in the same column and have the same atomic *number,* but that their atomic *weights* differ by 4. Such substances have chemical properties so identical that they are called inseparables, or non-separables, or isotopes, for they occupy the *same* place in the periodic table. Thus the old trouble of finding places in the periodic table for the thirty or forty radiant elements has suddenly vanished. They may be superposed even when their atomic *weights* differ, if their atomic *numbers* are the same. The nuclear charges of isotopes must be identical, but the distribution of electrons may be different. Other examples of inseparables are:

Lead, radium B, Radium D, all 82.

Thorium and radiothorium.

Radium and mesothorium.

If these views are distasteful to chemists let them discover some means of the separation of the known isotopes.

It must be further noted that the results of radiochemistry appear to require the presence of negative electrons in the nucleus itself. The expulsion of a β particle, or one negative electron, from the nucleus is equivalent to the gain of one positive electron, and involves a unit increase in the atomic number.

14. The last advance is the most important and far-reaching. There has been long search for the positive electron, and in vain; yet it seems likely that it has been under our eyes all the time. Since the hydrogen atom never loses more than a single electron, is it not possible, suggests Rutherford, that the nucleus of the hydrogen atom may be the positive electron?

The electro-magnetic mass of an electron is $\frac{2}{3}\frac{a}{e^2}$ where e is the charge and a the radius. If the mass of the hydrogen nucleus is wholly electro-magnetic, then its radius must be smaller than that of the electron (negative) as 1:1800, for that is the ratio of their masses, while their charges are equal and opposite. Hence we have

	Mass	Diameter
Atom	1	10^{-8} cm.
Negative electron	1/1800	10^{-13}
Positive electron	1	10^{-16}

Rutherford cautiously remarks that there is no experimental evidence against such a supposition.

Those who wish to follow the matter deeper must refer to many articles in the *Philosophical Magazine,*[3] several letters to *Nature,* Soddy's "Chemistry of the Radio-elements," part II., and Perrin's "Les Atomes." The chief writers have been Rutherford, W. H. Bragg, W. L. Bragg, G. C. Darwin, Moseley, Broek, Bohr, Russell, Fajans, Soddy, Hevesy, Nicholson and Mardsen.

Much has yet to be done, and much to be revised, but that the first great forward strides have been taken in the right direction there can be little doubt.

A. S. EVE

MCGILL UNIVERSITY,
May, 1914

STATISTICS OF CROPS

DEGREE OF ACCURACY OF THE REPORTS OF THE BUREAU OF STATISTICS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

IN the March 28, 1913, number of SCIENCE, Dr. C. G. Hopkins gives a discussion of this topic under the title of "Facts and Fiction about Crops." The Department of Agriculture is accused of "condemnable inflation of crop statistics." The writer does not believe that such a conclusion would be reached if the reports were more carefully studied.

He shows the percentage of error to be very great when the Bureau of Statistics estimates of corn in the southern states are compared with the census report. If the error is due to wilful deception, we should expect to find the

same over-statement in the important corn states.

The largest error is in the case of Louisiana, where the Bureau of Statistics report of corn is 97 per cent. above the census report for 1909, being an error of 25 million bushels, but the crop of Iowa was underestimated by 52 million bushels. The corn crop of the United States was overestimated by 9 per cent. But a careful study of the methods of enumeration makes this error less conclusive. By the census method of enumeration, corn grown for silage is unfortunately put with coarse forage crops. It ought to be enumerated separately. There were over four million acres of such crops, of which corn certainly made up the larger part. By the methods used by the Bureau of Statistics, much silage corn is doubtless included with other corn. It is probable that this would reduce the error to 5 or 6 per cent.

A study of Table I. shows that of the thirteen crops reported, the production was underestimated on six crops, overestimated on six crops and practically correct on one crop. Of the six most important American crops, three, hay, cotton and potatoes are underestimated, oats were correctly estimated, while only two, corn and wheat were overestimated. Certainly there is no indication of wilful exaggeration. The most serious error is in the underestimate of the hay crop. Census reports include salt-marsh hay and all wild hay. It is probable that many crop reporters do not consider any of this as hay except that portion that is used for stock food. But even making an allowance for this difference, it is certain that the Bureau of Statistics reports are too low.

Careful study of Table I. and of the reports for individual states indicate that the errors in individual states may be very large, but that the results for the United States are accurate enough to be very useful.

