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U. S. DEPARTMENT OF AGRICULTURE.

OFFICE OF EXPERIMENT STATIONS—BULLETIN NO. 142.

A. C. TRUE, Director.

PROCEEDINGS

OF THE

SEVENTEENTH ANNUAL CONVENTION

OF THE ASSOCIATION OF

American Agricultural Colleges and Experiment Stations

HELD AT

WASHINGTON, D. C.,

NOVEMBER 17–19, 1903.

EDITED BY

A. C. TRUE and W. H. BEAL, for the Office of Experiment Stations,

AND

H. C. WHITE, for the Executive Committee of the Association.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1904.

THE AGRICULTURAL COLLEGES.

ALABAMA—*Auburn:* Charles C. Thach.[a] *Normal:* Wm. H. Councill.[a] *Tuskegee:* Booker T. Washington.[b]

ARIZONA—*Tucson:* Kendrick C. Babcock.[a]

ARKANSAS—*Fayetteville:* Henry S. Hartzog.[a]

CALIFORNIA—*Berkeley:* Benjamin Ide Wheeler.[a]

COLORADO—*Fort Collins:* Barton O. Aylesworth.[a]

CONNECTICUT—*Storrs:* R. W. Stimson.[a]

DELAWARE—*Newark:* Geo. A. Harter.[a] *Dover:* W. C. Jason.[a]

FLORIDA—*Lake City:* Thos. H. Taliaferro.[a] *Tallahassee:* Nathan B. Young.[a]

GEORGIA—*Athens:* H. C. White.[a] *College:* R. R. Wright.[a]

IDAHO—*Moscow:* J. A. McLean.[a]

ILLINOIS—*Urbana:* Andrew S. Draper.[a]

INDIANA—*Lafayette:* Winthrop Ellsworth Stone.[a]

IOWA—*Ames:* Albert Boynton Storms.[a]

KANSAS—*Manhattan:* Ernest R. Nichols.[a]

KENTUCKY—*Lexington:* J. K. Patterson.[a] *Frankfort:* James S. Hathaway.[a]

LOUISIANA—*Baton Rouge:* Thos. D. Boyd.[a] *New Orleans:* H. A. Hill.[a]

MAINE—*Orono:* George Emery Fellows.[a]

MARYLAND—*College Park:* R. W. Silvester.[a] *Princess Anne:* Frank Trigg.[b]

MASSACHUSETTS—*Amherst:* Henry H. Goodell.[a]

MICHIGAN—*Agricultural College:* J. L. Snyder.[a]

MINNESOTA—*St. Anthony Park, St. Paul:* Cyrus Northrop.[a]

MISSISSIPPI—*Agricultural College:* J. C. Hardy.[a] *Westside:* W. H. Lanier.[a]

MISSOURI—*Columbia:* R. H. Jesse.[a] *Jefferson City:* B. F. Allen.[a]

MONTANA—*Bozeman:* James Reid.[a]

NEBRASKA—*Lincoln:* E. Benjamin Andrews.[c]

NEVADA—*Reno:* Joseph E. Stubbs.[a]

NEW HAMPSHIRE—*Durham:* Wm. D. Gibbs.[a]

NEW JERSEY—*New Brunswick:* Austin Scott.[a]

NEW MEXICO—*Mesilla Park:* Luther Foster.[a]

NEW YORK—*Ithaca:* Jacob Gould Schurman.[a]

NORTH CAROLINA—*West Raleigh:* G. T. Winston.[a] *Greensboro:* James B. Dudley.[a]

NORTH DAKOTA—*Agricultural College:* J. H. Worst.[a]

OHIO—*Columbus:* William Oxley Thompson.[a]

OKLAHOMA—*Stillwater:* Angelo C. Scott.[a] *Langston:* Inman E. Page.[a]

OREGON—*Corvallis:* Thos. M. Gatch.[a]

PENNSYLVANIA—*State College:* George W. Atherton.[a]

RHODE ISLAND—*Kingston:* Kenyon L. Butterfield.[a]

SOUTH CAROLINA—*Clemson College:* P. H. Mell.[a] *Orangeburg:* Thomas E. Miller.[a]

SOUTH DAKOTA—*Brookings:* James Chalmers.[a]

TENNESSEE—*Knoxville:* Chas. W. Dabney.[a]

TEXAS—*College Station:* David F. Houston.[a] *Prairieview:* E. L. Blackshear.[a]

UTAH—*Logan:* W. J. Kerr.[a]

VERMONT—*Burlington:* M. H. Buckham.[a]

VIRGINIA—*Blacksburg:* J. M. McBryde.[a] *Hampton:* H. B. Frissell.[b]

WASHINGTON—*Pullman:* E. A. Bryan.[a]

WEST VIRGINIA—*Morgantown:* D. B. Purinton.[a] *Institute:* J. McHenry Jones.[b]

WISCONSIN—*Madison:* Chas. Richard Van Hise.[a]

WYOMING—*Laramie:* Charles Willard Lewis.[a]

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[a] President. [b] Principal. [c] Chancellor.

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1904.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Office of Experiment Stations,
Washington, D. C., February 5, 1904.

Sir: I have the honor to transmit herewith for publication Bulletin No. 142 of this Office, containing the proceedings of the Seventeenth Annual Convention of the Association of American Agricultural Colleges and Experiment Stations, held at Washington, D. C., November 17–19, 1903.

Respectfully,

A. C. True,
Director.

Hon. James Wilson,
Secretary of Agriculture.

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W. O. Thompson, of Ohio.

Vice-Presidents.

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Secretary and Treasurer.

E. B. Voorhees, of New Jersey.

Bibliographer.

A. C. True, of Washington, D. C.

Executive Committee.

H. C. White, of Georgia, *Chair.;* G. W. Atherton, of Pennsylvania; W. H. Jordan, of New York; J. L. Snyder, of Michigan; C. F. Curtiss, of Iowa.

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W. E. Stone, of Indiana, *Chair.;* G. E. Fellows, of Maine, *Secretary.*

Programme Committee.

W. E. Stone, of Indiana; H. W. Tyler, of Massachusetts; G. E. Fellows, of Maine.

Experiment Station Work.

E. H. Jenkins, of Connecticut, *Chair.;* M. A. Scovell, of Kentucky, *Secretary.*

Programme Committee.

M. A. Scovell, of Kentucky; J. H. Shepperd, of North Dakota; B. W. Kilgore, of North Carolina.

COMMITTEES.

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Rural Engineering.

W. E. Stone, of Indiana, *Chair.*; A. R. Whitson, of Wisconsin; S. Fortier, of Montana; C. F. Curtiss, of Iowa; Elwood Mead, of Washington, D. C.

Methods of Seed Testing.

E. H. Jenkins, of Connecticut, *Chair.*; W. R. Lazenby, of Ohio; F. W. Card, of Rhode Island; E. Brown, of Washington, D. C.; A. D. Shamel, of Washington, D. C.

LIST OF DELEGATES AND VISITORS IN ATTENDANCE.

Alabama: J. F. Duggar, R. S. Mackintosh.
Arizona: R. H. Forbes.
Arkansas: G. F. Breckenridge, H. S. Hartzog, W. G. Vincenheller.
Colorado: B. O. Aylesworth, L. G. Carpenter.
Connecticut: H. O. Averill, W. E. Britton, L. A. Clinton, H. W. Conn, R. O. Eaton, J. B. Noble, E. H. Jenkins, R. W. Stimson.
Delaware: C. P. Close, J. A. Foord, G. A. Harter, A. T. Neale, C. L. Penny, W. Webb.
Florida: H. H. Hume, T. H. Taliaferro.
Georgia: R. J. Redding, H. C. White, C. L. Willoughby.
Hawaii: J. G. Smith.
Idaho: H. T. French, Mrs. H. T. French.
Illinois: E. Davenport, Mrs. G. N. Eastman, C. E. Calm, C. G. Hopkins, A. H. Jones, T. B. Wagner.
Indiana: J. C. Arthur, W. E. Stone.
Iowa: C. F. Curtiss, H. E. Summers, A. B. Storms.
Kansas: E. R. Nichols, Mrs. E. R. Nichols.
Kentucky: R. M. Allen, F. P. Anderson, J. K. Patterson, Mrs. J. K. Patterson, Mrs. Price, Miss Nettie Rodes, M. A. Scovell, Mrs. M. A. Scovell.
Louisiana: C. E. Coates, jr.
Maine: G. E. Fellows, C. D. Woods.
Maryland: C. F. Austin, S. S. Buckley, C. F. Doane, A. W. Harris, H. B. McDonnell, J. H. Mitchell, J. B. S. Norton, H. J. Patterson, R. W. Silvester, T. B. Symons.
Massachusetts: H. H. Goodell, H. W. Tyler, Mrs. H. W. Tyler.
Michigan: R. D. Graham, J. L. Snyder.
Minnesota: W. M. Hays, W. M. Liggett, C. Northrop, F. L. Washburn.
Mississippi: J. C. Hardy, W. R. Perkins.
Missouri: W. Bernays, F. B. Mumford, F. S. White.
Montana: V. K. Chesnut.
Nebraska: E. B. Andrews.
New Hampshire: W. D. Gibbs, F. W. Morse, F. W. Rane, Mrs. F. W. Rane, C. M. Weed.
New Jersey: W. S. Myers, Mrs. W. S. Myers, J. D. Smith, E. B. Voorhees.
New Mexico: L. Foster.
New York: L. H. Bailey, E. P. Felt, W. G. Johnson, W. H. Jordan, S. H. Perky, J. L. Stone, B. von Herff, H. E. Weed.
North Carolina: C. W. Burkett, Miss S. H. Dinwiddie, B. W. Kilgore, Mrs. B. W. Kilgore, F. L. Stevens, G. T. Winston, W. A. Withers.
North Dakota: Miss A. T. Shepperd, J. H. Shepperd, J. H. Worst.
Ohio: A. F. Burgess, G. M. Lummis, H. C. Price, D. L. Sampson, W. O. Thompson, C. E. Thorne, H. A. Webber, D. D. White, C. G. Williams.
Oklahoma: J. Fields, A. C. Scott.
Oregon: J. W. Bailey.

Pennsylvania: H. P. Armsby, G. W. Atherton, N. B. Critchfield, W. Frear, H. A. Surface.

Rhode Island: K. L. Butterfield, H. J. Wheeler.

South Carolina: P. H. Mell, H. Metcalf, Mrs. H. Metcalf, T. E. Miller.

South Dakota: J. Chalmers, J. W. Wilson.

Tennessee: C. W. Dabney.

Texas: D. F. Houston, E. J. Kyle.

Utah: J. A. Widtsoe.

Vermont: M. H. Buckham, J. L. Hills.

Virginia: W. B. Alwood, C. L. Goodrich.

Washington: E. A. Bryan.

West Virginia: B. H. Hite, T. C. Johnson, D. B. Purinton, W. E. Rumsey, J. H. Stewart.

Wisconsin: W. A. Henry, F. W. Woll.

Wyoming: B. C. Buffum, C. W. Lewis, C. E. Tait.

United States Department of Agriculture: A. C. True, E. W. Allen, W. H. Beal, D. J. Crosby, W. H. Evans, J. L. Farmer, J. Hamilton, C. F. Langworthy, H. W. Lawson, E. Mead, J. I. Schulte, C. B. Smith, and E. V. Wilcox, of the Office of Experiment Stations; H. E. Alvord, C. B. Lane, G. M. Rommel, E. G. Ritzman, and D. Stuart, of the Bureau of Animal Industry; B. T. Galloway, A. F. Woods, M. A. Carleton, F. V. Coville, L. C. Corbett, W. J. Spillman, C. R. Ball, M. A. Crosby, D. G. Fairchild, A. S. Hitchcock, Miss N. G. Holton, R. E. B. McKenney, J. B. Norton, R. A. Oakley, W. A. Orton, C. V. Piper, C. S. Scofield, W. W. Tracy, C. W. Warburton, H. J. Webber, C. F. Wheeler, and W. K. Wonders, of the Bureau of Plant Industry; H. W. Wiley and F. P. Veitch, of the Bureau of Chemistry; M. Whitney, F. H. King, T. H. Means, J. O. Belz, F. K. Cameron, G. H. Failyer, W. H. Heileman, J. C. Hogenson, L. A. Hurst, J. W. Nelson, W. C. Palmer, F. R. Pember, O. Schreiner, F. C. Schroeder, and J. F. Warner, of the Bureau of Soils; A. D. Hopkins, of the Division of Entomology; Miss J. A. Clark, of the Library.

War Department: M. L. Ireland, A. E. Johnson.

Guelph, Canada: H. L. Hutt, Ontario Agricultural College.

Concepcion, Chile: J. M. Castro.

CONSTITUTION OF THE ASSOCIATION.

[As amended at the seventeenth annual convention of the association, Washington, D. C., November 17-19, 1903.]

NAME.

This association shall be called the Association of American Agricultural Colleges and Experiment Stations.

OBJECT.

The object of this association shall be the consideration and discussion of all questions pertaining to the successful progress and administration of the colleges and stations included in the association, and to secure to that end mutual cooperation.

MEMBERSHIP.

(1) Every college established under the act of Congress approved July 2, 1862, or receiving the benefits of the act of Congress approved August 30, 1890, and every agricultural experiment station established under State or Congressional authority, the Bureau of Education of the Department of the Interior, the Department of Agriculture, and the Office of Experiment Stations of the last-named Department, shall be eligible to membership in this association.

(2) Any institution a member of the association in full standing may send any number of delegates to the meetings of the association. The same delegate may represent both a college and a station, but shall vote in only one section and shall cast only one vote in general sessions. Other delegates may be designated by any institution to represent it in specified divisions of the sections of the association, but such delegates shall vote only in such divisions, and no institution shall be allowed more than one vote in any sectional meeting.

(3) Delegates from other institutions engaged in educational or experimental work in the interest of agriculture or mechanic arts may, by a majority vote, be admitted to conventions of the association, with all privileges except the right to vote.

(4) In like manner, any person engaged or directly interested in agriculture or mechanic arts who shall attend any convention of this association may be admitted to similar privileges.

SECTIONS.

(1) The association shall be divided into two sections: (a) A section on college work and administration, (b) a section on experiment station work.

The section on college work and administration shall be composed of the presidents or acting presidents of colleges and universities represented in the association, or other representatives of such institutions duly and specifically accredited to this section, and no action on public and administrative questions shall be final without the assent of this section.

The section on experiment station work shall be composed of the directors or acting directors of experiment stations represented in the association, or of other representatives of such stations duly and specifically accredited to this section.

(2) Members of these two sections (and no others) shall be entitled to vote both in general sessions and in the section to which they respectively belong.

The representative appointed by the U. S. Bureau of Education shall be assigned to the section on college work and administration; the representative of the Office of Experiment Stations to the section on experiment station work; and the representative of the U. S. Department of Agriculture to either section as he may elect and the section by vote authorize; but such election once made and authorized may not be changed during the sessions of a given convention.

Each section may create such divisions as it may from time to time find desirable, and shall elect its own chairman and secretary for sectional meetings, whose names shall be reported to the association for record.

(3) Each section shall conduct its own proceedings, and shall keep a record of the same, and no action of a section, by resolution or otherwise, shall be valid until the same shall have been ratified by the association in general session and, in the case provided for in the foregoing paragraph (1), shall also have been approved by the section on college work and administration.

MEETINGS.

(1) This association shall hold at least one meeting in every calendar year, to be designated as the annual convention of the association. Special meetings may be held at other times, upon the call of the executive committee, for purposes to be specified in the call.

(2) The annual convention of the association shall comprise general sessions and meetings of the sections and provision shall be made therefor in the programme. Unless otherwise determined by vote, the association will meet in general session in the forenoons and evenings of the convention and the sections in the afternoons.

OFFICERS.

(1) The general officers of this association, to be chosen annually, shall be a president, five vice-presidents, a bibliographer, and a secretary, who shall also be treasurer; and an executive committee of five members, three of whom shall be chosen by the section on college work and administration, and two by the section on experiment station work: *Provided, however,* That a member chosen by either section need not be a member of that section. The executive committee shall choose its own chairman.

(2) Each section shall, by ballot, nominate to the association in general session for its action, a chairman and a secretary for such section.

(3) The president, vice-presidents, secretary, and bibliographer of this association shall be elected by ballot upon nomination made upon the floor of the convention, and shall hold office from the close of the convention at which they are elected until their successors shall be chosen.

(4) Any person being an accredited delegate to an annual meeting of the association, or an officer of an institution which is a member of the association in full standing at the time of election, shall be eligible to office.

DUTIES OF OFFICERS.

(1) The officers of the association shall perform the duties which usually devolve upon their respective offices.

(2) The president shall deliver an address at the annual convention before the association in general session.

(3) The executive committee shall determine the time and place of the annual conventions and other meetings of the association, and shall, between such conventions and meetings, act for the association in all matters of business. It shall issue

its call for the annual conventions of the association not less than sixty days before the date on which they are to be held and, for special meetings, not less than ten days before such date. It shall be charged with the general arrangements and conduct of all meetings called by it. It shall designate the time and place of the convention; it shall present a well-prepared order of business—of subjects for discussion—and shall provide and arrange for the meetings of the several sections. The subjects provided for consideration by each section at any convention of the association shall concentrate the deliberations of the sections upon not more than two lines of discussion, which lines as far as possible shall be related. Not more than one-third of the working time of any annual convention of the association shall be confined to miscellaneous business.

FINANCES.

At every annual convention the association, in general session, shall provide for obtaining the funds necessary for its legitimate expenses, and may, by appropriate action, call for contributions upon the several institutions eligible to membership; and no institution shall be entitled to representation or participation in the benefits of the association unless such institution shall have made the designated contribution for the year previous to that in and for which such question of privilege shall arise, or shall have said payment remitted by the unanimous vote of the executive committee.

AMENDMENTS.

This constitution may by amended at any regular convention of the association by a two-thirds vote of the delegates present, if the number constitute a quorum: *Provided*, That notice of any proposed amendment, together with the full text thereof and the name of the mover, shall have been given at the next preceding annual convention and repeated in the call for the convention. Every such proposition of amendment shall be subject to modification or amendment in the same manner as other propositions, and the final vote on the adoption or rejection shall be taken by yeas and nays of the institutions then and there represented.

Rules of Order.

(1) The executive committee shall be charged with the order of business, subject to special action of the convention, and this committee may report at any time.

(2) All business or topics proposed for discussion and all resolutions submitted for consideration of the convention shall be read and then referred, without debate, to the executive committee, to be assigned positions on the programme.

(3) Speakers invited to open discussion shall be entitled to twenty minutes each.

(4) In general discussions the ten-minute rule shall be enforced.

(5) No speaker shall be recognized a second time on any one subject while any delegate who has not spoken thereon desires to do so.

(6) The hours of meeting and adjournment adopted with the general programme shall be closely observed, unless changed by a two-thirds vote of the delegates present.

(7) The presiding officer shall enforce the parliamentary rules usual in such assemblies and not inconsistent with the foregoing.

(8) Vacancies which may arise in the membership of standing committees by death, resignation, or separation from the association, of members, shall be filled by the committees, respectively.

PROCEEDINGS OF THE ASSOCIATION OF AMERICAN AGRICULTURAL COLLEGES AND EXPERIMENT STATIONS.

MINUTES OF THE GENERAL SESSION.

Morning Session, Tuesday, November 17, 1903.

The convention was called to order at 9 a. m. in the banquet hall of the Shoreham Hotel, Washington, D. C., President J. K. Patterson, of Kentucky, in the chair. Prayer was offered by M. H. Buckham, of Vermont.

H. H. Goodell, of Massachusetts, moved that a committee of five, including the president of the association, be appointed to arrange for the visit of the body to the President of the United States.

The committee appointed in accordance with this motion was as follows: H. H. Goodell, of Massachusetts; H. C. White, of Georgia; W. M. Liggett, of Minnesota; W. O. Thompson, of Ohio, and J. K. Patterson, of Kentucky.

Report of the Executive Committee.

The report of the executive committee was presented by H. C. White, of Georgia, chairman, as follows:

Immediately on adjournment of the sixteenth annual convention of the association, in Atlanta, Ga., October 9, 1902, your committee met and organized by the selection of President H. C. White, of Georgia, as chairman, and Director E. B. Voorhees, of New Jersey, as secretary. Instructions were given the chairman to edit the proceedings of the convention just closed before publication, and to prepare and issue an abstract of the proceedings in form of the usual memorandum. After informal discussion of routine matters, adjournment was taken subject to the call of the chairman. The abstract memorandum was issued and posted to each member of the association, November 15, 1902. The edited proceedings were placed in the hands of Director True for publication by the United States Department of Agriculture, November 28, 1902.

Four subsequent meetings of the committee were held, at each of which a quorum was present, viz, at Washington, D. C., January 6, 1903; at Washington, D. C., January 10, 1903; at Columbus, Ohio, June 22, 1903, and at Washington, D. C., November 16, 1903. Business was otherwise transacted by correspondence or by attention, on request, by individual members of the committee. The matters which have received the attention of the committee and the results of action thereon are as follows:

The mining school bill was pending in the Fifty-seventh Congress at the time of adjournment of the last convention. Your committee made strenuous efforts through personal endeavor, by correspondence, and with the aid of friends outside the organization of this association to secure consideration of the bill by the House of Representatives. The efforts were unsuccessful for essentially the same reason that made ineffectual the endeavors of your former executive committee, namely, the inability to secure from the Committee on Rules of the House a rule for its consideration, and the Congress finally adjourned sine die without action on the bill. The great importance of this measure to the interests of the institutions comprising this association, the extent of favor and support which it met in the last Congress (that of a very large majority of the members of both the House and the Senate), the fact that its passage was prevented purely by parliamentary obstruction, and the belief of your committee that it would secure the approval and support of the present Congress lead the committee to recommend that this convention consider the question of bringing the measure before the present Congress in an appropriate manner.

By resolution of the association, the executive committee was "instructed to use its best efforts" to secure action by Congress ensuring the annual and prompt printing of a suitable edition of the Annual Report of the Office of Experiment Stations of the U. S. Department of Agriculture for distribution to the officers of the colleges and stations. Your committee accordingly appeared before the Committee on Printing of the House of Representatives and secured the promise of introduction and support of a proper resolution meeting the wishes of the association.

In pursuance of the assurance of the association, expressed by resolution, of its desire to cooperate actively with the Secretary of Agriculture of the United States in his plans for the promotion of the interests of farmers' institutes throughout the country, your committee appeared before the House Committee on Agriculture and urged, respectfully, a specific appropriation to the Department of Agriculture for the purpose. The House Committee recommended an annual appropriation of $5,000, which was subsequently made by Congress.

Your committee was "charged with the duty of soliciting from Congress the sum of $60,000 to meet the expense of installing and maintaining an exhibit of the distinctive work of the land-grant colleges and experiment stations at the Louisiana Purchase Exposition." Your committee discharged this duty by appearing before appropriate committees of the House and Senate and otherwise, and, as a result Congress appropriated $100,000 for the purpose indicated. For the generous response made to their solicitations, the committee and the association are especially indebted to the courtesy and interest of Hon. J. A. Tawney, chairman, and Hon. C. L. Bartlett, leading minority member of the House Committee on Industrial Arts and Expositions; to Hon. Joseph G. Cannon, then chairman of the House Committee on Appropriations, and to Senators Harris, Proctor, and Cockrell. After the appropriation was secured your committee notified the association committee on collective exhibits at St. Louis, who thereupon assumed charge of the association's interests in the premises. The report of this committee will be laid before the convention in due season and the executive committee ask for it the careful consideration of the association.

Your committee was instructed, "in its discretion," to urge upon Congress an increase in the appropriations to the several experiment stations by the sum of $15,000 annually. On consideration, the committee decided it would be unwise to attempt to secure action of this character by the Fifty-seventh Congress. By way of laying a foundation for possible effort in the Fifty-eighth Congress, however, the committee, under the dates given, addressed the following communications (which are self-explanatory) to the officers named of the U. S. Department of Agriculture:

"ATHENS, GA., *July 17, 1903.*

"Director A. C. TRUE,

"*Office of Experiment Stations, Washington, D. C.*

"DEAR SIR: The Association of American Agricultural Colleges and Experiment Stations, at the annual meeting held in Atlanta, Ga., October, 1902, instructed by resolution the executive committee of the association to secure, if practicable, an increase by Congress of the annual appropriations made for the support and maintenance of the agricultural experiment stations in the several States and Territories. At a meeting of the executive committee held in Columbus, Ohio, June 22, 1903, I was instructed to communicate with you and request, in behalf of the committee and the association, that, in your forthcoming report (for 1903) of the Office of Experiment Stations to the Secretary of Agriculture, you will present, in as much fullness of detail as may seem to you desirable and appropriate, an account, founded upon the inspections and examinations made through your office, of the present condition and work of the several stations, their capabilities for increased work of value to agriculture, and of the need (if it exists) of additional resources to enable such increased work to be undertaken. It is the purpose of the committee to address a communication, subsequently, to the Secretary of Agriculture, asking his special consideration of the report from your office and requesting him, if the statement of facts made by you should warrant, to recommend, in his annual report, an appropriate increase in the appropriations now made by Congress to the stations. Asking your kind consideration of this communication, I have the honor to be,

"Very respectfully, yours,

"H. C. WHITE,

"*Chairman Executive Committee.*

"ATHENS, GA., *October 22, 1903.*

"HON. JAMES WILSON,

"*Secretary of Agriculture.*

"DEAR SIR: At the last annual meeting, the Association of American Agricultural Colleges and Experiment Stations, after careful deliberation, expressed in formal motion the conviction that the time had arrived when increased appropriations for the work of the experiment stations might be made, with great advantage to the agricultural interests of the country, by Congress. The executive committee of the association was charged with consideration of proper measures in the premises. We are aware that the Office of Experiment Stations of your Department has, during the past year, made exhaustive inquiry into the conditions and needs of the work of the stations in the United States. The report of the Director of the Office, soon to be submitted to you, will, no doubt, contain the statement of all necessary facts upon which a judgment may be based as to the propriety and desirability of asking such additional appropriations at the hands of the present Congress. As furthering such purpose I am directed by the executive committee to bring, respectfully, this matter to your attention, and to beg that you will give consideration to such facts in this connection as may be presented in the report of the Director, and, in the event that the facts should seem to you to justify such action, you will be pleased to recommend in your forthcoming report to the President of the United States additional financial aid by the General Government to the agricultural experiment stations established under the act of Congress of March 2, 1887, commonly known as the 'Hatch Act.' Your kind attention to this request will be greatly appreciated.

"In behalf of the executive committee, by

"Very respectfully, yours,

"H. C. WHITE, *Chairman.*"

The report of Director True, recently submitted, exhibits a full and courteous response to the request of the committee. Due reply has been received from Secretary Wilson and the committee has in progress further conference with him. This matter is now referred back to the association for such further action as this convention may consider advisable.

Notwithstanding serious effort and considerable correspondence, your committee was unable to secure the consent of any institution represented in the association to undertake the conduct, under its auspices, of the Graduate School of Agriculture. Under the circumstances the committee did not think it wise to attempt to arrange for a graduate school during the summer of 1903, or to exercise the authority given it to assess upon the colleges and universities represented in the association a proper proportionate contribution to meet the expenses of a graduate school undertaken by the association independently of the initiative of some institution. The committee are of opinion that the interests of graduate work in agriculture are not unfavorably affected by failure to follow up, in a succeeding summer, the most admirable work of the graduate school at the Ohio State University in 1902. The time is, perhaps, not yet ripe for annual sessions of a Graduate School of Agriculture. Biennial sessions, at most, would perhaps at present be practicable or desirable. Your committee earnestly urge the maintenance by the association of the graduate school, under some suitable arrangements which may be found practicable, and recommend the creation by the association of a standing committee on graduate work in agriculture which shall be charged with the special care of this important phase of educational work, suggesting that such committee may, at this time, appropriately supplant the existing standing committee on "graduate work at Washington."

On request of the committee on collective college and station exhibit at the St. Louis Exposition, your committee gave prompt and cordial consent to the addition to that committee of Hon. W. T. Harris, U. S. Commissioner of Education.

On application on April 8, 1903, by Mr. F. D. Coburn, chief of live stock section, Louisiana Purchase Exposition, for appointment of two representatives of this association on an advisory committee to said section, your committee, through the chairman, nominated Prof. T. F. Hunt, of the Ohio State University, and Director C. F. Curtiss, of the Iowa Agricultural College, as members of the advisory committee, both gentlemen accepting appointment.

Prof. H. L. Bolley, of North Dakota, on going abroad in the service of the U. S. Department of Agriculture, resigned his office of chairman of the Section on Horticulture and Botany. After consultation with Prof. H. H. Hume, of Florida, secretary of the section, who preferred not to undertake the duties of chairman, your committee, through the chairman, requested Prof. J. C. Arthur, of Purdue University, to serve as chairman for the ensuing session. On June 26, 1903, Professor Arthur kindly indicated his willingness to act as chairman of the section.

The matter of participation in the benefits of the Cecil Rhodes scholarships bequest by institutions represented in this association having been brought to the attention of the committee by members of the association, the chairman of the committee was assured personally by the representative in the United States of the trustees of the Rhodes bequest that no discrimination, other than such as might lie in the specific terms of the bequest, would obtain against the peculiar institutions comprising this association.

Your committee having knowledge of the arrival in the United States in October, 1903, of a commission visiting this country on request and at the expense of Alfred Moseley, esq., of England, to "investigate the facilities offered and the provisions made for industrial and technical education," addressed a cordial invitation to the commission to attend this convention of representatives of the leading technical schools in America, venturing the opinion that the purposes of the commission might be furthered by conference with this body. The invitation was extended through President Nicholas Murray Butler, of Columbia University, New York, to whom the commission was referred by Mr. Moseley for arrangement of its itinerary. The following communication was received from President Butler:

"Columbia University, in the City of New York,
"*President's Room, October 14, 1903.*

"President H. C. White, *Athens, Ga.*

"My Dear Sir: I beg to acknowledge the receipt of yours of the 10th and to say that I am very glad indeed to hand the Moseley commission your very urgent invitation to attend the seventeenth annual convention of the Association of American Agricultural Colleges and Experiment Stations, to be held in Washington on November 17–20 next. I am not sure how many members of the commission will be in this country at that time, but I hope that some of them, at least, will be able to accept your invitation.

"Faithfully, yours, "Nicholas Murray Butler."

Your committee are hopeful that some members of the commission may be present during the course of this convention, in which event it will no doubt be the pleasure of the association to extend to them due and proper courtesies.

Your committee announce with great and sincere regret the death on August 26, 1903, of Mr. Victor H. Lowe, of the New York Experiment Station, secretary of the Section on Entomology. This sad event came to the knowledge of the committee so shortly before the convening of this convention that no effort was made to secure a secretary for the section. The duty of filling this office is respectfully remitted to the Section on Entomology.

The call for the meeting of this, the seventeenth, convention of the association was issued by your committee May 30, 1903. The programme of order of business for the convention was issued November 7, 1903.

As the expenditures of the funds of the association are made, for the greater part, upon the authorization and approval of the executive committee, your committee has pleasure in calling attention to the satisfactory report which the treasurer will present to the convention. The legitimate expenses attending the conduct of the proper and necessary work of the association are sometimes unavoidably heavy. During the past year such control has been exercised that it has been found possible to meet a number of previously outstanding obligations, to pay all current expenses, leave no unpaid accounts, and finish the year with a small balance in the treasury.

Respectfully submitted for the executive committee.

H. C. White, *Chairman.*

The report was received and placed on file.

Report of Treasurer.

The report of the treasurer was read, as follows:

Report of treasurer of the association, October 7, 1902, to November 17, 1903.

Amount on hand October 7, 1902	$78.40
Amount received from dues	1,610.15
Total	1,688.55
Expenditures	1,425.29
Balance in bank November 17	263.26

Edward B. Voorhees,
Secretary-Treasurer.

The report was referred to an auditing committee consisting of J. L. Snyder, L. G. Carpenter, and C. W. Dabney, who reported as follows:

The committee appointed to audit the accounts of Edward B. Voorhees, treasurer of this association, begs leave to report that the book, checks, and vouchers have been carefully compared and seem to be correct.

Respectfully submitted.

J. L. Snyder.
L. G. Carpenter.
C. W. Dabney.

The report was accepted.

Report of Bibliographer.

A. C. True presented the report of the bibliographer, as follows:

The publications of the Department of Agriculture issued during the year have contained a number of bibliographies which are included in the list forming a part of this report. Special mention, however, may be made of the list of references to publications relating to irrigation and land drainage, published as Library Bulletin No. 41, and to the publication of four additional parts of the index-catalogue of medical and veterinary zoology.

Annual reports of progress in chemistry, zoology, veterinary medicine, plant diseases, and other subjects have appeared as usual. Very useful indexes to the last ten volumes of each of the following have been issued recently: Zoologischer Jahresbericht, Jahresbericht über die Fortschritte der Thier-Chemie, and Zeitschrift für analytische Chemie. The following are among the subjects of the more important special bibliographies which have appeared during the year: Cotton, rusts of cereals, Mendel's law, grafting, nitrogen fixation, soil bacteria, pleasure gardens, eucalypts, silk culture, Coccidæ, Hessian fly, milk bacteria, and theories of immunity.

The first number of a bibliography of agriculture published in Italy, under the title Bibliographia Agronomica Universalis, has just appeared. This number contains references to 445 publications issued since January 1, 1903. These publications are for the most part in Italian, the intention being to include the foreign publications in subsequent numbers. The references are arranged alphabetically by authors under 11 headings. The publication promises to be a useful work of reference.

In the report last year special attention was called to the International Catalogue of Scientific Literature. At that time parts of the indexes for chemistry and botany for 1901 had been published. Since then our attention has been called to part 2 of the volume for chemistry and to the volumes for meteorology, physiology, bacteriology, and general biology. In some of these volumes there is a very evident omission of references to works of American authors. For instance, in the volume for bacteriology no reference could be found to any of the many contributions to the literature of bacteriology made by the Department of Agriculture and the experiment stations during the year. Less than a dozen of the many feeding experiments reported in 1901 are referred to in the volume for physiology. In justice to the catalogue it should be noted that, in each of the volumes referred to, it is stated that those portions of the literature for 1901 not indexed will be included in the corresponding volumes of the second annual issue. Notwithstanding this clause, it is to be regretted that the index is so incomplete.

All of the bibliographies to which reference has been made are noted more fully in the list of 110 titles which follows:

Ajello, G., and Parascandolo, C. Della psittaccosi (Psittacosis). Archives de Parasitologie, 5 (1902), No. 2, pp. 294–395. The literature of the subject is discussed in connection with an extensive bibliography.

Alwood, W. B. A study of cider making in France, Germany, and England, with comments and comparisons on American work. U. S. Department of Agriculture, Bureau of Chemistry Bulletin 71, pp. 114. A short bibliography of French, German, and English works on cider making is appended.

American Museum of Natural History. List of papers published in the bulletin and memoirs of the American Museum of Natural History, volumes 1–16, 1881–1902. New York: American Museum of Natural History, 1902, pp. 32. The main part of the list, containing about 278 references, is classified as follows: (1) Geology; (2) mammals, birds, reptiles, and fishes; (3) fossil vertebrates; (4) insects; (5) anthropology.

Anderson, L. Some of the influences affecting milk production. Thesis, Cornell University, 1901, pp. 97. An extended bibliography of the literature of experimentation touching upon the production of milk is appended.

Andreasch, R. Autoren- und Sach-Register zu den Bänden XXI–XXX (An author and subject index to volumes 21–30), Jahresbericht über die Fortschritte der Thier-Chemie. Wiesbaden: J. F. Bergmann, 1903, pp. 460.

———, and Spiro, K. Jahresbericht über die Fortschritte der Thier-Chemie (Annual report of the progress in animal chemistry). Jahresbericht Thier-Chemie, 31 (1901), pp. XXXVII+1054. This contains abstracts of the literature of animal chemistry for 1901, with subject and author indexes.

Barbour, E. H., and Fisher, C. A. The geological bibliography of Nebraska. Nebraska State Board of Agriculture Report for 1901, pp. 248–266. An alphabetical list (by authors) of 315 titles of articles on geography, physiography, stratigraphy, resources, water supply, etc., compiled from every available source.

Bateson, W. Mendel's principles of heredity. A defense. Cambridge University Press, 1902, pp. 212. A bibliography of 36 papers on hybridization is appended.

Bisson, E. Elenco di pubblicazioni attinenti alla bachicoltura, che vennero fuori nel corso del 1901 e 1902 (Bibliography of publications relating to sericulture which appeared during the years 1901–2). Annuario della R. Stazione Bacologica di Padova, 30 (1901), pp. 97–120. An extended bibliography arranged alphabetically according to authors.

Blankinship, J. W. The loco and some other poisonous plants in Montana. Montana Station Bulletin 45, pp. 75–104. A list of 55 American works relating to poisonous plants, exclusive of the fungi.

Bock, J. Jahresbericht über die Untersuchungen und Fortschritte auf dem Gesammtgebiete der Zuckerfabrikation (Annual report on investigations and progress in the manufacture of sugar). Brunswick: Friedrich Vieweg & Son, 1903, pp. XII+374. A review for the year 1901 of investigations on the culture and handling of sugar beets and the manufacture of beet sugar.

Bodländer, G., et al. Jahresbericht über die Fortschritte der Chemie und verwandter Theile anderer Wissenschaften, 1897 (Annual report of the progress in chemistry and related parts of other sciences for 1897). Brunswick: Friedrich Vieweg & Son, 1901–2, pp. 3344. This volume contains abstracts of literature of chemistry and related subjects, with classified table of contents and author and subject indexes. The first part of the volume for 1898, as well as volumes for some of the earlier years, have just been published.

Boulger, G. S. Wood. London: Edward Arnold, 1902, pp. 369. A bibliography of the more important literature is appended.

Britton, W. E. The white fly or planthouse aleurodes. Connecticut State Station Bulletin 140, pp. 14–17. A list of 18 references is appended.

Brunhes, J. L'Irrigation dans la Péninsule Ibérique et dans l'Afrique du Nord (Irrigation in Spain and North Africa). Thesis, University of Paris, 1902, pp. XVII+518. There is added a bibliography of a large number of publications on irrigation used or cited in the preparation of this treatise.

Castle, W. E. Mendel's law of heredity. Science, n. ser., 18 (1903), No. 456, pp. 396–406. A list of 14 references is appended to the article.

Chester, F. D. Bacteria of the soil in their relation to agriculture. Pennsylvania Department of Agriculture Bulletin 98, pp. 88. A bibliography of 105 titles is appended.

Crosby, D. J. School gardens, their development and functions. Outlook, 71 (1902), No. 14, pp. 852–861. A bibliography of the literature of the subject is appended.

Dammer, O. Die Fortschritte der anorganischen Chemie in den Jahren 1892–1902 (Progress in inorganic chemistry during the years 1892–1902). Handbuch der anorganischen Chemie. Stuttgart: Ferdinand Enke, 1903, vol. 4, pp. XXIV+1023. Abstracts of the literature of inorganic chemistry.

Daniel, L. La variation spécifique dans la greffe ou hybridation asexuelle (Specific variation in the graft or asexual hybridization). Troisième Congrès International de Défense contre la Grêle et de l'Hybridation de la Vigne. Lyons: Société Régionale de Viticulture, 1902, II, pp. 262–365. A bibliography of the works of 67 authors on various phases of grafting is appended.

Dietrich, F., et al. Bibliographie der deutschen Zeitschriften-litteratur (Bibliography of German periodical literature). Leipzig: Felix Dietrich, 1902, Vols. IX, pp. 374; X, pp. 373; 1903, Vol. XI, pp. 404. This is a subject and author index of original articles, mainly of a scientific character, published in German periodicals, pamphlets, and newspapers. Volume 9 includes the articles in over 1,400 publications appearing from July to December, 1901; volume 10, the articles in over 1,500 publications appearing from January to June, 1902; and volume 11, the articles in about 2,000 publications appearing from July to December, 1902. A list of the publications is given in each volume.

EISENBERG, P. Über die Bindungsverhältnisse zwischen Toxin und Antitoxin (The relationship between toxin and antitoxin). Centralblatt für Bakteriologie, Parasitenkunde, und Infektionskrankheiten, 1. Abt., 34 (1903), No. 3, Orig., pp. 259–283. A critical review of the literature of this subject, with references.

———, and KELLER, E. Über die Spezifizität der Serodiagnostik der Tuberkulose (The specific nature of serum diagnosis of tuberculosis). Centralblatt für Bakteriologie, Parasitenkunde, und Infektionskrankheiten, 1. Abt., 33 (1903), No. 7, Orig., pp. 549–567. The literature of serum diagnosis in the investigation of tuberculosis is critically discussed in connection with a bibliography of 88 titles.

ELLENBERGER ET AL. Jahresbericht über die Leistungen auf dem Gebiete der Veterinär-Medicin, 1901 (Annual report on investigations in the field of veterinary medicine, 1901). Berlin: August Hirschwald, 1902, pp. 312. A classified bibliography of books, pamphlets, and periodical articles on the subject in all its branches.

———. Jahresbericht über die Leistungen auf dem Gebiete der Veterinär-Medicin, 1902 (Annual report on investigations in the field of veterinary medicine, 1902). Berlin: August Hirschwald, 1903, pp. 277.

ELLIS, MARY. Index to publications of the New York State Natural History Survey and New York State Museum, 1837–1902; also including other New York publications on related subjects. New York State Museum Bulletin 66, pp. 653. This includes a list of publications, with author and subject indexes, and an index to descriptions of genera and species of fossils compiled under the direction of J. M. Clarke.

ERIKSSON, J. Sur l'origine et la propagation de la rouille des céréales par la semence (The origin and propagation of cereal rusts through the seed). Annales des Sciences Naturelles Botanique, 8. ser., 15 (1902), pp. 1–160. A bibliography of literature relating to rusts is appended.

FELT, E. P. Crude petroleum as an insecticide. Proceedings of the Society for Promotion of Agricultural Science, 1902, pp. 86–95. A brief bibliography of the subject is appended to the article.

———. Hessian fly. Bulletin New York State Museum, 10 (1901), No. 53, pp. 725–730. An extended bibliography of the literature on this insect.

FERNALD, MARIA E. A catalogue of the Coccidæ of the world. Massachusetts Station Bulletin 88, pp. 360. Full bibliographic references are given to the species recognized in this bulletin, which number about 1,500.

FERNOW, B. E. Economics of forestry. New York: Thos. Y. Crowell & Co., 1902, pp. XII+520. This book deals with the rôle of forests and forest products in public affairs and is a contribution to the literature of both political economy and forestry. A bibliography is included in the appendix.

FORBES, S. A. The corn bill-bugs in Illinois. Illinois Station Bulletin 79, pp. 435–461. A bibliography of recent literature, including abstracts, is appended.

FRESENIUS, H., and CZAPSKI, A. Autoren- und Sach-Register zu den Bänden XXXI–XL, 1892–1901 (Author and subject index to volumes 31–40, 1892–1901), Zeitschrift für analytische Chemie. Wiesbaden: C. W. Kreidel, 1903, pp. 268.

FROGGATT, W. W. Australian ladybird beetles. The Agricultural Gazette of New South Wales, 13 (1902), No. 9, pp. 895–911. A brief bibliography of works relating to Australian Coccidæ is appended to the article.

———. Cicadas and their habits. The Agricultural Gazette of New South Wales, 14 (1903), No. 5, pp. 418–425. A bibliography of the subject is appended to the article.

GLIKIN, W. Untersuchungen zur Methode der Fettbestimmung in thierischem Material (Studies of methods of estimating fat in animal substances). Archiv für die Gesammte Physiologie des Menschen und der Thiere, 95 (1903), No. 3–4, pp. 107–145. A bibliography of 29 titles is appended.

GOLDBERG, A. Über die Fortschritte auf dem Gebiete der Chemie des Wassers, sowie der natürlichen und künstlichen Mineralwässer (Progress in the field of the chemistry of waters, including natural and artificial mineral waters). Chemiker Zeitung, 26 (1902), No. 78, pp. 912–918. A review of investigations on this subject containing numerous references to articles which appeared during the years 1899–1901.

———. Über die Fortschritte auf dem Gebiete der Chemie des Wassers, sowie der natürlichen und künstlichen Mineralwässer (Progress in the field of the chemistry of waters, including natural and artificial mineral waters). Chemiker Zeitung, 27 (1903), No. 71, pp. 869–874. A review of the literature published during 1902 on this subject, with a list of 164 references.

HALL, A. D. The soil: An introduction to the scientific study of the growth of crops. London: J. Murray, 1903, pp. XV+286. A classified bibliography of some of the more important works on soils.

HARRISON, F. C. Lait et fromage amers (Bitter milk and cheese). Revue Générale du Lait, 1 (1902), No. 21, pp. 498, 499; Centralblatt für Bakteriologie, Parasitenkunde, und Infektionskrankheiten, 2. Abt., 9 (1902), No. 67, pp. 225, 226. A list of 31 references to the literature of this subject.

———. The identity of human and avian diphtheria. Ontario Agricultural College and Experimental Farm Report 1902, pp. 98–104. A discussion of the literature of this subject, with a bibliography of 48 titles.

———. The bacterial contamination of milk. Revue Générale du Lait, 2 (1903), No. 23, pp. 545, 546. A list of 68 titles is given.

———, and CUMMING, M. The bacterial flora of freshly drawn milk. Journal of Applied Microscopy and Laboratory Methods, 6 (1903), No. 2, p. 2181. A list of 25 titles is given.

HASELHOFF, E., and LINDAU, G. Die Beschädigung der Vegetation durch Rauch (The injurious effect of smoke on plant growth). Leipzig: Borntraeger Bros., 1903, pp. VIII+412. A bibliography of the more important references to the literature of this subject is appended.

HEDRICK, ELLEN A. List of references to publications relating to irrigation and land drainage. U. S. Department of Agriculture, Library Bulletin 41, pp. 181. The list includes references to irrigation and land drainage principally, but it has been deemed advisable to include also references to a few allied subjects, such as hydraulics and some departments of engineering.

HEMENWAY, H. D. How to make school gardens. New York: Doubleday, Page & Co., 1903, pp. XVI+107. A brief bibliography of school-garden literature is appended.

HENTSCHEL, E., and SCHOEBEL, E. Autoren-Register zu den zoologischen Jahresberichten für 1891–1900 (Author index to the zoological yearbooks for 1891–1900). Berlin: R. Friedländer & Son, 1903, pp. 226.

HILGER, A., DIETRICH, T., ET AL. Jahresbericht über die Fortschritte auf dem Gesammtgebiete der Agrikultur-Chemie (Annual review of the progress in agricultural chemistry). Jahresbericht Agrikultur-Chemie, 3. ser., 4 (1901), pp. XXXVIII+613. This contains abstracts of the more important articles in agricultural chemistry published in 1901 and titles of articles of less importance.

HINDS, W. E. Contribution to a monograph of the insects of the order Thysanoptera inhabiting North America. Proceedings of the United States National Museum, 26 (1903), pp. 79–242. A list is given of 480 works relating to the biology, life history, and means of combating insects of this order.

HOLLRUNG, M. Jahresbericht über die Neuerungen und Leistungen auf dem Gebiete der Pflanzenkrankheiten (Annual review of the literature relating to plant diseases, 1901). Berlin, 1903, pp. VIII+305. A review of the literature of plant protection during 1901, with abstracts of the more important articles.

HUNZIKER, O. F. A review of existing methods for cultivating anærobic bacteria. Reprint from Journal of Applied Microscopy and Laboratory Methods, vol. 5, Nos. 3, pp. 1694–1697; 4, pp. 1741–1758; 5, pp. 1800–1814; 6, pp. 1854–1856. An extensive bibliography is appended to an elaborate discussion of the literature of this subject.

INTERNATIONAL CATALOGUE OF SCIENTIFIC LITERATURE. D—Chemistry, II; F—Meteorology; Q—Physiology, I and II; R—Bacteriology; L—General Biology. International Catalogue of Scientific Literature, first annual issue, 2 (1903), pt. 2, pp. 685; 6 (1902), pp. 197; 3 (1902), pt. 1, pp. 417; 3 (1903), pt. 2, pp. 676; 8 (1902), pp. 328; 16 (1903), pp. 157. These volumes consist of author and subject indexes to the literature of the subjects mentioned. The indexes begin with the literature of 1901 and are more or less complete for that year. It is stated in each volume that references omitted will be included in the second annual issue. A list of journals as prepared by the regional bureaus engaged in the preparation of the catalogue has also been issued.

JOHN CRERAR LIBRARY, The. A list of bibliographies of special subjects. Chicago: The John Crerar Library, 1902, pp. 504. This is a classified list of subject bibliographies in the John Crerar Library, Chicago.

KLEE, R. Bibliotheca veterinaria. Leipzig: Hermann Seemann Nachfolger, 1901, pp. 247. A list of veterinary works in book form or in periodicals published in Germany, arranged alphabetically according to authors. A subject index is also given.

KOBER, G. M. Milk in relation to public health. U. S. Senate, 57th Congress, 1st session, Document 441, pp. V+235. A list of 164 references to the literature of this subject is given on pages 179–183.

KOMMISSION DEUTSCHER NAHRUNGSMITTEL-CHEMIKER. Vereinbarungen zur einheitlichen Untersuchung und Beurtheilung von Nahrungs- und Genuss-Mitteln sowie Gebrauchsgegenständen für das Deutsche Reich (Uniform methods for the examination and valuation of foods, condiments, and commercial products in the German Empire). Berlin: J. Springer, Nos. 1, 1897, pp. XIII+109; 2, 1899, pp. XII+184; 3, 1902, pp. X+184. An extended bibliography is appended to each of the principal sections.

M'WEENEY, E. J. Literature with reference to the infectivity of the milk of tuberculous cows. Journal Department of Agriculture and Technical Instruction for Ireland, 2 (1902), No. 4, pp. 673–675. A list of 34 articles.

MCCLATCHIE, A. J. Bibliography of the genus Eucalyptus. U. S. Department of Agriculture, Bureau of Forestry Bulletin 35, pp. 99–101. A list of the principal papers and books upon the genus Eucalyptus.

MACGERALD, W. (Editor). Practical farming and gardening. Chicago and New York: Rand, McNally & Co., 1902, pp. 500. Appended to the different chapters are lists of publications on (1) tillage and general agriculture; (2) field and forage crops, seed selection, and the eradication of weeds; (3) specific crops, truck farming, and the marketing of produce; (4) fruit culture and forestry; (5) injurious insects and plant diseases; (6) animal husbandry, bee keeping, and fish culture; (7) diseases of farm animals; (8) the construction and management of silos; (9) poultry and pigeons.

MAYER, P. Zoologischer Jahresbericht für 1901 (Zoological yearbook for 1901). Berlin: R. Friedländer & Son, 1902, pp. VIII+499. Detailed bibliographic lists relating to the various groups of animals. The more important publications under each group are briefly abstracted.

———. Zoologischer Jahresbericht für 1902 (Zoological yearbook for 1902). Berlin: R. Friedälnder & Son, 1903, pp. VIII+584. This report contains brief abstracts of the work done during the year in various lines of zoology in connection with classified bibliographical lists.

MOHLER, J. R. Infectiveness of milk of cows which have reacted to the tuberculin test. U. S. Department of Agriculture, Bureau of Animal Industry Bulletin 44, pp. 90–93. This includes 59 references to the literature of this subject.

———, and BUCKLEY, J. S. Report on an enzootic among cattle caused by a bacillus of the enteritidis group. U. S. Department of Agriculture, Bureau of Animal Industry Report 1902, pp. 297–331. A list of 17 references to the literature of this subject is appended to the article.

———, and WASHBURN, H. J. Takosis, a contagious disease of goats. U. S. Department of Agriculture, Bureau of Animal Industry Report 1902, pp. 354–390. A list of 14 references to the literature of this subject is given.

MUIR, R., and RITCHIE, J. Manual of bacteriology. New York: The Macmillan Co., 1903, American edition, pp. XX+565. A selected bibliography of the literature relating to bacteriology is appended.

MÜLLER, M. Über das Wachstum und die Lebenstätigkeit von Bakterien, sowie den Ablauf fermentativer Prozesse bei niederer Temperatur unter spezieller Berücksichtigung des Fleisches als Nahrungsmittel (The growth and activity of bacteria, and the fermentative processes which take place at low temperature, with special reference to flesh foods). Archiv für Hygiene, 47 (1903), No. 2, pp. 127–193. A list of 47 references to the literature of the subject is appended to the article.

MULLIE, G. Recherches comparatives sur les différents moyens de distinguer le lait cru du lait bouilli (Comparative tests of different methods of distinguishing raw and heated milk). Revue Générale du Lait, 2 (1902), No. 9, pp. 205–209. An extended bibliography of methods for the detection of heated milk.

NEGER, F. W., and VANINO, L. Der Paraguay-Tee (Yerba Mate) (Paraguay tea—Yerba mate). Stuttgart: Fr. Grub, 1903, pp. 56. A bibliography of the subject, including papers written by 29 different authors, is included.

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OPPEL, A. Die Baumwolle (Cotton). Leipzig: Duncker & Humblot, 1902, pp. 745. An extensive bibliography of this subject is given.

OSBORNE, T. B., and HARRIS, I. F. Review of literature of nucleic acid. Connecticut State Station Report 1901, pt. 4, pp. 367–388. An extended review of the literature on this subject, with bibliographic references.

OTTAVI, E., MARESCALCHI, A., ET AL. Bibliographia agronomica universalis. Casale: Ottavi Bros., 1903, No. 1, pp. 56. This is a list of 445 publications relating to agriculture which have appeared since January 1, 1903. The publications are for the most part in Italian, the intention being to include the foreign publications in the second number soon to appear. The references are arranged alphabetically by authors under the following headings: General agriculture; soils, agricultural machinery, crops and their utilization; pests and diseases of cultivated plants; special crops; forestry; horticulture; zootechny; animal products; beneficial insects; hunting, fishing, pisciculture; and miscellaneous.

PARSONS, A. L. Greensand marl. Mineral resources of the United States. Department of the Interior, U. S. Geological Survey, 1901, pp. 811–822. An incomplete bibliography relating to the occurrence and classification of greensand formation and its production and use is appended.

PATENT OFFICE, GREAT BRITAIN. Subject list of works on domestic economy, foods, and beverages, including the culture of cacao, coffee, barley, hops, sugar, tea, and the grape, in the library of the Patent Office. Patent Office Library Series No. 9. London: Darling & Son, Ltd., 1902, pp. 136. The list comprises 1,270 works representing some 2,043 volumes.

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———. Text-books and works of reference for students of elementary meteorology. Monthly Weather Review, 30 (1902), No. 8, pp. 408–410. A list of 83 text-books and works of reference.

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RHEES, W. J. List of publications of the Smithsonian Institution, 1846–1903. Smithsonian Miscellaneous Collections No. 1376, pp. 99.

RITCHIE, J. Bibliography on immunity. Journal of Hygiene [Cambridge], 2 (1902), No. 4, pp. 462–464. A list of 106 titles of literature relating to theories of immunity.

ROTHSCHILD, H. DE. Le lait (Milk). Paris: Octave Doin, 1903, pp. 90. A brief bibliography relating especially to the bacteriology of milk.

SALMON, D. E. Bovine tuberculosis and other animal diseases affecting the public health. U. S. Department of Agriculture, Bureau of Animal Industry Report 1902, pp. 332–353. A list of 31 references to the literature of this subject is appended to the article.

SCHNEIDER, A. Titles of literature concerning the fixation of free nitrogen by plants. Minnesota Botanical Studies, 3. ser., 1903, pt. 2, pp. 133–139. This includes 73 titles.

SCHWEITZER, G. Milchhygienische Studien (Studies on milk hygiene). Centralblatt für Bakteriologie, Parasitenkunde, und Infektionskrankheiten, 2. Abt., 10 (1903), Nos. 16–17, pp. 501–514; 18–19, pp. 563–570. A list of 23 references relating to this subject is appended.

SCUDDER, S. H. Alphabetical index to North American Orthoptera described in the eighteenth and nineteenth centuries. Boston Society of Natural History, Occasional Papers, VI, 1901, pp. 436. A compilation of references to the Orthoptera of North America and the West Indies from the time of Linnæus to the close of the last century.

SELBY, A. D. A rosette disease of potatoes. Ohio Station Bulletin 139, pp. 53–66. A list of 20 references to diseases of the potato attributed to Rhizoctonia.

SHARP, D. (Editor). The Zoological Record. London: Zoological Society, 1902, pp. 1144. A classified list of titles on zoological subjects for the year 1901.

SIEVEKING, G. H., ET AL. Die Milch und ihre Bedeutung für Volkswirtschaft und Volksgesundheit (Milk and its industrial and hygienic importance). Hamburg: C. Boysen, 1903, pp. 522. This book consists of 19 articles relating to the production and sale of pure milk, the articles being accompanied by extended bibliographies.

Smolensky, P. Traité d'hygiène (Treatise on hygiene). Paris: G. Steinheil, 1904, pp. XXXII+752. Appended to this volume, which is designed as a laboratory manual for the examination of foods and which is particularly valuable as a summary of Russian investigations, is an extended bibliography.

Stiles, C. W. The significance of the recent American cases of hookworm disease (uncinariasis, or anchylostomiasis) in man. U. S. Department of Agriculture, Bureau of Animal Industry Report 1901, pp. 183–219. A list of articles cited in this paper in connection with American cases of this disease is appended.

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Swingle, D. B. Formation of the spores in the sporangia of *Rhizopus nigricans* and of *Phycomyces nitens*. U. S. Department of Agriculture, Bureau of Plant Industry Bulletin 37, pp. 40. Twenty-six references.

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Terre, L. Essai sur la tuberculose des vertébrés à sang froid (Tuberculosis in cold-blooded vertebrates). Dijon: Barbier-Marilier, 1902, pp. 128. A critical review of the literature relating to tuberculosis in cold-blooded vertebrates, together with a bibliography of 168 titles.

The [London] Chemical Society. A catalogue of the library of the Chemical Society, arranged according to authors, with a subject index. London: The Chemical Society, 1903, pp. 324.

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Tjaden, A., Koske, F., and Hertel, M. Zur Frage der Erhitzung der Milch, mit besonderer Berücksichtigung der Molkereien (Concerning the heating of milk, with especial reference to dairies). Arbeiten aus dem kaiserlichen Gesundheitsamte, 18 (1901), No. 2, pp. 219–354. A list of 74 articles relating to the pasteurization of milk.

Tutt, J. W. A natural history of the British Lepidoptera, III. London: Swan Sonnenschein & Co., 1902, pp. XII+558. This volume contains numerous bibliographical notes relating to the families considered.

Vandevelde, A. J. J. Die kieming der zaadplanten, morphologie en physiologie (The morphology and physiology of the germination of Spermatophytes). Ghent: J. Vuylsteke, 1900, pt. 2, pp. 137–301. A bibliography of literature relating to this subject is given in connection with an extended discussion.

———. Repertorium van de geschriften over de voedingsmiddelen gedurende het jaar 1900 verschenen (Review of the literature of foods for the year 1900). Ghent: A. Siffer, 1901, pp. 140. A list of 520 publications on foods and food products, with notes concerning each.

———. Repertorium van de geschriften over de voedingsmiddelen gedurende het jaar 1901 verschenen (Review of the literature of foods for the year 1901). Ghent: A. Siffer, 1902, pp. 165. A list of 686 publications on foods and food products, with notes concerning each.

Warman, P. C. Catalogue and index of the publications of the United States Geological Survey, 1901 to 1903. United States Geological Survey Bulletin 215, pp. 234. This is supplementary to Bulletin 177, published in 1901. The two bulletins include all the publications of the Geological Survey from its organization in 1879 to June, 1903.

Watt, A. The art of paper making. London: Crosby Lockwood & Son, 1901, p. 246. A list of 16 works relating to paper manufacture.

Weed, C. M. A partial bibliography of the economic relations of North American birds. New Hampshire Station Technical Bulletin 5, pp. 137–179. A chronological list of 290 of the more important works on economic ornithology from 1888 to 1901, inclusive.

Weldon, W. F. R. Mendel's laws of alternative inheritance in peas. Biometrika, 1 (1902), No. 2, pp. 228–254. A bibliography of 32 papers relating to Mendel's law and the data upon which it is based.

Westermann, T. Uddrag af fremmed litteratur vedrørende landbrugets jorddyrkning og plantekultur for aar 1900 (A review of the foreign literature relating to agriculture, soil management, and plant culture for the year 1900). Tidsskrift for Landbrugets Planteavl, 8 (1902), Supplement, pp. 147. A classified list of references, with a discussion of the more important articles and an author index.

WILDEMAN, E. DE. Les plantes tropicales de grande culture (Tropical plants of commercial importance). Brussels: Alfred Castaigne, 1902, pp. IV+304. This work includes a bibliography of the literature relating to the distribution of coffee, cacao, vanilla, cola, and rubber-producing plants of central Africa.

WILDERMANN, M. Jahrbuch der Naturwissenschaften, 1901–1902 (Yearbook of the natural sciences, 1901–1902). Jahrbuch der Naturwissenschaften, 17 (1901–1902), pp. 533. This contains brief abstracts of the more important articles published during the year on different lines of science.

WILLIAMS, O. A bibliography of forestry. Forestry Quarterly, 1 (1903), No. 4, pp. 163–172. A list of articles relating to forestry published in Congressional documents.

ZIMMERMANN, A. Die Parasiten der Schattenbäume und Windbrecher (Parasites of shade trees and windbreaks). Centralblatt für Bakteriologie, Parasitenkunde, und Infektionskrankheiten, 2. Abt., 8 (1902), Nos. 24, pp. 774–776; 25, pp. 798–805. Bibliography of animal and plant parasites of trees in the Tropics.

The report was received and placed on file.

FARMERS' INSTITUTES.

A. C. TRUE. Since this was a matter in which the association at its last session showed so much interest, it seemed desirable to put before the association a report of the progress made in organizing this work.

As you have been already informed by the chairman of the executive committee, Congress, on the recommendation of the Secretary of Agriculture, with the very efficient aid of the executive committee of this association, was induced to include in the bill making appropriations for the Department a clause which distinctly recognized this work as a part of the business of the Department of Agriculture and, by the assignment of the Secretary, the general charge of the work has been committed to the Office of Experiment Stations, and we have begun active operations.

The first question which we had to determine was the general policy according to which this work should be carried on. It was easily and naturally decided that, since the management of the farmers' institutes had been inaugurated and carried on entirely by the States, it was in no way the function of the Department of Agriculture under existing legislation to attempt the management of these institutes, but that it was its business rather to recognize clearly in all its work the State management of the institutes and to cooperate with the State officers and aid them in every possible way to build up the institutes in the several States. And thus we have come into definite relations with the State managers of the institutes in all the States where the institutes are now held. It will be our policy to confer constantly with them and to try in our work to meet the needs of the several States as well as to act as a general agency for coordinating and strengthening this work throughout the country.

After an investigation of the general situation, with a view to deciding upon the special line of work we should follow, in view of the limited funds at our disposal, we came to the conclusion that the most important thing was to increase, so far as we could, the efficiency of the institute lecturers.

There is now in the United States a body of men numbering somewhat over 800 who lecture in these institutes. Less than half of this number are men engaged in the work of the agricultural colleges and experiment stations. There is, therefore, a considerable body of men outside of the colleges and stations who especially need advice and assistance with reference to the progress of agricultural movements, especially along educational and scientific lines. So we have begun to get into intimate relations through the State organizations with these institute lecturers. We desire to help them in every way possible, and our chief effort now is to devise ways and means for giving them the most efficient assistance.

We are doing this work with different objects in view. Primarily, of course, we desire to build up the institutes and make them most efficient; but we also desire, through our close contact with the institute lecturers, to help to bring them into closer relations to the agricultural colleges and experiment stations, and in this way ultimately to build up a force of men throughout the country who will be able to carry the great burden of the institute work.

Under present conditions, as you know, the officers of the agricultural colleges and experiment stations are not only greatly interested in the farmers' institutes, but are carrying a heavy burden of work in connection with them; and in a good many individual instances this burden is already so heavy that we have felt that it has interfered to a certain extent with their work as teachers and investigators in connection with the colleges and stations.

Now, it is obvious that under present conditions the college and station officers must to a considerable extent take the leadership in this institute movement, and they must make some sacrifices in order to help on this great movement for the education of the masses of our farmers. At the same time we ought to look forward to the day when we shall have a thoroughly equipped body of institute lecturers, who, while they are in close touch with the agricultural colleges and experiment stations, will be able to relieve the teachers in the colleges and the investigators in the stations from any considerable burden of institute work.

There is no change in the general policy of the Department with regard to this matter. We still hold that it is the primary and chief business of the station officers to investigate and of the college officers to teach in the colleges, and that they should help the institutes only so far as may be necessary under present conditions to get this movement on a right basis and to keep them in touch with the actual problems with which our farmers have to deal.

Under the legislation regarding farmers' institutes as related to the Department, one of our special duties is to aid in the dissemination of the results of the work of the Department and the stations among the farmers; and to this we are giving special attention. On the part of the Department the effort will be made to bring the officers of the Department in its different branches in closer touch with the institutes by having those officers go out more than they have been accustomed to do in the past to speak at the institutes in different parts of the country.

Of course it would not be possible, if it were desirable, for the Department officers to speak at the institutes generally, but it is our hope that in the "round-up" institutes, as they are called, and in other meetings where representative men are gathered together from a considerable region, the Department may be represented hereafter more frequently than it has been in the past.

To take immediate charge of this work in the Office of Experiment Stations, Prof. John Hamilton, formerly in charge of the department of agriculture of the State of Pennsylvania, has been appointed and has already entered on the service. It is his desire, as well as our own, that the college and station men here and generally in the States represented here should give him such suggestions regarding this work and such aid as they can. He would like to come in touch with them personally and through correspondence as much as possible. So I hope that during this convention and at other times you will get acquainted with him and come to understand the work he is trying to do in this line.

I do not want to close this imperfect statement regarding our efforts in this direction without trying to impress on you more fully the greatness and importance of this farmers' institute enterprise. I have not realized it myself until recently. The work undoubtedly has grown in importance and in strength quite rapidly in very recent years. When we consider that these institutes are practically held annually in every county of the United States and that they are attended in the aggregate by something like a million people who are engaged in the farming business, I think we can see that here is a force which, if it can be properly organized, will be of tremendous significance in the future development of the agriculture of this country, in the building up of a proper system of agricultural education and research, and in bringing up a generation of farmers who will understand and appreciate what the colleges and the experiment stations and other educational agencies are doing in behalf of agriculture.

And so, as far as the general interests of the institutions composing this association are concerned, it seems to me there is no subject which can more deserve their interest and sympathy; and I think that, if the managers of our colleges and experiment stations, as well as the officers who are engaged in the work, will look into this matter they will be convinced, as those of us have been convinced who have had occasion to look into it, that here is a force with which they ought to deal actively and out of which, properly organized, may grow great good to these institutions and to our country.

Appropriations for Mining Schools and Experiment Stations.

E. B. Andrews, of Nebraska, submitted the following resolution, which was referred to the executive committee:

Resolved, That the executive committee of the association be instructed to continue the effort to secure favorable action by Congress on the mining-school bill and for increasing the annual appropriation for the experiment stations.

The resolution was subsequently favorably reported to the association by the executive committee and agreed to.

Report of the Committee on Indexing Agricultural Literature.

A. C. True read the report of the committee on indexing agricultural literature, as follows:

During the past year considerable progress has been made by the Department of Agriculture in the indexing of the literature of agriculture and agricultural science. The library of the Department has regularly issued printed index cards for the Department publications. An extra number of sets of the index for the last Yearbook and for the later numbers of the Farmers' Bulletins have been printed to meet the demand for small libraries which have use for these publications. The library has received an increase of appropriation which will enable it to extend its indexing, and arrangements have been made to prepare a card index of agricultural periodicals which shall be uniform with the cards already distributed. Indexes for the "Landwirthschaftliche Jahrbücher" and "Annales de la science agronomique" are ready for publication. The periodicals relating to general agricultural which are most frequently consulted, complete sets of which are in the Department library, will be indexed first. In addition to the distribution of cards to agricultural colleges and experiment stations, provision will be made for their sale to institutions and individuals who may wish to procure them.

The Department library has also made arrangements which will make it possible for other libraries to obtain from the Library of Congress catalogue cards for publications on agriculture. During the past six months of the fiscal year the copy for current accessions to the library has been transmitted to the printing division of the Library of Congress for printing upon cards. Extra copies of these cards are available at a small cost on application to the Librarian of Congress. These cards may be ordered by simply sending the serial number found in the bulletin of "Accessions to the Department Library," and catalogue cards containing full descriptions of the books can thus be secured by agricultural college and station libraries at less cost than they could be prepared by each library. Special attention is called to the availability of this particular bibliographical matter relating to agriculture.

The card catalogue of the Department library now contains about 110,000 cards, derived from the following sources: (1) Cards for the current accessions; (2) index cards for the publications of the Department; (3) cards for articles published in certain scientific periodicals and issued by the publishing branch of the American Library Association; (4) cards for certain books in the Library of Congress which are of occasional interest to workers in the Department, and from their accessibility in the Library of Congress are not purchased by this library; and (5) cards for current botanical literature prepared by the New York Botanical Garden.

The library is thus in a position to render more efficient aid than ever before to the agricultural colleges and experiment stations by furnishing them information regarding agricultural and related literature, loaning books to the officers of these institutions with certain restrictions, and assisting in maintaining the agricultural libraries of these institutions on a more efficient basis.

The Office of Experiment Stations has now in press a general index to the first 12 volumes of the Experiment Station Record and Experiment Station Bulletin No. 2 It thus begins with the work of the experiment stations under the Hatch Act and covers the period down to the close of 1900. This index contains about 125,000 entries, and is undoubtedly the most extensive index to the literature of agricultural experimentation which has ever been prepared.

The Card Index of Experiment Station Literature issued by this Office has now reached No. 24600, and is quite closely up-to-date.

There is still need that this association should continue active efforts along this line. Many of the institutions represented in the association should give greater attention to the better organization of their library work. The indexes on cards and in books already available should be so cared for and kept as to make them more thoroughly useful to the students and faculties. Continued efforts will also be necessary to secure from Congress additional funds as they may be needed to increase and keep up-to-date the indexing of agricultural literature on the plans now being worked out by the Department library.

A. C. True,
T. F. Hunt,
W. M. Hays,
E. Davenport,
Josephine A. Clark,
Committee.

The report was accepted, and on motion of E. B. Andrews, of Nebraska, the Director of the Office of Experiment Stations was requested to furnish this report in printed form to the librarians of the agricultural colleges and experiment stations at as early a date as possible.

Report of the Committee on Uniform Fertilizer and Feeding-Stuffs Laws.

H. J. Wheeler, of Rhode Island, submitted the following report of the committee on uniform fertilizer and feeding-stuffs laws:

In the course of the past year your committee, as heretofore, has been in correspondence with parties in the several States who were interested in the passage of new fertilizer laws or in the amendment of existing ones.

Arizona, Idaho, New Mexico, Nevada, Montana, Wyoming, and Utah have not yet felt the necessity of legislation in this line. In Colorado and Arkansas recent attempts to pass such laws have been failures. The following reports have been received from some of the other States:

Ex-Director H. A. Huston, of Indiana, reports that the existence of the recommendations of this association was of much assistance in connection with the steps taken to amend the old fertilizer law in that State. The law as enacted was made to correspond to the recommendations in certain particulars; and the other points were practically all left to the discretion of the executive officers, thus rendering it possible to make rules in accordance with the recommendations.

Prof. E. F. Ladd, of North Dakota, reports that at the last session of the legislature in that State a fertilizer law was enacted and that the bill was drawn in accordance with the recommendations of this association, which, he says, were very helpful in the preparation of the bill and in securing the necessary legislation thereon.

R. E. Rose, State chemist, Tallahassee, Fla., writes that the law in that State has recently been amended to conform in so far as possible with the recommendations concerning uniformity. He adds that the recommendations were of material service.

Prof. F. B. Mumford, of Missouri, reports that the law in that State has been amended recently, and that the recommendations were of much assistance.

President J. M. McBryde, of Virginia, reported, July 4, 1903, that changes in the law in that State were then being considered, and that amendments in the line of the recommendations were being urged. In conclusion, he says, it "follows, therefore, that your recommendations will be helpful in securing the legislation needed."

Director H. P. Armsby reports that the recently amended law of Pennsylvania conforms very largely in substance to the recommendations.

Director A. M. Soule, of Tennessee, states that a new law was passed in that State in April, 1903. The law was drawn with the object of making it conform with the recommendations of the association, but a few amendments were made not in harmony therewith, which, it is believed, weaken the law. He adds that it is hoped later to secure such amendments as will make the law conform to the original draft, and that "had it not been for the existence of the recommendations, it would probably not have been possible to secure the passage of the present law."

Director J. F. Duggar, of Alabama, writes, under date of July 7, that in that State "the old law has been revised this year by a new one which embodies the recommendations of the Association of American Agricultural Colleges and Experiment Stations and of the Association of Official Agricultural Chemists," and that "the recommendations alluded to have had much weight in securing the revision of legislation along this line.

After careful consideration of the subject, your committee submits the following recommendations regarding laws regulating the sale of feeding stuffs:

(1) That for the purpose of defraying the expenses of feeding-stuff inspection, the State should make a direct appropriation, or, where this is impracticable, a brand tax should be levied. In view of the experience of Maine and Vermont, a tonnage tax is not to be recommended.

(2) That the following materials should be exempt from the provisions of feeding-stuff laws: Hays and straws and whole unmixed seeds, such as wheat, rye, barley, oats, Indian corn, buckwheat, broom corn, and the unmixed meals of the entire grains of such seed.

(3) The term concentrated feeding stuffs should include linseed meals, cotton-seed meals, cotton-seed feeds, pea meals, cocoanut meals, gluten meals, gluten seeds, maize feeds, starch feeds, sugar feeds, dried brewers' grains, dried distillers' grains, malt sprouts, hominy feeds, cerealine feeds, germ feeds, rice meals, oat feeds, corn-and-oat chops, corn-and-oat feeds, corn bran, ground beef or fish scraps, condimental foods, poultry foods, stock foods, patented proprietary or trade and market stock and poultry foods, and all other materials of a similar nature not included in section 2 above. Where practicable, the by-products from the milling of wheat, rye, and buckwheat should be included under the requirements of the laws.

(4) That a legible printed statement should be affixed to or printed on each package containing a feeding stuff named in section 3, giving the net weight of the package, the name and address of the manufacturer or importer, the name, brand, or trademark under which the article is sold, and the guaranteed analysis showing the percentage of crude protein and of crude fat. The law should provide that the chemical analysis, including determinations of crude protein and crude fat, shall be made by the official methods of the Associatian of Official Agricultural Chemists.

If the feeding stuff is sold in bulk or put up in packages belonging to the purchaser, the agent or dealer shall furnish him with a certified statement of the net weight of the lot, the name and address of the manufacturer or importer, the brand or trademark under which said article was sold, and the percentage of crude protein and crude fat which said article is guaranteed to contain, as determined by the official methods of the Association of Official Agricultural Chemists.

(5) That a certified copy of the statement in section 4 above be filed with the executive officer each year.

(6) That the law should contain a penalty, by fines only, for violations of its provisions and for adulterations of any feeding stuff; provided, however, that "mixtures" of adulterated goods may be sold if the true names of the constituents and the chemical composition are plainly marked or printed on each package.

The committee recommends to the Association of American Agricultural Colleges and Experiment Stations the adoption of the recommendations 1 to 6 inclusive, with the suggestion that this or some other committee should be instructed to use its efforts to secure the end in view by using its influence to aid in securing uniform legislation in the several States.

Respectfully submitted.

H. J. Wheeler,
C. D. Woods,
E. H. Jenkins,
H. P. Armsby,
M. A. Scovell,
Committee.

The report was accepted and its recommendations were referred to the executive committee, which later recommended that the report be referred back for presentation to the Section on Agriculture and Chemistry, and it was so ordered. (For further action on this report see p. 84.)

The convention then, on motion, took a recess until 8 o'clock p. m.

Evening Session, Tuesday, November 17, 1903.

The convention was called to order at 8 o'clock p. m., W. E. Stone, of Indiana, in the chair.

Vacancies on Standing Committees.

The recommendation of the executive committee that "the vacancies which may arise in the membership of standing committees by death, resignation, or separation from the association, of members, shall be filled by the committees, respectively," was agreed to, and thus becomes a standing order.

Report of the Committee on Graduate Study at Washington.

C. Northrop, of Minnesota (chairman), read the report, as follows:

Owing to the conditions growing out of the refusal of the regents of the Smithsonian Institution to accept the propositions made by this association regarding the organization of a bureau of graduate study, and the events which resulted in the endowment and organization of the Carnegie Institution, it has not seemed best for this committee to take any active measures during the past year. It now appears, however, that the Carnegie Institution will for some time to come devote itself mainly to the endowment of researches on a comparatively large scale, which are to be carried on in different countries and in connection with a great variety of institutions. It does not seem to be the intention of the Carnegie Institution to make any special provision for students to pursue graduate studies at Washington in connection with the different branches of the National Government.

