	19 C.°	21 C.°

All these soils are low in phosphates, the two prairie soils, both highly productive at first, and for 15 to 20 years, then falling off rather suddenly. The two pine soils, Nos. 206 and 218, would scarcely produce 500 pounds of seed-cotton per acre when fresh, and that only for three or four years. Many similar examples may be culled from the analyses of Texas and Alabama soils.

It is quite apparent that where the phosphoric acid percentage is very high the effect on vegetation and productiveness in cultivation is similar to that resulting from the presence of large lime percentages with less phosphates. Usually, however, high phosphates are associated with at least a fair proportion of lime. The following examples of soils from northwestern Georgia are illustrative:

Analyses of Georgia soils.

	WALKER COUNTY.		POLK COUNTY.
	Cherty lands.	Valley lands.	Red valley land.
	No. 506.	No 505.	No. 517.
Insoluble matter	81.470 } 88.926	89.680 } 91.393	67.319 } 72.526
Soluble silica	7.456	1.713	5.207
Potash	0.422	0.178	0.334
Soda	0.277	0.065	0.063
Lime	0.197	0.047	0.286
Magnesia	0.878	0.031	0.392
Brown oxide of manganese	0.178	0.041	0.034
Peroxide of iron	1.989	1.750	6.234
Alumina	3.050	2.677	9.721
Phosphoric acid	0.411	0.188	0.042
Sulphuric acid	0.103	0.041	0.328
Water and organic matter	4.405	2.980	10.015
Total	100.926	99.391	99.975
Hygroscopic moisture	6.310	4.340	9.770
absorbed at	13 C.°	14 C.°	16 C.°

Of these soils, No. 506, having a very high percentage of phosphoric acid and only a moderate supply of lime, is very productive. Nos. 505 and 517, one with high lime and low phosphoric acid, the other with the proportions reversed, are both about equally productive.

The effect of a large lime percentage in *increasing the amount of silica and alumina dissolved* in the extraction by acid is abundantly illustrated in the analyses of prairie soils from Mississippi, Alabama, and Texas. A glance at the columns giving the percentages of these substances in the tables will show this relation; but it will also be noted that while in calcareous clay soils it exists almost invariably there are cases in which a considerable percentage of soluble silica is not accompanied by any notably large proportion of lime. As this occurs usually in sandy or pervious soils, it is possible that these are cases in which the lime has been gradually removed by the well-known leaching process. At all events, no exact numerical proportionality between the present lime percentage and the soluble silica can be established.

In many cases of lime percentages rising to between 1 and 2 and even more carbonic acid is not reported at all, although a qualitative test for that substance was in all cases made. A most striking case is that of the soil and subsoil Nos. 9 and 10, Tennessee, in which, respectively, 6.5 and 8.4 per cent. of lime is present, and yet scarcely a trace of gas is evolved on treatment with acid. The lime consequently exists in the shape of a (zeolithic) silicate, in which doubtless the potash and alumina so abundantly present have a share; for the soluble silica shown in the table is not remote enough to combine with the alumina into kaolinite.

RELATIONS OF LIME TO HUMUS AND THE AVAILABLE PHOSPHORIC ACID IN THE "MATIÈRE NOIRE".—As remarked above, the determinations of the phosphoric acid contained in the soil extract, according to Grandeau, are not as yet sufficiently numerous to warrant definite conclusions as to the relations of the several soil ingredients to this factor. In some cases in which considerable lime is present the humus extract does not show a very large proportion of available phosphoric acid, but in some cases *all*, and in others a large proportion of the total phosphoric acid of the soil, is found in the humus extract, and in all such cases the lime percentage is relatively large. Thus in the two soils from the Houma region of Louisiana one-half of the total phosphoric acid of the soil is found in the humus extract; and in the "sugar-bowl" delta lands of the Brazos river, of Texas, as well as in the bottom of the Colorado river of the west, in southern California, the whole of the contained phosphoric acid is extracted with the humus. All these are soils of extraordinary productiveness. In nearly all the cases of soils poor in lime in which the determination has thus far been made the amount of phosphoric acid appearing in the humus extract is small, varying usually from one-fourth to one-tenth of the total amount in the soil, and even less.

It cannot be doubtful that a thorough investigation of this subject would lead to results not only interesting, but of great practical importance; but the amount and character of the work involved is such as to place it almost beyond the power of any single investigator, and commensurate only with the scale of a public work.