The percentage error is most likely to be high in states that grow little of the crop. The same is true of census reports. The error is also likely to be large in regions that are making the largest change in the area or yield of the crop.

The errors are the result of cumulative

TABLE I

COMPARISON OF CENSUS AND YEAR-BOOK REPORTS OF CROPS IN THE UNITED STATES IN 1909[1]

Yields of grain are given in bushels, hay in tons, cotton in bales, tobacco and hops in pounds.

	Acreage			Production			Yield Per Acre		
	Census Report	Year-Book	Per Cent. Error	Census Report	Year-book	Per Cent. Error	Census Report	Year-book	Per Cent. Error
Corn	98,382,665	108,771,000	11	2,552,189,630	2,772,376,000	9	25.9	25.5	−2
Wheat	44,262,592	46,723,000	6	683,379,259	737,189,000	8	15.4	15.8	3
Oats	35,159,441	33,204,000	−6	1,007,142,980	1,007,353,000	0	28.6	30.3	6
Barley	7,698,706	7,011,000	−9	173,344,212	170,284,000	−2	22.5	24.3	8
Rye	2,195,561	2,006,000	−9	29,520,457	32,239,000	9	13.4	16.1	20
Buckwheat	878,048	834,000	−5	14,849,332	17,438,000	17	16.9	20.9	24
Potatoes	3,668,855	3,525,000	−4	389,194,965	376,537,000	−3	106.1	106.8	1
Hay and forage	72,280,776	——	—	97,453,735	——	—	1.35	—	—
Hay	62,784,663[2]	45,744,000	—	80,302,526[2]	64,938,000	—	1.28[2]	1.42	—
Cotton	32,043,838	30,938,000	−3	10,649,268	10,004,949	−6	0.33	0.32	−3
Tobacco	1,294,911	1,180,000	−9	1,055,764,806	949,357,000	−10	815.3	803.3	−1
Flaxseed	2,083,142	2,742,000	32	19,512,765	25,856,000	33	9.4	9.4	0
Rice	610,175	720,000	18	21,838,580	24,368,000	12	35.8	33.8	−6
Hops	44,693	——	—	40,718,748	36,000,000	−12	911.1	—	—

[1] Year-book reports are from the Year-book of the United States Department of Agriculture for 1909 except the acreage of cotton, which is as reported in the 1910 Year-book. The production of cotton is the estimate as reported by the Bureau of the Census in the 1910 Year-book.

[2] The Census report for grasses, clover and alfalfa. These figures may not be exactly comparable with hay as reported by the Bureau of Statistics.

errors. It is unfortunate that the Bureau did not adjust its figures to the census basis in 1899. This has been done since 1909 so that we may expect a much smaller error in the future as the error will be corrected at each census year.

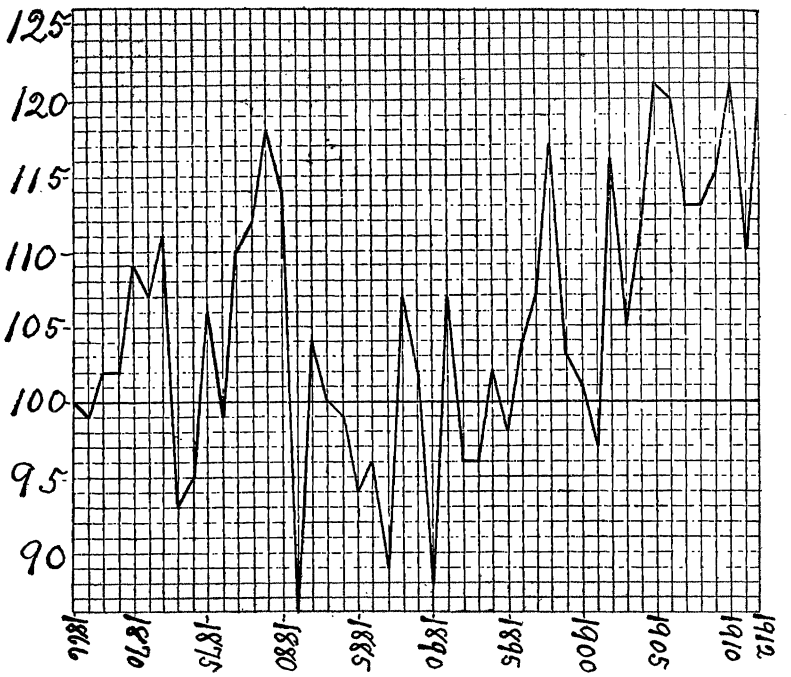

FIG. 1.