The way is therefore open for this association to continue its effort to provide some agency which will enable the students graduating from the institutions included in the association to take advantage of the facilities which are now, or may hereafter be, placed at their disposal in the Government departments. Your committee believes that work along this line may be profitably pursued in connection with other enterprises which the association may have in hand for the promotion of graduate study, such as the graduate school of agriculture, and therefore cordially indorses the recommendation of the executive committee that a single standing committee of graduate study be appointed to take the place of this committee, and any other committees of the association charged with the promotion of graduate study.

C. Northrop,
J. E. Stubbs,
M. H. Buckham,
A. C. True,
R. H. Jesse,
C. W. Dabney,
W. O. Thompson,
Committee.

The report was accepted.

H. C. White, on behalf of the executive committee, and in accordance with the report of that committee and of the committee on graduate study at Washington, moved that the title of the standing committee on graduate study at Washington be changed by the omission of the words "at Washington," so as to constitute a standing committee on graduate study, and that the personnel of the committee be not changed.

In view of the fact that President Northrop expressed an earnest desire to be relieved from further service on this committee his resignation was, on motion of H. C. White, "accepted with great regret," and the committee was authorized to fill the vacancy.

Address of the President of the Association.

The President pro tempore. I take great pleasure in introducing President James K. Patterson, of Kentucky, who will deliver the annual address of the president of the association.

Gentlemen of the Association of American Agricultural Colleges and Experiment Stations: I thank you for the honor which you have conferred upon me in selecting me to preside over your deliberations during the present session. The highest distinction within the power of this body to bestow is not to be lightly esteemed, and I can only wish that I had been more worthy of it. I propose to occupy your attention to-night for a brief space by some thoughts on the origin and work of the colleges and universities which this association represents, and the influence thereof upon the present and future of the American people.

Many men distinguished by learning and experience have in years gone by addressed you from this chair. Some having sown the seed which others in due time will reap have already passed over to the majority; others happily are still with us to animate by their zeal, encourage by their example, and stimulate by their attainments. Like the pioneers of freedom in the western world; like the founders of the great republic; like the statesmen who laid the foundation of the system of education which this association represents to-day—these men have builded wiser than they knew and results which they could not have anticipated have followed. Not visionary doctrinaires, but practical men, they addressed themselves to use to the best advantage the material ready to their hands, and as new material accumulated incorporated it with the structure as it grew—maintaining the original idea of utility and preserving the architectural symmetry of the fundamental conception.

The organization of this association was a happy thought. These annual meetings have brought together a body of workers and of thinkers whose thoughts and achievements, contributed to a common stock, have become the common heritage of all. Happy intuitions, intelligent scientific forecasts have been patiently experimented upon, translated from the hypothetical into the actual, accepted as accredited results, and added permanently to the stock of human knowledge. Of some the relationship became immediately apparent. They gravitated at once into position; discovered their proper place in the order of things; filled a space hitherto unoccupied; bridged over a hiatus; supplied a missing link. Others did not immediately yield to classification, and possible affinities required further investigation. But, assailed from this side and from that in the crucible and by the spectroscope, a stubborn isolation could not long be maintained, and in the end the most refractory yielded to the analytic of the human intellect and the potency of the human will.

But how greatly have these activities been stimulated by mutual conference and mutual cooperation—a hint in discussion has struck a spark which ignited the fuel into a flame; a bow drawn at a venture has found a joint in the harness and penetrated the vitals of an unsubdued fact; a stray seed dropped into a generous soil has, under the influence of sunshine and rain, sprung up and in due time brought forth fruit—first the blade, then the ear, and at length the full corn in the ear.

A little over forty years ago a new departure took place in education in America. Until then classics, literature, and philosophy had been the dominant features of college work. The natural sciences were still in their infancy; scientific men had, however, for more than half a century been working along scientific lines; a priori deduction had given place to induction founded upon observation and experiment. The atomic theory of Dalton; the correlation of physical forces worked out laboriously and brilliantly by Helmholtz, Joule, and Tyndall; the uniformitarian hypothesis of Sir Charles Lyell; the spectroscopic analysis of Kirschhoff, and, above all, the far-reaching generalizations of Darwin and Wallace had made a new epoch in scientific discovery. It recalled the spirit of adventure which roused into feverish activity the boundless energy and heroic endurance of Henry the Navigator, Vasco de Gama, Christopher Columbus, and Alphonso Albuquerque four centuries before.

A new world of ideas seemed to dawn upon mankind with the introduction of the telegraph, of railway construction, of steam navigation, and the application of science to the industrial arts. The age of the Utopia of Sir Thomas More and of the New Atlantis of Bacon, divested of fantasy and clothed in the habiliments of decorous sobriety, seemed to have dawned upon mankind. The stimulus given to immigration brought hundreds of thousands annually to our shores, and the impulse given to transcontinental migration through the development of the railway system east of the Mississippi transferred hundreds of thousands annually from the Atlantic and Middle States to the fertile lands stretching out in forest and prairie, ready to receive and reward the hardy and industrious pioneer with comfort and plenty.

The rich gold fields of the West acquired by conquest and purchase, the annexation of the great empire of the Lone Star State, the boundless domain between the Mississippi and the Rockies, inviting capital and enterprise for pasturage and cultivation, all contributed to develop a feeling of unrest and a longing for better things. The long pent-up energies of a young, vigorous, self-reliant people broke beyond the geographical limits which had hitherto bounded their labors and rewards and swept a living tide of humanity over hill and valley, over mountain and plain, beyond lake and river into the illimitable lands of the near and middle and far West—from the Alleghenies to the Mississippi and Missouri; from the Mississippi and Missouri to the great American desert, the Rocky Mountains, and the shores of the Pacific Ocean. And thus the wave of settlement, adjusting itself to peaceful industry, laid the foundations of new States, planted new industries, brought vast stretches of hitherto unproductive lands under cultivation, opened up the treasures of the mine, multiplied the lines of communication, and poured the agricultural and mineral wealth of the great West into the commerce of the world.

Concurrently with these recent economic changes, resulting from the operation of natural causes, economic changes of equal magnitude were brought about through fiscal legislation at home and abroad. The establishment of free trade in Great Britain opened the markets of that country to American agricultural products, stimulating to an unwonted degree production at home and correspondingly depressing agriculture in the British isles. American wheat and corn monopolized the supply of breadstuffs to the British artisan, building up and controlling a market into which no other competitors could enter on equal terms. Concurrently therewith the protectionist policy adopted by the United States not only rendered this country independent of foreign supplies, but enabled her in the end to become in many of the chief products of the mine, the forge, and the loom a formidable competitor for the chief part of the commerce of the world.

Under these conditions, vaguely apprehended by the majority, but apprehended with more or less clearness of vision by a few of the far-sighted statesmen of the country, the Morrill law of 1862 was passed by the Congress of the United States. There arose a demand for a system of education adapted to the needs of the time, which should go beyond the requirements for classics, law, medicine, divinity, and letters; an education which, without proscribing or neglecting classical and philosophical studies, should utilize for the public good the known and discoverable laws and processes of nature for the increase of production and the multiplication of the comforts and necessities of life. This demand the Morrill law was intended to satisfy, and upon this foundation more than fifty State colleges and universities are established.

Mr. Morrill saw that in the rapid alienation of the public lands through settlement and gratuitous allotment to railway corporations the public domain was rapidly being exhausted. He accordingly determined to dedicate a part of this rapidly diminishing public domain to the education of the American people along new lines and according to the necessities imposed by geographical and economic conditions peculiar to the Western Hemisphere. He provided that land script should be given to the several States in proportion to population for the endowment of institutions of learning, wherein should be taught those branches of learning related to agriculture and the mechanic arts, without excluding classical and other scientific studies, and including military tactics, for the education of the industrial classes in the several pursuits and professions of life. This was a radical departure from the old idea of education. It was a conception of university work such as had never yet been thought out by any thinker and whose realization had never yet been attempted. The existing body of human knowledge, whether of mind or of matter, hypothetically assumed or actually realized, was to be made available for appropriation by the learner; and the far greater domain of nature, unknown or partially known, invited the investigator through observation and experiment to new fields of discovery.

The old institutions looked doubtfully and not quite sympathetically on the new education. They gravely shook their heads at the credulity of those who thought that investigation in those branches of science relating to agriculture and the mechanic arts could be carried beyond the merest rudiments or would be productive of results at all commensurate with the expenditure of the time and money proposed. But when within a few years they saw an interpretation given to the legislation of Mr. Morrill which did not confine mechanic arts to blacksmithing, carpentry, and kindred handicrafts; which went beyond the still more advanced conception of manual training and discovered its ultimate application in engineering—mechanical, electrical, civil, sanitary, and mining; when they saw, as preliminary and preparatory to these, extended courses in mathematics, chemistry, and physics, reaching far above and beyond those in the older colleges and universities, they began to show more consideration for the new and to ask, "Can any good thing come out of Nazareth?" When, moreover, they saw that the foundations of a science of agriculture were being laid in extended courses of botany, comparative anatomy, and physiology, biology, chemistry, entomology—that, through these, barren fields were made fertile, the products of animal and vegetable industry improved in quality, multiplied in quantity, and increased manifold in commercial value—the exclusiveness of the old tacitly acquiesced in a modified recognition of the new.

Silently, steadily, resistlessly the new has moved on regardless of the contempt, the pity, the tolerance of the old. Ere long the new institutions, retaining for the most part the classics and the philosophies of the old, established chemical, physical, biological, and engineering laboratories on a scale of expenditure and completeness far beyond the resources of the old; they set the pace for scientific study and investigation in America. By their bold experiments and stupendous results they startled the old institutions out of their complacent lethargy and roused them to an activity hitherto unknown. They made it manifest that classical and philosophical attainments and discipline could exist side by side with thorough training and far-reaching acquirements in natural science, and that these latter found an application in the development of agriculture and manufacturing industry out of all proportion to the original conception on which the legislation of 1862 was based.

A few of the older universities, originally denominational but long since secularized—Yale, Harvard, Princeton, Columbia—with prestige, large endowments, and wealthy alumni, who have contributed freely to enlarge the sphere of their capability and activity; and a few recently founded and endowed by individual munificence on a scale of unprecedented liberality—Johns Hopkins, Leland Stanford, and Chicago University—stand well to the front and maintain each a staff of workers in the field of investigation who are the peers of any in the land. Most of the others, especially those which are dependent upon denominational support, have fallen hopelessly to the rear. The colleges and universities established under the Congressional act of 1862, whose areas of activity were enlarged by the supplementary legislation of 1887 and 1890, have grown so rapidly that they are now recognized in most of the States as the chief exponents of the higher education coupled with the practical education which finds expression in ever multiplying bushels of wheat and bales of cotton and tons of steel—an education which conditions and renders possible the supremacy of America in productive activity and commercial enterprise.

But our scientific achievements and their translation into material wealth must not be content with these triumphs. The last forty years—a period coincident with the life of these institutions—have witnessed an increase in population and in wealth such as the dreams of the most sanguine could not have ventured to anticipate. No parallel for it exists either in ancient or in modern history, either in the Old World or in the New; and the actually realized power and wealth of the nation are but the beginning of greater and mightier things yet to be. Within another half century our population will have quadrupled, our wealth increased in more than corresponding proportion, and our strength on land and sea such that no power or combination of powers will be able to gainsay or resist. In this mighty onward march the State colleges and universities will lead the van. But they must do more than point the way which leads to material wealth and dominion. Problems relating to mind and matter of surpassing interest to mankind are pressing for solution, and to their solution the scientists and laboratories of these colleges and universities must contribute an adequate if not a preponderant share.

For example, I have seen it stated that the theory set forth in Prof. Osborne Reynolds's Sub-Mechanics of the Universe "that not a flawless, continuous ether, but a granular structure of the spaces of the universe that not only explains all observed phenomena and the cause of gravitation, but reveals the prime cause of the physical properties of matter finds for the present one of its chief facts of interest in the fact that few if any of living mathematicians are capable of following his demonstrations and none are strong enough to attack it."

Sir William Crookes, in an address to the International Congress for Applied Chemistry at Berlin, June 4 of this year, said that chemists now admit "the possibility of resolving the chemical elements into simpler forms of matter or even of refining them away altogether into ethereal vibrations of electrical energy." He further declared that "a number of isolated hypotheses as to the existence of matter in an ultragaseous state, the existence of material particles smaller than atoms, the existence of electrical ions or electrons, the constitution of Röntgen rays and their passage through opaque bodies, the emanations from uranium and the dissociation of the elements are now welded into one harmonious theory by the discovery of radium." He added that if the hypothesis of the electronic constitution of matter were pushed to its logical limit "it is possible that we are now witnessing the spontaneous dissociation of radium, and if so must begin to doubt the permanent stability of matter. If this be so the 'formless mist' must once more reign supreme and the visible universe dissolve."

Sir Oliver Lodge in the Romanes lecture delivered at Oxford on the 14th of June suggested that "atoms of matter are actually composed of concentrated portions of electricity which could exist separately or in association. Seven hundred such electrons in violent orbital motion among themselves would constitute an atom of hydrogen; 11,200 electrons would form an atom of oxygen, and 150,000, an atom of radium. We have on this theory arrived at the ultimate chemical particle, various combinations of which form all the infinitely diverse aspects of matter."

Sir Oliver observes that "the attraction of this hypothesis is that it represents a unification of matter and a reduction of all material substance to a purely electrical phenomenon." This electrical theory of matter involves two consequences—a continual increase in the velocity of the constituents of an atom and the ultimate instability of those constituents. There is thus a state of flux and decay "in the foundation stones of the universe, the elemental atoms themselves." Sir Oliver thinks, however, that "there is at the same time a system of reaggregation at work which constitutes a sort of regenerative process which will preserve the universe by the creation of new forms of matter in the place of forms that have been dissolved."

If these things be so it can no longer be said "that the ultimate details of atomic constitution are beyond our scrutiny." But, granted that these details are known, the mysteries of the universe are still unsolved. What is the nature of electric phenomena? What are those things which can evolve out of structureless simplicity the infinite complexities of the earth and heavens? Does a directive force, intelligent and eternal, become the necessary postulate for a rational conception of the universe? Are we warranted in concluding with Tennyson that—

"Only that which made us, meant us to be mightier by and by,
Set the sphere of all the boundless heavens within the human eye;
Sent the shadow of Himself, the boundless, through the human soul
Boundless, inward in the atom, boundless outward in the whole."

We are manifestly on the threshold of mighty discoveries. What part will the American intellect play in the investigation and solution of these problems? What part will the colleges and universities of this association play in the unfolding of this stupendous drama? In the laboratories of the chemist and the physicist the work must be done. To this end we need skillful workers, clear thinkers, prophetic men with trained intellects and scientific imaginations. To this end we need special endowments for research; but special endowment for research means large expenditure for the best material facilities which ingenuity can devise and skilled workmanship can construct. It means also highly disciplined and trained investigators whose time is not occupied with the drudgery of instruction, but which is devoted entirely to original work.

These conditions necessarily imply large expenditure, and the means for this must be obtained from the liberality of the nation and from the generosity of individuals. We must encourage the study of higher mathematics in order to develop men who shall be able to follow and interpret the mathematics on which such theories as those of the Sub-Mechanics of the Universe rest. We must create in our laboratories the Curies and the Kelvins and the Crookes and the Clerk-Maxwells, the Rutherfords and Bancrofts and Oswalds, who shall grapple with and if possible solve the mysteries of the physical universe. This, I trust, will fall largely to the lot of the colleges and universities which we represent to-day. Let us hope that from their halls shall issue the honored few; from their ranks shall arise the heroes of science who, in the achievement of these last and greatest results, shall be welcomed to join the ranks of the immortals.

With the accession of the Tudors in 1485 the influence of England in continental affairs had materially diminished. The days of Crécy and Poitiers and Agincourt with the passing of England's heroes—the Black Prince and Henry V—had also passed away. The treaty of Pecquini had left England none of her continental possessions except Calais, and this too was to pass to the house of Valois before the Tudors ceased to reign. The ascendency of Spain was unquestioned. Even after the abdication of Charles V the Spanish monarchy was the most powerful in the world. The vast over-sea possessions which that monarch had inherited from Ferdinand and Isabella he transmitted, enlarged and consolidated, to his son Philip. But the growing sea power of England, after the accession of Elizabeth, was destined ere the close of the century to give the Spanish power a fatal blow. The defeat of the Armada sealed the fate of Spanish supremacy, and proved that something more than prestige and gold was needful on which to build national power and national prosperity. From 1588 the star of Spanish dominion gradually declined and the scepter was by degrees transferred to mightier hands.

England followed close upon the track of discovery, but more than a century passed before any permanent settlement was made by her in the New World. Though she entered later on the race of trans-Atlantic adventure than either Spain or France, yet she was destined to outstrip all her competitors in colonial dominion. The colonies founded during the reign of the successor of the great Tudor queen were established not by men impelled by the lust of gold, but by men who sought political freedom and liberty to worship God according to their conscience. They carried with them love of home, reverence for law, a deep sense of the inalienable rights of man, and the conviction that in their veins flowed the blood of Alfred and of the barons who extorted the Magna Charta from King John on the field of Runnymede; and here, with these convictions and with these traditions, they laid the foundations of what in the immediate future will be the mightiest nation which the world has ever seen. The Revolution of 1776 broke the political bonds which united the original colonies to the mother country; but it did not break the bonds of blood, of inherited traditions, and of the glory which attached to the common inheritance. All the glorious ideals of the race have quickened, enlarged, and intensified; and have found realization to a degree which could never have been attained within the narrow limits of the original home in the Old World. The immemorial heritage of freedom brought by Angle and Jute and Saxon from the banks of the Saale to those of the Thames and the Humber and the Dee, and after ages of growth within the British Isles transplanted to ampler fields in America has found its ultimate development in the great nation of whose origin and history we are all so proud to-day. And it may surely be a source of legitimate pride to the mother country that the great empire, which neither the ambition of Louis XIV nor the conquering power of Napoleon could dismember, received its first rude shock from the courage which she had communicated to her emancipated offspring, and that amid trans-Atlantic wilds grew up a race of men who have established real liberty on the principles which they inherited from ancestors who were the countrymen and compatriots of Bacon and Sidney, of Hampden and Oliver Cromwell.

In the United States of to-day even the busiest and the most actively employed in the intervals of leisure stop to inquire whence they came, what they are, and whither they tend. The apprehension has been felt and expressed that we are too much given up to the acquisition of wealth, too material, that we care nothing for the past, are absorbed in the cares of the present, and clothe the future in the draping of the accumulated gains built upon the foundations which we have laid. The hundreds have grown into the thousands, the thousands into the millions; we look to a future when the latter shall have expanded into billions; and then the golden age in another sense than that of the ancients will have superseded and supplanted all others, and wealth not brains will rule mankind. But wealth in the second generation, if not in the first, looks anxiously for a background of respectability. This is a wholesome feeling and a healthy indication. The wealthy long for something more than mere wealth to differentiate them from the masses. Energy and capacity and ability to accumulate wealth were indispensable, but these must have had an antecedent existence in the family. Heredity and atavism are assumed as the necessary conditions and these are sought for in family history. Family traditions, family records, title deeds, names and surnames, on this side the Atlantic and on the other, are eagerly examined, studied, collated, and translated into genealogies embodied in family trees with all the accessories of crests, mottoes, armorial bearings, and coats of arms. These ideas are not incompatible with republicanism. The Washingtons and Jeffersons and Adamses and Winthrops of colonial time were proud of their title deeds and genealogies and descent from the gentry and gentlemen and nobility of the mother country. Not only were the leaders in the American revolt of 1776 gentlemen and the sons of gentlemen, but most of the noncommissioned officers and men were of reputable English and Scotch and Irish descent. Gentlemen fought and won in the Revolutionary contest. In no subsequent war in which the United States has been engaged did the armies of the Republic contain so large a proportion of gentlemen. What, then, is called the modern craze for geneaology is a healthy, conservative, mental condition, an effort to discover, and if not to discover, to make a place in the annals of recorded or unrecorded gentility. Fortunately the original contributory elements which make up the history of the great Republic are not so difficult to discover. The early history of Puritan, Pilgrim, and Cavalier is well known. The politico-religious ferment which led to the emigration of the one and the spirit of adventure which led to the voluntary expatriation of the other are matters of history.

Other contributory elements from Germany and Scandinavia and central and eastern Europe have swelled the population of this newer and mightier England which occupies the best half of the North American continent, but the basis, the backbone, the brain of the country remains and will remain Anglo-Saxon. Our history thus finds its roots in the history of the peoples of the Old World and preeminently in that of middle England, which stands midway between the Saxon of the Saale and the Saxon of America. Through our relations with them Robert Bruce and Bannockburn are ours; Hastings and Runnymede, Evesham and Crécy, Bosworth field and Marston Moor, Blenheim and Culloden. Through them we inherit the glory of an inalienable birthright in the common law, in the growth of parliamentary government, in the reformation of Knox, and the martyrdom of Latimer and Ridley. Through them we claim an equal inheritance in Wyclif and Bacon and Shakespeare; in Newton and Boyle and Harvey; in Burleigh and Halifax and Chatham; while we allow them to share the greatness of those who are peculiarly our own, Franklin, Washington, Longfellow, Andrew Jackson, and Abraham Lincoln.

Now, inasmuch as the students in our colleges and universities are or should be educated not as scholars and scientists only, but as citizens who will be concerned in shaping the destinies of the greatest people whom the world has ever seen, it is not less incumbent that adequate provision be made for the attainment of the one end equally with the other. The State university must be what Ezra Cornell, in founding the university which bears his name, wanted it to become, viz, a place where everything could be taught which it is possible to teach, and where everything could be learned which it is possible for one to know.

I would urge, then, with all the insistence which I may, the necessity that history and political philosophy with all their correlated subjects should become a special feature of the university and collegiate instruction which we represent. In many institutions they are already distinctive features. They should be made distinctive and obligatory in all.

Within the last two hundred years history has been made rapidly in America. For a time almost isolated from contact with European nationalties and in touch with the Old World mainly through official relationships, political life developed without interference from abroad. ·The theory of the New England commonwealth gradually became more political and less theological; the limits imposed upon religious freedom gradually relaxed and political freedom became more unrestained. The colonists were law-abiding, but the laws to which they subjected themselves were of their own making. So strong, however, was the traditional respect for law and order, and so conservative were they when least restrained by external authority, that their legislation never tended to sap the foundations of the commonwealth nor to impair the obligations of contract. Legislation was generally along the lines of precedent, following the recognized principles of the common law and adhering closely to the rights and duties laid down in the great charter of English freedom. When under new conditions new legislation was needed for which no precedent existed known to the lawmakers, the ample shield of the spirit of the common law and of Magna Charta was invoked to cover them. So in the interpretation of the law by the judge on the bench; if statute law did not exist to meet the cause in action, the common law was so interpreted as to apply, and the spirit of jurisprudence came to the relief of the dispenser of justice.

And this was exactly what had happened hundreds of years before in Wessex and Kent and East Anglia and Mercia and Northumbria. The principles of law and equity had grown up silently in the community, enlarging in their application as new conditions arose, and became embedded in the hearts of Englishmen ages before they found articulate expression in the laws of Ina and Offa, Alfred and Ethelred; ages before the charters of John and Henry and Edward placed the seal forever on the recognized and inalienable rights of Englishmen. This spirit and these traditions they brought with them to the new world. England alone of all the world could supply such colonists, and England alone of all the world could continue, without exhaustion, the work of colonization on such a scale as to assure ultimate success. The Puritans of the North and the Cavaliers of the South, reinforced in later times by the sturdy Scot from the Lowlands and the Highlands and, later on, by the equally hardy Scots of Ulster formed the basis of American nationality, and a nobler ancestry the world has never seen. The characteristics of the first settlers remain the predominant characteristics of the typical American of to-day and, however affected by subsequent infusions from continental sources, remain in large measure unmodified. This prepotency of race and of blood is manifest in every phase of the history of the American people. Only people of Anglo-Saxon blood, Anglo-Saxon endurance, and Anglo-Saxon devotion to freedom could have maintained and carried the struggle for independence to a successful issue against the power of the mother country. Only people of Anglo-Saxon blood could have maintained and successfully concluded the second trial of strength with the might of the British Empire in the war of 1812. Only the descendants of this heroic stock could have routed the armies of Mexico and planted the Stars and Stripes upon the ramparts of Chapultepec and Churubusco; and in that terrific contest, fought out forty years ago for the maintenance of the integrity of the Republic, when armies larger than those engaged at Marengo, Wagram, Austerlitz, Jena, or Waterloo, met each other on the field of battle, the men on both sides, who led them to victory or defeat, and the men who composed them were in the main the descendants of the pioneers whose ancestors had lived for thirty generations within the four seas of Britain. Lee and Jackson and Stuart and Hampton and Gordon, McClellan and Grant and Sheridan and Sherman and Thomas are as thoroughly British names as Cromwell and Marlborough and Wolf and Wellington. With this people, its noble ancestry, its inspiring traditions, its stupendous achievements, and its glorious history, I would have the most ample provision made in every institution in this association for its students to become acquainted. The educated American should know the history of his own people in itself and in its relations. We go back beyond 1776, beyond 1620 and 1607. The roots of our being are identical with those of the patriots who worked out patiently and laboriously for six hundred years the problems of parliamentary government, of the relation of the subject to the state, of taxation to representation, of the coordination of liberty and authority. English history before 1776 belongs as much to Americans as to Englishmen, and American institutions are unintelligible if dissevered from their rational relationship. The American Constitution without the prior existence of Magna Charta, Habeas Corpus, and the Bill of Rights would have been impossible.

On one occasion Lord Beaconsfield gave utterance to a felicitous expression which roused to an intense self-consciousness the hearts of the British people. "Libertas et imperium" struck a note which vibrated through the British Isles. They felt that they had achieved empire through freedom. I would strike a kindred note here to-day. I would have this association adopt the motto: Education and Empire. Freedom we have. Freedom forms the basis of our national existence, the air which it breathes, the inspiration of the life which it lives. But the inspiration and the vitality of freedom and of empire must henceforth be intelligence—developed, strengthened, exalted, purified.

Not long since a conference of allied colonial universities was held in London. There were present men like Lord Kelvin and the leader of the House of Commons, eminent representatives of learning and science, men high in authority in the old universities of the mother country, and men of distinction in the more recently established universities of the King's oversea dominions. Mr. Balfour announced the object of the meeting to be "An alliance of all the universities that in an increasing measure are feeling their responsibilities not merely for training the youth which is destined to carry on the traditions of the British Empire, but also to further those great interests of knowledge, scientific research, and culture, without which no empire, however materially magnificent, can really say that it is doing its share in the progress of the world." What the statesmen of the kindred people beyond the Atlantic seek to do, we have already been doing for years. This federation of colleges and universities has been addressing itself to realize the objects set forth in the language just quoted, viz, the furtherance of the great interests of knowledge, scientific research, and liberal culture, "without which no empire, however materially magnificent, can really say that it is doing its share in the progress of the world." No such federation of educational agencies and activities as this association of ours has ever been seen. It is the first, the greatest, the most far-reaching in its aims, and the most successful in its results. It has long since passed beyond the embryonic stage. Embracing within its ample scope all that is valuable in the old and incorporating it with new ideals, it presents to the nation and the world a system complete because all-embracing, and, inspired by the vigor of youth, goes on conquering and to conquer. "To the solid ground of nature trusts the mind which builds for aye."

American institutions have materially influenced the principles of government in the Old World; American education is accomplishing a similar work in influencing the educational systems of Europe. Germany has felt its power, great though Germany be in intellect, in pure science, in discovery; England frankly acknowledges her obligations to American methods in university training and in the application of science to industrial production; Russia in her commercial exclusiveness pays a reluctant tribute to American enterprise. All these are legitimate sources of an honorable pride, and all the more gratifying because the federation of American colleges and experiment stations is the exponent of the idea. The precedence which we have won we must maintain.

In hoc signo vinces. State and nation are alike interested in the existence and development of the units which form this organization; and State and nation will respond with equal liberality in order to maintain the most comprehensive, most economic, most fruitful educational activity which human wisdom ever devised.

From a glorious past, through a marvelous present, to an illustrious future, the transition is natural and easy. If the growth and prosperity witnessed within the memory of living persons have been unexampled, it is because conditions—intellectual, moral, religious, social, material, and political—existed such as never existed before. Some of these will continue, others will undergo material modification. The intellect through scientific discovery and liberal culture will probably become more keen and more intense in its activity. Social conditions and relations will change as they are changing now. The rich will become relatively richer and the poor perhaps poorer. A greater mastery will be obtained over the powers of nature, subordinating them to human control and to human utility. The visible embodiments of the collective will in civil government—executive, legislative, and judicial—will be determined by the moral and religious ideas and convictions which prevail.

If there be wholesome, vital, intense, and strong social and political convictions, the relation of the individual to the community, of the citizen to the State, will be determined by honest and rational means for the attainment of high and honorable ends. Upon the moral and religious life of the future will depend the future greatness of the great Republic. The vigorous beliefs in which the fathers and the mothers of the olden times were brought up have without doubt changed. Is it for the better or for the worse? Let us hope that human elements only have been eliminated and all that is divine is retained; that the dross and tin have been purged and that the gold remains. But somehow the shadow of a doubt sometimes crosses the mind that not the form only but the essence has changed, that—

"Now there are new religions, many the codes and the creeds,
Many the quibbling changes to fit with our fanciful needs,
All of them waxing milder, waning in strength and tone;
None of them stern and sturdy; none of them stand alone.
None like the old religions—those that the fathers made,
Built on the fearless basis—the God of the unafraid."

The moral and religious tone of the country upon which the greatness of the nation will depend will be influenced largely by the moral and religious tone which pervades the colleges and universities which compose this association. Let us see to it that the God of our fathers, reliance upon whom carried them through the throes and perils of the birth of the nation, is not forgotten; let us see that "the divinity that shapes our ends, rough-hew them how we will," is still recognized and reverenced—conscious that amid human affairs there is a power that works for progress and for righteousness and that the great lesson of all history, specially emphasized and exemplified in our own, is the realizing of the divine in the human; of the infinite in the finite; of the eternal in the temporal; that—

"Not in vain the nation's strivings
Nor by chance the current's flow,
Error mazed yet truth directed
To their destined goal they go."

We can picture to ourselves ere the close of this century a nation of seven hundred millions of people, Christian, peaceful, rich, and happy; with realized industrial, agricultural, and commercial wealth, tenfold that of the present; with a predominant influence in the councils of the world; with a fiscal system light in its burdens, with income balancing expenditure, with laws just and equitably administered; with ignorance banished, crime restrained, and pauperism nonexistent; with the relations of wealth and labor rightfully adjusted; and above all with a deep, all-pervading sense of the fatherhood of God and the brotherhood of man.

We can fancy these colleges and universities with endowments counted by millions and students by tens of thousands, recognized as the prime factors in individual and national wealth and greatness; venerable abodes of learning diffusing through their sons and daughters an enlightenment and culture pervaded by a deep religious sense, enlightened by science, and a science leavened and glorified by religion. We can think of them as the depositories of discovered truth whence the pilgrims of every kindred and clime recruit their stores for the enlightenment of mankind; as beacons whose illuminating beams irradiate every continent and transcend every sea. Then shall we realize the vision of the Hebrew prophet: "Who are these that fly as a cloud and as doves to their windows? Their sons shall come from afar and their daughters shall be nursed at thy side, * * * and I will make the place of thy feet glorious."

Happy land, happy people, yea happy is that people whose God is the Lord.

The convention at 9.30 p. m. adjourned.

Morning Session, Wednesday, November 18, 1903.

The report of the committee upon memorials being called for, H. E. Alvord, on behalf of that committee, stated that arrangements had been made for the delivery of the two addresses desired, one by Dr. F. W. Gunsaulus, of Chicago, on President Beardshear, of Iowa; the other by President P. H. Mell, of South Carolina, on President Broun, of Alabama; but that notice had been received that Doctor Gunsaulus had met with an accident which would prevent him from being present.

The other address was delivered by President Mell, as follows:

Memorial Address on President W. L. Broun.

Dr. William Le Roy Broun was born in Loudon County, Va., in 1827, and died in Auburn, Ala., January 23, 1902, in the seventy-fifth year of his age. His was a life of long and faithful service to his country in the contribution he made to science and in the great work he did as an educator of national reputation. The writer was associated with Doctor Broun as student and colleague for more than thirty years, and this opportunity has been peculiarly advantageous for studying his character and his work in public and private life.

Doctor Broun was educated at the University of Virginia and graduated from that institution in 1850 with the degree of master of arts. Soon after graduation he was elected to a position in a Mississippi college which he filled until 1854, when he was selected by the board of trustees of the University of Georgia for the chair of mathematics. He remained in connection with the University of Georgia until 1857, when he resigned to organize the Bloomfield School, situated near the University of Virginia, and he conducted this school with great success until the opening of hostilities between the States in 1861. In 1859 he was married to Miss Sallie Fleming, of Hanover County, Va.

When war was declared between the States, Doctor Broun enlisted as lieutenant of artillery, and spent one year in the field with the army of Virginia. He was then ordered to Richmond and made superintendent of armories with the rank of major, and was detailed to examine into the resources and facilities at the command of the South for the manufacture of arms and ammunition. He visited many places, particularly in North Carolina and Georgia, to determine the practicability of making sulphuric acid and other chemicals required for the manufacture of powder and percussion caps. In 1862 he was stationed at Holly Springs, Miss., in charge of a factory designed for the manufacture of small arms, but the defeat of Gen. A. S. Johnston's army at Shiloh, Tenn., compelled him to remove the machinery to Meridian, Miss., and shortly afterwards he was attached to the ordnance department and ordered to Richmond, where he remained until its evacuation.

Some illustrations here given show the importance of Colonel Broun's services to the Confederate cause.

He suggested and conducted the first civil-service examination ever held in this country. This was brought about by the numerous applications for service in the ordnance department because of an enactment of the Confederate congress authorizing the appointment of 50 new ordnance officers. This examination was held in 1862. Colonel Broun was president of the board of examiners.

He prepared a field ordnance manual by abridging the old United States manual and adapting it to the Confederate service. This work was published by the government and distributed in the army.

He was appointed commander of the Richmond arsenal in 1863, where the greater part of the ordnance stores were manufactured. It is said that, but for the valuable work performed in this connection by Colonel Broun, the Confederate struggle would have ended long before it did. His fertile genius used every available resource. In an article published several years since in an issue of the Journal of the United States Artillery, Colonel Broun speaks of this work as follows: "Cannon were made in the Tredegar Iron Works, including siege and field guns, Napoleons, howitzers, and banded cast-iron guns. Steel guns were not made. We had no facilities for making steel and no time to experiment. The steel guns used by the Confederate States were highly valued, and, with the exception of a few purchased abroad, were all captured from the Federals."

In this arsenal the old United States machine, which did not yield a large supply of percussion caps, was greatly improved, so that 2 men with 6 boys and girls were able to complete 300,000 caps every eight hours, or a capacity of 1,000,000 caps per day.

Under his direction sulphuric acid was manufactured in North Carolina after many failures in attempting to obtain the lead required for lining the chambers. Niter was obtained from caves and from leaching in ricks the remains of dead horses and other animals. The sulphuric acid and niter were made into nitric acid at the arsenal, and thus the fulminate was developed which was required for the manufacture of caps. The mercury supply becoming exhausted near the close of the war, the problem became a serious one—how to make the caps without fulminate of mercury. Experiments, however, were conducted, resulting in the use of a combination of chlorate of potash and sulphuret of antimony. Battles around Petersburg were fought with caps made of this compound.

He developed a plan for increasing the accuracy and range of the smooth-bore muskets which were in general use by the armies at the opening of the war.

All orders from General Lee for arms and ammunition were honored, and even a train load of ammunition was sent to Petersburg after the order was received for the evacuation of Richmond.

Probably the last order given in Richmond was issued by Colonel Broun to the keeper of the magazine to destroy these stores at 5 o'clock on the morning of April 13, 1865.

The work of Colonel Broun in the manufacture of arms and ordnance stores is remakable when we know that at the opening of the war the South had no factories of this kind nor skilled mechanics. This fact being well understood, one marvels how it was possible that so large an army was supplied with all the munitions of war during four years of the most stupendous struggle the world has ever witnessed.

After the war the University of Georgia again called Doctor Broun to her service as professor of natural philosophy, and subsequently he was elected president of the college of Agriculture and Mechanic Arts, a branch of the university. His services in the university extended over the years 1866–1875. While holding this position he organized and engineered the plan to establish a State geological survey and an agricultural department, and organized the State Agricultural College. He was also one of the leading spirits in the State Agricultural Society of Georgia, and took an active part in all the meetings of these important farmers' associations. Doctor Broun, I am informed, was the first in the South to introduce the inspection and analysis of commercial fertilizers. He had this work done through the State Agricultural Society by the chemist of the State Agricultural College. The samples were drawn under the direction of the secretary and analyzed by the chemist without State aid and without cost to the farmers. Shortly after this work was instituted the State agricultural department was established, and the analysis of fertilizers was sanctioned by law.

In 1875 Doctor Broun resigned the chair in the University of Georgia to accept the chair of mathematics in Vanderbilt University, in which position he remained for seven years. In 1882 he was elected president of the Alabama Polytechnic Institute, which he held for one year and then resigned to accept a call to the professorship of mathematics in the Texas University and the chairmanship of the faculty. There he was associated with Doctor Mallett, of the University of Virginia, and other distinguished teachers who had been gathered there from every part of the country by the board of trustees of the Texas University. Doctor Broun returned to the Alabama institution in 1884 at the earnest solicitation of the board of trustees, and remained in charge of the affairs of that college, which he discharged with great success and distinction until his death in 1902.

More than twenty-three years ago, in an address delivered in Alabama before an educational gathering, he asserted that a correct interpretation of the act establishing the agricultural and mechanical colleges would develop the institutions into schools where a liberal and broad education could be obtained, an education giving skill to the hands as well as to the brain, and in fact yielding to all the faculties of the mind and body great powers for usefulness in developing the resources of the country. He believed that all the sciences should be provided for in the courses of study in these colleges, and that there should be a sufficient amount and number of the literary topics introduced in order to make the students thoroughly educated and well-rounded men, to do much more than simply to lift them out of the sphere of "hewers of wood and drawers of water." In reorganizing the Alabama State College he provided not only for those subjects related to agriculture and the mechanic arts, but he also established chairs for the teaching of the modern languages and Latin, believing that it was in the mind of Senator Morrill, when he wrote the bill, that the "industrial classes" should have provided for them in these colleges an education of equal value and dignity to the education then furnished by the best university of the land.

The results accomplished by this active and intelligent man were varied and valuable. His chief work was as a teacher, and in this department he was preeminently prominent. The young men who received instruction from him are to-day in many instances occupying distinguished positions in many walks of life. He was a teacher for more than fifty years, and who can tell of the noble influences he set in motion with the thousands of young men who have passed under his tutorage? He had a most vigorous mind, which was well stored with knowledge on many different subjects, and he was continually pouring out information to students and friends without stint and without compensation. He was a hard student and all of his life the word energy was not only often used by him when instructing his students, but it was a force strongly evident in the development of his own life. He has often said in the hearing of the writer that men were made to work and to work at all times for the benefit of the country, in order that the community in which they live might be made better because they lived in it. He was well versed in science, but he was in no sense a specialist. He read in all lines of literature and could speak intelligently on many subjects which were of interest to many different classes of men. His address before this honorable body while presiding in New Orleans some years ago will be recalled by the older members as an able production, containing information of value concerning the interests relating to the work of the association. His versatile mind, full of suggestions and plans, developed the Alabama Polytechnic Institute into one of the best scientific colleges of the country. Under his administration the Alabama institution has accomplished some notable results. The work of this institution under Doctor Broun's direction, however, is well known by the college and station workers over the United States, and it is not necessary to enumerate them in this paper.

His ability to organize and establish important interests caused him to be sought after by parties in the commercial world, because his versatile mind made him a valuable man for their enterprises, but he preferred the life of a quiet professorship and devoted his energies to teaching young men to acquire knowledge for the important positions in life. These men are scattered over the country adding to the wealth of the nation, and in their labors they are reflecting the work of their noble teacher, for whom they have the greatest admiration and affection.

On the morning of January 23, 1902, while in apparent good health and in the full possession of his faculties, the summons came, and Doctor Broun in a moment stepped from the stage of action in this world. He died suddenly in harness, full of years and honors, but with a mind strong and vigorous to the last.

He has left a place in the ranks not yet filled. His influence for usefulness and the results of a long, consistent Christian life will last through the years to come.

C. F. Curtiss, of Iowa, moved that as Doctor Gunsaulus, who was selected by the committee to deliver the address on President Beardshear, was unavoidably absent, the association convey to Doctor Gunsaulus their deep regret at his inability to be present, and request his manuscript for publication in the proceedings.

The motion was agreed to.[a]

Exhibit at St. Louis Exposition.

The following report of the committee on collective college and station exhibit at the St. Louis Exposition was read by the chairman of the committee, W. H. Jordan, of New York:

Your committee having in charge the exhibit at the Louisiana Purchase Exposition, 1904, at St. Louis, of the progress in the United States of education and research in agriculture and the mechanic arts, beg leave to submit the following report of progress:

The movement to install this exhibit was instituted at the 1901 meeting of the Association of American Agricultural Colleges and Experiment Stations in Washington, and two committees were appointed to consider the matter, one representing agriculture and the other mechanic arts. At the Atlanta meeting, in 1902, these committees reported in favor of exhibits. The two committees were consolidated into one as an exposition committee. At this point it should be stated that early in the work of your committee it was found extremely desirable to call in for advice Hon. William T. Harris, United States Commissioner of Education, and it was

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[a] Doctor Gunsaulus subsequently expressed regret at his inability to furnish a paper in time for this publication.

agreed, after conference with him, that he should be added to the association committee, not only to secure his valuable counsel, but to have the Bureau of Education properly represented on the committee, and the approval of this arrangement was obtained from the executive committee of the association.

The executive committee at the Atlanta meeting was "charged with the duty of soliciting from Congress the sum of $60,000 to meet the expense of installing and maintaining an exhibit of the distinctive work of the land-grant colleges and experiment stations."

Because of the desire on the part of the live-stock interests that instruction and research in animal husbandry should be more fully emphasized than could be accomplished with the above-named sum, the executive committee subsequently decided to ask Congress for $100,000.

THE ACTION OF CONGRESS.

In accordance with its instructions, the executive committee, aided by members of the exposition committee, appeared before the House Committee on Expositions, of which Hon. James A. Tawney, of Minnesota, is chairman, and presented the wishes of this association in support of a bill which Mr. Tawney had previously introduced, and explained the nature and scope of the proposed exhibit.

The substance of this bill was finally incorporated in the sundry civil appropriation bill, and was passed with practically no opposition. It is eminently fitting that, in this connection, your committee should call attention to the able and earnest efforts of Mr. Tawney in promoting the desire of the association and make to him, in behalf of the institutions here represented, most sincere acknowledgments for this valuable service.

The text of the law governing this appropriation is as follows:

"Additional Government Exhibit: For the selection, purchase, preparation, transportation, arrangement, installation, safe keeping, exhibition, and return of such articles, animals, and materials, belonging to or used by the agricultural colleges and experiment stations, hereinafter referred to, as the Government board created by act of Congress approved March third, nineteen hundred and one, as amended by the act of June twenty-eighth, nineteen hundred and two, may decide to exhibit as a part of the Government exhibit, to show the progress of education and experimentation in agriculture, mechanic arts, and animal husbandry at the Louisiana Purchase Exposition, to be held under authority of said act, of the colleges of agriculture and mechanic arts and agricultural experiment stations receiving the benefits of the acts of Congress of July second, eighteen hundred and sixty-two, March second, eighteen hundred and eighty-seven, and August thirtieth, eighteen hundred and ninety, one hundred thousand dollars, to be immediately available; which sum shall be expended for that purpose only, and upon the authority of said Government board: *Provided*, That the Louisiana Purchase Exposition Company, at its own cost and expense, shall furnish to said Government board adequate and suitable space in an appropriate building or buildings for the installation of said exhibit and its exhibition during the continuance of said exposition."

Special points in the law to be noticed are that the expenditure of the appropriation thus made is placed under the control of the United States Government Board of the Louisiana Purchase Exposition, and that this board was authorized to arrange with the colleges of agriculture and mechanic arts and the agricultural experiment stations for an "exhibit of the progress of education and experimentation in agriculture, mechanic arts, and animal husbandry." It is provided that the exhibit is to be accomplished through the display of "articles, animals, and materials belonging to or used by the agricultural colleges and experiment stations." It is also specified that the Louisiana Purchase Exposition Company shall provide, at its own cost and expense, adequate and suitable space in appropriate buildings of said company for the installation of said exhibit.

ARRANGEMENTS WITH THE GOVERNMENT BOARD.

In accordance with these terms, the chairman and secretary of your committee promptly conferred with the Government Board and asked it to declare its policy regarding the management of the business connected with the exhibit of agricultural colleges and experiment stations and its relations to the committee of the association.

The necessary statements as to the origin, character, purpose, and plans of the exhibit were also filed with the Government Board. The Board thereupon appointed a special committee on the exhibit of the agricultural colleges and experiment stations, and instructed it to confer with the committee of the association and report back to the Board a plan for the management of the exhibit. This committee consisted of the following members of the Board: J. H. Brigham, chairman; E. M. Dawson, W. H. Michael, G. W. W. Hanger, and J. B. Brownlow.

Before proceeding with the organization of the work the Board obtained the assent and agreement of the Louisiana Purchase Exposition Company to the provision that this company, "at its own cost and expense, shall furnish to said Government Board adequate and suitable space in an appropriate building or buildings for the installation of said exhibit and its exhibition during the continuance of said Exposition."

After several conferences of the special committee of the Board and the representatives of your committee, and upon recommendations of the special committee, the Government Board from time to time authorized the following:

The official recognition of your committee as in charge, under the direction of the Government Board, of the association's exhibit; the appointment of each member of the committee as a special agent of the Board; the designation of a member of your committee to represent it before the Government Board, who should also certify all vouchers to the chairman of the board, Dr. A. C. True being designated for these duties; the appointment of Mr. James L. Farmer as chief special agent of the Board; the employment of the necessary clerical help and the purchase of necessary supplies; the acceptance of a general plan for the installation of the exhibit as outlined and presented by your committee.

Your committee desires to express at this time its obligations to the Government Board for the prompt, businesslike, and courteous treatment which we received at its hands.

ARRANGEMENTS WITH THE EXPOSITION AUTHORITIES.

On April 7, 1903, a meeting of your committee was held at St. Louis for the purpose of conferring with the officers of the Louisiana Purchase Exposition in regard to the location and general plan of the exhibit. After a thorough conference, in which the officers of the Exposition gave to your committee every possible consideration, it was decided that the main portion of the exhibit should be located in the Palace of Education. It was also agreed by the Exposition authorities that a special pavilion should be constructed which should accommodate an extensive exhibit in methods of instruction and research in animal husbandry. Subsequent conferences and correspondence with the Exposition authorities have resulted in a definite location of the main exhibit in the northwest corner of the Palace of Education, running from the corner to the central entrance on the west side. The total area of this space is approximately 16,000 square feet, including aisles. Deducting aisles there is left almost 11,500 square feet for actual exhibition space. (Diag. I.)

Your committee deems it a privilege to express its indebtedness to the Exposition authorities for the manner in which it was received. Our exhibit has been located on what is perhaps the most desirable space in the Palace of Education, and the wishes of your committee, so far as possible, have been met in every particular.

ORGANIZATION OF THE COMMITTEE.

At the St. Louis meeting the following subcommittees were appointed:

General organization.—The chairman, the secretary, Doctor Harris, Doctor Stone.

Plant introduction, rural engineering and rural economics.—Professor Hays, chairman; the secretary.

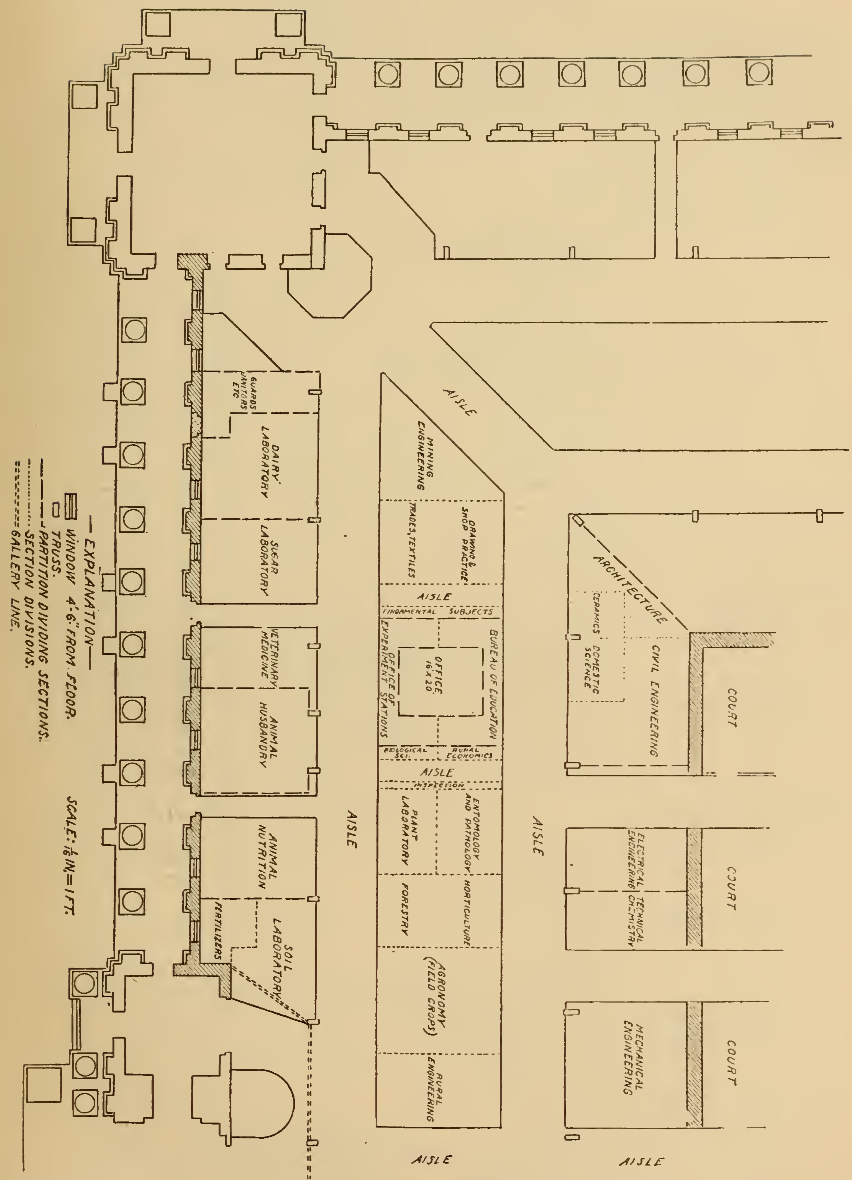
Animal husbandry and agrotechny (inside exhibit).—Professor Hunt, chairman; Professor Curtiss, Professor Waters.

Animal husbandry and agronomy (outside exhibit).—Professor Curtiss, chairman; Professor Hays, Professor Waters.

Mechanic arts.—Doctor Stone, chairman; Doctor Patterson, Professor Tyler.

Assembling and installation.—The chairman, the secretary.

Awards and congresses.—The chairman, Doctor Harris, Professor Waters.



DIAG. I.—Proposed installation plan of collective college and station exhibit at the St. Louis Exposition.

CLASSIFICATION OF THE EXHIBIT.

The classification of the exhibit agreed upon is as follows:

DEPARTMENT OF AGRICULTURE.

Group 1. Biological sciences.
- Class 1. Botany, economic zoology, entomology, etc.

Group 2. Inspection or control work.
- Class 2. Fertilizers, feeding stuffs, foods, dairy glassware, nursery stock, insecticides, etc.

Group 3. Plant production.
- Class 3. Plant laboratory.
- Class 4. Soils laboratory.
- Class 5. Fertilizers.
- Class 6. Field crops (agronomy).
  - (a) Improvement.
  - (b) Varieties.
  - (c) Culture.
  - (d) Harvesting.
  - (e) Preservation.
- Class 7. Horticultural plants and forestry.
  - (a) Improvement.
  - (b) Varieties.
  - (c) Culture.
  - (d) Harvesting.
  - (e) Preservation.
  - (f) Orchard and garden management.
- Class 8. Plant disease.
  - (a) Control.
- Class 9. Economic insects.
  - (a) Control.

Group 4. Zootechny.
- Class 10. Animal husbandry.
  - (a) Types and breeds; animal form and animal mechanics.
  - (b) Breeding; laws of heredity.
  - (c) Animal production; feeding, care, and management.
- Class 11. Veterinary science.
  - (a) Anatomy and physiology.
  - (b) Pathology.
  - (c) Surgery.
  - (d) Diseases.

Group 5. Agrotechny.
- Class 12. Dairying.
  - (a) Milk.
  - (b) Butter.
  - (c) Cheese.
- Class 13. Sugar making.
  - (a) Cane.
  - (b) Beet.
  - (c) Maple.
- Class 14. Canning, cider and vinegar making, olive oil, raisins, etc.
- Class 15. Finished meat products.
  - (a) Slaughtering.
  - (b) Block tests.
- Class 16. Tobacco manufacture.

Group 6. Rural engineering.
- Class 17. Lay-out of farms.
  - (a) Model farmstead and crop relations.
- Class 18. Buildings and fences.
  - (a) Silos, barns, ventilation, etc.
- Class 19. Water systems.
  - (a) Power for pumping.
- Class 20. Irrigation.
  - (a) Experimental system.
- Class 21. Drainage.
  - (a) Model of drainage system.

Group 6. Rural engineering—Continued.
- Class 22. Sewage system.
  - (a) Chemical studies; sewage systems for irrigating vegetable gardens, etc.
- Class 23. Farm machinery.
  - (a) Development of machinery.
  - (b) Grading and planting.
  - (c) Special machines.
- Class 24. Roads.
  - (a) Charts and models showing principles of road construction, materials, models, etc.
  - (b) Stone and iron culverts.

Group 7. Rural economics.
- Class 25. Farm administration.
  - (a) Statistical study of cost of production.

DEPARTMENT OF MECHANIC ARTS.

Group 8. Fundamental subjects.
- Class 26. Chemistry (general).
- Class 27. Physics (general).
- Class 28. Mechanics.
- Class 29. Mathematics (pure and applied).

Group 9. Civil engineering.
- Class 30. Railway engineering.
- Class 31. Hydraulic engineering.
- Class 32. Municipal and sanitary engineering.
- Class 33. Surveying.
- Class 34. Roads and pavements.
- Class 35. Bridges and framed structures.

Group 10. Mechanical engineering.
- Class 37. Steam engineering.
- Class 38. Heating and ventilation.
- Class 40. Railroad engineering.
- Class 41. Marine engineering.
- Class 42. Naval architecture.
- Class 43. Mechanical engineering.
- Class —. Strength of materials.

Group 11. Electrical engineering.
- Class 44. Electrical engineering.
- Class 45. Electric railways.
- Class 46. Electro-chemistry.
- Class 47. Electric power transmission.
- Class 48. Telephony.

Group 12. Mining engineering.
- Class 50. Assaying.
- Class 51. Metallurgy.
- Class 52. Metallography.
- Class 53. Mine surveying.
- Class 54. Geology.
- Class 55. Economic mining machinery.
- Class 56. Application of electricity to mining operations.

Group 13. Technical chemistry.
- Class 58. Application of chemistry to making chemical products.
- Class 59. Analytical chemistry.
- Class —. Chemical engineering.

Group 14. Architecture.
- Class 60. General architecture.
- Class 61. Architectural engineering.

Group 15. Drawing and shop practice.
- Class 63. Shop practice.
- Class 64. Mechanical drawing, including descriptive geometry.

Group 16. Industrial and domestic arts.
- Class 65. Domestic science.
- Class 66. Textile industries.
- Class 67. Ceramics.
- Class 68. Decorative art.
- Class 69. Trades.

ALLOTMENT OF SPACE.

The following is the allotment of space under this classification:

GENERAL.

	Square feet.
Bureau of Education	299
Administrative office	320
Guards, janitors, etc	279

AGRICULTURE.

Office of Experiment Stations	299
Biological sciences	76
Rural economics	76
Inspection	107
Economic entomology	153
Plant pathology	153
Plant laboratory	306
Horticulture	520
Field crops	550
Rural engineering	581
Fertilizers	116
Soil laboratory	490
Animal nutrition	540
Animal husbandry	648
Veterinary medicine	405
Sugar laboratory	540
Dairy	645

MECHANIC ARTS.

Fundamental subjects	153
Drawing and shop practice	612
Mining engineering	460
Architecture	300
Ceramics	130
Domestic science	195
Civil engineering	560
Electrical engineering	459
Technical chemistry	221
Mechanical engineering	772

ALLOTMENT OF FUNDS.

After careful estimates, based upon experience at previous expositions, an allotment of funds has been made as follows:

ALLOTMENTS APPROVED BY GOVERNMENT BOARD.

Administration	$14,000
Preparation and collection, installation, maintenance, and return	54,000
Animal husbandry exhibit	22,000
Contingent fund	10,000
Total	100,000

ALLOTMENT OF FUNDS MADE BY THE COMMITTEE.

Administration (including $5,000, proportionate share of Government Board expenses)	$18,865
Preparation and collection	19,500
Installation	22,250
Maintenance	9,870
Packing and return	3,450
Animal husbandry in special pavilion	21,000
Contingent fund	5,065
Total	100,000

APPOINTMENT OF EXPERTS.

In order to secure an efficient collaboration and preparation of the various subjects to be presented in the exhibit, its several divisions have been assigned to experts, in accordance with the following list:

ASSIGNMENT OF EXPERTS—GENERAL.

Relations of the United States Government with education in agriculture and mechanic arts—Dr. W. T. Harris, United States Commissioner of Education.

Relations of the United States Government with institutions for research in agriculture—Dr. A. C. True, Director of Office of Experiment Stations, U. S. Department of Agriculture.

AGRICULTURE.

1. Biological sciences—Dr. George E. Stone, professor of botany and mycology in the Massachusetts Agricultural College.
2. Soils laboratory—Prof. M. F. Miller, assistant professor of agronomy in the Ohio State University.
3. Inspection—Prof. M. A. Scovell, director of Kentucky Agricultural Experiment Station.
4. Fertilizers—Prof. E. B. Voorhees, agriculturist of Rutgers Scientific School and director of the New Jersey Agricultural Experiment Stations.
5. Plant laboratory—Dr. Walter H. Evans, botanist, Office of Experiment Stations, U. S. Department of Agriculture.
6. Field crops—Mr. J. I. Schulte, agronomist, Office of Experiment Stations, U. S. Department of Agriculture.
7. Horticulture and forestry—Prof. Samuel B. Green, professor of horticulture and forestry in the University of Minnesota and horticulturist of the Minnesota Agricultural Experiment Station.
8. Plant pathology—Prof. F. C. Stewart, botanist of the New York Agricultural Experiment Station.
9. Economic entomology—Prof. Clarence P. Gillette, professor of zoology and entomology of the State Agricultural College of Colorado.
10. Animal nutrition—Dr. H. P. Armsby, lecturer on stock feeding in the Pennsylvania State College and director of the Pennsylvania Agricultural Experiment Station.
11. Animal husbandry class room—Prof. Thomas F. Hunt, member of the exposition committee, professor of agronomy, and manager of the university farms, Cornell University.
12. Veterinary medicine—Dr. David S. White, professor of veterinary medicine and dean of the College of Veterinary Science in the Ohio State University.
13. Dairy laboratory—Prof. E. H. Farrington, professor of dairy husbandry in the University of Wisconsin and dairy husbandry of the Wisconsin Agricultural Experiment Station.
14. Sugar laboratory—Dr. William C. Stubbs, professor of agriculture in the Louisiana State University and director of the Louisiana Agricultural Experiment Stations.
15. Rural engineering—Prof. Elwood Mead, professor of irrigation in the University of California and chief of irrigation investigations, Office of Experiment Stations, U. S. Department of Agriculture.
16. Rural economics—Prof. Fred. W. Card, professor of horticulture and acting professor of agriculture in the Rhode Island College of Agriculture and Mechanic Arts.

MECHANIC ARTS.

1. Fundamental subjects—(To be filled.)
2. Civil engineering—Prof. Anson Marston, professor of civil engineering in the Iowa State College.
3. Mechanical engineering—Prof. W. F. M. Goss, professor of mechanical engineering and dean of the schools of engineering, Purdue University.
4. Electrical engineering—Prof. Bernard V. Swenson, assistant professor of electrical engineering in the University of Wisconsin.
5. Mining engineering—Prof. S. B. Christy, professor of mining and metallurgy in the University of California.

6. Technical chemistry—Dr. W. H. Walker, professor of industrial chemistry in the Massachusetts Institute of Technology.

7. Architecture—Prof. W. H. Lawrence, associate professor of architecture in the Massachusetts Institute of Technology.

8. Shop practice, drawing, etc.—Prof. F. Paul Anderson, professor of mechanical engineering, State College of Kentucky.

9. Domestic science—Miss Maude Gilchrist, dean of women's department of the Michigan Agricultural College.

10. Ceramics—Prof. Edward Orton, jr., professor and director of department of clay working and ceramics; dean of College of Engineering, Ohio State University.

Upon these experts, who have generously consented to devote so much time to the preparation of this exhibit, devolves the duty of arranging the minor details of the subjects placed under their charge and of securing the necessary objects and materials. They are now in correspondence with various institutions, and any information relative to the details and material of preparation should be sought of the experts having in charge the subjects under consideration. These experts will be efficiently and indispensably aided by the Office of Experiment Stations in the way of collaborating and assembling parts of the exhibit and in the preparation of labels.

GENERAL CONSIDERATIONS.

Your committee desires to impress most emphatically upon the members of this association that this is a cooperative exhibit, the responsibility for the success of which rests upon the institutions here represented. It is to be a display of your work, the materials for which you must to some extent contribute and aid in preparing. It has at no time been expected that the funds appropriated by Congress would be adequate to the payment for all services and all materials necessary properly to show our methods and progress in education and research. All the money has been set aside for the purchase of materials that the situation appears to warrant and our deficiencies must be supplemented by the aid of individual colleges and stations.

The loyal and generous way in which so many institutions have so far responded to requests for assistance is an encouraging indication that your committee will be abundantly supported in carrying this great and laborious undertaking to a triumphant conclusion. In all cases full credit will be given to collaborators and preparators and to institutions furnishing objects, materials, or data.

This is most certainly a splendid opportunity for impressing upon educators—both at home and abroad—as well as the general public, that the work of the land-grant colleges and experiment stations represents one of the great educational efforts of modern times—if indeed it is not made evident that it is the chiefest effort of them all in its relations to human needs and to the strength and progress of human society. We must labor together to make this exhibition of what we are doing attractive, dignified, and impressive, and therefore your committee bespeaks your most earnest, prompt, and generous cooperation.

It would not be proper to close this report without recognizing the helpful and sympathetic attitude of Hon. James Wilson, Secretary of Agriculture, toward this effort of the association, especially in allowing the Office of Experiment Stations to supplement in such a large measure the work of your committee. Hon. J. H. Brigham, Assistant Secretary of Agriculture, acting as chairman of the Government Board, has also given to the organization of this exhibit every needed attention and aid.

Respectfully submitted.

By authority of the committee, W. H. Jordan, *Chairman.*

W. H. Jordan. Mr. President, it is generally supposed that the chairman of a committee does a large part of the work, but I wish to emphasize the fact that in this case he has probably done less than anybody else; that the members of the committee which I represent have individually and in cooperation done a large amount of work in getting this matter into its present condition. It is perhaps unnecessary for me to say that we have found Doctor True, as a member of the committee, indispensable as an adviser and as a helper in the relation he sustains.

The report was accepted and the committee continued.

Designation of Substations and Trial Stations.

The following report of the committee on designation of substations and trial stations was read by W. M. Hays, of Minnesota (chairman):

Your committee respectfully reports that none of the suggestions pending at the time of the report a year ago seem worthy of recommendation. We would therefore respectfully recommend that the report as adopted a year ago stand and that the committee be discharged.

W. M. Hays,
W. J. Spillman,
Committee.

The report was accepted and the committee discharged.

Pure Food Legislation.

The following report of the committee on pure food legislation was read by W. A. Withers, of North Carolina (chairman):

Your committee upon pure food legislation wishes to report that much progress has been made during the year toward the securing of purer food products for the American people.

Two States have been added to the list of those which have established bureaus for the control of food products, and the importance of the subject has been felt in other States in which legislation has been proposed but not yet enacted.

The most important legislation of the year, however, is embraced in the following excerpt from the act making appropriations for the Department of Agriculture (Public—No. 158), approved March 3, 1903:

"To investigate the adulteration of foods, drugs, and liquors, when deemed by the Secretary of Agriculture advisable; and the Secretary of Agriculture, whenever he has reason to believe that articles are being imported from foreign countries which by reason of such adulteration are dangerous to the health of the people of the United States, or which are forbidden to be sold or restricted in sale in the countries in which they are made or from which they are exported, or which shall be falsely labeled in any respect in regard to the place of manufacture or the contents of the package, shall make a request upon the Secretary of the Treasury for samples from original packages of such articles for inspection and analysis; and the Secretary of the Treasury is hereby authorized to open such original packages and deliver specimens to the Secretary of Agriculture for the purpose mentioned, giving notice to the owner or consignee of such articles, who may be present and have the right to introduce testimony; and the Secretary of the Treasury shall refuse delivery to the consignee of any such goods which the Secretary of Agriculture reports to him have been inspected and analyzed and found to be dangerous to health, or which are forbidden to be sold or restricted in sale in the countries in which they are made or from which they are exported, or which shall be falsely labeled in any respect in regard to the place of manufacture or the contents of the package.

"To enable the Secretary of Agriculture to investigate the character of food preservatives, coloring matters, and other substances added to foods, to determine their relation to digestion and to health, and to establish the principles which should guide their use; to enable the Secretary of Agriculture to investigate the character of the chemical and physical tests which are applied to American food products in foreign countries, and to inspect before shipment, when desired by the shippers or owners of these food products, American food products intended for countries where chemical and physical tests are required before said food products are allowed to be sold in the countries mentioned, and for all necessary expenses connected with such inspection and studies of methods of analysis in foreign countries; to enable the Secretary of Agriculture, in collaboration with the Association of Official Agricultural Chemists, and such other experts as he may deem necessary, to establish standards of purity for food products and to determine what are regarded as adulterations therein, for the guidance of the officials of the various States and of the courts of justice."

In conformity with the provisions of this act, the preparation of standards of purity for various food products is in progress, investigations relating to the effect upon health of added preservative, coloring matter, etc., have begun and the inspection of imported foods is in active operation. The daily imports are about 200 cargoes, 150 of which from their nature are not liable to be adulterated. Of the remaining 50 cargoes, 10 a day are inspected and about 10 per cent of them are found to be improperly labeled or prepared otherwise contrary to law. The Secretary of Agriculture has asked Congress for an additional appropriation of $25,000, so that he can have a force adequate to inspect all suspected cargoes. This national control of food products is a portion of the duties of the Bureau of Chemistry, under the general direction of the Secretary of Agriculture.

This national inspection confirms the work of the different States in showing the great extent to which food adulteration is practiced, and the consequent necessity for enlarging its scope so as to include all suspected products.

The national pure-food bill was passed by the House of Representatives, and by a close vote of 32 to 28 the Senate, on March 3, 1903, determined to consider it, although it had passed a previous Senate in substantially the same form.

The committee wishes to congratulate this association as well as the food manufacturer and consumer upon the progress which has been made toward a national law which shall supplement the work of the States and upon the growth of public sentiment in this direction, and would respectfully recommend that the association continue its support of the cause.

Very respectfully,

W. A. Withers,
H. J. Patterson,
H. J. Wheeler,
Wm. Frear,
Committee.

The report was received and placed on file.

Military Instruction in Land-Grant Colleges.

On call for the report of the committee on military instruction in land-grant colleges, G. W. Atherton, of Pennsylvania (chairman), said: Mr. President, until I received the printed programme I had no intimation that this report would be called for or expected. I considered that the one duty which we had imposed upon us last year at Atlanta had been discharged by the circular report made to all the land-grant institutions. Stated briefly, the situation is this: An order (No. 94) has been issued by the War Department calling upon the colleges to increase the amount of military instruction in various ways. The order was issued to the officers detailed from the War Department, one purpose of the order evidently being to furnish a little more liberal training for the officers themselves. The detail which was raised by slow pressure from three years to four has now been reduced to two years, with the idea apparently (of course, I am not trying to interpret the motives of the Department) of giving as many officers as possible a chance at this detail, because the War Department distinctly recognizes that one of the most valuable branches of the training of the younger officers is the course of detail at these institutions. Now, while that may be just to the officers, it is extremely hard on the institutions. Some of the officers, especially the younger officers, come to the college with an impression that they have been sent to take command of the institution. It requires some little time and something approaching a court-martial to get their ideas properly adjusted to their environment, although in the case of a sensible man there is really no great difficulty in this respect. Then in a little while another detail is made, and the process of adjustment is repeated, sometimes successfully and sometimes otherwise.

The report I have to submit is briefly this: We all thought at Atlanta last year that it was necessary to get a good understanding with the War Department. The committee was asked to call upon the officers of that Department to ascertain whether some modification of its order might not be made. This was done and it was found that the administration of the order was in the hands of the War College; that the order had been drafted in consultation with the Secretary of War; that it had been given upon his personal authority, so that he would be unwilling to modify it so far as its general terms were concerned; but that the details had been arranged in consultation with the officers who had been detailed, as well as the institutions concerned, and with the War College. The officers temporarily in charge of the War College did not feel authorized to make any modification in the letter or the interpretation of the order. They were especially insistent upon the idea that the Secretary of War would not be willing to make any modification, because he had given so much attention to the matter.

I have often wished in the course of these years that I have been connected with this committee that the Secretary of War would consult us in advance, and I think we might well be consulted before orders are issued. This order was made without any previous consultation with the institutions concerned. It seems to me, as we come in contact with the War Department, we ought to impress upon it the idea that, while we are in thorough cooperation with the purposes of the Department in general, our interests are not respected as perfectly as they seem to suppose, and therefore a little previous consultation would save, if not friction, some hardship at certain points.

On the occasion to which I have referred we found the officers were insistent upon a literal interpretation of the order, but on the other hand they were very willing that the interpretation should be made as elastic as the circumstances of the different institutions required. It was difficult to get any concession further than that; but the substance of the suggestion wereceived was that, while they did not feel willing to yield anything in form, they were willing to yield all that was necessary in substance. We met, as a representative of the Department, an officer who has had active military service during the Spanish war, who is a thorough soldier in all his instincts and training, and at the same time a stickler for the literal interpretation and application of his orders. Yet, going over this whole field with him as we did, and with his purpose distinctly stated to carry out the orders of the War Department just as far as circumstances would allow, we had absolutely no difficulty in fulfilling the requirements of the War Department according to his understanding.

The order of the War Department is likely to stand; there is no likelihood of securing any important modification or relaxation of it, but with good sense and patience, with due consideration of the circumstances of each institution, and with a thoroughly loyal purpose to carry out the object of the law, so far as circumstances will allow, there is not likely to be any friction with the War Department, or, if there is, a personal visit to the Department, either by the committee or some of its members, or by a Senator or Representative in their behalf, will secure a fair and considerate statement of the situation in every case—certainly in ninety-nine out of a hundred—and relieve all possible cause of complaint on our side.

I do not think, Mr. Chairman, that the committee needs to be continued, and I should like to move that it be discharged.

The motion of Mr. Atherton was seconded.

E. A. Bryan, of Washington. Mr. Chairman, I am opposed to the discharge of the committee; I should be glad to see it continued, and I should be glad to see some improvement in the condition of military instruction in this country as a result of the action of this association and this committee.

The system of military education in the land-grant colleges has now been in operation for forty years; in all that length of time it has made no advancement. If this class of instruction is to be a part of the recognized military instruction of the United States, there should undoubtedly be a great deal of improvement in the conditions now prevailing. If it is not to be a part of the system of military instruction of the United States, then I think it would be well that some change should be made. I think that this committee ought to be continued and we should look forward to some change.

As a matter of fact, there has been less attention given on the part of Congress to the military instruction in the land-grant colleges than there has been to the instruction of the National Guard in the several States; yet the amount of instruction in any given year to any given set of men has been twenty times as great in the land-grant colleges as in the National Guard.

No provision is made for armories for the land-grant colleges, and no provision for uniforms for the cadets. Very inadequate provision is made for instruction, so far as my observation goes. This line of instruction may have had a good end in view at the beginning, and a good end might be subserved by it under proper conditions. But I think there should be a modification of the existing system, and I should be very glad to receive from this committee a review of the whole question of military instruction so far as the land-grant colleges are concerned. Such a review will not be given, of course, if the committee is discharged.

W. E. Stone, of Indiana. Mr. Chairman, I approve heartily the plans which seem to have been in the mind of the War Department. I am heartily in favor of military instruction in these colleges. But with this sympathy with the system of instruction, I find it impossible at our institution to conform to General Orders No. 94. I think that probably the same difficulty exists in most of the land-grant colleges.

I have sought instructions from the War Department and have received only orders of a kind which seem to disregard the conditions in the institution. I do not understand that the War Department is authorized legally to issue orders to the land-grant colleges.

It seems to me that the situation is one which is fraught with very great possibilities of friction and misunderstanding. I do not like to be placed in the position of disregarding the law, but I am in the position of not being able to carry out the provisions of General Orders No. 94. Under these circumstances it seems to me highly important—for I take it that the condition in our institution is not much different from that in most of the institutions—that this association should take steps to confer with the War Department, so as to secure a better understanding on both sides. I should like to see this accomplished either by the continuance of this committee or by the adoption of resolutions by this association, or in some way bringing to the attention of the War Department the fact that, no matter how much we strive to meet its wishes, we are unable at present to do so, because of its apparent disregard of the local conditions.

E. B. Andrews, of Nebraska. It seems to me it can hardly be the proper thing for this association to permit itself to drift in this important matter. There is evidently a feeling on the part of all the colleges here represented that the War Department orders No. 94 are severe and drastic. We have been making for the last year what I may call an heroic effort to live up to those orders. I think the Secretary of War himself will say that we have done fairly well in this respect. But there is a feeling throughout the faculties of our colleges that the time and strength given to this work are too great relatively for the best interests of their institutions. Such is emphatically my feeling, although perhaps I have as much sympathy with the purposes of the order referred to as has any man in this association. I feel that it is in the highest degree desirable that, if the order is thought to be too drastic, an effort should be made to secure a modification of the order. However much the present Secretary of War might dislike to modify it, he would perhaps, upon proper report, be willing to do so. I wish the order might be put in such a shape that we could all cordially cooperate in putting it into successful operation.

I therefore hope that some of these gentlemen who have spoken on the point will draft a resolution, to be brought before the association in the course of its sessions, to have the matter further attended to by the continuance, as I think would be proper, of the committee. This committee, which has already been in communication with the War Department, would probably do the work better than any new body of gentlemen that might be appointed. If no one else offers such a resolution to the association, I propose to do it myself.

C. W. Dabney, of Tennessee. I fully sympathize with all that has been said on this subject. The committee makes a very modest report. I think the members of it have done everything they possibly could under the circumstances. Yet their proposition, as some of us look at it, does not meet the requirements of the situation. It will not do, it seems to me, to allow this matter to rest at the present stage.

There must be some accommodation between the work of the colleges and the wishes of the War Department. We believe that such an accommodation can be reached by proper conference. These orders of the War Department have been drawn up without consultation with us, and I must say that they are impossible of execution by our institutions as at present organized. We can not carry out those orders as thoroughly as we would like to do, and the matter rests upon our consciences.

There is another matter I should like to refer to, that is the attitude of the War Department toward this whole matter in the colleges. They send an officer and order him to do certain things; then they drop the whole business and expect us to carry it out. Now, no military post could be carried on in that way. We need a great deal more than they give us. If the Department expects to train young officers in our colleges and to train the material for a citizen soldiery, it should supply us with a great many more things than we now receive from the Department. We want armories, we want furniture, we want equipment; we want to have another noncommissioned officer, at least; and the Department ought to supply uniforms for our young men. The young men in the land-grant colleges are ready to give up a considerable part of their time in order to take this instruction, and it is proper that the War Department should do something more for them than at present.

I concur mostly heartily in the motion that the committee be continued, and I would like to add the suggestion that the committee try to secure proper equipments and the appointment of some officer to help carry out this work.

E. A. Bryan. It seems to me apparent from the remarks which have been made here that General Orders No. 94 is impossible of execution, but beyond that, there is the fact that the Department has no right in any sense whatever to issue orders to the land-grant colleges. While in form it is not the issue of such an order, it in reality amounts to that. The Department has of course the right to issue an order to an officer of the Army. The Department details an officer for the carrying out of the order, and this amounts simply to the issue of an order direct to an institution over which the Department has no direct control and should assume no such control. We are expected to carry out a system of things which can not be carried out. This, I submit, ought to be made clear by the committee to the War Department—that, if this system is to be made a successful part of the military education of the country, much more should be done in order to make it successful. In all these forty years there has been only one year in which the true position of these institutions has been recognized; that was the year 1898, when President McKinley made it possible for some of the graduates of these institutions to pass an examination for the Regular Army. I feel confident that it will meet with the approval of gentlemen here when I say that something further should be done either to abolish this system or to make it worthy of the colleges and of the nation.