PART II.

STATISTICS AND AGRICULTURAL DESCRIPTIONS

OF THE

COTTON STATES,

WITH A PRELIMINARY DISCUSSION OF THE GENERAL FEATURES OF THE ALLUVIAL PLAIN OF THE MISSISSIPPI RIVER BELOW THE MOUTH OF THE OHIO.

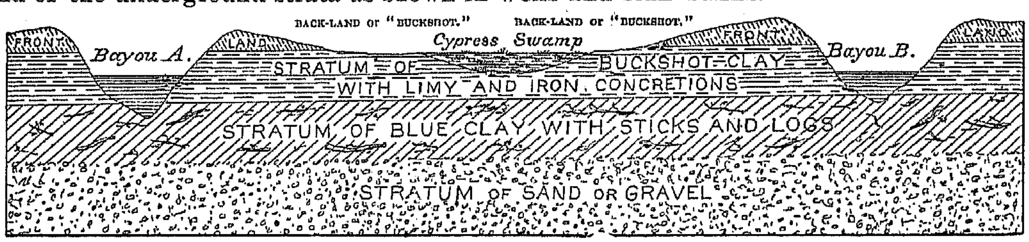
BY

E. W. HILGARD.

GENERAL FEATURES OF THE ALLUVIAL PLAIN OF THE MISSISSIPPI RIVER BELOW THE MOUTH OF THE OHIO.

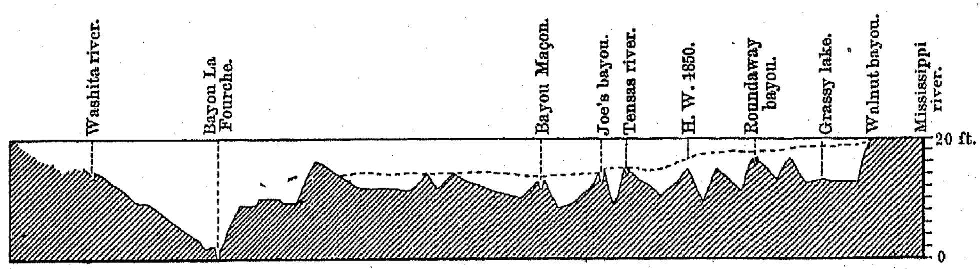
The agricultural features of the Mississippi bottom and delta plain are so intimately connected with the geology and topography of this region that a succinct preliminary statement of these must of necessity precede the discussion of its soils. This statement will apply, with some local modifications, to the great alluvial plain from the confluence of the Ohio down to the shores of the Gulf of Mexico.

To the eye of the casual observer the alluvial region appears substantially as a plain, forest-covered throughout—what are called "prairies" being in most cases simply old Indian clearings. Closer observation, and still more the leveling instruments of the surveyor, soon reveal the fact that, as a general rule, the banks of the water-courses are the highest points; that, in other words, each stream has its bed in the axis of a ridge that accompanies it throughout. This ridge is formed of the deposits of the stream itself, and from it the land slopes off gently, until, midway between two water-courses, we usually find a low cypress swamp lying from 2 to 6 feet below the banks, and sometimes even below the ordinary water-level of the streams. This state of things will be best understood by reference to the subjoined diagram (*a*) representing a section across two "bayous" (*b*) and the intervening lands and swamp, and of the underground strata as shown in wells and bluff banks.



Ideal section across two bayous in the Mississippi bottom, showing surface-structure.

What is true of the smaller streams or bayous holds no less, of course, as regards the larger streams and the great Mississippi itself. The subjoined sections across the Mississippi bottom (one from the main river to the Yazoo bluff, the other from the same to the west bank of the Washita river, about Monroe, Louisiana,) exhibit the same features on the large scale. It will be seen that the bank of the Mississippi river at Melrose Landing, Bolivar county, Mississippi, is 20 feet above that of the Yazoo, due east from that point; while the banks of the Washita river near Monroe, Ouachita parish, Louisiana, are about 10 feet below the level of the banks of the Mississippi near the mouth of the Yazoo.



Section showing surface of Mississippi bottom, and high-water mark of 1850, from banks of Mississippi river above Vicksburg, west to the Washita river, below Monroe, Ouachita parish, La. (From Report on the Mississippi river, by Humphreys and Abbot, Plate No. IV.) Distance, about 70 miles.

