has developed during the past third of a century into a truly learned profession. There was never a time in the history of the world when the questions of general education were more carefully considered than at the present; and there was never a time when this country was more concerned with the work of the engineer than now. The nation, just awakening to a consciousness of its power and responsibility, is taking its place among the nations of the earth, and is seeking to decide the destiny of the peoples of the earth. We are now sending our manufactured products to all parts of the world, and if we are to have part in the commercial conquest of the earth, it will be because of the ability, the foresight, the wisdom of our own engineers. The only agency seeking to prepare engineers for their work is the engineering college. Their work in molding and directing the engineering education of the future will be no less important than in the past. They enjoy the respect and confidence of the public, and a still wider field of influence and responsibility lies open before them. May the deliberations of this Society continue to be a source of strength and inspiration to the engineering colleges. May the engineer of the twentieth century have better technical training, broader culture and nobler aspirations. May the profession of engineering come to occupy a still higher position in the esteem and respect of the public.

Ira O. Baker.

University of Illinois.

PROGRESS IN IRRIGATION INVESTIGATIONS.

The organization and objects of the irrigation inquiries of the U. S. Department of Agriculture have been partly explained in an earlier number of this Journal.* Congress at its last session increased the appropriation for this work from $35,000 to $50,000.

It was realized at the outset of these investigations that a basis of settlement of the controversies over rights to water for irrigation purposes, which are very frequent and acute in the arid region, where the supply of water is limited, must be reached before it would be wise to attempt to greatly increase the use of water for irrigation. The uncertainty of water rights and ignorance as to the amounts actually needed for successful agriculture led irrigators to claim more water than they could possibly use, frequently more than the natural supply yielded, and encouraged extravagant rather than economical use of water. It was for this reason that the Department directed attention first to the collation and publication of information regarding the laws and institutions of the irrigated region in their relation to agriculture, and a number of bulletins dealing with this phase of the subject, as well as with general irrigation practice, have been published. At the same time it was realized that an exact knowledge of the water requirements of cultivated plants at different stages of growth and under varying conditions of soil, climate, etc., is fundamental to an economical, rational practice of irrigation. It was therefore determined that one of the two main lines of work undertaken should be the collation and publication of information regarding the use of irrigation waters in agriculture as shown by actual experience of farmers and by experimental investigations. It was decided, however, that the strictly scientific studies provided for in this plan could be more intelligently pursued after the actual practice as regards irrigation in the various localities where it is already engaged in had been ascertained. Inquiries having the latter object in view were planned and put into operation on a comprehensive scale. The results of the

* Science, 11 (1899), p. 798.

first year's work along this line are given in a bulletin* on 'The Use of Water in Irrigation,' which is now in press. This bulletin deals with the methods in use in the arid States in the distribution and use of water in irrigation, and gives a large number of measurements made to determine the 'duty of water' and the losses from seepage and evaporation in canals; and discusses the methods by which the water supply may be more effectively and economically applied to crops. It contains papers discussing the results of the year's investigation by Elwood Mead, expert in charge; tables for use in measuring water and diagrams showing use, by Clarence T. Johnston, assistant; and reports and discussions of irrigation investigations in different localities by special agents Thomas Berry, Colorado; W. M. Reed, New Mexico; W. H. Code, Arizona; W. Irving, California; R. C. Gemmell and George L. Swendsen, Utah; D. W. Ross, Idaho; Samuel Fortier, Montana; and O. V. P. Stout, Nebraska. The bulletin is illustrated by numerous plates, diagrams, and maps showing the location and character of the investigations made. It is probably the most complete collection of data on the 'duty of water' in irrigation which has ever been published, and is especially valuable because it is based on measurements, systematically planned and synchronously made, of the amount of water actually used on a large number of farms in widely separated portions of the arid region.