G. T. Winston, of North Carolina. I desire to express my accord with the sentiment which I know exists in this association in favor of carrying on the military instruction required by the Government in the order which has been referred to to as large an extent as it is possible to do so.

I think it clear that when the act under which these institutions were organized prescribed certain studies to be pursued and then specifically said "including military instruction," the act intended that, whatever else might be omitted, military instruction should not be. I will not take time in dwelling upon that point; I simply remark that the act singles out military instruction as especially to be included in the curriculum of these institutions. I think it will be conceded that the National Government in that act intended that an important part of the work of these colleges should be the training of a select body of young men along military lines, so that if circumstances should demand it they might serve their country as officers in time of war. For the carrying out of this purpose considerable machinery has been provided. Army officers are detailed for this instruction and, when they are lacking, naval officers are detailed. These officers are paid by the Government. Arms and equipments are furnished. There can be no doubt in my mind as to the intent.

Similarly, there is no doubt in my mind as to the advisability of this requirement. I think this is one of the best features of the act and that the wisdom and patriotism of this provision are as evident as in the provision for industrial instruction.

I desire to say also that where this military instruction is given by the officers and received by the students with pride and enthusiasm, there is afforded to the institution an element of great strength. Speaking from my own experience, I would not consent to part with any single portion of the military instruction that is given in the college over which I have the honor to preside. I am now seeking to obtain from the Government here in Washington equipments for more extended military instruction than we are now giving. I consider that this larger military instruction will be a benefit to the institution not merely along military lines, but along other lines. By means of this sort of education we have among the students a spirit of self-control, a buoyancy, an enthusiasm, a manliness of bearing, a spirit of decorum, an esprit du corps which it would be very difficult to secure in this institution by any other means than by the military system.

I do not believe there will be any great difficulty in dealing with this question if we recognize the intention of the framers of this act and the purpose of the establishment of these colleges to have been in no small degree the giving of military instruction in the same spirit that we give industrial instruction. I believe we should endeavor to carry out this as a clear purpose of these institutions. I know of institutions where it is not carried out at all, except formally. Of course it ought to be required to be carried out; it ought to be a part of the prescribed course of instruction. Who is competent to prescribe it? If we should undertake to set up ourselves as competent to help drill soldiers or to set forth the kind of military instruction which is to be given in our institutions, our position would not be tenable for a moment; the Government would not listen to our pretensions and ought not to do so.

The War Department represents the military authorities of the country, who have the skill and experience, who know what is needed for the military service, and we should endeavor to do what they want. If the military authorities should undertake to direct us along scientific lines, that would be an entirely different proposition, but the War Department does not undertake any such thing.

I hope the impression will not get abroad that anybody in this association is trying to minimize the military instruction as a part of our agricultural college course. I do not believe that sentiment prevails here by any means. I believe that an honest, efficient, and thorough carrying out of the military requirements of the law will be very beneficial to these institutions.

I know that it will be very difficult to do this in institutions where the agricultural college is but a small portion of a larger institution. It will be well-nigh impossible for some of such institutions to carry out these requirements. That is one of the difficulties that we have to contend with. But military requirements must not be thrust out of the way because of such difficulty. The difficulty should be met and met honestly. Where there is no such fusion of the agricultural college into a great university, then no such difficulties exist.

At our college we have a special department for preparing men for the cotton industry; we also have a special line of instruction in machinery, in which students spend their time largely in machine work. It will be seen at once that young men of that sort might not care to be troubled with military drill, for some of them take only a six months' course. Naturally they would not care to spend any part of their short term under military instruction or to bear the expense of uniforms. Recognizing that they can not be made officers or soldiers within such a short period, we excuse them from military instruction. But four-fifths even of those young men apply for and receive permission to enter the battalion; they do so voluntarily. I mention this as convincing evidence, in my mind, of the merits of the military system—that the young men coming to our institution for the purpose of taking only a six months' course, with a view to engaging in the cotton industry or entering the machine shops, are willing to go to the expense of providing their uniforms in order to take this military course, when they might be excused.

I hope that we shall carry out the order of the War Department—those of us who can carry it out—to the fullest extent, and that those who can not carry it out to the fullest extent will do the best they can in that direction. I hope that we shall ask the Government for additional facilities for military instruction instead of asking that some of the present requirements be withdrawn.

Let us ask the War Department to make a further supply of arms and equipments so as to carry out to the fullest extent this great purpose of the National Government to train young men all over the land to be ready in time of national danger to help defend their country as officers and as drillmasters. Such service is one of our greatest privileges and duties, and I hope we shall do what we can toward that end.

D. F. Houston, of Texas. Personally, on general principles, I am opposed to military government in college work. I do not believe, however, that this is a matter to be discussed on general principles. I believe that a moral duty rests upon every land-grant college to furnish instruction in military science. Personally I have felt opposed to doing or attempting to do anything in college work that we can not do efficiently. I do not see how it is possible to give efficient military instruction in our land-grant colleges, if we attempt to do substantially less than what the War Department requires. I believe, therefore, it is our duty to attempt to carry out this order of the Department and to give substantially as much instruction as that order requires.

There seem to be, Mr. President, two antagonistic suggestions here. One is that this committee should continue to endeavor to induce the War Department to change or modify the requirements; the other is that we should endeavor to get the War Department to give the colleges still further aid in carrying out a course of military instruction. Now, it certainly would be exceedingly unwise, in my judgment, to ask the Government to reduce its requirements and at the same time ask it to give more in the way of military supplies than it is now furnishing.

For a great many years many of the colleges have complied in only a very meager way with the requirement that they shall teach agriculture and the mechanic arts. They are now teaching agriculture and the mechanic arts more or less efficiently; but very few of them are giving efficient military instruction. It has been a wonder to me that a movement has not been made to withdraw support from some of these colleges on both these grounds. It seems to me to be the part of wisdom to comply as fully as possible with the military requirements, as the best colleges are now complying with the agricultural and mechanical requirements.

I hope, therefore, that this committee will not be requested to ask the War Department to modify materially the orders which have been referred to, but that the committee may request the War Department to give us help in carrying out those orders.

I fully recognize the difficulty experienced by institutions which have the agricultural and mechanical features in combination with the regular university features. I realize the great difficulty of carrying out these orders of the War Department in such institutions. I do not see just how they can meet the problem. But I do know that agricultural colleges which are isolated can carry out these orders efficiently; I know several that are now doing it.

G. W. Atherton. In regard to one suggestion which President Winston emphasized, I wish to say that neither the committee nor anyone connected with our institutions has presented to the War Department any thought of trying to belittle the work of the military department; the idea has simply been that the order of the Department as it stands is impossible of execution. It needs modification, and therefore it was suggested that modification should be made upon consultation with the officers of the Department.

The report was received and the committee continued. (For further discussion of this subject see p. 86).

Amendment of the Constitution.

The question of constitutional amendment being laid before the convention, C. E. Thorne, of Ohio, moved that the whole matter be laid on the table, because he considered the present constitution satisfactory and regretted to see so much invaluable time frittered away upon these matters of detail when it was needed for the purpose of discussing questions of greater importance to the work of the association.

G. W. Atherton, of Pennsylvania. It is true, as Professor Thorne has said, that a great deal of time has been spent on this subject. But there has been very strong dissatisfaction with some features of our organization as it stood, and last year at Atlanta, after a very full comparison of views, in a perfectly cordial and fraternal spirit, certain amendments were agreed upon in form. The amendments which now come up represented the best judgment of all parties concerned after a very careful review of the whole situation. I have no doubt that, if the question could have been put to a final vote of the convention last year, these amendments would have been unanimously adopted. I have had no other thought than that when presented at this convention they would be unanimously adopted as expressing the mature judgment of this body. I think there would be serious disappointment in many quarters if the understanding reached last year in absolute good faith should not now be carried out. The motion of Professor Thorne, as I understand, has not been seconded. In order to bring this whole matter up and expedite action upon it, I move that the proposed amendments of the constitution be adopted as a whole and referred to the executive committee to be incorporated into the present constitution.

The motion of Mr. Atherton was seconded and agreed to; yeas, 53; nays, 1.

The proposed amendments were as follows:

(1) The association shall be divided into two sections: (*a*) A section on college work and administration, (*b*) a section on experiment station work. The section on college work and administration shall be composed of the presidents or acting presidents of colleges and universities represented in the association, or other representatives of such institution duly and specifically accredited to this section, and no action on public and administrative questions shall be final without the assent of this section. The section on experiment station work shall be composed of the directors or acting directors of experiment stations represented in the association or of other representatives of such stations duly and specifically accredited to this section.

(2) Members of these two sections (and no others) shall be entitled to vote both in general sessions and in the section to which they respectively belong. The representative appointed by the U. S. Bureau of Education shall be assigned to the section on college work and administration; the representative of the Office of Experiment Stations to the section on experiment station work, and the representative of the U. S. Department of Agriculture to either section as he may elect and the section by vote authorize; but such election once made and authorized may not be changed during the sessions of a given convention. Each section may create such divisions as it may from time to time find desirable, and shall elect its own chairman and secretary for sectional meetings, whose names shall be reported to the association for record.

Change the number of paragraph (2) to (3).

At the end of the present paragraph (2) add, *and in the case provided for in the foregoing paragraph* (1) *shall also have been approved by the section of college work and administration.*

Under the subtitle "Officers," strike out all of paragraph (1), after the first sentence, and in lieu thereof insert the following:
And an executive committee of five members, three of whom shall be chosen by the section on college work and administration, and two by the section on experiment station work: *Provided, however,* That a member chosen by either section need not be a member of that section. The executive committee shall choose its own chairman.
Amend paragraph (3) under the same subtitle by striking out the words "All officers" and inserting in lieu thereof the words *The president, vice-presidents, secretary, and bibliographer.*
Under the subtitle "Membership," in paragraph (2), strike out all of the first sentence after the word "Association."
In the same paragraph, second sentence, after the word "shall," insert *vote in only one section and shall,* so that the sentence shall read:
The same delegate may represent both a college and a station, but shall vote in only one section and shall cast only one vote in general sessions.
Under the subsection entitled "Membership," in last sentence of paragraph (2), substitute the word *division* for the word "section."

H. P. Armsby. I move that the executive committee be also requested to take such steps as may be necessary for reorganization under this constitution.

The motion was agreed to.

Animal and Plant Breeding.

The report of the committee on animal and plant breeding was presented by W. M. Hays, of Minnesota, as follows:

Your committee begs leave to report most satisfactory progress. Upon the invitation of the American Association for the Advancement of Science a meeting has been called for December 29 and 30, 1903, at St. Louis. The above-named association has kindly provided a room for the meeting and arrangements for reduced rates on the railroads will no doubt cover our meeting. A programme is being rapidly perfected and your committee is much gratified with the general and almost unanimous approval of the plan of bringing into an association the breeders of animals, the breeders of plants, the teachers of animal breeding, the teachers of plant breeding, those who are experimenting in plant or animal breeding, and also biologists and others who are interested in the problems of heredity. A programme is assured in which discussions of practical problems of breeders and the results of scientific research are happily combined. All who are interested are earnestly requested to attend this meeting, or if that is not practicable, to become members of the proposed association.
Your committee respectfully recommends that it be continued for another year.
Respectfully submitted.

W. M. Hays,
T. F. Hunt,
H. J. Webber,
C. F. Curtiss,
L. H. Bailey,
Committee.

W. M. Hays, of Minnesota. I wish to say a few words in regard to the proposed association referred to in the report just read. The first great and general object, of course, is to study and investigate the philosophy of heredity, the facts and scientific theories relating to the improvement of plants and animals. The second object is to bring about cooperation and to stir up interest in the work of improving those plants and animals which we use in this country to produce annually something like four billions of dollars' worth of wealth.

It is believed, at least, by the most enthusiastic of us, that at least $1,000,000,000 worth of this wealth can be largely influenced by breeding—probably to the extent of 10 per cent average increase, equaling $100,000,000. This, however, can only be done by a great amount of work and thorough organization.

The practical breeders of both animals and plants in this country—the men who are doing advanced work in these lines—have been invited to attend the meeting referred to in the report. We are inviting them to meet scientific men, teachers, and experimenters, that these two classes may be brought into relations of mutual helpfulness.

The report was accepted.

Methods of Seed Testing.

The following report of the committee on revision of methods of seed testing was read by A. D. Shamel, of the Bureau of Plant Industry of the U. S. Department of Agriculture.

The standing committee on methods of seed testing respectfully reports:

In 1897 the committee unanimously agreed on a schedule of rules for seed testing, which was adopted by the association and published as Circular No. 34 of the Office of Experiment Stations.

In addition to rules for seed testing this schedule also included a description of a standard germinating chamber. Since this report was issued the form of the standard germinating chamber has been improved and a less expensive one, which is perfectly satisfactory for routine work of the stations, has been devised. Several other important pieces of apparatus have been designed by the seed laboratory of the U. S. Department of Agriculture.

It is desired that these improved pieces of apparatus should be brought to the attention of the agricultural colleges and experiment stations, and at the same time that certain minor changes should be recommended in methods of testing. The instructions for sampling, a matter of prime importance, should be made more specific. More definite information should be given for each of the common seeds as to the character of the seed bed, the temperature at which germination tests should be conducted, and the duration of the tests. A table giving this information and based on the work done in the seed laboratory is to be incorporated in the revised rules.

E. H. Jenkins,
W. R. Lazenby,
F. W. Card,
E. Brown,
A. D. Shamel,
Committee.

The report was accepted and placed on file.

Experiment Station Record.

C. E. Thorne, of Ohio, introduced a resolution referring to the extension of the Experiment Station Record, which, under the rules, was referred to the executive committee (see p. 85).

On motion, the convention adjourned until 8 o'clock p. m.

Evening Session, November 18, 1903.

The convention met at 8 o'clock p. m., but almost immediately adjourned until 9 a. m. the following morning, to allow the members of the convention to attend a reception tendered the association by the Secretary of Agriculture at his home.

Morning Session, Thursday, November 19, 1903.

The convention was called to order at 9 o'clock a. m. by the president, and the chairman of the executive committee announced a revised order of business.

History of Experiment Stations.

H. H. Goodell, of Massachusetts. We have had at various times papers on the origin of the movement for the establishment of agricultural and mechanical colleges. That subject has been well written up by men who are and have been from the very first actively engaged in that work. We have had no such paper with reference to the establishment of experiment stations. There is only one man connected with our association who really was in it from the very beginning and who knows its history thoroughly—that is President Atherton. It seems to me that we ought, if possible, to have such a paper as that on file. I therefore move that the secretary of the association be instructed to write to President Atherton asking him to contribute such a paper to be presented at our next annual convention.

The motion, being duly seconded, was agreed to.

Illness of ex-President B. F. Koons.

The chairman of the executive committee, H. C. White, read a letter from ex-President Koons, of Connecticut, stating his inability on account of illness to attend the sessions of the convention, and offered the following resolution, which was adopted:

Resolved, That this association extend to ex-President B. F. Koons, a former member of this association, and one who still retains our most cordial friendship, our sincere sympathy in his illness, and express the hope and prayer that he may have a speedy recovery.

Methods of Teaching Agriculture.

A. C. True, of the Office of Experiment Stations. Before reading the formal report of the committee, I desire on their behalf to call attention to one or two matters in the line of their work. During the past year, as the outcome of suggestions made by the committee, the Office of Experiment Stations has completed and published a bulletin (No. 127) entitled "Instruction in Agronomy at Some Agricultural Colleges." This document has been distributed, and some of you, at least, may have already seen it. That bulletin has met with a very favorable reception, which has encouraged the committee to request that a similar bulletin be prepared on Zootechny, and the Office of Experiment Stations hopes to undertake that work at an early day.

The committee has also observed with very great interest the development of a definite movement to establish courses in agriculture and mechanics in the agricultural colleges, and to provide adequate equipment in the way of buildings and apparatus for such courses. We hope soon to see this movement so far developed that our colleges will have systematic and thorough courses of instruction along different branches of rural engineering.

Coming now to the report proper, the committee decided this year to present to the association a brief discussion of the relation of what are commonly called the natural sciences to agriculture in a four years' college course.

The more definite formulation of courses of instruction in agriculture, the division of these courses according to the several branches of the science of agriculture, and the consequent specialization of the courses due to the employment of an increased force of experts in various agricultural subjects, have already led to a considerable reorganization of faculties and courses in our agricultural colleges. This movement is continuing and will further develop with the increase of the resources and equipment of the agricultural departments of these institutions. One effect of this movement has been to change the relation of the natural sciences to agriculture in the scheme of instruction in the agricultural colleges. As long as agriculture was taught almost wholly on a practical basis and without much regard to its pedagogical formulation the teachers of the natural sciences were called upon not only to develop the relations of these sciences to agriculture in their courses of instruction, but to give instruction in strictly agricultural subjects, and this was done to a considerable extent, especially in chemistry and botany. Out of this grew a series of text-books and manuals in which the general principles of these sciences were more or less extensively combined with statements of their relations to the theory and practice of agriculture. Thus we have books on agricultural chemistry, agricultural botany, agricultural physics, etc. The preparation of such books was a very useful work. They helped to turn the attention of scientists to the importance of the problems of agriculture and thus led to the further investigation of these problems; they brought together many facts and principles out of which in large measure the science of agriculture itself is now being constructed. But this method of procedure, as we can now see, had also some unfortunate results from which we are seeking to escape through the more thorough formulation of the science of agriculture and of courses based thereon, and the readjustment of the courses in the natural sciences to meet this new condition of agricultural pedagogy.

One result of the prolonged study of the relations of science to agriculture was to lead both teacher and student too far afield in the pursuit of problems which, though important scientifically and even economically, had too remote connection with agriculture itself to make it worth while for the student whose aim was to be a master of the theory and practice of agriculture to follow after them. Thus, for example, agricultural chemistry developed a system of analysis of fertilizers, feeding stuffs, and adulterated products which in the minds of many teachers came to be so prominent a part of this branch of chemistry that it often assumed an undue importance in the general agricultural courses in our colleges. Now, we shall always need expert analysts of fertilizers and feeding stuffs, and special courses for the training of those experts should be offered in our agricultural colleges. But these should be clearly differentiated from the courses intended to lay the foundations for the scientific study of agriculture. Under the old system the emphasis was often laid so much on analytical work that the colleges produced many analysts and but few agricultural experts. So in botany it is easily possible, for example, to lay so much stress on studies of fungi and bacteria, or grasses, that the students are led to strive to become experts in vegetable pathology or agrostology. It is true we need many more such experts, but, nevertheless, it should not be the object of botanical studies underlying the general course in agriculture to aim at the training of pathological experts, or agrostologists, or any other kind of botanical experts. While botanical experts and agricultural experts may for a time profitably study botany together, their paths should soon diverge, and this must be kept in mind by teachers of botany.

Another unfortunate result of the old arrangement of courses in our agricultural colleges was that the study of the general principles and outlines of the various natural sciences was often unwisely abridged in order to give more attention to their economic applications. This has, perhaps, not been so much the fault of the science teachers as of the managers of the agricultural colleges. The attempt to create a very practical atmosphere in these institutions has often led to great disregard of established pedagogical principles in the teaching of the complex subjects relating to agriculture and other arts. Nothing is more firmly established in pedagogical science than the principle that, before proceeding to the study of complex problems, the pupil should become acquainted with the elementary facts and principles involved in the solution of these problems. It is also very generally agreed that an outline study of a general subject which will enable the pupil to have some comprehension of the subject as a whole and the relations of its different parts should precede detailed study of special topics included in this general subject. Thus it is best both practically and pedagogically that the boy in the graded schools should be taught an outline of the history of the United States. He will thus acquire a certain amount of information which will be useful to him if he goes out into life from the graded school, and he will also have laid the best foundation for such special studies of United States history as he may have opportunity to pursue in higher courses of instruction. In like manner in the natural sciences there should be a sufficient period of general study before special topics are taken up, and the abridgment of this preliminary course throws the future course of the student out of pedagogical balance.

The general readjustments of science teaching which are demanded by the present development of our agricultural colleges are, therefore, first the more thorough teaching of the foundations of the natural sciences; secondly, the clearer differentiation of the courses in natural science associated with the courses in agriculture from those which are intended for the training of experts in various economic specialties related to agriculture; and, thirdly, the separation from the science courses of those subjects which may be more appropriately taught by the instructors in the various branches of agriculture itself. From the nature of the case it is obvious that the details of these readjustments can be worked out only as the result of many experimental efforts and long discussion of the practical and pedagogical points involved. The evolutionary forces which are to result in the elaboration of more perfect and satisfactory courses of instruction in agriculture are already at work in our agricultural institutions and they will continue to work for an indefinite period. It has seemed, however, to your committee that at this juncture it would be helpful to call attention to some of the general factors of this evolution and even to suggest a somewhat definite mode of procedure to secure the sought-for ends. In this, as in other lines of its work, the committee has assumed that it would be more useful to present a definite scheme rather than general suggestions. This is done with the understanding, as heretofore, that the committee is not seeking to establish dogmas or write prescriptions, but only to furnish a definite basis for discussion. It is the more encouraged to continue efforts in this line because it is convinced that, as the result of its previous efforts, the movement for the betterment of courses of instruction in our agricultural colleges has been materially aided, though no institution has adopted in detail the programme laid down in the reports of this committee.

As the basis of our presentation of a scheme of science teaching for a four-year college course in agriculture, we take (1) the standard entrance requirements laid down in the report of your committee on entrance requirements as published in Bulletin No. 41 of the Office of Experiment Stations; (2) the general outline of the college course as made by that committee and our committee and published in Circular No. 37 of the Office of Experiment Stations; and (3) the syllabi of courses in the different branches of agriculture as laid down in the reports of this committee published in Circulars Nos. 39, 41, and 45 of said Office.

The standard entrance requirement scheme has been taken rather than the abridged scheme presented by the entrance requirement committee, because in our judgment there can be no satisfactory arrangement of college courses in agriculture until the students admitted to the college courses have had suitable preparation in secondary schools. Within the past few years there has been a wonderful development of the high schools in all parts of our country and there has been set on foot a movement for the establishment of secondary schools and courses especially adapted to the requirements of our agricultural communities. The agricultural colleges should encourge this development of secondary education in many ways. But they should do so especially by differentiating their college courses more distinctly from secondary courses, and putting their college courses on a sufficiently high basis to make the bachelor's degree from an agricultural college represent an education of as high a grade as a bachelor's degree from any other college. For this purpose the standard entrance requirement scheme referred to above is none too high. This provides for at least a year's instruction in some natural science. It is believed by your committee that ordinarily an elementary course in physics or chemistry in the high school will best lay the foundation for further science study. In the scheme herewith presented we selected physics as the science to be taught in the high school as the preliminary to science study in the college course in agriculture.

In the general scheme of the four-year college course in agriculture presented herewith, we have first provided for courses in general physics and chemistry on the assumption that these would naturally precede the study of plants and animals, whether in a general way under the head of botany, physiology, or zoology, or in a special way under the different branches of agriculture. Some knowledge of physics and chemistry is also essential to a proper understanding of even the elements of meteorology and geology, as provided for in this course. Botany has been so placed as to run along with agronomy, and physiology and zoology with the more scientific presentation of zootechny.

While we believe it would be well for the agricultural student in his undergraduate work to take all of the subjects included in the scheme as here outlined, yet we have recognized the demand for an earlier specialization of agricultural work by so arranging the course that in senior year at least some studies may be substituted for those laid down in our scheme. For example, if the student is aiming to be a plant expert he may omit veterinary science and take more of applied botany or horticulture, or specialize in agronomy as far as additional courses in these subjects are offered in the institution he attends. In a similar way the student devoted to animal industry may substitute special studies along this line for the horticulture and forestry.

Agricultural experts can not, however, expect that any properly adjusted undergraduate course will fully meet their needs for training along their chosen lines. Persons who expect to enter positions in our Department of Agriculture, experiment stations, or agricultural colleges should attain at least the master's degree. And ere long the doctor's degree will be a prerequisite to entrance on the career of agricultural teacher or investigator in our colleges and universities and the National Department of Agriculture.

In outlining the courses in the various sciences the purpose has been to indicate in a general way the topics which may properly be included in such courses, taking into account the time limitations and what will be taught under the head of agriculture. The arrangement of these topics and the emphasis to be laid on each of them will of course vary with the teacher, as well as the equipment and other conditions existing in particular institutions. Our effort has been chiefly to so present this matter as to indicate how the science teaching may be differentiated from and at the same time related to the teaching of agriculture in a college course.

In arranging this scheme the committee has had the assistance of the expert officers of the Office of Experiment Stations and of Prof. G. P. Merrill, the geologist of the Smithsonian Institution. Text-books and specialists in a number of different lines have also been consulted. As the result of a conference with Mr. A. F. Woods, assistant chief of the Bureau of Plant Industry, who is chairman of a committee appointed by the section of botany and horticulture of this association to formulate a scheme for courses in botany, it was ascertained that, after an independent study of this matter, that committee had reached substantially the same conclusions as had our committee as far as the lines of our work coincided, and that both committees were in general accord with the scheme proposed by a committee of the Society for Plant Morphology and Physiology. Special attention is therefore invited to the report presented by Mr. Woods to the section on botany and horticulture.

The standard series of entrance requirements referred to above is as follows:

(1) Physical geography.
(2) United States history.
(3) Arithmetic, including the metric system.
(4) Algebra, to quadratics.
(5) English grammar and composition, together with the English requirements of the New England Association of Colleges and Preparatory Schools.
(6) Plane geometry.
(7) One foreign language.
(8) One of the natural sciences.
(9) Ancient, general, or English history.

The general relation of the natural-science courses to those in agriculture and other subjects may be seen in the following outline of the agricultural course in college as laid down in a previous report of this committee.

Agricultural course in college.[a]

Freshmen.		Sophomores.		Juniors.		Seniors.	
Subjects.	Hours.	Subjects.	Hours.	Subjects.	Hours.	Subjects.	Hours.
Physics	150	Agriculture:		Agriculture:		Agriculture:	
Chemistry	150	Zootech...60	150	Agron.....50	150	Dairying..70	190
Geometry and trigonometry	155	Agron.....90		Zootech..100		Farm mechanics .60	
English	120	Meteorology	60	Geology	120	Rural economics..60	
Modern language	180	Agricultural chemistry	180	Botany	60	Veterinary medicine	180
		Botany	120	Physiology	180	Horticulture and forestry	180
		English	80	Zoology	120	History and political economy	190
		Modern language	100	Psychology	60	Ethics	40
		Drawing	60	Modern language	60		
	755		750		750		780

[a] A general outline of this course, without reference to its division according to years, was given in the second report of this committee. (See U. S. Dept. Agr., Office of Experiment Stations Bul. 49 and Circ. 37.) The number of hours assigned to each subject includes the time given to laboratory exercises, each of which would occupy two hours. Thus, for example, 150 hours of physics may be divided into 60 lectures or recitations, and 45 (=90 hours) laboratory exercises. Our committee has not attempted to say how the time should be divided between lectures or recitations and laboratory exercises, but presupposes that a reasonable number of laboratory exercises or practicums will be given in all the science courses.

The arrangement of the college course here suggested proceeds on the assumption that it is best for the student to devote his time largely during the first two years to language, mathematics, and the fundamental sciences, physics, chemistry, and botany. He will thus be prepared for a better understanding of the more complex sciences of agriculture, zoology, animal physiology, and veterinary medicine in the second half of his course.

The course in agriculture has been arranged with reference to taking up first in sophomore year some of the simpler topics in zootechny, such as stock judging and types of breeds, which do not require scientific knowledge, but are well calculated to arouse the interest of the student in agricultural subjects. Agronomy may then be taken up systematically and run along with the study of meteorology, agricultural chemistry, and botany, and the more scientific study of zootechny may be parallel with the study of physiology and zoology. In senior year a considerable number of electives could be offered, one or more of which might be substituted for veterinary medicine, horticulture and forestry, or history and political economy, so as to enable the student to specialize in agronomy, horticulture, zootechny, dairying, farm mechanics, vegetable pathology, entomology, etc. In general, however, it is believed that the course as here outlined will be satisfactory as providing a liberal education, including systematic study of the theory and practice of agriculture, and as a good foundation for specialization in agriculture and the sciences related thereto in post-graduate courses.

COURSES IN THE NATURAL SCIENCES.

PHYSICS—PREPARATORY COURSE.

General laws and principles of—
- Dynamics of solids, liquids, and gases.
- Heat.
- Electricity and magnetism.
- Sound.
- Light.

PHYSICS—COLLEGE COURSE—150 HOURS.

GENERAL CONSTITUTION AND PROPERTIES OF MATTER.

DYNAMICS, OR THE GENERAL LAWS OF FORCE AND THE RELATIONS EXISTING BETWEEN FORCE, MASS, AND VELOCITY AS APPLIED TO	Solids (mechanics). Liquids (hydrostatics). Gases (pneumatics).
HEAT	Measurement of temperature (thermometry). Expansion (solids, liquids, gases). Measurement of quantity of heat (calorimetry, specific heat). Latent heat. Fusion and solidification. Evaporation and condensation. Conduction. Radiation. Thermodynamics. Relation of temperature to movements of the atmosphere.
ELECTRICITY AND MAGNETISM.	General theories and laws. Sources and production. Measurement. Atmospheric electricity. Applications.
SOUND AND LIGHT	Sound—production and propagation. Light: Propagation. Reflection. Refraction. Polarization. Applications—lenses and optical instruments. Color.

GENERAL CHEMISTRY—150 HOURS.

PROPERTIES OF ELEMENTS AND CHEMICAL REACTIONS.

INORGANIC PREPARATIONS.

INTRODUCTION TO QUALITATIVE ANALYSIS: Blowpipe analysis. Separation of groups.

INTRODUCTION TO ORGANIC CHEMISTRY.

AGRICULTURAL CHEMISTRY—180 HOURS.

- General introduction and review
  - Composition and properties of matter.
  - Properties and laws of combination of elements and simpler compounds.
  - Laboratory manipulations.
  - Classification of elements, equations, formulas, etc.
- Chemistry of
  - Air and water.
  - Soils and fertilizers.
  - Plant growth and products.
  - Animal life
    - Foods.
    - Nutrition.
    - Animal body and products.
  - Dairying.
- Introduction to analytical methods.

BOTANY—180 HOURS.[a]

The accompanying outline course for botany in the agricultural colleges is based very largely upon the standard elementary course recommended for adoption by the Society for Plant Morphology and Physiology, and embraces one year's work, the lectures and laboratory work required being about 180 hours. The various topics and sequence need not be strictly followed, and in many cases it will be found advisable to transfer subjects from one group to another in the sequence of teaching. Either group may be condensed, or each may be extended to cover a year's work. If 120 hours are given in the second year and 60 hours in the third year, the adjustment can be made to suit the convenience of the instructor and the facilities for instruction. Instruction in taxonomy is not provided, since the use of the manual, while desirable in itself, is not essential for an elementary course in botany. In Botany II it is recommended that the earlier groups of plants be passed over rapidly, particular attention being given to their economic features, and that progressively more time be given to the higher and more conspicuous forms. The course as a whole may be given in about 80 hours of lectures or recitations and 100 hours of practicums.

BOTANY I.—GENERAL PRINCIPLES.

- Anatomy and morphology.
  - The seed
    - Types.
    - Structures.
    - Homologous parts.
    - Food supply.
    - Germination.
  - The shoot
    - Gross anatomy.
    - Phyllotaxy.
    - Buds
      - Common forms.
      - Winter forms.
    - Tissues
      - Structure.
      - Distribution.
    - Specialized forms of stems, leaves, etc.
    - Growth, annual.
    - Shedding of bark, leaves, etc.
  - The root
    - Gross anatomy of typical root.
    - Secondary roots.
    - Specialized forms.
    - Tissues
      - Structure.
      - Distribution.

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[a] The time allowance for this course might with advantage be extended to 240 hours by taking 60 hours from physiology, which has been given a relatively liberal time allowance.

- ANATOMY AND MORPHOLOGY—continued.
  - The flower
    - Typical structure.
    - Function of parts.
    - Morphological study of several parts.
    - Construction of diagrams.
      - Transverse.
      - Longitudinal.
  - The fruit
    - Structure with especial reference to changes from flower to fruit.
    - Morphological study of types.
  - The cell
    - Contents.
    - Structure.
    - Modifications.
    - Formation of tissues.
- PHYSIOLOGY
  - Rôle of water
    - Absorption.
    - Transfer.
    - Transpiration.
    - Turgidity.
    - Plasmolysis.
  - Photosynthesis
    - Rôle of chlorophyll.
    - Rôle of light.
    - Rôle of carbon dioxid.
    - Evolution of oxygen.
    - Study of starch grains.
  - Respiration
    - Rôle of oxygen.
    - Evolution of carbon dioxid.
  - Digestion
    - Action of diastase.
    - Translocation of food.
  - Irritability
    - Nature of stimulus.
    - Nature of response.
    - Geotropism.
    - Heliotropism.
    - Hydrotropism, etc.
  - Growth
    - Localization.
    - Amount of growth in seeds, stems, etc.
    - Relation to temperature, moisture, etc.
  - Reproduction
    - Fertilization.
    - Sexual.
    - Asexual.
- ECOLOGY.—A STUDY OF PLANTS IN THEIR RECIPROCAL RELATIONS.
  - Modifications for special functions.
  - Dissemination.
  - Cross pollination.
  - Light relations.
  - Plant societies
    - Mesophytes.
    - Hydrophytes.
    - Halophytes.
    - Xerophytes.
    - Climbers.
    - Epiphytes.
    - Parasites.
    - Saprophytes.
    - Insectivorous plants.
    - Symbiosis.
    - Plant associations.
    - Zonal distribution.

BOTANY II.—NATURAL HISTORY AND CLASSIFICATION.

Classification.
Structure.
Reproduction.
Homologies.
Adaptations.

Types for study:
- Algæ
  - Pleurococcus.
  - Spirogyra
  - Vaucheria.
  - Fucus.
- Fungi
  - Bacteria.
  - Yeasts.
  - Rusts.
  - Smuts.
  - Mildews.
  - Toadstools.
  - Puffballs.
- Lichens — Parmelia.
- Bryophites
  - Hepatics (Marchantia or Porella).
  - Mosses.
- Pteridophytes
  - Ferns.
  - Horsetails.
  - Lycopodium.
- Gymnosperms — Pine.
- Angiosperms
  - Monocotyledon.
  - Dicotyledon.

METEOROLOGY—60 HOURS.

The course here outlined assumes some knowledge of general weather changes as illustrated on the daily weather map and as recommended by the conference on geography of the National Educational Association in 1893 for the lower schools, and that the student has taken an elementary course in physics in the high school or first year in college, and especially has precise knowledge of mass, volume, density; force, inertia, velocity, rotation, centrifugal force; gravitation, gravity, weight; atom, molecule; solid, liquid, gas; expansion, heat, temperature, specific heat, latent heat.

Definition and scope.

The atmosphere (in general):
- Origin.
- Composition.
- Extent and weight.
- Arrangement about the earth (relations to geosphere and hydrosphere).

Temperature:
- Sources, nature, transmission of heat.
- Variations.
- Measurement.
- Distribution over the earth.

Pressure:
- General principles.
- Measurement.
- Distribution.
- Relations to atmospheric circulation.

Circulation—general movements and local winds:
- Measurement.
- Distribution.
- Causes and modifying influence (convectional theory and effects of earth's rotation).
- Classification.

- **Atmospheric moisture.**
  - Origin.
  - Measurement.
  - Distribution.
  - Condensation in form of
    - Dew.
    - Frost.
    - Clouds.
- **Storms**
  - Cyclones
    - Tropical.
    - Extratropical.
    - Anticyclones.
  - Thunderstorms.
  - Tornadoes.
- **Precipitation**
  - Rainfall
    - Sources.
    - Measurement.
    - Distribution.
    - Relation to atmospheric circulation.
  - Snow, hail, etc.
- **Weather**
  - Of different zones and seasons.
  - Observation and prediction.
- **Climate**
  - Of different zones, elevations, and localities.
  - Variations.

GEOLOGY—120 HOURS.

THE EARTH IN ITS RELATION TO THE SOLAR SYSTEM.

- **Geognosy: the materials of the earth.**
  - The atmosphere—composition, volume, and weight.
  - The ocean—composition, volume, and weight.
  - The solid globe—dimensions, shape, and constitution.
    - Elements constituting rocks.
    - Minerals constituting rocks.
    - Rocks.
  - The weathering of rocks and formation of soil.
    - Principles involved.
      - Action of the atmosphere and of heat and cold.
      - Chemical action of water.
      - Mechanical action of water and ice.
      - Action of plants and animals.
    - Considerations of special cases.
      - Weathering of granite, gneiss, trappean rocks, sandstones, limestone, slate, etc.
      - Proportional amounts of various constituents removed or lost.
      - Physical manifestations of weathering—size and shape of resultant particles, and their chemical composition.
- **Dynamical geology**
  - Volcanoes, hot springs, and geysers.
  - Earthquakes.
  - Upheaval and depression.
  - Circulation of water in springs, rivers, and oceans.
  - Glaciers and glaciation.
  - Erosion and deposition.
  - Metamorphism.
- **Structural geology**
  - Architecture of the earth's crust, stratification and bedding, jointing, cleavage, mode of occurrence of rock masses.
- **Stratigraphic geology (historical geology).**
  - General principles.
  - Development of life.
  - Development of continents.

Man as a geological agent. — The earth as modified by human action; effects of deforestation, etc.

Economic geology ...
- Ore deposits—occurrence and mode of deposition.
- Ores of the metals.
- The nonmetallic minerals.
- Building and decorative material.
- Road metal.
- Mineral waters, artesian waters, etc. (hydrography).
- Soils—surveys and mapping.

Physiographic geology. — Physiography—its influence on distribution and development of the human race, etc.

PHYSIOLOGY—180 HOURS.

Physiology is the science of the functions of living tissue (here confined to animals). The main facts and theories of animal physiology apply to man and the various domesticated animals, and constitute the subject of general physiology. If preferred, a course in human physiology covering substantially the same topics may be substituted. In the agricultural college the hygiene of domesticated animals will ordinarily be taught under the separate subject of zootechny, and the same may be said for metabolism and digestion in different species of animals. Illustrative materials and simple demonstrations will be used in connection with the lectures or text-book.

Definitions, problems, methods of study.

Protoplasm .....
- Composition.
- Functions ......
  - Metabolism.
  - Change of form.
  - Movements.
  - Development of energy.
  - Irritability.
  - Reproduction.

Physical and chemical conditions of animal life.
Mechanics of animal life.

Digestion ......
- Saliva.
- Gastric juice.
- Bile.
- Pancreatic juice.
- Intestinal juices.
- Lacteals and lymphatics.
- Mechanism of digestion.
- Absorption.
- Assimilation.
- Distribution of the products of digestion.

Blood ....
- Composition and elements.
- Distribution in the body.

Respiration .....
- Respiratory changes in the blood and tissues.
- Oxygen, carbon dioxid, and nitrogen in the blood.
- Mechanics of respiratory movements.
- Nervous control of respiration.
- Relations of circulatory and respiratory systems.

Excretion ......
- Composition and excretion of urine.
- Excretion of sweat and nature and amount of perspiration.
- Feces.

Circulation ....
- Structure of heart, arteries, veins, and capillaries as related to their functions.
- Course of circulation.
- Mechanics of circulation.
- Nervous control.
- Blood pressure.
- Pulse.
- Fluctuations in quantity of blood.

Muscular action.
- Simple muscular contraction.
- Relation of nervous and muscular systems.
- Changes in muscles during contraction:
  - Chemical.
  - Thermal.
  - Electrical.
- Conditions which determine muscular irritability and action.

Nervous system.
- Brain:
  - Structure and anatomy of brain as related to nervous functions.
  - Localization of motor and sensory areas in the brain.
  - Conditions of cerebral action.
- Spinal cord:
  - Structure and functions.
  - Reflex actions.
- Special senses:
  - Sight:
    - Structure and optical principles of the eye.
    - Function of various parts of the eye.
  - Hearing.—Structure and functions of the ear.
  - Smelling.—Structure and functions of the nasal fossæ.
  - Taste.—Functions of various organs concerned in this sense.

Reproduction.
- Function of various organs.
- Nutrition of the fetus.

Comparative physiology.
- Comparative study of various functions in animals and man, e. g., digestion in man, horse, cow, sheep, hog, and chicken.

ZOOLOGY—120 HOURS.

Zoology is the science of animal life in its broadest sense. In agricultural colleges the subject-matter of zoological courses is perhaps best largely confined to a study of the anatomy, habits, distribution, and natural enemies of the important injurious and beneficial species. The special economic aspects of domesticated mammals and birds would naturally be taught under zootechny, while the general subject of the interrelations of animals to man comes under the subject of zoology. An outline course in economic entomology is provided in connection with the course in zoology. The course, as a whole, provides for forty to forty-five lectures and about eighty practicums (of two hours each).

Definition and general orientation.

Classification.
- Protozoa.
- Cœlenterata.
- Echinodermata
- Molusca.
- Vermes.
- Arthropoda.
- Bryozoa.
- Brachiopoda.
- Tunicata.
- Vertebrata:
  - Fishes.
  - Amphibians.
  - Reptiles.
  - Birds.
  - Mammals.

- GROSS ANATOMY
  - Discussion and study of types of various groups.
  - Comparative morphology of organs in various groups.
  - Anatomical evidences of relationship and evolution.
- MICROSCOPICAL ANATOMY
  - Simple cell.
  - Muscle cell.
  - Gland cell.
  - Bone cell.
  - Nerve cell.
  - Various forms of tissue.
- DEVELOPMENT, EMBRYOLOGY
  - Fertilization.
  - Segmentation of egg.
  - Germinal layers.
  - Origin of organs.
  - Study of types.
  - Embryological evidences of relationship.
- DISTRIBUTION
  - Means of distribution.
  - Laws of distribution.
  - Natural barriers and life zones.
- ECONOMIC ASPECTS OF ANIMAL LIFE.
  - Feeding habits of various groups.
  - Interrelation of various groups.
  - Usefulness of animals and economic animal products.
  - Direct relationship of animals to agriculture.
    - Birds.
    - Mammals.
    - Insects (entomology).
      - Classification.
      - Habits.
      - Life history.
      - Useful species.
      - Injurious species.
      - Means of repression.
        - Parasitic insects.
        - Predaceous insects.
        - Fungus diseases.
        - Cultural methods.
        - Mechanical methods.
          - Barriers.
          - Tar bands.
          - Traps.
          - Ditches, etc.
          - Heat.
          - Cold.
        - Chemical methods.
          - Dry insecticides.
          - Spraying.
            - Contact insecticides.
            - Poisons.
            - Spraying calendar.

A. C. TRUE,
H. H. WING,
T. F. HUNT,
H. T. FRENCH,
J. F. DUGGAR,
Committee.

A. C. TRUE. I fear the presentation of this matter has been somewhat wearisome; but it seemed to us desirable to put the matter before the association so that you might get at least some general notions regarding the scheme as proposed by the committee. We shall ask your further patience hereafter in reading the published report, and shall invite criticisms and suggestions on this part of our work, as we have always done on work in general in which we have been engaged.

H. C. WHITE, of Georgia. I am sure that we are all very much indebted to the committee for this report. I have several times taken occasion to state on the floor of the convention that I regard the work of this committee as one of the most important species of work that is being done by the association—an attempt to reduce to pedagogical form sciences and the application of sciences to agriculture. I think we owe the committee a debt of gratitude for the painstaking way in which they have worked out this matter.

When in Europe last summer I heard it said that this kind of work in particular is being better done in America than elsewhere in the world, and I believe it is true. I believe that this attempt to reduce to systematic form a kind of teaching which is new in the world is being pursued by this committee in a way that is not pursued elsewhere. I hope the section on college work, to which these matters particularly appertain, will take up this subject next year and consider it.

There are a great many questions which arise in connection with this subject. One particularly, which occurs to me now, I judge the committee has considered very carefully. One of the greatest difficulties, I presume, that all of us have—certainly that we have in our community—is the preparation in the secondary schools for entrance into the college. Literary institutions, of course, have their forms and requirements for such preparation, not only in attainments in particular studies, but the intellectual training for admission into their regular, well-settled college courses. There ought to be, it seems to me, some sort of training in the secondary schools which one might call scientific—pertaining to the natural sciences, yet not simply a mass of undigested and erratic information—knowledge that would have some sort of value as an intellectual implement, training the minds of the students in the same way somewhat that the old courses in Latin and Greek were supposed to train them for a literary education.

I observe that the committee has selected physics as one topic of study. On the spur of the moment it seems to me I should not approve that. I do not think the schools ought to be encouraged to teach chemistry, physics, botany, and all the differentiated departments of science. They can not do it well, and they had better not undertake to do it than do it badly.

For several years past I have often thought it might be possible for some one who can give this matter consideration, and who is qualified to do it, to construct a course in what might be called general science—something that would introduce the student to the methods of scientific thought, by which he might be prepared to take up the differentiated sciences of the college course. I do not believe you can teach chemistry or physics or any of our differentiated sciences in the schools. But there ought to be some sort of training in the schools which will bring pupils up to a point where they can appreciate differentiated sciences. I hope the committee will, and no doubt they will, take this matter into consideration.

E. A. BRYAN, of Washington. I wish to express my concurrence in the remark of President White that the work of this committee has been most useful, that it is one of the most important parts of the great movement in which we are engaged. But so far as concerns the general scheme proposed in this report, I should like to make one or two suggestions of minor importance.

Horticulture and forestry are proposed to be introduced in the senior year to the extent of 180 hours. Now, there has been in practical work a great differentiation between the work of the horticulturist and the agriculturist—I mean the fruit grower and the farmer. There should be a differentiation in the curriculum leading to those subjects of study. It seems to me unadvisable that there should be introduced into the course in agriculture, at least in the senior year, this amount of horticulture and forestry. I should say that a corresponding curriculum leading in the direction of horticulture would be much preferable.

There is another point to which I should like to call attention. A remark was made by Director True that it was the general view of the committee that the primary sciences should be studied in the earlier part of the curriculum because they formed in a certain sense the foundation for the work in agriculture further along. This seems to be true. There is, however, this very practical difficulty—that the teachers in agriculture are not brought into contact with the students who wish to do that work. The students are brought into contact with the teachers of these primary sciences, who are not particularly interested in the application of these sciences. That gives rise to very great practical difficulty. If a young man is allowed to go on to the sophomore or junior portion of the course before he comes in contact with the teacher of agriculture or horticulture, as the case may be, the result must be undesirable. I believe that the practical gain would be greater by bringing him into contact as early in his career as possible with the men who are interested in the practical applications of these subjects.

I know that the theory is that primary scientific methods should be somewhat understood before undertaking these matters of detail; but I doubt whether, as a practical proposition, that object is so highly important as some suppose.

I notice that physical geography is suggested as one of the subjects. Now, as physical geography has been taught in the academies and high schools of the country, it seems to me ill adapted to the purposes in view here. It is not a science, nor does it give training in scientific methods as ordinarily understood. Physical geography may be a very useful study in an ordinary college or university; but it is pursued by purely informational processes and the student gets no training in scientific methods. We regard this and similar subjects as ill adapted to the purposes in view. A beginning in the study of scientific methods through an attack on one of the biological sciences would seem to be of very great importance in the secondary schools and would be far better than such a collection of things as is usually embodied under the name of physical geography.

In the main, however, I believe the work of this committee has been very useful, and I think that there is no one thing in which our colleges might make greater advancement than in the pedagogy of agriculture.

E. B. Andrews. As is well known to gentlemen here, there is in some of the States a movement on foot to develop the teaching of the elements of agriculture in the public schools, not with any particular view to prepare the pupils to enter the agricultural colleges, but as an important matter in connection with the general instruction of young people in the agricultural States. It seems to me that this is a movement which, from every point of view, ought to be fostered and furthered so far as possible by this association and the institutions represented here. It may be that the committee to whose admirable report we have just listened with delight have in mind some plan looking in that direction. If not, I should be glad to make a motion at the proper time that this committee be requested in its discretion, next year or as soon as it can conveniently do so, to include in its report as fully as possible suggestions and directions to public school superintendents, principals, and teachers, as well as the representatives of this association who are interested in public school work, toward the formulation of suitable courses, text-books, etc., calculated to be helpful to the efforts now making to give the instruction in the elements of agriculture in the public schools.

This is a very rough presentation of the thought I have in mind, but I should be glad to ascertain from Doctor True whether the mind of the committee has been turned in that direction.

A. C. True. This matter was taken up in a way last year. As regards secondary instruction, that might be given in the public schools. A report made on that subject last year has been published by the Office of Experiment Stations as Circular 49. But with regard to the lower grades of our schools, we have not yet as a committee done any definite work.

I might say, however, that the Office of Experiment Stations has on its own account been giving in recent years considerable attention to that matter, and we have recently issued a circular containing a list of books relating to this subject. I simply speak of this as one indication that we are thinking about the subject. We have also taken special pains, so far as we could, to come in contact with the State superintendents and the teachers to discuss this matter.

We have one man in the Office of Experiment Stations who is giving a large share of his time to the study of that problem. He has recently been in the State of Missouri at the invitation of the State superintendent and has given lectures on topics connected with the subject. During the time he was there he talked with a large number of teachers, and he has done the same in some other States so far as his time would permit. I simply say this to indicate that we are taking up this question. I am sure that, if it be the desire of the association, the committee will be glad to consider definitely this subject.

With regard to what President Bryan has said, I would state that while I do not desire to go into a discussion of details at this time, the committee from the outset has gone on the presumption that courses in horticulture, or in which horticulture would be a chief subject, would generally be provided by the colleges as interest in the subject develops. This has already been done in a considerable number of our larger colleges. In the course outlined by the committee, only enough horticulture has been introduced to give an outline of the subject to the general student of agriculture.

As regards physical geography, I presume in that respect the entrance requirement of the committee simply follows what is taught in the schools generally. Whether that is best or not is another question.

The importance of reducing agricultural science to pedagogical form, and the progress which is being made in the preparation of elementary agricultural text-books and in the introduction of agricultural instruction in the lower schools were discussed by W. O. Thompson, of Ohio; E. B. Andrews, of Nebraska; T. E. Miller, of South Carolina, and others.

C. Northrop, of Minnesota, suggested that the subject of agricultural instruction in secondary or primary schools be one of the topics for discussion at the meeting of the section on college work next year, and that those who are interested should bring to the convention the laws, the text-books, and other printed matter relating to the subject from their various States.

The report was received and placed on file.

Graduate Work in Agriculture.

H. C. White (reporting from the executive committee) said: "This committee has suggested and the convention has ordered that a standing committee on graduate study in agriculture be organized. I therefore move that the convention express to this standing committee on graduate study their desire and hope that they may be able to arrange for a graduate school in agriculture for the summer of 1904."

The motion was agreed to.

Cooperation Between Experiment Stations and the Department of Agriculture.

E. A. Bryan, of Washington, read the following report:

Your committee on cooperative work between the experiment stations and the Department of Agriculture would respectfully report:

First. That in the opinion of your committee nothing need be added to the statement of fundamental principles embodied in the two previous reports of your committee.

Second. That satisfactory progress has been made in most instances in the adjustment of the details of such work.

Third. That the views heretofore expressed by your committee of the importance of a full and free consultation between the stations and the members of the Department in regard to the work undertaken in the several States is to be further emphasized, and that attention to this matter would do much to remove possible sources of irritation.

Fourth. That it is with great gratification that your committee learns that the Secretary of Agriculture has recently issued an order appointing a committee from members of the Department charged with the duty of perfecting the details of a system of cooperation.

Fifth. That in the opinion of your committee a standing committee on cooperation should be maintained by the association.

Respectfully submitted.

E. A. Bryan,
H. H. Goodell,
W. A. Henry,
L. G. Carpenter,
B. T. Galloway,
Committee.

The report was received and the committee continued.

Rural Engineering.

W. E. Stone, of Indiana, read the following report from the standing committee on agricultural engineering:

At the last meeting of the Association of Agricultural Colleges and Experiment Stations the following resolution was adopted:

"Whereas the agricultural colleges and experiment stations, as well as the United States Department of Agriculture, are broadening their work relating to irrigation and farm machinery and other lines of agricultural engineering, and there is pressing need of the more definite formation of plans for this work; Therefore, be it

"*Resolved*, That this association make provision for the appointment of a standing committee on agricultural engineering, to consist of five members, and that it be made the duty of this committee to cooperate with the Department of Agriculture in promoting education and research along the different lines of agricultural engineering."

Your committee appointed in pursuance of this resolution begs leave to submit the following progress report:

Rural engineering, as defined in Circular 45 of the Office of Experiment Stations, is "the science and art of laying out farms, designing and constructing farm buildings and works, and making and using farm implements and machinery."

A careful examination of existing conditions in the United States leads to a belief that there should be a strengthening of the courses of instruction in these subjects in our colleges, and the inauguration of comprehensive investigations and research work to ascertain the best practice in this and other lands and provide up-to-date information for instruction in our institutions of learning. This is equally true whether the opportunities for students or the needs of the American farmers are considered. The field of practical usefulness for the one and the need of the other are alike extensive. In support of these conclusions we submit the following facts:

The comparatively large areas of American farms makes the laying out and arrangement of the different fields a matter of special importance to our farmers. In order to maintain the fertility of the soil, rotation of crops must be practiced. To do this fields should have such areas and such number as will make a regular system of rotation feasible. This gives an opportunity for the exercise of skill and intelligence, and, in connection with the building of roads leading from farm buildings to different parts of the farm, may involve marked economy or serious waste in the expenses of construction and in the distances traveled in going to and from the fields. It is, therefore, one of the things to which attention should be directed in our institutions of learning.

Closely related to the arrangement of fields is the construction and grouping of farm houses and farm buildings, not only to secure efficiency and economy, but to contribute to the healthfulness and attractiveness of farm life. There is no doubt that present conditions in these particulars in the United States are inferior to those in most European countries, and it is equally certain that improving the conditions of farm life will have much to do with determining whether the exodus of people from the country to the cities will be checked or become greater in the future than in the past.

In the construction of farm buildings, both barns and houses, the farmer is almost entirely dependent on his own knowledge and ingenuity in preparing plans and often in their execution. The designing of city buildings is largely in the hands of architects and engineers, and they are constructed by expert mechanics. They have, therefore, a finish and convenience which add largely to the attractiveness of city life. In the country, however, exactly the reverse is true. The great majority of farm buildings are unsatisfactory, whether considered from the standpoint of appearance, durability, adaptability to the work to be done, healthfulness, or pleasantness for the occupants. Some problems in connection with farm buildings need careful study. Among these is ventilation. The fact is we do not know either the effect of poor ventilation or the most efficient means of securing good ventilation. But the majority of the improvements to be wrought do not require research so much as the application of skill and ingenuity in design. One illustration of this is the fact that nothing is of more service in a home than a convenient water system. Much of the dislike which many women have to farm life comes, consciously or unconsciously, from the heavy work of handling water in cooking and washing, all of which could be easily saved by the adoption of readily available means. There is no reason why a farm house should not be as attractive as a city house, and there is no reason why the grounds surrounding farm houses should not be made as attractive as city parks. It is largely because farm life and the farm home are not attractive that many of the enterprising, aggressive youth of the country flock to the cities.

Heretofore nearly all farm buildings have been built of wood. A change in this direction is inevitable in the near future. Timber is becoming scarce and costly and must be supplemented by brick, stone, or concrete. We ought to begin in the near future to determine the relative value and cost of these different materials, and this is particularly a work for the colleges and stations. The character of farm buildings has also changed greatly in the past quarter of a century. Formerly they were simply storage places for grain or shelters for live stock. With the introduction of feed cutters, silos, power churns, centrifugal cream separators, and scores of other machines formerly unknown, these buildings are becoming as complex in their designs and uses as factories, and there is need of scientific study to determine the most economical designs to fulfill these different requirements.

Another reason for strengthening these courses of study is the fact that all of the public lands susceptible of cultivation in their natural condition have been taken up, so that this outlet for our growing population is closed. We have, however, large areas of land which, when drained or irrigated, can be settled upon and cultivated. The importance of irrigation is manifest from the statement that in two-fifths of the United States it is an absolute necessity to the existence of civilized life, and there is every reason to believe that it is destined to be an important means of increasing production throughout the whole country. But in order that fields may be irrigated they must be smoothed so that water will flow over them; and in order that the best results may be obtained, the methods of applying water to crops to secure the greatest economy in use and the largest yields must be studied, and the mutual relation of peoples who depend on the same water supply must be ascertained in order that we may have institutions which will secure harmony and justice.

An excellent beginning in the study of these questions has been made in a few institutions and by the Office of Experiment Stations, but there is a great field for the extension of both instruction and research and for a broader cooperation between the Department and the State institutions in both the cultural and engineering sides of this branch of agriculture.

Of wider application and scarcely less importance is the subject of drainage. The marsh and overflowed lands along our seacoast and the bottom lands bordering many of our rivers are at present unsightly, unproductive, and in some instances a menace to the health of surrounding districts. They need only to be diked and drained to be the most valuable lands in the country. The carrying out of these improvements will add immensely to the agricultural values of the country, and the work is certain to be undertaken in the near future. It involves, however, a larger knowledge of agricultural engineering than can now be obtained in our land-grant colleges. In fact, the profession of agricultural engineer, so prominent in Europe, is almost unknown in this country. Very little has been done in this country to develop a satisfactory drainage practice. The principles of drainage are understood by but few, and instruction in our colleges is meager and far from being up to date. Drainage laws are far from satisfactory and need to be modified, because this work is beyond the means of individuals and must be carried out by organizations of large numbers of landowners associated under some definite legal plan. Careful work must be done in the study of the practical side of this subject, in determining the most effective methods of constructing ditches, in determining the kind of underdrains to be used, the depth at which they should be laid, the distance apart, etc.

We believe that in irrigation and drainage there is a field for cooperation between the Department of Agriculture and the experiment stations and colleges which ought to be more fully utilized, the Department of Agriculture coordinating the work of the stations and aiding them in carrying out original researches.

Associated with drainage and irrigation is another branch of hydraulic agriculture whose importance has not been properly realized. This is the terracing and draining of hillside farms in order to protect them from the destructive effects of erosion. It is an unfortunate fact that much of the activity of the last century in subduing and settling this country has been of a destructive character. Forests have been cut from the headwaters of streams; the hillsides which they protect have been exposed to the erosion of storms, and the evils of the work done by rainfall have been aggravated by the planting of these lands to crops which require clean culture, such as corn, tobacco, and cotton, which provide no binding material for the soil. As a result, much of the accumulated fertility has been carried down into the channels of streams, thus leaving thousands of acres of what was fertile land not many years ago scarred with gullies and practically abandoned to weeds and brush. We must stop this destructive style of farming, if we are to maintain the prosperity and provide an adequate food supply for many sections in the eastern half of the United States. To find out how best to do this and to encourage farmers to begin action is a work which both the Department of Agriculture and the different State experiment stations should take up at once. The hill lands of France, Germany, and England are as fertile as they were a century ago, although many of them are devoted to cultivated crops. The credit for these results is due to the existence of a body of trained agricultural engineers, a class of professional men not now existing in the United States. The time has come when our colleges should lend themselves actively to this sort of training. The opportunities for employment in irrigation, drainage, and hillside protection are sufficiently great to make it an attractive course to young men having aptitude for such work, and it is the field to which we must look for the largest results in the extension of our productive area and in the conservation of the fertility of much of the land now being farmed.

Another branch of rural engineering is the construction of country roads. Increase in population in our cities has resulted in larger areas being devoted to the production of perishable products—such as milk, garden truck, and fruit. The marketing of these has greatly increased the travel on country roads. The character of these products is such as to demand quick transportation, thus rendering it necessary that the roads should be hard and smooth, and this is being emphasized by the fact that the automobile and traction engine require a better roadway than the horse and cart. To build roads suited to the conditions of modern life, especially in the vicinity of cities, requires a knowledge of engineering wholly different from that of a quarter of a century ago, and demands not only that the courses of instruction be strengthened, but that facilities be provided for experimentation regarding the best materials to use.

It is believed, however, that the greatest opportunities for students and for the improvement of the general agricultural practice of this country will be found in the systematic study of the manufacture and use of agricultural machinery. This country is the greatest maker and user of farm machinery in the world, and it is due largely to this fact that we have become the most prosperous agricultural country in the world. It has enabled the farmer to pay the high prices for labor created by the competition of our manufactories and has taken away from farm life much of the drudgery of manual toil and made it in the best sense an intellectual pursuit. Improvements in machinery have brought about a steady reduction in the cost of production, notwithstanding the steady rise in wages. The self-binder enables one man to accomplish the work done by four men with the best machinery in use at the close of the civil war. The check-row corn planter and the two-horse cultivator have, according to a recent writer, lessened by more than half the labor cost of producing a bushel of Indian corn. Machinery has enabled the eastern farmer to adopt intensive farming. The windmill pumps the water used in the dairy, the centrifugal separator skims the milk, and water or wind power runs the churn. The gasoline or steam motor is beginning to haul the product of the truck farm to the city market, rendering the farmer equally independent of horses and railways.

In the same way it has enabled the western farmer to plant and harvest large areas, notwithstanding the scanty labor supply to be found there. Last year a traction engine in California cut and thrashed over a hundred acres of wheat in a single day, doing the work of nearly one hundred horses with modern mowing and reaping machinery, and equaling the result accomplished by that many men and horses fifty years ago. Less than a century separates the operation of machines like this and the cutting of grain with the scythe and thrashing it with the flail, and the improvements which have been made in harvesting machinery have been duplicated in many other lines of farm work. There are now traction engines which plow 30 acres of ground in a day. Recently a gasoline motor has been invented which promises to be as successful in displacing the horse in certain lines of work on the farm as the automobile is on the country roads.

The demands which these changes are making on the farmer for a knowledge of the principles of mechanics and for a certain amount of skill in their application is so much greater than it was a century ago that it can not be stated as a percentage. The question we have to consider is whether we have recognized this change in the courses of instruction in our agricultural colleges. Your committee is unanimously of the opinion that we have not, and that the facilities for instruction are not in keeping with the importance of this branch of agriculture. In the majority of institutions the same kind of mechanical training is given agricultural students as to students who expect to work in factories, while the work to be done by the farmer in the use of machines and tools is of a radically different character. On the farm one man must do many kinds of work and hence must use many different kinds of tools; in shops and factories one man does one thing or a few things only. This highly developed specialization produces efficient labor. A man uses a tool until he understands it thoroughly, recognizes immediately any defect, acquires a feeling of ownership in it, gives it constant care, and is often able to make improvements in its construction. All this is very different in the experience of the farmer. He uses one machine only a short time and then must take up another. What is learned about the construction and use of a machine at one time is largely lost before it is again called into use. The result of all this is that the farmer fails to develop that interest and mechanical sense which are necessary to the highest efficiency in the operation of the complex machinery which now forms a part of the equipment of every modern farm.

The records of the last census show that over one hundred million dollars worth of farm machinery is made and sold each year. The saving which would come to the people of this country by extending the life of each machine one year would be an immense addition to the annual profits of our farmers. This saving can be more than realized and it can be augmented by the greater efficiency which would come from expert care and management. At present it is notorious that the American farmer, with all his mechanical aptitude and inventive skill, is behind the other leading agricultural countries in his management and care of agricultural machinery. It is believed that this is largely due to the neglect of this subject in our schools. In Germany, France, and more recently in England, a well-equipped laboratory for testing agricultural machines and a museum filled with samples of machines of different patterns for examination by students is held to be as essential to proper instruction as a chemical laboratory. The first floor of the agricultural high school at Berlin contains a museum in which are found the best types of agricultural implements of the United States, England, and Germany. The student who makes proper use of that museum has a better understanding of the principles which govern the construction of the tools he is to use and the modifications to conform to different uses than it would be possible for him to acquire in any other way, and it is a kind of training especially demanded by the conditions of American farm life.

This training in the agricultural institutions of Germany is regarded there as of the highest value not only by farmers but by manufacturers. It gives them trained workmen in their shops; it gives them trained agents to extend their export trade in different countries. The union of agricultural and mechanical knowledge in their employees and agents has enabled German implement makers to greatly increase their export trade, and it is believed that the same result would follow similar training here. If we are to maintain our standing as a producing and manufacturing nation we must maintain our superiority as designers and users of farm machinery, and this can be best promoted by bringing the trained intelligence of the experts of the Department of Agriculture and of the students and professors of our agricultural colleges to bear on this problem. A few colleges have created departments for instruction in certain branches of rural engineering, the departments of irrigation engineering in Colorado and California being illustrations of this, and a number of colleges are now considering the establishment of courses in rural engineering with farm mechanics as the leading feature, and there is much interest in the development of these courses as independent lines of work. Among these are the colleges of agriculture in Illinois, Wisconsin, Minnesota, Iowa, and North Dakota. In each case this work has been inaugurated as a branch of instruction in agronomy. While this may answer as a beginning, the importance of the allied branches of rural engineering taken together entitles it to be made an independent department of instruction, having equal rank with agronomy or animal industry as they have been established in a number of institutions. The scheme outlined in the fifth report of the committee on methods of teaching agriculture, and published in Circular 45 of the Office of Experiment Stations, brings together in a logical way the scattered instruction which bears on this branch of agriculture and furnishes a systematic and well-rounded course. Such departments are needed to furnish opportunities for specialization by students who wish to prepare themselves for leadership along these lines of work, and would furnish a field for experimentation and systematic training for farmers in the subjects which to-day constitute the most important factors in the expenses and profits of American agriculture.

The same policy should be followed in the organization of the work of the Department of Agriculture. This Department is now doing important and useful work in a number of branches of rural engineering, but its influence on the development of the country and the effectiveness of the investigators would be greatly promoted if all of these related lines of work were gathered together in one division, instead of being made simply incidents of the work of several bureaus organized to do other things, as is now the case. It is believed that the importance of these subjects warrants the adoption of this plan at an early date. One of the reasons for believing this is the consideration given to these subjects in other countries where their importance is far less than with us. The bureau of hydraulic agriculture is one of the leading bureaus of the agricultural department of France. It includes only drainage and irrigation. The relative importance of these subjects in France and this country is shown by the fact that France has only 400,000 acres of irrigated land, while we have nearly 8,000,000 acres irrigated, and the work is still in its infancy. In France irrigation is not a necessity—only an aid to agriculture. In two-fifths of the United States it is a necessity for civilized life. Furthermore, the conditions which have been created in this country by the character of our irrigation development give to the irrigation investigations of the Department of Agriculture a significance and importance not possessed by similar work in any other country in the world.

Over 8,000,000 acres of sagebrush desert land has been reclaimed by the unaided efforts of farmers, without any assistance from either the Federal Government or the States, in such a manner as to produce good crops. This task is one of the greatest achievements of the agricultural classes of this or any other continent. It has involved an amount of experimenting and a waste of money in failures and partial failures which is inconceivable to those not practically familiar with western conditions. This task, however, has not been completed. Some of the most difficult problems yet remain to be solved. Some of the things which remain to be done are to determine the amount of water which each farmer should receive, and to provide for an equitable distribution of the waters of streams. The uncertainty regarding rights to water is one of the grievous evils which confront western farmers. It is believed that if these rights were so well established and protected that each farmer could know certainly that in times of scarcity he would receive his proper share the value of each one of these 8,000,000 acres would be increased on an average at least $5, or an aggregate of $40,000,000 in all. But this is only one feature of the gain. Such a change will put an end to litigation and to the enormous expenditure of time and money which it involves.

The watering of 8,000,000 acres of land involves the handling of an enormous quantity of water each year. If this water could be transferred from the streams to the field with the same system and skill that is exercised in the operation of some of our railroads, or that is shown in the distribution of water in some of the best districts of Italy and France, the gain in the saving of water and in the increased production of crops would be something enormous. At present in many parts of the West there is either a very defective system or no system at all, and a competent investigator has estimated that we are losing each year at least $10,000,000 on account of the faulty distribution of appropriated waters. These figures are sufficient to show the necessity for a systematic study of these questions by the Department of Agriculture and to show also why, with the increase in the cultivated area which is each year going on, the necessity for these investigations and their importance to the whole country is destined to increase.

There is no country where drainage problems are as important as in the United States. The swamp and overflowed lands of this country if reclaimed will equal in productive capacity practically the whole of France, yet the problems of drainage and diking, on which their successful reclamation depends, have as yet received but little study, and the practice in both directions is susceptible of great improvement.

The construction of country roads is an essential feature of rural engineering. The great extent of our country, its recent settlement, and the necessity for extensive improvements in those directions make it an important factor in the work of the Department of Agriculture. The necessity for improvements in roads has been referred to above, but the study of the character of these improvements involves also a study of the kind of machines and vehicles that are to travel on them. Along with the study of road making should go a study of the limitations and requirements of traction engines, automobiles, and all of the new forms of transportation which are becoming an essential factor of American farm life. The relation of the problems of farm machinery to irrigation and drainage has already been shown by the necessity of including in these investigations a study of the applications of power to pumping, because pumping is the only means of supplying water for irrigation in certain districts and an essential means of removing water from over irrigated lands in others. The study of pumping has, of necessity, led to a study of the relative economy and effectiveness of different forms of power for the operation of pumps. There is equal need of similar studies of the applications of the different forms of power, whether steam, gasoline, electricity, water, or wind power in the other branches of farm work, and these are being brought home each year with increasing force to both the manufacturers and users of farm machinery. We believe, therefore, that all these related lines of work should be brought together in the Department of Agriculture in a single bureau, exactly as all the related lines of instruction in these subjects should be brought together in one distinct course in our colleges.

The necessity for increased attention to those subjects has been recognized by both the Secretary of Agriculture and the Director of the Office of Experiment Stations. Doctor True has recommended that the name "irrigation investigations" be changed to "irrigation and agricultural engineering" in order to more correctly indicate the nature of the work being done, and the Secretary of Agriculture, on the recommendation of Doctor True, has included in his estimates to Congress a request for this change and for an increased appropriation to be expended in making investigations in the applications of power to farm machinery, the direction of these inquiries, as indicated in Doctor True's report, to be:

"(1) Preliminary work in the collection and publication of information regarding the evolution, character, and uses of farm implements and machinery in this and other countries. This is important because the available literature on the subject is scattered, fragmentary, and out of date. A small beginning has just been made in this direction in a bulletin on The Evolution of Reaping Machines, recently published by this Office, and another bulletin describing corn-harvesting machinery, which is being prepared.

"(2) Laboratory and practical tests, involving a study of principles of construction and methods of operation of farm implements and machinery with special reference to efficiency and economy. These might very properly include certain strictly technical inquiries regarding the fundamental nature of the various mechanical farm operations with a view to suggesting the best means of performing them with the implements and machines at present available, or with others, the construction of which will be indicated by the results of the inquiries. Such inquiries would require considerable laboratory equipment, but the results obtained would be useful to the farmer by securing for him the most efficient implement or machine for performing the desired operation, and to the manufacturer by assisting him in the construction of the desired implements and machines."

This committee recommends that the association declare itself in favor of the creation of separate departments of rural engineering in the colleges, that it give its hearty support to the efforts of the Secretary of Agriculture to extend the work of his Department along these lines, and that the executive committee be instructed to urge upon Congress the importance of giving the Department liberal appropriations for these purposes.

W. E. Stone,
A. R. Whitson,
Samuel Fortier,
C. F. Curtiss,
Elwood Mead,
Committee.

The report was received.

J. H. Shepperd, of North Dakota. In connection with this report I wish to state that we have been able to get a great deal of very intelligent help from the firms of the country dealing in farming implements and machines. With us, the agents for such machines now realize, although they did not do so at first, that it will not do for them to pursue any narrow policy; that it is necessary for them to discuss the merits of these various machines with us on general principles and on a broad basis rather than to support in any narrow way any particular make of machine.

During the winter we have found that our work fitted in very well with the machine and implement business, because during that season their most expert men were at liberty; and the different firms seemed to be very glad to send us a very high class of men to handle and explain the machines sent by them, and we found advantage in discussing with these men the adaptation of their machines to our different soil and crop conditions.

We are fortunately located at Fargo, because this city ranks second or third in the United States in the amount of farm-implement business. We are thus enabled to have a good and varied stock of implements presented for our inspection. After the implement men understood what we were trying to accomplish there was no trouble in getting machines, or parts of machines, or anything they could furnish us to help out in our work. The only trouble sometimes was in finding available space for the proper exhibition of the different implements or machines.

C. F. Curtiss, of Iowa. The report of this committee is certainly very comprehensive, valuable, and timely. It will, I think, be of great service to our different institutions throughout the country. It has been customary heretofore to publish the reports of the committee on methods of teaching agriculture in circular form. I trust that policy will be continued. I merely wish to suggest that this report be either included in full in the regular report of our proceedings, or that it be published as a separate circular, in which form it might go to the colleges in larger numbers and more convenient form than if it were simply a part of the regular proceedings of the convention.

B. C. Buffum, of Wyoming. I think this matter is one of very great importance to many of our institutions, and I should be glad to see this association express its sympathy with this work and its interest in it. I therefore move that it is the sense of this association that we approve Secretary Wilson's efforts to extend the work along the lines of agricultural engineering in the United States Department of Agriculture and to cooperate with the stations in such work.

The motion was agreed to.

Uniform Fertilizer and Feeding-Stuffs Laws.

H. J. Wheeler, of Rhode Island. The report of the committee on this subject was presented to the association (p. 31) and subsequently referred to the Section on Agriculture and Chemistry. That section adopted sections 1 to 6 of the report relating to uniformity in the laws in relation to feeding stuffs in the several States and in regard to making such legislation operative. It is desirable that the association as a whole should now act upon these recommendations. They have already been read, so that perhaps it is unnecessary to read them again.

The amendments agreed upon in the section are as follows:

In the second paragraph of the report insert "peas" after "broom corn."

At the end of the fourth paragraph add "and a maximum of fiber which shall not be exceeded."

In the sixth paragraph, after the words "determinations of," insert "crude fiber."

In the sixth paragraph strike out all after "provisions" in the second line.

On objection being raised to the first recommendation of the committee regarding the method of defraying the expenses of inspection, the report was accepted as a report of the section on agriculture and chemistry, with the understanding that the matter is to be brought up for the action of the association at the next convention.

Experiment Station Record.

The resolution on this subject offered by C. E. Thorne, of Ohio (p. 62), was reported by the executive committee in the following modified form and recommended for adoption:

Resolved, That we respectfully request the Director of the Office of Experiment Stations to include in the Experiment Station Record not only the titles, but more generally brief abstracts of the publications of foreign agricultural experiment stations and kindred institutions, and that the executive committee be instructed "to present the matter to the Department of Agriculture and give such aid as may be appropriate to secure the object of this resolution."

A. C. True. If I may be allowed a brief statement by way of explanation of this matter, I would say that, in the Experiment Station Record as at present made up there is a very large element of foreign literature. The point really under consideration is the extension of that element, especially in the direction of making the abstracts longer, more definite and elaborate. Now, this seems to me on the whole desirable, provided it can be done in a proper way. The effort of the Office now is to utilize its present force and resources very fully in its different lines of work; and so far as the Experiment Station Record is concerned, a special effort has been made to bring that review up to date and to make it comprehensive. We are now trying to cover in a general way all the literature of agricultural science and to bring our review to the attention of our readers as promptly as possible.

When we consider that in addition to the station publications and the Department publications, and the fugitive publications of various kinds irregularly issued, more than a thousand periodicals are regularly received by the Department of Agriculture which must be examined by the editors of the Experiment Station Record, and that about two-thirds of these publications are in foreign languages, an idea may be gained of the magnitude of the task which we have on our hands in the preparation of this journal.

Now, we desire to do very fully what this association and the institutions represented here desire that we shall do in this matter; but we feel also very strongly that we can not do any more than we are doing at present with the means at our disposal and the force which we are able to employ.

C. E. Thorne, of Ohio. I wish it to be distinctly understood that my resolution is in no sense a criticism, but just the opposite. It is because I have found the Record, so far as it goes, so very valuable to me in my work that I want more of so good a thing; and it is because I have realized in my administration of the finances of the Ohio Station that, when a work is blocked out on a certain scale, it is impossible to extend that work without additional appropriations that I inserted a clause in the resolution requesting the executive committee to take such action as might be necessary to assist in getting the additional appropriations.

I realize that the additional work contemplated by this resolution is a very large element. It means the employment of several additional assistant editors for the editorial corps of the Record; and these must be experts in a number of these foreign languages. But there is work being done in these foreign countries and published in foreign languages of which we can not afford to be ignorant. We all recognize the admirable work which the Office of Experiment Stations has done. This publication, the Experiment Station Record, would abundantly justify, without anything else, all that has been given this Office from the United States Treasury. It is because of the admirable way in which the work of that Office has been done, the abundant facilities that it has for the extension of this work—facilities which can not be duplicated anywhere else—that I felt, if we could heartily stand behind the Office and support it in its work and ask it to go still further, it would be a very great thing for the whole work here in America.