Comparative crop yields for the United States east of the Mississippi River. Yield of 1866 considered as 100 per cent.

The writer believes that the accuracy of the reports could be greatly increased if there were added to the present method of reporting a system of reports by farmers on actual areas grown and yields received. If the Bureau of the Census could send a large number of letters to farmers each winter asking for the area of the farms, area of each crop grown and total yield, these reports could be compared with reports from the same farms for previous years. The changes in areas of farms, failures of some men to report and other problems involved, would not, in the writer's opinion, be at all insurmountable. This information would allow the final report for each year to be corrected so that the error from year to year would not be cumulative.

ARE OUR CROP YIELDS DECREASING?

In the same issue Dr. Hopkins discusses the question of crop yields. The conclusion is reached that for the ten years 1899 to 1909, *"An increase of 15.4 per cent. in farmed land with an increase of only 1.7 per cent. in production reveals the truth of reduced yield per acre."*

This conclusion is based on serious errors in the use of statistics. The production used is the total bushels of cereals. The acreage used is the area of improved land in farms. This land is not all farmed, much less is it all planted to cereals.

The census report states that

> Improved land includes all land regularly tilled or mowed, land pastured and cropped in rotation, land lying fallow, land in gardens, orchards, vine-

yards and nurseries, and land occupied by farm buildings.

TABLE II

States East of the Mississippi River

		All Cereals, Bu.	Corn, Bu.	Wheat, Bu.	Oats, Bu.	Hay and Forage, Tons	Cotton, Bales	Potatoes, Bu.
New England..	1879	28.0	34.5	15.5	32.7	0.96		109
	1889	29.7	38.6	19.1	30.7	1.09	.....	85
	1899	34.5	39.4	18.0	35.9	1.13	.....	130
	1909	36.2	45.3	23.5	32.9	1.23	.....	177
Middle Atlantic...	1879	23.4	33.1	14.1	28.5	1.10	.....	95
	1889	24.1	32.8	16.7	27.4	1.29	.....	70
	1899	25.3	34.0	14.9	30.9	1.19	.....	95
	1909	24.6	32.2	18.6	25.5	1.32	.....	107
East North Central...	1879	27.8	34.6	16.8	31.8	1.17		—
	1889	29.1	34.3	15.7	34.5	1.30	.....	91
	1899	31.5	38.3	12.9	37.4	1.22		85
	1909	32.7	38.6	17.2	33.3	1.38	.....	101
South Atlantic...	1879	11.8	13.3	8.8	9.9	0.84	0.35	—
	1889	12.5	13.7	10.3	10.8	1.09	0.35	70
	1899	13.0	14.1	9.5	11.7	1.02 −	0.39	77
	1909	15.1	15.8	11.9	15.5	1.02 +	0.45	92
East South Central...	1879	15.9	19.1	7.7	10.3	0.82	0.39 −	—
	1889	18.1	20.7	10.6	12.1	1.06	0.35	81
	1899	16.1	18.4	9.0	11.1	1.03 +	0.39 +	63
	1909	17.5	18.6	11.7	13.4	1.03	0.32	82

States West of the Mississippi River

West North Central...	1879	26.8	37.4	10.6	28.9	1.32	.....	—
	1889	29.1	36.4	13.2	30.9	1.26	.....	90
	1899	24.8	31.4	12.2	32.0	1.34	.....	95
	1909	23.1	27.7	14.9	27.5	1.33	.....	92
West South Central...	1879	13.4	14.0	6.6	17.0	0.82	0.47	—
	1889	20.0	20.9	10.6	20.2	1.35	0.41	73
	1899	20.6	21.9	11.9	25.8	1.48	0.39	67
	1909	15.9	15.7	11.0	21.4	1.03	0.27	63
Mountain...	1879	21.1	16.6	18.8	28.9	1.13	.....	—
	1889	21.3	14.4	20.0	27.8	1.36	.....	69
	1899	22.4	16.5	19.2	30.4	1.59	.....	113
	1909	26.5	15.8	23.1	34.9	1.73	.....	143
Pacific.....	1879	18.6	27.1	16.3	30.5	1.45	.....	—
	1889	17.3	30.2	15.0	28.4	1.49	.....	95
	1899	18.7	25.2	15.6	31.4	1.44	.....	129
	1909	21.7	24.0	17.7	35.3	1.73	.....	131