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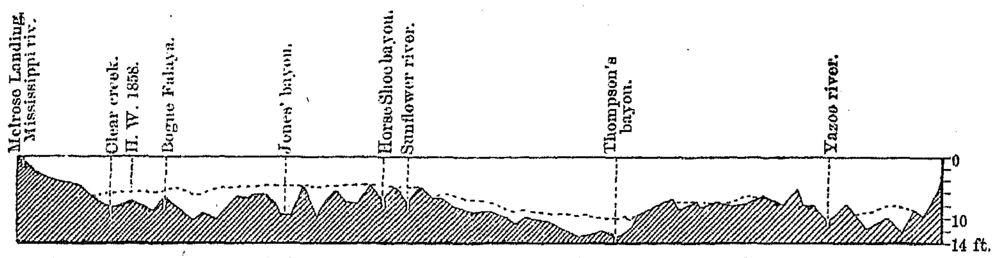
a See "Remarks on the Geology of the Mississippi Bottom", by Eugene A. Smith, in *Proc. of the Am. Ass'n for the Adv. of Sci.*, 1871, p. 53.

b The French Creole term *bayou* applies properly to water channels branching *out* from the main stream and carrying *off* a portion of its water. Since this office is performed in time of flood by almost every stream in the alluvial plain (whereby the natural current is not uncommonly reversed for some time), the name has come to be applied indiscriminately to all the water-courses of that plain, and thence has been largely transferred in Louisiana to the upland streams also.



Section showing surface of Mississippi bottom, and high-water mark of 1858, from Melrose Landing, Bolivar county, Miss., east to the Yazoo bluff. Distance, about 75 miles.

A glance at the surface profiles across the great bottom explains the primary importance of preventing the waters of the Mississippi from passing the natural or artificial barriers on its own banks; for, these once passed, the flood descends with a considerable velocity upon the lower ground inland, and not unfrequently reaches the foot of the bluff on either side. There are numerous natural channels through which a partial discharge of floods in this direction takes place wherever not artificially prevented, as has perhaps too frequently been done. Among the more important of such "passes" is the Yazoo pass; the bayous connecting the heads of the Sunflower river with the Mississippi; Jack's bayou and bayou Vidal, forming connections with the Tensas river; and lower down, bayous Plaquemine and Manchac. The opening or closing of these important connections in time of flood, involving the exposure or protection of certain regions, has been from time to time the subject of passionate discussion, in connection with the question of the maintenance of levees or embankments intended to confine the Mississippi river within its banks.

The floods of the Mississippi occur in the six months from December to June, but are usually distinguished as "the spring rise" and "the June rise". The spring rise, broadly speaking, is caused by the spring rains and melting of the snows in the nearer and level portion of the Mississippi valley, from the Alleghanies westward to the great plains; it most commonly occurs in March and April, and when it subsides in time does not materially interfere with the planting of crops in the bottom-lands, where the growing season is several weeks longer than in the adjacent uplands. The second or June rise is caused by the melting of snows in the Rocky mountain region, and is frequently aggravated by persistent rains in the nearer portions of the basin, resulting in a concurrence of the mountain floods, carried by the Missouri and Arkansas rivers, with those of the Ohio and direct tributaries north and south of the same. The June rise, occurring after all the expense of pitching crops has been incurred, is, on that account, usually chargeable with the largest amount of direct damage. When, as is sometimes the case, the putting in of crops is altogether prevented by a continuation of the high water through spring to the end of June, the planter has at least saved a heavy cash outlay, and may more readily make up for the loss of a year's crop during a succeeding favorable season. The average height of the June rises appears to be at least not below that of the spring rises.

In whatever direction the solution of the question of protection of the Mississippi alluvial plain from overflows may ultimately be found, it is certainly the vital question for the development of the immense agricultural resources of this region, as much as is that of irrigation in other portions of the United States. In either case, a few years' respite from inundation or from drought is apt to bring about a relaxation of the efforts for a final settlement of the question, and to induce the investment of large sums in improvements, which are then ruthlessly swept away by one or two seasons' excess, or deficiency, of the vital fluid. In the case of the Mississippi bottom this insecurity has largely restricted cultivation to the soils of the higher ground immediately adjacent to the water-courses.

