account of the apparatus. Practically no apparatus has been lost in years. Each student on opening the apparatus locker must check over the pieces and report anything missing or broken. If such a report is made, the responsible student is located at once by consulting the records of the previous section. The use of inked data sheets also helps to reduce temptation. The paper of the data blank is such that any erasure of the ink is detected at a glance. The student is further deterred from dishonesty because of the knowledge that the instructor has a copy of the original data.

The "doctoring of results" by students is due to their desire to secure a better grade. With this thought in mind, a procedure has been established minimizing the credit given for the data taken, and magnifying the other parts of the experiment. The actual grading is made up according to the following values: neatness and condition of place of working 10 points, diagram of apparatus 5 points, method of working 10 points, theory of experiment and answers to questions 40 points, data taken 35 points, with a total of 100. A form printed on the cover shows the amounts allowed for each part of the work, so that the student can see where he is deficient. The method of grading the data is such that very accurate results are not required. Average results are not severely graded, so that a student learns he will not suffer severely if his observations are those of average conditions. The practise of requiring very accurate results with the penalty of a repetition of the experiment when the data shows a departure from these required results, encourages the practise of "doctoring data." The present plan of placing the credit on the *interpretation* of the results seems better in theory and is found more satisfactory in practise. Of course work that is careless or very poor must be repeated, and for the first few weeks of the course a considerable number are required to repeat or to rewrite work. Excellent work is encouraged by marking it with exceptional grades.

It is realized that the above plan followed in the laboratory work is to be criticized because it tends to make the laboratory a machine that will turn out so many students all in the same way. It is hard to see how this can be entirely avoided with large classes. An effort is made to keep quiz sections small in number of students, so that frequent opportunities are offered for expression of original ideas. The development of individuality is also considered in writing the directions for performing experiments.

Final examinations are given at the end of each semester in both the lecture and the laboratory work. The final examination, however, is given a weight of only a third or less in the total grade, the class work and written quizzes counting most in putting a mark on the student's work.

Some of the methods which we have used have been chosen because of local conditions, but many of our conditions are similar to those found in all larger institutions, particularly in institutions with large engineering colleges. We change details of the course each year, but the above represents a general plan which has been found efficient in instruction, and easy to manage.

A. P. CARMAN
F. R. WATSON

UNIVERSITY OF ILLINOIS,
November, 1910

THE AGRICULTURAL PRODUCTION OF THE UNITED STATES[1]

YEAR after year it has been my privilege to record "another most prosperous year in agriculture." Sometimes the increased prosperity has been due to weather unusually favorable to agriculture, sometimes to higher prices, caused either by a greater yield or demand, or by a scant production, but usually the advance in farmers' prosperity has been in spite of various drawbacks. It would seem that this country is so large in extent and has such varied climate, soil and crops that no nation-wide calamity can befall its farmers. Combined with this strong position in agriculture, the nation may now begin to derive

[1] From the annual report of the Secretary of Agriculture.

increased confidence in its agriculture because of improvements that are permeating the whole country in consequence of a grand movement sustained by the National Department of Agriculture and the various state agencies.

Nothing short of omniscience can grasp the value of the farm products of this year. At no time in the world's history has a country produced farm products within one year with a value reaching $8,926,000,000, which is the value of the agricultural products of this country for 1910. This amount is larger than that of 1909 by $305,000,000, an amount of increase over the preceding year which is small for the more recent years.

The value of farm products from 1899 to the present year has been progressive without interruption. If the value of that census year be regarded as 100, the value of the agricultural products of 1900 was 106.4; that of 1901 was 112.7; that of 1902 was 119.1; that of 1903 was 124.8; that of 1904 was 129.8; and that of 1905 was 133. The year 1906 was an extraordinary one for agriculture, both in quantity and in value of production. The value increased to 143.4, as compared with 100 representing 1899. In the next year, 1907, the value of agricultural products rose to 158.7; in the next year, 1908, to 167.3; in 1909 to 182.8; and in 1910 to 189.2, or almost double the value of the crops of the census year eleven years preceding. During this period of unexampled agricultural production, a period of twelve years during which the farmers of this country have steadily advanced in prosperity, in wealth and in economic independence, in intelligence and a knowledge of agriculture, the total value of farm products is $79,000,000,000.