The resolution was adopted.

MILITARY INSTRUCTION IN LAND-GRANT COLLEGES.

E. B. ANDREWS. Agreeably to the notice which I took the liberty of giving, I offer the following resolution with reference to military instruction in land-grant colleges:

Resolved, That the committee on military instruction is directed to try and secure some modification of War Department General Orders No. 94, relating to military instruction in the land-grant colleges, abolishing the fixed five-hour per week requirement for military instruction, and allowing such colleges larger liberty in arranging their programme of weekly exercises.

Resolved, That the committee is further directed to submit to the association at its next convention a draft of recommendation to be, if approved, urged upon Congress looking to more complete provision for the military instruction required of the land-grant colleges.

C. E. COATES, Jr., of Louisiana. I thoroughly approve the resolution just read, but I should like to offer a brief amendment to it. It so happens that the State which I represent has a very strong military spirit indeed, and it has been found perfectly practicable there to carry out a system of military instruction and discipline very closely analagous to that at West Point. Nevertheless, it has been found impossible to comply with the order of the War Department in reference to this matter. We have been giving a great deal of attention to the formulating of a course in military instruction and discipline, a course which in general would comply with the spirit of the law. But we have found considerable difference of opinion on this subject among various institutions throughout the country. In the course of an investigation into this subject I found—not very greatly to my surprise, for I already knew the facts to some extent—that there is great variation among the land-grant colleges in the methods of procedure and the time allotted to this matter of military instruction.

Now, as the bond of obligation in this matter lies equally strong on every land-grant college, I think it would be well for this committee to report at the next meeting of the association some recommendation in plain figures as to what would meet the obligations of these schools along these lines. I therefore move that this committee, in addition to their present duties, be asked to formulate some definite line of military instruction to which in their judgment it is advisable for all the colleges to attempt to approximate. It is not perhaps advisable that such a scheme should be binding on any particular college that might wish to give more or less than the prescribed time to this study; but I suggest that the committee formulate some definite general scheme of military instruction to which in their judgment it is advisable for most of our colleges to approximate to.

J. L. SNYDER, of Michigan. I am in sympathy with the views expressed by the gentleman who has just taken his seat; but I do not believe it would be best to adopt his amendment as a rider to this resolution. I second the resolution of President Andrews, and shall be glad later to second the proposition of the gentleman from Louisiana.

The resolution of President Andrews was, with the approval of the executive committee, adopted.

A resolution by C. E. Coates, jr., of Louisiana, favorably reported by the executive committee, was subsequently read and adopted, as follows:

Resolved, That this association recognizes fully the value of the results aimed at by General Orders No. 94, of the War Department; and in order to reach those results most effectually,

That the committee on military affairs be requested to collect statistics on what is now being done in military training in land-grant colleges, including time devoted to drill, detailed duty, etc.;

That the committee secure expressions of opinion on the effect of such training upon academic work;

That it formulate a scheme of military instruction to be recommended for general adoption, such scheme to contain details as to time allotted, as to the classes taking the work, and as to the methods of instruction; it being understood that the recommendation is to be in no wise mandatory on any given college.

Plans for New Buildings, Department of Agriculture.

B. T. Galloway, of the Bureau of Plant Industry of the U. S. Department of Agriculture, briefly explained the tentative plans and specifications of the proposed new buildings of the Department of Agriculture.

Organization of Section on College Work and Administration.

W. E. Stone, of Indiana. Mr. President, the newly organized section on college work and administration held a preliminary meeting yesterday afternoon and appointed its permanent officers and also selected three members of the executive committee of the association, as provided for in the newly revised constitution. The officers of the section for the ensuing year are as follows:

Chairman, W. E. Stone, of Indiana; secretary, G. E. Fellows, of Maine.

The section also appointed as a committee to have charge of the programme for the next year, the chairman, the secretary, and one member of the section—Professor Tyler, of the Massachusetts Institute of Technology. The three appointments for members of the executive committee of the association are President H. C. White, of Georgia; President G. W. Atherton, of Pennsylvania; and President J. L. Snyder, of Michigan.

Organization of Section on Experiment Station Work.

H. P. Armsby, of Pennsylvania, reported the organization of the section on experiment station work, with officers as follows:

Chairman, E. H. Jenkins, of Connecticut; secretary, M. A. Scovell, of Kentucky. Members of the executive committee: W. H. Jordan, of New York; C. F. Curtiss, of Iowa. Committee on programme: J. H. Shepperd, of North Dakota; B. W. Kilgore, of North Carolina; M. A. Scovell, of Kentucky (see also p. 192).

The reports of the organization of the two sections were received and ordered to be placed on file.

Election of Officers.

On nomination of W. D. Gibbs, of New Hampshire, seconded by C. F. Curtiss, of Iowa, W. O. Thompson, of Ohio, was unanimously elected president of the association for the ensuing year.

By vote of the association the rules were suspended and the secretary was instructed to cast the ballot of the convention for other officers, who were declared elected, as follows:

First vice-president, D. F. Houston, of Texas, nominated by W. A. Henry, of Wisconsin; second vice-president, J. C. Hardy, of Mississippi, nominated by W. M. Liggett: third vice-president, J. H. Worst, of North Dakota, nominated by T. E. Miller, of South Carolina; fourth vice-president, H. J. Wheeler, of Rhode Island, nominated by H. P. Armsby, of Pennsylvania; fifth vice-president, B. C. Buffum, of Wyoming, nominated by B. W. Kilgore, of North Carolina; secretary and treasurer, E. B. Voorhees, of New Jersey, nominated by J. L. Snyder, of Michigan; bibliographer, A. C. True, of the Office of Experiment Stations, nominated by H. P. Armsby.

Place of Next Meeting of Convention.

An invitation to hold the next convention at Portland, Oreg., was received and referred to the executive committee.

Resolution of Thanks.

H. C. White, from the executive committee, reported back favorably the following resolution offered by H. H. Goodell, of Massachusetts, which was considered and adopted:

Resolved, That the cordial thanks of the association are due and are hereby tendered to—

(1) His Excellency the President of the United States, for the courtesy and heartiness of his reception of the association;

(2) Hon. James Wilson, Secretary of Agriculture, for official and social attentions shown the association;

(3) The officials of the Department of Agriculture for many and valuable services by which the business of the convention has been greatly expedited;

(4) The members of the press for full and accurate reports of the proceedings of the convention;

(5) The management of the Shoreham Hotel for courtesies greatly contributing to the comfort and convenience of those in attendance upon the convention.

The convention then adjourned sine die.

MINUTES OF THE SECTIONS.

SECTION ON COLLEGE WORK.

Meetings of this section were held on the afternoons of November 18 and 19, 1903.

In the absence of J. W. Heston, of South Dakota, secretary of the section, G. E. Fellows, of Maine, was elected secretary pro tem.

The following paper, read by W. O. Thompson, of Ohio, was received with hearty approval, and was discussed at considerable length by G. T. Winston, of North Carolina; and in a brief manner by D. P. Purinton, of West Virginia; E. Davenport, of Illinois; C. E. Coates, jr., of Louisiana; L. H. Bailey, of New York; C. G. Hopkins, of Illinois.

THE MISSION OF THE LAND-GRANT COLLEGES.

The history of the movement out of which the land-grant colleges have grown began on Monday, December 14, 1857, and the Hon. Justin S. Morrill, then a member of Congress, introduced the first bill. This was the beginning of a somewhat stormy debate. His first request was that it be referred to the Committee on Agriculture. After some debating, on the 15th the bill was referred to the Committee on Public Lands. On the 15th of the following April the bill was reported back to the House adversely by Mr. Cobb, of Alabama. The bill passed the House April 28, 1858, by a vote of 105 in the affirmative and 100 in the negative. Mr. Morrill's argument in support of the bill was chiefly from the side of agriculture. He presented statistics showing that the conditions of agriculture in many regions were growing less favorable and that the products of the soil were decreasing to such a degree as to endanger the perpetual prosperity of that great industry. The decrease in the number of animals and the somewhat widespread discouragement in the older States led him to make a strong plea for such provision as would eventually prevent the exhaustion of the soil and maintain the permanent prosperity of the farmers.

Some argument was made on behalf of mechanic arts, but the main emphasis was given to the need of agricultural education. It was his claim that the measure was "no less of public good than of public justice—just politically, just to all the States, and just, above all, to the manhood of our country." I quote further: "We exert our power and expend millions to protect and promote commerce through light-houses, coast surveys, improvement of harbors and through our Navy and naval academies. Our military 'crown jewels' are manufactured at West Point on Government account. We make immense grants of lands to railroads to open new fields of internal trade. We secure to literary labor the protection of copyright. We encourage the growth and discipline of hardy seamen by eking out their scanty rewards through governmental bounties. We secure to ingenious mechanics high profits by our system of patent rights. We make munificent grants to secure general education in all of the new States, but all public encouragement to agriculture has been rigidly withheld."

During the progress of this speech Mr. Morrill covered in a comprehensive way the conditions of the country; the importance of agriculture; of mechanic arts and the right of these interests to consideration. He showed an accurate and comprehensive grasp of the problems that are now being wrought out in these colleges. He dwelt rather more upon the importance of experimentation than is in accord with present policies in the colleges. He seems at this point to have covered the field now occupied by the experiment stations. The trend of the argument was to the effect that the education of the country was incomplete, and that some such provision as was made in this bill was necessary in order to give opportunity to all classes of our people. He met strongly the constitutional objection that had been urged and that was urged to the last.

It is worth while to note in the discussion of this bill that the opposition, as represented by Mr. Cobb, chairman of the Committee on Public Lands, discussed very strongly two points—first, that the bill was unconstitutional, and, second, that it was against public policy. It was further argued that the effects of the bill were uneven and therefore to that degree unjust.

The constitutional argument was based on the doctrine of limited powers in a federal government. It was argued that the bill was an interference with the rights of the States in controlling matters of education which were local. The power of Congress to donate the public lands was distinctly denied.

On April 23 the bill was reported back to the Senate and referred to the Committee on Public Lands. On May 6 the bill was reported back to the Senate by Mr. Stuart without recommendation. Here the bill had a tortuous road. It seems impossible not to conclude that the opponents of the bill used every effort to avoid a vote. Mr. Pugh, of Ohio, in the progress of the debate submitted a veto of President Pierce of a bill for the benefit of the indigent insane. The aim of this was to emphasize that the proposed measure was not entirely different from the one hitherto vetoed and therefore against public policy. President Pierce had argued against the constitutionality of the measure referred to above. Senator Pugh, of Ohio, desired to reinforce that argument and apply it to the bill for the aid of colleges of agriculture. He further argued that the entire subject of education was a local question with which the States only should deal. He protested against the measure as an invasion of the rights of the States. He further argued against the measure from the standpoint of the disposition of the public lands. Mr. Rice, of Minnesota, joined in this protest, not only on constitutional grounds, which he affirmed, but on the grounds that it gave the monopoly of lands within the limits of one State to another State and thus brought about conflicting interests. He argued that it was not only unconstitutional, but unjust. His words are: "I look upon the success of this measure as bringing death almost to Minnesota; not sudden destruction, but that slow, lingering decay which eats into and gradually destroys every community whose energies are confined by combinations of nonresident proprietors. The State that I represent is one of the richest, largest, and fairest in the Union. Pass this bill and within six months the agents of nonresidents will traverse her limits for the purpose of culling out over the entire State the choicest lands held by actual settlers, thus blighting, like the locusts, every region that may attract them by its richness or its beauty." (Globe, Pt. I, 2d sess., 35th Cong., p. 717.)

Senator Mason, of Virginia, used these remarkable words (p. 718, supra): "To my conception it is one of the most extravagant engines of mischief under the guise of gratuitous donation that I can conceive could originate in the Senate. It is using the public lands as a means of controlling the power of the State legislatures. It is misusing the property of the country in such mode as to bring the appropriate functions of a State entirely within the scope of the bill under the discretion of Congress by a controlling power, and it is doing it in the worst and most insidious form—by bribery, direct bribery of the worst kind; for it is an unconstitutional robbing of the treasury for the purpose of bribing States." Senator Mason further argues that "direct appropriations were just as legitimate as this use of the public lands."

Senator Greene, of Missouri (supra, 720), argued also that the donation of lands was equivalent to the donation of money.

Senator Simmons, of Rhode Island, argued strongly for the appropriations in the seminary grants, the grants for common schools, and the appropriations to support the schools for army and navy officers.

Senator Clement C. Clay, jr., of Alabama, taunted the Democratic members who seemed to favor the bill as forsaking their historic constitutional ground and attempted to give the measure a party flavor. He argued against it as extravagance in the presence of the country's need, that it was really not desired by the honest tillers of the soil, that the measure itself was intended to promote agriculture, and that its result would be the education of men for other pursuits in life. He regarded the bill as humiliating to the States, and made a strong plea for its defeat on the ground that it opened the door and practically left no limit to Federal patronage of private interests within the States.

Notwithstanding this vigorous debate the bill was passed in the Senate, by a vote of 25 to 22, on the 7th of February, 1859. On February 26 President Buchanan sent his veto to the House of Representatives. The President's objections to this bill were, first, the poverty of the country at the time the bill was passed; second, he objected to the intermingling of the functions of the General and State governments in the matter of education, believing that they should be kept distinct and separate; third, he thoroughly believed the bill would work injury to the new States; fourth, he doubted whether the bill would contribute to the advancement of agriculture and mechanic arts; fifth, it would interfere with existing colleges in the several States, on the ground that sciences and classical studies would not be excluded; sixth, he argued against the constitutionality of the measure.

Immediately after the veto of this measure Mr. Morrill attempted to have it passed over the President's veto but failed, the vote being 105 in the affirmative and 96 in the negative. In the remarks submitted at that time Mr. Morrill very briefly but clearly denied the partisan character of the measure; submitted that it had the support of the agricultural interests throughout the whole country; corrected some errors of the President concerning the revenues from the public lands; denied the intermingling of the State governments and the General Government, the injuries to the new States; and, in fact, met every objection, as it now seems, fairly and squarely that the President had submitted in his veto message.

This, however, closed the history of this remarkable measure. It is introduced here in this paper simply to recall to mind that nearly every important consideration for or against the bill was presented at that time. Doubtless Mr. Morrill secured the material for his argument from the advocates of the bill the country over, but it is interesting to observe that in his first speech in favor of the bill, after its introduction in the House of Representatives, he covered every essential point and made the argument so complete that subsequent debates seemed only an echo of what he had already given to the country.

THE SECOND BILL.

The death of the first bill by veto did not defeat the cause. On December 16, 1861, Mr. Morrill reintroduced the measure which again was reported back unfavorably. In the following June, 1862, Mr. Morrill attempted to offer a substitute for this bill and asked leave to have it printed, but objection being offered the matter went over. Meantime, on May 5, 1862, Senator Wade, of Ohio, introduced the same measure into the Senate. On May 16 the bill was reported back with amendments from the Committee on Public Lands by Mr. Harland, of Iowa. In the Senate the bill passed through a series of debates. It is interesting to note that from the State of Kansas we hear the argument that the disposition of public lands as proposed would ruin that State. The argument is given presentation also from the State of Minnesota. The amendments and debates at this time were chiefly upon the details with reference to the locating of the lands. Mr. Lane, of Kansas, however, did come forward and object to the passage of the bill "as an old-line Democrat." This was the only appearance of party feeling revealed in the debate. Finally, on June 10, the bill passed the Senate by a vote of 32 to 7. A week later, on June 17, the bill was taken up in the House by Mr. Morrill and pushed to an issue and on that day, by a vote of 90 to 25, was passed. The bill was signed by President Lincoln, July 1, and reported to the House on July 2, 1862, and thus became a law.

The purpose of this measure is set forth in section 4 and found in the familiar words: "College where the leading object shall be, without excluding other scientific and classical studies, and including military tactics, to teach such branches of learning as are related to agriculture and the mechanic arts, in such manner as the legislatures of the States may respectively prescribe, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions in life."

I presume it would be fair to interpret this statute in the light of the debate which led to its enactment. I submit the following observations:

First. Evidently there was no design to cast any reflection upon education as it was then encouraged. There was an evident feeling, however, that the so-called classical or literary education did not meet the demand; indeed, the approval of that kind and type of education is legitimately in the statute. Any fair interpretation of the expression "without excluding other scientific and classical studies" will recognize general approval of the then existing methods in education.

Second. This statute was intended to introduce new lines of education. It was intended to provide what was not already provided. It was to meet the need that had existed but hitherto had been unrecognized. This statute recognizes the industrial classes in the field of agriculture and mechanic arts as substantially unprovided for beyond the opportunities in the public schools. It is worthy of note, however, that at the date of this statute the public school system was a long way from its present efficiency. It was generally conceded that the wealthy classes and the favored classes were able to take care of themselves. The older institutions were somewhat aristocratic in their original conception. They appealed largely to the favored classes and by easy processes neglected the large masses of the people. This statute was a distinct effort to extend a form of higher education to a class of people hitherto unreached.

Third. This statute evidently brings in the new conception of what we now term higher education. It evidently carries with it the doctrine that education other than classical and scientific, in the general conception of the word, is to be regarded as of equal importance with education at that time in vogue. It is interesting here to observe that the trend of educational sentiment in this country since the adoption of the elective idea has steadily been toward the conception of higher education, as set forth in the Morrill Act. It is clear now that classical education is liberal education. It is also clear that some other kinds of education are equally liberal. The land-grant colleges in putting emphasis upon this type of education are steadily winning for themselves recognition. The sneers that were not uncommon in earlier days are becoming rare. The genuinely liberal people of the country have come to recognize that there may be two good things in the same world. It is no longer believed that we should cultivate by the processes of higher education one, and only one, type of manhood or of character. A civilization of such great variety as ours finds easy place for an equally great variety of tastes and of education.

Fourth. There can be no doubt that this statute means exactly what it says, that the leading object of these colleges shall be agriculture and the mechanic arts. Precedence is always to be given to these subjects. My understanding of this is that they were to be chiefly schools of applied science. The existing conditions of the country demand, of course, that foundations shall be laid with this end in view. The sciences related to agriculture and the sciences related to mechanic arts are to be the chief subjects of instruction and investigation. Underlying the whole conception of this statute and running through the entire argument that was made for it was the doctrine that the pursuits of agriculture and mechanic arts demanded specific training in order to bring about the highest development of efficiency in the industrial classes and the promotion of these great interests in the country. The statute does not lose sight of the importance of other forms of industry or of labor, but it keeps in full view the importance of these fundamental industries. It emphasizes in these colleges, as it is emphasized nowhere else, the importance of this type of education.

Fifth. In my judgment a subordinate place is given in this statute to military tactics. This does not mean that the subject is to be treated unfairly or with little respect; but that the organization of these institutions is primarily in the interest of industry and not of war. They are a preparation for a peaceful life rather than for strife. I understand it, therefore, to be the duty or the mission, if we prefer that expression, of these colleges to keep faith with the Government in both particulars. We are primarily educational institutions of the industrial sort rather than of a military type. We recognize to the fullest extent the importance of military tactics, but the precedence of these institutions is not given to military tactics. My own interpretation of the statute is that general science, classical studies, and military tactics are on substantially the same level. They occupy a position of honor. No discredit may be attached to any of them. They are rightfully in these schools, but they may not take precedence over the others.

In the statute of 1890, subsequently enacted, there is provision that the money therein provided shall be applied only to "instruction in agriculture, the mechanic arts, the English language, and the various branches of mathematical, physical, natural, and economic sciences, with special reference to their application in the industries of life and to the facilities for such instruction." The debate that led up to this provision made clear the fact that the United States intended the money to be applied as set forth in the above proviso. It has been supposed that this second act of 1890 was in a degree an interpretation of the act of 1862. In the debates on the second bill there was manifestly a feeling that some of the land-grant colleges had not kept strictly within the limits of the act of 1862. The provision just recited makes it clear that, by the application of the proceeds of the second act to certain specific subjects, the educational work in these colleges will put the desired emphasis upon industrial education. This in no way was an interference with the text of the first statute, and in my judgment is not an exclusive interpretation as regards general sciences or classics.

There would doubtless be a more general acquiescence in the use of the funds provided for in this act for instruction in general science than there would be for classics. There could not have been such a presentation to the Congress in behalf of classical education as would have made the bill possible. The subjects of instruction herein provided were believed then, and history has confirmed the belief, to be such as would minister efficiently to the public welfare. They may legitimately be regarded as a means of national development. The provision of a purely classical education was not necessary. Facilities for that were substantially abundant to meet reasonable demands. The uprising of the land-grant colleges has met another and a distinct need, and at the same time has had a modifying influence upon institutions already in existence. Where the land-grant colleges are combined with State universities, or where the State supplements the national grant by money, it would seem entirely proper, therefore, to pursue work in general science and classics. In the State universities where the combination is complete there is no reason why the classical and literary departments should not be as supreme and superior in their lines as the colleges of agriculture and the mechanic arts are in theirs. In this class of institutions the colleges of agriculture and the mechanic arts, as in the Ohio State University, for example, are really separate colleges. The aim in such institutions is to bring these colleges to the highest point of excellence. This we interpret to be entirely in accord with the text of the bill requiring "the leading object" to be in these lines. However, in States where agriculture and the mechanic-arts colleges are distinct institutions from the State university or from the literary college, it would seem to be a wise policy not to attempt any such developments in the fields of general science or of classics as would give second place to agriculture and the mechanic arts. Our care should be that since the State must provide for this expense it should avoid duplication. Another reason lies in the fact that an attempt of that sort might be construed as an effort to avoid a literal obedience to the organic law of the institution.

Sixth. Another consideration is submitted, namely, that the aim of the education provided for in the Morrill Act was the liberal as well as the practical education of the industrial classes. I understand the conception of education here to be that the type of education provided for in the so-called agricultural and mechanic-arts colleges is a liberal education. It recognizes that the literary form of education was a liberal education; so without excluding these forms we intend to promote the liberal education of the industrial classes. I do not understand that this signifies that only the classical education is to be interpreted as liberal, but that the technical education here provided is both liberal and practical. I have long believed that classical education was both liberal and practical, but the world in general has not believed that, nor has the so-called liberally educated world believed that the so-called practical education was liberal. The work of these colleges is yet in its infancy, and we have not had opportunity to prove beyond doubt that this practical education is of such character as to warrant being called liberal. The signs, however, all point in that direction. It seems, therefore, the opportunity of the land-grant colleges by their fruits to prove that the liberalized soul may work the skillful hand or associate itself with technical knowledge or practical science.

Seventh. I offer another observation, namely, that it is important not to lose sight of the fact that these land-grant colleges are really national institutions. They were founded upon the doctrine that the public domain should serve the people. The Nation having jurisdiction over this domain has wisely, we believe, turned its proceeds over in a large measure to a system of education prior to that time very much neglected. The growth and development of these colleges have been beyond all reasonable expectation. They have called out the sympathetic cooperation of the local communities and States in which they are located. They have been a bond of union in educational circles, and have done much to dignify industrial education. Indeed, I believe that the industrial feature in these institutions has emphasized in a practical way what many people have held as a theory, namely, that industry is our great national virtue. While giving equal emphasis with all other colleges to the importance and dignity of scholarship, culture, and character, they have emphasized the place of industry as a formative element in both individual character and national civilization. With the rapid accumulation of wealth among our people it seems of the highest importance that we have means of technical education. It seems important that both the farmer and the mechanic, along with men engaged in other pursuits of life, shall be intelligent and efficient men. This will be our safe protection against the classification of society. It is absolutely impossible in a democracy to level down. It is a tremendous problem to level up. These land-grant colleges are serving a great purpose in leveling up. No nation has ever decayed or declined for lack of wealth. The classics of Greece did not serve her. The strongly centralized government of Rome was not everlasting. Our country will find its future largely and more largely in the minds and hands of men who know her industries from the standpoint of science. We are growing so rapidly in both wealth and all forms of material civilization that many people have not stopped to consider that an economic use of the world is imperative. There is no known limit to society's ability to enjoy the possible comforts of the world. Agriculture and mechanic arts, speaking broadly, lie at the basis not only of our wealth, but of much of our enjoyment. It is to the men who have the training for which these institutions stand that we shall look in the future for preserving and enlarging those phases of life ministered to by the material advances of the world. We shall look to these men to hand the world to succeeding generations as a precious heritage rather than a wasted and worn-out patrimony.

At the very outset of the first Morrill bill important emphasis was laid upon the necessity of preserving the fertility and fruitfulness of the soil. It was recognized that this could be done only by the faithful application of scientific methods to agriculture. There are people now who do not appreciate the importance of doing this, but every year makes increasing demands, and we must recognize it as a wise policy for a country of such breadth to be able to maintain its own existence. Further, the debate revealed the desire to provide such an education as would make men efficient in the industries. No doubt the emphasis there was upon men as producers. I desire to put the emphasis to-day quite as strongly upon men as preservers. Ignorance is a synonym for waste; intelligence is a synonym for economy. The locomotive with its splendid achievements has for years been a very expensive necessity. Transportation will not long endure the wastefulness of these years past. More economic methods are in demand. This only leads to a scientific problem that must be solved. There are hundreds of these problems to which educated men and women must address themselves if the permanent prosperity of the world is to be preserved. I believe, therefore, that these land-grant colleges should be regarded as institutions for national preservation. More directly, perhaps, than any others there is a national patriotism in them. We believe in education not only for the sake of the individual, but for the sake of the Nation. As a group they now comprise the strongest and most efficient agency for applied science in the Nation. They are in the freshness of their youth, but will in future years render a service of increasing importance with increasing appreciation.

The subject of short courses was informally but quite fully discussed by E. R. Nichols, of Kansas; C. E. Coates, jr., of Louisiana; G. E. Fellows, of Maine; H. H. Goodell, of Massachusetts; G. A. Harter, of Delaware; E. A. Bryan, of Washington; C. Northrop, of Minnesota; R. W. Stimson, of Connecticut, and J. C. Hardy, of Mississippi.

Nearly all were agreed that the short course should not be taken by young students who might profitably pursue agricultural high school or college courses, and that no credits for degrees should be given for short-course work. H. H. Goodell stated that at the Massachusetts Agricultural College short-course students have taken agriculture, horticulture, bee culture, etc., in the regular college classes. This plan was criticised by several, President Northrop laying especial emphasis on the desirability of keeping the short-course work outside of the circle of regular college work. He considered the short courses as "charitable or benevolent appendages" on the college, allowable only when they will not detract from the efficiency of the regular college work. R. W. Stimson considered short courses as pioneer work, more or less temporary expedients, for the purpose of extending the influence of the college and of drawing students to the long courses.

In the subsequent informal discussion the idea was advanced that young students should go to agricultural high schools or colleges, and older students should get their instruction in farmers' institutes and like organizations. In opposition to this plan J. C. Hardy contended that there is a wide gap between the farmers' institute and the agricultural high school, and the technical instruction of all grades should be provided for, either in the agricultural colleges or in special schools organized for the purpose.

In accordance with the amended constitution this section reorganized under the name of the Section on College Work and Administration. (For officers elected see p. 87.)

SECTION ON AGRICULTURE AND CHEMISTRY.

The first meeting of this section was called to order at 2 o'clock p. m., November 17, in the banquet hall of the Shoreham, by the chairman, C. G. Hopkins, of Illinois, at whose request B. W. Kilgore, of North Carolina, took the chair pro tempore.

C. G. Hopkins, of Illinois, read the following paper:

The Present Status of Soil Investigation.[a]

The permanent maintenance of the productive capacity of the soil is a subject which transcends all other subjects in its importance to American agriculture, if not, indeed, in its importance to the American people.

Does not the ultimate position or final destiny of America rest upon the question whether the crop-producing power of our soils shall continue gradually to be reduced or whether it shall be increased, or at least maintained? We need not ask whether the fertility of the soil can be absolutely and completely exhausted. The fundamental question is, Will the system of farming which we practice or advise ultimately reduce the productive capacity of the soil?

Because of the present very general interest in soils and soil investigations, it seems especially appropriate to discuss this general subject at the present time. Surely there is no subject pertaining to agricultural science and practice regarding which there is such a diversity of opinion as the subject of soil improvement for increased crop production. Both practical farmers and even eminent scientific authorities disagree almost absolutely on some fundamental principles. Indeed, these differences of opinion are so marked and so frequent that I feel compelled to ask, in language which has recently been declared to be grammatical, "Where are we at?" To illustrate:

There is a large class of fruit farmers who practice and advocate clean cultivation of orchard soils, sometimes with a cover crop during the latter part of the season; while another class of successful fruit growers maintain and strongly advocate a continuous grass cover kept under suitable control. Some of the important details of this practice are included in what is sometimes called the "Hitching system" of orchard cultivation. So far as can be learned, the advocates of each system are equally positive that their practice is vastly superior to the other. It is extremely doubtful if an absolutely fair and complete test has been made of the comparative value of the two methods. It seems difficult, for example, for the advocates of clean cultivation to understand that a permanent grass cover can mean anything else but an ordinary hay field or an unrestrained growth of grass and weeds.

Again, there are about 75,000,000 pounds of nitrogen resting upon every acre of the earth's surface, and the investigations of several American experiment stations, especially those of Delaware, Illinois, and Canada, have furnished abundant evidence that under proper conditions nitrogen can be obtained from the atmosphere for the use of farm crops at a cost of about 1 cent a pound. On the other hand, several other experiment stations, as New Jersey and Ohio, advocate the purchase, to a greater or less extent, of commercial nitrogen, at a cost of 15 cents a pound, for use on ordinary farm crops, such as corn, oats, wheat, or timothy.

Dr. Bernard Dyer, one of the eminent English authorities on scientific agriculture, even advocates the purchase and use of sodium nitrate for growing leguminous crops, especially for alfalfa.[b] From our own investigations in Illinois we have conclusive proof that at 15 cents a pound we have obtained at least $45 worth of nitrogen from the atmosphere per acre per annum by means of alfalfa properly infected with the alfalfa bacteria and provided with suitable soil conditions, free from acidity and well supplied with the mineral elements of plant food, and the evidence strongly indicates that even much more nitrogen than that was obtained from the air.[c] Dyer does not state, so far as I can learn, whether his alfalfa was well infected with the proper bacteria. If not, of course the application of sodium nitrate would be expected to produce a marked effect.

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[a] See also Illinois Sta. Circ. 72.

[b] Reprint from Trans. Highland and Agr. Soc., Scotland, 5. ser., 14 (1902); also Reprint from Jour. Roy. Hort. Soc., 27 (1902), No. 4.

[c] Illinois Sta. Bul. 76.

In America we commonly harvest from 5 to 8 tons of alfalfa per acre during the season, and a total yield of 10 tons of well-cured hay is not infrequent, and no nitrogenous fertilizer is used. Dyer does not give his yield of cured hay, but he reports the average annual yield of green or freshly cut alfalfa forage as shown in the following table:

Alfalfa yields in fertilizer experiments (Bernard Dyer).

Plant food applied.	Green alfalfa per acre.	Plant food applied.	Green alfalfa per acre.
	Tons.		*Tons.*
Phosphates and potash only	11.4	Phosphates, potash, 2 cwt. nitrate	15.9
Phosphates, potash, 1 cwt. nitrate	14.2	Phosphates, potash, 4 cwt. nitrate	14.8

Dyer estimates the value of the green forage at $2.50 a ton, and as the cured hay would certainly be worth at least $10 a ton in England, it seems safe to conclude that the highest yield which he obtained, even with the use of sodium nitrate, did not exceed 4 tons per acre. This is less than the increase only which has been obtained by proper inoculation. It should also be stated that the annual application of potassium in Dyer's experiments was less than would be contained in 2 tons of ordinary alfalfa hay, and the question arises whether the effect of the sodium nitrate in increasing the yield of alfalfa may not have been due in part at least to the liberation of potassium from the soil by the addition of sodium, or even to the partial substitution of sodium for potassium by the alfalfa plant. Results[a] obtained at Woburn by the agricultural experiment station of the Royal Agricultural Society of England tend to confirm the suspicion that the benefit of the sodium nitrate was indirect, to some extent at least, as will be seen by referring to the following table:

Alfalfa yields in fertilizer experiments at Woburn.

Plat No.	Annual fertilizer per acre.	Green alfalfa per acre. 1897.	Green alfalfa per acre. 1898.
		Tons.	*Tons.*
1	None	15.0	8.9
2	8 hundredweight phosphates[a]	16.0	8.5
3	4 hundredweight potassium sulphate	17.3	12.1
4	2 hundredweight ammonium sulphate	12.1	8.0
5	2 hundredweight sodium nitrate	17.2	11.1
6	Phosphates,[a] potash, and ammonium sulphate	22.1	16.6
7	Phosphates,[a] potash, and sodium nitrate	23.9	16.4

[a] 4 hundredweight superphosphate and 4 hundredweight bone dust.

It will be observed that potassium sulphate produced a higher yield than sodium nitrate, the difference being greater the second year than the first. Dyer makes no comment on this fact, but, in referring to the effect of nitrogen, he says: "The bad effect of sulphate of ammonia used alone on plat 4 is probably due to the scarcity of lime in the soil, which is unsuitable for the continuous use of this fertilizer unless lime be occasionally applied, either as lime or in some such form as basic slag or bone meal. In conjunction, however, with bone dust, superphosphate, and sulphate of potash, sulphate of ammonia has produced a substantial increase. Nitrate of soda, even without the use of mineral fertilizers, has produced a very remunerative return in these two years, but it has done far better in conjunction with mineral fertilizers."

These conclusions are not justified by the data given, because of the fact that there was no plat fertilized with phosphorus and potassium without nitrogen. Each of the elements phosphorus and potassium, when used singly, proved beneficial (except in 1898 the acid phosphate appears to have produced an injurious effect upon the alfalfa, probably due to its increasing the acidity of the soil), and if both mineral elements had been applied to one plat no doubt the yield would have been larger than where either one was used alone. Furthermore, if the soil were acid, as Dyer evidently believes, it was unsuited for the alfalfa bacteria.

The fact that reprints of Dyer's reports, advocating the use of sodium nitrate for leguminous crops, are being very widely circulated in America, presumably by

[a] Jour. Royal Agr. Soc., December, 1899 (through reprint of Dyer's report).

parties interested in selling nitrates, certainly justifies calling special attention to this marked disagreement among scientists as to the wisdom or economy of purchasing nitrogen for the use of legumes.

The agricultural experiment stations are becoming more and more responsible for the methods of soil management which are being practiced in this country. We stand as the guardian of the fertility of American soils. If leguminous crops do not obtain sufficient atmospheric nitrogen, is it not our business to discover why they do not, and then to advocate a system of soil treatment or soil management which shall enable legumes to obtain from the free and absolutely inexhaustible supply of the atmosphere all of the nitrogen which they need for maximum yields? By proper inoculation we have grown a crop of alfalfa which contained as high as seventeen times the quantity of nitrogen which was contained in a crop grown without inoculation, but otherwise under exactly the same conditions and in soil which last year produced more than 60 bushels of corn per acre.

Director Thorne, of the Ohio Experiment Station, unquestionably one of our most careful and exact agricultural investigators, has fully demonstrated during the past dozen years that a five-year rotation of corn, oats, wheat, clover, and timothy, when grown on certain Ohio soils, does not secure sufficient atmospheric nitrogen for maximum crops. He has also obtained abundant proof that the purchase and use of commercial nitrogen in that rotation, either alone or in combination with other elements, is attended with financial loss, as will be seen from the following data taken from the recently issued Ohio Station Bulletin No. 141:

Fertilizers for crops grown in five-year rotation in Ohio.

Soil plat number.	Plant food applied.	Cost of plant food in five years.	Wooster field.		Strongsville field.	
			Value of increase.	Profit (+) or loss (−).	Value of increase.	Profit (+) or loss (−).
5	Nitrogen	$12.00	$5.64	−$6.36	$0.57	−$11.43
2	Phosphorus	2.40	11.40	+ 9.00	14.56	+ 12.16
3	Potassium	6.50	4.44	− 2.06	.53	− 5.97
6	Nitrogen, phosphorus	14.40	22.05	+ 7.65	16.76	+ 2.36
9	Nitrogen, potash	18.50	6.24	−12.26	2.50	− 16.00
8	Phosphorus, potash	8.90	16.57	+ 7.67	14.35	+ 5.45
11	Nitrogen, phosphorus, potash	20.90	27.83	+ 6.93	19.98	− .92
12	Nitrogen, phosphorus, potash	26.90	28.97	+ 2.07	20.33	− 6.57
14	Nitrogen, phosphorus, potash	14.30	22.70	+ 8.40	17.02	+ 2.72
15	Nitrogen, phosphorus, potash	7.70	15.57	+ 7.87	10.22	+ 2.52

It will be observed that on these Ohio soils commercial nitrogen used alone, or with potassium only, has produced an increased yield sufficient to pay less than 50 per cent of the cost of the nitrogen used. When used in connection with phosphorus, or with both phosphorus and potassium, it has not increased the yield above that produced by the phosphorus alone, or by the phosphorus and potassium together, sufficient to pay for the cost of the nitrogen used. As a matter of fact no other treatment has produced a net profit equal to that resulting from the use of phosphorus alone. To be sure we have larger yields from other applications, but we must bear in mind that it is not large yields that we desire, but large profits. (Large yields remove large quantities of plant food from the soil.)

What shall we say then? Shall we advise farmers to buy commercial nitrogen for use in this rotation? Or shall we rather advise them to grow a catch crop of stock peas or soy beans with the corn or a crop of clover with the oats, or, if necessary, to add another full leguminous crop to their rotation?

A recent contribution[a] from the U. S. Department of Agriculture, Bureau of Chemistry, suggests and offers some experimental data in support of the suggestion that a chemical analysis of the soil might be made each year in order to ascertain the amount of available plant food contained in the soil and the consequent kinds and quantities of fertilizers to be added for the more certain production of the crop desired.

The opinion is advanced[b] "that the mineral plant food which a plant does take up is that which existed in the soil in an assimilable form at the time of planting." The cost of determining the assimilable, or available, plant food and the necessary laboratory equipment is described, and the statement[c] is made "that samples (of soil) could be brought to such a laboratory and four days later the results could be

[a] Jour. Amer. Chem. Soc., 24 (1902), p. 79. [b] Ibid., p. 106. [c] Ibid., p. 98.

received as to the immediately available phosphate and potash." It is even asserted[a] that "on lines similar to those followed in this paper (from the Bureau of Chemistry) it would be possible to establish solvent conditions as representing the feeding ability of any plant, whereupon the desired crop would be specified when the soil sample is forwarded for analysis."

Following this contribution, and in almost absolute disagreement with it, has appeared Bureau of Soils Bulletin No. 22, of the U. S. Department of Agriculture, on "The Chemistry of the Soil as Related to Crop production," in which it is asserted[b] with confidence "that practically all soils contain sufficient plant food for good crop yields, that this supply will be indefinitely maintained, and that the actual yield of plants adapted to the soil depends mainly, under favorable climatic conditions, upon the cultural methods and suitable crop rotation."

It is further asserted[b] that this is "a conclusion strictly in accord with the experience of good farm practice in all countries, and that a chemical analysis of a soil, even by these extremely delicate and sensitive methods, will in itself give no indication of the fertility of this soil or of the probable yield of a crop, and it seems probable that this can only be determined, if at all, by physical methods, as it lies in the domain of soil physics."

Again I feel compelled to ask, "Where are we?" Shall we analyze our soils chemically every spring before seeding time? Or shall we analyze them not at all? Shall we continue to use commercial fertilizers and farm manure for any other purpose than physical effect? Shall we continue our efforts to encourage the nitrogen-gathering bacteria to gather nitrogen? Or shall we simply rotate and cultivate?

It may assist us in solving some of these soil problems if we keep in mind the fact that the soil serves the plant in two different ways, or, we may say, the soil has two distinct offices, or functions, in connection with crop production: First, the soil furnishes a home for the plant, a mere lodging place, in which the seed germinates and the plant "lives and has its being;" second, the soil furnishes food, or nourishment, for the growth, development, and maturing of the plant.

Is the soil hard and compact and almost impenetrable to plant roots, or is it loose and porous? Is its texture fine and plastic, medium and friable, or coarse and granular? Does it readily absorb and retain moisture, resist drought, and permit the free movement of water through it and thus facilitate drainage? Or is it almost impervious to water, nonabsorbent, and nonretentive of moisture? These questions deal with the first function of the soil—that is, with its physical properties, which determine whether the soil is a suitable home for the plant.

The second function of the soil is to feed the plant, to supply nourishment absolutely required for the growth and maturity of the crop. Does the soil contain a sufficient store of nitrogen, phosphorus, potassium, and other required elements of plant food, and will a sufficient quantity of these be made available during the progress of the season to meet the needs of the growing crop? Can we add to the store of nitrogen in the soil, or furnish it direct to the growing plant, from the uncombined nitrogen contained in the air by bio-chemical means? Can we supply or supplement the soil's supply of plant food by applications of farm manure or other fertilizers? Can we hasten the disintegration of soil particles and the consequent liberation of plant food from the soil by increasing the amount of decaying organic matter in the soil or by applications of lime or other materials? These questions deal with the feeding or nourishing of plants. This is soil chemistry, the other is soil physics, and neither can truthfully say to the other, "I have no need of thee."

We have in Illinois an area of land whose principal type of soil contains only 600 pounds of phosphorus per acre in the plowed soil to a depth of 7 inches. A good crop of corn, such as we commonly produce on the best soils in the State, removes from the soil 23 pounds of phosphorus per acre. Twenty-five or thirty good crops would actually remove from the soil as much phosphorus as is contained in this plowed soil, and the plowed soil is considerably richer in phosphorus than the soil below it.

It is mathematically impossible that the "supply will be indefinitely maintained," if good crops should be removed from this land for any considerable number of years. The question is asked, if this is not a very small area of abnormal soil. It is true that this area is a fraction of the State of Illinois, but, nevertheless, it is large enough to make eleven States the size of Rhode Island. In former years this part of Illinois supplied sufficient corn to the rest of the State so that it was nicknamed "Egypt," and it is still popularly known by that name.

We have another area comprising seven counties whose principal type of soil, after

[a] Jour. Amer. Chem. Soc., 24 (1902), p. 113.
[b] U. S. Dept. Agr., Bureau of Soils Bul. 22, p. 64.

eighty years of cultivation, does not contain as much nitrogen to a depth of 3 feet as would be contained in twenty good crops of corn.

Another large area, evidently comprising several hundred thousand acres, does not contain sufficient potassium in the plowed soil to make twenty good crops of corn, and the subsoil is still more deficient in potassium than the top soil.

By chemical analyses we have found that one of these extensive soil types contains more than six times as much phosphorus as another; one contains five times as much potassium in the top soil as another, with a still greater difference in the subsoils; one type contains from ten to sixty times as much nitrogen as another. The principal types of soil in central and northern Illinois contain from two to three times as much plant food and produce two to three times as much corn as the principal types in southern Illinois. These are not mere theories; they are absolute facts, based upon chemical analysis of the soil, upon pot cultures carried on under controlled conditions, upon actual field experiments, and upon regular crop yields in ordinary farm practice.

Plant food in some Illinois surface soils (pounds per acre).

Elements of plant food.	Black prairie (Wisconsin glaciation).	Red clay hills (unglaciated).	Gray prairie (lower Illinoisan glaciation).	Peaty swamps (recently drained).
Nitrogen	6,200	1,000	2,800	67,000
Phosphorus	1,600	1,000	600	2,000
Potassium	8,800	5,600	4,200	1,200

Crop yields in soil experiments.

Plant food applied.	Corn.	Wheat.	Wheat.	Corn.	Corn fodder.
	Bushels.	*Grams.*	*Grams.*	*Bushels.*	*Pounds.*
None	a 75	3	10	0	1,000
Nitrogen		26	9	0	1,200
Phosphorus		3	14	0	2,000
Potassium		3	10	36	3,600
Nitrogen, phosphorus		34	21	0	1,400
Nitrogen, potassium		33	7	40	3,500
Phosphorus, potassium		2	14	38	3,100
Nitrogen, phosphorus, potassium		34	27	60	4,400

a A very common yield. No experiment, on this type.

To the old, worn, unglaciated hill soil of southern Illinois, whose chemical composition shows it to be markedly deficient in nitrogen, we added both phosphorus and potassium and obtained practically the same yield as where no plant food was applied, but when nitrogen was added the yield of wheat was increased from only 3 grams to from 26 to 34 grams per pot.

To the principal type of soil in the lower Illinoisan glaciation, whose analysis shows that its phosphorus content is only one-third of a normal fertile soil, we added both nitrogen and potassium and produced no increase whatever, but when phosphorus was added the yield of wheat was increased from 10 grams to from 14 to 27 grams per pot.

To the peaty swamp soils representing some hundred thousand acres in north-central Illinois whose composition shows that it contains less than one-fifth as much potassium as the best soils in the corn belt, we added both nitrogen and phosphorus and obtained practically the same yield of corn as where no plant food was added, the total yield per acre amounting to only a ton or less of corn fodder with practically no ear corn, and yet where we applied potassium to that soil we obtained about two tons of corn stover and from 36 to 60 bushels per acre of good corn, and following up these results, the farmers who own and manage those lands are already profitably using carloads of potassium salts upon those soils, not highly manufactured so-called complete commercial fertilizers, but crude potassium salts direct from the German mines and in quantities sufficient for a good crop of corn. It will be observed that after the most needed element has been applied the other elements added may produce more or less increase in the crop.

Are all these results produced by the physical effect of these materials? Does nitrogenous material produce this physical effect in one soil, phosphatic in another, and potassic in a third? We have tried potassium chlorid and sodium chlorid side by side. Potassium increases the yield threefold and sodium not at all. To be sure we have been studying Illinois soils for only two years, and we have made only a mere beginning in that great State, but we are making use of soil chemistry, soil physics, soil bacteriology, pot cultures, field experiments, and in fact every method or agency which promises to aid us, and we hope to rapidly obtain much more complete knowledge of Illinois soils than we now have.

Bulletin No. 68, just received from the Florida Experiment Station, contains forty chemical analyses of the ordinary very sandy loams upon which nearly all of the pineapples produced in that State are grown. In commenting upon these soils, the authors say:[a] "Few of the soils would be able to produce more than two or three crops of pineapples, if all the plant food present were available." Probably these sandy loams should be considered as abnormal soils, but there are actually all gradations between these sandy soils and the heaviest clays or the most peaty swamps. Where shall we draw the line between the soil whose fertility can be reduced so as to affect the crop yield and the soil whose supply of fertility "will be indefinitely maintained."

The conclusions of the Bureau of Soils reported in Bulletin No. 22 were based in part upon the fact that no special correlation was found between ordinary crop yields and the chemical composition of an aqueous extract of the soil and in part upon a cursory examination of the literature bearing upon the subject. I say a cursory examination because of the large amount of existing data which appear to have been overlooked.

For example, in the bulletin from the Bureau of Soils it is suggested that the application of plant food is usually of little or no value, provided a proper rotation is practiced, and the results obtained from wheat grown continuously and from the four-year rotations of wheat, roots, barley, and fallow, which have been carried on at Rothamsted during fifty years are cited as proof. The statement[b] is made that "the yield of wheat grown continuously without manure for fifty years has been reduced from 33½ bushels, the average maintained on the best fertilized plat, to 15 bushels."

One would at first suppose this statement were a misprint. We might almost in truth make the opposite statement, namely, that by the use of farm manure the yield of wheat grown continuously has been increased from 13½ bushels, the average maintained on the unfertilized plat, to 33½ bushels. It is not the reduced yield from cropping without manuring that is noteworthy, but it is increased yield due to the application of plant food. The unmanured plat never produced 33½ bushels.

Wheat grown continuously at Rothamsted[c] *(bushels per acre).*

Harvest year.	Without manure.	With farm manure.	Difference.
1843	[d]18	[d]18	0
1844	15	21	6
1845	23	32	9
1846	18	27	9
1847	17	30	13
1848	15	26	11
1849	19	31	12
1850	16	28	12
1851	16	30	14
Eight years' average	17	28	11
1884	13	32	19
1885	15	40	25
1886	9	36	27
1887	15	35	20
1888	10	38	28
1889	12	40	28
1890	14	43	29
1891	14	48	34
Eight years' average	13	39	26
Fifty years' average	13½	33½	20

[a] Florida Station Bul. 68, p. 691.
[b] U. S. Dept. Agr., Bureau of Soils Bul. 22, p. 55.
[c] Agricultural Investigations at Rothamsted, U. S. Dept. Agr., Office of Experiment Stations Bul. 22, Pl. 1, between pp. 146 and 147.
[d] Supposed yields for 1843.

The first recorded yield from the unmanured plat, in 1844, was only 15 bushels, and the average of the first eight years (1844 to 1851) was only 17⅜ bushels.

It is also stated by the Bureau of Soils[a] that "by a simple rotation and change of cultural methods from year to year, with the change of the crop, the yield of wheat has been maintained practically constant for forty-four years," and the yields from a few selected years are cited as proof. The statement[b] is made, for example, that "the yield of wheat has not been sensibly reduced, the yield, even when the roots were carted off and the land left in fallow, being 33½ bushels in 1883, as against 30½ bushels in 1851, 37⅝ bushels in 1855, and 35 bushels in 1859."

While it is true that 33½ bushels was the yield in 1883, and that some other very satisfactory yields have since been obtained, nevertheless, the original data show that during the four courses, covering sixteen years (1852 to 1867) the average yield of wheat was 36 bushels per acre, while during the next four courses, covering a second period of sixteen years (1868 to 1883) the average yield was 20 bushels, although in 1883 the yield was 33½ bushels, and during the sixteen-year period (1884 to 1899), the average yield has been 29 bushels.

It is true that when not manured the average crop of wheat in the four-year rotation has been larger than where wheat was grown continuously, but is the difference due primarily to physical conditions of the soil? All students of agriculture, practical and scientific, not only admit, but have always advocated, that the physical condition of the soil is a highly important factor, and in my judgment the statement[c] by the Bureau of Soils, "that fertilizers rarely take the place of efficient methods of cultivation and of cropping in increasing or maintaining crop yields," is at fault, in so far as it intimates that fertilizers may sometimes be substituted for good farming. Applications of plant food are not expected to retard, but to encourage, the growth of weeds. Fertilizers do not take the place of cultivation; their value is usually enhanced by cultivation, by means of which they are more thoroughly distributed and incorporated with the soil.

The fact is that in this four-year rotation the wheat crop followed a year of fallow cultivation, and we might expect the one crop to utilize the total amount of plant food made available during the two years' time. That this is probably true is indicated by a further study of this rotation.

Yield of crops grown in four-year rotation at Rothamsted[d] (roots, barley, fallow, and wheat) root crop removed from land.

Number of course.	Roots, tons. Applied— No plant food.	Roots, tons. Applied— Nitrogen, phosphorus, potassium.	Barley, bushels. Applied— No plant food.	Barley, bushels. Applied— Nitrogen, phosphorus, potassium.	Wheat, bushels. Applied— No plant food.	Wheat, bushels. Applied— Nitrogen, phosphorus, potassium.
First[e]	8.8	19.7	34	37	30	30
Second	1.9	20.4	32	38	37	38
Third	2.3	16.4	44	48	36	42
Fourth	.1	4.4	35	61	45	53
Fifth	.4	9.1	34	45	27	22
Average 2 to 5	1.2	12.6	36	48	36	39
Sixth	.0	.0	21	40	11	17
Seventh	2.6	16.6	21	32	24	29
Eighth	1.6	15.5	23	31	10	12
Ninth	1.6	22.5	29	34	34	37
Average 6 to 9	1.5	13.7	24	34	20	24
Tenth	.9	14.9	16	19	35	39
Eleventh	.8	21.6	16	20	32	41
Twelfth	.5	26.2	20	19	22	33
Thirteenth	.8	17.3	11	21	27	33
Average 10 to 13	.8	20.0	16	20	29	37
Average 2 to 13	1.2	15.4	25	34	28	33

[a] U. S. Dept. Agr., Bureau of Soils Bul. 22, p. 56.
[b] Ibid, p. 55.
[c] Ibid, p. 60.
[d] Memoranda of the origin, plan, and results of the field and other experiments at Rothamsted (1900) pp. 110, 111.
[e] Clover instead of fallow in first rotation.

It is approximately correct, as stated by the Bureau of Soils,[a] that "the yield of wheat in this same experiment, where mixed mineral and nitrogenous manures had been used in some part of the rotation, had not been sensibly larger [than where no manure was used]," but the fact appears to have been overlooked that the root crop immediately following wheat has produced, during the forty-eight years, an average annual yield of 1.2 tons without fertilizing, and an average yield of 15.4 tons where mixed mineral and nitrogenous manures were used. If it were the physical condition which so markedly affected the yield of wheat, it certainly failed utterly in benefiting the root crop.

In addition to this we have the simple fact reported by Lawes and Gilbert[b] that during the forty years, from 1852 to 1891, where mixed mineral and nitrogenous fertilizers were used the yield of wheat averaged 33¼ bushels when grown in this rotation, and 36½ bushels when grown continuously. We might presume from these data that the higher yield produced where wheat was grown continuously is due to the improved physical condition of the soil, but more probably it is due to the fact that the crops grown continuously received somewhat heavier applications of plant food than the rotation crops. This shows, for comparison, the results obtained in the four-year rotation at Rothamsted when the roots were either fed off by sheep or cut and spread on the land. In this case only two crops were removed in four years, and yet the average yield of wheat was sensibly higher, and the yield of barley markedly higher, where mixed mineral and nitrogenous manures were used than where no plant food was applied.

Yield of crops grown in four-year rotation at Rothamsted[a] *(roots, barley, fallow, and wheat). Roots not removed (fed or spread on land).*

Number of course.	Roots, tons.		Barley, bushels.		Wheat, bushels.	
	Applied—		Applied—		Applied—	
	No plant food.	Nitrogen, phosphorus, potassium.	No plant food.	Nitrogen, phosphorus, potassium.	No plant food.	Nitrogen, phosphorus, potassium.
First[b]	8.9	21.4	45	44	31	27
Second	1.4	19.5	33	37	37	37
Third	1.7	17.0	44	67	35	40
Fourth	.1	4.4	33	58	42	49
Fifth	.4	9.3	35	47	23	20
Average 2 to 5	1.0	12.6	36	52	34	37
Sixth	.0	.0	21	38	14	17
Seventh	2.5	16.6	21	47	24	30
Eighth	1.6	18.9	22	45	12	10
Ninth	1.9	22.8	31	48	34	39
Average 6 to 9	1.5	14.6	24	45	21	24
Tenth	1.0	14.8	23	32	33	41
Eleventh	1.2	21.2	17	23	31	45
Twelfth	.6	25.0	19	26	23	32
Thirteenth	1.2	16.6	13	35	27	39
Average 10 to 13	1.0	19.4	18	29	29	39
Average 2 to 13	1.2	15.5	26	42	28	33

[a] Memoranda of the origin, plan, and results of the field and other experiments at Rothamsted (1900), pp. 114, 115.
[b] Clover instead of fallow in first course.

In connection with the very extensive and truly valuable data furnished by the Bureau of Soils in this bulletin and the conclusion[c] drawn, that "all types of soil furnish about the same amount of plant food when treated with the same proportion of water, other conditions as time, temperature, etc., being also the same," it

[a] U. S. Dept. Agr., Bureau of Soils Bul. 22, p. 56.
[b] Agricultural Investigations at Rothamsted, U. S. Dept. Agr., Office of Experiment Stations Bul. 22, pp. 151 and 189.
[c] U. S. Dept. Agr., Bureau of Soils Bul. 22, p. 46.

may be remembered that Lawes and Gilbert,[a] by a very careful examination of soils to considerable depths, by methods which were also exceedingly sensitive and accurate, found 17 pounds per acre of soluble nitrogen in soil supporting a crop of alfalfa, and 103 pounds, or more than six times as much, in soil where white clover was growing. To explain such discrepancies will require further and more comprehensive investigations.

Agriculture demands and deserves all the investigation which is being given to it; it is in need of, and is worthy of, all the investigators whose services are being devoted to this greatest of all our industries; but let us remember that it is only a genius who can draw correct conclusions from incomplete data or insufficient premises, that we are to use all obtainable information to guide us, and that we are to work together as a unit for the betterment of American agriculture. The work is greater than any man or any office. Let every man develop and magnify the line of work which he is called upon to perform, but let us neither decry nor ignore nor underestimate the value of any other good work.

And God speed the time when we shall agree on some fundamental principles, and when we shall discover and demonstrate the best and most economic methods for the permanent maintenance or increase of the productive capacity of our soils, not only by maintaining the most suitable physical conditions of the soil and by effecting the utmost possible control of soil water and by the most economic utilization of the virgin fertility already stored in the soil, but also, wherever necessary and profitable, by liberal additions to the soil of valuable plant food; not by the purchase and use of sodium nitrate, almost certainly not, but undoubtedly by the assimilation and utilization of unlimited quantities of atmospheric nitrogen; probably not by the use of acid phosphates, containing 6 per cent of phosphorus and 60 per cent of manufactured land plaster, usually supplying, as commonly practiced, less than one-half of the phosphorus actually removed by the crops and stimulating the soil to give up a greater quantity of the stock of plant food it contains, thus leaving it in a still more impoverished condition, but much more likely by returning to the land in pure form the bone meal produced on the farm and by using, together with farm manures and leguminous green fertilizers, large quantities of fine-ground rock phosphate direct from the almost inexhaustible natural phosphate deposits in our Southern States, as has already been done with marked profit, and greater promise, by the Ohio[b] and Maryland[c] experiment stations; and possibly not by using mixed manufactured fertilizers containing from 2 to 4 per cent of potassium, but by making the most complete use of the comparatively large amounts of potassium contained in the straw and stover and other coarser parts of our farm crops and in farm manures, by making much greater use than we now do of the immense store of potassium contained in our heavy clay subsoils, or, if necessary, by using concentrated potassium salts direct from the German mines, or what may ultimately prove to be more economical and certainly more unlimited, by recovering on our arid coasts, as they are now doing in southern France, potassium salts from the inexhaustible supply of the sea.

In closing, I beg to assure you that no spirit of captious criticism has prompted the preparation of this paper. The field is old, but the work is new, and it is being prosecuted by many widely separated and almost independent investigators. My one purpose in pointing out some specific differences or disagreements is to bring about a more perfect harmony among us, hoping thus that we may avoid the criticism and win the more complete confidence of that rapidly increasing class of progressive, educated, and even college-bred American farmers who are not only watching closely the progress of our work, but who are already putting our teachings to the practical test. Not infrequently these well-trained and well-educated farmers are prepared to repeat our tenth-acre plat experiments upon a 100-acre field and with a consequent percentage accuracy which may even exceed our own.

To more fully appreciate the tremendous importance of this work, we need only to bear in mind the fact that agriculture is no longer merely a means of obtaining a living, but it is now a real business enterprise, and the business of agriculture, especially throughout the great Central West, is rapidly taking its rightful rank as an industry which may be managed and controlled with a good measure of scientific accuracy. The American farmer has a right to expect that, if he adopts the methods which we advocate, the fertility of his soil is secure, that the productive capacity of his land will be increased, or, at the very least, that it shall be permanently maintained—not

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[a] Investigations at Rothamsted Experimental Station, U. S. Dept. Agr., Office of Experiment Stations Bul. 8, p. 82; also Agricultural Investigations at Rothamsted, U. S. Dept. Agr., Office of Experiment Stations Bul. 22, p. 115.

[b] Ohio Sta. Bul. 134, pp. 94–98.

[c] Maryland Sta. Bul. 68, pp. 18–24.

only for a season, not only for a score of years, but so long as the American farmer shall till American soil.

F. K. Cameron, of the Bureau of Soils, U. S. Department of Agriculture, protested against what he understood to be a misapprehension by Mr. Hopkins of Bulletin No. 22 of the Bureau of Soils. He explained that in the first place the bulletin was not intended to be a discussion of the fertility of soils; and in the second place the Bureau of Soils recognizes that good does come from the application of fertilizers. The question of the yield of the crop was made up of many factors, each of which affected the yield. He maintained that, if any progress was to be made in connection with this subject, it must be in connection with the study of the soil solution.

As to the question, What can fertilizers do, the Bureau of Soils did not pretend to have fully and satisfactorily settled that question, but they know more about it than they did a few months ago. The factors involved in the question of soil fertility formed a subject for very serious study and were receiving very careful investigation from the Bureau. Upon the studies thus far pursued, the Bureau had not ventured to make any premature announcement of results, although it was perfectly well satisfied that fertilizers do have a very recognizable effect. He regretted if anything reported by the Bureau had been misinterpreted. The Bureau was ready with all others to go forward in the investigation of the soil and to do whatever it could to obtain trustworthy results.

F. H. King, of the Bureau of Soils, U. S. Department of Agriculture, read the following paper:

Differences Between Four Southern and Four Northern Soils, and Improvements in Soil Management which these Differences Suggest.

The soils of the South Atlantic and Gulf coastal plains east of the Mississippi are generally recognized as being strongly contrasted with the soils of the North and Middle West in their general present productive capacities.

The Division of Soil Management of the Bureau of Soils of the U. S. Department of Agriculture has been making a comparative study in these contrasted regions, working this year with eight soil types, two each in North Carolina and Maryland and two each in Pennsylvania and Wisconsin, with a view to ascertaining if recognizable fundamental differences could be found which would suggest improvements in the methods of managing these soils to increase their productive capacities. Two suitable 2-acre areas, about 200 by 440 feet, on two soil types in each locality having recognized different productive capacities, were selected for these comparative studies, and on these areas, treated in every respect alike, corn and potatoes were grown, using the same seed for all and planting on the same date.

To produce differences in yield on the same soil type for each locality, the 440-foot strips of land were divided crosswise into 20 subplats, which were treated in groups of 5, to one of which in each group nothing was added; to a second, 5 tons of stable manure; to a third, 10 tons; to a fourth, 15 tons; and to a fifth, 300 pounds of Acme guano. Each fertilization was thus repeated four times across the respective areas. The manure used was first brought together in a common pile, well mixed, and from there hauled to the two soil types, distributing it in such a way that each load was subdivided so that a proportionate part fell upon all subplats of a given soil type. The guano was bought in one lot and subdivided for the eight soil types. This was also true for the seed planted, "Iowa Gold Mine" being used for corn and "Rural New Yorkers" for potatoes. Corn occupied one-third of every subplat, potatoes one-third, and the middle one-third between the corn and potatoes was kept fallow and cultivated free from weeds with the areas under crop.

Comparative physical and chemical as well as crop studies have been made on all of the different conditions of treatment of the eight soil types, and it is some of the results of these studies which we wish to bring to your attention, with the lessons they appear to teach regarding improvements in the management of Southern soils.

Soil samples were taken from every subplat under the three-crop conditions once every week during the growing season up to August 24 for the surface foot; for the second foot samples were taken once in every two weeks, and for the third and fourth feet samples were taken at the start, in the middle of the growing season, and near the close. These samples of soil have all been so taken as to permit both the percentage and the absolute amounts of soil moisture to be computed under all of the conditions; so as to permit the absolute volume of soil air per cubic foot to be calculated at each date of sampling; so as to give the total pore space, the absolute water capacities, and the weights per cubic foot of water-free dry soil.

The soil temperatures have been determined weekly on the same day in the four localities for the eight types of soil at depths of 6 inches, 12 inches, 24 inches, and 36 inches, the records extending through the entire season. A continuous record of the soil temperature at 1 foot below the surface under the corn on the eight types of soil has also been obtained. A continuous record of the temperature in a closed shelter 4 feet above the ground in the field of corn growing on one of the soil types in each locality has also been obtained. Likewise a continuous record of the evaporation from 11 square feet of soil kept continuously saturated by capillarity has been kept for one of the soil types at each of the four stations. So, too, has the total evaporation from ten stalks of corn growing on one of the soil types at each station been measured.

The amounts of readily water-soluble salts which could be recovered by a three-minute washing in distilled water have been determined for the different soil types under the different fertilizations and at different times during the season for depths extending to 4 feet by 1-foot sections. Samples of the corn and potatoes growing upon the ground were collected at the times the soil samples were taken, under the different fertilizations, and these have been examined for the kinds and amounts of water-soluble salts they contained, so as to be able to compare these with those found in the soil moisture upon which the crops were grown.

The fallow area was maintained between each crop area on the different soil types so as to get a measure of the amounts of water-soluble salts which might be developed and retained by the different soils under the different treatments where no crop was present to influence in any manner what might form or accumulate through a capillary rise of moisture from below.

Samples of soil have also been taken directly under hills of corn and potatoes and at points between rows farthest removed from the hills so as to be able to compare the differences in soil moisture and in water-soluble salts with those of the fallow ground where no influence of crop has been felt.

The relative rates of nitrification under like fertilizations and like physical relations have been measured for the different soil types. A study has also been made of the capillary movement of water-soluble salts as influenced by methods of tillage, in order to ascertain in how far the position of water-soluble plant food may be influenced or controlled by practical methods.

We have measured the relative powers of the different soil types to retain water-soluble salts contained in a solution passing over or through them, as always happens when fertilizers are applied to fields and rains follow which may produce percolation, and which takes place in all soils during periods of protracted dry weather when large amounts of water are evaporated from the surface and the supply is kept up through the capillary rise from below.

In another series of studies, instead of simply washing the soil sample three minutes in distilled water a single time, we have repeated the washing of the same sample eleven consecutive times in order to obtain some idea of the amounts of water-soluble salts which are recoverable by the use of distilled water only.

We have studied the textural differences of the soil types, measuring the relative permeability of the different types to air, the effective size of the soil granules, and their comparative resistance to tendencies to break them down in such a manner as to result in imperfect soil ventilation.

Permit me to present as concisely and briefly as I may some of the results secured by these studies, and to point out their practical bearings.

Beginning with the results which have come from the physical investigations, we have found that, generally, the Southern soils are much more compact, especially at the surface, having a much higher dry weight per cubic foot, and much smaller pore space and absolute water capacity. To illustrate: The two Janesville soils and the two Lancaster soils had a combined mean dry weight in the spring of 60 pounds per cubic foot, while the two Maryland and Goldsboro soils had a mean weight of 76 pounds, or 16 pounds more per cubic foot. At the end of August the northern and middle-west soils weighed 74 pounds per cubic foot, while the coastal-plain soils had an average mean weight of 84 pounds, being 10 pounds higher. The pore space of the northern soils is thus much larger than that of the southern soil, the amounts being 64 per cent for the former and 54 per cent for the latter. This difference in the pore space has a very important influence on these soils, and I have no doubt that it is a very important indirect factor in determining the relative agricultural values of the soils in the two regions.

In the second place it has been shown that the northern and middle-west soils are not only better granulated, but the tenacity of granulation is appreciably stronger, and these differences again are important indirect factors in determining their relative agricultural values. The larger pore space and coarser granulation provides greater capacity and better facility for the storing of the rain as rapidly as it falls, and as a consequence of this difference there is much less surface drainage, less surface washing of fields, and less loss of water-soluble salts in proportion to the rainfall from the northern and middle-west soils. The smaller pore space, the closer texture, and the feebler granulation, combined with the heavier rainfall of the South, all conspire to produce the excessive surface washing of the fields so generally destructive in the South. Whenever a heavy rain falls there the close texture and feeble granulation of the soils result in the surface pores of the field becoming quickly so completely closed that the soil air finds little opportunity for escape, and as a result of this the water can only enter by the slow process of capillarity, greatly opposed by the trapped air. The result is that the surface soil, after having lost much of its coarser granulation, is more easily taken up by the water held on the surface during rains, and is then carried with the water-soluble salts, which have accumulated by capillarity and evaporation, into the drainage channels, thus giving the muddy waters so characteristic of southern streams.

What, then, shall be done to establish and maintain a deeper openness and a coarser and stronger granulation in the soils of the South, that less of the most valuable surface soil, less of the rainfall, and less of the water-soluble fertility shall be directly and immediately borne away in the surface drainage with every heavy rain?

The temperature of the soil at Goldsboro has averaged for the entire growing season 79.4° at 6 inches, 74.9° at 12 inches, 73.4° at 24 inches, and 72.3° F at 36 inches between 1 and 3 o'clock p. m. At Upper Marlboro it has averaged 7.2° colder at 6 inches, 5.2° colder at 12 inches, 5.5° colder at 24 inches, and 6.6° colder at 36 inches. At Lancaster the soil temperature has been 11.6° colder than at Goldsboro at 6 inches, 9.5° colder at 12 inches, 9.6° colder at 24 inches, and 10.5° colder at 36 inches. At Janesville the mean soil temperature has been 15.3° colder than at Goldsboro at 6 inches, 15.4° colder at 12 inches, 13.4° colder at 24 inches, and 14.8° colder at 36 inches.

Differences in soil temperature such as these are enough in themselves to cause measurable differences in rates of nitrification in the different soils. They would be considered important differences in greenhouse work also, but just how far these differences, under field conditions, may have affected quantitively the yields or the quality of the product produced we can not at present say. It seems at least probable that the differences have been influential in determining the number of days required for maturing the crops.

When the two soil types in each locality are compared the differences in temperature at Goldsboro and at Upper Marlboro are about 2° F. throughout the zone of 3 feet, the more productive soils in each locality being the colder. In the case of the two soil types at Lancaster and the two at Janesville the differences in temperature have averaged a little less than 1°. As would be expected in all four regions the soils having the least water capacity, or those which are most sandy, have had the highest temperature.

It is reasonable to expect that the temperatures above ground which are influential in determining plant growth are those of the interior of the plant itself rather than those of the atmosphere which surrounds the plant, and as these, especially during sunshine, are quite different the temperature of the air at the place can not be taken as indicating the temperature of the growing plant. It is not an easy matter to get with accuracy comparable temperatures from the plant itself, and on this account we have set up in each of the four regions in the corn on one of the soil types a thermograph, inclosed in a cylindrical galvanized-iron shelter provided with a conical top, the shelter having the same form and dimensions at the four stations and all set at 4 feet above the surface of the ground, so as to record the temperature in the cornfields at about the mean height of the corn plant.

The mean temperatures of these shelters for seventy days, beginning June 15, are: For Goldsboro, 104.3°; for Upper Marlboro, 96.5°; for Lancaster, 90.1°, and for Janesville, 87.7°. While these temperatures are not to be supposed to be the temperatures of the corn plants in the four regions, they do probably represent their comparative temperatures and are probably nearer the actual temperatures of the plant than that of the atmosphere would give, the figures, however, being probably a little higher on account of the influence of evaporation in lowering the temperature not being felt in the shelters except when wet from rain or dew.

The Upper Marlboro record shows an average temperature 7.8° below that at Goldsboro; the Lancaster record 14.27° lower, and the Janesville record 16.8° lower at 2 o'clock p. m. At 6 o'clock a. m. the mean temperature at Goldsboro for the same period was 69.7°; at Upper Marlboro, 64°; at Lancaster, 64.6°, and at Janesville, 58.°, making the mean range of temperature during this period about 35° at Goldsboro, 33° at Upper Marlboro, 26° at Lancaster, and 30° at Janesville.

The total evaporation from a continuously capillarily saturated surface of the soil evaporimeter at Goldsboro was 23.92 inches between May 11 and September 22, or at the mean rate of 2.12 inches, or 11 pounds per square foot per ten days; at Upper Marlboro the rate was 1.92 inches, or 9.8 pounds per square foot per ten days; at Lancaster the rate was 1.53 inches, or 7.96 pounds per square foot per ten days, and at Janesville it was 1.8 inches, or 9.38 pounds per square foot per ten days. The number of inches of water evaporated from the four evaporimeters stands: 23.92 inches for the one at Goldsboro; 27.27 inches at Upper Marlboro; 21.74 inches at Lancaster, and 25.26 at Janesville.

From areas exactly equal to those of the soil evaporimeters and of the same soil, but upon which ten stalks of the "Iowa Gold Mine" corn matured, the total evaporation at Goldsboro was 25.07 inches, where the yield computed per acre and at 15 per cent moisture of ears and stalks was 9.8 tons; at Upper Marlboro the evaporation was 20.23 inches for a yield of 2.6 tons per acre; at Lancaster it was 24.49 inches for 7.4 tons per acre, and at Janesville 26.81 inches for a yield of 12 tons per acre of ears and stalks computed to 15 per cent of moisture. These yields per acre on the evaporimeters are from one and one-half to four times that secured from the fields on the subplats to which no fertilizers were added. These relatively large yields are due to the facts that only the surface 9 inches of soil were used to fill the evaporimeters, that more plants were grown per unit area, and that a constant supply of water was maintained in the soil. A closer stand upon the ground was made in these trials, because it was desired to tax the capacities of the different soils to their maximum limits of production, the comparative feeding power of the soils being the primary object of this series of observations. In order that an abundance of sunshine should be provided for this closer stand, the evaporimeters were located on the fallow ground rather than in the cornfields surrounded by the field corn.

When the rate of evaporation is expressed in inches per day for the whole period of growth of the crop it is found to be at the rate of about 2.4 inches per ten days at Goldsboro, 1.6 inches at Upper Marlboro, and 1.8 inches for both Lancaster and Janesville, computed to the actual area of the soil occupied by the plants. The rate of evaporation at Janesville was a little higher than that at Lancaster, the difference being about 2 per cent. The rate at Goldsboro, however, was appreciably higher than either of the other places, it being about 20 per cent above the average for Lancaster and Janesville.

From these results it appears that for the United States east of the Mississippi the mean rate of evaporation from June to September, inclusive, from a wet-soil surface, kept saturated capillarily, is not very different in different portions, and that the average is about 0.96 of a pound per square foot per day, or 0.19 inch.

The mean field yields secured from the eight soil types, placing the four southern soils in one group and those of the North in a second group, stand: 33.586 bushels to 64.324 bushels of shelled corn per acre, computed to 10 per cent moisture, and 78.356 bushels to 213.146 bushels of potatoes per acre. It is thus seen that the yield of corn on the northern soils has been nearly double and that of the potatoes has been 2.7 times the yield of the southern soils, or for the two crops combined the northern soils have given a mean yield in bushels per acre 2.47 times the yield secured from the southern soils under conditions in every way alike, except those due to climatic differences. These ratios of yield are clearly not the results of bad management of the southern soils, because for both corn and potatoes they have been notably larger than those usually obtained. The yields of the northern soils, while good for the corn, are not large for favorable conditions, and for the potatoes the yields are small rather than good for favorable conditions of growth. It is perhaps not improbable that the smaller yield of potatoes at the South has been partly the result of a too high soil temperature, but otherwise the temperature relations have been more favorable to good yields in the South than in the North. The distribution and quantity of rainfall during the growing season was generally favorable to good yields, except at Lancaster, where the early season was too dry and the later too wet and cold. The rainfall at the four stations between April 29 and September 10 was 19.44 inches at Goldsboro, 19.78 inches at Upper Marlboro, 18.87 inches at Lancaster, and 18.75 inches at Janesville; and there was no period of ten days after May 24 with less than 0.35 inch of rain at either station. So, too, there was no 10-day period at either station with more than 3.84 inches, while the heaviest rainfall during any one day was 2.52 inches at Lancaster.

The absolute amounts of soil moisture carried by the different soil types, when expressed in inches for the surface 4 feet, have not been very different, the total mean for the season in the surface 4 feet having been 13.37 inches in the southern soils and 14.76 inches in the northern, making a total difference of only 1.39 inches, or the equivalent of 0.45 inch of rainfall per foot of depth. In the surface foot the northern soils have carried a mean of 3.03 inches of soil moisture, while the southern soils have carried a mean of 2.29 inches, the difference being equivalent to 0.74 inch of rainfall. There is, therefore, comparatively little indication that the differences in yield which have been secured are due to differences in the absolute amounts of soil moisture present in the different soil types upon which the crops are grown.

The mean yields which have been secured under the different fertilizations adopted have been, using round numbers, for corn, 57 to 24 bushels per acre, making 33 bushels in favor of the northern soils where nothing was added; 64 to 32 bushels, making 32 bushels in favor of the northern soils where 5 tons of manure were added per acre; 69 to 38 bushels, making 31 bushels in favor of the northern soils where 10 tons of manure were added; 69 to 45 bushels, making 24 bushels in favor of the northern soils where 15 tons of manure were added, and 64 to 31 bushels, making 33 bushels in favor of the northern soils where 300 pounds of Acme guano were added.

The mean yields of potatoes, in round numbers, have been 169 to 54 bushels per acre, making 115 bushels per acre in favor of the northern soils where nothing was added; 211 to 82 bushels, making 129 bushels in favor of the northern soils where 5 tons of manure were added; 236 to 96 bushels, making 140 bushels in favor of the northern soils where 10 tons of manure were added; 254 to 97 bushels, making 157 bushels in favor of the northern soils where 15 tons of manure were added; and 213 to 79 bushels, making 134 bushels per acre in favor of the northern soils where 300 pounds of Acme guano were added.

With the southern soils 5, 10, and 15 tons of stable manure have increased the yields of corn at the rates of 7, 14, and 20 bushels per acre, while the yields of potatoes have been increased at the rates of 28, 42, and 43 bushels per acre. With the northern soils 5, 10, and 15 tons of stable manure have increased the yields of corn at the rates of 7, 12, and 12 bushels per acre, and the yields of potatoes at the rates of 42, 67, and 85 bushels per acre. The larger increase of potatoes per acre as compared with the corn is apparent rather than real, on account of the fact that the corn is a much more concentrated product, containing much less water. If we compute the yields of shelled corn to the same per cent of water which the potatoes contain the increases in yield associated with 5, 10, and 15 tons of manure will stand, for the southern soils: 59, 116, and 169 bushels per acre—using a weight of 60 pounds per bushel instead of 56—while for the northern soils the increase would be 59, 103, and 103 bushels per acre.