The high land near the bayous—the "front-land"—is not, however, distinguished by its position alone. As a rule, it is a "light" soil, a loam, sometimes quite sandy, and, on the whole, the more so as the stream depositing it is larger; hence, on the banks of the Mississippi itself, we frequently find it almost too sandy for cultivation. Old abandoned water-courses are also thus frequently marked by ridges of sandy or loam soil, whose timber growth always differs more or less from that of the "back-land", by the presence of the cottonwood and the comparative scarcity or absence of the trees denoting a heavy soil, such as sweet-gum and swamp-chestnut oak.

The immediate banks of the Mississippi river are, as a rule, occupied by a growth of cottonwood trees, sloping up from the seedling near the water's edge to the full-grown forest tree a hundred yards inland, and producing the impression of an elevated, sloping bank. This tree thus serves to fix and consolidate the sandy deposits, checking the current and causing slack-water sediments to form during high water, which ultimately constitute the cultivable soil. Opposite caving shores of bends, and in the eddies below islands, the forming alluvial soil is similarly occupied, the low, gently sloping banks constituting the "battures" and (in the case of islands) "tow-heads". Below Red river, these are chiefly occupied by willows, which are better adapted to the warm climate than the cottonwood.

The "back-land", occupying the landward slope between the front-land and the cypress swamp, is of a totally different nature from the present deposits of the streams, while closely resembling the clayey soil now in process of formation in the swamps. Its special name of "buckshot" is due, partly to the occurrence in it of rounded ferruginous concretions, which cause the same name to be applied to the (of course entirely different) white silt soils

elsewhere, and partly to its peculiarity of crumbling into small, roundish-angular fragments in drying; a property to which much of its agricultural value is due, since it thus combines the great intrinsic fertility of a heavy soil with the easy tillability of a light one. The dark-tinted "buckshot" soils are the most highly esteemed for productiveness and durability, being in these respects probably exceeded by few, if any, soils in the world.

Examination of the strata in the banks of the streams, and of those found in digging wells, shows that the dark-colored clay stratum from which the "buckshot" soil is derived underlies the whole of the Mississippi bottom from Memphis to the delta, its thickness commonly varying from 8 to 30 feet, 12 to 15 being the usual one. Into this clay stratum, evidently formed at the time when the entire bottom plain was a continuous swamp, the present streams have excavated their beds, and upon it they now deposit their alluvium. The comparatively firm nature of the banks formed by this "buckshot" clay prevents to a great extent the continual shifting of the smaller channels, so apt to occur in the alluvial plains of other rivers. In the larger channels, however, and especially in that of the main Mississippi, the depth of water and its velocity in times of flood becomes so great as to reach and wash away the sandy or gravelly strata which underlie the clay; and thus undermined the latter breaks off and tumbles into the water in large fragments. It is thus that the "neck" separating from each other the two limbs of a bend is frequently washed away, forming a "cut-off" and, for the time being, making an island of the land in the bend. Generally, however, the entrances to the old river bed are filled up by the deposits formed in the slack water, connection with the newly-formed bed at ordinary stages of water ceases, and a crescent-shaped lake remains in the place of the old channel. These lakes are abundant along the larger streams of the bottom plain, and their banks, being high and dry, are often the preferred sites for residences.

Except as to the kinds of trees forming the timber, these general features of the great bottom suffer but little change as we descend the river until we reach the region of comparatively slack water, below Baton Rouge. From the junction of the Ohio river down to the Mississippi state line, below Memphis, the Mississippi river generally keeps within a short distance of the eastern uplands, so that only comparatively small tracts of bottom land lie within the states of Kentucky and Tennessee (about 320 and 600 square miles respectively), while the foot of the bluff is washed by the river at Columbus and Hickman, Kentucky, and at the four "Chickasaw bluffs" in Tennessee, on the most southerly of which stands the city of Memphis. From the latter point the river turns diagonally (southwestward) across the bottom, striking the high lands of Arkansas near Helena. The bottom plain lying to the northward of this cross-cut in Missouri and Arkansas is popularly known as the *St. Francis bottom* (6,300 square miles), that stream flowing near its western edge and joining the main river a few miles above Helena. Similarly, the extensive area of bottom lying to the southward, in the state of Mississippi, and along whose eastern edge flows the Yazoo river, is known as the *Yazoo bottom* (7,100 square miles); it terminates at Vicksburg, where the great river once more strikes the eastern bluff after having made a great bow to the westward, at the vertex of which it receives the Arkansas river. From Vicksburg to Baton Rouge, Louisiana, where it enters the delta plain proper, the Mississippi river remains within a short distance of the eastern highlands, which it frequently strikes, forming high and steep bluffs at several points, as at Grand Gulf, Rodney, Natchez, Ellis' Cliffs, and Port Hudson, small patches only of alluvial land remaining on the eastern side.