In the statement that follows concerning the crop quantities and values for 1910, no figures should be accepted as anticipating the final estimates of this department to be made later. Only approximations can be adopted, such as could be made by any competent person outside of this department. All values are for products at the farm, unless otherwise stated, and in no item are values at the produce or commercial exchange.

A national asset amounting to 3,000 million bushels, worth 1,500 million dollars, is found in the corn crop. Its production this year was 3,121,381,000 bushels, a crop that exceeds that of even the great agricultural year 1906. It is greater than the average crop of the preceding five years by 14 per cent. A notable feature of corn production this year is the growing importance of the south. This has been manifested in a small way in very recent years, but now the increased magnitude of the crop in that section, both absolute and relative to national production, forces itself upon the attention. Let a comparison be made with corn production in the south in the census year 1889, or twenty-one years ago. At that time the South Atlantic states produced only 6.2 per cent. of the national crop of corn. This year they produced 9.1 per cent., or an increase relatively of about one half. The relative increase for the south central states is even greater, being from 14.8 per cent. of the national crop of 1889 to 23.4 per cent. in 1910. Then the south produced hardly more than one fifth of the national crop; now it produces one third. The power that this increased corn production gives to southern farmers with respect to independence, release from buying feeding stuffs, in producing meat, and maintaining dairy and other domestic animals is well understood.

While the value of this corn crop is below that of 1909 and also of 1908, its amount belongs to stories of magic. It can hardly be reckoned at less than $1,500,000,000, a sum sufficient to cancel the interest-bearing debt of the United States, buy all of the gold and silver mined in all of the countries of the earth in 1909, and still leave to the farmers a little pocket money. The corn crop is a national asset in more than one sense. It is not merely wealth in existence for the time being, but it is an asset of perpetual recurrence. Year after year, throughout the ages, a stupendous amount of corn, with incredible value, can be produced.

The cotton crop, including seed, is worth this year only three fifths of the value of the corn crop; the wheat crop only two fifths; the hay crop, less than one half. All of the cereals, except corn, are together worth only three fourths as much. The great allied iron and steel industries had in the latest census year for which results have been published, 1904, a production worth only 60 per cent. of the value of this year's corn crop.

For many years the cotton crop was fourth in value among the crops, being exceeded usually by corn, wheat and hay. But in those days the price of cotton was very low. The crop of this year may be worth in lint and seed around $900,000,000 at the farm, or more than the corn crop was worth in any year prior to 1901, or more than the wheat or hay crop was ever worth. Apparently the cotton crop of this year, including seed, is worth $129,000,000 more than the crop of last year, and that crop was far above any previous one in value. During the last five years the cotton crop had an average value of $685,000,000, so that the value for this year is 13 per cent. above the five-year average. The number of bales in this year's cotton crop will be determined by the Bureau of Statistics of this department next month, and at the present writing no forecast of that estimate can be suggested. From commercial sources, however, it is evident that the cotton production of this year will be considerably short of being a record breaker, although possibly it may be the fourth in order of magnitude that this country has produced. The average cotton crop of the preceding five years had a weight which perhaps is not far from most of the commercial estimates for the crop of this year.