It thus appears that the stable manure has produced an increase in yield of corn on the southern soils nearly proportional to the amounts of manure added, but the largest amount not being quite as effective, as indeed was to be anticipated. Relatively, on the northern soils the increase has not been so nearly proportional to the amounts of manure added, which again is as should be expected; first, because these soils carry more plant food in water soluble form than the southern soils do, and second, because the season this year has been less favorable to corn in the North than it has been in the South. Again, the manure has been relatively more effective on the northern soils in increasing the yield of potatoes than it has been on the southern soils, and this relation, in my judgment, is chiefly due to the fact that the climatic conditions have been more favorable for the potato crop in the North than they have been in the South, especially this year, which in the North has been unusually cool.

There has been made a very critical and somewhat extensive comparison of the amounts of plant food which might be recovered by a single three-minute washing, in distilled water, of these soils, and it is found that as an average of 48 separate determinations of each of the surface 4 feet of the eight types of soil at the beginning of the growing season, in the middle of the growing season, and at its close, that in the aggregate for the 4 feet it was possible to recover by a single three-minute washing more than 207 pounds of potash per acre from the northern soils as against 138 pounds per acre from those of the South, making a difference of 69 pounds per acre more in the soils which have given the largest crops. Of lime, expressed as Ca, there was washed out with the distilled water more than 795 pounds per acre from the northern soils as against 300 pounds from the soils of the South, making for this ingredient a difference of 495 pounds per acre more for the northern soils. In the case of magnesia, expressed as Mg, the amounts stand more than 273 pounds for the northern soils to 138 pounds for the southern. Of NO_3 the amounts are 285 pounds to 94 pounds. Of HPO_4 the amounts stand 204 pounds for the northern to 111 pounds for the southern soils per acre. Of SO_4 there was recovered at the rate of 1,435 pounds per acre from the northern soils against 600 pounds per acre from those of the South.

In addition to the potash, lime, magnesia, nitrates, phosphoric acid, and sulphuric acid, we have determined the bicarbonates, chlorides, and silica, and when the total water-soluble salts recoverable by a single three-minute washing in distilled water from the surface 4 feet of the two groups of soils are taken the amounts stand more than 3,846 pounds for the northern soils as against 1,635 pounds per acre for the southern soils. These amounts are computed in round numbers on the basis of 3,000,000 pounds as the mean weight of an acre-foot of dry soil, whereas the actual mean weight of the surface 4 feet is very nearly 4,000,000 pounds. The amounts given, therefore, are considerably under the absolute values.

In another series of determinations of the surface foot only, covering six different periods, the mean total salts recoverable by three-minute washings in distilled water were 482.45 parts per million of the dry soil as a mean for the two northern areas, and 192.73 parts per million for the two southern areas, making the amount from the northern soils 2.48 times that from the southern soils.

Taking the dry weight of the surface foot at only 2,000,000 pounds, which is much less than the lightest soil, the soil moisture of the surface foot carries more than 965 pounds per acre at the North as against 385 pounds per acre for the South.

From several lines of evidence it has been demonstrated that a three-minute washing of soils in distilled water, which we have adopted arbitrarily as a matter of convenience for our comparative studies, does not recover all of the water-soluble salts which are present in these soils. In order to form some idea of how large amounts of water-soluble salts may be recovered by repeated washing in distilled water, two series of observations have been made by repeatedly washing the same sample in distilled water eleven consecutive times, with alternate drying of the samples between each washing. With this treatment applied to the eight soil types under comparison, there were recovered from the surface foot alone of the northern soils at the rate of 699 pounds of potash (expressed as K) against 613 pounds from the southern soils. Of lime, there were recovered 2,179 pounds from the northern and 512 pounds from the southern. Of magnesia, 873 pounds from the northern as against 290 pounds from the southern. Of nitrates, 431 pounds from the northern as against 211 pounds from the southern. Of phosphates (expressed as HPO_4), 984 pounds from the northern as against 408 pounds from the surface foot of the southern soils, and of SO_4, the amounts stand 1,800 pounds from the northern to 736 pounds from the surface foot of the southern soils.

To make sure that such differences as these were not accidental, or mere coincidences, there have been brought together into comparison five independent series of determinations, three of which represent the amounts recoverable by single three-minute washings, while the other two combine the amounts recovered by eleven repeated washings of the same sample. Two of the three sets of results obtained from the three-minute washings are averages of long series of observations, while the other one is a single series of determinations made on a set of composite samples composed of a large number of soil cores. So, too, with the two series of eleven-times-washed soils. These are single determinations made on composite samples of many cores.

When the total water-soluble salts recovered from these five series are compared, taking the amounts recovered from the southern soils as 1 in every case, the ratios stand: 2.22 to 1, 2.48 to 1, 2.09 to 1, 2.37 to 1, and 2.78 to 1, the last two ratios being the eleven-times-washed soils.

It must be clear, I think, from the ratios found for these two groups of soils that there is a real difference between them expressed by the ratios; and that, if the absolute amounts of water-soluble salts in these two groups of soils are not in the ratios represented, then the amounts which can be washed out from the soils by using distilled water, as has been done, are represented by the ratios.

Taking the mean value of these ratios, the total amounts of recoverable water-soluble salts by the methods used stand 2.39 for the northern soils to 1 for the southern, while the mean yields of corn and potatoes from these two groups of soils, expressed in bushels, stand, possibly as a mere chance, very nearly in the same ratio, namely, 2.47 to 1.

When the process of washing in distilled water is reversed and a solution of known salts is passed through the soils by percolation, or they are simply brought in contact with the solution, the different soils have markedly different effects upon the solution, retaining the ingredients of the solution in varying amounts.

In one series of observations on the eight soil types under investigation, after samples of them had been eleven times washed in distilled water by percolation, there was passed through the same samples three times in quick succession a quantity of a solution equal to five times the dry weight of the soil which carried 300 parts per million of K in solution, 340 parts of lime, 300 parts of magnesia, 470 parts of NO_3, 100 parts of HPO_4, and 1,600 parts of SO_4, the salts used being calcium phosphate ($CaHPO_4$) calcium nitrate, potassium sulphate, and magnesium sulphate. It was found, after passing this solution three times through the eight soil types, that they had retained, as a general average for the eight soils, 427 parts per million of their dry weight of K, 660 parts per million of Ca, 753 of Mg, 269 of NO_3, 120 of HPO_4, and 1,032 of SO_4. Even a freshly powdered granite, composed of orthoclase-feldspar, quartz, and muscovite mica, removed from the same solution 230 parts per million of its dry weight of K, 575 of Ca, 163 of Mg, 80 of NO_3, 69 of HPO_4, and 125 of SO_4, and yet in each of these trials the layer of material through which the solution percolated was only about three-sixteenths of an inch thick. The solution passed through each time in less than fifteen minutes, and was in contact with the soil grains less than forty-five minutes.

In other words, by using a solution of the same order of strength as that which the soil moisture would have possessed had it carried in solution all of the salts which were recovered by the eleven-times washing, the identical samples became again charged during the short treatment with from one to three times the amounts of each of the ingredients which had been recovered from them by eleven-times washing in distilled water. Even the freshly crushed granite charged itself, under the same treatment during the brief period of percolation, with more of each ingredient, except magnesia and SO_4, than had been recovered, on the average, by the eleven-times washing of the 8 soil types. The solution, in percolating through the samples of the northern soils, lost nearly double the amount of potash that it did in percolating through the samples of the southern soils.

Through determinations of the water-soluble salts carried in the sap of corn and potatoes growing upon the 8 soil types at the time the soil samples were taken at the close of three periods—8, 12, and 14, taken June 15, July 13, and July 31, respectively—it was found that the plants of the northern soils carried as a mean 25,254 parts per million of their water-free dry weight of potash as against 23,900 parts per million carried by the plants of the southern soils; the lime stood 2,824 parts per million of the plants on the northern soils, and 1,891 parts per million of those on the southern; the magnesia stood 4,224 for the former and 1,753 for the latter; the NO_3 stood 18,985 to 7,065; the HPO_4, 5,374 to 5,263; the SO_4, 3,243 to 1,939; the HCO_3, 10,209 to 9,418; the SiO_2, 164 to 132, while the amounts of chlorin stood in the reverse order, 5,495 parts per million in the plants on the northern to 5,972 parts per million in those of the southern. It is also true that the amounts of chlorin recoverable from the southern soils have been found larger than those in the northern soils, although the amounts have been small in both cases.

The mean total water-soluble salts was found to be 7.58 per cent of the dry weight of the corn and potatoes grown on the northern soils and 5.73 per cent of the dry weight of the plants grown on the southern soils. Since the dry matter produced on the northern soils has been more than double that produced on the southern soils, it follows that the absolute amounts of water-soluble salts recovered by the crops from the soils and still unassimilated at the times of the sampling must have been more than double from the northern soils what they were from the southern soils. We have here, therefore, an entirely independent line of evidence showing that there is a fundamental difference between these two groups of soils which has permitted the crops to acquire from the soil moisture in the same time more than double the amounts of water-soluble salts from the northern soils of what were acquired from the southern soils. Such agreement, too, gives us confidence in the character of the plan of work followed through the season, in the reliability and sensitiveness of the methods developed for the work, and through it we are forced to see with what industry, skill, and faithfulness the essential details have been handled by the men who have done the work.

In their relative capacities for nitrification, too, there has been found a marked difference between the four soils at the South and the four in the northern group. Samples from the surface foot of the eight types of soil brought to the optimum water content and kept for seventy days under like condition had acquired at the end of that time, as indicated by single three-minute washings in distilled water, for the northern soils, 169, 162, 177, and 143 parts per million of their dry weights of NO_3 while the southern soils had acquired 70, 89, 71, and 121 parts per million of their dry weights of NO_3 or an average for the four northern soils of 163 and for the four southern soils 88 parts per million, the northern soils having acquired double the amounts of NO_3 at the end of seventy days that the southern soils had acquired.

Further than this, the two groups of soil differ in a marked way in the amounts of organic matter which they carry recoverable by washing in distilled water, the northern soils carrying much the larger amounts, but our methods for determining these amounts are not yet sufficiently perfected to give us reliable quantitative values to the differences between them.

In regard to the difficulties with the southern soils and improvements in their management, it can be said that the most fundamental difficulty with them is their imperfect and feeble granulation. It is this imperfect and feeble granulation which gives the southern soils their great tendency to wash, their small and greatly subdivided pore space, and consequent imperfect drainage, aeration, slow capillary movement of water, and the shallow depth of the root zone of crops. All of these differences conspire to give a low efficiency to the rainfall of the South and to force the crops to suffer from drought when the third and sometimes even the second foot of soil is too wet for best crop conditions.

The southern soils are also deficient in organic matter, and, I believe, also in available water-soluble salts. These difficulties are in part due to bad management, in part to climatic differences, and I have no doubt partly also to difference in origin, for in this they stand, geologically speaking, in striking contrast with the newer glacial soils of the North which have been formed so largely by the mechanical grinding and mixing of fresh rock materials from widely varied sources rather than by chemical disintegration in place.

The best way to overcome these defects can not be briefly stated except in the most general way. It is certain that much may be done by adopting different methods of tillage and different tools. I am satisfied that deeper plowing and a more complete and deeper turning under of the roughage which grows upon the fields is imperative. Much more attention must be given to systematic rotation of crops, and the maximum possibility of agriculture will never be reached in the South, as it never has been in the North, until live stock is more extensively introduced and proper attention given to it as an adjunct to maintaining soil fertility.

I believe we have demonstrated this year that at Goldsboro, N. C., the yield of corn may be easily maintained at 30 bushels per acre instead of at 15 or less, as is now the case. Our heavier yields this year there have been due more largely to the seed we have used and to the closeness of planting than to the treatment given the soil, although this, too, has been important. The corn was planted 42 inches each way, with 3 to 4 stalks in a hill, but using the small variety of corn which develops much less shade. Side by side with the "Iowa Gold Mine" was planted the local variety of corn, both at Goldsboro and at Upper Marlboro, but with the same result—that it failed to develop the proper ratio of ears to stalks, and for the simple reason, I believe, that too much shade was developed by the heavy stalks of the Southern corn, for we have the same results in the North even in the long, warm seasons, no matter how strong the soils may be, and we get the same results, too, with the smaller varieties of corn if they are planted too close.

The paper was discussed by R. J. Redding, of Georgia, and B. W. Kilgore, of North Carolina, who questioned whether the conditions of the northern and southern soils were strictly comparable.

The second meeting of the Section on Agriculture and Chemistry was held in the banquet hall of the Shoreham at 3 o'clock p. m., Wednesday, November 18.

The section was called to order by its chairman, C. G. Hopkins, of Illinois.

Extension and Practical Application of Soil Surveys.

Milton Whitney, of the Bureau of Soils, U. S. Department of Agriculture, spoke as follows:

Mr. Chairman and Gentlemen of the Section: The work of the Bureau of Soils and the progress of the soil survey is so well known, scattered as it is through so many States, that it is hardly necessary to dwell upon the purpose of the work. It will interest you possibly to hear of the progress that has been made up to this time. We have surveyed and mapped 122 areas. The work has been carried on in 41 States and Territories. We have surveyed up to the present time 54,000 square miles, or about 34,000,000 acres. The average size of an area is 350 square miles, and the average cost per square mile has been $3.10, making about $1,000 the cost for the survey of the average-sized area.

In addition to the actual field work of the survey provided for by Congress in a general fund for the maintenance of the Bureau of Soils, from which an allotment was made this year of about $80,000, there is also provision for the printing of the reports and maps. This is done by Congress in such a way that we have no control over the expenditure of the money. The printing of these reports is very expensive, and as a matter of fact the printing of the reports and maps costs just about as much as the work itself. It has been possible through the more efficient organization of the Soil Survey to steadily reduce the cost of the field work. We keep our parties in the field now all the year—in the northern States during the summer and in the southern States during the winter. We have just issued a statement of our winter assignments, taking all our parties from the northern areas into the Gulf States. We have twenty parties working thus continuously all through the year, and it is needless to say that we have accomplished and are doing a large amount of work. The map here shows the location and size of the areas that have been surveyed up to this time.

Three reports have been published and the fourth is about to come out. Reprints of many reports on the separate areas have already been received. The fifth report is in preparation and will be ready to go to the printer about the middle of February. Congress has ordered a large edition of 17,000 copies of the bound report for distribution. This gives each Representative only about 16 copies, and each Senator about 33 copies, and the Department of Agriculture 8,000 copies. The Secretary last year recommended a change in the method of publishing and distributing the reports, asking that leave be granted to publish advance sheets, so that reports of each area can be sent to the printer as soon as the work is completed instead of having to wait until the middle of February, when the year's work is finished, and thus keeping the reports in the office from eight to twelve months after the field work is completed. The bill failed of passage in the last days of the last Congress, but it is probable that such a change will be enacted at the coming session. This will give each Representative in whose district the survey is made 2,000 copies, and will give each Senator from that State 500 copies, and the Department of Agriculture 1,000 copies for its use. In the edition of 17,000 copies the maps cost about 9 cents apiece, so that a reprint is not very expensive, although the aggregate cost of this large edition is very great.

With twenty parties continuously in the field, spending from three to six or nine months in an area, the Bureau is getting hold of a vast fund of information about localities, about the possibilities of changing the methods of cultivation, and the possibilities of introducing new crops and new industries, but in the continual movement of our parties from area to area, it is impossible for them to take the time to impress in any other way than through their reports these facts upon the farmers. It is inadvisable for us to leave them in an area longer than the time necessary to make their survey and finish their report, so that much of the good of the information obtained by the Bureau is lost—is buried—and has little effect upon the people. As you know, matters treated of in reports of this kind are lightly passed over, especially so by a conservative class of farmers such as we have. In many cases it has been possible for us to force these matters upon the attention of the people by actual demonstration work, as, with the introduction of the Sumatra tobacco in the Connecticut Valley; as we are doing in the introduction of the Cuban filler leaf on certain soils that we have encountered in the South; as with the demonstration work we are doing in the reclamation of alkali lands in the West, where it has been taught for years that certain methods could be used for the reclamation of these lands, but no active movement has ever been started for their actual preservation and reclamation. The Bureau is now able, through its appropriations, to take up certain tracts for demonstration. We have three such alkali tracts now in process of reclamation, and we are taking up three more--six tracts in different parts of the country—where we are actually reclaiming alkali fields and are attracting attention that we could not expect to get from the publications alone.

In the classification of the soils of an area and the collection of data relative to the uses they can be put to, it is necessary for us to have all the information we can get through any means that may be necessary as to the use of the soils for crops, and as to the necessity for different methods for their proper and most economical use. One of the most important subjects that has appealed to us, and, as you will recognize, appeals to anyone, is the manipulation and handling of the soil for any particular crop it is desired to grow.

One of the most important problems in connection with this has been the relation of the chemistry of the soil to crop production; a subject that has vexed the world for the past seventy-five or one hundred years. What relation is there between the plant food in the soil and the yields obtained by ordinary methods of cultivation? It has seemed to me that one of the most important lines of work that the Bureau could take up, an essential feature of the work of the Bureau, was to do all we could to develop and extend information along these as well as along physical lines. We have just published, as you are all aware, a bulletin, No. 22, on certain conclusions we have arrived at from investigations on the chemistry of the soil as related to crop production.

Since this bulletin was published we have continued our investigations and have obtained many new results, and as I have been aware that a great deal of interest has been shown in this bulletin and some misunderstanding, perhaps, of the purpose and scope of the work, it has seemed to me that it would be well in connection with my talk to-day to take you into my confidence a little bit more, I regret to say, than I would otherwise like to at this stage of the work. We are not quite ready to publish our results; the investigation is not completed; and I speak of these matters rather unwillingly, because I should like to have presented them as a finished result rather than in the preliminary way in which I shall have to ask you to receive them now.

The subject was left in Bulletin 22 with the general statement that our investigations showed no necessary relation between the amount of plant food as determined by our methods and the yields of crops; that is to say, that high yields were not associated necessarily with high amounts of plant food, and the reverse; that the use of fertilizers, which we all admit are beneficial to the soil, could not under this reasoning be for the amount of plant food they added to the soil, but it has seemed evident that the effect must be due to some other cause, which, as the coroner's jury would say, "is unknown at present to the jury." Further, it has seemed evident to us that the effect was probably associated with the physical condition of the soil, as there were certain evidences that would lead us to think that the trouble, in many cases at least, was a lack of a suitable moisture supply for the needs of the crop. For example, on our Susquehanna clay which we find in large areas between here and Baltimore, the vegetation has the desert characteristics; the leaves protect themselves against evaporation, and only certain classes of plants are found, although we know that the soil has an ample supply of moisture as measured by the moisture determinations made in the laboratory. We have long recognized that the infertility of this soil is not associated with a low food content, as analyses had shown no difference either in the physical or in the chemical properties as compared with the limestone soils of Pennsylvania and western Maryland.

Starting from this point, therefore, where Bulletin 22 left off, we made a thorough investigation of the physical properties of the soils with particular reference to the movement of water, believing, as we did at that time, that fertility was at least largely dependent upon the movement of water with its dissolved salt content to the roots of the plants. We thought we should find that certain soils were unable to supply the necessary amount of plant food, simply because they were physically unable to deliver to the plant an adequate amount of this nutrient solution. After a very thorough investigation of the problem, we found, to our surprise, that there is practically no difference in the rate of movement of water in soils, even of very different texture, when you have the amount below the optimum and considerably below the point of saturation of the soils. We had to devise new methods for the study of this subject, for the old methods of investigation, where we allow water to percolate through the soils or where we allow water to climb up by capillary attraction through dry or moist soils, give us conditions that are entirely unlike field conditions. We never grow an agricultural plant under such conditions at all. It is, for the most part, of little interest to us to know what amount of water the soil can move if there is an optimum maintained at all times. The important thing was what the soil would deliver after it had become partially dried—that is, after it was approaching the drought limit. There was the place where we would expect to find the individual characteristics of the soil that would affect crop production, so that our aim was to study the movement in soils far short of saturation and below the optimum water content for the plant.

It will be impossible, in the short space of time that I have now, to go into the details of the investigation. That will all be presented in sufficient detail in the publication that we will probably issue in a short time. Suffice it to say that we have found that, in a soil below the point of optimum water content, the water has very different properties from what we recognize in water in mass. It does not obey the ordinary physical laws as we recognize them in capillarity, nor does it obey the laws of electricity as we recognize them in solution in mass. In other words, water in a slightly moist soil has lost some of the properties that we attribute to water in mass. Now, why this is we do not know. The electrical conductivity is very much higher in this water; it is fifteen times as high in a moderately moist sand as it ought to be. We do not know where it has gone; we do not know what has become of it; we do not know what has happened to it. It may be due to the thinness of the film. We have not been able to get these results with soap bubbles, however thin we may blow them. We believe that the film in the soil is much thicker than in the bubble with which we have compared it. At any rate, all I want to tell you now is that the electrical properties of the water in a moderately moist soil are different from those in the saturated soil, and different from the properties of liquid in mass. Another thing is that moisture in a moderately moist soil that is below the optimum quantity for plant growth does not obey the ordinary laws of capillary movement. There is a change. What it is due to we do not know, but the movement in these moderately moist soils is entirely different from the relative rate of movement of water in percolation experiments or in the capillary rise through moist or dry sands.

As, however, we have found no relation between the delivery of water from a dry and moderately moist soil, whether it be a light sand or an apparently impervious brick clay, it was obvious that it was not in this respect that we should look for the solution of the question of fertility. However, to determine definitely, once for all, whether the fertility of the soil, using this word as I do in this connection to indicate the possibility of plant growth from the composition of the soil—I am using it in a limited sense to-day—to see if this was related to the physical properties of the soil or to the chemical properties, we made an extract of the soil according to a conventional method of analysis, that is, by using 1,000 grams of soil and 1,200 cubic centimeters of water, stirring for three minutes, allowing twenty minutes to settle, and filtering through a Pasteur filter, which removes the clay and incidentally the bacteria. Then we grew plants in the water culture so prepared and found that the plants grown in these solutions exhibited the same characteristics as the plants grown in the soils from which the solutions were derived, showing that we had transferred the limiting conditions of fertility from the soil into the solution that had been prepared. It was therefore evident that the limiting conditions of fertility did not exist in the physical properties of the soil.

With that indication before us we again took up the investigation of the chemical constitution of the soil, directing our attention particularly to the molecular combination of the salts—that is to say, whether the character of the salt itself had any effect upon the plant, as we believed from our investigations in Bulletin 22 that the actual amounts of potash, lime, and phosphoric acid were not associated ordinarily with crop production.

The first thing that we found was that it was possible to determine easily the functional activity of the plant in these different solutions, prepared from good and from poor soils—that is, from fertile and infertile soils—by growing them either in soil extracts or in the soil itself, by measuring the relative transpiration of the plant. Transpiration, as you will observe, is in a sense a measure of respiration—that is, it can be taken as a relative measure of that if you have plants under the same conditions of sunlight, heat, and ventilation. Transpiration is the evaporation of water from the leaves. It is not an essential thing in itself, but accidental and incidental to the respiration of the plant, just as the loss of water through the lungs is incidental to the breathing of a person. It can, however, be taken as a measure of the functional activity of the plant, and we have so used it.

One of the first things we found was that plants grown in extracts of poor soils, or on the poor soils themselves, transpired much less water than plants grown in the good solutions or on the good soils. They were functionally less active. It takes about six to nine days to notice the difference, however. After that the plants in the poor solutions evidently suffered. They did not act as though there were a toxic substance in the soil or as though they were poisoned, because the daily rate of transpiration would then have gone up to a maximum and fallen again, as we have frequently observed. On the contrary, transpiration went right on, but the daily increment of solution used—that is, the daily plant food used—was greater always on the good soil than on the poor soil. This difference appeared usually from six to nine days after the seedlings were started, and the curves representing the transpiration continued to diverge in a very marked way, so that soils can be easily recognized by their behavior to the transpiration and respiration of the plant. Now, it seemed important to find out the cause of this, and it was finally located in the effect of the salts on the roots. In the solutions that showed a very low transpiration, the tips of the roots—the growing part, the part that absorbs water—had thickened up and corked over. It was not able to absorb as it did before. On the contrary, roots growing in the solutions from the good soils remained perfectly clear, transparent, and healthy, and showed no tendency to this corking or thickening or hardening or whatever it may be. It appears that the salt itself, or the complex that may exist in the soil combination, or whatever it may be that exists in solution in the soil, may have a more or less irritating effect on the root, and if it is irritating the root corks over and shuts itself up, so to speak, so that it will get rid of this irritating substance. As soon as the root adjusts itself to this condition, in order to prevent wilting the leaves adjust themselves to the root, so that there is actually less transpiration than if this irritation had not been set up at the root. It is well known to all of you that it is possible to almost entirely prevent the transpiration of water and to starve a plant in a very strong culture solution.

Then one of the important questions was whether the nature of the salt had much to do with this transpiration and with the effects on the roots. For this purpose we made up a number of solutions with potassium, calcium, magnesium, sodium, and ammonium, combined with different acids, to give nitrates, chlorids, phosphates, sulphates, and carbonates, and by adding these same bases in the amounts per million of water, in different combinations with the acids, as, for example, first as nitrate of potash, sulphate of lime, and so on, and then as nitrates of lime and sulphate of potash, and going around changing the character of the salts containing the same amount of essential plant-food bases, we got very different results in the functional activities of the plants. So far as we can see now, the development of the plant, its functional activity, is not dependent upon the quantity of plant food in solution, but upon the character of the plant food. Plants will grow as well—that is, have the same functional activities—in a soil solution which has a resistance of 5,000 ohms in our electrolytic cell as they will in the culture solution made up of these different salts with a resistance in our cell of 250 ohms; that is, there is ten or fifteen times as much plant food in one as in the other, and yet there is no apparent difference in the development of the plant, no apparent difference in the functional activities of the plant. It breathes as well, it feeds as well from these dilute as from the more concentrated solutions; but when we put a trace of lime or a trace of manure extract or a trace of some of the salts that are used in fertilizer work or ordinarily applied to the soil, to either the stronger or more dilute culture solution, we may change, to a marked degree, the functional activities of the plant and make it altogether a different soil or a different solution as regards the growth or development of the crop.

Our experience, since Bulletin 22 was issued, indicates very clearly that the amount of plant food in solution does not affect the character of the crop within very wide limits, but that the character of the salt in this solution, or the character of the salt added to the solution, has an important and remarkable effect in many cases on the development of the plant. It seems as though the potash salts were not needed by the plant as an additional source of food. You can safely use potassium chlorid or potassium nitrate or potassium phosphate or potassium sulphate, although they appear to have somewhat different effects on plants—possibly have different effects on different plants. We have not gone far enough to determine this definitely. But when you add the other potash salts, such as potassium chlorate, which has potash and chlorin associated with oxygen, you get an entirely different effect, and it can not be substituted at all for potassium chlorid. You have the potash and the chlorin, but the potassium chlorate has different properties as a salt from potassium chlorid, and it is unquestionably a fact that the influence of these salts is felt not only through the ions, but through the undissociated portion of the salt, if there be any present. In this respect it is quite analagous to the effect of salts on the human system. We take sodium chlorid as a necessary salt to aid digestion. You can not successfully substitute ammonium chlorid, still less could you substitute potassium chlorate as a source of chlorin. One combination of mercury and chlorin is used as a medicine; another combination is deadly poison to the system; both contain mercury; both have chlorin; it is not in any one of these but in the combination that the effect is felt. So it seems to be in the case of the plant. Potassium sulphate may be healthful; it may prevent the plant from corking up; it may protect it from the irritating condition of the soil. How it is accomplished I do not know, but I have seen the effect. Potassium chromate will cause the plant to cork up very quickly, and will check the transpiration so rapidly and completely that the plant can not adjust itself to its conditions and live, so the plant dies.

Another very interesting thing—a very significant thing—that has developed is that, if the plants are growing with their roots freely exposed to the moist air above the culture solution or to the moist air at the side of the soils, these deleterious influences that seem to exist in the poor soils do not affect them appreciably. In some of our earlier experiments plants were grown in about 400 grams of soil in glass tumblers. The transpiration was measured, but we got no differences from different soils compared with what we got in larger pots. After a great deal of work and a great many experiments had been tried we found that the roots were confined almost entirely to the air space between the soil and the glass formed by the contraction of the soil. The roots formed a network around the soil. They were not actually growing in the soil, but half in and half out of the soil, and the development of the hair roots was most marked. They looked like plumes. Even after weeks of growth they showed none of the characteristics of plants growing in the larger masses of soils or in the soil solutions. Then an attempt was made to see if in the culture solution prepared from the soils, with an equal amount of aeration as in the tumblers, these differences in the different soil solutions would disappear, and the evidence is that they do disappear. That is, if you let the solution trickle down the roots, or if you give the plant an intermittent watering; or, if they are put in test tubes and the water allowed to drop slowly upon them and arrange that the tube when filled be automatically emptied by a siphon, leaving the roots exposed for a time, these differences disappear; we get normal roots in solutions which when grown without that treatment give us a root system that is corked up and undeveloped and impossible of further development. It would seem, therefore, that our position in Bulletin 22 in that respect is confirmed—that the use of fertilizers, at least sometimes, appears to have the same effect as good cultivation, and it appears now that if we have perfect aeration, such as we get in a small volume of soil, and conditions where the root can grow half in the soil and half in the air, these differences disappear, and fertile and poor soils grow plants of equal vigor and feeding capacity. When the soil is removed from the tumbler and dipped in hot paraffin to cut off the supply of air, there is no longer any tendency for the roots to come to the surface as they can get no air there, and, with a soil so prepared by the use of hot paraffin after the plants are started, the characteristics of the soil then appeared as shown in the transpiration.

It appears that with soils of this character you can get better effects, you can improve the functional activities of the plant, either by giving it more air—as by growing it in that small pot, under the conditions described—or by the use of fertilizers and chemicals, which may have the effect on the plant to protect it from this hardening or the formation of cork, or whatever physiological effect it may be which limits and controls the functional activities and feeding capacity of the plant.

It would seem possible, therefore, to develop a method along these lines by which the fertilizer requirements of a soil can be closely determined, as nearly and perhaps more certainly than they could have been by the older methods of chemical analysis that we all have long hoped would be able to solve these same questions. It will never be possible, however, by this or any other method, to tell what can be advantageously used on a soil during a subsequent year. We know that in certain seasons potash will do good; in other seasons phosphoric acid will do good. The character of the season probably has a great effect in modifying the action of these salts in solution upon the physiological activities of the plant. It will never be possible to tell what any particular soil will need unless we know what the character of the season is going to be. The only thing we can hope to do will be to tell what that soil will respond to under certain conditions under which we can place it, and then, I presume, take our chances on having the results come out as we expect them to do under field conditions.

It seems probable, therefore, that we shall be able to develop a method that can be used in the field for the study of the condition of the soil as related to the growth and functional activities of the plant, and that we shall be able, possibly, to determine how far we can change them by methods of aeration or by methods of physical treatment; but certainly, I think, it is going to be possible for us to determine what fertilizers can be used to correct these difficulties under the conditions of our experiment, which is a long way ahead of anything that we have at the present time.

There probably will be a great deal of criticism, a great many questions to be asked, a great many questions to be solved, but I believe this matter can be put on a proper basis and can be thoroughly worked out. One of the questions to be asked is: What is the reason the different forms of phosphoric acid produce different results as to plant growth? Now, it seems to me that is easily answered if we consider that the insoluble phosphate of lime and the reverted phosphate and the acid phosphate of lime are different salts. They are altogether different salts and have different properties—have different properties in solution, have different effects on plants. It seems to me it can not be the amount of phosphoric acid that these various salts add to the soil. The solubility of calcium phosphate is about six parts of lime in a million parts of water. That is strong enough for plants to grow in. It is as strong as many of our soil solutions, so that the plant can get from the solution of the so-called insoluble calcium phosphate enough phosphoric acid for its needs. The effect of these different forms of salts appears to us to be due to some external influence they have upon the conditions of the roots, so that the roots may make a more or less healthy development, and will present more or less of an absorbent surface. You understand that the tips of the roots, which absorb the moisture, do not continue in this state for an indefinite time, but for only a short time. The tip of the root is active but for a few days at most in ordinary soils. After it has existed for that length of time it hardens and becomes nonabsorbent to a great extent, and the tip grows out and presents constantly a new surface for the absorption of its moisture and food material. This is another question that I might have referred to further back in my talk. The fact that these tips are constantly growing makes it relatively unimportant for us to know how much water the soil can deliver at a given point. If the soil were delivering at the roots so many grams per day, we need not assume that it could deliver this quantity continually until the water supply was exhausted, as there would be no object in delivering water at that point, for the root is going to grow and get into another portion of soil where it will get a fresh supply of water and of food.

Without going into a great deal more detail than our time will permit, I think I have given a statement, brief and to the point, of the facts as we have developed them so far governing the fertility of the soil as dependent on this chemical question. It seems to be not dependent upon the amount of material so much as upon the character of the material and the effect of that material upon the absorbent power of the plant. That we can influence this is unquestionable, because the experiments are easily performed, and when this work is presented to the public, as I hope it soon will be, the methods will be fully described, and it will be a simple problem for any one of you to use this method in developing new and important fields of research as to the chemistry of the soil and its relation to crop production. The work is not going to be finished with the publication of this new bulletin; it will have only begun. It is going to open new fields and new ideas and new possibilities of studying this fundamental question of the relation of soils to crop production.

If there are any questions that I have not made clear, or that any of you want to be informed upon, I shall be very glad to have the questions asked.

L. H. Bailey, of New York, asked some questions regarding the specific physiological effect of fertilizers, which Professor Whitney said had not yet been definitely determined.

Chemistry of Soils as Related to Crop Production—Bureau of Soils Bulletin No. 22.[a]

The following paper, by E. W. Hilgard, of California, on this subject, was read by C. E. Thorne:

The following quotations will best define the scope of this bulletin of seventy-one pages and the theses which it is intended to establish and maintain:

Page 7. "The investigations made by the Bureau of Soils during the last ten years have shown that the economic distribution of crops is dependent mainly upon the physical characters of soils and upon climate."

Page 13. "Briefly stated, the results given in the following pages appear to show, contrary to opinions which have long been held, that there is no obvious relation between the chemical composition of a soil as determined by the methods of analysis used and the yield of crops, but that the chief factor determining the yield is the physical condition of the soil under suitable climatic conditions."

Page 63. "The exhaustive investigation of many types of soil by very accurate methods of analysis under many conditions of cultivation and cropping, in areas yielding large crops and in adjoining areas yielding small crops, has shown that there is no obvious relation between the amount of the several nutritive ingredients in the soil and in the yield of crops."

Page 64. "It appears further that practically all soils contain sufficient plant food for good crop yield; that this supply will be indefinitely maintained, and that the actual yield of plants adapted to the soils depends mainly, under favorable climatic conditions, upon the cultural methods, a conclusion strictly in accord with the experience of good farm practice in all countries."

The bulletin contains extended tables showing the results of the analytical work, and at the end a full description of the methods employed therein.

The above four paragraphs, taken respectively from the beginning and the latter part of the bulletin, summarize the conclusions to which, as it states, "the Bureau of Soils has been forced."

These conclusions are certainly startling, to say the least, and perhaps not the least remarkable is the concluding one, which hardly agrees with the impressions left upon the mind of most of those who have made themselves acquainted with the history of agriculture and its past and present practice in the most advanced civilizations.

Were such statements to emanate from a private laboratory on a mere personal responsibility it would be likely to be passed over and allowed to run its course; but when it emanates from the head of the Bureau of Soils in the U. S. Department of Agriculture, and is expressly and persistently given as the opinion of that Bureau, it can not be thus passed over unchallenged.

The above quotation from page 7 of the bulletin practically prejudges or begs the main question at issue. To anyone outside of the Bureau the cogency of this statement is far from apparent, except in so far as it may mean what has long been known and recognized and need not therefore have been shown anew by the Bureau.

If we examine the experimental basis upon which all these assertions are made, we find it to be the assumption that the aqueous soil solution is the exclusive source through which plants derive their food, and the fact assumed to be demonstrated by a newly devised method of analysis that that solution is practically of the same composition in all soils, so far as the mainly important plant food ingredients are concerned. Throughout the bulletin the determinations thus made are considered

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[a] See also Science, 18 (1903), No. 467, p. 755.

and mentioned as constituting an "exhaustive investigation of many types of soils by very accurate methods of analysis."

It is not the intention of the present writer to question the accuracy of the analyses, such as they are, but it is notorious that there are a great many methods that may, and have been, used for the chemical analysis of soils, each susceptible of great analytical accuracy, but in many, if not in most cases, having no practical bearing upon the agricultural value of the soils analyzed. The method of ultimate silicate analysis is one, and it is generally conceded that the results so obtained have but a very remote bearing upon the practical value of a soil. The method of extraction with distilled water is another; it is the opposite extreme and, unlike the silicate analysis, can certainly not be considered "exhaustive."

Now, the criterion usually applied to the relevancy of soil analyses is whether they will stand the test of agricultural practice. Judged by this test, both the ultimate analysis and that by distilled water are equally failures, according to Whitney's own testimony. But his conclusion is that, since his method fails as a criterion of rich and poor soils, therefore the chemical composition of soils has no bearing upon crop production, and that therefore "the chief factor determining the yield is the physical condition of the soil under suitable climatic conditions."

To this assertion "non sequitur" is the obvious first answer. But, before discussing it, it seems proper to recall, as regards the personal standpoint of the present writer, that he was the first one to undertake systematic physical soil work in the United States, in the early sixties, and has steadily pursued it ever since, as his publications[a] show. He has always held, taught, and written that the physical soil conditions are the first thing needful to be considered in the estimate of a soil's practical value, the chemical composition second, since faults in the latter can in most cases be much more readily remedied than faulty physical conditions. But that chemical composition is the chief determining factor of phytogeography in the humid region, and inferentially of crop production within the same, became his conviction in the prosecution of the agricultural survey of Mississippi, and hence he made it prominent in his work in that State. In the arid region, where moisture is the dominant factor and soil composition much less varied, soil physics has received his chief attention. It can not, therefore, be truthfully said that the writer has not fully recognized the enormous importance of physical soil conditions, both in his teachings and his publications.

Eleven years ago it fell to his lot to controvert the hypothesis then put forth by Whitney to the effect that fertilizers act, not by conveying nourishment to plants, but by modifying the physical texture of the soil.[b] The recent enunciation of the Chief of the Bureau of Soils, while still maintaining the preferential claim for the physical properties of the soil, at least admits the importance of the functions of plant foods, but claims that fertilization is unnecessary because the supply will be "indefinitely maintained." He in fact takes us back to the times of Jethro Tull and the Louis Weedon system of culture, which also presupposed the indefinite duration of productiveness, but signally failed to realize it when the test of even as much as twelve years came to be applied. How can Whitney reconcile this predicted indefinite productiveness with the actual facts well known to every farmer, good and bad, who has ever taken fresh land into cultivation, and when pricing it is perfectly aware that, after a period ranging from three years on the long-leaf pine lands of Mississippi to thirty or more years in the black prairies, he must needs resort to fertilization if he wants a paying crop, while in the Yazoo clay lands and the alluvial soil of the Houma country hardly a diminution of production has occurred even yet? If, indeed, the soil solution is of the same composition in all these lands, then the common-sense conclusion is, obviously, that if the soil solution is the sole vehicle of plant nourishment it must be supplied more quickly and continuously in the "rich" than in the "poor" soils. Certainly, considering that both rich and poor soils are represented in the entire gamut of physical texture, it is impossible to conceive that such changes in texture as would be brought about by poor cultivation should not occur in both. Yet the rich soils—those shown by the despised chemical analysis with strong acids to contain abundance of plant food—continue to produce abundantly, while the poor lands "give out." Hence, admitting for argument's sake that the soil solutions are really of the same chemical composition, it is clearly not the physical texture alone, or chiefly, that can account for these differences.

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[a] Proc. Amer. Assoc. Adv. Sci., 1872, 1873; Amer. Jour. Sci., 1872, 1873, 1879; Proc. Soc. Prom. Agr. Sci., 1882 to 1898; Wollny's Forsch., 1879 to 1896; Centbl. Agr. Chem., 1886; Agr. Sci., 1892; Jour. Amer. Chem. Soc., 1894; U. S. Weather Bureau Bul. 3; Ann. Sci. Agron., 1892; California Station Reports and Bulletins, 1877 to 1902.

[b] Agr. Sci., 1892, pp. 321, 566.

Whitney states in this connection (see p. 51) that I have "called attention to an apparent exception to his rule (that production is sensibly proportionate to the water supply) in the case of heavy adobe (heavy clay) and sandy lands in California which bear equally good crops of wheat." It happens that this "exception" holds good throughout the somewhat extensive arid region of the United States; and my explanation is not only, or mainly, that the roots go deeper, but that in the arid region soils are, as a rule, quite as rich in plant food (again by chemical analysis of the rejected sort) as the clay soils. Hence the abundant and lasting production of the arid sandy lands (even drifting sands) when irrigated.

The argument that even the rich arid soils can not yield more than the maximum crops in the humid region can hardly be taken seriously.

It is a striking fact that in the entire bulletin only a single full-soil analysis (i. e., one made with strong acids) is quoted. There is a table giving the results of determinations of available plant food, determined by the official method, alongside of the distilled-water extract, and it is apparent that the two differ widely. But there is no definite agreement among soil chemists as to the "available" determinations, whether as to value or method; the matter is still in the tentative stage, and I wholly dissent from the "official prescription." The table in question proves nothing. But it would have been instructive, so long as Whitney wishes to disprove the value of soil analysis as usually made, to have at least some of the soil classes he adduces as proofs analyzed by the usual methods, if only in order to show that these soil types—the Cecil clay, the Sassafras loam, Norfolk sand, etc.—are really, as alleged by him, the same soils over the area assigned to them. How have these soils been identified in the mapping? We are informed (p. 8) that "the classification of soils in the surveys made by this Bureau is based mainly on physical differences apparent to a trained observer." It it apparent from the annual reports that the mineralogical and geological data, which are elsewhere considered as essential to a definite characterization of a soil, and which certainly are to be counted among the physical characteristics, are in most cases wholly ignored. Instead, we have local names by the thousand, conveying no meaning whatever to those not acquainted with the localities, since nothing but a scantily interpreted physiological analysis is ordinarily given. Even when the mineral composition of the soil is obvious, these meaningless local names are retained against preexisting local or descriptive designations. Thus, we have, e. g., a "Fresno sand" appearing also in the report on Orange and Monterey counties, Cal., localities hundreds of miles apart. To the uninitiated only the physical analysis is offered as a mark of their identity by the trained observer. It seems a pity that that training should not have extended to calling that material a granitic sand, which would have rendered the designation intelligible all over the world, at the same time conveying important practical information in view of the well-known cultural characteristics and value of granitic soils. It is given out that these studies will be made later in the laboratory. But it may be seriously questioned whether it would not be better to cover less ground more thoroughly and be content with less extended and less hasty mapping. This superficial method of work naturally excites criticism, not only at home but also abroad.[a]

Until some better proof of identity is shown we can not accept Whitney's conclusions, based on the similarity of the soil solution, with widely varying production on "the same soil;" and his entire argument suffers seriously from the absence of any convincing proof that "rich" soils do not supply plant food, even in aqueous solution, more rapidly than does "poor" land.

But is the aqueous solution the only source of supply? Whitney rejects in toto the idea that anything but the carbonic acid secreted by the roots aids the solution of plant food; but his method of analysis practically ignores even this solvent, the use of which was suggested and actually carried out by David Dale Owen, and tried by myself in the early fifties. I found it unsatisfactory and abandoned it; but it would seem to have been incumbent upon Whitney and his coworkers to introduce this inevitable agency into their soil extractions, if it was intended to represent natural conditions.

But there is still a wide difference of opinion in this matter of the acid-root secretions, and the investigators quoted by Whitney have by no means settled the matter. Among others, Kossowitch,[b] when observing the fact that much calcic bicarbonate leached from his vegetation pots, failed to establish the absence of organic acids from the solution. The old etching experiments have not, to my mind, lost their force; and in my experience I find it difficult to overcome the evidence of litmus paper reproducing a faithful image of citrus roots (in the soil) filled with an 83-per-cent

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[a] Centbl. Agr. Chem., 32 (1903), p. 143.
[b] Ann. Sci. Agron., 2. ser., 1 (1903), p. 220.

solution of citric acid.[a] If the paper can take up the acid from the root surface, surely the much stronger capillary action of the soil can do so, according to Cameron's experiment quoted on page 54 of Bulletin 22.[b] But if so, Whitney's entire argument based on watery-soil solutions falls to the ground.

Not the least remarkable part of the bulletin is that in which Whitney discusses the use and action of fertilizers. He does admit that "there is no question that in certain cases, and in many cases, the application of commercial fertilizers is beneficial to the crop." But he calmly brushes aside as so many cobwebs the enormously cumulative evidence of all the practical experience of three-quarters of a century in the use of commercial fertilizers, as well as the carefully guarded culture experiments made during that time by numerous scientific workers, and announces the truism that climatic and seasonal conditions may neutralize the beneficial effects of any and all fertilizers used. This has been often said, experienced, and foreseen. Everyone knows that deficiency of moisture or heat, or imperfect cultivation, as well as the improper manner of application of fertilizers, will render them wholly ineffective. We have also long known that soluble fertilizers soon become insoluble (but not necessarily unavailable) in the soil, in a manner fairly well understood, and that hence they can not long influence the watery-soil solution to which Whitney pins his faith. But since the same conditions influence the unfertilized soils to even a greater degree, manifestly because of the slower and less vigorous development of the plants, it is not easy to see what special corroboration Whitney's hypothesis can derive therefrom. He calmly discards, as having been made under "abnormal conditions," the elaborate and conclusive experiments made by the best observers in pot culture, in which the physical factors were so controlled as to eliminate them from the problem of the action of special fertilizers, and we are told that "very little effect is obtained in field culture in attempts to increase the value of crops showing inferior growth by the application of fertilizers." A trip through the malodorous turnip fields of the low countries of Switzerland in autumn would convince even the Bureau that the thrifty inhabitants know that when fertilizer is made to reach the feeding roots its action is invariably most strikingly beneficial. That a top-dressing of soluble fertilizers on a growing crop can do but little good needs no discussion; and it is but too true that a great deal of the fertilizers used in the arid region remains wholly ineffective for a long time because of the deep range of the feeding roots and the shallow application of insoluble fertilizers.

In the classic water-culture experiments of Birner and Lucanus, quoted in the bulletin (p. 15), the well water was supplied continuously and in different amounts. It is thus no wonder that the results were so good, for at no time was there a lack of food supply, nor would such changes as would injuriously affect the growth occur. But for these frequent renewals of water the result would doubtless have been very different, if only as a consequence of changes in the reaction of the solution. It is singular that this important point is not even casually mentioned in the bulletin with respect to the soil solutions. The deleterious effect of the soil acidity upon most culture plants, long known in general, has been well and thoroughly investigated by H. J. Wheeler. Yet neither in the tables nor in the text of this bulletin do we find any evidence that this point has had any attention with respect to its possible bearings on the differences in production on what are held by the Bureau to be identical soil areas. We are not informed whether the large amounts of lime present in some of these solutions were sulphate or carbonate; yet the importance of this difference is enormous, as is well shown by the contrasts between the natural vegetation as well as the cultural value of gypseous as against limestone lands, which are everywhere among the most productive. An excellent illustration of what this omission may mean exists on the Gulf coast of Mississippi, where (as I have shown in the Report on Cotton Culture, Tenth Census, vol. 5, p. 69) the soil of the infertile "sand hammocks" differs from the highly and lastingly productive soil of the "shell hammocks" almost alone in the proportion of lime (calcic and carbonate) and phosphoric acid present, and in having an acid reaction; the percentages of plant food being very low in both and both equally of great depth. This observation, together with others, led me very early (1860) to the conclusion that mere percentages of plant food were not in all cases proper criteria of soil fertility, and also to the enunciation of the state-

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[a] California Sta. Rpt. 1896–97, p. 181.

[b] "When a porous cell, having deposited in it a semipermeable membrane through which water can pass freely, but through which salts and certain organic substances like sugar can not pass readily, is buried in a soil short of saturation, but yet in fair condition for plant growth, the soil will draw water from the cell against a calculated osmotic pressure in the cell of thirty-six atmospheres, or about 500 pounds per square inch."

ment which I have repeated many times both in my teaching and in my publication, to wit:

"While all soils of high plant-food percentages are highly productive under all but very extreme physical conditions, the reverse is by no means true, since soils with low percentages may be highly productive if the relative proportions of the several ingredients be good and the soil mass deep."

I have for some years carried on an investigation to determine the limits of dilution within which plants will do equally well in soils of high fertility (and plant food percentages) when these are diluted with quartz sand. While not yet completed, this investigation has already shown that a rich adobe (clay) soil, and an equally rich sandy soil, diluted to an extent of four to one, show equally good growth, but that when in these soils the dilution reaches five to one development is quite slow and in a short season would mean a crop failure. The moisture content was in all these cases maintained at two-thirds the maximum water capacity of each diluted soil. Photographs show clearly that here the roots made up by their extension for the lack of concentration of the food supply; but at the dilution of one to five they were unable to make up the deficiency, at least within a reasonable time. Other things being equal, it is the proportion, then, between the several soil ingredients, quite as much as the absolute quantity at hand, that determines production. Incidentally, this experiment shows the wide variation of physical composition (from a soil containing 35 per cent of colloidal clay to one with only 8.75 per cent, and in the sandy soil from 7.6 per cent to 1.9 per cent) within which plants will do equally well, provided the plant-food ingredients are rightly proportioned; and provided, also, that a proportionally large soil mass is available to each plant.

In the foregoing discussion only the salient points of the bulletin in question have been taken up and their most obvious weaknesses briefly considered. To do more would involve the writing of a paper as long as the bulletin itself; and it is to be hoped that the matter will be taken up by others also. Thus, for instance, the Rothamsted station might have something to say regarding the singular interpretation put upon the splendid work of Lawes and Gilbert.

In conclusion, it seems to the writer that the verdict upon the main theses put forward so confidently in this paper must be an emphatic "Not proven!"

R. H. Forbes, of Arizona, read the following paper:

Utility of Soil Surveys in the West.

Soil survey as applied to western conditions naturally falls under two heads—(1) the classification, area determination, and mapping of the different mechanical grades of soils in a certain district, ranging from the finer and heavier soils through the most distinctive intermediate grades to the sandiest and lightest ones; and (2) the determination and portrayal of the water-soluble content of those soils, or, as it is commonly known, the alkali.

With the first form of soil survey you are familiar here in the East, notably in connection with the extension of tobacco culture and truck gardening, but excessive accumulations of soluble salts, in part plant foods which, through very excess, have become plant poisons, the lurking underground enemy of the farmer, the migratory and ubiquitous alkali, are to most men in this assemblage probably (and fortunately) a rare curiosity.

I can most quickly bring the value of soil and alkali survey work to a pioneering people before you by means of illustrations drawn from our own experience in the far Southwest with the results of this work.

It was our good fortune some four years ago to be associated with the Bureau of Soils in a cooperative soil and alkali survey of Salt River Valley. Our elder brothers in this undertaking finished the work in due form, and it was finally placed before our people, affording them definite and extensive information regarding the land of their very recent adoption. It is safe to say that, since the publication of the maps depicting the location and nature of the different soil areas, a very large share of the real estate business of this district, especially of the new, unfarmed lands, has been guided by the information thus afforded; and they have often protected the purchaser and curbed the fervent imagination of the real-estate man. But the most interesting instance of the usefulness of this branch of the work just recently occurs in connection with the establishment of a great, new industry in that locality. I refer to the beet-sugar factory resulting jointly from the experimental work carried on for six years past by the Arizona Station and the business enterprise of some of our moving men.

The results of cultural work indicated very clearly those types of soil which, under our climatic conditions, could produce satisfactory quality and tonnage of beets. This information, in connection with the soil maps of the survey, made it immediately possible to locate the new factory accurately with reference to the most suitable lands whose products shall in future support its operations. The farmer, also, as well as the factory, is protected in this instance, and he is spared the useless effort to grow scanty tonnages on too sandy and unsuitable areas, despite the blandishments of the beet-contract man, who for a bonus of so much an acre would willingly lure the farmer into disappointing toil.

It is evident, therefore, in this instance, that the results of this pioneering soil survey, preceding rather than following the inception of much of our agricultural industry, exert a strong, safe, guiding influence upon our development. With us it need not be "cut and dry, and dry again," but choose reasonably that location where soil conditions justify the expectation of certain results.

But of still greater value is the alkali survey of a new district such as ours, either as a forerunner of the settler or for the interpretation of constantly arising conditions.

The soil is comparatively an open book in which any man with a spade may read as deeply as he needs. The alkali is a treacherous, concealed enemy whose ambuscade for untold centuries has been patiently awaiting a victim. Scattered through the surface 10 feet of virgin soil, the farmer has no means of estimating its amount or calculating its force when irrigation shall have concentrated it in the top soil. Localities, therefore, which on close inspection seemed free from this dreaded contingency are often laid waste by the slow and relentless "rise of the alkali."

In the West, therefore, where development is rapid, where the territory is vast, where the conditions are new to the incoming settlers, where the emergencies are unexpected and severe, and the demands upon the time of station men are frequent and urgent, the possession of rapid field methods for alkali determination, even though not of refined accuracy, is of inestimable value. Such methods are those developed for field use by the Bureau of Soils, especially the electrolytic bridge for determination of total soluble salts.

Let me illustrate the usefulness of the latter by a recent instance: Probably the finest deciduous orchard in the Southwest changed hands about a year ago, the purchaser being an eastern man but little familiar with southwestern agriculture. The trees, mainly in good condition until recently, suffered considerably during the severe conditions of the past season from an unknown cause. The station was called upon to determine the difficulty, if possible, in time to avert threatened disaster. The first examination revealed none of the ordinary diseases of deciduous fruit trees in our region. Crown gall was absent. The Bryobia mite and the red spider were guiltless. Sunburn could not consistently explain the appearance of the trees. Alkali was not suspected by the owner, the district being reputed free therefrom and accumulations of salts not being even then conspicuous. The appearance and lingering manner of death of the trees, however, indicated that as a possible cause; so, another day, armed with a bridge, a table for temperature corrections, an alkali curve for that region, an auger, and a pair of overalls, we began a series of borings in the most thrifty and least thrifty parts of the orchard. To be brief, the day's work, in part calculated upon the ground, proved the association of the largest percentages of soluble salts with the greatest loss of trees. For instance, in an unflooded tree row, where many trees were dying, there was found in the first foot of soil 0.09 per cent soluble salt, in the second foot of soil 0.06 per cent soluble salt, in the third foot of soil 0.07 per cent soluble salt, in the fourth foot of soil 0.07 per cent soluble salt, in the fifth foot of soil 0.10 per cent soluble salt.

In an unirrigated middle near by was found in the first foot of soil 0.11 per cent soluble salt, in the second foot of soil 0.13 per cent soluble salt, in the third foot of soil 0.09 per cent soluble salt, in the fourth foot of soil 0.10 per cent soluble salt.

In another part of the orchard, where the trees were in good condition, a tree row gave in the first foot of soil 0.05 per cent soluble salt, in the second foot of soil 0.06 per cent soluble salt, in the third foot of soil 0.06 per cent soluble salt; and in an adjacent middle was found in the first foot of soil 0.02 per cent soluble salt, in the second foot of soil 0.02 per cent soluble salt, in the third foot of soil 0.02 per cent soluble salt, in the fourth foot of soil 0.04 per cent soluble salt, quantities ranging from a half to a fourth of those found where trees were dying.

It was possible at the same time to determine approximately the effectiveness of flooding as a remedy for the existing condition. At a point near the alkaline tree row just mentioned, where the ground had been flooded three times during the summer, the first foot contained 0.03 per cent soluble salt, the second foot contained 0.03 per cent soluble salt, the third foot contained 0.04 per cent soluble salt, or about one-third the salt content of the adjacent unirrigated tree row. This circumstance indicated the readily drainable character of this soil and led to the recommendation, after the verification of these figures by repeated borings, of the method of throwing up embankments on either side of the tree rows and using the limited supply of irrigating water available for flooding the space between. This method is used (rule of thumb) by the peon farmers of Mexico for the irrigation of oranges with alkaline water, and has proved successful in the orange orchards of Salt River Valley also.

In brief, it was possible in one working day, by means of an expeditious method, to determine and locate with sufficient accuracy the danger to a valuable property, and make proper recommendations for its management.

Field determinations of this sort also are additionally valuable from the fact that the bridge readings, having comparative value among themselves, instantly indicate the trend of the results obtained. The location of borings during the progress of the work may be therefore made to the best advantage and dead work avoided. The owner also, quickly learning the significance of the readings, participated intelligently in the work and derived additional value from the fact.

The appearance of alkali in this instance could not ordinarily have been foretold by a survey of the virgin ground. Originally, that soil did not contain excessive salts; but the succession of abnormally hot, dry summers of the past few years so concentrated our irrigating water supply that its brackish qualities gradually made themselves evident in the increasing alkalinity of the soil.

To conclude, therefore, let me emphasize the utility of the pioneer soil survey to the newer portions of our country, and the great value of expeditious methods whereby the maximum of work may be accomplished in the scanty time of many of our station workers. In the older portions of the country a soil survey largely states facts which are already generally known through long tillage, but in the West it offers guidance to the settling stranger in his choice of location where he shall make his great effort for a home.

For further discussion of the subject of soil fertility, see page 127.

Uniform Fertilizer and Feeding-Stuffs Laws.

The report on this subject has already been given in full in the proceedings of the general session, with the amended recommendations adopted by the section (p. 31).

The recommendations were the subject of considerable discussion, especially that referring to the method of defraying the expenses of inspection, which was as follows: That for the purpose of defraying the expenses of feeding-stuffs inspections, the State should make a direct appropriation, or where this is impracticable, a brand tax should be levied. In view of the experience of Maine and Vermont, a tonnage tax is not to be recommended.

It was explained by B. W. Kilgore, of North Carolina, and others that in many Southern States the tonnage tax was practically the only available means of providing for the expenses of inspection; that the system had worked well in connection with fertilizer inspection, and promised to be equally satisfactory in feeding-stuffs inspection where it had been tried.

A motion to strike out the section, however, was not agreed to.

The other recommendations were then considered in detail with the results already stated (p. 84)..

C. G. Hopkins (having temporarily called another member of the section to the chair) offered and moved the adoption of the following resolution:

Resolved, That the committee on uniform fertilizer laws be asked to include in their report a recommendation that in the statement of the analysis either the name of the compound, as ammonia, phosphoric acid, potash, etc., or the name of the element, as nitrogen, phosphorus, potassium, be required; that the other be also allowed; and that the name of the element be given preference so far as practicable.

In support of the resolution, Professor Hopkins read the following paper:

Shall We Say Nitrogen or "Ammonia," Phosphorus or "Phosphoric Acid," Potassium or "Potash"?

Nitrogen is sometimes sold under the name of "ammonia," phosphorus commonly under the name of "phosphoric acid," and potassium under the name of "potash." To the farmer, who really wishes and tries to understand the subject of plant food, these names are very confusing. Indeed, it is almost impossible for anyone but a chemist to understand how these elements of plant food can be bought and sold under such names.

Let us consider, for example, the material sodium nitrate. This contains the three elements, sodium, nitrogen, and oxygen, as the name indicates. It is valued only for the nitrogen it contains, which amounts to nearly 16 per cent in a good commercial grade of sodium nitrate. This is all simple enough. If sodium nitrate contains 16 per cent of nitrogen this would be 320 pounds of nitrogen in a ton of the material, and, at 15 cents a pound for nitrogen, a ton of sodium nitrate would be worth about $48. It is both absurd and unnecessarily complicated to sell sodium nitrate on the basis of "ammonia": First, because it contains no "ammonia"; second, because "ammonia" is not what the plant needs; and, third, because it is not "ammonia" that we should wish to buy even if we needed to purchase nitrogen.

"Ammonia" is a compound of nitrogen and hydrogen, but no hydrogen is contained in sodium nitrate, and we have no need to purchase hydrogen, as water contains abundance of that element.

Let us consider steamed bone meal. This is valued for its phosphorus content, but it is commonly sold on the basis of "phosphoric acid." This is perhaps more confusing and more absurd than "ammonia." Phosphoric acid is not contained in bone meal, and phosphoric acid is not suitable for plant food, and people do not mean phosphoric acid when they say "phosphoric acid" in connection with fertilizers. What they do mean is phosphoric oxid, a compound of phosphorus and oxygen, containing less than 44 per cent of the element phosphorus, the real thing which we wish to purchase. Phosphoric acid is a compound of phosphorus, oxygen, and hydrogen, the last two elements being contained in water. Why all this unnecessary complication? Good steamed bone meal contains about 12½ per cent of phosphorus, or 250 pounds of phosphorus in a ton. This is a valuable element of plant food. At 10 cents a pound for phosphorus, the steamed bone meal would be worth about $25 a ton. This is all simple and plain enough so that any one can easily and fully understand it, the farmer as well as the fertilizer dealer or manufacturer.

Again, let us consider such a material as potassium chlorid, a compound of the two elements potassium and chlorin, containing in the common market grade about 42 per cent of the element potassium. This compound is commonly sold under the incorrect and confusing name of "muriate of potash," and it is sold on the basis of "potash." The term "muriate," ending in *ate*, would indicate that this material contains oxygen, but this is not true, as it contains only potassium and chlorin, although there is no indication of chlorin in the name "muriate of potash." "Potash" is a compound of potassium and oxygen, containing 83 per cent of the element potassium; but, as stated above, there is no oxygen in potassium chlorid, and consequently there is no "potash" in potassium chlorid. Furthermore, "potash," which is potassium oxid, contains the element oxygen, which nobody cares to consider in the purchase, as the air is one-fifth oxygen and water is eight-ninths oxygen.

Potassium is a valuable element of plant food. Ordinary potassium chlorid contains about 42 per cent of that element, or about 840 pounds in a ton of material, which at 6 cents a pound for potassium would be worth $50.40 a ton. This, again, is direct and simple, and all that is necessary to fully understand the purchase of this element.

Of course we can say "potash" and explain what we mean by it. For example, if potassium chlorid contains 42 per cent of potassium it contains sufficient potassium to make about 50 per cent of "potash," if the potassium were made to unite with oxygen to form "potash;" but as the "potash" which might thus be formed would contain oxygen, its value per pound would be less than that of potassium, the value of "potash" depending entirely upon the amount of potassium it would contain. By remembering that "potash" would contain only about 83 per cent of potassium it will be seen that, with potassium at 6 cents a pound, potash would be worth only about 5 cents a pound, and consequently that a ton of potassium chlorid (or shall we say "muriate of potash"?) containing sufficient potassium to make 50 per cent of "potash" would contain in one ton enough potassium to make 1,000 pounds of "potash," which at 5 cents a pound for potash would make $50 a ton for potassium chlorid, or, if we were to make all the computations with absolute accuracy, it would come out $50.40, as given above for potassium.

I once spent nearly two hours' time with a very progressive and intelligent Illinois farmer who desired me to explain exactly what "muriate of potash" is, and what the analysis showing 50 per cent of "potash" means. After nearly two hours' work, he actually gave the problem up, saying that he could not understand it. As a chemist, I can understand it, but I can not understand why scientific men, working in the interest of agriculture, should encourage the continuation of such an outrageous system for reporting the analysis of fertilizers or plant-food materials.

About the only reason which is ever given for using the terms "ammonia," "phosphoric acid," and "potash" is that they do so in the older States; although there are some people who say that the farmers don't need to understand the matter.

It may be that there would be some difficulty in the older States in changing from these long-used, though misused, names to the names of the elements, but it would be no more difficult than to change from the older money systems to the decimal systems, as has been done by almost every civilized nation excepting England, or to change from the old cumbersome systems of weights and measures to the simpler metric system, as has been done by nearly all countries excepting the United States and Great Britain.

Certainly we have no right to force these old, incorrect, and meaningless names upon the progressive farmers of the great central West.

They desire to understand both the practice and science of agriculture. It is only in agriculture that these absurd names are used. In the steel and iron industry, when they have anything to say about phosphorus, they say phosphorus; in pharmacy and medicine, when they say phosphoric acid they mean phosphoric acid.

In the latest publication from the U. S. Department of Agriculture, Bureau of Soils (Bulletin No. 22, "The chemistry of the soil as related to crop production"), all analyses reported show the amount of the element potassium and not potash.

Already several of the States have passed laws compelling the use of nitrogen in place of "ammonia" in fertilizer analyses, and the Illinois legislature, upon request of the Illinois State Farmers' Institute, has passed a law requiring that all fertilizers sold in the State shall bear a statement of the analysis which shall show the exact percentages of the three elements, nitrogen, phosphorus, and potassium contained in the fertilizer sold.

The Illinois fertilizer manufacturers supported the bill for this law, making the purchase and use of plant food more readily intelligible to the farmer; and it is not too much to hope that other States will join in reducing the purchase and sale of fertilizers and the use of plant food to the simplest possible basis.

The matter was referred to the section for consideration at the next convention.

The third meeting of the section was called to order at 2 o'clock p. m. Thursday, November 19, by the chairman, C. G. Hopkins, of Illinois, in the banquet hall of the Shoreham Hotel.

L. G. Carpenter, of Colorado, read the following paper:

Artificial Irrigation in Humid and Semiarid Districts.

In an arid country irrigation is a primal necessity, while in a humid country it is an adjunct to agriculture and may be dispensed with. The attitude of the two regions toward the practice is therefore fundamentally different. In the one case every other consideration for its practice must yield to the necessity. Water is applied because it is water, wet. In the other the consideration is to be judged by the same standard as any other practice, viz, Do the returns justify the expense?

An answer to the general question goes farther afield than the time or the occasion permits. The practice, in fact, like so many others, may be profitable and desirable in one community, unprofitable and therefore undesirable in another, advantageous on one farm and disadvantageous on its neighbor. There are besides other differences between the East and the West which need to be taken into account in a consideration of the question.

An answer can best be given by indirect statement and recalling some of the primary considerations. For what purpose would irrigation be applied? We may broadly distinguish:

(1) As a matter of insurance. As against disaster from droughts. There are few places where droughts are not disastrous at times. The expenditure justified for such a purpose would be governed by the same considerations as determine the amount to be paid for any other insurance. A prudent person is willing to pay more than his actual risk; only because of that can a company thrive. Usually the more prudent and farseeing the man, the more anxious is he to dispose of his risk. For the same reason a careful man can afford to invest more than the risk actually is worth to insure against crop failure. The justification is that a single failure may cripple a man beyond recovery.

(2) Connected with the consideration is the assurance of production approaching the maximum. The two considerations merge into each other, but vary essentially in character. The one contemplates irrigation as an emergency and in occasional years; the other as an ordinary resource, available every year; no year when crops do not suffer from lack of water at the proper time. There is, of course, the case of excess of water in wet years, but even in these years other crops suffer at some other season of the year by reason of a deficit. There are, to be sure, failures, partial or complete, from various causes—plant diseases, insects, poor preparation of soil, but

most of those from other causes can be met by ordinary resources of science. The most common source of loss, and the greatest, is from lack of moisture at the proper time. Such loss, when it occurs, affects more the profit of the farmer. A certain yield is needed to pay the expense. Above that the yield is almost clear profit. Hence, while the same business considerations govern the relation of the expenditures to the return, yet the measure of the value of irrigation is more than indicated by the excess crop. It may mean not only a profit, but prevent a failure more or less complete of the expenditures and effort that have previously been made. From a business standpoint it may mean the success of the effort otherwise made. In such cases irrigation may well command an artificial value.

Where irrigation is thus available it often means a greater freedom of choice in the selection of crops, thus a power to change according to the demands of the market; hence, again, a greater return and an increase in the value of the land. It also tends to the stability of agricultural returns. This is a consideration of considerable importance from an economic standpoint, for as the risks are reduced the relation between effort and return becomes more certain, a distinct heartening is given to zeal for preparation, and a corresponding effect on the character and stability of the people.

The above conditions apply essentially to cultivated or hoed crops and to intensive agriculture, and in their broader characteristics apply to humid as well as arid regions. The methods of application and the considerations which govern are much the same in both cases.

A third cause for irrigation applies more peculiarly to humid or cold countries. In a dry region, or where grain or fruit are sought, irrigation must be practiced with temperance, and in such cases, irrigation in a wet country is of the nature of insurance. Where leaf or stalk or foliage development are sought, the conditions are different. Here the more water applied the greater is the development. This lends itself peculiarly to hay or grass crops. An adage common to mountainous countries of Europe is, the more water the more grass.

This lends itself especially to grass and to dairying and the practice of soiling. Singularly enough, there seems to be almost no case of irrigation with moderate quantities of water—that is, intermediate between the small amounts for hoed crops and the excessive amounts for grass crops in cold and wet countries. The practice is common in all mountainous regions of Europe—Sweden and Norway, Austria and Germany, France and Switzerland. Water is applied profusely, enough to cover the land several hundred feet in depth in the course of a year. In one case of actual measurement over 2,000 feet were applied in one year. Of course, this is an extreme case and only important as emphasizing the fact that there is a place for irrigation under the most humid conditions. In the valley of the Po, where the rainfall averages about 36 inches, something like 3,000,000 acres are irrigated. Most of the irrigation is for grass. Large expenditures are made for preparing the land for this purpose. The same methods apply to the mountainous regions of this country. In such cases, irrigation is given, not so much to supply moisture; it may be considered as the application of an exceedingly weak fertilizer. There are, however, complex relations between the water and the soil and between the water and the crops, some of which were developed by Mangon as long as forty years ago, but need further study and elucidation.

It is hardly necessary to say that the methods must vary according to the purpose and according to the conditions. As the conditions infinitely vary the details are also infinitely varied.

There are some fundamental differences between the East and the West. In the East, however necessary or beneficial, it would seem that irrigation must be essentially an individual enterprise. This is aside from the popular reluctance to adopt a new practice, but the laws and customs have grown up in a country where it has been necessary to take away rather than to apply water. The development is therefore hampered by the common-law doctrine of riparian rights. Development must take place on small or insignificant streams, or through other than gravity sources, where mill or navigation rights will not be interfered with. These conflicting rights may be adjusted—as they have been in France—but this adjustment remains for the future. The doctrine of riparian rights will prevent large enterprises, except in exceptional circumstances. At present in the humid States the only way to acquire the right is to break the law. If broken long enough, a right may become vested and acquired by prescription. This is, of course, not a situation to encourage large investment, even if other conditions were favorable.

In the arid States it is recognized that a diversion of water is a necessity. The essence of the Kansas-Colorado case now before the Supreme Court is in the conflict of these two conditions or ideas—one where water must remain in its channel, the other that water may be diverted and beneficially used. The one is proper for a wet country, the other is a necessity of existence in an arid country; and yet as all regions other than those developing from the Anglo-Saxon civilization have felt it necessary to recognize the diversion of water, it is undoubtedly the case that such will be the development in the eastern United States as it has been found to be necessary in the western.

Granting, however, that a person is satisfied that irrigation is worth his consideration, the methods both of obtaining water and of application must vary with the situation of the land. The purpose of irrigation is not to be lost sight of as is often done. The main purpose is to keep the soil with just the proper degree of moisture for best production. The physical problem is to accomplish this in the best manner possible, and to make a uniform distribution of water over the tract to be irrigated—quickly or copiously on a sandy or absorptive soil and for a longer time on a clay soil, and in no case for a time long enough to damage the crop. Gentle and frequent rains are the most efficient and economical distribution. Irrigators do not find it possible to distribute small quantities of water uniformly. Hence, irrigations are not so frequent as is desirable and are more copious than would best accomplish the purpose. The large quantities, however, are a consequence of the difficulty of making a uniform distribution. This can be improved by a more perfect preparation of the surface of the ground and becomes a matter of greater consideration in the East, where there is greater liability of excess. If the surface is uneven the lower spots receive too much water in order that the higher ones get enough. Hence, effort and expense need to be given to smoothing the tract for irrigation. The more pains taken this way the more satisfactory will be the results. In Italy an expense of several hundred dollars per acre is incurred for preparing the ground for the Marcite or water meadows. The basin method is applicable to grades of 10 feet per mile. The furrow system is best applicable to slopes of about 20 feet per mile, but a greater slope may be used by running the rows diagonally. It may be used up to slopes of even 200 feet per mile. The flooding system may be used on ground on any slope by modifying the distance between the ditches and using collection ditches.

A gravity system, for reasons already given, is practically inapplicable to the greater part of the East. It requires long canals and costly enterprises, except in the case of streams of rapid fall. As the lands justifying the expense are near market centers, the last condition is not present and the former is not applicable. Hence, for market gardens the question in many cases reduces itself to pumping.

C. E. Thorne, of Ohio, read the following paper:

Methods of Conducting Investigations Relating to Maintenance or Increase of Soil Fertility.

There are two principal lines along which the problem of fertility maintenance must be attacked, the one lying through the laboratory, the other through the field.

While the chemist can not yet meet the popular expectation by prescribing a special fertilizer for a particular soil on the basis of a chemical analysis of that soil, yet he has been and will ever continue to be an indispensable helper in our pursuit of knowledge concerning this great problem. In addition to the fundamental information which he has given us concerning the composition of soils and plants and the sources from which plants derive their sustenance, we must turn to him for help in determining whether the chemical constituents of a soil are associated in normal ratio to each other, and for knowledge concerning the materials with which we may most economically reenforce its stores of plant food.

In the earlier days of soil investigation it was assumed that this was to be chiefly or altogether a chemical problem, but we now know that we must call upon the geologist for information concerning the origin of the soil and the probable bearing of that origin upon its present composition; upon the soil physicist for advice regarding its mechanical texture and the effect of that texture upon the availability of its stores of plant food, and upon the bacteriologist for knowledge of the minute organisms which inhabit the soil, and whose work, unsuspected until a very recent date, has been shown to be a most important factor in the daily sustenance of the growing crops.

But after all these have given us all the help in their power there still remain unsolved problems of vital importance, whose solution is only to be found in the field itself.

Our soils lie in broad sheets, varying in geologic origin, in physical texture, and in chemical composition; they lie upon subsoils equally variable in formation; they are exposed to constant changes of temperature and alternations of moisture, to sunlight and its imperfectly known influences, and to the still less understood influences of that mysterious force which we call electricity. Not only this, but they are occupied by living organisms, of whose functions we as yet know but little, although that little is sufficient to show that they are of the utmost importance. These conditions never recur in orderly succession, but each season has its peculiar influences which work for the welfare or the detriment of the crop. Some of these conditions may be more or less completely reproduced in the laboratory; others are altogether beyond control. All that the laboratory can do, therefore, is to point out the way in which progress is indicated; the final and crucial test must be made in the field itself, for it matters not how promising a method may appear under the conditions of the laboratory, if it be not also applicable to those of the field it is of no practical value.

No greater mistake can be made than to assume that the scientific investigation of this problem ends with the laboratory; that field research is merely a simple affair, which may be conducted by the ordinary farmer, and that it is his business to take up the work at the point where the laboratory leaves it. The fact is that it is the laboratory investigation which is the relatively simple matter, while the making of such a field investigation as shall add to the sum of human knowledge involves an expense in preparation and equipment, a patience and exactitude in execution, and a discernment in interpretation which makes this form of research one of the most costly and difficult known to science.

While, therefore, the student of the soil will continue to use the chemist's, the physicist's, and the bacteriologist's laboratories, his chief laboratory must be the field itself; and I believe that as the magnitude and vast importance of this work are more fully comprehended, and as the scope and province of the field experiment, its limitations, and its possibilities, are more fully understood, the employment of this form of investigation will steadily increase.

A field experiment in fertility maintenance, if it is to accomplish any useful purpose, must be continued, not merely for a single summer, but for many years and on the same soil, in order to meet the varied conditions of changing seasons and to adequately study the peculiarities of the soil. As we look back over ten years of such work at the Ohio Station we feel that we have only made a beginning, and in the final endowment of the Rothamsted investigations, after fifty years of continuous work, the greatest field experimenter the world has ever known has expressed his conviction of the necessity for long-continued, stationary effort.

For a work involving such an enormous outlay in time and labor as does a field experiment conducted along the lines I have indicated, it is of the highest importance that the preparation be as thorough as possible. As a matter of course the soil upon which a comparative test is instituted should be as uniform in character as possible, but this uniformity is extremely difficult to secure. If the land lies level there will be shallow depressions from which the surplus rainfall escapes more slowly than elsewhere, thus increasing the water supply to an injurious extent in wet seasons and giving to these depressions an undue advantage in dry seasons, when water may be the controlling factor in producing increase of crop. On the other hand, slopes from which the rainfall rushes rapidly must be avoided, as on such slopes more or less fertilizing material will be carried from plat to plat, or the land will be washed into gullies, thus interfering with cultivation. The ideal topography for this work is a broad, even slope of about 1 or 2 per cent—or just enough to give easy though not rapid drainage.