United States

	1879	22.7	28.1	13.0	25.3	1.15	0.40	—
	1889	25.1	29.4	13.9	28.6	1.26	0.37	84
	1899	24.0	28.1	12.5	31.9	1.28	0.39	93
	1909	23.6	25.9	15.4	28.6	1.35	0.33	106

If the area of cereals bore a constant ratio to all improved land, the final conclusion might have been correct in spite of the error in method used, but this is far from the case. Other crops have increased much more rapidly than cereals. The area of cereals increased 3.5 per cent., and other crops increased 22 per cent., in ten years.

The truth is that the area of cereals harvested increased 3.5 per cent. (not 15.4 per cent.) while the bushels of cereals increased 1.7 per cent.

Another serious error involved is in the use of figures for the entire United States. A large amount of arid land in the Dakotas, Nebraska, Kansas, Oklahoma and Texas that was not farmed in 1899 is now planted to crops and lowers the average yields for the entire country.

Nor is it safe to use total bushels of cereals as a measure of production. The normal yields of oats and wheat in bushels are not the same and the proportion of land planted to each is very far from constant.

In order to study the question, we must deal with the individual crops grown in some particular region. The accompanying table gives such a comparison with the states grouped by the method used in the last census. The production of cereals in bushels and averages for the United States are included for comparison with the article by Hopkins, although the writer does not consider either of these figures safe ones to use, for reasons given above. The yield of hay and forage shows a decided increase, but again this is made up of a number of crops whose normal yields are different, so that a shift in kind of crop changes the yield.

In the states east of the Mississippi River, comparatively little new land has been added to farms in the last twenty years. For this reason these states are the ones that give the best information as to changes in crop yields.

The highest yield of cereals ever reported by the census for New England, the East North Central, and South Atlantic, states is the crop of 1909. In the Middle Atlantic states, the highest yield ever reported is for 1899 with

1909 second. In the East South Central states 1889 is first with 1909 second.

The Corn Crop.—The highest yield per acre of corn reported by the census for Illinois, Indiana, Ohio, is for 1909. The total for all states east of the Mississippi River gives 1909 as the highest yield, but in some of the groups of states there have been better yields. The fact of a lower yield for the entire country in 1909 is not, therefore, as is commonly stated, due to a decrease in yields in the older states.

Wheat.—The highest yield of wheat reported in any census year is for the year 1909, with an average of 15.4 bushels. The nearest competition was the year 1889, when the yield was 14 bushels. The year 1909 is the best year ever reported in each of the groups of states except in the West South Central.

Oats.—In the New England, Middle Atlantic and East North Central states, the best oat yield reported by the census is for 1899. For the southern states east of the Mississippi, the best year reported was 1909.

Hay and Forage.—The highest yield per acre of hay and forage ever reported is for the year 1909. As stated above, this figure should not be given too much weight, because shifts in acreage of the different kinds of crops in this collective group might affect the result.

Potatoes.—The highest yield per acre of potatoes ever reported by the census is the last report. This is true for each of the groups of states east of the Mississippi River. The only groups that show a decrease are the West North Central and West South Central.

Cotton.—The old South Atlantic states reported by far their best cotton crop for the year 1909. The best report from the East South central states is for 1899. The cotton yield per acre for the entire United States was lower in 1909 than in any other census year, but this is in spite of high yields in the old Atlantic states. The area of cotton in the United States increased nearly one third in the ten years. This increase was mostly due to extending the crop on arid lands and on other lands that were considered too poor to farm ten years before. The West South Central states, where most of the new arid land has been added, have shown a steady decrease in yield. Oklahoma increased its area by 190 per cent., but production increased only 146 per cent. Low yields in Oklahoma should not be charged to soil exhaustion in Georgia. The poor results in Texas and some of the other neighboring states are also partly due to the boll weevil as well as to season and soil.

Considering the above five different regions east of the Mississippi River and the six important crops, corn, wheat, oats, hay and forage, cotton and potatoes, we find the following:

Number of instances of first rank in crop yield:

1879	*1889*	*1899*	*1909*
0	3	5	19

These figures show very strikingly the general increase in crops in later years in these older states.