Wheat has often contended with hay as to precedence in value and the place in 1910 goes to hay, notwithstanding its short crop. The value of the hay crop is about $720,000,000, an amount which has been exceeded but once, and that in 1907, when the crop was worth $744,000,000. Indeed, the value of the crop of this year is much above that of the high crop values of other preceding years, illustrating the principle that a somewhat deficient crop is usually worth more in the aggregate than an abundant one. The value of the crop of this year is 13 per cent. above the average of the preceding five years. The quantity of the hay crop is 60,116,000 tons, and has been exceeded a dozen times. It is 5 per cent. below the average crop of the preceding five years. The feeding value of the hay crop, however, is greater than its tonnage implies. Alfalfa has entered into the production of this crop in recent years and has now become in itself a crop of large proportions. In relative geographic distribution, the hay crop has changed perceptibly during the twenty-one years since the census year of 1889. During the interval the North Atlantic states have increased their production of the national crop from 24.3 to 27.8 per cent.; the western division, 7.9 to 16.4 per cent.; the South Atlantic, from 3.1 to 3.9 per cent.; the south central, from 3.3 to 5.8 per cent.; the two southern groups of states, from 6.4 to 9.7 per cent.; and consequently, the north central states have lost relatively in a marked degree, or from 61.4 to 46.1 per cent. of the national crop.

Fortunately the wheat crop is divided into two sowings, autumn and spring, and consequently it is not improper to regard wheat as having two crops. These to some extent cover the same territory, but they belong largely to different geographic areas, subject to different climatic accidents, with the frequent result that one of the crops is a successful one and the other is not. Such was the fact this year, when the winter crop was a large one and the spring-sown crop suffered from severe drought. The production of both crops this year is 691,767,000 bushels, or substantially the average of the preceding five years, whereas the value is about $625,000,000, or 7.6 per cent. above the five-year average. The quantity of this year's wheat crop has been exceeded four times, but the value has been exceeded only once, in 1909, although the crop of 1908 was nearly as valuable. Wheat is another crop that has undergone perceptible change in relative geographic distribution since the census

year 1889, but in a less degree than corn and hay. During the twenty-one years the fraction of the national crop produced in the North Atlantic states declined from 6.8 to 5.9 per cent.; in the north central states, from 68.6 to 62.9 per cent.; whereas there were increases in the other geographic divisions—from 5.9 to 6.6 per cent. in the South Atlantic; from 5.2 to 9.7 in the south central, and from 13.5 to 14.9 in the western states.

Easily the fifth crop in point of value is oats, a position that it has long occupied. The value this year is probably over $380,000,000 and has been exceeded in this respect only by the crop of 1909. Compared with the average value of the five preceding years, this year's value is 12 per cent. greater. In quantity the crop of this year is a magnificent one. For the second time in the history of this country the crop exceeds one billion bushels, the precise estimate standing at 1,096,396,000 bushels, or about 90 million bushels above the great crop of 1909. The crop of this year is 22 per cent. greater than the average of the five previous years. The production of this crop has shifted somewhat into the south central and western states in comparison with the national production since 1889. The share of the North Atlantic states has declined from 10.8 to 8.6 per cent.; of the South Atlantic states, from 2.9 to 2 per cent.; of the north central states, from 79.7 to 77.2 per cent.; the south central states gained the difference between 4.7 and 6.5 per cent.; the western states the difference between 1.9 and 5.7 per cent.

Next in order of value is the potato crop, which was exceeded in only two or three former years. Compared with the average value of the five previous years, the value for this year is 1 per cent. greater. With the exception of the crop of 1909, which was in a degree an over-production, the crop of potatoes this year was the largest ever grown in this country, the preliminary estimate of this department being 328,787,000 bushels. This quantity is 8 per cent. greater than the average for the preceding five years.

Beet-sugar production in 1910 has been subject to vicissitudes of climate and other influences. A smaller acreage of sugar beets was planted in Colorado; there was a lack of moisture necessary to a full crop in Utah and Idaho; whereas the production of California, Michigan, Wisconsin and other states considerably exceeds that of last year, partly due to three new operating factories. Five new factories will be in operation in 1911—two in California and one each in Colorado, Utah and Nevada. All acreage planted this year returned beets excellent in both quality and quantity.

It is too early now to forecast accurately the production of beet sugar for 1910, but the indication is that the crop will be about as large as that of 1909, or, say, 512,000 short tons. The factory value of this sugar is about $51,000,000, or hardly less than the value of the crop of 1909, which was the record year.