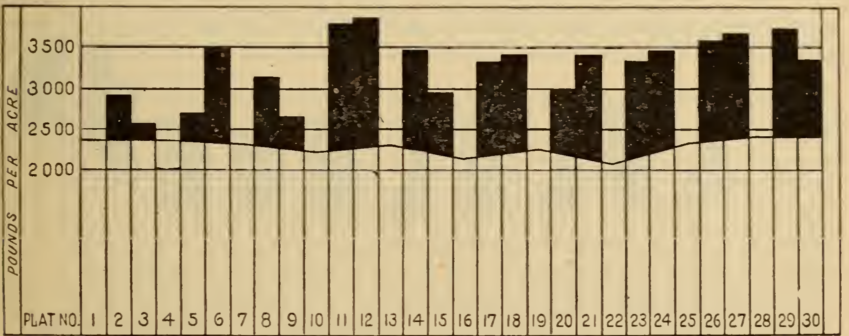
Not only the surface but the subsoil must be considered in locating a field experiment. Where beds of drift gravel or loosely stratified rocks lie near the surface they will materially modify the drainage conditions, and uniformity of drainage is a matter of prime importance.

Most of the agricultural colleges have been located with reference to other matters than field experiment; or, if this question was considered at all, it was with the idea that an experiment farm should have a variety of soils, an idea which seems to be practically universal in the minds of men not trained in the actual work of field experiment. The result is that very few of the farms attached to these colleges possess any qualifications for this work.

The Ohio station had the good fortune to be permitted to select a farm for its work, after some ten years' experience on an agricultural college farm. We found a soil possessing in an unusual degree the points which we had found to be necessary for successful field investigation, it being a sheet of drift, lying in gentle slopes upon and largely modified by a shaly sandstone of the Waverly series, the drift sheet being sufficiently thick to have formed a subsoil comparatively impervious to water. We were not able to secure all the desirable points, as some of our slopes are too steep for the best results, and in some places it has been impossible to avoid cross drainage, while in others differences in previous treatment, which I will refer to, again, have brought about permanent inequalities in the natural fertility of the soil; but, as we have gone forward with the work and observed other soils throughout the State, we feel that we have probably secured as many of the important features as are likely to be found on any soil that has been long in cultivation. The soil is a sandy clay, quite uniform in texture, easily worked, and very responsive to treatment, whether by tillage or by fertilizing.

The land was laid off in plats 16 feet wide by $16\frac{1}{2}$ rods long, this width of plat being well adapted to the various kinds of agricultural machinery. The plats were slightly ridged at the outset of the work, thus providing independent surface drainage from each plat, and this ridging is repeated at ten-year intervals. At other times the land is plowed across the plats. The plats are separated by paths 2 feet wide, and under every alternate path a tile drain is laid, thus providing a drain on one side or the other of every plat, and locating the drains 36 feet apart. In a few cases the drains have been put under every path, and it would be better for each plat to have its drain either under the path or under the middle of the plat. On clay soils 18 feet would be none too close for drains for this work.

We have not yet discovered any reason for making the dividing spaces between the plats wider than 2 feet. On the contrary, with care in application of fertilizers and with our method of ridging, by which the plats are separated by dead furrows which the plant roots are reluctant to cross, we believe that this distance is better than a wider one would be. In the case of oats or wheat, sown with the ordinary grain drill, a 2-foot space between plats gives 2 feet 8 inches between rows of grain, which is sufficiently wide for cultivation when that is necessary to keep the weeds down.



DIAG. II.—Ten-year average yield and increase on Section C, Ohio Experiment Station.

It was fortunately possible to lay off our plats generally across the previous plowings, thus eliminating the discrepancies caused by old back furrows and dead furrows. This is an important matter, as an old ridge or furrow may completely reverse the results of a plat experiment.

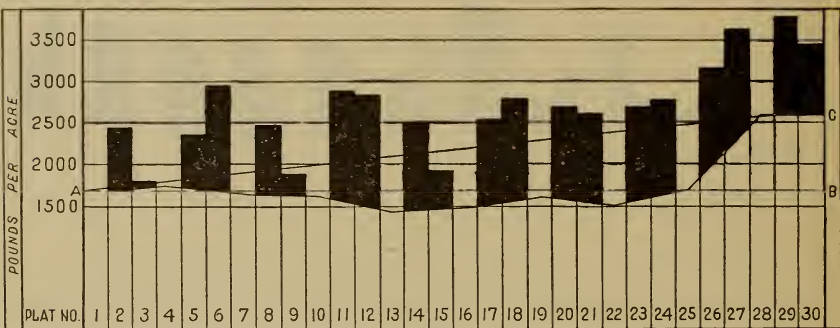
At an early date in the history of our work in field experimentation we became convinced of the necessity for frequent repetition of check plats, and, therefore, in the experiments with fertilizers now in progress every third plat has been left continuously unfertilized. This gives an unfertilized plat adjoining every fertilized one, and is a compromise between the ordinary method and the ideal method of leaving alternate plats as checks. Our only reason for not employing this last method was the immense amount of land required. We hoped, at the outset, that after some years' work the check plats might develop sufficient uniformity to permit the use of a part of them for other purposes; but at the end of ten years we find ourselves apparently no nearer ready to dispense with any of the checks than at the outset.

In calculating the increase from the fertilizers we assume that variations between the check plats are progressive, and on this assumption we compare each pair of fertilized plats with the two check plats between which they stand, by treating the four plats as the four terms of an arithmetical series. We never make our comparisons on the basis of simple averages, either of all the plats or of the two nearest checks. To illustrate the results of this frequent repetition of checks and of our method of calculation, I have prepared the accompanying diagrams, which show the average increase found on the different plats in one of our rotation experiments, the five-year rotation at Wooster.

In this experiment five sections of 30 plats each, A, B, C, D, and E, have been laid out on land apparently uniform in formation and previous treatment. Beginning with plat 1, every third plat up to No. 28 has been left continuously unfertilized. The experiment is defective in that there was not a final unfertilized plat—No. 31—but this was omitted because of limitation of suitable land. The present season gives the tenth annual crop on sections A and C, the ninth on D and E, and the eighth on B, of which records have been kept, the rotation beginning in 1894.

Diagram II shows the annual yield and increase in total produce—corn and stover, wheat, oats and straw, and hay—for the whole period on section C, and Diagram III shows the same for the average of the five sections. In the ten years covered by two complete rotations this would give two crops of each of the cereals and four of hay on each section, the rotation being corn, oats, and wheat, one year each, and timothy and clover mixed, two years. Of late years the clover has frequently failed to stand over winter, in which case it has been plowed under and soy beans have been grown instead, the beans being followed by millet or by another crop of beans. This, however, does not affect the present discussion.

The broken line represents the level of the unfertilized yield, as found by carrying the line from one unfertilized plat to the next, according to the method I have explained, and it will be seen that there has been a marked variation in the yield of some of these plats. No. 28 is especially noticeable in this respect. The land upon which this section is located was all in one field, as originally purchased by the station, and no difference was observed in its character until the yield of the first crops



DIAG. III.—Ten-year average yield and increase on the five sections, Ohio Experiment Station.

grown in preparation for this test came to be examined, when the sudden rise in the yield of plat 28 caused inquiry to be made regarding the previous history of the field. This inquiry revealed the fact that a lane had once occupied the space now covered by plat 28 and parts of the adjacent plats 27 and 29. This lane had been abandoned some ten years or more before the land came into possession of the station and was thrown into the field, yet the yield of corn this year, 1903, twenty or more years after the lane had been abandoned, is nearly double the best yield on any other unfertilized plat in the series. A glance at the diagram will show that a computation of increase on the basis of the general average of all the unfertilized plats, as shown by the line AB, would have given enormously exaggerated yields to the plats at this end of the test, while, had we adopted the formerly common method of leaving but one or two unfertilized plats and No. 28 had happened to be one of them, and had our work been limited to this one section, we should have had results absolutely misleading and worthless. The line AC would then have indicated the supposed average.

It should be explained that plats 17, 21, 23, and 24 receive the same quantities of nitrogen, phosphorus, and potassium, the nitrogen being conveyed in different carriers. Plats 11, 26, 27, and 29 also receive the same quantities of each of the three elements, the phosphorus being carried in raw bone meal to plat 26, in dissolved bone black to plat 27, and in basic slag to plat 29. The first four plats now receive half the quantity of nitrogen and twice the quantity of phosphorus that is given to the other four, but previous to 1899 the eight plats received the same quantities of each of the three elements.

In the following table I have given the average annual increase found on these plats in section C by the different methods of computation:

Increase found on section C by different methods of computation.

Plat.	By nearest checks.	By average of all checks.	By extreme checks.
17	1,024	831	377
21	1,071	912	458
23	1,127	1,003	249
24	1,132	1,066	612
11	1,334	1,187	732
26	1,166	1,463	1,009
27	1,323	1,915	1,471
29	1,292	2,198	1,744

A glance at this table and a comparison of the two diagrams given show that whereas our method of calculation yields practically consistent results, the outcome of either of the other methods is altogether unreliable.

In view of this comparison I find it easy to understand why some experimenters who have contented themselves with the use of but one or two check plats in a series should have come to the conclusion that there is no possibility of obtaining reliable results in field experiment.

I do not claim that it is possible to obtain the exact results in this form of experiment that may be reached in the chemist's laboratory, where all the conditions are under absolute control. The field experiment deals with general problems, the laboratory with special ones, and the field experiment must be interpreted with respect to its limitations. The field experiment bears somewhat the same relation to laboratory investigation that the oil painting does to the photograph. The painter's brush can never approach the camera in exactitude and minuteness of detail, yet the goal of photography is the blending into one harmonious and true picture of land and sea, mountain, forest, and stream, sky and cloud, which the master painter attains. The experiments I have been describing are made on a soil of very indefinite history; they have been in progress not quite long enough to complete two rotations on the separate sections. During the ten years covered by this investigation have occurred five seasons of greater or less injury to the wheat crops from unfavorable seasons and Hessian fly, in one of which the average wheat yield for the State was reduced to the lowest point in half a century. The corn crop has also suffered from drought and insects, the one just harvested especially being severely injured by white grub. Both this insect and the Hessian fly, however, are apt to distribute their operations over entire fields, so that the comparative results are not so much disturbed as they would be in case of chinch-bug attack, which we have fortunately thus far escaped.

But these insect attacks have added to the practical value to the farmer of the experiments, in demonstrating that manure and the fertilizing materials in common use do not prevent such attacks, but nevertheless accomplish a useful service in enabling the plant to overcome them.

Investigations of this kind may include the growing of crops in continuous culture, in order to study the feeding habits of different plants, but rotative cropping is necessary when the object in view is the study of fertility maintenance. But no satisfactory results can be secured from an experiment in rotative cropping unless each crop of the rotation is grown every year. An experiment in which the different crops follow each other without any fixed plan, either of cropping or of fertilizing can not be called a scientific investigation, and if the experiment is to be made this season here and next season yonder it might as well not be made at all.

In illustration of the importance of continuity in this work, I give a table showing, in two five-year periods, the total value of the increase on a few of the plats in the five-year rotation under consideration, estimating corn at one-third of a dollar per bushel, oats at 25 cents, wheat at two-thirds of a dollar, stover at $3 per ton, straw at $2, and hay at $6.66⅔, thus reducing the crops to a common denominator based upon approximate market values, which has this advantage over giving merely the total weight, that it brings out more distinctly the increase or decrease of the more valuable constituents of the crop, and is therefore the more truly scientific method.

Comparison of increase by five-year periods.

Plat.	Fertilizing elements.	Value of increase.		Net gain over cost of fertilizer.	
		First period.	Second period.	First period.	Second period.
2	Phosphorus	$7.66	$15.01	$5.26	$12.61
6	Phosphorus and nitrogen	16.92	28.75	2.52	14.35
8	Phosphorus and potassium	12.62	19.90	3.72	11.00
11	Phosphorus, potassium, and nitrogen	21.86	35.03	.96	14.13

During the first five years or more of this test phosphorus seemed to be the controlling element in producing increase of crop, and while the addition of potash and nitrogen regularly increased the yield, the increase was not sufficient to justify the use of these elements, at least in the quantities employed in this test, quantities based upon the chemical composition of the crops, except that nitrogen has been used in a much smaller ratio to phosphoric acid and potash than would be indicated by the composition of average yields of the crops grown in this experiment. The actual quantities used on each five-year rotation are as follows:

	Pounds.
Phosphoric acid, in acid phosphate, per acre	50
Potash in the muriate, per acre	130
Nitrogen, in nitrate of soda, per acre	75

The fertilizers are distributed over the three cereal crops of the rotation—corn, oats, and wheat—the mixed clover and timothy following for two years without any further fertilizing. The experiment was planned with the assumption that the clover would probably make up the deficit in nitrogen; but latterly the clover has been refusing to grow, especially upon the plats treated with acid phosphate, and while the hunger of the soil for phosphorus is apparently being gradually satisfied, the demand for nitrogen remains constant or increasing, and it is the plats receiving large applications of nitrogen which are now not only giving the largest gross yield, but also the largest net profit, even though the nitrogen costs 15 cents per pound.

I am not able to see how this result could have been arrived at by any shorter or surer method than the one we have followed.

One of the great difficulties in field investigation, especially with cultivated crops such as corn or potatoes, is to secure a uniform stand. We are sure to have some missing hills, and potatoes are often more or less affected by blight or rosette. It has been our practice to count the hills on each plat, and, in the case of corn, to count the stalks, separating those which bear two ears and those which are barren, and to count the ears and nubbins. Unless the stand has been very irregular, however, we do not attempt to make any correction, as we have not yet discovered an entirely satisfactory basis for such corrections. The additional space given to the survivors by the failure of a stalk or hill seems to result in a partial compensation. The most satisfactory basis of correction seems to be that of the actual stand, rather than that of the full stand. This method gives average results corresponding to the yield actually harvested, whereas when we calculate to full stand the yields are often exaggerated.

It is sometimes absolutely necessary to make such corrections or else to lose the experiment, or suffer it to tell a misleading story.

Another difficulty is to avoid mistakes in weighing, and as a check in this direction we have adopted the plan of leaving the grain from each plat of wheat or oats in labeled sacks until the reported weights can be studied in the office. The first operation is to calculate the weight of straw per bushel of grain; if we find a discrepancy here the sacks are weighed again. By this method we have several times secured the correction of such mistakes. In the case of corn, the ears and nubbins are counted separately and separately weighed. If a discrepancy appears in the weights per ear or per nubbin, a basis of correction is found by comparing the counts of ears, nubbins, and stalks.

It goes without saying that the greatest care should be exercised to secure uniformity in the preparation of the seed bed, in the selection and planting of the seed, in the distribution of the fertilizers, and in the culture of the crop. Wherever possible machinery should be employed, as properly handled machinery will do more uniform work than can be done by hand.

In conclusion, I would repeat my conviction that conclusions relating to the maintenance or increase of soil fertility must be confirmed in the field before they can be accepted as final; that the work of the field, if it is to have any value, must be conducted on principles as thoroughly scientific as those which control the most elaborate laboratory investigations, and that when the work is thus conducted it will yield results as decisive as those attained in any other line of scientific research.

And since the existence and increase of the human race depends upon the maintenance and increase of soil fertility, I maintain that this problem transcends in importance all other objects of scientific investigation.

E. B. Voorhees, of New Jersey, read the following paper:

Methods of Conducting Investigations Relating to the Maintenance or Increase of Soil Fertility.

The terms "maintenance" or "increase of soil fertility" have reference, first, to methods of practice which may result in changes in the physical character of the soil and in the form of the essential constituents—nitrogen, phosphoric acid, or potash—and may have no relation whatever to the increase in the soil of potential fertility, or, second, to the addition to the soil of actual essential constituents, thus adding to potential fertility; or, third, to the addition to the soil of organic matter containing nitrogen, which may affect its chemical and physical character, and which may also result in the addition to the soil of nitrogen, because of the introduction into the soil of living organisms which have the power of fixing atmospheric nitrogen.

Experiments which have for their object the study of any one of these three kinds of improvement, to be of service, may be either general or specific. A method of inquiry, which is general in its character, does not permit of a close study of the reasons for and thus an explanation of the phenomena involved, but has to do primarily with results. General methods of inquiry have their place, and a very useful one, from the practical standpoint, but it seems to me that they can only be regarded as preparatory, and, in a sense, educational, and not for the purpose of establishing new facts and principles.

In the second method of inquiry the work is purely scientific and is planned with the specific purpose of enabling an accurate observation of all the changes taking place and a control of all of the conditions which are involved. By this method pots and cylinders or other means of obtaining small areas are usually included. The advantage of this specific method of experiment is that because of an exact control of all of the conditions—chemical, physical, and bacteriological—a reason for any change which may take place in the soil is suggested, and thus facts and principles are established upon which may be based a working theory for the improvement of soils in general.

Nevertheless, I believe that there is a field for general methods of experimentation that have for their purpose the improvement of methods of practice and that will result in the maintenance or conservation of soil fertility; and whenever it is possible to so conduct these experiments as to have the results serve as object lessons, the work should not be ignored. As an example of what I mean by this, I may cite an experiment very general in its character conducted by our own station on the relation of the income and outgo of soils to the improvement or crop-producing power of soils. This experiment was planned for the purpose of showing that by the observation of natural laws and of the principles already established it was possible to grow profitable crops, while at the same time to maintain or increase active fertility.

In this experiment three general principles already well established were observed: First, that nitrogenous plant food particularly is available in proportion to its solubility; second, that natural agencies are constantly at work changing dormant constituents into active or available forms, and, consequently, third, that soils when left bare during fall and winter are liable to suffer a loss, not only of the nitrates that may have been accumulated during the summer, but also that under such conditions of cropping mechanical losses are liable to occur, and that the first parts to be carried away by the winds or the washing of the winter rains are the finer particles which constitute the best part of the soil. Hence, in the experiment the first rule adopted was that the land should not lie bare at any season of the year, and if the removal of regular crops was so late as to prevent the seeding of a crop that would live during the entire winter, such crops were planted as would grow late in the fall and remain to protect and mulch the surface soil during the winter and early spring. This is to show that the practice would result not only in a saving of the soluble plant-food constituents, but would prevent the mechanical waste of soil particles, and besides, in case of certain crops, would provide for an accumulation of nitrogen or an actual increase in potential fertility. For example, if rye were used in the fall losses would be prevented; the actual gain would be chiefly in the roots and stubble, as the crop would be harvested and but very little addition of organic matter made to the soil. If crimson clover were used, then a crop rich in nitrogen would be harvested, leaving a residue also rich in nitrogen, adding to the soil stores of both nitrogen and vegetable matter. If turnips or rape were used, then the chief gains would be in the organic matter stored up in the fall and in the protecting of the soil from washing and from leaching during the winter. The next rule observed was based upon the principle that the dormant constituents of soils are changed into active in proportion as the soil particles are made finer and greater surfaces brought into contact with the atmospheric agencies. Hence, the experiment provided for frequent and practically continuous cropping, which was naturally accompanied by more frequent cultivation and changing of the soil particles and a greater accumulation of organic matter in the soil, by virtue of the residues of the catch and other crops. The biological properties of soils were also recognized, and care was taken to have the soil covered during the hot, dry periods, in order that the life would be maintained and encouraged and not destroyed by the high temperatures that would be developed in the bare soils during the hot summer months.

The results obtained by this experiment for 2 acres of land are tabulated herewith:

PLAT 16, 1 ACRE.

Year.	Applied.			Taken off.			Balance.		
	Nitrogen.	Phosphoric acid.	Potash.	Nitrogen.	Phosphoric acid.	Potash.	Nitrogen.	Phosphoric acid.	Potash.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
1896 and 1897	18.78	31.11	41.37	67.40	35.52	85.08	− 48.62	− 4.41	− 43.71
1898 and 1899	82.78	100.79	144.35	290.68	114.20	287.52	−207.90	−13.41	−143.17
1900 and 1901	71.15	122.52	254.33	203.92	86.74	277.82	−132.77	+35.78	− 23.49
Balance, six years.	....	....	....	....	....	....	−389.29	+17.96	−210.37

PLAT 19, 1 ACRE.

Year.	Nitrogen applied.	Phosphoric acid applied.	Potash applied.	Nitrogen taken off.	Phosphoric acid taken off.	Potash taken off.	Nitrogen balance.	Phosphoric acid balance.	Potash balance.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
1896 and 1897	15.81	....	....	55.91	25.14	50.38	− 40.10	−25.14	− 50.38
1898 and 1899	80.68	131.07	160.86	148.92	59.07	197.67	− 68.24	+72.00	− 36.81
1900 and 1901	56.55	77.93	190.39	251.39	91.40	336.00	−194.84	−13.47	−145.61
Balance, six years.	....	....	....	....	....	....	−303.18	+33.39	−232.80

The table shows the income and outgo to the soil of the fertilizer constituents, nitrogen, phosphoric acid, and potash, on 2-acre plats. The increase or decrease in soil constituents are grouped in periods of two years each. It is shown, in the case of plat 16, that there was removed by the first two crops nearly 50 pounds more of nitrogen, and about 44 pounds more of potash than was applied, yet the crops for the next series of two years were able to obtain over four times as much nitrogen as in the first series, over three times as much phosphoric acid, and over three times as much potash as the crops of the previous period, and hence a considerable loss of potential fertility. Or, in other words, notwithstanding that there was a marked loss of the fertilizer elements in the first period, the soil was improved in actual fertility, making its crop-producing power in the second period three times as great when measured in terms of constituents removed. In the third period the crops were not as great as in the second, though showing a very much greater yield of crops than in the first period. This lower crop yield is due rather to seasonal conditions than to any decrease in active fertility. The same relative results are also shown in the case of the other plat, and demonstrates that by the proper observation of natural laws, and the judicious application of manures, it is possible to increase soil condition and crop-producing power, while at the same time to very materially reduce the potential fertility. These experiments, though in a sense general and unscientific, gave results of great value in suggesting rational methods of practice.

In relation to the second, or specific method, which must in the long run be regarded as of the greatest importance, because resulting in the establishment of principles, I shall refer briefly to experimental methods already in operation at our station, and to preliminary results that have been obtained, as showing by contrast the greater value of more scientific methods of investigation.

A question of great importance at the present time, and which is properly receiving more attention than any other that has to do with the maintenance of soil fertility, is the question of the utilization by crops of atmospheric nitrogen and of its accumulation in the soil. The fact has been established that the members of the legume family of plants do have the power under proper conditions of absorbing and using in their own development the nitrogen of the air. The question next of importance from the standpoint of soil improvement and maintenance is whether the supply of nitrogenous plant food in the soil has any influence in determining the condition of soil in reference to proportion or amount of nitrogen that may be appropriated by this class of plants, and further the effect of their growth under different conditions of soil supply of nitrogen upon the nitrogen content of the soil, as well as the subsidiary question of the relative value of the nitrogen so appropriated for the nourishment of the nonlegumes.

The method of investigation used in the study of these points is here outlined. A soil was employed that contained an abundance of phosphoric acid and potash, and was, moreover, rather light in character, a condition that would favor the decay of organic substance. This soil originally consisted of equal parts of weight of shale and quartz sand, and contained 0.09842 per cent of nitrogen in the air-dry state. This soil was used for vegetation experiments during three seasons, and at the end of that time the soil nitrogen had diminished very considerably. After these experiments the soils from the several boxes were thoroughly mixed and inoculated with soil from an area upon which cow peas had been grown, and on which the nitrogen-fixing bacteria were present, and 160-pound portions were weighed off and placed in each of the several boxes. Hence, there was in each box a medium sandy soil, rich in mineral plant food. Nitrogenous manures were added or withheld according to the following plan of study:

(1) The study of the source of nitrogen to cowpeas under the following conditions:
- (a) The addition of no nitrogen.
- (b) The addition of different amounts of nitrate nitrogen.
- (c) The addition of different amounts of dried-blood nitrogen.
- (d) The addition of different amounts of ammonia nitrogen in ammonium sulphate.
- (e) The addition of different amounts of cow-manure nitrogen.

(2) The availability of cowpea nitrogen, as compared with nitrate, organic, ammonia, and manure nitrogen for the growth of nonlegumes.

(3) The possible accumulation of nitrogen in cultivated but uncropped soils.

The wooden boxes used here were numbered from 1 to 57, both inclusive, and only the first 30 were employed during the first season. Accordingly they received:

Boxes 1, 2, 3, nothing.
Boxes 4, 5, 6, 1 gram of nitrogen as nitrate of soda.
Boxes 7, 8, 9, 2 grams of nitrogen as nitrate of soda.
Boxes 10, 11, 12, 1 gram of nitrogen as dried blood.
Boxes 13, 14, 15, 2 grams of nitrogen as dried blood.
Boxes 16, 17, 18, 1 gram of nitrogen as ammonium sulphate.
Boxes 19, 20, 21, 2 grams of nitrogen as ammonium sulphate.
Boxes 22, 23, 24, 1 gram of nitrogen as in solid and liquid manure.
Boxes 25, 26, 27, 2 grams of nitrogen as in solid and liquid manure.
Boxes 28, 29, 30, nothing, and kept bare.

The fertilizers and manure were applied to the respective boxes July 5, 1902; 20 seeds of black-eyed cowpea were planted in each box, with the exception of 28, 29, and 30, and 8 quarts of water were added to supply the initial moisture.

The growth during the season was fairly uniform. At the end of the summer the cowpeas were harvested, dried, and ground, and after aliquot portions were taken for analysis the ground material was kept dry in the laboratory. In the spring of 1903 millet was planted in the several boxes which had been treated as follows:

Boxes 1–27, inclusive, received each the corresponding cowpea crop of 1902.
Boxes 28, 29, 30 received no application of nitrogen.
Boxes 31, 32, 33 received 1 gram of nitrogen in nitrate of soda.
Boxes 34, 35, 36 received 2 grams of nitrogen in nitrate of soda.
Boxes 37, 38, 39 received 1 gram of nitrogen in dried blood.
Boxes 40, 41, 42 received 2 grams of nitrogen in dried blood.
Boxes 43, 44, 45 received 1 gram of nitrogen in sulphate of ammonia.
Boxes 46, 47, 48 received 2 grams of nitrogen in sulphate of ammonia.
Boxes 49, 50, 51 received 1 gram of nitrogen in solid and liquid manure, fresh.
Boxes 52, 53, 54 received 2 grams of nitrogen in solid and liquid manure, fresh.

Each box received May 29, 1903, 1 teaspoonful of barnyard millet seed, but the germination being poor another teaspoonful of millet seed was added about ten days later.

NITROGEN IN THE COWPEA CROP.

A table has been prepared which shows the percentage of nitrogen and the total nitrogen contained in the crops grown.

Percentage of nitrogen and total nitrogen in crops grown.

Box.		Average nitrogen in crop.	Average nitrogen in crop.	Average of applied nitrogen available.
		Per cent.	*Grams.*	*Per cent.*
1, 2, 3	Check	2.282	3.287	....
4, 5, 6	Nitrate of soda, 1 gram	2.257	3.590	30.3
7, 8, 9	Nitrate of soda, 2 grams	2.185	3.664	18.9
10, 11, 12	Dried blood, 1 gram	2.393	3.949	66.2
13, 14, 15	Dried blood, 2 grams	2.188	3.683	19.8
16, 17, 18	Sulphate of ammonia, 1 gram	2.345	3.518	23.7
19, 20, 21	Sulphate of ammonia, 2 grams	2.314	3.703	20.8
22, 23, 24	Manure, 1 gram	2.380	3.626	33.9
25, 26, 27	Manure, 2 grams	2.365	4.029	37.1

The first point of importance to be observed is that a very considerable crop was obtained without the addition of nitrogen, and second, that there was an increase in the total nitrogen in the crops of all of the groups upon which nitrogen had been applied, though even in the greatest increase the yield was but slightly higher than was that in the group upon which no nitrogen had been added, or that the readily available nitrogen did not encourage the plant to make an extensive use of other sources of nitrogen.

Another point of importance was also shown, namely, that in the case of the soluble nitrate and ammonia, and of organic nitrogen in dried blood, the smaller quantity seemed to influence the yield to a greater extent than the larger quantity. In the case of the manure there was an increase from the larger quantity. In other words, the slowly available manure nitrogen yielded more to the cowpea crop than the concentrated and highly available nitrate and ammonia nitrogen. This is just the reverse of the results obtained in a study of the availability of these materials for the non-legumes.

The tabulation also shows that the crop itself was proportionately richer in nitrogen on the series where only 1 gram of nitrogen was applied. While these points are interesting and useful the point of greatest importance was to determine whether, under all these conditions, the plant was capable of appropriating its nitrogen from the air and the influence of the growth of the plant upon the nitrogen content of the soil. This involved a chemical examination of the soils previous to and after the crops were grown. The analysis of the soil previous to the planting of the crop showed that each box contained 54.94 grams of total nitrogen. The seed used and the water applied to each box during the season of growth contained 115 milograms, or a total of 55.055.

The accompanying table has been arranged and shows the exact conditions in reference to the changes that took place in the nitrogen content of the soils during the experiment and the amounts actually contained when the crops were harvested.

Income and outgo of the nitrogen in the box soils.

Series.	Originally present.	Nitrogen in seed and water.	Nitrogen in fertilizer or manure.	Total nitrogen present at the beginning of the first season.	Present in soil at the end of the first season.	Average.	Gain in soil.	Nitrogen in crop.	Total gain.
	Grams.	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*
1	54.94	0.115	....	55.055	61.48				
2	54.94	.115	....	55.055	62.44	61.50	+6.44	3.29	9.73
3	54.94	.115	....	55.055	60.58				
4	54.94	.115	1.00	56.055	60.82				
5	54.94	.115	1.00	56.055	60.58	59.38	+3.33	3.59	6.9
6	54.94	.115	1.00	56.055	56.94				
7	54.94	.115	2.00	57.055	61.00				
8	54.94	.115	2.00	57.055	60.82	60.13	+3.08	3.66	6.74
9	54.94	.115	2.00	57.055	58.58				
10	54.94	.115	1.00	56.055	58.16				
11	54.94	.115	1.00	56.055	59.82	58.81	+2.76	3.95	6.71
12	54.94	.115	1.00	56.055	58.44				
13	54.94	.115	2.00	57.055	64.62				
14	54.94	.115	2.00	57.055	56.98	60.72	+3.67	3.68	7.35
15	54.94	.115	2.00	57.055	60.56				
16	54.94	.115	1.00	56.055	56.54				
17	54.94	.115	1.00	56.055	61.02	59.05	+3.00	3.52	6.52
18	54.94	.115	1.00	56.055	59.60				
19	54.94	.115	2.00	57.055	58.42				
20	54.94	.115	2.00	57.055	56.52	57.45	+ .40	3.70	4.10
21	54.94	.115	2.00	57.055	57.42				
22	54.94	.115	1.00	56.055	60.70				
23	54.94	.115	1.00	56.055	57.84	59.70	+3.65	3.63	7.28
24	54.94	.115	1.00	56.055	60.58				
25	54.94	.115	2.00	57.055	61.26				
26	54.94	.115	2.00	57.055	62.14	62.27	+5.62	4.03	9.65
27	54.94	.115	2.00	57.055	64.62				
28	54.94	.04	....	54.98	56.12				
29	54.94	.04	....	54.98	58.08	56.89	+1.91	....	1.91
30	54.94	.04	....	54.98	56.48				

These results show, first, that there was a fixation of nitrogen by the cowpea crop, and that this fixation was greater where no nitrogen was applied than in any other series, or, in other words, that the soil upon which no nitrogen had been applied contained, after the crop of cowpeas had been removed (which crop contained nitrogen equivalent to 6 per cent of the total contained in the soil upon which the crop was grown) 6.44 grams, or 11.7 per cent more nitrogen than it contained before the plants were grown. This fact has not been heretofore shown, viz, that this plant, a member of the legume family, has the power not only of absorbing from the air the nitrogen necessary for its own growth, but also in its growth contributes to the stock of nitrogen in the soil. In the case of those groups of soils receiving more or less of the different kinds and forms of nitrogen the same general conclusion is reached, but the important point is that in no case was the absorption of nitrogen from the air greatly in excess of that upon plat 1, and in every case the fixation of nitrogen in the soil was very much less. Thus in 4, 5, and 6 (1 gram of nitrate), there was an average gain of 6.92 grams of nitrogen in the soil and crop, while in 7, 8, and 9, where double the amount of nitrogen was applied (2 grams of nitrate), the total gain was only 6.74 grams of nitrogen. Similarly in 16, 17, and 18 (1 gram of sulphate of ammonia), there was a total average gain of 6.52 grams, and in 19, 20, and 21 (2 grams of sulphate of ammonia), there was a total average gain of 4.10 grams of nitrogen. In all of the soils where either nitrate or ammonia was applied the gain was much less than in the soils where no nitrogen salt was applied. This, taken together with the fact that the application of the double portion of either nitrate or of ammonia resulted in a smaller yield as compared with the single portion, shows clearly that the soluble nitrogen exerted a depressing effect on the process of fixation.

On the other hand, we find that the total average gain in 10, 11, and 12 (1 gram dried blood), was smaller than that in 13, 14, and 15 (2 grams of dried blood), the corresponding amounts being 6.71 grams and 7.35 grams. In 22, 23, and 24 (1 gram of manure), the average total gain was 7.28 grams, and in 25, 26, and 27 (2 grams of manure), the corresponding gain was 9.65 grams. Here we find that the less soluble organic nitrogen was not detrimental to the fixation of atmospheric nitrogen when applied in double the amounts.

I have given this plan of experimentation and certain of the results mainly for the purpose of showing the importance of investigations of this character and the value of the scientific control of the conditions involved. In but one phase of the experiment important facts have been discovered; these, as the work proceeds, may be supplemented or modified by other facts and suggestions, so that when the experiment is completed in all its phases something may have been added to the sum of human knowledge.

F. B. Mumford, of Missouri, read the following paper:

Experiments in Animal Breeding.

Applied agriculture is far from being an exact science. Throughout the entire history of agriculture until recent times the cultivator of the soil has pursued methods the results of which could not be predicted with any degree of certainty. This lack of exactness has been due largely to the natural conditions which surround the activities of agriculturists. The uncertainties of climate, soil, and inherited tendencies of plants and animals employed by the farmer have all conspired to render his occupation one of the most uncertain and unreliable of all those known to man.

While this has been true, and it is largely true at the present time, the investigations of experiment stations in more recent times have succeeded in reducing many of the practices of agriculture to an exactness which would in earlier times have been considered wholly impossible. This is well illustrated by the results of the experiments in feeding. The cattle feeder of to-day can estimate with considerable accuracy the efficiency of a given amount of corn fed in connection with clover hay to cattle of a certain age and condition. The swine feeder knows that a bushel of corn when fed to pigs weighing 100 pounds will yield in all probability a certain definite amount of pork. This ability to estimate the results from feeding operations has been due entirely to the accurate, painstaking work of the experiment stations.

Not only in feeding have the stations contributed to the exactness with which the science of applied agriculture is now conducted, but in many other lines the stations have successfully prosecuted investigations whose results have made it possible for the farmer to carry on his business in a much more exact and profitable manner. The teachers of agronomy, animal husbandry, and dairying now speak with assurance and definiteness on many of the most fundamental facts underlying these subjects. The teaching of agriculture, which a few years ago was merely an expression of opinion on the part of the teacher, usually unsupported by any actual investigations, has now been reduced to a much more thoroughly organized subject.

ANIMAL BREEDING AN EXCEPTION.

While all this may be said with perfect truth of the subjects mentioned above, it is also equally true that in the subject of animal breeding the experiment stations have given practically no help whatsoever to the modern teacher of this subject. The most important investigations which throw light upon the practical work of the breeder of live stock were performed in most cases many years ago and by men not connected in any way with experiment stations. With one or two exceptions only the experiment stations of the United States have not even attempted to solve the problems which confront the breeder. The breeder of live stock to-day is engaged in the most uncertain of all the operations conducted by the farmer. He is still dependent upon "rule of thumb" methods. He has no great and guiding principles which, when followed, can be relied upon to produce desired results with certainty. He must still cut and try with the hope that some of his plans may result in success.

Recognizing, as we must, this condition which exists, we may well ask ourselves the question whether it is possible for the experiment stations to investigate in a scientific manner the important problems which confront the breeder. If we decide that there are problems to be solved, and that these problems are proper subjects of investigation on the part of the experiment stations, then there can be no valid excuse for neglecting longer this branch of animal husbandry. It must be admitted that investigations calculated to throw light upon the complex problems of the breeder are among the most difficult and expensive of any which have so far been undertaken by the American stations. The element of time is also a factor which can not be ignored. The station that undertakes to successfully prosecute experiments in animal breeding that shall yield valuable results, must not expect immediate results, and may possibly hope only to point out the way for others who will take up this question later. It is probably this fact that has deterred most stations from taking up this line of investigation.

INSTRUCTION IN ANIMAL BREEDING.

As long as animal breeding is included in the curriculum of every agricultural college, just so long will there be a crying need for careful observations on certain phenomena, and just so long will there be need of accurate observations to determine the truth or fallacy of certain questions of breeding. There is perhaps no subject taught in our agricultural colleges that is so largely based upon unreliable and unscientific data. Our present knowledge of breeding is based upon chance observations, mostly by untrained observers. No systematic effort has so far been made to investigate these breeding problems with the definite purpose of formulating fundamental general principles.

The embryologists and cytologists have given us some valuable suggestions as to the real problems of heredity, but they have not furnished any satisfactory solution of many of the mysterious and intricate questions of heredity. Many of the observed phenomena bring about changes in the developing embryo too minute to be observed by any present methods of investigation at our command. In this connection the investigation of Sutton and others on the individuality of the chromosomes, and the work of Guyer on spermatogenesis of hybrids, should be remembered. These investigations point to a cytological explanation of Mendel's law.

PROPER SUBJECTS OF INVESTIGATIONS.

It may be stated at the outset that there are certain questions which are not in the present state of our knowledge proper subjects for investigation. The peculiar conditions by which they are surrounded makes the securing of valuable data exceedingly improbable. We need at the present time carefully planned and executed experiments where all the conditions can be controlled. I can not hope at this time to even suggest all of the fruitful lines which might be undertaken by investigators in animal breeding, but I venture to call your attention to certain classes of facts which it seems to me are proper subjects of investigation and upon which the experiments of the animal breeder may throw some light.

The one quality most desired, and from every standpoint most important in our improved breeds of live stock, is prepotency. The ability of a well-improved animal type to perpetuate its improved qualities is the most valuable character it can possess. In a breeding animal all other qualities sink into insignificance in the absence of this power of transmission. I believe, therefore, that an investigation of prepotency should form the foundation stone of a rational series of breeding experiments. In investigating the conditions which control or influence prepotency we must study the influence of limited inbreeding, continuous in-and-in breeding, cross breeding, telegony, the relative influence of parents, the age of the animal, and their physical condition at the time of mating; but an investigation of these questions has to do with the fundamental principles of stock breeding. The results secured from such a series of investigations would give us data of the most valuable character.

Experiments conducted for the purpose of determining the effect of continued inbreeding ought to throw light upon the supposed bad influences following this practice as well as the desirable results. However strongly we may hold to the belief that diminished size, lessened fecundity, and weakened constitution follow this practice, it is generally conceded that in-and-in breeding does result in giving to the animal a greater prepotency.

We are likewise generally agreed that certain results are almost sure to follow the cross breeding of well-established types, and one of the results which is most widely accepted is that it destroys the prepotency of animals, and in certain cases this seems to be a result, but recent investigations have suggested that certain dominant characters may be transmitted from parent to offspring unchanged, and this is especially true of types which are markedly different.

We are in the habit of thinking of the whole subject of the relative influence of parents upon offspring as a superstition unverified by accurate observation. Leading biologists are perhaps a unit in the belief that there can be no influence exerted by an animal due to sex alone. When certain characters have apparently been transmitted by the male and others by the female, it is generally held that the strength of transmission in such cases is determined by a greater prepotency as a result of better breeding. Authorities seem to be agreed that there can be no such thing as prepotency depending upon sex. At the same time there are a large class of facts and some accurate observations that indicate in the case of reciprocal crosses there is a decided difference between the qualities of the offspring. It is, perhaps, not unreasonable to suppose that by natural selection the male may have acquired prepotency in connection with other characters. In nature, among gregarious animals, the strongest male always survives. The increase, therefore, is always from strong and usually mature males. On the other hand, the females of a herd are all preserved. If we deem that vigor, strength, and similar constitutional characters are transmitted, and that these can be intensified or accumulated in succeeding generations, it is not unreasonable to suppose that males may have acquired by natural selection alone an ability to transmit their characters more strongly than the females. The only way of throwing light upon this question is by careful observation through many generations and by reciprocal crosses, which will eliminate the error which might arise from differences in prepotency due to pure breeding.

One of the most remarkable series of experiments of recent times, particularly with plant breeding, are those experiments which have been undertaken to discover the truth or falsity of Mendel's law of heredity. Investigations so far conducted with plants seem to confirm in most cases the mathematical law of transmission worked out by Mendel. A few observations on animals have also followed with some accuracy the same law. This law has been of the greatest value to plant breeders, and if it is found to apply with equal certainty to animal breeding, it may lead to exceedingly valuable results. It is important that its applicability to animal breeding should be tested at the earliest opportunity. Another law of transmission, which is undoubtedly very near the truth, is Galton's "law of ancestral heredity." This law should be further investigated and its truth or falsity under varying conditions should be determined.

ONE PLAN OF EXPERIMENTS.

Many of the experiments so far undertaken have been imperfectly planned and their value has therefore been very much diminished. In investigating the many problems mentioned above, it is my opinion that reciprocal crosses with well-established breeds will yield the most valuable results. In investigating these problems it is highly important that we should start with at least two breeds of well-established characters. These should be reciprocally crossed, they should be bred purely, and they should be inbred. These experiments should be carried on coextensively and for a sufficient time to study the tendencies resulting from continued inbreeding, and these compared with simple pure breeding. In connection with these observations it is easily possible to study the influence of these methods of breeding upon prepotency. It will also give us an opportunity to study the relative influence of parents. The material secured ought to furnish us with the necessary data for studying Mendel's law, and ought to yield the data for examining into the law of ancestral heredity proposed by Galton. These experiments may be so planned that the subject of telegony may be one of the problems under observation.

The records of this experiment should show the mature weight in breeding condition of every animal in the experiment. They should include photographs of the pure types resulting from the crosses. The birth weights should be carefully kept and studied Accurate measurements of the extremities, length of body, heart girth, size of skull, and other important measurements should be recorded. A careful study of these records ought to throw light upon Mendel's law, upon Galton's law of ancestral heredity, and on the effects of cross breeding, inbreeding, and the relative influence of parents.

A STANDARD OF MEASUREMENT.

In the interpretation of the results of various methods of breeding we are greatly handicapped by reason of a lack of some standard of measurement. It has seemed to the writer for a long time that a step of first importance in breeding investigations is to settle upon some standard of measurement. Any measurements of mature animals are bound to be unsatisfactory by reason of variations, which may be due entirely to the result of environment. In studying the effects of inbreeding or cross breeding, it is necessary that we should separate these from all other influences whatsoever. In considering this question, the possibility of using the birth weight of animals has frequently suggested itself. The birth weight, perhaps, comes as near being an accurate measure of breeding influences as any other standard so far proposed. In any event it is worthy of consideration, and it is important that we determine the conditions which control birth weight.

The conditions which determine the birth weight of animals are not well understood, and investigators seem to have paid little attention to this class of facts. Under certain conditions the birth weight of animals seems to be closely associated with the subsequent growth and development of the young animal, and in general it may be said that a comparatively heavy birth weight is desirable. There is undoubtedly a normal birth weight which is fairly uniform for all healthy animals of a given size and breed. It is also undoubtedly true that the birth weight may be greatly influenced by the conditions affecting the mother.

The nutrition of the embryo, which will be largely dependent upon the condition of the mother during pregnancy, will probably be a determining factor in fixing the birth weight. It is also possible that the condition of the mother during the period leading up to the ripening of the egg will influence the nutrition of the embryo, and consequently the birth weight of the young.

During a period of four years the writer kept accurate records of the birth weight of lambs from a small flock of sheep. These birth weights were studied in connection with the size and condition of the parents, the sex of the offspring, and other important conditions. Careful records of the subsequent growth of the young were also made and important differences noted. One of the subjects of investigation was the possible influence of the increased size or breed of the male upon the birth weight of the young. The breeding ewes in this experiment were native sheep purchased in the vicinity of the Missouri Experiment Station. The rams represented three breeds, the Hampshire, Shropshire, and Delaine Merino. In summing up the results of the entire experiment it was found that the average birth weight of 41 half-blood Hampshire lambs was 7.8 pounds; of 33 half-blood Shropshire lambs, 8.4 pounds, and of 36 half-blood Merino lambs, 7.7 pounds. The average weight of the Shropshire rams used in this investigation was 195 pounds; of the Hampshire rams, 185 pounds; and of the Merinos, 142 pounds. These weights have no constant relation to the birth weights of their offspring. Not only was this true in individual cases, but it also seemed to be true that males of the larger breeds did not produce young having a greater birth weight than rams of the smaller breeds.

By comparing the birth weight of lambs with the weight of the mothers it was found that the birth weight of lambs varied directly with the weight of mother. This is shown in the following table:

Relation of weight of dam to birth weight of lamb.

Weight of dams.	Number of lambs.	Average birth weight of all lambs.
		Pounds.
Below 90 pounds	8	7.2
90 to 100 pounds	6	7.4
100 to 110 pounds	22	7.5
110 to 120 pounds	32	7.9
120 to 130 pounds	23	8.3

From this table it would seem that the birth weight of the young has a constant relation to the weight of the mother.

It may be well in this connection to ask what significance the birth weight may have in the development of the young animal. To determine this point, the records of the growth after birth for periods of six to nine weeks were carefully tabulated, and these are indicated in the subjoined table:

Relation of birth weight to subsequent growth.

Birth weight of lambs.	Number of lambs.	Average length of feeding period.	Average weekly gain, including birth weight.	Average weekly gain, excluding birth weight.
		Weeks.	*Pounds.*	*Pounds.*
10 pounds and above	7	8.55	5.4	4.5
9 to 10 pounds	8	6.05	5.5	4.2
8 to 9 pounds	14	7.33	3.7	2.5
7 to 8 pounds	13	9.03	3.4	2.3
Below 7 pounds	6	7.05	2.62	1.7

This table shows that so far as these observations extend the size of the young at birth has a very important relation to the subsequent growth of the young animal. Large birth weights were in every case favorable to large gains and vigorous growth, while small birth weights were as uniformly unfavorable to good gains. If this fact should prove to be true under all conditions, then the birth weight of animals becomes an exceedingly important standard of measurement. Any conditions or influences which tend to increase the birth weight of animals will have direct practical value in indicating the possibility of vigorous development and early maturity.

I have attempted in this paper to point out some of the problems of breeding, but particularly to indicate possible lines of experiments which may yield valuable results. It is not supposed that these are the only feasible lines of investigation nor necessarily the best. But the importance of the subject of experiments in animal breeding makes it obligatory on the experiment-station investigators to carry on investigations which may result in permanent value to the breeders of domestic animals.

Soil Fertility.

H. W. Wiley, of the Bureau of Chemistry, U. S. Department of Agriculture, spoke as follows:

Mr. President, Ladies, and Gentlemen: For the vice-presidential address before the American Association for the Advancement of Science, at Buffalo in 1886, I took as a subject "The Economical Aspects of Agricultural Chemistry." The object of that address was to show what the crops of the United States took from the soil and what they owed to it in order to balance the account. Again, as president of the American Chemical Society in 1893, in an address on "The Waste and Conservation of Plant Food," the very theme was considered which has been discussed here this afternoon. These addresses need not be summarized, as they are accessible in the published proceedings of the associations named. In the opening paragraph of my work on soil analysis it is stated that the soil "consists chiefly of mineral substances, together with some products of organic life and of certain living organisms." It is ten years since that sentence was written, and the more thought I give to the question the more I am convinced it is true that the soil is a living organism and that it deserves the same consideration at the hands of the farmer that any other living creature receives. That is, if the soil is to be considered not as a dead body, but as a living organism, it is entitled to kindness, fair treatment, and proper nutrition. We know well the principles of pig feeding, and from them we get to some extent the fundamental principles of man feeding. Johnson has told us how plants feed and how crops grow, and we are now beginning to understand some of the principles of soil feeding. As our investigations go on these principles will become more clear, and we shall know how to keep our soils in good condition.

In one of the addresses referred to I said that up to that time there had been but little scientific agriculture in the United States, and I believe that statement to be true. This is a severe accusation to make against the scientific agriculturist of the country, but if you will study the history of our soils and see how they have been treated, if you will note their former condition and their present condition I think you will agree with me.

Why is it that the wheat crop of the United States averages only 13 bushels per acre, while that of France averages 27 bushels per acre, and that of some other countries still higher? Is this because the other countries have better soils to begin with, or is it because their soils have better treatment and the agriculturists take better care of them? The soils there have been in cultivation two thousand years, as we know, and probably a great deal longer, yet our soils, so far as this leading grain is concerned, have been in cultivation—some of them—not more than ten or fifteen years.

There must be some reason for this difference. You know the principles of extensive agriculture. The great West, the central West, will show you what is done in this respect. I have had some experience there myself as a farmer; I know the habits of the farmers. I have seen hundreds of stables built of rails, so when the manure got so high that the cattle could no longer get into them the stables could be moved. Any of you who have lived in the West have seen instances of that kind. I have seen fields year after year raked and scraped, and then fires built to get rid of the "trash" on top, so that cultivation might be the more easy. In this way the soil is robbed, not only of crops, but of remnants of crops, by the rapacious farmer, and it is no wonder that our soils have been so reduced in fertility. They have the same appearance as compared with a well-cared-for soil that a starved horse has in comparison with a well-fed one; the two occupy about the same relation. And the same principle which, if followed, will keep a horse in good condition will, if applied to a soil, keep it in good condition.

My purpose this afternoon in making the few remarks that I have to make is to state broadly what my view is of some of these principles by means of which soil fertility may be conserved and increased. In the first place, we must have some idea of what fertility is. My idea of fertility is the ability of a soil under given conditions to produce a crop. We all understand that a soil alone, without the environment in which it lives, can not produce a crop. The soil may be very good at the North Pole, but the crops are very meager because the other conditions of the environment are not good. Therefore, the first step in order to study the comparative fertility of any soils is to bring them under the same conditions; in other words, the environment must be the same. But given the required environment, that soil is fertile which will produce a good crop, and that soil is infertile which produces a poor crop. That is my idea of soil fertility—the ability of the soil to produce a crop. I shall not now discuss the factors which produce this ability.

In the experiments and studies made in this direction we have departed somewhat from the ordinary course of the two forms of experiments which have been described. Mr. Ewell, one of my former assistants, wrote some years ago an article for the Yearbook, in which he tried to show that every farm should be an experiment station and every farmer an experimenter. When a man sends to me a specimen of soil and writes, "Please analyze this soil and tell me what crops I can grow on it," I send him word, "Ask your soil itself what you can grow on it; by asking your question directly of the soil, you can get a better answer than in any other way."

I believe, therefore, that if we could obtain some comparative notion of the fertility of different soils peculiar to the United States when brought under the same conditions we might throw some light on the problems of soil fertility, its conservation and increase. So we have brought to Washington soils from a number of our States. These soils were, I believe, with one or two exceptions, secured from the agricultural experiment stations. We also brought here from England, through the courtesy of Sir Henry Gilbert, some of the celebrated soils of Rothamsted. After collecting these we had only one varying element as affecting comparative soil fertility, and that was the soil itself. These soils were all treated in exactly the same way—exposed to same temperatures, the same degree of light—receiving the same treatment in every respect. The product thus obtained was an accurate measure of their fertility under those conditions. The elementary conditions of crop culture have been already well described, so I shall take no time in going over them now. We had considerable trouble in getting the best form of pots in which to grow experimental crops. I made personal observations of the various pot experiments carried on in this and other countries in order to learn as much as possible from the various methods pursued. We adopted from different ones those features which seemed best suited to our purposes and thus finally obtained a method of conducting our experiments. These experiments have now been continued for nine years, and the results are being prepared for publication.

We fully appreciate what has been said here by previous speakers on this subject—that in order to have value such experiments must be continued for a long period of time and with a systematic purpose. For this reason some experiments, in themselves interesting, have not the full value which attaches to those which have been continued through a number of seasons.

I have here some photographs of these pots representing the crops produced by different soils in the same year under the same conditions. These soils, as I have said, are mostly from the United States. Without going into other particulars, I may say that there is shown a difference in the appearance of the same crops on different soils, but with absolutely the same environment. A mere glance shows that the relative fertility of these soils differs very widely. Here [indicating] we find the yield almost nothing, there we find a very rich crop, and between these extremes there exists every grade of yield.

In this way we put the direct question to the soil, "Are you a fertile soil? We give you the conditions under which you can show what you are." This is the answer which these soils have given. These results show that the soils themselves have inherently different fertilizing principles; that they are different in their characteristics, and in most cases have different crop-producing capacities.

Now, there is another question which we ask of these soils—"How rapidly under these conditions do you lose your fertility?" Here are a few photographs illustrating the answers which the soils give to this question. We have hundreds of these photographs; I have simply picked out a few. Here are answers to that question running over a term of four years, showing the results in the case of the same soil, the same crop, and the same conditions at different seasons. These soils had not previously been under cultivation. There [indicating] you see a diminishing fertility; but the diminution is mostly in the first year in this particular experiment. As you see, the soil does not have the same ability to produce year after year. One of these experiments was accidental, but the result is of great interest, and I am sure you will pardon me for mentioning it. We were troubled with certain fungi in these soils. We did not want to apply fungicides for fear it might change the character of the soil, which should remain constant, so the soils were sterilized. All the soils of one pot were placed in a pan, covered with another pan, and exposed for several successive days to the temperature of steam, even above the temperature of boiling water. In this way beyond doubt all the fungi were killed and also all the bacteria, so that when the experiment was started again we had to resort to inoculation. But, much to our surprise, the soils were restored almost to their former condition of fertility after being sterilized, nothing else having been done, which seems to show that a high temperature has the power of unlocking additional sources of plant food. And this is demonstrated in every one of the thirty-seven and more soils with which these experiments were made. This shows that if there were a way of sterilizing the soils and then reinoculating them, we could restore fertility for a certain length of time by unlocking these additional plant foods. This experiment was made in 1900. We find also a diminution of the crop again the succeeding year. The increased solubility of the plant foods was determined immediately by chemical analysis of the ordinary fertilizing ingredients, and it was shown that certain of these were considerably more soluble in our ordinary reagents than before, which proved the fact that these were unlocked.

Of course, we understand perfectly well that this process could not go on indefinitely. No matter how large your bank account may be, if you check against it again and again and again it will gradually grow smaller, until at last your deposit is exhausted. The same is true of the soil. You may draw upon it every year, but finally there will be nothing left and your check will be dishonored.

I will not detain you by going into the details of these experiments, but will pass over the results rapidly. The chemists, as you know, have been trying for years to find some way to gauge the fertility of the soil by chemical analysis. We know how to determine the total amount of the constituents of a soil. That process is easy and accurate. But how can we determine (if it is possible to do so) by chemical analysis what portion of the fertilizing constituents of the soil the plant takes out of the soil during its growth? Every agricultural chemist here present understands, without any explanation, the immense difficulty of such a problem, because the fertility of the soil is the sum of a number of conditions. You may say of a soil that it is as infertile as its weakest constituent, no matter how abundant the other constituents may be. You may have a soil abundantly supplied with a certain number of fertilizing ingredients—nature is usually extravagant; she makes a thousand seeds for one complete plant, and she furnishes to the soil a hundred times more plant food than the crop takes out of it in any one season; she is extremely extravagant in her supplies, is not a very good housewife in many respects—but, I say, that if a single essential ingredient is absent, I do not care what it is, you can produce no crop at all. Suppose a crop takes out of the soil 100 pounds of potash per acre. You might devise a method which, when applied to the soil, would extract 100 pounds of potash, so as to meet exactly the requirements of the crop; but that method, if applied, might not extract the correct amount of phosphoric acid or of nitrogen. That is to say, every one of the elements of plant food must have a method of its own. When the crop is changed you must change the method, because each crop acts differently toward the elements of plant food in the soil.

Nitrogen presents a more complicated problem, because a plant uses it only in one form; no matter how much nitrogen you may give the plant in another form it will not eat it. You may feed a growing green plant with all the free nitrogen you please and with all the ammonia the soil will hold, and the plant will not take a single molecule of them. The nitrogen must be in the form of nitric acid before the crop can eat it. Hence the available nitrogen in a soil is not by any means determined by an analysis which determines nitrogen in the various forms in which it exists. The only nitrogen in the soil that the green plant can eat at any time is that which exists as nitric acid.

Nitric acid and nitrates are the most soluble of all the plant foods, and they are the only plant foods which the soil has no power to hold back when a solvent is placed on the soil. There is no tendency on the part of the soil to hold nitric acid when water is thrown upon it, while there is a tendency to hold other fertilizing elements. Hence nitric acid is the most evanescent as well as the most important in point of cost of all the plant foods. Now, the total amount of nitrogen which is available at any time in a soil is the amount which happens to be nitrified, and which is not washed out nor appropriated for other purposes.

Hence you may find the means of measuring the amount of phosphoric acid which a plant will take out in an ordinary crop; you may find methods of determining how much lime a plant will take out of the soil in a certain crop; you may find out how much potash a given crop will take out; but this will not give you any idea of how much nitrogen that crop will take out. We have been somewhat successful in measuring by chemical methods the amount of potash and phosphoric acid which a given crop will take from the soil. Chemists have tried various experiments and have obtained from them interesting data, but none of these experiments will give an entirely satisfactory answer to the nitrogen problem. However, from experiments with soils taken from various parts of the United States we obtained some reasonable idea as to how much nitrogen the soil will yield. These results assume, of course, that these soils furnished a reasonable amount of other plant foods; otherwise there would have been no crop at all.

Another thing that we observe is this: Economy of production, as far as plant food is concerned, is attained always with a maximum crop—that is to say, a small crop takes a larger percentage of plant food from the soil in proportion to the organic matter than does a large crop. All our data go to prove that the farmer, if he seeks economical results, will produce a maximum crop, because for such a crop a proportionately less quantity of plant food is required. That is another point most definitely brought out in these researches of ours into the elements of soil fertility.

In our analytical work on the availability of plant food we use the methods of the Association of Official Agricultural Chemists, but in making the solutions we do not always use the official methods, because they are designed only for particular cases. Our solutions for this special investigation were made with dilute hydrochloric acid, using a large quantity of soil and a large excess of reagents, but the same for each soil. These are placed in a revolving apparatus where the contents are kept mixed all the time and the temperature is constant.

We must not forget that temperature is an important function in solubility of all kinds—sometimes increasing it, sometimes diminishing it; therefore, in experiments to determine comparative solubility, the temperature must always be constant. All our experiments to determine solubility were made at what we considered an average temperature for summer, when the upper layers of the soil have probably a temperature of 40°. Of course, the temperature may be much higher in some localities and lower in others, but in general when the soil is exposed to the full sunlight the temperature of the surface would be about 40°.

In conducting these investigations a number of men in the Bureau of Chemistry of the Department of Agriculture—Mr. Ewell, Mr. Moore, and others—collaborated. Mr. Ewell was particularly concerned in the investigation of the power of the soil to induce nitrification. We all understand that organic nitrogen is available only as the nitrifying organism prepares the food for the use of the plant. We must cook for the plant and prepare its food the same as for any other living being, and the nitrogen must be prepared especially for the use of the plant. The following experiments and methods were employed for this purpose:

Samples of soils were taken from different localities and kept in sterilized tubes in such a way that no organism could be introduced into them from the time they were taken until the experimental work had begun. These were sent to the laboratory and the nitrifying power of the soil was studied systematically in each case. In these experiments we used simply an ammonia salt—not wishing to study particularly the organism which produces ammonia, but rather that element in the soil which produces nitric acid from ammonia. Carefully protected ammoniacal material, to which no additional organism had been added, was used, and the material was then subjected to the ordinary processes of nitrification, with the results displayed upon these charts.

The nitrous organism must begin its work before the nitric organism can act. At first the nitric organism is usually a little behind, but it soon overtakes its colaborer, so that after a few weeks the nitrous acid completely disappears. The work of the nitrous organism is overcome by the more vigorous action of the nitric ferment.

In our experiments it was found that in nearly all the cases the lack of nitrification was not so much due to the absence of organisms as to the lack of a nitrifiable base. By the addition of lime to a soil which had a weak nitrifying power the latter was greatly increased. This shows the importance, especially in clover growth, of having some substance present in the soil, like lime, which will neutralize the nitric acid formed, and prevent it from exercising any toxic effect on the plant; for, strange to say, some of these plant foods do exercise a toxic effect on plants if allowed to accumulate, and acids, of which nitric acid is one, are illustrations of that fact. Thus the application of lime to a soil not only modifies the physical conditions, but also favors the development of nitrifying organisms. The result of these experiments is to demonstrate that in order to conserve the fertility of the soil the nitrifying organism must be cared for and must have something to work upon. The nitrogen in the soil in organic matter is useless unless it is converted into nitric acid.

Of course, it goes without saying that no matter how well you care for a soil, how carefully you rotate your crops, how much care you take to grow leguminous crops to increase your stores of nitrogen, or how much these stores may help to loosen other locked-up mineral foods, there will come a time when you must feed to the soil, however rich, something to take the place of that which is taken away. The aim of the practical farmer is to return to the soil just as much as possible of what he takes out, and even a little more.

Thus the farmer himself has a duty to perform. No matter what we may do we must look forward to the time when the soil must be fed. We owe a debt to posterity. We have no right to take from posterity the means of subsistence. The agriculturist of to-day who does his duty to his farm must pass it to his successor in a more fertile condition than that in which he receives it. The man who does not do this robs posterity; and it is just as much a crime to rob future generations as it is to rob those who are living on the earth to-day. Therefore, in agriculture we have a moral duty to perform which we should not forget; and that is, the duty which we owe to those who are to come after us. Let us, then, as agricultural chemists and practical agriculturists, see to it that the fields which we till shall be, when they pass from our hands, better producers than when we received them.

The address of Doctor Wiley was discussed by C. G. Hopkins, B. W. Kilgore, and others.

The following paper, prepared by C. S. Plumb, of Ohio, was, in the absence of the author, read by title and ordered printed:

Methods of Investigation Relating to the Breeding of Animals.[a]

There are no fixed methods of investigation relative to the breeding of animals. While most of our present breeds of live stock have been improved through the intelligent action of the mind of man, there has been comparatively little method in the work. Great breeders have lived and have brought animals up to a high stage of development, but their methods have been rather general than specific and that of the practical man rather than the scientist. An immense amount of literature has been published on the subject of feeding and men have written much on their methods of feeding, but not so concerning breeding. The live-stock journals of to-day print articles on feeding in great number, with but few contributions on breeding that bring out new ideas. Reports on feeding experiments emanate from our experiment stations with frequency, while those on breeding animals are among the things to be. As I have remarked elsewhere,[b] there are men in the service of some of our experiment stations who have made themselves famous as investigators and authorities on feeding, but no one as yet has brought fame to himself for his discoveries in this special field of breeding.

Under these circumstances it might be fairly assumed that no very extensive methods of investigation have as yet been developed, so far as breeding animals goes. There are a few isolated cases in which practical breeders have with much care and persistence worked at problems of breeding, and have secured most interesting and valuable results. Examples occur where the people of a region have united to improve a breed or type and have accomplished their object. Instances have also occurred in continental Europe where the state has promoted the development of a breed or class of stock, while there are several instances of men more or less scientific working on problems of breeding worthy our attention.

In order to throw as much light as possible on the methods used by some of the intelligent breeders of the past I now propose to direct your attention to a number of examples, a consideration of which I am sure will be of benefit to all persons interested in improved live stock and the problems of the breeder of animals.

It is very likely that in early times considerable intelligence was displayed in the breeding of certain animals, of which the Arabian horse may serve as an illustration. It is improbable, however, that there was much live stock of an improved type prior to the middle of the eighteenth century. Early writings do not indicate it, and Culley, the first British author of a work exclusively on live stock,[c] in describing the breeds of farm animals in Great Britain, mentions but few compared with the considerable number of to-day. Culley was a prominent breeder at that time,

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[a] One of a series of unpublished lectures delivered before the Summer Graduate School of Agriculture at the Ohio State University in July, 1902.

[b] Lecture on breeding farm animals before the Kansas State Board of Agriculture, January 18, 1902.

[c] Observations on Live Stock, 1789.

yet his writings would indicate that the stock of that time must have been quite inferior to that of to-day.

In these early days, however, a man appeared in the live-stock field who reached the zenith of fame in his time, and who has since frequently been referred to as "the father of modern live-stock husbandry." This was Robert Bakewell, a man of remarkable character, and, as I have often thought, the greatest student of breeding farm animals that this world has ever seen. Bakewell was born in 1726, in the county of Leicester, England, and his work as a great breeder became especially notable subsequent to 1750. Undoubtedly he was a wonderful investigator of animal breeding. While he left little in the form of records for the use of those who were to follow him, and by some authors was regarded as secretive, the fact is that he was visited by Arthur Young and others interested in improved live stock and did not hesitate to discuss his methods with them. Not only did Young make two memorable visits at his home, but Bakewell wrote several articles for the Annals of Agriculture, then being published by Young.

Bakewell realized that the farm animals in the vicinity of his home were unprofitable as feeders and of inferior quality, and he began a systematic and extended effort to improve them. Young states that, "the leading idea, then, which has governed all his exertions, is to procure that breed which, with a given food, will give the most profitable meat, that in which the proportion of useful meat to the quantity of offal is the greatest; also, in which the proportion of the best to the inferior joints is likewise the greatest."

Bakewell for years carried on experiments such as perhaps have not been attempted by any other breeder in history. He secured specimens of different breeds of sheep, studied their qualities, and experimented with them. He undertook the systematic improvement of the native sheep of Leicestershire and perhaps Lincolnshire, until from them he developed what was long known as Bakewell's or the Dishley sheep, and later the improved Leicester. So intensely did he study the quality of the individuals, that he slaughtered and preserved in pickle specimens of the parts of different animals for study. He kept specimens of bones, flesh, etc., of some of his most famous animals, to use for comparison. One of his most celebrated Longhorn cows was known as "Old Comely." Some parts of her, says Houseman,[a] were seen in pickle at Dishley, years after her death, among Mr. Bakewell's relics of his most remarkable animals, and it is recorded that the fat on her sirloin was 4 inches thick. Young also writes in the Annals in 1786, "He has also a piece of rump of beef that has been in pickle a year and three-quarters, 4 inches thick of fat." In comparing the Southdown with the coarser Norfolk breed, Mr. Bakewell shows, says Young, that the latter is much inferior, "the former having flatter backs, more spreading, rounded carcasses, a much greater disposition to fatten, points infallibly attending (in a well-made animal) the deficiency of tallow within and less offal. By which term is to be understood, not only the skin, tallow, head, and pluck, but the horns, hoofs, and bones of every joint. It is remarkable that the last are very small in those breeds that have a true disposition to fatten. They are much less in the Southdowns than in the Norfolks. Mr. Bakewell, when last in that county, ate a neck of mutton at an inn, which afforded him a bone which he considered as a curiosity and kept it. It was full twice the size of that of one of his own sheep, which had 4 inches of fat on it. This bone, he found on inquiry, to have come from a true Norfolk sheep." Going still further, Young says, "Good as the Southdowns are, on comparison with the Norfolks, Mr. Bakewell's own breed far exceeds them; their form is truer, their backs much flatter, their carcasses heavier in proportion; and they have so much a greater disposition to fatten beyond all other sheep as to make a parallel absurd. He has the part of a neck of mutton in pickle, which at present is 4½ inches thick with fat on the bone." Says Houseman, "Skeleton and pickled joints of specimens of the best of the Dishley sheep and cattle formed a little museum at the Grange, for the comparison of one generation with another, ancestor with their descendants. The fineness of bone, size and shape of frame, thickness of layers of muscle, and amount and character of inner and outer fat could be studied. Such examination must have served a valuable purpose."

Undoubtedly Bakewell early comprehended the significance of the great law that "like produces like." He practiced a wise selection in his breeding work and mated his animals to secure: (a) Utility of form; (b) quality of flesh, and (c) propensity to fatten.

His method of selection resulted in introducing in-and-in breeding, which he practiced in his herd for twenty consecutive years. He did not, however, arrive at this practice without what to him were the necessary preliminaries, and many years

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[a] Jour. Roy. Agr. Soc. England, 1894, pt. 1, p. 25.

of his life were ones of considerable experimentation in the introduction of various lines of blood and types of animals into his herd for study. Numerous stories are told of his crosses, and visitors to Dishley saw about his stables several breeds and crosses of sheep. Young says that in his 1785 visit he saw "ten different sorts of rams, none of the Dishley breed, tied up in separate stalls, and each had his food weighed out to him in order to try which sort of sheep has the greatest stomach."

That about Bakewell which makes it appropriate to give him so much attention lies in the fact that he was a true experimenter in the breeding of animals. He comprehended some principles, although he gave no definitions. There was a method in his investigation. He learned experimentally that, within reasonable limits, like produces like. He sought alien blood as a means of introducing desirable improvement in his herd, and he bred in-and-in to retain valuable qualities, until he learned of its dangers. I know of no other breeder in history who has preserved for study parts of the anatomy of animals of his own breeding to serve as a guide in making future improvement. Surely Bakewell was a wonderful man!

Most of the improved breeds of to-day have been developed through a combination of two practices, viz, selection and crossbreeding. In the various counties or districts of England and Scotland men early came to recognize certain types of farm animals as having a peculiar value and adaptability to those localities. As a knowledge of methods of improvement became known men took up the work, and selection and crossbreeding became responsible for much of the now existing breeds.

Following after Bakewell's time, I now wish to direct attention to a number of interesting lines of experimental investigation, relating to some phase and method of animal breeding. There is not a great deal of such work available to the student, and even then but comparatively little consideration is given to the methods used. These experiments, however, do give us something of an insight into the methods used and teach us in a measure how, through the persistent use of methods based on principles, we very naturally expect to secure certain results.

In 1783 Louis XVI of France purchased at Rambouillet, about 25 miles from Paris, an estate of considerable size. As the Spaniards were at this time leading producers of fine wool, it was feared that they would increase their factories and prohibit wool exportation and would thus injure the wool interests of France. Consequently the French sought to improve the wool situation for France, and Trudaine, a French minister, studied this problem from 1766 to 1776. On the purchase of Rambouillet the King began to stock it with choice animals and, at the suggestion of the superintendent of the estate and others high in authority, the King of Spain was asked for permission to allow the purchase of a flock of sheep from Spain for Rambouillet. This was granted, and on June 15, 1786, a flock was selected by Professor Gilbert about Segovia and shipped to France in charge of Spanish shepherds. This consisted of 383 head, of which 334 were ewes, and were selected among various races. In 1801 another importation was made, but the first flock was regarded as composed of the best sheep.

That which principally interests us in this matter is that this movement inaugurated by France led to a systematic line of experimental breeding at Rambouillet, which has continued without intermission up to the present day. The purity of the flock has always been maintained, we are told, as the administration especially desired to preserve this quality. The fold was kept under the supervision of a director, and careful records have always been made of the development from year to year. It was sought to produce sheep of greater size than the Spanish stock, to secure a heavier fleece of finer staple. Vigor of constitution was also sought for. In order to follow up this work intelligently, records have been kept almost from the beginning. These involve measurements of body and fleece, weights of sheep and wool, general descriptions, and records of fecundity. A smooth-bodied type of merino was adopted and the matings were conducted toward a certain end. Along in the latter part of the first half of the nineteenth century the Government experimented somewhat in the use of English races to improve the form and mutton. This movement to produce a sheep more for mutton than wool, it is said, was probably not satisfactory. In a discussion of the Rambouillet sheep, M. L. Bernardin, director of the national sheep farm of France, in 1881 writes:[a] "The fold of Rambouillet can show by record and statistics that the managers have produced a type of sheep which they sought to produce from the start; that the race of sheep has been kept pure for a century, and everyone applauds at sight the incomparable perfection attained at Rambouillet; that the modes of feeding, different regimen, methods of breeding, improvement by selection, care, and good management by shepherds have produced a sheep of early development for consumption, rapid

[a] American Rambouillet Record, Vol. I, 1891, p. 38.

growth to maturity, and showing a gain by average from 120 pounds for rams and 75 to 80 pounds for ewes in 1800, to 200 to 250 pounds for rams and 120 to 150 pounds for ewes in 1880; that the weight of fleece of rams has increased from 10 pounds in 1800 to 16 to 20 pounds in 1880, and ewes from 5½ pounds in 1800 to 10 pounds in 1880, with length of staple increased from 2 inches in 1800 to 3 and 3½ inches in 1880; that the fineness of fiber and crimp of the wool have reached the highest degree of perfection, and that for length, strength, and elasticity it has no equal; that a density of bulk and fleece has been attained which does not exist in any other race of sheep; that the wethers and lambs are noted for their rapid and steady growth to maturity, their aptitude to fatten, and the excellent quality of mutton, and that other merinos are not of the same value and title as those of Rambouillet, either regarding the production or the qualities of wool and meat."

This work at Rambouillet represents, in the main, the application of the principle of selection to secure a result desired by the experimenters. It is a good example of a persistent application of the motto of the Royal Agricultural Society to "Practice with science." Baron von Homeyer, of Pomerania, Prussia, took up this same breed and improved it by selection to develop a somewhat larger and still heavier-fleeced sheep than did the French. Von Homeyer was one thoroughly imbued with the scientific spirit, and on his great estate he kept very thorough records and bred with much intelligence. He gave much careful attention to the breeding of his sheep, and occupied the entire time of one of his employees in studying and working on pedigrees. Certainly the Rambouillet represents a breed that has come to its present high development through a more systematic and longer continued and more careful investigation relating to the known principles of breeding than is the case with any of our other breeds of farm stock. Probably more connected records of observation are available at the Rambouillet fold than could possibly be obtained elsewhere in the world.

Still another investigation in breeding sheep in France is worthy our attention in view of the character of the problem worked on. This relates to the method adopted by Malingie-Nouel, director of the agricultural school at Charmois, in producing a new breed, as given by Mr. Pusey.[a]

With the falling off in the price of wool in France came a demand for less Merino blood and better mutton. The French stock consisted of pure breds and mongrels, the latter with more or less Merino blood. It was thought that if pure-bred English rams were bred to French ewes, including Merino mongrels, that good results from the mutton point would ensue. It was found that the lambs from this cross resembled the mother more than the father, though a few resembled both parents. When the ewes of the latter type were bred to English rams the offspring resembled the sire more than the dam, both in shape and features, with a fleece of English character. No sooner are the lambs of this mating weaned, however, than they begin to fail in vitality and become inferior and stunted with the heat of the French summer. They appear like unacclimated foreigners, lacking the vigor of the native French breeds. Experiments carried over several generations seemed to demonstrate that English breeds of sheep required the peculiar conditions of Great Britain to maintain their character. Leicester, New Kent, and Southdown rams were used in this experiment. It was found that the foreign influence was most marked in those crosses from English sires of greatest purity of race, as Southdown.

Where a Leicester ram, a mixed New Kent, or impure Southdown was used on pure French ewes, very little English character was seen in the offspring. Very little difference in fact, it is said, oftentimes happens between lambs that are Leicester-Merino, Kent-Merino, or Southdown-Merino, and another lamb of the same age that is pure Merino. Such lambs, however, have no trouble with climatic conditions. If now, these same ewes were bred to very pure Southdown or New-Kent rams, the English character became more marked in the offspring. Where the offspring from each of these crosses is raised, the lambs in which the English blood does not exceed one-half seem to be raised as easily as French lambs. When these same Anglo-French ewes, however, are bred to English rams, disaster follows. Years were spent in experimenting after this manner, in endeavoring to create a new breed that should have good mutton character and be adapted to French climatic conditions. Finally, a different method was adopted, which worked out successfully. Four classes of ewes of French breeding, representing the four races of Berry, Sologne, Touraine, and Merino were bred together to form one mixed type without decided character, without fixity, and with little intrinsic merit, excepting that they were well adapted to French climatic conditions. These mixed blood ewes were then bred to a pure New-Kent ram. Thus was obtained offspring containing 50 per cent of the purest and

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[a] Jour. Roy. Agr. Soc. England, 1853, pp. 214–224.

most ancient English blood, with $12\frac{1}{2}$ per cent each of four different French races. Here the English blood showed strikingly in the offspring, all the lambs resembling each other. Even Englishmen took them for lambs of their own country. When these young ewes and rams were bred together they produced lambs closely resembling themselves, without any marked return to the features of the old French races, from which the granddams were derived. Slight traces only could be seen here and there by the experienced eye. This was the origin of the Charmois breed of sheep. M. Malingie-Nouel states that from the first dropping of his lambs the strongly marked English character gave the strongest hope that they would retain the excellences of the English sires and he was not disappointed. The young animals as they grew up preserved their beauty of form, maintained their condition without extraordinary food, and did not suffer from weaning. The ewe lambs were carefully preserved, a few ram lambs saved, and the rest castrated. The next year the same cross was tried with equal success. The third year was still more interesting. The first ewe lambs at the age of twenty months were bred to the rams that were saved. The offspring was very uniform in quality, though from parents of a first cross. For years there was maintained at La Charmois a double set of lambs, one from the New-Kent rams and the mixed-blood ewes and the other from rams and ewes the result of that cross. There continued a perfect resemblance between the two sets of lambs obtained by the two methods. They were often divided into two lots and it was found impossible, even by careful examination, to distinguish one set of lambs from the other. This, M. Malingie-Nouel seemed to think, indicated the fixity of the breed.