For the West North Central and West South Central groups, there is only one instance in which the 1909 yield is the best. In these states there appears to be a general decrease in production. This difference is primarily due to the bringing in of arid land that was not formerly used. The Mountain and Pacific states show a general increase in yields.

REPORTS BY THE BUREAU OF STATISTICS

A better method of comparing crop yields is on the basis of the reports by the Bureau of Statistics because these yields are secured for every year. The amount of rainfall in any particular year makes the figure for a single year inconclusive.

As has been previously shown, the Bureau of Statistics estimates the yields of the important crops with a fair degree of accuracy. The yield per acre of corn for 1909 was estimated at 2 per cent. less than the census results. The yield per acre of wheat was 2 per cent., oats were 6 per cent. and potatoes 1 per cent. higher than census returns.

Fig. 1 shows the comparative yields of corn, wheat, oats, barley, rye, buckwheat, potatoes and hay in states east of the Mississippi

River based on the 1866 yield as 100 per cent. The comparative yields of each crop, considering the 1866 crop as 100 per cent., were calculated. These percentages were weighted according to the area planted to the crop in order to secure a percentage representing the yield of that year.

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Cornell University

STANFORD UNIVERSITY MEDICAL SCHOOL

Dr. Victor C. Vaughan, dean of the department of medicine and surgery of the University of Michigan, has made, under date of June 9, 1914, the following report to Dr. J. C. Branner, president of Leland Stanford Junior University:

In compliance with your telegraphic request I have visited Palo Alto and San Francisco and inspected the libraries, laboratories and hospitals of Stanford University. The laboratories of chemistry (general, physical, inorganic, organic and physiological), biology, histology, neurology and physiology are well housed, adequately equipped and exceptionally well manned. In all these, high grade work is being done. The laboratories of bacteriology and anatomy need better housing and I understand that this is to be provided in the near future. But in the buildings now occupied, most excellent work is being done. In fact each of the scientific departments at Stanford is under the direction of an eminent man supplied with able and enthusiastic assistants and with necessary equipment. There is abundant evidence even in a hasty inspection that the appropriations have been economically and wisely expended and that good work is being done both in instruction and in research. I wish to compliment the trustees and president upon the evident wisdom which they have displayed in the development of these departments of the university. What I have said of the scientific branches is equally true of the other departments of Stanford University. Although one of the youngest of the higher institutions of learning in this country Stanford ranks as one of the best in all departments, both scientific and humanistic. In all branches it represents the highest aims and ideals. While I am not fitted to express anything more than a general opinion as to other than scientific education I wish to emphasize the fact that all learning is one and the same spirit should pervade the whole. This I believe to be true at Stanford. It furnishes a wholesome atmosphere in which the student can grow whatever special line of training he may follow later. The greatest need of our country is the man whose fundamental knowledge is broad and comprehensive and whose special training is exact. No man can have useful knowledge of a part unless he has general knowledge of the whole. The working of the part must be in harmony with the movements of the whole; otherwise disaster is the result. While I am especially interested in medical education, I recognize the fact that it is futile to try to develop a good medical man out of one whose fundamental training has not been sound. The young man who has learned to work with the right spirit, whether it be in Greek or biology, in philosophy or chemistry, will enter medicine, law or any profession in the right frame of mind and will be likely to prove an honor in his chosen profession. In his preliminary college training the prospective medical student should not be confined to the physical or biological sciences. It is desirable that he know the classics, history and philosophy and it is most desirable that the training that he gets along these lines should be of the highest grade. I believe that Stanford University furnishes suitable conditions for the development of the young man who is going into medicine. Therefore I hope that the medical work done at Palo Alto may continue. If the medical school should be closed, this would relieve Stanford of only one of the laboratories at Palo Alto. Physics, chemistry, biology, physiology, histology, embryology, neurology and bacteriology must be taught and research work in these branches must be done in a university of the high rank Stanford holds. Closing the medical school would give only trifling financial relief to the university. I therefore recommend that the premedical and medical work now done at Palo Alto be not only continued but be developed as fast as the finances of the university permit. I make this recommendation not only for the good of the medical school, but, as I believe, in the interest of the university as a whole. If the medical department should be discontinued, anatomy is the only subject which could be dropped at Palo Alto and even then this should not be done. Anatomy is one of the great and fundamental biological sciences and even human anatomy should be taught in a great scientific university. Anatomy is no longer taught as a mere foundation for medicine and surgery. It includes the development of structure from the lowest to the highest forms of life.