Commercial estimates indicate that the cane-sugar crop of this year will be about 347,000 short tons, which has been frequently exceeded in recent years. The factory value of this sugar is about $28,000,000, an amount that has been exceeded in four years.

If prospects are realized, the entire sugar crop of factory production, beet and cane combined, will be about 859,000 short tons, or a production that has been exceeded in only one year, 1909. In factory value the two sugar crops will equal about $79,000,000, and if to this be added the value of molasses, syrup, beet pulp and sorghum and maple products, the combined value of the production of sugar, syrup and molasses, with subsidiary products, is about $97,000,000, or only $4,000,000 under the high-water mark of 1909.

The tobacco crop has slightly exceeded the production of the record year 1909, and its 967,150,000 pounds are 26 per cent. above the average production of the five preceding years. Apparently the tobacco prices of 1909 are barely maintained for the crop of this year, and the total value of the crop is therefore about the same as it was for the crop of 1909, or, say, $95,000,000. No tobacco crop previous to 1909 was worth its amount by fully 20 million dollars. Tobacco, under the better prices of recent years, is steadily climbing upward in

production. The average prices for the last five years, including 1910, have been 10 cents a pound and a little better. It seems to be required that the average price of the crop, all types and grades included, shall not decline if this crop is to maintain its increasing production.

Barley this year has hardly maintained the average production of the preceding five years, the production of this year being 158,138,000 bushels, as compared with the five-year average of 161,240,000. This year's crop, however, has been exceeded only three times, in 1909, 1908 and 1906. In point of value the crop of 1910 has been exceeded only in 1907, and the value of this year is 16 per cent. above the average of the previous five years. The price of barley suddenly increased about 60 per cent., to 66.6 cents in 1907, after which it declined to about 55 cents a bushel in 1908 and 1909, but a higher price than this is indicated for the crop of this year. In relative geographic redistribution of the barley crop since 1889, the share of the North Atlantic states has declined from 12.2 to 2 per cent., while the share of the north central division of states has increased from 60.3 to 62.8 per cent. and that of the western states from 26.9 to 34.4 per cent.

Flaxseed follows barley in order of importance of value of crop. At this writing the indication is that the value of the flaxseed production of this year will be about $33,000,000, which would be the record amount were it not for the greater value of the crop of 1909. Compared with the previous five years, the value of this year's crop is 13 per cent. greater. While the value of this year's crop remains near the top, the production is far below that of recent years, the preliminary estimate being 15,050,000 bushels. The low production and high value of the flaxseed crop are reconciled in the high price of flaxseed per bushel beginning early in this year. The November 1 price at the farm in 1908 was $1.08; in 1909, same month, $1.40, and in 1910, same month, $2.29.

Next in order of value is the rye crop, the 32,088,000 bushels being worth at the farm about $23,000,000. This crop is constant in production and varied little in value in recent years. A larger share of the national crop is now produced in the North Atlantic states than in 1889, the increase being from 28.4 to 33.9 per cent. During this time the north central states have declined in their share from 63.2 to 57 per cent.

Rice production in 1910 remains substantially at the figure of 1909, or, say, a little over 1,000,000,000 pounds of rough rice. No year previous to 1909 produced as large a crop; it exceeds the average of the previous five years by 25 per cent. The price of rice, however, has declined, so that the crop of this year is worth hardly $16,000,000, or about the same as the crops of 1906 and 1907. This value has been exceeded in 1908 and 1909, so that the value of this year's crop is about 2 per cent. below the five-year average.

The estimates of persons outside of this department indicate that the hop crop of this year will be 13 per cent. below the average quantity of the preceding five years, and the smallest crop in a dozen years or more. The farm price of hops in 1910 has improved somewhat over the average of the previous five years, so that the total value of the crop of this year is 3 per cent. above the five-year average.

For transportation purposes and as a rough indication of the production of all cereal crops, a statement of the total production of these crops in bushels is interesting. In no previous year has the production of these crops equaled the 5,140,896,000 bushels of the cereals of 1910. The production of this year is 13 per cent. above that of the five-year average, which is about 4½ billion bushels. In value, however, the cereals of this year fall below that of 1908 and 1909, principally on account of the decline in the farm price of corn. This year's value is $2,710,000,000, or about $230,000,000 below the total for 1909 and $50,000,000 below that of 1908; however, it is 11 per cent. above the five-year average.