While this historical sketch of a breeding experiment deals with a breed unfamiliar to us, it has unusual interest from the fact that it is probably unique in the annals of breeding. Note the problem dealt with. First, the destructive conflict of breed characteristics. Second, being overcome by climatic conditions. Third, the survival of the fittest, when strength of blood was united to weakness. Fourth, overcoming climatic conditions. No more instructive experiment on the beneficial results to be secured from intelligent crossing is available to students of animal breeding than occurs in the origin of the Charmois breed of sheep.

An interesting experiment in crossing is at present in progress in the United States. Mr. Charles Goodnight, of Clarendon, Tex., has for over twenty years been engaged in an attempt to cross the American buffalo on different breeds of cattle.

In 1879 he captured four buffalo calves, and these he made use of as his foundation stock. By crossing these with our improved breeds of cattle, Mr. Goodnight has hoped to establish a new race or breed having certain valuable qualities for the semiarid grazing lands of the Southwest. Unless accomplished very recently, he has never been able to cross the buffalo with other breeds of cattle excepting the native Texas cow and the Galloway and Aberdeen-Angus. The Galloway crosses are hornless, thus showing the intense polled habit of the breed of this name, but otherwise they are somewhat uncertain. The Aberdeen-Angus crosses have proved more satisfactory and certain. With the Angus cross, all of the first calves proved to be females. The half-bred Angus heifers breed once a year, while the buffalo cow breeds only every two years. These half-bred cows mate well with buffalo bulls, but if a male hybrid results it is sterile, though the females of this blood breed readily. In a communication to Dr. Norgaard, Mr. Goodnight says:

"I have now been breeding them about twenty years and I am quite positive no case of blackleg has occurred during that time, and up to this writing it holds good to those that are only one-fourth blood. I will this year have several head of calves only one-eighth blood, and I shall give them every chance to take blackleg, in order to test them, although I think they are immune.

"I have been trying for several years to establish a race of cattle from the buffalo. So far I have only partially succeeded. When this is done, it will be the greatest thing for the cattle industry of America. They have some characteristics that are very valuable to this interest. Besides their great weight and the extra quality of meat, they are, first, most probably immune from blackleg; second, they never eat loco; third, they never lie with their backs downhill, which causes so much loss in weak cattle; fourth, they do not go in bog holes; fifth, they have the greatest lungs in any animal on earth; sixth, they put on more flesh for what they eat than other animals."

In connection with the exemption of this crossbred from blackleg, Mr. Goodnight was first moved to think of this from the fact, so far as his knowledge goes, based on extended experience with the buffalo in days of its abundance, that this animal never suffered from this disease.

Mr. Goodnight's experiment is one of much interest from both the practical and scientific standpoints. He is pursuing his work rather from the standpoint of the experienced cattle breeder, crossing and recrossing, and bids fair to attain most interesting results of a useful character.

Among the various experiments in breeding that have attracted considerable attention in the past have been those relative to the control of sex. Numerous methods have been advanced for regulating sex in offspring, of which the following may be given.

(1) The right ovary and the right testicle produce males and the left females.

(2) Early stages of œstrum produce females, later males.

(3) A preponderance of spermatozoa will cause male sex, while a small amount will result in female offspring.

(4) Alternate ova will produce the same sex.

(5) The preponderance of sex rests with the female.

(6) The sex is in excess according to which is the stronger, the male or female.

(7) Sex is influenced by the activity of the function of nutrition. Where there is the most nutrition females occur, where least males.

(8) Young males breed females, old males males.

Numerous experiments have been conducted by various persons on these problems, but thus far without securing data of a permanent character, so far as settling the problem is concerned. One of these experiments is of sufficient interest to be presented here, even though somewhat old. This is an experiment reported by M. Charles Girou de Buzareingues, of France,[a] who, on July 3, 1826, proposed to the Agricultural Society of Severac to demonstrate the control of sex by method of age—that is, that young males sire female offspring and old males male offspring. Two of the members of the society owning flocks of sheep placed them at the disposal of the society for conducting this experiment.

The first experiment was conducted as follows: M. Girou recommended very young rams to be put to the flock of ewes from which the proprietor wished the greater number of females in their offspring, and also that, during the season when the rams were with the ewes, they should have more abundant pasture than the other; while to the flock from which the owner wished to obtain male lambs chiefly he recommended to put strong and vigorous rams 4 or 5 years old.

The following table gives the result of this experiment:

Flock for female lambs.[a]			Flock for male lambs.[b]		
Age of dam.	Sex of lambs.		Age of dam.	Sex of lambs.	
	Male.	Female.		Male.	Female.
Two years	14	26	Two years	7	3
Three years	16	29	Three years	15	14
Four years	5	21	Four years	33	14
Total	35	76	Total	55	31
Five years and under	18	8	Five years and over	25	24
Total	53	84	Total	80	55

[a] Two rams served this flock, one 15 months old and the other nearly 2 years old. There were three twin births in this flock.

[b] Two strong rams served this flock, one 4, the other 5 years old. No twins here.

Late in the same summer another French sheep breeder, in the village of Bez, took a flock of 84 ewes and divided it into two parts of 42 each, one part consisting of the strongest ewes, from 4 to 5 years old, and the other of the weakest ones, under 4 years old or above 5. Lot I was bred to four male lambs, about 6 months old each and of good promise. Lot II was bred by two strong rams more than 3 years old. A third lot of 22 head, owned by the shepherd of the owner of the 84 ewes, were placed with Lot II. The results secured were as follows: Lot I dropped 15 males and 25 females; Lot II dropped 26 males and 14 females; Lot III dropped 10 males and 12 females.

The sheep of Lot III were in better flesh than the others. M. Girou states that the general law, so far as we are able to detect it, seems to be, that, when animals are in good condition, plentifully supplied with food, and kept from breeding as fast as they might do, they are most likely to produce females. Or, in other words, when a race of animals is in the circumstances favorable for its increase, nature produces the greatest number of that sex which, in animals that do not pair, is most efficient for increasing the number of the race. But if they are in a bad climate or on stinted pasture, or if they have already given birth to a numerous offspring, then they produce more males than females.

[a] Ann. de l'Agr. Francais, XXXVII, XXXVIII; also Jour. Agr., 1828–29, pp. 63–65.

This experiment is not given here because it gives information of value to the scientist, but rather as one method of investigation bearing on breeding questions. It is true that the experiment in itself gave most inconclusive results, but it is not difficult to foresee that, had a persistent and systematic study been undertaken on this same line, results might have been secured that would have had a positive rather than a negative value.

One of the most interesting and novel lines of investigation bearing on the breeding of animals is that of breeding race horses by the figure system, as introduced by the late C. Bruce Lowe.[a] Mr. Lowe, after many years of study of the history of the English race horse, including an analytical study of pedigree, came to the conclusion that racers descended from certain parentage were logically to be regarded as of greater speed inheritance and ability than those of other parentage. Forty-three different families of race horses are given numbers from 1 up. These families are ranked numerically, on the basis of a statistical study of the contestants of the three most prominent English races—the Derby, Oaks, and Leger. The family having the largest number of winners is No. 1, the next No. 2, and so on. Some of the families investigated have never won a race. By placing the numbers adopted by Mr. Lowe on a regular tabulated pedigree, the horseman can easily tell at a glance what families have been used in the breeding of the horse in question, and whether from high-class speed ancestry, as 1, 2, 3, 4, or 5; or outside one, as 10, 14, 15, 18, 33, etc. Of these various lines, Nos. 3, 8, 11, 12, and 14 are classed as the five great sire families, coming from stock very prepotent in the stud. Emphasis is laid on the fact that it does not follow that because an animal is rich in the running strains—1, 2, 4, and 5—that he is going to be a success at the stud. In fact, strange as it may seem, a sire from these families is likely to prove a failure unless mated with mares from the sire families 3, 8, 11, 12, 14. "All the great sires of the world, from Eclipse to the present day, either descend directly from these five great families or are inbred to them, and horses not in these families (or inbred strongly to them) are, so to speak, powerless to sire winners unless the sire element is strong in their mates."

The English races previously referred to were established in 1777, 1779, and 1780. When the English stud book was first compiled, many years ago, it contained about 100 mares or so-called "top roots." Of these, nearly 50 are represented in the more recent stud books, of which less than 20 play any prominent part in the pedigrees of modern horses, while only about 9 appear indispensable in the pedigree of any first-class race horse of the present day. These 9 classes are divided into two groups, running and sire, or feminine and masculine. It is contended in this study that the breeding of some of these families must show in the three nearest top removes, and in proportion to the amount of inbreeding to these choice families will be the measure of vitality contained in the individuals—other conditions of course being equal. Further, Lowe insists that every great race horse and sire of this century will be found to have in his three top removes one or more of the following figures, 1, 2, 3, 4, 5, 8, 11, 12, 14. The three great lines of male descent are given as the Darley Arabian, the Byerly Turk, and the Godolphin Barb.

In connection with this theory is given a statement concerning each of the families in question, with a list of the winners at any or all of the three great races.

To illustrate this method of studying the speed ancestry of racing stock, the following pedigree is given of Salvator, who holds the world's record for speed, having run a mile in 1.35½.

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[a] Breeding Race Horses by the Figure System. Compiled by the late C. Bruce Lowe, 1898, pp. 262, numerous plates.

NOTE.—The figures over each column indicate the percentage of blood in this animal of each one in that generation.

100 — 50 — 25 — $12\frac{1}{2}$ — $6\frac{1}{4}$ — $3\frac{1}{8}$ — $1\frac{9}{16}$

The pedigree of

SALVATOR,

A thorough-bred horse. Record $1.35\frac{1}{2}$, the world's running record of 1 mile.

- Prince Charlie (12).
  - Blair Athole (10).
    - Stockwell (3)
      - The Baron (24)
      - ....
        - Glencoe (1)
    - Blink Bonny
      - Melbourne (1).
      - Queen Mary
  - Eastern Princess.
    - Surplice (2)
      - Touchstone (14)
      - Crucifix
    - Tomgris
      - Seostris (12)
      - ....
        - Glaucus (3)
- Salina (12).
  - Lexington (12).
    - Boston (40)
      - Timoleon (41)
        - Sir Archy (41)
        - ....
          - Saltram.
      - ....
        - Balls Florizel
    - Alice Carneal
      - Sarpedon (41)
        - Emilius (22)
      - ....
        - Sumpter (4)
          - Sir Archy (41).
  - Lightsome.
    - Glencoe (1)
      - Sultan (8)
        - Selim (2)
      - ....
        - Tramp (3)
    - Levity
      - Trustee (7)
        - Cotton (2)
        - ....
          - Whisker (1).
      - ....
        - Tranby (21)
          - Blacklock (2,2,1)

This breeding shows very strong blood lines on both sire and dam's side, tracing back to the famous Eclipse, with the occurrence of the valued sire blood in family three times. The five leading families occur nine times in this pedigree, which speaks very highly for it.

While Lowe gives no experimental records of his own, the theory he advances is logical as based on the laws of heredity, and his illustrations are clear and convincing. In fact, the different adopted lines of families associated with the various pedigrees, studied in themselves, do represent a method of investigation as valuable and useful in themselves as though a line of breeding was conducted for this special study. Lowe's is a distinct contribution to the literature of heredity and should serve as a valuable guide to the progressive breeder of race horses, as well as an important suggestion to breeders in general.

If the consideration of methods of investigation so far discussed have referred to the work of practical men, it is in the main because scientific men have undertaken but little breeding investigation with domestic animals, and especially farm animals. The writings of the leading students of animal breeding have contained almost no illustrative information, based on systematic experiments with farm animals. Darwin gives many notes of records, but nearly all are incidental observations and without doubt some of these have been interpreted wrongly. This constitutes one of the most serious defects in the study of animal breeding. While it is true that it is not absolutely essential that breeding problems shall be studied with farm animals in order to get an intelligent understanding of them, it is to be regretted that animals of this class have been used so little in careful, systematic, and extended breeding that was conducted for the very purpose of studying cause and effect.

At Halle, Germany, in connection with the university and agricultural experiment station, there have been conducted experiments in breeding animals for over thirty years. In 1900 it was my pleasure to spend a brief time examining this institution and the stock experimented with. There is quite an extensive series of barns or sheds of brick with very small runs associated, and these usually paved. Here was a considerable collection of breeds and crosses of horses, cattle, sheep, and swine, and also a most interesting lot of species of various lots gathered from Europe, Africa, Asia, and America, used in crossbreeding. There were wild boars, buffalo, sacred oxen from Asia, queer fat-tailed sheep from Somaliland, and a wealth of breeding material, not excluding dogs, foxes, wolves, etc. The conditions of confinement were those of a zoological garden and certainly abnormal, but I doubt if such a breeding laboratory exists elsewhere in the world. It is unfortunate that the work of this institution should be unknown to English and American literature. I only know that here much experimental work in breeding has been and is being conducted, but thus far it does not seem to be known or recognized by English or American writers on this subject. It is presumable that the investigations conducted represent the characteristic thoroughness of the German scientists.

Perhaps that investigator attracting the most attention at the present time in breeding problems is Dr. J. Cossar Ewart, regius professor of natural history in the University of Edinburgh, Scotland. About 1895, Professor Ewart inaugurated his present experiments. As expressed in his writings, the purpose of his experiments has been to make a study of certain questions in breeding, concerning which both breeders and scientists are at variance. These include telegony, the relative influence of male and female parents, the influence of mental impressions, and the transmission of acquired characters, as the more important subjects.

It is impracticable to attempt anything more than a general discussion of the methods and work of this investigator.

That which might attract the stockman most is represented in using a Burchell zebra, known as Matopo, on horses and ponies, and thus creating a variety of hybrids. The first cross attempted was on a pony from the island of Rum, from which resulted a hybrid named Romulus, born on August 2, 1896. This pony proved strong and hardy, was easily broken to harness, and moves more like a zebra than a horse. It is doubtful if he ever proves fertile. As might be expected this pony has some stripes, of a dark color, on a coat which has varied since the first shedding from a leather to a mouse dun. Matopo was also bred to Valda, a chestnut polo pony, getting the hybrid Birgus, foaled May 12, 1900. The stripes in this hybrid when very young were nearly as distinct as in a zebra foal, but as in all the hybrids bred the body color is darker than in zebras. Another previous breeding of Matopo and Valda had resulted in twins on May 31, 1898, and these were smaller and less distinctly marked than their full brother Birgus. One twin died and the other remained relatively small, with an action more like a stag than a colt or young zebra.

Matopo was also bred on two different years to a bay-cart mare, 15 hands high. The first hybrid, Brenda, was stronger than her full sister Black Agnes. Brenda resembled their common dam; Black Agnes took after one of her maternal ancestors. Matopo seems incapable of transmitting his light body color, or his special form of stripes.

In addition to these hybrids, other crosses were made to study the influence of telegony. The mare Valda, already referred to, after having the twin hybrids, was bred to a chestnut thoroughbred horse named Lockstitch, and Hector was foaled as the result. A bay Irish thoroughbred pony, Rona, was bred to a bay Hackney pony stallion, as a 3-year old, getting the foal Argo. The year before Rona had dropped a hybrid foal to Matopo. Neither Hector nor Argo furnishes any evidence whatever that the influence of the first breeding is felt in subsequent generations, where other sires are used. Another foal, Circus Girl, from a mare bred to a Shetland pony that had had a colt by Matopo the previous year, also did not support the telegony idea. In fact, Circus Girl was a faithful reproduction of the dam in conformation, color, gait, and disposition.

A number of other hybrids and crosses have also been bred by Professor Ewart, concerning which he gives more or less information in his writings.[a] Special consideration is given to the telegony idea as reported on Lord Morton's chestnut mare foaling to a black Arabian horse after she had previously and for the first breeding foaled to a quagga. As evidence that the assumption that the stripes on the second foal of Lord Morton's mare were inherited from the quagga impregnation is fallacious, Professor Ewart exhibited in his collection, in 1900, a pure-bred Arab filly that had a dorsal band and distinct bars on both fore and hind legs and vestiges of shoulder stripes. These markings he regards as an instance of reversion to what he designates the striped ancestor of all the horses.

In addition to the zebra and various horses, ponies, and crosses, Professor Ewart has conduced rather extensive experimental work with various animals and birds. This includes rabbits, guinea pigs, cats, dogs, goats, pigeons, etc.

A most unique and valuable exhibition of his work was made by him in 1900 at the show of the Royal Agricultural Society of England at York, which it was my pleasure to visit. A small temporary building on the grounds was devoted entirely to this exhibition. This was provided with stalls for the horses and cages for the other stock. The exhibit was arranged in systematic order, with numbers and abbreviated information at each exhibit. If the visitor desired he could for a shilling (25 cents) purchase a valuable illustrated guide to the exhibit, which gave the essential facts concerning each number. In addition to the living animals, the walls of the rooms were decorated with skins of several types of zebras, as well as other objects relating to the experiments in progress. This exhibit, so far as my experience goes, stands alone as the finest educational show relative to stock breeding that has yet been placed before the public. It was worthy of the highest commendation. This exhibit was especially instructive and certainly must have been interesting to many of the English lovers of live stock.

While these investigations have not been continued a long series of years, still they have a reasonable amount of age, and in certain respects are unique in themselves. Professor Ewart proposed to study a certain problem, as, for example, telegony. In the scientific world one authority views telegony from one standpoint, while another thinks his evidence insufficient. The telegony markings in the case of Lord Morton's quagga had been much quoted. This Scotch scientist, not having access to a quagga, as the next best thing uses a zebra, a near relative of the quagga and even more strikingly marked. Then the process of hybridizing begins methodically and persistently, and, so far as possible, using the Lord Morton illustrative material. But Professor Ewart goes much further, in that he not only uses other animals of the horse and zebra type, but he makes a study of telegony with a variety of animals and birds. This experimental work is supplemented as the earlier work was not in two ways, viz, by the duplication of experiments by the same man and by the use of the camera, which has a high value in scientific research. Thus the method furnished the means of securing a considerable amount of evidence, which it is fair to assume was gathered in a truly scientific spirit.

It is not my purpose here to go further into the details of the method of Professor Ewart, but, before concluding a consideration of his investigations, it will be appropriate to give some of the opinions he has arrived at as a result of this work, although I do not understand that these are final conclusions, for his work is still in progress. "I find," he says, "as the result of many experiments, that in animals, as in plants, the offspring can rarely be said to be intermediate between their parents, or to unite in equal proportions the characters of their immediate and less immediate ancestors; and further, that the crossing of perfectly distinct strains, varieties, or breeds is not

[a] The Penycuik Experiments, 1899; Guide to the Zebra Hybrids, etc., 1900.

necessarily followed by reversion. The offspring, or some of them, may (1) down to the smallest details resemble one of the parents, sometimes the male, sometimes the female; or (2) they may reproduce both the mental and physical peculiarities of one of the grand parents, or of even a fairly remote ancestor; or (3) they may consist of an unequal mixture of two or more breeds and well deserve to be designated mongrels; or (4) they may combine the more striking characters of the two breeds; or (5) they may present quite new characters; when this happens, they are often termed 'sports.'"[a]

Ewart further calls attention to the fact that in large litters of dogs, cats, pigs, rabbits, etc., sometimes both parents and one or more remote ancestors are faithfully reproduced, and when the parents belong to fairly distinct strains, there may be almost a restoration of a quite remote ancestor. He gives an illustration from a photograph of three rabbits, full sisters. One reproduces the characters of the dam, one an Angora like the paternal grandam, and one a Himalaya like the maternal great-grandam. Of a litter of four kittens from white parents, two are white like the parents, and two dark colored like the great-grandam.

In a discussion of telegony, Ewart picks to pieces the evidence concerning the Lord Morton quagga hybrid and throws great doubt upon the original interpretation. Then coming to his own investigations, he says: "I may mention that neither in the case of horses, cattle, sheep, dogs, cats, rabbits, mice, or guinea pigs, nor yet in the case of ducks, fowls, or pigeons, have I ever seen a case of telegony." Many remarkable instances of variation and reversion (which some would doubtless have explained by the infection hypothesis) have been observed, but in every instance it was possible to account for the phenomena without resorting to the telegony doctrine. He then refers to his experiments with horses and cites ten mares that have had an opportunity of being infected by Matopo, the zebra. There is not the slightest evidence that any of these mares have ever been infected.

The methods of Ewart are of the new school, so far as investigating breeding problems are concerned, and should inspire others to take up similar research in this great field.

Before passing to another phase of this subject it will be appropriate here to refer to some of the experimental work on breeding conducted by an American institution. I refer to the poultry-breeding experiments of the Rhode Island Station, and more particularly those relative to geese and to some extent turkeys. For years the poultry industry has received attention by the Rhode Island College and Station. Inasmuch as Rhode Island has considerable poultry interests and is famous for her turkeys, it was quite appropriate for the college to promote this industry. The various reports published by the station contain in the aggregate much interesting and valuable information.

In 1892 the station undertook its first special breeding work by introducing a wild turkey gobbler, raised from wild turkey eggs from Maryland, and attempted breeding him to domestic hen turkeys. The purpose in this was to introduce enough wild blood in the domestic turkey to secure some of the hardiness and vigor of the wild stock, and thus add to the vitality of domestic birds. The first season this work was attempted the wild gobbler would not associate with the domestic hens, drove them from him, and did not strut or gobble that season. The following year 4 wild gobblers were secured, and these were used by the station, and several farmers also engaged in the work. From this stock a quantity of cross-bred turkeys were produced by the station, which were kept under observation. A number of Rhode Island farmers also produced some crossbreds. Following this, the next season, the station distributed three-eighths and half-bred wild gobblers to 42 Rhode Island turkey growers for practical breeding and observation in their flocks. It was considered that birds resulting from this cross improved the turkey stock of those using it. One person who reared 300 turkeys from three-quarter wild gobblers secured a larger percentage of mature birds for market, and they proved more uniform in size, larger in weight, fatted quicker, and dressed better than those of domestic blood.

The most elaborate breeding work by this station, however, has been with geese. This began in 1893. Toulouse and Embden geese were crossmated each way, and records kept of the development of the goslings from June 19 to September 5, weekly weights being made of the crosses, as well as extended records of pure Toulouse and Embden stock. In 1894 cross-breeding work on a somewhat larger scale was undertaken, and African and Chinese crosses were also introduced. Records of the growth of the products of the various crosses, 52 birds in all, were made, showing the growth at various dates from June 9 to December 8, 1894. Later specimens were slaughtered and a record made of live and dressed weight, with shrinkage, and the dressed birds

[a] Guide to the Zebra Hybrids, p. 25.

were then shown at the winter show of the Rhode Island Poultry Association. In 1895 this work was made even more extensive and a greater variation in cross conducted. A number of birds were kept and fed under uniform conditions, and again another exhibit of dressed young geese was made at the Rhode Island poultry show. In 1896 the chief work of the poultry division of the station was given to the breeding of pure and cross-bred geese, numbering in all 21 birds. Records were kept of the egg-laying qualities of African, Embden, Brown China, White China, and Toulouse geese. The records of growth were kept on 221 goslings that were reared to maturity, weights being obtained at 5, 8, and 10 weeks of age, and representatives of the various crosses photographed.

The 1897 report of this station contains a contribution of 205 pages, which is devoted to the geese-breeding experiments. It contains numerous handsome half-tone illustrations of pure and cross-bred geese, and gives considerable of a practical nature as well as much detail concerning the breeding experiments of both 1896 and 1897.

In 1897 there were 21 pens of various types of geese. Early in January each goose was weighed. Records of egg production were then kept during the year from not only the pure bred, but also cross breds, and the weights of eggs of each pen recorded, including largest, smallest, and average. Records of this sort in fact were continued for two years. A special investigation of interest included a study of the effect of incubation on goose eggs, these being weighed during incubation, and a record of weight of the hatched goslings also being included. A record was also made showing the relative fertility of eggs produced by the different matings of geese in 1897. The general growth of the goslings from each cross was again recorded this year, though the experiment was not of so long a duration. Some of the birds were killed and sent to commission merchants, once in August and again in September, and estimates were placed on their quality by these judges. Thirteen dressed goslings exhibited at the Rhode Island poultry show were afterwards sent to Brown University, where Professor Bumpus dissected them, and made a study of and a report upon the percentage of drawn to dressed weight, weight of solid meat, skin and fat, bones, offal, and feathers, blood, etc.

Besides the general study of the pure and cross-bred geese as a matter of development and productivity, two subjects in a somewhat different field also received attention, viz, the influence of one white parent on cross-breeding geese, and the influence of Toulouse blood in the production of goslings with yellow bills.

This work of the Rhode Island Station represents methodical and systematic effort and is a valuable contribution to the literature of breeding. The various records, notes, and illustrations will serve for valuable use no doubt at this station as well as by others interested in the study of breeding. While these investigations had mainly a practical aim on the part of those conducting them, they contain evidence that some day will perhaps be used in still other phases of a study of breeding.

The methods of investigation which I have referred to up to this point relate first, to the records of men engaged in practical stock growing, having special breeding problems in mind, and second, to a limited extent, to the work of the scientific investigator of the principles of breeding.

There is also another class of investigators, rather limited in number, who in comparatively recent years have taken up evolutionary and biological study on the basis of statistical consideration, or by quantitative method, wherein mathematics are introduced to assist in reducing error to the smallest degree. It is assumed that there is no such thing as chance either in life or death, and that all things in nature occur with more or less regularity. If a copper be flipped in the air a thousand times, while we do not know how it will turn at an individual throw, we do know that experiment has shown that it will turn face up about 500 times and tail up about the same. We may go further and take the dice example given by Pearson.[a] Twelve dice were thrown together 26,306 times, and on each occasion the number of dice having 5 or 6 pips on their upper faces was recorded. The most frequent occurrence—6,100 odd times—is 4 fives and sixes in the throw of 12 dice. This occurrence, which happens not necessarily a majority of times, but more frequently than any other, is termed the "mode." If different sets of counts are made, these will group into various classes, and the proportion of individuals falling into a class gives what is known as the "frequency" of the class. The "mode" in this case is the 4 dice in the 12 thrown with 5 or 6 pips.

Studying the throwing by diagram, it is shown that there is a system of frequency which in a measure forms a polygon, and which conveys a notion of law and regularity in chance distributions. This same thing is shown to apply to drawing counters or cards and to tossing coins. If the records of numbers or measurements are taken

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[a] The Chances of Death, etc., 1897, p. 11.

and charted, it is seen that these will permit of the formation of a curve, deviating from the mode, which is called the frequency curve. There are two features of this curve discussed by Pearson, which will be referred to. First, the mode is not necessarily the same thing as the mean. He says: "Suppose we set about counting buttercup petals, then we should find that 5 petals occur most frequently, but that there are buttercups to be found with 10 and even more petals. The mean will be found to lie nearer to 6 than 5 petals, and after selection and cultivation, may even differ by as many as 2 petals from the mode. The amount by which the mean differs from the mode gives us a conception of the amount of asymmetry or skewness of the frequency curve—the greater length of tail, so to speak, on the mean side of the mode." Second, experience soon shows that very large deviations are not frequent, most of the frequency occurring in a limited range about mode and mean, and by calculation a standard deviation is adopted as applying to this. There is a course variation in the standard deviation, according to the subject under record. The frequency classes can be plotted off on diagram sheets, having the various classes located along a base line and drawing perpendiculars at these points proportional in length to the frequency. When the tops of the perpendiculars are joined by a line, the so-called frequency polygon results. This polygon may be symmetrical or unsymmetrical. The condition of skewness depends upon the symmetry of this polygon. The more symmetrical it is, the less variation may be expected in the subject studied.

Experimental work of this kind, which has thus far had its greatest application in biology in general rather than as applied to farm animals, is worked out through the use of mathematical computation in which logarithms play an important part. It certainly is a line of investigation suited only to those familiar with calculus and advanced mathematics.

Again quoting Pearson,[a] he says: "The reader will be curious, however, to learn what frequency curves, deducted from coin tossing and dice experiments, have to do with mortality. The answer is this: If the laws of frequency we are here dealing with hold very generally for the distribution of artificial frequency in cases where we have no knowledge how the individual instance will turn out, but only statistics of what happens in the mass, may we not reasonably assume that they are essentially the laws of all large numbers, and that even the frequency of death, its distribution with age, will obey the same laws?"

Davenport has published a little work on this subject,[b] which is really a laboratory manual with many mathematical tables. In this he lays special emphasis on the necessity for quantitative study as applied to the laws of variation, causes of variation, selection, etc. Touching a matter quite direct in its application to animal breeding, he says: "Quantitative studies in heredity will give definite information on prepotency of sex or race. By examining hybrids quantitatively and comparing them with their parents, we shall unravel the laws of inheritance in crossbreeding, and the principles of mixing character in biparental inheritance."

While human subjects have furnished a considerable field for investigation in this line of inheritance and breeding, commencing with Galton twenty-five years ago or so, no doubt future investigators will give greater attention to its application to farm animals than has heretofore been the case. As mathematics is regarded as the basis of all exact science, we should promote as fully as possible its reasonable use in those investigations bearing on the breeding of farm animals. Most certainly it is true that repetition in observation and extensive duplication of record will do much to assist in reducing our knowledge to a more exact basis, and permit of drawing more stable conclusions.

At the present time there is being expended in the United States by various agricultural experiment stations something in the neighborhood of $1,000,000 per year. A large percentage of the stations using this money are more or less engaged in conducting feeding experiments with farm animals. If you will consult the records generally available on the work of the stations, with the exception already given, you will find almost nothing relative to breeding experiments. Some work in grading or crossing has been attempted as, for example, grading up sheep, or feeding crossbred sheep or swine, but these have really been feeding experiments rather than a study on breeding problems. It has not been so much of a case as to how a breed might be improved as, having a given type or form of animal, how will it feed? Farmers over the United States have studied long and industriously over feeding tables, and have anxiously inquired for information on what to give or buy to feed, and how to feed to secure desired results, without giving any serious consideration to

[a] The Chances of Death, etc., p. 18.

[b] Statistical Methods with Special Reference to Biological Variation. By C. B. Davenport, 1899, pp. 59.

the sort of stock to be fed. They have neglected most important things regarding breeding animals, that in truth they should know are of paramount importance, without the application of which wise feeding is impossible. Men have studied how to feed animals that were a disgrace to intellectual breeding. And the experiment stations have done but little to bring light to the eyes of the stockman, in spite of the importance of the matter, and the fact that they have been the leaders in the quest for knowledge in things agricultural.

Important breeding experiments will be undertaken in this twentieth century, and no doubt much of this should and will be conducted by agricultural experiment station men. Just what these will be time only can tell, but they at least should be well planned and be consistently conducted, with many individuals, covering such a period of time as will demonstrate its importance. These experiments, so far as possible, should deal with the recognized farm animals for subjects, although work with other domestic animals may have high value and will be quite comparable with farm animals for accuracy of result. If, however, the investigations are made upon the horse, cow, sheep, or pig, they will attract the attention of the class the station is primarily working for much more readily than if rats, mice, rabbits, or guinea pigs are the experimental material.

In an address on "Suggested experiments in breeding,"[a] Prof. W. H. Brewer recommends that experiment stations investigate the problem of the transmission of acquired characters concerning which there is so much controversy. He suggests using rabbits, taking several breeds, and mixing them by crossing as the experiment proceeds, "in order that the mongrel produced may have a greater tendency to vary under the conditions imposed than if one original breed was used, whose characters were well fixed and more liable to breed true to the parent type." He recommends two sets from the same stock to be bred along two parallel lines. One lot is to be well fed during growth and the stock kept of good size and maturity, the other to be stunted during growth by underfeeding. This work should be conducted for ten or fifteen generations under these different conditions, with careful record kept of each. A record of the number of offspring produced would throw some light on the question of sex.

Another experiment is also suggested, using much the same animals of mongrel stock, to determine the influence of exercise or disuse of function. One set of animals mutilated at birth by a severed limb, or deprived of sight of one eye, might be compared with another set in normal condition for fifteen generations or so. Disuse could be secured by bandaging or tying up a limb.

These problems will furnish information of interest and value, but we should be able to work at some of our stations, at least with as much valuable material as that used by Professor Ewart. Supposing one of our stations should make a careful study of telegony, and use therein cattle or swine, suited to the purpose. It would not be a difficult thing, for example, to select a line of cattle, such as 10 white Shorthorn cows, and breed these to a Galloway bull at their first service, and this later to be followed by the use of a white Shorthorn bull for subsequent service. And so a type of 10 white sows might be used, being mated for the first time to a black boar of a well recognized purity, and subsequent matings to follow with boars of the same breed as the females. Other animals might also be used for this same purpose, and so a very extensive, interesting, and no doubt important, investigation would be conducted that would receive a respectful consideration from scientific men, especially if careful notes and records were kept and the camera made liberal and intelligent use of.

A problem long thought important by practical breeders is the influence of sex on offspring. That experiment station which would conduct a careful, continuous, and extensive experiment on this subject with farm animals would receive a degree of applause and approval that would give it fame for a long time to come not only among breeders, but also among biologists as well. To be sure the problem is a knotty one that has been labored on for over a century, but that makes it all the more important and worthy of solution.

As one studies over the various works on animal breeding, he can but realize how little they contain as substantial evidence to demonstrate questions in controversy. Miscellaneous illustrations are given, but these are often striking in their oneness and would seem to demonstrate the proposition with about as much force as that one swallow makes a summer.

What will be demanded of the investigator in future will be facts in generous duplication, intelligently interpreted. Valuable aid will be rendered by the practical breeder, and the careful scientist will receive his recognition and reward. The

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[a] U. S. Dept. Agr., Office of Experiment Stations Bul. 16, p. 162.

old methods will be used and they have a place, perhaps, but the new method of the laboratory may be regarded as the methods of the future. This requires trained specialists. It will call for more concentration of effort in experiment-station work. It is to be most sincerely hoped that the time is not far distant when men engaged in investigations at our stations will not be expected to constantly publish bulletins of progress and give to the press the various occurrences of their laboratories, unless the time is propitious for doing so. There should be no haste to place such information as this before the public until the facts are all in, the conclusions drawn, and the records in due form.

In his presidential address on "The progress of science," before the American Association for the Advancement of Science, at Denver, on August 27, 1901, Prof. C. B. Davenport said, among other things: "Prominent among the advances of the century will be the ability to control biological processes. We shall know the factors that determine the rate of growth and the size of an animal, the direction and sequence of cell divisions, the color, sex, and details of form of a species. The study of animals in relation to their environment, long the pastime of country gentlemen of leisure, will become a science. Some day we shall be able to say just what conditions determine an animal's presence at any place, and more than that we shall be able to account for the fauna—the sum total of animal life of any locality—and to trace the history of that fauna."

One can not peer into the future, excepting darkly, but it does not require a very profound foresight to see new and far better methods in use in studying problems in animal breeding. The instructor in mathematics will no doubt join hands with the one in thermatology, and thus the wise application of statistical methods will take a place in the work such as the nineteenth century has hardly seen. Crude opinions and desultory observation will certainly not meet with favor, but scientific accuracy in all its details will be the requirement of the future. With the advent of such methods, one may look for a profound addition to our knowledge of the principles of breeding.

The section then adjourned sine die.

SECTION ON HORTICULTURE AND BOTANY.

Meetings of the section were held on the afternoons of November 17, 18, and 19, 1903, at 4 p. m.

It was decided to take up the papers in two groups: First, those relating to experiment-station work; second, those relating to college or teaching work.

F. V. Coville, of the Bureau of Plant Industry of the U. S. Department of Agriculture, gave a brief outline of the work at the Carnegie Arid Region Laboratory and briefly discussed the results thus far obtained. A number of photographs were exhibited illustrating the vegetation of the region.

The following paper was presented by W. A. Orton, of the U. S. Department of Agriculture:

Crop Rotation in the Southern States as Influenced by Plant Diseases.

The several reasons for the rotation of crops may be classed under three general heads:

I. To increase and maintain the productive capacity of the land—
   (a) By the addition and conservation of nitrogen and other available plant foods through the agency of leguminous and other crops.
   (b) By alternating crops of different food requirements.
   (c) By improving the physical and biological condition of the soil, through the addition of humus, the alternation of cultivated with cover crops, etc.
   (d) By growing deep-rooted crops to bring up plant food for shallow-rooted crops and to establish deeper aeration.
   (e) By the conservation of soil moisture.

II. To make farm operations economical—
   (a) By having the income derived from several crops instead of from one.
   (b) By securing continuity and regularity in the employment of labor.

III. To control natural enemies—
(a) Weeds.
(b) Insects.
(c) Plant diseases.

This paper relates primarily to the last item, the rôle of plant diseases in crop rotation, though it manifestly will be necessary to include some consideration of the other related factors.

The problems of crop rotation vary in different parts of our country, and most of what has been written on the subject relates to our northern conditions, where plant diseases have an influence quite subordinate to the fertility factors. The principal plant diseases that modify rotations in the North are potato scab, cabbage club foot, onion smut, etc., which are familiar examples to us. This paper deals with southern problems, the section treated being bounded on the north by Virginia and on the west by the Mississippi River. Here in this eastern cotton belt rotation of crops is needed more and practiced less than anywhere else in the country.

PRESENT PRACTICES.

The methods that have contributed so largely to the decline of agriculture in the South have changed but little as yet. All practices still center around the great staple crop—cotton—which consequently will be the principal topic of this paper. There is, first, the all-cotton system on immense numbers of acres, where no rotation is practiced and only commercial fertilizers are used to maintain the productiveness of the land; that cotton is not an exhaustive crop is amply proved by the fact that much land remains productive to-day after forty years of continuous cropping. Second, cotton with corn; the most common rotation now practiced in the South is cotton alternating with corn, which may or may not have cowpeas planted between the rows. Third, fallowing or resting is practiced where land is exhausted. This is not done as much as it was before the era of commercial fertilizers; but old farmers still lay stress upon the mysterious influence of "broom-sedge" in renovating land, and on the sea islands of South Carolina fallowing is the accepted practice, and all good farmers allow half their land to lie out and grow up in weeds while the other half is planted in cotton. This is their regular rotation, except that some plant half the fallow in cowpeas, making a four-course rotation—cotton, rest, fallow, cowpeas.

DEFECTS.

The fallowing system is a wasteful one. We see no reason why a useful forage crop might not be grown instead of the weeds, and a legume put in to gather more nitrogen. The rotation with corn shares with the all-cotton plan the great defect that it gives continuous clean culture, a feature especially bad in the South, where the intense heat of the summer sun and the torrential winter rains burn up or wash away more plant food than is taken up by the crops. The soil is deprived of its humus, and its physical condition is lowered. This reacts directly on the cotton plant, producing the pathological conditions commonly referred to as "shedding of bolls" and "rust." It is not merely that the size of the plant is reduced from the lack of nutrition, but it has become more sensitive to changes in environment and is easily thrown out of balance, so that it sheds its bolls more readily when subjected to sudden drought or any other unfavorable circumstance.

Rust in cotton, probably the most destructive of its diseases, causes an annual loss mounting into the millions of dollars, all due primarily to lack of rotation. It occurs on land where the supply of vegetable matter has been depleted, and especially when there is also a lack of potash or poor drainage. If one visits a farm where a good system of rotation is practiced no complaint of rust will be heard, for the disease is easily overcome in this way.

Other common diseases of cotton, such as anthracnose, angular leaf spot, cercospora, etc., which are due to fungus or bacterial parasites and spread through the air rather than in the soil, may not be so directly controlled by rotation, but they would undoubtedly be diminished, both by the superior vigor and hardiness of the cotton plants and by the diminution of the opportunities for infection.

PRESENT NEEDS.

The great need of the South to-day is the general adoption of a better system of rotation, for this would imply more diversification of crops. To control the diseases we have mentioned it will be necessary to restore and maintain the supply of vegetable matter in the soil, and to do this two things are essential—(1) that some leguminous crop be used for soil renovation, and (2) that a winter cover crop be used to prevent washing. One of the simplest rotations practicable is already widely used. It has three courses: (1) Corn, with cowpeas between the rows; (2) oats, followed by cowpeas, and (3) cotton. This is an excellent rotation, and is probably better adapted to present conditions in the South than any other. Owing to the fact that many farmers feel obliged to plant half their land in cotton each year, it is often necessary to add another year in cotton to this, making two years of cotton. Where such a rotation is adopted and a liberal application of potash and phosphoric acid made to the pea crop, rust in cotton is rarely ever seen, and much less trouble is experienced from shedding of the bolls.

The function of winter cover crops is mainly to prevent the washing that occurs when the soil is left unprotected, but they also furnish valuable winter pasture. Hairy vetch, with wheat or oats; burr clover, with Bermuda grass; crimson clover and rape are the most prominent in the list of available plants. They have not yet come into use in the South enough to have become parts of any common system of rotation. Their value is unquestionable, but there is need for more experiments and demonstrations to introduce these crops to the public.

More extended systems of rotation will come later with the increase in stock raising. For the present the simple system first outlined will be a great advance. Some modifications of it for special conditions will be mentioned later.

Next in order for consideration come a number of diseases requiring special attention. The cotton wilt, caused by the fungus *Neocosmospora vasinfecta*, is a soil disease widely prevalent in sandy and gray land. It occurs in spots of varying size, often covering many acres. The fungus is able to live in the soil for many years in the absence of cotton, and rotation is consequently not a remedy after land becomes infected, though, if practiced in advance, it would undoubtedly do much to prevent the disease from gaining a foothold. The cotton wilt must be combated by breeding resistant strains. It has been shown that this can be done successfully, and the Department of Agriculture has originated varieties that will grow on wilt-infected land. This does not entirely settle the question, however, as the wilt problem is further complicated in many instances by root knot, caused by the nematode worm *Heterodera radicicola*, which occurs to a considerable extent in sandy soils south of Virginia. The nematode worm inhabits the same warm, sandy lands that suffer from cotton wilt, and while the two do not always occur together a great deal of wilt-infected cotton land also contains nematodes. They increase the injury done by wilt and must be considered in every case. The matter is more serious because root knot occurs on a number of other farm crops, particularly on cowpeas, and the extensive use of cowpeas as a rotation crop has resulted in great injury in many cases by increasing the amount of root knot. Cowpeas are particularly liable to this disease, and cotton following them on infected fields is liable to suffer more from both wilt and root knot. The wilt-resistant cotton developed by the Department of Agriculture does not resist nematodes and can not be used successfully on such land unless a system of rotation is practiced. It is quite certain that the remedy for root knot is rotation of crops. The essential point is to starve out the nematodes by growing immune crops and to avoid the use of any crop that is subject to attack.

The subject of root knot is a most important one and is not given proper consideration by southern farmers and their advisers. In the Gulf States especially root knot may be suspected in all sandy soil and all rotations must consider this factor. Cowpeas in general must not be grown; the Iron cowpea is practically immune to root knot, as are also some new hybrids obtained by the Department of Agriculture, and they can be grown in root-knot rotations, but all other varieties must be avoided. There are fortunately other good legumes adapted to this section. We may use for this purpose the Iron cowpea, velvet bean, beggar weed, and peanuts.

ROTATIONS SUGGESTED.

In arranging a rotation for the South economic conditions must be considered and the backward state of agriculture kept in mind. The crops grown must be useful ones and easily grown and marketed. Corn, the grains, and grasses are the best cleaning crops and also have a money value. The effect of oats on root knot is very marked, and a single crop will do much to reduce the root knot in a field. For land badly infested with nematodes, which it is desired to clean out, three years in immune crops are recommended. An example of a rotation that may be adopted is: Corn, with Iron cowpeas or peanuts between the rows; oats, followed by velvet beans, and beggar weed for hay. Of the leguminous crops available, the velvet bean is especially adapted to the extreme South. In Florida and the Gulf States it excels all others in vigor of growth and rank foliage. It is practically free from root knot, though it has been known to be attacked. Beggar weed subserves a different purpose, and its growth should be encouraged for the fine hay it makes and on account of its entire freedom from root knot. The peanut has been free from root knot in all the cases examined, but requires further study. Its special merits are its value as a forage for hogs, its adaptability to southern conditions, and its service in improving land. Farther north and in the upper sections of the South, alfalfa, clover, and other legumes are available and are efficient in rotations for improvement, but their susceptibility to root knot is unknown to the speaker. Corn is not attacked and can be used at will. Oats are particularly good, as is wheat or rye, but the latter two are not so well adapted to the far South. Oats may be followed by a natural growth of crab grass if care is taken to exclude Amarantus and other weeds that harbor root knot. Bermuda grass allowed to remain for hay and pasture would effectively dispose of the root-knot problem. I can not speak of sorghum, but sugar cane is attacked by root knot to a considerable extent. The injury is not so apparent to the cane as it is to cotton following it the next year. The small amount of cane grown in the Southeast makes this of small importance, but land free from root knot should be chosen for it.

Two points are important in connection with these rotations. One is that the preparation of the land should be thorough, and the seeding of oats, beggar weed, or other crop heavy, in order to secure a perfect stand and prevent the growth of weeds that harbor the root knot. The benefit expected from a rotation may be largely lost if weeds are allowed to propagate the nematodes.

The second point is that many southern soils are so weak and deficient in available plant food and vegetable matter that the removal of a forage crop like hay, sorghum, or even grain, causes marked injury unless it is balanced by the culture of a legume. On such soils the rotation should introduce a legume at more frequent intervals.

We have experiments under way to show the practicability of controlling root knot by rotation of crops, and we shall use the wilt-resistant cotton to avoid wilt.

WATERMELON WILT.

Another instance where a plant disease compels rotation is the watermelon wilt, caused by a soil fungus (*Neocosmospora vasinfecta* var. *nivea*), closely related to the cotton-wilt fungus. This is one of the most active parasites known and is found almost everywhere that watermelons are grown commercially, especially North Carolina, South Carolina, Georgia, Florida, Illinois, and California. It is in most cases impossible to grow more than one crop on any land, and even where no sign of wilt is discovered in the first crop a second planting in the same field is almost certain to result in failure. For that matter, it is equally impossible to succeed on land that has received the drainage water from a watermelon field, since the fungus spores are carried in this way, as many a grower can testify from his personal failures. The rotation here must be a long one; seven to ten or twelve years are the periods allowed by some growers, while others never plant land a second time in watermelons. The period the fungus will live in the absence of a melon crop varies according to the nature of the soil. There is a lack of well-authenticated experiences bearing on this point.

Another instance of compulsory rotation is the Fusarium wilt of tomatoes, a disease of general distribution in Florida, where it has an important bearing on the trucking industry. In this case, also, only one crop can be grown with good success, and a period of three to five or more years must elapse before tomatoes can be planted again on that land. No regular system of rotation has yet come to be practiced with watermelons and tomatoes. Melon growing is a transient industry, following the new railways and becoming unprofitable as soon as all the land near the railway has been planted once. The tomato wilt affects a crop that is worth $3,000,000 annually to Florida alone. It hinders the permanent development of the promising trucking sections of that State and will do so until other crops come in to make a regular system of rotation profitable.

The wilt diseases in general require more than rotation. They are difficult to control by this means, since the period of soil infection is so long, and as a practical means of relief it is necessary to obtain wilt-resistant varieties, if the areas to be cultivated are too large to allow of using fresh land each year. The cabbage wilt, for instance, is a garden disease and can be dealt with by moving the garden. The cowpea wilt usually disappears after two or three years' rotation. The occurrence of this cowpea wilt, *Neocosmospora vasinfecta* var. *tracheiphila*, is an indication of the need for crop rotation. In the northern States and in European countries clover sickness prevents the continual use of clover. The cowpea in the South in like manner finally succumbs to "pea sickness," and we find the cause to be this wilt fungus or the root knot. The occurrence of such diseases is an indication of nature's demand for rotation, and we should heed her call by changing the legume we employ in our rotation from time to time. Let the velvet bean, beggar weed, or crimson clover take the place of the cowpea occasionally, even though we have the disease-resistant Iron cowpea available.

Another instance where rotation affords an easy remedy for a serious disease is found in Texas, where a fungus root rot, formerly known as Ozonium, causes much injury to cotton, alfalfa, and other plants. This malady is readily controlled by rotation with corn, grasses, or other immune crops for three or four years.

ROTATIONS FOR ORCHARDS.

Peach orchards in Georgia and Florida are frequently troubled by root knot and fungus root diseases, and a long-course system of rotation is required. First, before planting the orchard two or three years should be given to free the land of root knot and put it into good condition by planting oats, velvet beans, corn, and Iron cowpeas or beggar weed. Then, during the life of the orchard the intercultural and cover crops should be those not subject to root knot. Finally, after the orchard is taken out, a period of five years should be given to renovate the land and free it from root knot and fungus diseases. Root rot from the attacks of fungi is to be feared where peaches are replanted too soon.

ROTATIONS FOR NURSERIES.

Rotation in the nursery is particularly important in view of the prevalence of root knot, crown gall, etc., in nurseries, and the danger to the public of spreading these diseases. If possible, fresh land should always be taken for growing nursery stock. Three years of the right rotation would be sufficient for root knot, but the time crown gall will persist in the land has not been determined, and it would be safer if five years were allowed.

ROTATIONS FOR TRUCK FARMS.

Where early vegetables are grown for the northern market, it is often of great importance that a rotation should be practiced to avoid plant diseases. Particular instances are: (1) Potatoes: To avoid scab and stem rot (Rhizoctonia). Disinfection of the seed will not avail when the soil is full of disease germs. (2) Cabbages: To avoid black rot and the Fusarium wilt, cabbages should not come oftener than once in three years, and a longer period would do well.

Other truck crops will be benefited in the long run by a regular system of rotation.

In conclusion, I wish to urge a greater interest in the subject of crop rotations in the South not only for controlling plant diseases, but for all the other objects as well. It is very important that careful experiments be made, and even more important that extensive practical demonstrations be undertaken to show the farmer the necessity of the work and the methods of doing it.

After a brief discussion of the paper, F. L. Stevens (North Carolina) read the following paper:

NOTES ON COOPERATIVE EXPERIMENTS.

Cooperative experiments may be divided fundamentally into two classes according to the purpose they serve. Their purpose may be first to uncover unknown truths and to extend knowledge; second, to demonstrate to practical farmers methods the efficiency of which is already known to the scientist. In weighing the efficiency of cooperative experiments these two categories should be clearly recognized. The value of cooperative experiments for demonstration should not be underestimated. Investigators in the pursuit of new truths labor unceasingly to add to the store of knowledge, and then too often abandon the newly discovered facts before pushing them on to practical utility. The experiment stations have accumulated volumes of information which would lead to immense improvement in methods of farming and accrue to the great financial interest of the agricultural community, if the farmers could only be brought to realize their value. Results of research are published at great expense in bulletin form, yet only to meet too often a fate known to us all. The farmer is conservative. He is prone to follow in the steps of his grandfather, and the bombardment of bulletins seldom suffices to turn him from his course.

One of the greatest needs of the present day is some means that will bring the advancement of science within the ken of the farmer in so far as it relates to his vocation. With the younger generation the chief hope lies in agricultural education.

The man who is farming to-day is beyond such gentle influence. With such most promising work may be done through cooperative experimentation. The number of instances where knowledge of improved methods now rest stored beyond the reach of the average intellectual inert farmer is manifold. It was to test the efficiency of cooperative experimentation as a means of wholesale demonstration that experiments were initiated two years ago in North Carolina with the oat-smut treatment. I outline the method of conducting these experiments, realizing that human nature is a reasonable constant quantity, and with the hope that my experience may be of use to others working along similar lines.

In selecting observers to cooperate with me for the year 1902-3 the following plan was adopted: First, the names of a large number of influential, reliable farmers were secured through the director of the station and other sources. Letters were sent to these inquiring whether they were troubled with the oat smut and offering to furnish directions and materials for treatment of their oat fields, if they desired. If no answer was received to this letter a second letter was sent on the 10th of October. In this letter attention was called to the serious inroads and the insidious nature of the oat smut, and a circular was sent giving directions for the treatment. The chief object of this letter was to call attention to the seriousness of the disease and the ease of its prevention. In response to these letters 51 people, scattered over the State, responded, requesting the material for the smut treatment. To these 51, formalin varying in quantity from 1 to 7 ounces was supplied. and circulars giving full directions for the treatment were also sent. In February a third letter containing a self-addressed postal card was sent with the request that the experimenter signify the probable time of his harvest. At this time it was the hope of the writer to make a visit to as many of the fields as was feasible. A fourth letter was sent out in April to those who did not respond to the third letter. The replies elicited by these third and fourth letters numbered 36 out of the possible 51. They were in every case cordial and expressed the hearty cooperation of the worker.

The year, however, was exceedingly unfortunate owing to the attacks of the Hessian fly and the rust. In many cases the crop was not worth harvesting and in many cases the observers stated that the growth was so poor that they could not report at all upon the results. The fact that the year was so unfortunate may account for the falling off from fifty-one to thirty-six in the number of correspondents.

Later in the season a fifth letter was sent giving explicit directions for the recording of the results and inclosing a blank on which to record them. Fifteen observers responded more or less in detail on this blank. Some of the letters received showed extremely well-trained powers of observation and accuracy of recording, others were very meager indeed, while several were valueless on account of the failure of the crop.

Further study of the problem convinced me that more satisfactory and extensive work might be accomplished through the aid of the country schools. During the past year, at farmers' institutes and country teachers' institutes and at many country meetings, I have taken the names of all people who might be interested in the prevention of oat or wheat smuts, and have offered in every case to furnish 1 ounce of formalin, sufficient for approximately 2 acres of oats, gratis, if the recipient would see that this formalin was administered under the supervision of the district school and was used to present an object lesson to the school. In order to be sure that interest was not lagging and that the teachers were still willing to abide by this agreement, I directed a letter to all of these people early in the fall, calling their attention to the fact that I expected of them a full and accurate report, and that they were to use the formalin before their schools, and that the whole school was to take part in making the experiment and recording the results. I also sent a letter to all of the county superintendents permitting them to extend this offer to all their teachers. In this way 266 letters have been sent, and 45 replies requesting formalin have been received. Many others will doubtless be heard from as the schools have not yet all opened, and many do not sow until spring.

It is of course too early yet to state what results may come through the aid of the schools. Whether the results reported are accurate or not, it is practically certain that the formalin treatment in this way will be brought before a large number of people, and that it will find people possibly in a more receptive mood than do the bulletins or the farmers' institutes.

At a cost of less than 15 cents, 2 acres of oats are treated in a given school district. The attention of all the pupils, and therefore all the residents of the district, is called to the experiment. Under the guidance of the teacher, and with the experiment conducted under the auspices of one of the leading farmers of the district, the success of the treatment can not fail to attract the attention of all the district and should tend to a saving of the crop now lost through smut, which for the year 1899 amounted to about $247,000.

As a result of my observation on cooperative experiments so far, I am not over-sanguine concerning their utility on a large scale for the discovery of new facts. Their accuracy and reliability is ever open to doubt. As a means of demonstration of fact already known, I believe that the operative experiments can accomplish as much good as either the bulletins or the institutes.

At this point the following report from E. M. Wilcox, of Alabama, chairman of a special committee appointed at the Atlanta meeting, was read by the secretary:

Your committee appointed at the Atlanta convention to consider the nomenclature of plant breeding begs leave to report as follows:

We recommend to the section the adoption of the new term "clon," proposed by Dr. H. J. Webber, to designate "groups of plants that are propagated by the use of any form of vegetative parts such as bulbs, tubers, cuttings, grafts, buds, etc., and which are simply parts of the same individual seedling."

Clon (pronounced with long ō) is derived from the Greek word κλῶν, meaning a twig or slip, such as used for propagation. The adjective form would be *clonal* and the plural would be *clons*.

We recommend that the committee be continued as a permanent committee of the section on the nomenclature of plant breeding.

Respectfully submitted.

E. MEAD WILCOX, *Chairman.*

A motion was adopted expressing approval of the work of the committee. The committee was continued.

F. L. Stevens then read the paper given below, illustrating his remarks by means of lantern slides.

THE HISTORY OF THE TOBACCO WILT IN GRANVILLE COUNTY, NORTH CAROLINA.[a]

The disease here designated as the "Granville wilt" has already been the subject of two bulletins of the North Carolina Experiment Station, a press bulletin, and a preliminary bulletin numbered 188. Its chief claims to interest lie in its newness, its seriousness, and the apparently small area as yet subject to it.

As the disease is caused by a parasite distributed principally by soil, its invasion into new territory is practically a certainty, unless some means of control be happily discovered or invented. Soil once affected is rendered useless for further culture of tobacco, at least, unless a protracted period of from ten to twenty years of rest be allowed. The disease thus resembles the formidable wilt of the melon, cowpea, and cotton.

While study of the disease is young and it is unwise to generalize, it seems very probable that the disease is quite local. Indeed, if it were widely distributed it would surely have crept into literature long ago, since its exceeding destructiveness and prominence in a field once affected are characters that lead to unenviable notoriety. Occasional rumors of its occurrence reach us from various sections of the State and United States, but so far each rumor owes its origin to a wilt of some other nature, not to a contagious wilt of this type. The conditions in Granville County indicate that the disease is spreading there from an infected center still comparatively small. While the wilt has been known for something like twenty years in this region, it is still in its infancy. It presents an interesting case of the invasion of a State by a highly contagious disease so recently that its starting point and progress may be traced with reasonable accuracy. The slow spread of the peach yellows and rosette across the country and the importation of the hollyhock rust are similar instances. Seldom, however, do we find the place of original infection so definitely marked and the history so well preserved as in this instance.

Three characters, viz, the wilt, the root rot, and the permanent soil infection, mark this disease with sufficient certainty to enable one to collect the essential facts of its history in a given community. The farmers of Granville County recognize these essential characters, particularly the permanent soil infection, and differentiate this disease from its simulators, the sore shin and sporadic wilts due to other and various causes.

From the farmers of Granville County I have been able to glean the following history: The wilt was first abundant enough to attract attention in 1881 on the farm of B. F. Stems, where all, or practically all, of the plants died. From here the infection spread to the land of Mr. S. T. Parrott, across the road. The disease was found in

[a] See also North Carolina Sta. Bul. 188.

1891 and 1892 on the land of S. A. Flemming, farther to the east. These fields were visited by the writer this year. They are still infected. Similarly, in 1891 and 1892, the disease was prevalent on the land of John O'Brion and A. G. Flemming, near Bennehan. In the meantime the disease has spread northwest to Lyons and Knap of Reeds, and east to Wilton, and south into Wake County. Recently there has been a serious outbreak near Tar River, half of one field being as badly infected as any near Creedmore or Hester. This is conspicuous, as it is a new center of infection separated on all sides by considerable distances from other infected soil.

In regions where the chief money crop must be tobacco; where the soil is pre-eminently a tobacco soil, the damage wrought by this disease is very great. It does not take merely an occasional plant, but rather a majority of those in the field. So great is the injury that it may be called practically complete destruction of the crop.

The disease resides in the soil. A field with only a few sick plants one season, on the next planting will have many, and another planting in tobacco would mean that nearly all of the plants must succumb. The damage, therefore, is not measured merely by the loss of one crop. The greatest loss is the permanent injury to the soil, prohibiting further culture of tobacco unless some remedy be discovered. This depreciation in value is evidenced by a decrease, ranging from 50 to 75 per cent, in the selling price or rental of land when it is known to be infected.

For the sake of clearness I append the following description:

DESCRIPTION.

The wilting.—The first indication of the disease is given through the leaves, which droop, becoming soft and flabby, as though suffering from want of water. The symptom is not accompanied by any change in color, the leaves remaining green for some time after the wilt appears. As a rule the lower leaves droop first, the wilting gradually proceeding from the ground upward. Frequently the leaves on one side of the plant succumb earlier than those on the other side. Some growers believe that one side of the plant may occasionally survive to maturity, though the other side be wilted, but that is not usual. Frequently even a single leaf will show a one-sided infection. The wilted leaves soon die, dry up, and eventually the whole stalk dies. It then remains standing, with its dead leaves still hanging.

The stem.—At the stage of earliest wilting a section across the stem shows a yellowish discoloration of the woody portion. In more advanced stages, or in sections taken lower on the stem, the wood is found either on its inner or outer parts to be penetrated longitudinally by black streaks, varying in size from that of a cambric needle to that of a knitting needle. These streaks are so abundant in stages immediately preceding death that the whole or nearly all of the wood seems to be so affected. Frequently similar streaks penetrate the pith, though this is only in the most extreme cases. The black streaks in the wood are usually more abundant adjacent to the cambium than to the pith, and simply removing the bark from near the base of sick plants discloses them in abundance. The blackening often progresses from the wood outward through the bark, producing shrunken, blackened patches on the surface of the stem.

In the most advanced stages, when all the leaves are wilting, the wood at the base of the plant is blackened nearly throughout the pith, and the decay leaves the stem hollow or filled with the soft rotten remains of the pith. The bark near the level of the ground turns black and becomes dry and hard. The pith in the upper portion of the plant usually dries up before decay overtakes it. This results in the collapse of the upper portion of the plant in irregular longitudinal folds in parts where the woody layer is too soft to maintain the shape of the plant when the support of the distended pith is withdrawn. If a badly diseased plant be cut off near the ground, a dirty yellowish exudate issues from the cut wood, accumulating in the lower parts one or two millimeters long. This exudate is slightly viscous, hanging together in strands two to four millimeters when picked with a knife.

The root.—The root seems to be the seat of the original infection, and any plant in an advanced stage enough to show symptoms in its foliage will be found to possess roots already in an advanced stage of decay. In early stages one root or more may be diseased; in later stages all succumb. In the more advanced stages of disease in any root the bark is soft and dry, a spongy mass of fiber left by the decay of the more watery parts. In the worst cases even this spongy covering may drop off, leaving the wood of the root bare. Usually, however, the bark remains as a spongy layer, surrounded by a papery jacket more or less cracked transversely, the remains of the epidermis. The wood of the root undergoes changes similar to those of the stem. In the root, as in the stem, the disease manifests itself earlier in the wood than in the bark, appearing first as longitudinal streaks of black in that portion of the woody cylinder lying close to the bark. The disease is most conspicuous in the largest roots, but the smallest fibers, upon close examination, are seen to be similarly affected. In cases where the woody cylinder is blackened before the adjacent bark shows injury the smaller feeding roots passing from the diseased wood through the still healthy bark die, being either directly infected by the wood connecting the two, or succumbing first and then conveying infection to the main root.

R. E. B. McKenney, of the U. S. Department of Agriculture, called attention to the fact that the same disease is undoubtedly present in other sections of the country where tobacco is grown.

M. A. Carleton, of the U. S. Department of Agriculture, gave a brief discussion of the methods of keeping records and notes on the work in cereal investigations. Several blank books used for the purpose were exhibited. The plans adopted systematize the work of note taking and record keeping and appealed to those present as being a remarkable advance along these lines.

The following paper, prepared by L. H. Pammel, of Iowa, was then read by the secretary:

Botany in the Agricultural Colleges.

The committee on methods of teaching agriculture, in its several reports made to the Association of the American Agricultural Colleges and Experiment Stations, after considerable study, has made certain recommendations with reference to the amount of work to be done or required of students taking the four years' course in agriculture. In the second report[a] the committee makes the following suggestion as to the total number of hours required in the four years' course, allowing fifteen hours per week for thirty-six weeks, with ten hours laboratory work or practicums, making a total of three thousand six hundred hours:

	Hours.		Hours.
Algebra	75	Psychology	60
Geometry	40	Ethics and logic	40
Trigonometry	40	Political economy	60
Physics (class-room work)	75	General history	80
Physics (laboratory work)	75	English	200
Chemistry (class-room work)	75	Constitutional law	50
Chemistry (laboratory work)	75		
Modern languages	340	Total	1,285

And the committee suggests the following additional subjects:

	Hours.
Agriculture	496
Horticulture and forestry	180
Veterinary science, including anatomy	180
Agricultural chemistry in addition to general chemistry	180
Botany, including vegetable physiology and pathology	180
Zoology, including entomology	120
Physiology	180
Geology	120
Meteorology	60
Drawing	60
Total	1,746

Under the term "agriculture" they include the following:

	Hours.
Agronomy, or plant production	132
Zootechny, or animal industry	162
Agrotechny, or agricultural technology	72
Rural engineering, or farm mechanics	60
Rural economics, or farm management	60
Total	486

[a] U. S. Dept. Agr., Office of Experiment Stations Circ. 37, p. 1.

It is very evident that in some agricultural courses more botany should be required than in others. It seems to me that we must also take into consideration the amount of preparation a student has had before entering college. Nearly all of the colleges, or the better colleges, at least, require one term's botany equivalent to about fifty or sixty hours of elementary botany for entrance to the freshman class, covered by a study of such a book as Bergen's Foundations of Botany, Atkinson's Elementary Botany, Leavitt's Outlines of Botany, or Coulter's Plant Studies.

Taking some of the different agricultural colleges, I find the following requirements in botany for some of the different courses in agriculture:

Table showing number of hours of botany required in the different agricultural colleges and universities where the agricultural college is connected with them.

	Illinois.	Indiana.	Iowa. a				Michigan. b	Minnesota.	Missouri.	Nebraska.	New York.	South Dakota. c	
			1.	2.	3.	4.						1.	2.
Vegetable histology			64	64			104						
Ecology			32	32	32	32	39			d 96			
Bacteriology I			32	32	32		24			e 224		60	60
Bacteriology II							120						
Cryptogamic				64					48				
Economic		72		32				f 185		g 256			
Vegetable pathology				32									
Vegetable physiology				32									
Elementary botany											51	60	60
Trees and shrubs							30						
Systematic							39					60	60
Physiological												60	60
Seeds and grasses												60	60
Evolution of cultivated plants												24	24
General comparative morphology and physiology of plants											96		
Histology and physiology	90												
Morphology	90	76							h 63				
Fruits and seeds							60						
Fungi							117						
Weeds and grasses							52						
Forestry							362						

a (1) Agronomy division; (2) horticulture division; (3) dairying division; (4) animal husbandry division.
b These are total hours, not class hours alone.
c (1) General agriculture group; (2) horticulture group.
d Sophomore year.
e Junior year.
f Agricultural botany, through entire freshman year.
g Senior year.
h Includes ecology.

There seems to be a lack of uniformity in the botany required in these different institutions. In some cases the amount required seems to be wholly inadequate. In the group in animal husbandry especial attention should be given to those topics which are of special importance in connection with animal husbandry work. First of all the student should be made familiar with the general principles of botany. There should be at least a semester of five hours per week, followed up, say, by half a semester of two hours per week, on the subject of diseases of plants, especially as the subject is allied to the animal husbandry work, followed up by a course in bacteriology and later giving special attention to the subject of grasses, as they form so large a part of the nutrition of animals. The student taking this work should also become familiar with poisonous plants. In the group in agronomy several of the colleges are now giving this work. The foundation work should be much the same as in animal husbandry, followed up by more specific work along the lines of histology, cytology, and systematic botany. Under this head I would include a study of the life history of the more important flowering plants and cryptogams. This should be followed by a good course in vegetable physiology supplemented by a strong course in vegetable pathology. In fact, too little work is given in our agricultural colleges along both of these lines. The man who studies agronomy should also take a course in seed testing and the adulteration of seeds and grasses; in fact, the course in agronomy needs to be especially strong along botanical lines. What applies to the work along the line of agronomy might also apply to the group in horticulture. Here botany should be especially emphasized. Plant breeding should be especially emphasized along with the other lines of work.

The group in dairying need not necessarily be very much different from the group in animal husbandry, but one of the more important considerations in these agricultural colleges is the establishment of courses in chemical engineering in which chemical and botanical problems should be considered in their broadest scope. What we need at this time should be some uniformity of requirements for the various courses in the different agricultural colleges. It seems to me that a committee might well be named to look over this work and report on what is needed and what should be given in the way of instruction and entrance requirements. It seems to me we should ever bear in mind that botany can be of distinctive service both to science and the practical man by combining the theoretical with practical instruction. The mere veneer study can not long stand the test of time. It must be backed up with a good substantial foundation. The object of a course is to prepare and fit the young student for the duties of life. He should, therefore, have a broad and liberal education embodying enough of general information to make him a good citizen.

The following paper was read by H. Metcalf, of South Carolina:

The Foundations of Agricultural Teaching.

The value of continuity in any course of study has become a truism in pedagogy. A single subject pursued for a considerable time has more educative value than several separate subjects to which the same aggregate of time is given. The classical college course of the old type derived its greatest merit from the fact that it compelled a student to devote from five to eight consecutive years to one subject. In the more liberal college curricula of the present day the principle is fully recognized. Either certain subjects are required for more than one year, or the student is required to elect some one major subject around which his other electives must to some extent center. In technical education we find the principle fully recognized; every course has some one subject, which, whether of practical application or not, is the educational pièce de résistance of the whole course. In civil and mechanical engineering this course is mathematics; in electrical engineering it is mathematics or physics; in medicine it is animal biology; in the various chemical industries it is pure chemistry.

We may well inquire what are the characters which give these courses their prominent positions.

In the first place, they are subjects of unchallenged training value—excellent grindstones for the mental edged tools. They present problems or better experiments to be worked out directly by the student. In other words, though they may impart information, they are not merely informational. The problems or experiments are directly under the control of the student and not subject to accidental and incidental conditions; and, above all, the problems and experiments are simple at the outset and grow naturally and logically more complex. They are, furthermore, exact subjects, at least within certain limits; they are directly related in spirit and method to the art or industry which the student expects to pursue; and to some extent their principles are directly utilized in that art or industry. The most important consideration of all is: The subjects train in scientific method and logical habit of thought, and are pursued long enough to give the student a certain mastery over them and facility in their use.

But in agriculture we have no such course. We note with pride that the course in agriculture is becoming so diversified and specialized, but fail to see that herein lies the greatest danger from the teacher's standpoint. Ten times one does not make ten in pedagogy. Agriculture draws its data from so many sciences that a course in agriculture, no matter how carefully the agricultural standpoint is kept before the student, does not have the educational value of the same amount of time spent on a really unified subject. Practical agriculture must be the soul and center of the agricultural course, and the students must give the bulk of their time to it; no other science or combination of sciences can replace it. Yet we can not close our eyes to its grave pedagogical deficiencies. In addition to the lack of continuity already indicated, agriculture, as now taught, is made largely informational; much of its data is empirical; its experiments are too complicated and too much governed by accidental circumstances (e. g., the weather) to set forth effectively the principles of scientific method.

In certain colleges all this appears to be fully recognized, and the situation is met by requiring a continuous course in some one strictly scientific subject, usually chemistry. Beyond question chemistry is, in itself, the most efficient training subject in the agricultural curriculum. It is an exact science, of unchallenged cultural value, logical in treatment, and no better exponent of scientific method can be found. But it has little immediate bearing on agriculture; and too great emphasis upon it or upon any other single science apart from agriculture detracts from the unity of the course.

In other institutions there is an even stronger tendency toward making the agricultural course like any other college course, with simply a veneer of agriculture, perhaps in the last two years. The students are taught everything about agriculture, but no agriculture. This tendency is, to my mind, utterly deplorable. If there is not educational stamina in agriculture enough to develop an effective course in which agriculture holds the fundamental and most prominent place from the beginning to the end, then the whole system of agricultural education should be given up.

But may there not be a way of securing for the agricultural curriculum a fundamental course of high educational value, which at the same time will not detract from the unity of the whole curriculum? I believe that it is possible for the botanist to develop a course in agricultural botany capable of taking as prominent a place in agriculture as is held by mathematics in engineering and that without detracting from the unity of the whole course, but instead adding to it. This is a daring proposition, especially when we remember how relatively insignificant is the present development of botany in the agricultural colleges. Yet, is the botanical course, as at present developed, deserving of any greater prominence than it has? This question is exceedingly difficult to answer, since there has been no public expression of the botany course in the agricultural college, either in the shape of a text-book, or even a general discussion of method. If we look to the general botanical texts now in print, our answer must certainly be negative.

Botanical teaching in America has developed along three lines. For our present purposes we need consider as examples only the books containing laboratory directions. While some of the text-books—e. g., those of Gray and of Bessey—have profoundly influenced teaching, they are not as definite exponents of method as the laboratory manuals.

First in order was developed the course which is principally devoted to the seed plants and may lead to the analysis of plants. The most definite expression of this school is Setchell's Laboratory Practice for Beginners.

The second is the course which consists of type studies, beginning with the protophytes; hence devoted almost exclusively to the cryptogams. This method has received its most typical treatment in Campbell's Structural and Systematic Botany.

The third, which might be termed the impressionistic method in botany, is based upon ecology; it has been thoroughly exploited in Coulter's text-books, but has found its most definite expression in a little known pamphlet by C. H. Robison, entitled Field Studies of Some Common Plants.

Many recent text-books are combinations or compromises between these methods, e. g., those of Bergen and Leavitt and the pedagogical discussions of Ganong. Perhaps the only book that can not be fitted into an old niche is MacDougal's Nature and Work of Plants—the most original, and, perhaps, it is not unjust to say, the only original laboratory manual that has appeared in many years. From this and possibly from another book, which is not a botany—Hodge's Nature Study and Life—we may glean suggestions; but we look in vain to any book now before the public for anything more definite than suggestions as to a fit course in botany for the agricultural college. Nothing is more certain than that if botany is to take its proper place in the agricultural course, we must develop. de novo, a botanical method suited to our special needs. And it is probable that when this botany is developed it will also prove better adapted to secondary school use than any existing course. As to what must be the content and method of this new botany, each teacher must determine by his own experience. I venture to make the following general suggestions:

(1) The course should be presented absolutely from the standpoint of agriculture and as an integral part of the agricultural course. The bearing of each fact and theory upon agricultural processes should be emphasized. The aim of the course should be to present the facts of plant life which underlie plant production; in other words, to explain the immediate phenomena of agriculture, in so far as those phenomena can be explained, by reference to the plant; and in so far as such problems have been explained at all by investigation to date.

(2) The cultivated plants should be the primary objects of study; if the native flora is introduced at all it should be only those plants that are of economic interest. This would mean that the student would acquire a minute familiar knowledge of the common crop plants. The cryptogams should be studied from the broad standpoint of what they do, before their morphology is considered. For example, an exhaustive study can be made of the phenomena of fermentation, without raising the question as to the form of an individual yeast plant or bacterium. In general, the naked-eye characters, morphological and physiological, should be studied before the microscopical.

(3) Throughout the course experiments should not be presented as facts to be verified, but definite questions should be asked (and not leading questions), which the student should answer from the results of the experiment. Nor should descriptive definitions be given in words, but deduced from observation and expressed in

the student's own language. In a word, experiments and observations should be conducted in such a way as to exemplify every phase of scientific method. The student should be taught how to experiment and how to observe, how to check results and eliminate all possible error. This should be made as prominent as possible without actually teaching the logic of scientific method as such.

(4) Necessarily a course which aims to explain the fundamental phenomena of plant production must give great prominence to physiology. Very simple experiments suffice for the first year's work; later in the course greenhouse facilities and moderately elaborate apparatus would be necessary. Next to physiology, descriptive and systematic work is of the most value. I should personally advocate the giving over of the last third of the first year's course to this and as large a proportion of the whole course. A practical difficulty here exists, in that we have no manual containing the majority of the cultivated plants. This lack in our botanical literature should be supplied.

(5) The course should be continuous throughout the four years' course, including those courses more often taught separately from botany under the names of bacteriology, plant pathology, agrostology, etc.

A course fulfilling these requirements and presented coherently, as one subject and with one method, would supply what is at present lacking—an educational backbone for the agricultural course. It would be part and parcel of the work in practical agriculture, supplementing and explaining it at every step. It would react favorably toward botanical science, tending to develop investigation in a neglected field; at the same time it would greatly enlarge the material aspects of botany.

In our agricultural education we are too prone to overlook pedagogical questions in the absorbing interest of a technical subject. This tendency is to be deprecated. Why is it, with pedagogical journals on the increase and with agricultural education continually more popular, that we find so few discussions of the special problems of agricultural education? But, better than discussions, which must necessarily deal largely in glittering generalities, would be the publication from agricultural teachers of definite text-books adapted to their peculiar work; and especially welcome would be a few laboratory manuals from the botanists, presenting in detail the methods actually in use.

Some subject is bound to be developed to complete the unification of the agricultural course and take the leading educational place. Botany is naturally qualified for this position; whether it will take it or not depends upon its pedagogic development in the next few years. This is by all odds the greatest problem and the greatest opportunity now before the teaching botanist.

A. F. Woods, of the U. S. Department of Agriculture, chairman of a committee appointed at the last convention to report on introductory courses in botany, presented the report of the committee as follows:

Introductory Courses in Botany.

At the last meeting of the Association of Agricultural Colleges and Experiment Stations the Section of Horticulture and Botany passed the following resolution:

"*Resolved*, That a committee of three be appointed by the chair to prepare and report to this section one year hence an outline of what might be considered an ideal introductory course in botany, designed for students of agricultural colleges—one that shall constitute a scientific basis for further work in applied botany."