The bottom plain west of the river, from about the northeast corner of Louisiana (where the bayou Tensas diverges from the main river) down to the mouth of Red river, is known as the *Tensas bottom* (about 3,115 square miles), and lies wholly within the state of Louisiana.

Of these three chief divisions of the great bottom the Tensas bottom proper is altogether uninterrupted by any ridges above the highest overflows. In the Yazoo bottom there is a long, narrow ridge, entirely above present overflows, extending from the region opposite Helena, Arkansas, to the northern end of Honey island, Holmes county, Mississippi. It is thus about eighty miles in length, and varies from two to six miles in width. Its soil and timber-growth are different from those of the rest of the bottom, dogwood being a largely prevalent tree; it is, in its northern portion, known as the "Dogwood ridge". Its soil is very productive, and approaches in character that of the "front-lands" of the larger bayous.

The St. Francis bottom is much more intersected and diversified by ridges of varying elevation and character. Some of these are true upland ridges, extending in from, and connected more or less with, the mainland. Others are isolated islands of such land, and others again are of a character approaching that of the "Dogwood ridge" of the Yazoo bottom, just referred to. These will be found described in detail in the portion of the report relating to the state of Arkansas.

The same feature is continued into Louisiana, in the upland ridges dividing the flood-plains of bayous Maçon, Bœuf, and Bartholomew from each other, and that of the latter from the bottom of the Washita. Minor ridges of less elevation, and more nearly related to the present alluvium, occur at various points, as is indicated on the map of Louisiana.

The country bordering on the main Mississippi, from Red river down to New Orleans, is popularly known as the "upper coast", in contradistinction to the "lower coast", which embraces the river country from New Orleans to the mouths. The belts of cultivated land lying along the other larger streams (Atchafalaya, Tèche, Lafourche, &c.), are habitually referred to by the names of the streams, not as "bottoms", but "country".

In approaching the tide-water region, the crescent-shaped lakes, so characteristic of the alluvial plain above,

become rarer, and lakes formed merely by the widening of the stream beds, as well as marsh basins, take their place. The lands lying nearest the channels are still the highest, and those chiefly cultivated; but the difference in the character of the "front-land" and "back-land" becomes less striking, the bayou lands not being as sandy, nor the modern cypress or marsh land as clayey, as is the case in corresponding positions in the Yazoo and Tensas bottoms, where the stiff "buckshot" clay of the ancient swamp contrasts strongly with the sandy sediments deposited from the more swiftly-flowing streams. The tide-water bayous deposit usually a fine silt.

In the tide-marsh region proper these bayou-land ridges, mostly distinguishable at a distance by their groves of live-oak timber, skirt the bayous up to within 8 to 20 miles of the Gulf shore, gradually narrowing, and finally disappearing insensibly in the reedy marsh or grassy prairie of the coast; of which but little, so far, has been brought under cultivation.

The mouths or "passes" of the main Mississippi, unlike the bayous, and in fact unlike any other river in the world, extend rapidly to seaward, independently of the mainland, and far beyond it, by building up narrow banks of a stiff, clayey material on either side. These banks are not formed of the material at present carried by the river, but of clayey masses upheaved from the bottom of the river channel, inside the bar, and generally known as "mud lumps". They form most formidable obstructions to navigation, and frequently compel a change of the river channel, at least for a time; those in the axis of the current may ultimately be washed away, but those arising near the edge remain and serve as a basis for the accumulation of more deposit. Thus the banks are finally elevated above ordinary water-level, and effectually divide, with their tough material, the river current from the sea. The soil thus formed is very fertile, but too much impregnated with salt for immediate cultivation. In the upper portion of the lower delta, above the head of the passes, older soil of this character has produced fine crops of rice.

INDEX TO GENERAL DISCUSSION.