This is the year of highest production for corn, oats, the total of all cereals, and for tobacco. But the only crop that reached its highest value this year is cotton. The list of crops that stand next to the highest, either in

quantity or value, or both, is much larger than the foregoing. In production next to the highest year are found for 1910 the crops of rice, hay, beet sugar and the total for all sugar. In the list of the crops that are next to the highest in value are wheat, oats, barley, tobacco, flaxseed, beet sugar and the total for all sugar. The potato crop was third in order of quantity and the corn crop and the total for all cereals were third in value. Barley and rye were fourth in production and potatoes fourth in value. Fifth in production was wheat and fifth in value rice.

The average production of the five years preceding 1910 includes the remarkably productive year 1906 and was generally a period of vigorous production. Notwithstanding the high character of the period, the production of 1910 is above the five-year average in the case of corn, oats, rice, rye, buckwheat, beet sugar, the total for all sugar, potatoes, tobacco and wool. In comparison with the average of the preceding five years the value of the crops of this year was greater in the cases of corn, wheat, oats, barley, rye, buckwheat, cotton, beet sugar, the total for all sugar, flaxseed, hay, potatoes, tobacco and hops.

The value of the farm products of 1910 shows both gains and losses in comparison with 1909. A gain of $130,000,000 is made for cotton lint and seed, $30,000,000 for hay and $3,000,000 for barley. A loss was suffered in wheat, amounting to $104,000,000; corn, $98,000,000; oats, $26,000,000; potatoes and wool, $23,000,000 each.

The farm value of the cereal crops declined $230,000,000 in 1910 from 1909, and the value of all crops declined $119,000,000. A gain was made, however, in the value of animal products, amounting to $424,000,000. It has been a year of high prices for meat and animals, for poultry and eggs and for milk and butter, and for these reasons the total value of all farm products increased in 1910 $304,000,000 above the estimate for 1909.

THE MINNEAPOLIS MEETING OF THE AMERICAN ASSOCIATION

The sixty-second meeting of the American Association for the Advancement of Science, and the ninth of the "convocation week" meetings, will be held in Minneapolis, December 27 to 31, 1910, at the invitation of the University of Minnesota.

A meeting of the executive committee of the council (consisting of the general secretary, the secretary of the council, the permanent secretary and the secretaries of all of the sections) will be held at the office of the permanent secretary, in the Hotel Radisson, at noon, on Monday, December 26.

The opening session of the association will be held at 8 o'clock P.M. on Tuesday, December 27, in the First Baptist church, 10th Street and Harmon Place.

The meeting will be called to order by the retiring president, Dr. David Starr Jordan, who will introduce the president of the meeting, Dr. A. A. Michelson. There will be short addresses of welcome and a reply by President Michelson. The annual address of the retiring president, Dr. David Starr Jordan will then be given on "The Making of a Darwin."

At 9.30 there will be a reception to the members of the association and affiliated societies, after the presidential address, in the parlors of the Hotel Radisson, the headquarters.

On December 28 at 9 A.M. the Council will meet in Room No. 101, Folwell Hall, University of Minnesota.

The sections will organize in their respective halls and the regular program of papers will begin.

Addresses by retiring vice-presidents will be given at 2.30, as follows:

Vice-president Brown, before the Section of Mathematics and Astronomy. Title: The Relations of Jupiter with the Asteroids.

Vice-president McPherson, before the Section of Chemistry. Title: The Formation of Carbohydrates in the Vegetable Kingdom.

Vice-president Brock, before the Section of Geology and Geography. Title: Northern Canada.

Vice-president Ritter, before the Section of Zoology. Title: The Controversy between Mechanism and Vitalism: Can it be Ended?

A session will be held in St. Paul in the evening, the arrangements for which are in