The committee appointed was as follows: A. F. Woods, F. A. Waugh, and E. M. Wilcox, with a special advisory committee consisting of E. C. Bessey, and G. F. Atkinson.

In his letter naming the committee Professor Craig added the following explanation:

"The purpose of the resolution was to bring before the section next year for discussion the subject of beginning courses in botany. Horticulturists are warmly interested, especially in colleges where students take up horticulture prior to the junior year. It was the belief of those representing horticulture and botany at the recent meeting that a tentative outline, prepared by a committee and offered next year, showing the sequence of courses in botany, would prove a profitable subject to discuss."

The object of a general elementary course in botany should be to develop in the student an accurate, comprehensive knowledge of the life and relationship of plants. He must be taught how to study and interpret them. This involves, first, an elementary, introductory, or fundamental course, which should cover essentially the same ground, whether in common school, preparatory school, or college. What should such a course include, and how long a time should be devoted to it? In answering these questions we desire first to call attention to the third report of a committee appointed by the Society for Plant Morphology and Physiology to consider the formulation of a standard college entrance option in botany. The full-year option recommended in that report was formally adopted by the college entrance examination board (formerly of the Middle States and Maryland) in December, 1901. The principles upon which the course was formulated are stated in the report essentially as follows:

(1) It is founded upon the two important reports of the National Educational Association—the Report of the Committee of Ten (Washington, 1893), and the Report on College Entrance Requirements (Chicago, 1899).

(2) It is intended primarily as an option for entrance to college, but equally for the education in the high school of the general student who can follow the subject no farther; there are in botany no advantages in having the college preparatory and the general educational courses different, at least none that are at all commensurate with the additional burden thus laid upon the schools.

(3) It should, if possible, be founded upon a considerable body of botanical fact learned through "nature study" in the lower schools; it should form part of a four-years' high-school course in the sciences; it should be considered and treated as an elementary or preliminary course leading to second courses in college, and colleges accepting the option should make provision to articulate second courses economically with it.

(4) The immediate plan of its construction is very simple, namely, to include those topics in the leading divisions of the subject which most teachers now regard as fundamental, either for their value in scientific training, or as knowledge; but the individual teacher is left free to follow his own judgment as to sequence of topics, text and other books, and special methods. Advice is occasionally offered, however, upon important points in which most teachers are now known to agree.

(5) It recognizes the existence of, and provides for, two modes of procedure in the sequence of topics. In one, that here advised, the general principles of plant structure and function, permitting a beginning with large and familiar objects and phenomena, are first studied, to be followed later by a study of representatives of the groups of plants from the lower to the higher; the other makes the study of the groups the backbone, as it were, of the course, beginning with the lowest forms and introducing the physiological and morphological topics at appropriate places in the ascending series. The two modes, however, lead to substantially the same result, and a common examination is practicable for both.

(6) It is designed to yield a mental discipline fully equal in quality and quantity to that yielded by any other subject studied for the same length of time.

(7) The time per week, inclusive of recitation, preparation, and laboratory, should be the same as for any other subject. Where five periods a week, with an hour of preparation for each, are demanded for other studies, this course should receive the equivalent of two recitation periods with their preparation, together with three double (not six separated) periods in the laboratory and a small amount of outside work or preparation. Variation from this should be toward a greater, not a lesser, proportion of laboratory work. The preparation of records of the laboratory work, in which stress is laid upon diagrammatically accurate drawing and precise and expressive description, is regarded as an integral part of the course.

The specifications for the full-year option are:

(I) A half year devoted to the general principles of anatomy, morphology, physiology, and ecology.

(II) A half year devoted to the natural history of the plant groups, with classification.

The full-year option may consist of II enlarged to a year and including the essentials of I. (See principle 5 above.)

I. The Half Year in the General Principles of Anatomy, Morphology, Physiology, and Ecology.

The fundamental topics are presented in the report as follows:

A. In Anatomy and Morphology.

The seed. Four types (dicotyledon without and with endosperm, a monocotyledon, and a gymnosperm); structure and homologous parts. Food supply; experimental determination of its nature and value. Phenomena of germination and growth of embryo into a seedling (including bursting from the seed, assumption of position, and unfolding of parts).

A. In Anatomy and Morphology—Continued.

The shoot. Gross anatomy of a typical shoot, including the relationships of position of leaf, stem (and root), the arrangement of leaves and buds on the stem, and deviations (through light adjustment, etc.) from symmetry.

Buds, and the mode of origin of new leaf and stem; winter buds in particular.

Specialized and metamorphosed shoots (stems and leaves).

General structure and distribution of the leading tissues of the shoot; annual growth; shedding of bark and leaves.

The root. Gross anatomy of a typical root; position and origin of secondary roots; hair zone, cap, and growing point. Specialized and metamorphosed roots. General structure and distribution of the leading tissues of the root.

The flower. Structure of a typical flower, especially of ovule and pollen; functions of the parts. Comparative morphological study of six or more different marked types, with the construction of transverse and longitudinal diagrams.

The fruit. Structure of a typical fruit, especially with reference to changes from the flower, and from ovule to seeds. Comparative morphological study of six or more marked types, with diagrams.

This comparative morphological study of flowers and fruits may advantageously be postponed to the end of II, and then taken up in connection with classification of the angiosperms.

The cell. Cytoplasm, nucleus, sap cavity, wall. Adaptive modifications of walls, formation of tissues.

As to the study of the cell, it is by no means to be postponed for consideration by itself after the other topics, as its position in the above outline may seem to imply, but it is to be brought in earlier along with the study of the shoot or root, and continued from topic to topic. Although enough study of the individual cell is to be made to give an idea of its structure (a study which may very advantageously be associated with the physiological topics mentioned first under B), the principal microscopical work should consist in the recognition and study of the distribution of the leading tissues.

B. In Physiology.

Rôle of water in the plant; *absorption* (*osmosis*), *path of transfer*, *transpiration*, *turgidity and its mechanical value*, *plasmolysis*.

Photosynthesis; *dependence of starch formation upon chlorophyll, light and carbon dioxid; evolution of oxygen*, observation of starch grains.

Respiration; *necessity for oxygen in growth, evolution of carbon dioxid.*

Digestion; *digestion of starch with diastase* and its rôle in translocation of foods.

Irritability; *geotropism*, *heliotropism*, and *hydrotropism*; nature of stimulus and response.

Growth; *localization in higher plants; amount in germinating seeds and stems; relationships to temperature.*

Fertilization; sexual and vegetative reproduction.

Although for convenience of reference, the physiological topics are here grouped together, they should by no means be studied by themselves and apart from anatomy and morphology. On the contrary, they should be taken up along with the study of the structures in which the processes occur, and which they help to explain; thus, photosynthesis should be studied with the leaf, as should also transpiration, while digestion may best come with germination, osmotic absorption with the root, and so on. The student should either try, or at least aid in trying, experiments to demonstrate the fundamental processes indicated above in italics.

C. In Ecology.

Modifications (metamorphoses) of parts for special functions.

Dissemination.

Cross-pollination.

Light relations of green tissues; leaf mosaics.

Plant societies; mesophytes, hydrophytes, halophytes, xerophytes; climbers, epiphytes, parasites (and saprophytes), insectivora.

Plant associations and zonal distribution.

The topics in ecology (particularly the first four and in part the fifth) like those in physiology, are to be studied not by themselves, but along with the structures with which they are most closely connected, as cross-pollination with the flower, dissemination with the seed, etc. The fifth and sixth may most advantageously be studied with G in Part II.

C. Ecology—Continued.

Plant associations and zonal distribution—Continued.

In this connection field work is of great importance, and for some topics, such as the sixth, is indispensable, though much may be done also with potted plants in greenhouses, photographs, and museum specimens. It is strongly recommended that some systematic field work be considered as an integral part of the course, coordinate in definiteness and value as far as it goes with the laboratory work. The temptations to haziness and guessing in ecology must be combated.

II. The Half Year in the Natural History of the Plant Groups and Classification.

A comprehensive summary of the great natural groups of plants, based upon the thorough study of the structure, reproduction and adaptations to habitat of one or two types from each group, supplemented and extended by more rapid study of other forms in those groups. Where living material is wanting for the latter, preserved material and even good pictures may be used, and a standard text-book should be thoroughly read. The general homologies from group to group should be understood. In general, in this part of the course, it is recommended that much less attention be given to the lower and inconspicuous groups, and progressively more to the higher and conspicuous forms.

Following is a list of recommended types from which, or their equivalents, selection may be made:

A. Algæ. Pleurococcus, Sphærella, Spirogyra, Vaucheria, Fucus, Nemalion (or Batrachosperum or Polysiphonia or Coleochæte).

B. Fungi. Bacteria, Rhizopus, Yeast, Puccinia (or any powdery mildew), Mushroom.

Bacteria and yeast have obvious disadvantages in such a course, but their great economic prominence may justify their introduction.

C. Lichens. Physcia (or Parmelia).

D. Bryophytes. In Hepaticæ, Radula (or Porella or Marchantia).
In Musci, Mnium (or Funaria or Polytrichium).

E. Pteridophytes. In Filicineæ, Aspidium or equivalent, including, of course, the Prothallium.
In Equisetineæ, Equisetum.
In Lycopodineæ, Lycopodium and Selaginella (or Isoetes).

F. Gymnosperms. Pinus or equivalent.

G. Angiosperms. A monocotyledon and a dicotyledon, to be studied with reference to the homologies of their parts with those in the above groups; together with representative plants of the leading subdivisions and principal families of angiosperms.

Classification should include a study of the primary subdivisions of the above groups, based on the comparison of the types with other (preferably) living or preserved material. The principal subdivisions of the angiosperms, grouped on the Engler and Prantl system, should be understood.

The ability to use manuals for the determination of the species of flowering plants is not considered essential in this course, though it is desirable. It should not be introduced to the exclusion of any other work, but may well be made voluntary work for those showing a taste for it. It should not be limited to learning names of plants, but should be made a study in the plan of classification as well.

The preparation of an herbarium is not required nor recommended except as voluntary work for those with a taste for collecting. If made, it should not constitute a simple accumulation of species, but should represent some distinct idea of plant associations, or of morphology, or of representation of the groups, etc.

It is the opinion of your committee that the course outlined above should be adopted as a general standard elementary course. It is clearly recognized that each phase of it is capable of great expansion. Enough is outlined, for example, under ecology or physiology for a year's work in college. It will be possible, therefore, to present only the main fundamental propositions under each head, leaving the more thorough study for future work along special lines. A sufficient amount can be accomplished in this course to furnish a good foundation for subsequent courses somewhat more specialized. In all respects this foundation course is the most important part of a botanical training. During this period either a liking or a dislike for the science will be developed; right or wrong methods of study and investigations will be acquired; in fact, the foundation for future development along any of these lines of pure or applied botany is laid at this time. This is work for specialists in botany and not for a teacher who has many other specialties besides. The botanist must also be a good and an enthusiastic teacher in his chosen field. In some localities preparatory schools and high schools will be able to present this course properly, having teachers trained in the subject and providing the necessary apparatus and other equipment. When this can not be done it is a mistake for a school to undertake the work at all, at least, to go beyond the grade of so-called "nature study." The fact is that most of our agricultural colleges will for a long time to come be obliged to offer a course in elementary or foundation botany, and every student who is going into any branch of agricultural work from the standpoint of agronomy should be required to take it. The committee on methods of teaching agriculture will recommend the adoption of this same general course, giving to it 120 hours[a] in the sophomore year and 60 hours in the junior year. The course in general is shown by the following table, as furnished by Doctor True of the committee on methods of teaching agriculture:

Agricultural course in college.

[As proposed by Doctor True of the committee on methods of teaching agriculture.]

Freshmen.		Sophomores.		Juniors.		Seniors.	
Subject.	Hours.	Subject.	Hours.	Subject.	Hours.	Subject.	Hours.
Physics	150	Agriculture: Zootechny 60, Agronomy 90	150	Agriculture: Zootechny 100, Agronomy 50	150	Dairying, agriculture, farm mechanics, rural economy.	186
Chemistry	150	Meteorology	60	Geology	120	Veterinary medicine.	180
		Agricultural chemistry.	180	Botany	60	Horticulture and forestry.	180
Geometry and trigonometry.	155	Botany	120	Physiology	180	History and political economy.	190
English	120	English	80	Zoology	120	Ethics	40
Modern languages.	180	Modern languages.	100	Psychology	60		
		Drawing	60	Modern languages.	60		
	755		750		750		776

Agricultural course in college.

[Modified so as to include more Botany.]

Freshmen.		Sophomores.		Juniors.		Seniors.	
Subject.	Hours.	Subject.	Hours.	Subject.	Hours.	Subject.	Hours.
Physics	150	Agriculture: Zootechny 60, Agronomy 70	130	Agriculture: Zootechny 100, Agronomy 50	150	Dairying, agriculture, farm mechanics, rural economy.	186
Chemistry	150	Meteorology	60	Geology	60	Veterinary medicine.	180
		Agricultural chemistry.	160	Botany	80 80 60	Horticulture and forestry.	180
Geometry and trigonometry.	155	Botany	160	Physiology	180	History and political economy.	190
English	120	English	80	Zoology	120	Ethics[b]	40
Modern languages.	180	Modern languages.	100	Psychology[c]	40		
		Drawing	60				
	755		750		770		776

[a] Hours is used to indicate periods of class or laboratory work. Two hours laboratory are considered equivalent to one hour recitation.
[b] Surveying (elective) in place of ethics.
[c] English composition (elective) in place of psychology.

There is no doubt that the elementary botanical course may be fairly well covered in 180 hours, or possibly 160, but to do it will require strict attention to the essentials both by the teacher and by the student. No interesting tangent lines can be explored.

An examination of the agricultural course as recommended by the committee on methods of teaching agriculture[a] shows 486 hours given to the subject in its narrower technical sense, divided as follows:

	Hours.
1. Agronomy, or plant production	132
2. Zootechny, or animal industry	162
3. Agrotechny, or agricultural technology	72
4. Rural engineering, or farm mechanics	60
5. Rural economics, or farm management	60
Total	486

In the committee's syllabus of the course in agronomy considerable space is given to subject matter which must necessarily be covered in a course in botany. The ground covered is essentially as follows:

THE PLANT	Structure (anatomy). Composition. Physiology. Environment.
PLANT PRODUCTION.	Agriculture has for its object the adaptation of environment to the anatomy and physiology of the plants under cultivation, with a view to securing crops which are best suited to the uses of man or the domestic animals.

We may conveniently begin the study of plant production by considering the general characteristics of the environment of plants as grown in the field.

ENVIRONMENT (General factors.)	Light. Heat. Moisture. Air.		
	Soil	Natural With fertilizers	Plant food.

ENVIRONMENT (Divided according to position.)	1. Above ground (Climate.)	Light Heat Moisture Air	Study the relation of each of these factors to plant growth and also briefly their effects in different combinations—i. e., different climates.
	2. Under ground (Soil.)	Heat Moisture Air Earth (soil) Fertilizers	Point out that the relation of these factors to plant growth may be most clearly perceived by first considering them in their relation to each other.

Briefly, it is proposed to study the structure, composition, physiology, and environment of crop plants from the standpoint of plant production. If this course is preceded by the proper botanical training, the ground from the standpoint of agronomy can be covered in very much less time and with greater success, as provided for in the syllabus under the head of individual farm crops. If this special botanical portion of agronomy be transferred to botany, we estimate that there would be a saving of at least 20 hours, which should be added to botany in the sophomore year. Twenty hours should also be taken from agricultural chemistry and added to botany, giving 160 hours for this subject, 2 hours' lecture and 4 hours' laboratory work for 40 weeks. This would leave practically 120 hours for that portion of agronomy not presented in the botanical course, and would leave 150 hours for chemistry in the

[a] U. S. Dept. Agr., Office of Experiment Stations Circ. 39.

freshman year, and 160 hours for agricultural chemistry in the sophomore year. After a mastery of the elements of botany, at least two additional courses will be necessary. Before considering secondary courses in botany, attention should be called to the necessity of a fundamental training in chemistry and physics as a basis for further work in plant morphology and physiology. These courses should be required of all students. It should also be borne in mind that ability to read German and French, especially the former, is a necessary requirement for all who expect to equip themselves as teachers or investigators in the fields of plant industry. A lack of this knowledge is often a handicap to many students otherwise well prepared. In the formulation of second courses in botany for agricultural colleges the aim should be to furnish the proper foundation for applied work in agronomy, horticulture, and forestry.

GENERAL SPECIFICATIONS OF SECOND COURSE.

At least 2 hours of lecture and 4 hours of laboratory work per week for one-half year should be given to an extension of the work on the physiology of the higher plants, monocotyledons and dicotyledons. Special stress should be laid in this course on the response of the plant to varying conditions and combinations of conditions in its environment. It should include a more special study of plants with regard to temperature, light, and moisture relations, and the effects on the plant of variations in soil and nutrition. This work should include not only normal but also abnormal physiological reaction, and should therefore serve also as an introduction to those phases of plant pathology which deal with the effect on the plant of its nonliving environment. In connection with this course and as a part of it, there should be a sufficient extension of morphological and histological work to make clear the physiological processes not only of the plant as a whole, but of its various organs and tissues, and the course should include the ordinary technology of such work. The general topical arrangement of this course might be as follows:

Résumé and extension of the work on root, stem, and leaf structure of the elementary course.

Secondary growth in stems and roots.

Seed and fruit structure.

Minute study of cell structure and cell contents.

Cell division (the various kinds in detail).

The morphological and histological work should not be conducted separately, but coordinated with the following physiological work:

NUTRITION.—Constituents of plants; essential elements; accessory elements and their effects; nature of soil solution; degree of concentration of same in relation to plants; effect of soil and atmospheric moisture in varying quantity; photosynthesis; chemosynthesis; translocation; and storage.

(This will involve water, sand, soil, and air culture experiments with varying combinations of nutritive elements and conditions. Field experiments are also desirable.)

RESPIRATION.—Aerobic and anaerobic; energy liberated; products of destructive metabolism and their fate; movements of gases; respiration of roots under varying soil conditions, favorable and unfavorable; respiration of fruits, etc.

FERMENTATION.—Ferments; enzyms (the chief kinds, their distribution and mode of action).

GROWTH.—Seat and conditions of growth; periodicity and grand period; rate of growth under varying conditions.

IRRITABILITY.—Movements of protoplasm and plant parts; geotropism; hydrotropism; heliotropism; nyctotropism; response of plants to various stimuli.

REPRODUCTION.—Pollination (close and cross); cleistogamy; dichogamy, etc.; fertilization; hybridization—methods, results, cytology; variation—general rules and theories; plant breeding.

Following the half year above outlined, another course of a half year (2 hours of lecture, 4 hours of laboratory) should be devoted to a special, broad study of the physiology and classification of fungi and bacteria, with special reference to beneficial and injurious species. This course should include some culture and infection work and practical work in methods of controlling plant diseases. As a general outline the ground covered in Diseases of Plants, by Tubeuf and Smith, is to be recommended, but other text and reference books will be necessary.

Referring again to the agricultural course prepared by the committee on teaching agriculture, we find 60 hours devoted to botany in the junior year. This is, of course, insufficient time for either one of the courses above suggested and believed to be absolutely necessary as a basis for applied lines in plant industry. These courses must have not less than 80 hours each. It would appear practicable in the general college course above referred to to put psychology on the same basis as ethics, giving it 40 instead of 60 hours, and further to put geology on the same basis as meteorology, giving it 60 instead of 120 hours. This will make a saving of 80 hours, which can be devoted to botany. Then, by adding 20 hours to the total junior course, 160 hours can be devoted to botany in the junior year. One other course is believed to be desirable in order to furnish a good solid foundation on which work in applied botany can be based. This course should cover a period of about one-half year (2 hours' lecture and 4 hours' laboratory or field work per week) and should consist of a special study of the classification and distribution of gymnosperms and angiosperms with special reference to those of economic importance and those which have given rise to cultivated varieties. In this course the student should obtain a clear idea of the origin and relationships of our cultivated plants. In order to provide time for this course the 60 hours of modern language in the junior year could be dispensed with. One hundred and eighty hours of modern languages in the freshman year and 160 hours in the sophomore year should be sufficient in a general course. The 60 hours thus saved could be devoted to the botanical course last mentioned. If the arrangement suggested can not be adopted, the last-mentioned botanical course should be omitted rather than either of the 80-hour courses.

Starting from these courses as bases, it will be possible for a student to begin to specialize in those branches of botanical work that will be most useful to him in the general end for which he is working; for example, a student who wants to specialize in agronomic lines would go on from this point with a more thorough and systematic study of cereals, grasses, and forage plants, weeds, poisonous plants, etc., and a student in general horticulture might take up further studies in physiology or especially along the pathological lines so far as they relate to horticultural work, and if the student desires to specialize or to prepare himself for investigation work or for teaching botany, he could elect his further work in such lines as he might choose. In histological lines he could take up the study of cytology, histology, embryology, histogenesis, etc. In taxonomic lines he could take up systematic botany, morphology and classification, and ecology. In physiological lines he could continue with physiology and pathology. It has been found profitable in many colleges to have a student devote the senior year to the careful investigation of some problem as a thesis. This is the best plan to follow, especially where students propose to go into some branch of practical agriculture. If the student has in mind becoming an investigator or teacher, the special investigation work is best carried out as postgraduate and the regular college time given to strengthening the general course. The courses here outlined are designed not to produce teachers and investigators, but to furnish a good foundation training for further development.

A resolution was passed adopting the report and expressing appreciation of the work of the committee.

H. L. Hutt, of Ontario, gave a full discussion of the methods of teaching horticulture in the Ontario Agricultural College.

F. W. Rane, of New Hampshire, was elected chairman of the section, with F. L. Stevens, of North Carolina, as secretary.

The following resolution was passed:

"That a committee of five, of which the chairman of the section should be one, be appointed by the chair to outline courses in horticulture."

At this point attention being called to the fact that the old sections, as such, had been abolished, it was, on motion, declared to be the sense of the section that the chairman and secretary, just elected, be constituted a committee to look after the interests of the section.

The section then adjourned.

SECTION ON ENTOMOLOGY.

The Section on Entomology met at the Shoreham Hotel on the afternoons of November 17 and 18, 1903. In the absence of the regular officers, J. B. Smith, of New Jersey, was elected temporary chairman, and C. M. Weed, of New Hampshire, temporary secretary.

The first paper read was the following by A. D. Hopkins, of the Division of Entomology, U. S. Department of Agriculture:

Methods of Work and Some Results in Forest Insect Investigations.

The work of the forest entomologist differs in many respects from that of the entomologist who devotes his attention especially to horticultural and farm insects. The comparatively meager literature on American forest insects compels him to rely more on original investigations for the requisite knowledge of the life, history, habits, and natural enemies, on which to base conclusions relating to practical methods of preventing losses. The methods of obtaining this information are peculiarly difficult and complicated, owing to the widely different conditions prevailing in the forests of the northeastern, southeastern and southern, central and northern, the southwestern and northwestern, the Pacific slope, and the Rocky Mountain regions of the country. Each section has its peculiar insects and widely differing problems, regarding which comparatively little is known. Long, tedious journeys have to be made by rail, stage, horseback, and on foot, and when the primitive forests are penetrated the services of a guide are often required.

The equipment necessary for field work is a light ax or hatchet, a stout penknife, beating net, many small phials of various sizes, and a hunting coat with many small and large pockets. Trees must be felled, bark removed, sections of the trunk cut out, roots, trunks, and branches examined, and specimens collected, each of which must be numbered and recorded in the notebook. The latter does not differ so much from the usual entomological work, but perhaps greater care must be exercised in determining and recording facts on habits, life histories, and the peculiar relations of the insects to their hosts. The labor of procuring specimens of bark and wood showing characteristic work, and their transfer from the forests to the nearest shipping station or post-office is an item of considerable importance. Then one must know the trees from which the specimens are collected, and often botanical specimens must be taken for accurate determination. The forests must be studied to determine the relations of fires, storms, lumber operations, and general forest management to the multiplication of destructive insects, but above all to determine if any changes in management or lumbering operations will prevent losses from special enemies or classes of injuries.

The breeding of forest insects also presents some peculiar features. Instead of the ordinary breeding cage, small phials and bottles of various sizes with cotton stoppers, glass jars with clamp tops, large, tight tin boxes, barrels and large wooden boxes, are the proper equipments for this purpose, with specially devised paraffin cells, or tin cages attached to the sides of trees, or wire cages to inclose stumps and sections of logs in the forest.

The specimens of wood and bark, branches and leaves, showing the work of the insects, require special cases for storage and classification, and the mass of material of this kind in a large collection requires much room for its proper arrangement for reference and study.

THE DETERMINATION OF METHODS OF PREVENTING LOSSES.

It is in the determination of methods of preventing losses and in their recommendations for practical application that the work of the forest entomologist presents some strikingly different features. Very few of the methods of combating forest and shade tree insects, and less of those as applied to the farm and garden can be adopted for forest trees. Forests can not be sprayed, neither can they be treated with hydrocyanic-acid gas, or lime, sulphur, and salt, or by any other of the many expensive methods which are practicable with trees under cultivation. Rotation of forest crops is out of the question, and it will be many years before clean culture and high forestry can be applied in this country, except on a limited scale in farmers' wood lots, and under specially favorable conditions in more extensive forests.

We have had to search for different and inexpensive methods, and as our knowledge of the life history and habits of the principal depredators on forest trees and forest products increases, as the results of recent investigations, it becomes plain that a vast amount of loss from this source can be prevented without cost.

It is in the adjustment of business methods in harvesting and caring for forest products that we have a simple and inexpensive means of dealing with the principal forest insect problems. We have found that certain methods of lumbering and caring for the manufactured products contribute to the multiplication of the destructive insects and consequent losses from their work. We have also determined that a change in these methods, which involves no hardship or additional expense, will have the opposite effect. This has been demonstrated in the Maine woods, where, upon recommendation, the principal cutting is concentrated in the areas of dying and beetle-infested spruce. We have another example, in the tan-bark industry, where it has been shown that, if the bark is utilized for tanning before it is three years old, the heretofore great loss of bark from insect work is entirely prevented. It has been shown that the pine forests of the Black Hills forest reserve may be saved from possible destruction by the pine-destroying beetle, by cutting a large per cent of the infested trees during seven months, from the 1st of October to the 1st of May, and converting the same into merchantable products, and that this can be done without cost to the Government. We have experiments under way the results of which are already making it clear that very extensive losses in the cypress lumber business of the South, from insect work, can be avoided without additional cost. It will only be necessary to adjust the operation of girdling trees so that the principal work will be done at a time of year which will result in unfavorable conditions for insect attack.

The methods of determining the facts on which to base recommendations for this class of preventive measures involves some expensive experiments, but with the cooperation of the Bureau of Forestry and the practical lumbermen, which is being so liberally extended, we feel that much will be accomplished along this line in the future.

There is another method involving the destruction of infested trees which has yielded encouraging results. In cases where the felled timber can not be utilized and must be burned, it is an expensive process, and is only available where the promised results will justify it, while in other cases where the felled timber can be converted into merchantable products, there is little or no loss. The practicability of this method seems to be demonstrated this year at Belle Isle Park, Detroit, where a large number of hickory trees, thickly infested with the hickory bark-beetle, were felled and burned during May, the work having been done just in time to effectually destroy the broods before the adults commenced to emerge. The result of this work by the park commission was specially satisfactory, as no evidence of the work of the insect has since been observed, while the previous summer it seemed that all of the hickories in the park (one of its most important features) would be completely exterminated.

The methods of obtaining facts on which to base recommendations for the cutting and destruction of infested trees involves the determination of the life histories of the destructive insect and its principal natural enemies, in order to designate the beginning and ending of the period within which the infested timber must be felled. It is important to determine whether or not the entire tree or only the bark of the trunk should be burned, or if the simple operation of removing the bark would be sufficient to kill the young broods. The life history and habits of the natural enemies must be studied to determine whether or not they emerge some days or weeks in advance of the tree-destroying insects, in order that they may be allowed to escape before the trees or bark is burned.

We have also the trap-tree method of combating forest insects, which consists in the providing of girdled and felled trees at the proper time of year to attract certain destructive bark-infesting insects. By this method swarms of the beetles are concentrated on a few trees, and after they have entered the bark and the broods are partially developed, they are all destroyed by the simple removal of the bark from the infested parts of the stumps, trunks, and larger branches, leaving the wood available for lumber or fuel.

The determination of the particular species of insects which can or can not be trapped and destroyed in this manner, and the proper time and method of doing the work to meet the requirements of each species, involves extensive experiments and the use of a large number of different kinds of trees in different sections of the country. As an example, over 200 large trees were utilized in one experiment last year in the Black Hills Forest Reserve. The results from this and other similar experiments have so far been very gratifying in showing that some species are readily attracted to felled and girdled trees, while others, like the pine-destroying beetle of the Black Hills, show no preference whatever for the injured trees over the near by perfectly healthy ones. This latter result proves beyond all question that healthy trees are attacked and killed by this bark beetle; that it can not be attracted to trap trees; that its broods can be destroyed by felling the infested trees during the fall, winter, and spring months and removing the bark from the main trunks and leaving it on the ground to dry; that the wood of such trees can be profitably utilized for railroad ties, mine timbers, and cord wood.

Thus we have found that while some of the methods of work in forest insect investigations are complicated and expensive, both in money and time, they have led to the discovery of some simple, inexpensive, and practical methods of preventing losses.

The reading of the paper was followed by an appreciative discussion in which J. B. Smith, C. M. Weed, and others took part.

The following two papers by E. P. Felt, of New York, were then read:

Importance of Laboratory and Field Work in Economic Entomology.

The purpose of this paper is not so much to present new facts as to provoke a discussion, and in this way draw out valuable points in the experience of different workers. It always seemed to the speaker that laboratory work should form the basis for field experiments, and that one should always accompany the other. There has been more or less talk in recent years about experiments of magnitude; those conducted on a commercial scale and the like, and yet, in reality, some of our most satisfactory results have been obtained in breeding jars no larger than a jelly tumbler, or even a small homeopathic vial. It is very true that the breeding jar, be it large or small, does not afford natural conditions, and results are more or less affected by this variation; and yet, an insect confined in such small quarters can be observed much more closely and a correspondingly larger amount of knowledge gained concerning its habits; for example, we have had no trouble in keeping elm-leaf beetle, *Galerucella luteola* Müll., for approximately thirty days under such close observation, and in spite of the apparently unfavorable conditions they approximated a full quota of eggs. Even more remarkable results were obtained with the grapevine root worm beetle *Fidia viticida* Walsh, a specimen of which not only lived in a breeding jar for upwards of nine weeks, but deposited the very large number of 900 eggs. The advantage of these very small jars is that they permit isolation and enable one to make much more accurate observation than would be possible in the field. The results obtained in the laboratory are carefully checked by others in the field, and in our experience (in some cases at least), it pays well to build larger breeding cages in the field and observe conditions there, not only in comparison with the indoor breeding cages, but also with uninclosed food plants; for example, some exceedingly valuable data were gained the past season in a series of eight large cages, which contained from one to two full-sized grapevines in the midst of a commercial vineyard. The conditions were somewhat abnormal on account of the fine wire screening, preventing, to a slight extent, the normal circulation of air, and the temperature inside of the inclosures was consequently a little higher; nevertheless, by means of such cages we obtained unquestioned data as to the time the beetles appeared above ground, something of great importance, whether the adults are to be destroyed by catching or killed by an application of some arsenical poison. These cages also gave exceedingly valuable data on the proportion of pupæ which could be killed by cultivation, and likewise the efficacy of poison in destroying the beetles. Our indoor cages, for example, show that where the insects were confined absolutely to leaves which had been covered by the poison, they could be killed in nine to twelve days or thereabouts, whereas, in our larger outdoor breeding cages, in spite of the fact that the spraying was done by hand in a most thorough manner, practically none of the insects were dead after a period of twelve days. The results from the indoor and outdoor cages differ, and yet there was a relative gradation in those obtained between the indoor and outdoor cages and the larger experiments where an acre or more was involved. The point we wish to make in this connection is that while no one of these experiments gave conclusive data, the combination of the three enabled us to form a very fair judgment of what actually was occuring, and we believe that by these means we have been able to estimate, with considerable accuracy, the relative value of various methods of controlling the pest under consideration. In this connection a word regarding the reliability of the untrained observer is not out of place. It frequently occurs that the experimenter has not the money or the time to make an extended series of experiments, and he is therefore often obliged to avail himself of the experience of intelligent parties who follow his advice. Occasionally it is possible for him to be present when the spraying, for example, is in progress, and to observe the manner in which the work is done, and he may later examine the premises and decide for himself as to the efficiency of the work. At other times such is not the case, and he may not even see the field; yet, very satisfactory reports come regarding the results obtained, or believed to be obtained. The reliability of these reports, in our experience, depends very much upon the individual making the observations, and especially upon his familiarity with the insect he is attempting to control. The trouble with such observers is that they are very apt to attribute any improved condition of the plant to the application and to accept an apparent decrease in the numbers of the pest as actual proof of the efficacy of the insecticide, whereas, such may not be the case at all. An incident of this character came to our attention the past summer where several parties had sprayed for *Fidia viticida* Walsh (the grapevine root worm), and thought they had obtained most excellent results due to the fact that the vines made better growth and that the poison protected the leaves to a greater or less extent. An examination, however, showed that the protection was more apparent than real, and as this is by no means an isolated case it follows that a great deal of caution should be exercised in accepting the judgment of untrained observers. On the contrary, our observations on the grapeberry moth accorded exactly with those of an untrained observer, and in this instance there was hardly room for error, because there was an opportunity to compare sprayed and unsprayed vines in several plats side by side. We would unhesitatingly accept the judgment of a grower in such a case, whereas, in the more difficult one of estimating the value accruing from arsenical poisons in attempting to control the grapevine root worm we much prefer to investigate for ourselves.

The outdoor cage, as a general thing, is not entirely satisfactory, and yet it is a device which we believe can be adopted with benefit in cases where ordinary outdoor experiments fail to give the results they should in comparison with laboratory work. One can never tell just what will be possible in these outdoor cages. We were able last summer in our Fidia work to get definite data on the destruction of pupæ and the dates when beetles appeared; yet the insects, in spite of the fact that they were in quite roomy cages, 6 feet high, 6 feet broad, and 8 feet to 16 feet long, almost refused to breed and, as a consequence, final determinations of the efficacy of different poisons and the value of the check cage, as illustrating the destructive possibilities of the beetles emerging from under the vines therein, were impossible, though beetles of this species, as stated previously, were very amenable to treatment in the much smaller jelly tumblers, and we were therefore somewhat surprised at the results. On this account we are inclined to restrict the use of large outdoor breeding cages to more difficult cases where it is necessary to go to considerable trouble in obtaining satisfactory results.

Record Devices.

Office traditions have gotten us into the habit of making many records, particularly of species which are contributed by various correspondents, and for this purpose we have found nothing more satisfactory than a little card about the size of the old postal card, with blanks for the scientific name, the common name, the stage, the food plant, date of sending, name of sender, locality, and a space for inserting the name of any other party or institution through which the specimen may have been sent. There is also a blank space for noting any additional data, and spaces for the catalogue number, the name of the party by whom the specimen was determined, the accession number, and the field book number. Both catalogue and field book number are prefixed by letters so they can not be confused with accession numbers. The former is convenient because the number given the species is that of some well recognized catalogue, and affords a ready means of arranging the cards in their proper order. It is also very convenient when consulting one of these cards to know who determined the specimens. We have a system of recording scale insects in the order of their reception, and each sending is given an accession number which always appears upon this card and enables an instant reference to the original record. We have also a small book called the field book, which is usually carried into the field and brief observations recorded therein regarding captures. This field book is numbered, and besides the name of the insect it gives also, if possible, the name of the food plant. The placing of the field-book number upon these cards aids greatly in referring to the original record. To each of the more important orders is assigned a letter, which always precedes the catalogue number, and as this designation appears upon every card there should be no confusion regarding their use. The idea of employing ordinal abbreviations and catalogue numbers is to facilitate the ready arrangement of the cards by comparatively unskilled labor. These little slips have been in use in our office for some three years and are much superior, in our judgment, to the old record book, since they can be readily rearranged in almost any way, entered properly, and it would even be possible to have the printer set directly from them, though we have always sent typewritten copy.

Experience has led to forsaking the old form of record book, and almost all of our present notes are written or dictated upon uniform-sized sheets and temporarily filed in small pigeon holes until the end of the season, when they may be either worked up into a report or special bulletin. The advantage of uniform slips for such records is probably apparent to all, and most original records relating to such matters can easily be filed alphabetically or subjectively in ordinary letter files.

The correspondence of the office is a large one, and the proper handling of the accumulated letters is a serious problem. Heretofore all such correspondence has usually been filed alphabetically, except in case of some more important correspondents, where their letters have been kept in special boxes. We have recently sorted out the more important letters and filed them topically, and we are inclined to believe that this will prove an important aid in conducting the correspondence, since it will enable a ready reference to all letters written regarding any special insect or topic. We are making a practice of retaining carbon copies of all letters written, and it is our plan to minute upon the original communication the subject, and to file only the copy topically. This does away with the need of an index card for the purpose of finding any letter which may relate to a special topic; and the carbon copy, of course, shows the party to whom the letter was written, while the record upon the original gives the topic under which the reply is filed. Only letters which have been in the office two or three months, or more, are filed in this way; and the occasions when both communication and reply are necessary are so few that we believe this method gives the maximum benefit with a minimum expenditure of labor.

Both of these papers were discussed at considerable length by W. Webb, A. D. Hopkins, W. E. Britton, F. L. Washburn, and others.

J. B. Smith then read the following paper:

The New Jersey Ideal in the Study and Report upon Injurious Insects.

Probably everyone who enters upon a position like that of an entomologist to an experiment station has a more or less definite idea of what is required of him and an ideal toward which he strives. It may not be a very definite aim that lies in his mind, and he may not even be conscious that he is striving toward an ideal; nevertheless, consciously or unconsciously, there is a model. It may be unconsciously that of some teacher or of some preceding author; or, consciously, one fixed by his own belief in what is necessary or desirable.

The writer of this paper began his work in the early days of experiment stations; not among the first by any means, and indeed not until he had rather severely criticised, in an editorial way, some of the bulletins that had been issued before an offer came to him from New Jersey. Having placed himself in the position of a critic, it was incumbent upon him to avoid those faults which had been found reprehensible. It was therefore consciously that I marked out for myself a guide line, to which I have adhered rather closely since 1889, amplifying, of course, to some extent and changing as experience dictated. I decided that my constituency wanted, first of all, practical information. I decided also that it would be a very good thing for them to know how the information was practical and why I made recommendations. I would make my publications educational; there would be something that could be learned by anyone who chose to read them, and I would make them so that any man of reasonable intelligence could understand what I was trying to tell him and could see why I recommended a specific practice in preference to any other.

I decided further that very few farmers or fruit growers cared very much about entomology or cared to become entomologists. It made very little difference to them whether an insect had one generic name or another, and they cared absolutely nothing whether the name that was given to it was the first ever proposed for the species or not. What they did want was some name by which to call an injurious insect so that they would know what they were talking about when they used that name, and would know to what I was referring when I wrote concerning that species. I made it a rule, therefore, although this is one of a somewhat later development, that when I once had used a scientific term or combination of terms for an injurious insect, that for my purposes this became the common name of the insect, and would be used as such, no matter what changes were made later on in the catalogues. Of course, if the insect has an English name, it does not make so much difference what Latin name you tack on behind it. The farmer will very rarely commit it to memory, and it will not make any difference to him how frequently you change it; but when he has learned to know a species as *Pentilia misella*, he does not know what I am talking about when I refer to it as Smilia in another place, and he is altogether at sea when a third time I call it Eusmilia or something else.

Classification is not necessary, except in so far as a knowledge of classification assists to a recognition of the method in which an insect should be treated. I consider it important, therefore, to teach the horticulturist how an insect feeds and how he may recognize the structures that will enable him to determine that point. Knowing it, he will know in a general way the character of the insecticides that must be used. He is to be taught that stomach poisons are not available against sucking insects, and that when plant lice are to be dealt with Paris green is of little use, while soap mixtures and other contact poisons will probably produce good results. It is for this reason that, whenever I make a study of an insect, I go to considerable trouble to explain just how the injury is done. I want the farmer to understand how his plant is affected by the attacks of the insect. I want him to understand how the insecticide that is recommended acts upon the insect, and I want him to realize what his aim must be in the application of the material. He should know whether it is his aim to cover all the leaf surface that the insects may be killed as soon as they begin feeding upon it, or whether he must drive his spray into the midst of the insects where they are already congregated that he may cover them as completely as possible, whether all the foliage is hit or not.

I decided also that whenever an insect could be controlled without the application of insecticides especial stress should be laid upon the life history, that the farmer might understand thoroughly the reason why a particular line of farm practice was recommended to him. I found by experience that a farmer generally believes that he knows more about farm practice than the entomologist, and so far as I am personally concerned I admit that his belief is well founded. It is always my effort, therefore, to fully impress upon him that what I recommend in the way of farm practice is not because it is the best farm practice, but because that particular line of work will be the worst for the insect to be reached. In this way you prevent his feeling that you are trying to change what he has found by experience to be a satisfactory routine. You admit all that he contends for; but give him another end to be attained, and, by putting him upon a different point of view for considering the subject, my experience is that he is very apt to be guided by suggestions which he would resent when presented in any other way.

From the very start I determined that, while laboratory experiments and results were extremely useful as guides, it was the outdoor conditions and the outdoor surroundings that had to be dealt with. Methods that are practical in the laboratory may seem and may actually be entirely impractical in the field. On the other hand, a farmer or fruit grower is sometimes ready to do a great deal of unnecessary work, provided he can do it at his own time or in his own way; and I generally like to arrange matters so as to give the farmer his own way just as much as it is possible to do so. All this time, however, I deal with him by suggestions. I agree to everything that he says and to all that he suggests; but I throw in a little doubt here and there, and I venture an expression of opinion in a timid sort of way. Sooner or later this bears fruit, and a man reverses his previous practice almost completely without any idea that it was done through any but his own good will and pleasure and because he himself thought it the best thing to do; in other words, while I kept before me the ideal to be attained I never presented it, unless I felt that it would be likely to meet with acceptance.

Now, I am quite ready to agree that while all this may be feasible in a small State like New Jersey, where it is possible to come into personal contact with farmers everywhere, it is not satisfactory as a guide in larger States where conditions are different. In New Jersey agriculture and horticulture is of the most varid possible description. We run all the way from grain and dairy farming to the most intensive truck farming; from the orchard fruit to almost every small fruit that ever gets into the market. We have canneries where a thousand acres go into one crop to keep them running during the season, and we have gardens and truck patches consisting of a few acres where crop after crop comes off for the local or city market. Under these circumstances no one locality can properly represent the varying conditions found throughout the State. Therefore, I have no insectary connected with my department of the experiment station, and while at one time I thought that such a thing might be desirable, I have long since abandoned the idea. I find it possible to visit localities where injurious insects occur, at short intervals; find it possible to observe them in the field under absolutely natural conditions, and find it quite possible to do what little breeding is necessary with the few cages in the laboratory. I find it possible also, working in this way, to secure the cooperation of the farmer whose crop is attacked and to interest him in the study as well as in the fight against the insect. He will make applications at my suggestion, sometimes when I furnish the materials and at other times when he has to buy them himself; but he sees exactly what I am driving at. He learns to understand the theory upon which it is attempted to control the insect, and if we succeed, he forms the best possible teacher to the surroundings. And while progress is sometimes discouragingly slow yet when

I look back a dozen years and see what has been actually accomplished, I sometimes marvel that so much has been done.

Following out these ideas I have always avoided scientific discussions in the station publications. Nor have I ever described new species in a bulletin with the idea of rendering them recognizable as scientific descriptions. Occasionally it does happen that an undescribed species becomes troublesome. When that does occur the scientific description belongs in a publication where the specialists will be apt to look for it, and to the bulletins belongs only so much as is necessary to identify the insect from the practical standpoint. I am aware that not all my colleagues agree with me in this matter, but then I am stating only my own practice and beliefs, and am not attempting to lay down laws for the guidance of other people.

Neither do I care to go too far into the history of an injurious insect, or to detail what others have done in the matter. All that is very interesting and important in a paper presented before a body like this, and there is a certain fascination in following out from the earliest times what has been done—for instance with the codling moth; but what the fruit grower wants to know is how he is to get rid of the codling moth at this present time, and he cares very little indeed for what was done one hundred or even fifty years ago. I do not believe in using other people's observations as though they were my own, but, on the other hand, neither do I believe in the necessity of citing a reference for every statement of fact that has become public property. When, after looking up what has been published on any particular point, I present my own compiled account of the subject to the farmer, unless I present it so as to give the impression that I had personally made the observations, I am doing no one an injustice in omitting to credit every individual phase of the subject to the one who actually worked it out. The man for whom it is written would probably not understand more than half the references, and would certainly never take the trouble to look them up. On the other hand, where I quote another man's recommendation I give him full credit for it, if only to avoid the responsibility for making it myself.

I think it a positive disadvantage to make too many citations, because it gives the reader the impression that you know very little about the subject yourself, and are only writing out what somebody else has said, the probability being that that somebody else knew just as little about it as you do. I was impressed when Doctor Fletcher told me once upon a time about the importance of speaking offhand before farmers. They do not consider the preparation of a formal paper any evidence of careful preparation, but rather consider it as something taken from a book and written down lest you forget it. I feel somewhat the same way in the preparation of a bulletin and try to make it a readable account, claiming nothing for myself save what appears as mine from the narrative.

In a general way I may sum up my ideal as follows:

(1) To make a clear statement of the character of the injury caused to a crop by a specific insect, so that the farmer may, if he sees the injury alone, be enabled to refer it to the proper cause.

(2) To explain just how the insect causes the injury and in which stage of its life cycle it is injurious. Under this head such anatomical details as may be necessary to show how the injury is produced may be presented.

(3) There should be a life history of the species carrying it through an entire year; with the danger periods emphasized as far as possible.

(4) The experiments made should be given in some detail. My experience has been that a farmer likes to be made acquainted with the processes that lead up to the next head.

(5) The conclusions and reasons for the conclusions.

(6) Last, come the recommendations for practice; and if the other points have been well covered, these recommendations will need very little explanation.

I do not claim for a moment that I have in all cases lived up to my ideal. I know that in some cases I have fallen distinctly short of it; but at any rate there has been an advantage in knowing that I was working toward a definite end, and, such as it is, it is presented for discussion and criticism.

After an extended discussion in which the main points of the paper were emphasized, the section adjourned for the day.

In the absence of the author, C. W. Woodworth, of California, the following paper was read by title:

Cooperative Work in Economic Entomology.

Under this title I propose to discuss a form of coöperative work between farmers and the experiment station, which, while possibly not presenting anything new in its fundamental conception, still has developed into a more definite policy at the California Station than elsewhere.

The necessity for something of the kind arises primarily from the peculiar diversity of conditions existing in this State, and the particular form of cooperation here developed has been a growth dependent largely upon the distinctive tendencies of our agriculture.

One of the features of California farming which first strikes a stranger is the concentration of the various cultures into small districts, and the more one becomes acquainted with these districts and their pecularities the more significant this local specialization appears. Undoubtedly, we have hardly begun to determine the adaptability of the larger part of the State for any particular culture, but the existing centers of production represent beyond question combinations of favorable conditions not usually found associated. Some of these conditions may be artificial, such as nearness to markets, etc., but most of them are strictly natural and are those which we loosely group together as soil and climate. Sometimes the same fruit, even the same varieties, may be grown successfully in two or more geographically different regions and will then usually present peculiarities as to earliness or quality that will mark the product as distinct. For instance the early oranges of the Palermo and Porterville districts of central and northern California ripen a month before the southern California fruit; and the late apples of the Pajaro Valley, as well as of a few smaller coast localities, are a distinctive product of unusual quality.

A similar series of phenomena may be observed in respect to the insects of economic importance. No insect is injurious over the whole region where its food plant is grown. The Black scale, so troublesome in southern California, is practically unknown in the olive and citrus orchards of the Sacramento and San Joaquin Valley. The San José scale, so generally destructive, is practically unknown in the region about Berkeley. The codling moth is unknown in some of our best and oldest apple orchards, even though but a few miles away and generally all over the State it is a pest of first importance. In the Santa Clara Valley the hopper attacking the grape is *Tettigonia circillata*, while in most of the other grape-growing sections the ordinary *Typhlocyba comes*, belonging to a different group and with entirely different life-history, takes its place.

The economics of an insect in any particular region usually presents different problems in the different commercial center of the production of its host plant. With these facts in mind it is at once perfectly clear that it is necessary to go into each region where a crop is grown on a commercial scale and there study the problems involved in the suppression of the insects giving the trouble.

It was a recognition of this general principle applying to most agricultural problems that led to the establishment of the experiment stations all over the United States instead of spending the same funds for strengthening the work of the Agricultural Department at Washington. These stations, scattered about over the country, were calculated to be able to study the local problems where they could be best studied, and the eastern stations do cover the territory quite satisfactorily as far as their location is concerned.

To provide adequately for the varying conditions in California it would be almost necessary to have a station at each important shipping center and then the ground would be no better covered than by the stations as they are distributed in the States bordering the Atlantic coast.

A doctrine that should control the administration of an experiment station is that the funds should be so spent as to return to the State and the country at large the greatest financial benefit. I do not mean that abstract problems without immediate economic returns should not be investigated by the station when they are fundamental to practice or theory in agriculture, but rather that they should be pursued only when there is prospect that in the end there will be returns to justify the effort more fully than other lines of research.

In economic entomology, where our effort is to prevent losses due to insects, the best place for our study will ordinarily be that locality where the greatest losses occur, and in such a State as California it will be a different locality for almost every problem investigated. There is, indeed, work enough in each locality to profitably employ one's time indefinitely, but with our diverse conditions and lack of investigators it is usually necessary to spend only a season or part of a season in one place.

Until within the last two years the funds available from the station for entomological work only provided for occasional trips to localities where insect troubles occurred and such cursory examinations can by no means be classed as investigations. Serious study demands considerable time and consecutive observation of the results of experiments. An investigator must be located where he can study the insect under the best conditions and stay with it in most cases through a twelve months.

The only way it seemed possible to do this was to secure the cooperation of the growers most interested. The fact that the producers of any one crop are usually in one locality where the large contiguous acreage makes the aggregate loss very evident, contributes not a little to their appreciation of the desirability of such cooperation.

The first arrangement of this kind will well illustrate the conditions, methods, and purposes of cooperative work of this kind. The bulk of the peaches grown for eastern shipment as fresh fruit is produced in Placer County along the line of the Southern Pacific Railroad in an area about 10 miles long and extending out on either side not over 4 or 5 miles.

The average loss for the preceding four years from the attack of the peach worm had exceeded $300,000 per year in spite of spraying operations done in accordance with the best information obtainable.

In response to the urgent request of the peach growers of that locality a man was placed in the field by the experiment station, and the people of Placer County paid the local expenses of the investigation. More important than the financial aid given was the feeling of personal interest aroused in the orchardists whereby large areas of bearing peach orchards were placed under the control of the investigator and everything done to aid in his work. Indeed the real cooperative spirit was manifested.

Station entomologists do not fully enough realize the importance of working under commercial conditions. It is quite a different thing to get results on a dozen trees and on a thousand acres. The small experiments are essential in securing facts upon which to base our work, but the large scale experiment is the final test of the practical value of the facts. It is only by some system of cooperation that an investigator can get control of a sufficient experiment-station plant for such large scale work.

Some entomologists hold that their function is to work with insects to the extent of determining their life history, habits, and such matters, and when this is accomplished their whole duty is done, and the facts obtained should then be turned over to other hands to bring to a practical conclusion. For these the name "economic entomologist" is a misnomer. We can not be content until the thing is accomplished toward which all our energies are directed, namely, the decrease of the loss due to insects.

It is not enough to find out how the loss can be prevented. It is necessary to demonstrate this to the farmer in such a way that it shall become part of his regular practice. In no way can this be accomplished so well as by this cooperation in which the leading orchardists of a district, working under the direction and direct supervision of the investigator, succeed in saving their crops. They come into close touch with the experiments and profit by the failures as well as by the successes, for by their very nature experiments are not all successes.

The peach worm investigation proved to be eminently successful. The investigation began in January and the key to the problem was discovered before the first of March, so that it was possible to obtain results that year. Mr. Clarke, who was in charge of the experiments, addressed meetings of growers in various parts of the district and by the use of the local press made known the facts obtained by his laboratory experiments, and the recommendations based thereon appealed to the good sense of the growers to such an extent that nearly 90 per cent of the acreage in peaches were sprayed as directed; this includes the orchards under the immediate control of Mr. Clarke for experimental purposes.

But it is not necessary to go into further detail, for the results are known to you through the publications of our station.

We did not know at the time how complete a victory had been secured until the season advanced toward picking time, and the insect was followed with the greatest care and with the expectation of continuing the attack, but the spring operations had accomplished all that could be desired.

The loss had been reduced where the spraying was well done and all conditions favorable to an amount below 1 per cent in orchards which the year before had suffered to the extent of half the crop.

It is not often that such results can be secured with so little effort, and, under ordinary experimental conditions, it would have required years to introduce the treatment as an established practice. In this case the attitude of the peach grower changed from helplessness to confidence, and the past season, without any supervision from the station, they have been able to entirely duplicate last year's results. The insect has changed from the worst pest in this region to one of the least.

Other cooperative investigations have been conducted in Los Angelos, Sutter, Yuba, Stanislaus, Marin, Santa Cruz, and Monterey counties. Most of these have been comparatively small studies, but one, that of the Pajaro Valley on the codling moth, now nearly concluded, has involved the expenditure of $2,750 contributed by the locality, the use of several hundred acres of bearing orchards, the losses in some of which, through unsuccessful spraying experiments, has probably equaled the direct contribution of funds. This does not include the cost of spraying, which was borne by the orchardists the same as other cultural operations.

The problems presented by this investigation were very much more difficult to handle, and will have to be continued through another season at least before they can be satisfactorily settled, but much has been learned which will be discussed in a series of bulletins, the first of which is about to be published.

Some of the results of the studies upon the cause of the spotting of oranges, which were supposed to be due in some cases to red spider and in other cases to distillate spraying, have already appeared in bulletin form, as well as the study of the red spider attacking almonds. The other investigations are still under way and represent quite a variety of problems, some of which may never yield results of much significance.

The demands for assistance have been very pressing, and the difficulty has been to provide men for the purpose who are capable of conducting such studies. The plan has been to detail advanced students for this work, selecting such as have shown special aptitude for research work and who are reliable, and to so supervise their experiments that they will be saved from making the mistakes which, because of inexperience, they would be liable to do if working alone. This has involved a large amount of traveling—over 16,000 miles this season; but the results have justified the effort. These investigations have been particularly valuable because of the opportunity they have afforded of giving the students actual practice in entomological research under unusually favorable conditions.

When we are called upon for an investigation which we consider important enough and have a student available for the purpose, our policy has been to reply that we will place an assistant in the field, who will be paid by the station and work under direct supervision of the entomologist at Berkeley, in case they consider it important enough to pay the local expenses of the investigation.

These local expenses will ordinarily consist of the items of board, a room for laboratory, and generally the use of a horse and buggy. Microscopes and such laboratory apparatus are brought from Berkeley, and the people of the locality are always glad to offer without any special arrangement the use of orchards for experimental purposes, and the material and labor for whatever spraying apparatus may be desired.

The above sketch of the California system of cooperative work in entomology is presented with the thought that though it may not be applicable in its entirety in other regions, certain features of it, nevertheless, may be of value elsewhere.

C. M. Weed, of New Hampshire, gave a short description of his methods of keeping notes and storing specimens, showing samples of the boxes used. Other members took part in the discussion that followed.

The following paper by A. F. Burgess, of Ohio, was read:

The Necessity for Uniform Methods of Inspection and Treatment of Nursery Stock.

With the advent of the San José scale in some of the larger nurseries in the eastern States it became necessary to establish some system of inspection of growing stock in order to protect the horticulturist from having this pest introduced upon his premises on young trees or plants which he might buy. The reasons for such inspection were chiefly due to the rapidity with which this insect would multiply, its deadly effect upon the trees and plants attacked, and the almost entire absence of suitable remedies for its control. Fruit growers and nurserymen alike were anxious to keep their premises free from this pest, and enough public sentiment was soon aroused in many of the States to procure laws designed to prevent its introduction and to provide for the control of this insect. In most cases other dangerously injurious pests were specified in the laws, so that the scope of nursery inspection was considerably broadened from the original plan.

In order to prevent the dissemination and secure the control of any insect pest it is essential that the movement in that direction be attended with no delay, and that the work be placed in competent and experienced hands. Many of the States failed to pass the legislation necessary to provide for this work, and as a result they have been made the dumping ground for the diseased stock from other States which already had inspection laws, and the problem of control has become far more difficult than would otherwise have been the case. Promptness in dealing with this pest is imperative, and the horticultural interests are now reaping the harvest for having delayed action, and will continue to bear the burden of applying insecticidal treatment to orchards, the infestation of which might have been prevented had the work been provided for at the proper time.

With the passage of the inspection laws it became necessary to organize a force to carry on this line of work. In most cases this work was delegated to the State entomologist or the entomologists of the State experiment stations. In States where few nurseries existed the matter of inspection required but little time, but where the nursery interests were large it was necessary to perfect some system of inspection so that a careful record might be kept of each nursery from year to year. It was also necessary to thoroughly train men for this particular kind of work, which, of course, required time, careful selection, and thorough drilling.

Nearly all the laws relating to inspection require that an examination of each nursery and premises be made annually. They also provide that, if the nursery stock and premises is found apparently free from dangerously injurious insect pests and plant diseases, that the owner shall be given a certificate of inspection stating the facts. This places the responsibility for the condition of any nursery upon the party who is authorized to issue such certificates.

Freedom from injurious pests, and hence the value of a certificate of inspection, depends largely upon the party who makes the examination; hence it is desirable that the work should be carefully and systematically done and that the inspector should be a well-trained and a keen observer. In the early days of nursery inspection it is doubtless true that many nurseries were examined in a superficial manner which would not stand the test of nursery inspection as it has been developed at this time. Each year results in the adoption of more perfect methods, based upon previous successes or failures. On the whole this work has been highly beneficial to nurserymen in preventing the introduction and dissemination of infested stock, and has saved many times its cost to the fruit growers of the country.

Before discussing some of the methods employed by the division of nursery and orchard inspection of the Ohio State Board of Agriculture, it may be well to consider some of the principal sources from which nurseries may become infested with the San José scale. The location of the nursery premises will often determine to a large extent its liability to infestation. One of the most difficult phases of the nursery problem with which the inspector is called upon to deal is where the stock is grown in cities or towns, or adjoining neglected orchards. It has been the common practice among the owners of city lots to buy trees and shrubs in a promiscuous fashion from irresponsible agents and tree pedlars, and this has been the primary cause of the infestation of many districts in thickly settled communities. In cases where nursery grounds are in the immediate vicinity, it is a difficult problem to prevent the infestation of the growing stock, as many owners of such lots take very little interest in the condition of their trees, and the treatment which they apply is apt to be hastily or carelessly done. Neglected orchards also furnish a convenient breeding ground if this pest once becomes established, and as it is expensive to properly treat them, the problem of controlling the scale is a very serious one. Aside from nurseries that are located in such situations (and on the whole they furnish a very small percentage of the actual number of nurseries in Ohio), the principal cause of nursery infestation is undoubtedly due to the use of affected cuttings and buds in the propagation of young stock. It has been the policy of the writer for several years to advise and urge nurserymen nev. r to use buds, grafts, or scions in their nurseries unless they have been properly fumigated. In spite of this advice several cases have been found where stock had become quite seriously infested with the scale, the cause being directly traceable to the use of cuttings and buds taken from badly infested orchard several miles distant. It therefore becomes apparent that one of the duties of any nursery inspector should be to ascertain the source from which the buds and cuttings have been obtained and also to satisfy himself concerning their proper fumigation.

In order to test the effect of hydrocyanic-acid gas on the buds which were about to be set, the writer conducted a series of experiments during the summer of 1902. Peach buds were used for this purpose, as they were the most tender species obtainable at that time. It was found that a charge consisting of three-fourths of an ounce of potassium cyanid, three-fourths of an ounce of sulphuric acid, and 2¼ ounces of water to each 100 cubic feet of space was effective in killing the San José scale and did not injure the buds. They were exposed to the action of the gas for forty minutes. In fact, when the cyanid was used at the rate of 1 ounce to each 100 cubic feet no injury to the buds resulted if they were not exposed for a greater length of time. The effect of the gas upon the scale was tested by fumigating badly infested apples at the same time with bud sticks. Dipping the bud sticks for fifteen minutes in whale-oil soap mixture, when used at the rate of 2 pounds of soap to each gallon of water, does not prevent the buds from developing, but renders them unpleasant to handle and more difficult to set in the seedling trees. This method is less satisfactory than fumigation, as it can not be depended upon to kill all of the old female scales. From these experiments it will be seen that any nurseryman can prevent the introduction of the San José scale into his plantings upon buds, grafts, and scions, by carefully fumigating before using them on his premises.

It is the custom in Ohio to examine the trees row by row in the smaller nurseries, taking advantage of the direction in which the sun is shining. A careful examination can not be made without inspecting the trees near the ground, for if any infested buds or grafts have been brought into the nursery the scale will be most abundant at the point where the budding or grafting took place. Inspection of nursery stock is a laborious task, and no man can become a successful inspector who is not willing to bend his back or who is afraid that his clothes may become soiled from the contact with the dirt. Only a general inspection is made of seedling stock and 1-year-old grafts, which are to remain on the premises and are not to be offered for sale. The next annual inspection of such stock is very thoroughly made in order to ascertain its condition. One of the greatest difficulties encountered in nursery inspection is in properly examining peach trees. These are rapid growers, and if the inspection is made early in the summer the trees are usually well covered with foliage, so that it is very difficult to examine them closely. In cases where any suspicion is aroused that they may be infested a reexamination is made later in the season, after the trees have been trimmed. In the large nurseries, where it is impossible to make a row-by-row examination, the method followed is for the inspector to pass back and forth across the blocks, examining the trees on either hand. It is customary to cross them at intervals of about 15 feet, and in this way all the varieties are examined. In case any infested trees are found a tree-by-tree examination is made.

Great care should be taken to examine carefully the packing and heeling-in grounds and the nursery premises, and special attention should be given to such surplus stock as is allowed to remain after the packing season is over.

It is, however, beyond the realm of human possibility for any man to say that a nursery is absolutely free from the San José scale, no matter how thoroughly the examination may have been made, and this is the principal defect in the present system of nursery inspection.

It is also well-nigh impossible to detect infestation with woolly aphis or infection by crown gall, as an examination of the roots is usually necessary; hence, nurserymen are instructed, under penalty of having their certificates revoked, not to ship trees having roots affected by these pests.

Doubtless the methods thus far indicated are, in the main, used by all nursery inspectors; hence, very few suggestions as to uniformity can be made.

The system of keeping reports of inspection must vary with the local necessities, based on the judgment of the inspector in each State. Such reports should be made on blanks that can be filed systematically, so that the condition of any nursery can be easily determined.

It is the policy of the majority of the States to accept an official certificate of inspection from another State inspector at its face value. Several of the western States require that all stock which is shipped in shall be examined by the local inspectors before it is planted, and the Dominion of Canada has adopted the rule of fumigating all stock from without at certain specified points of entry.

Alabama, Georgia, and Virginia have enacted laws providing that no stock from outside the State shall be delivered within their borders, unless it is accompanied with a valid certificate of inspection, together with an official tag issued by the State entomologist. This is an additional precaution designed to assure the State entomologist that the certificate of an outside nurseryman is satisfactory before tags are issued allowing him to do business in the State.

Several States require that all nonresident nurserymen shall secure a license before being allowed to transact business within their State, it being granted after the presentation of a satisfactory certificate of inspection and the payment of a definite fee. Some strong arguments are put forth in favor of a tag system, and it has undoubtedly been of considerable value in the States where it is in use; still it would appear that the universal adoption of the system would be a source of confusion to the larger nurserymen who do business in many States, and it would make the situation far more complex than it is at present.

Owing to the fallibility of certificates of inspection, based on the fact that occasional infested shipments are received, several States have provided, either by legal enactments or by official regulations, that all stock received from outside nurseries must be fumigated before it is planted.

This applies in Connecticut, Georgia, Michigan, New York, Idaho, and Utah. The last two require that an official certificate of fumigation shall be attached to each shipment.

Properly conducted fumigation is a very satisfactory way of treating stock; the chief essentials are that the house shall be gas tight, the chemicals of high grade, and applied in the proper proportions for a sufficient length of time to kill the scales without injuring the stock. Failure to observe any one of these details is likely to cause the treatment to be unsatisfactory; hence, great care is necessary in applying this process. The recommendations for fumigation issued by most of the State inspectors are uniform as to the first two essentials, but a wide variation occurs in the formula advised and the length of time required for treatment.

In a few cases the charges required to be used are fixed by law, but it is doubtless fair to presume that most of them are either copied or modified forms of the formula recommended by the Division of Entomology of the U. S. Department of Agriculture, or are based on the extensive fumigation experiments of Prof. W. G. Johnson.

The one recommended by the Division of Entomology, and which may be called the 1, 1, 3 formula, that is, one ounce of potassium cyanid, one fluid ounce of sulphuric acid, and three fluid ounces of wate to each 100 cubic feet of space, for a time exposure of forty minutes, has been used since 1900 by the government inspectors of the Dominion of Canada, and I am informed by Dr. James Fletcher, the Dominion entomologist, that it has given perfect satisfaction. This formula has been used in Ohio for nearly two years in fumigating all kinds of nursery stock, and no complaint has been received of any injury to the stock. In the case of the fumigation of bud sticks or scions during the summer, three-fourths of the amounts of cyanid and acid have been advised, although no injury has resulted if the full strength formula was applied forty minutes.

Through the courtesy of the inspectors or officials having charge of nursery inspection, the writer has received a statement of the formula recommended or required in twenty-seven States.

In fourteen States the proportions recommended vary so slightly from the 1, 1, 3 formula that very little change would be necessary in order to make them perfectly uniform.

California and Oregon recommend a 1, 1, 2 formula with forty minutes' time exposure. Virginia recommends a 1, $1\frac{1}{5}$, 3 formula with forty minutes' time exposure. Georgia, Kentucky, and Illinois use a 1, $1\frac{1}{4}$, 3 formula with a fifty-minute exposure, while the formula required in Alabama is the same with an exposure of forty-five minutes. New York requires a 1, $1\frac{1}{2}$, 3 formula with an exposure of from thirty to forty-five minutes.

Connecticut, Pennsylvania, and West Virginia use a 1, 2, 4 formula with a thirty-minute exposure, and the same amount of chemicals are used in New Jersey, but the time is lengthened to sixty minutes.

In North Carolina a 1, $1\frac{1}{4}$, $2\frac{1}{2}$ formula, and in Delaware and Montana a 1, $1\frac{1}{2}$, $2\frac{1}{4}$ formula is required.

In the remaining twelve States the proportions vary from a $\frac{2}{3}$, $\frac{2}{3}$, 2 formula for 150 cubic feet for a forty-minute exposure to one where 2 ounces of cyanid are used for the same amount of space and the stock exposed three hours.

Several States have adopted a formula based on the metric system, and as the proportions used vary considerably, this would not appear to be a step in the direction of securing uniformity.

In a number of cases the charges are reduced from one-fourth or one-third the required formula for the treatment of peach, plum, and tender stock.

It is unquestionably true that fumigation is destined to become more important in nursery inspection work than it has been in the past, and doubtless more States will be added to the list of those that require a certificate of fumigation on all stock that is shipped in from other States. This being the case, it would appear most desirable that a standard formula be adopted, as it would seem inconsistent for an inspector to require a definite formula used in his own State and still accept stock from other States fumigated in a manner that he would not permit at home.

As pointed out by Dr. S. A. Forbes in his address at the last annual meeting of this section, nursery inspection "legislation has not yet reached its permanent form, but is still in process of adaptation and development." This being the case, every reasonable effort should be made to secure uniformity of methods as a means of facilitating the administration of the work of protecting the fruit growers from injurious pests and of aiding and not hampering the nurseryman in the conduct of his business.

It was informally agreed to defer the discussion of this paper to the meeting of the Association of Horticultural Inspectors.

The following officers were elected for the next meeting, chairman, H. E. Summers, Iowa; secretary, W. E. Britton, Connecticut.

The section then adjourned.

SECTION ON MECHANIC ARTS.

No sessions of this section were held.

SECTION ON EXPERIMENT STATION WORK.

Two meetings of this section organized under the amended constitution were held November 18 and 19, 1903.

The section was called to order by the secretary of the association and effected an organization by the election of E. B. Voorhees as temporary chairman, and H. P. Armsby as temporary secretary.

On motion of C. D. Woods, it was voted that a committee of five be appointed by the chair to recommend to the section what officers, if any, be elected in addition to those provided for in the constitution, and to present nominations for all officers, including the two members of the executive committee. The chair appointed as this committee C. D. Woods, of Maine; H. J. Patterson, of Maryland; W. M. Liggett, of Minnesota; H. T. French, of Idaho, and R. J. Redding, of Georgia.

The following resolution, offered by W. H. Jordan, of New York, was unanimously adopted:

Resolved, That a committee of five be appointed by the chairman to report to this section, during the present session of the association, recommendations for the organization of the work of this section.

The chairman appointed as such committee H. P. Armsby, of Pennsylvania; C. F. Curtiss, of Iowa; C. E. Thorne, of Ohio; J. L. Hills, of Vermont, and B. W. Kilgore, of North Carolina.

The committee appointed to consider the question of officers for the section reported, recommending that the officers consist of a chairman, a secretary, and a standing committee of three on programme, of which the secretary of the section shall be ex-officio chairman. This report was adopted.

The same committee also reported the following nominations:

For members of the executive committee, W. H. Jordan, of New York, and C. F. Curtiss, of Iowa.

For chairman of the section, E. H. Jenkins, of Connecticut.

For secretary of the section, M. A. Scovell, of Kentucky.

For committee on programme, the secretary ex-officio, J. H. Shepperd, of North Dakota, and B. W. Kilgore, of North Carolina.

Upon motion the secretary of the section was authorized to cast the ballot of the section for these nominations, which was done, and they were declared duly elected.

The committee appointed to consider the organization of the work of the section reported as follows:

Your committee has been directed to report recommendations for the organization of the work of this section. A necessary preliminary to this is a clear conception of what that work is. The newly adopted constitution broadly designates the section as the "Section on Experiment Station Work." Your committee interprets this phraseology to mean, in the first place, that it is the function of this section to consider all phases of station activity, including on the one hand those administrative questions which concern the relations of the station to the public, to the institution of which it forms a part, and to the United States Department of Agriculture, and of the various departments of the station to each other; and, on the other hand, that it is no less its work to discuss methods and appliances of research in all the varied departments of agriculture in its broadest sense.

In the second place, we understand that the new constitution contemplates the discussion of all these questions by a single section, having, indeed, authority to subdivide if it should seem expedient, but still essentially one organization. In the past, questions relating to research in agriculture have, at various times, been considered in from two to five different sections, often meeting simultaneously, while no definite provision has existed for the discussion of the specific administrative questions which confront the stations. There is now substituted for this state of things a single gathering of station workers, to which chemist and botanist, agronomist, zootechnist, and entomologist, as well as director, may each bring his contribution and where each may profit by the broader view thus secured of the relation of his specialty to the work as a whole. We look upon this unification as a very important advance and as affording a great opportunity for promoting the efficiency of the experiment-station enterprise.

Guided by these considerations, your committee submits the following recommendations:

(1) That the section do not, for the present, subdivide.

(2) That two general classes of questions be considered at meetings of the section, viz: (a) Questions of station administration. (b) Methods and appliances for investigation.

(3) That meetings of the section be not regarded as the place for the presentation of results of experiments or for the reading of general papers.

(4) That, as regards the second class of questions, the programme for any one convention include but one general line of work, to be selected by the section at the previous convention upon recommendation of the committee on programme, provided that the committee on programme may recommend the addition to the programme thus provided for of special topics of unusual interest.

The section has already wisely provided, on recommendation of another committee, for a committee on programme. It is obvious that the success of the section will largely depend upon the work of this committee, and we believe there is a general feeling that in some way an element of permanence and continuity should be given to the committee on programme. In this present formative stage of the matter, however, it seems to us that the section might wisely content itself with a general recognition of the principle involved, leaving the practical application to be worked out in the light of future experience.

On motion the report of the committee was adopted.

After an informal discussion by the section of the selection of a subject for the meeting of the section at the next convention, the matter was referred to the committee on programme, with the understanding that it make an early report.

The section then adjourned.

INDEX OF NAMES.

O

THE AGRICULTURAL EXPERIMENT STATIONS.

ALABAMA—
  College Station: *Auburn;* J. F. Duggar.[a]
  Canebrake Station: *Uniontown;* J. M. Richeson.[a]
  Tuskegee Station: *Tuskegee;* G. W. Carver.[a]

ALASKA—*Sitka:* C. C. Georgeson.[b]

ARIZONA—*Tucson:* R. H. Forbes.[a]

ARKANSAS—*Fayetteville:* W. G. Vincenheller.[a]

CALIFORNIA—*Berkeley:* E. W. Hilgard.[a]

COLORADO—*Fort Collins:* L. G. Carpenter.[a]

CONNECTICUT—
  State Station: *New Haven;* E. H. Jenkins.[a]
  Storrs Station: *Storrs;* L. A. Clinton.[a]

DELAWARE—*Newark:* A. T. Neale.[a]

FLORIDA—*Lake City:* T. H. Taliaferro.[a]

GEORGIA—*Experiment:* R. J. Redding.[a]

HAWAII—
  Federal Station: *Honolulu;* J. G. Smith.[b]
  Sugar Planters' Station: *Honolulu;* C. F. Eckart.[a]

IDAHO—*Moscow:* H. T. French.[a]

ILLINOIS—*Urbana:* E. Davenport.[a]

INDIANA—*Lafayette:* A. Goss.[a]

IOWA—*Ames:* C. F. Curtiss.[a]

KANSAS—*Manhattan:* J. T. Willard.[a]

KENTUCKY—*Lexington:* M. A. Scovell.[a]

LOUISIANA—
  State Station: *Baton Rouge.*
  Sugar Station: *Audubon Park, New Orleans.*
  North Louisiana Station: *Calhoun;* W. C. Stubbs.[a]

MAINE—*Orono:* C. D. Woods.[a]

MARYLAND—*College Park:* H. J. Patterson.[a]

MASSACHUSETTS—*Amherst:* H. H. Goodell.[a]

MICHIGAN—*Agricultural College:* C. D. Smith.[a]

MINNESOTA—*St. Anthony Park, St. Paul:* W. M. Liggett.[a]

MISSISSIPPI—*Agricultural College:* W. L. Hutchinson.[a]

MISSOURI—
  College Station: *Columbia;* F. B. Mumford.[c]
  Fruit Station: *Mountain Grove;* P. Evans.[a]

MONTANA—*Bozeman:* F. B. Linfield.[c]

NEBRASKA—*Lincoln:* E. A. Burnett.[a]

NEVADA—*Reno:* J. E. Stubbs.[a]

NEW HAMPSHIRE—*Durham:* W. D. Gibbs.[a]

NEW JERSEY—*New Brunswick:* E. B. Voorhees.[a]

NEW MEXICO—*Mesilla Park:* L. Foster.[a]

NEW YORK—
  State Station: *Geneva;* W. H. Jordan.[a]
  Cornell Station: *Ithaca;* L. H. Bailey.[a]

NORTH CAROLINA—*Raleigh:* B. W. Kilgore.[a]

NORTH DAKOTA—*Agricultural College:* J. H. Worst.[a]

OHIO—*Wooster:* C. E. Thorne.[a]

OKLAHOMA—*Stillwater:* J. Fields.[a]

OREGON—*Corvallis:* J. Withycombe.[a]

PENNSYLVANIA—*State College:* H. P. Armsby.[a]

PORTO RICO—*Mayaguez:* F. D. Gardner.[b]

RHODE ISLAND—*Kingston:* H. J. Wheeler.[a]

SOUTH CAROLINA—*Clemson College:* P. H. Mell.[a]

SOUTH DAKOTA—*Brookings:* J. W. Wilson.[a]

TENNESSEE—*Knoxville:* A. M. Soule.[a]

TEXAS—*College Station:* John A. Craig.[a]

UTAH—*Logan:* J. A. Widtsoe.[a]

VERMONT—*Burlington:* J. L. Hills.[a]

VIRGINIA—*Blacksburg:* J. M. McBryde.[a]

WASHINGTON—*Pullman:* E. A. Bryan.[a]

WEST VIRGINIA—*Morgantown:* J. H. Stewart.[a]

WISCONSIN—*Madison:* W. A. Henry.[a]

WYOMING—*Laramie:* B. C. Buffum.[a]

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[a] Director. [b] Special agent in charge. [c] Acting director.