Among the important facts brought out in the report is the enormous loss of water from canals and reservoirs by seepage and evaporation. From actual measurements made it is estimated that in some cases at least the loss from these causes might be so far reduced by better methods of construction and management as to double the area at present irrigated by the canals. Attention is also called to the large losses occurring when water under small head is spread in a thin layer over soils heated to the high temperatures common in some parts of the arid region, and to the great advantages of rotation in the use of water as contrasted with the wasteful methods encouraged by the common system of contracts which gives to the irrigator the right to a uniform and constant flow of water. The results, therefore, not only furnish the basis for improving methods of irrigation already in use and for framing more equitable laws, but it is believed that they indicate more clearly the lines along which strictly scientific inquiries may be most successfully directed.

Owing to the absolute dependence of agriculture upon irrigation in the arid region, attention was first directed to the irrigation problems of that region, but the work is being extended to the eastern or so-called 'humid' portion of the United States, for the necessity for irrigation is by no means confined to the region west of the hundredth meridian. The aggregate loss from total or partial crop failure as a consequence of periods of drought in the region where the rainfall is usually considered sufficient for the needs of agriculture is far greater than is generally realized. This fact is clearly brought out in a report by E. B. Voorhees on 'Irrigation in New Jersey.'* This bulletin discusses the need of irrigation in New Jersey, reports the results of experiments at the experiment station at New Brunswick and elsewhere in New Jersey during 1899 to determine whether irrigation during periods of drought is a profitable undertaking, and gives descriptions and statements of cost of a number of small irrigation plants in New Jersey.

The rainfall records of Philadelphia for 70 years are cited to show the frequency of injurious droughts:

* U. S. Dept. Agr., Office of Experiment Stations, Bul. 86, pp. 248.

* U. S. Dept. Agr., Office of Experiment Stations, Bul. 87, pp. 40.

"In 62 years out of 70 there was one month in the growing season from April to August in which such a marked deficiency occurred as to cause a serious shortage of crop, and for the same period there were 39 years in which the deficiency extended throughout two months, while in 21 years it extended throughout three months, or in 30 per cent. of the years included in this record there were three months during the growing period in which the average rainfall was deficient one inch or more. It is thus observed that a wide series of crops would be likely to suffer in more than one-half of the years for which the record is available, while a still larger number would suffer in nearly one-third of the years, for it must be remembered that even a slight deficiency in one month may result in a serious reduction in yield and consequent loss, if it occurs at a time when the crop is making its largest development."

Some idea of the extent of the losses occasioned by such periods of drought may be gained from Professor Voorhees' estimate that the loss to the hay crop of New Jersey alone from the drought in May and early June, 1899, was $1,500,000, while small fruits, vegetables, and other crops were also seriously affected.

"In 1897 and 1898, years of abundant rainfall in April and May, the yield of hay [at the Station] averaged 2.65 tons per acre. In 1899 it was a fraction over one ton, owing to the deficiency of rainfall in April and May—at the low price of $10 per ton, a loss for the 25 acres of over $400. The yield of crimson clover forage for 1897 and 1898 was 8.5 tons per acre; in 1899 the yield was but five tons, or in a good year the yield was 70 per cent. greater. The deficiency in the rainfall at the critical period was alone responsible for this difference in yield. . . . Oat and pea forage in 1897 and the early seeding of 1898 averaged six tons per acre; in 1899 the yield was but 3.3 tons."

In experiments at the Station with small fruits the increase in yield due to irrigation was as follows: Blackberries, 1,038 quarts per acre, worth $93.42; raspberries, 329 quarts per acre, worth $32.90; currants, 311 quarts per acre, worth $31.10. The results of similar experiments in other parts of the State with a variety of crops confirmed those obtained at the Station. These results show beyond question that supplemental irrigation under such rainfall conditions as those noted above is a profitable undertaking, especially on fruits and garden crops. Since the rainfall conditions described may be considered typical of the whole eastern half of the United States, the conclusions reached regarding the profitableness of irrigation are believed to be generally applicable to the agriculture of that region.

W. H. Beal.

---

*REMEASUREMENT OF THE PERUVIAN ARC.**

In 1889 the question of the remeasurement of the Peruvian Arc was brought before the International Geodetic Association by the Delegate of the United States (Professor George Davidson, Assistant Coast and Geodetic Survey) who suggested that France should have a prior right to execute this work in consequence of the first measure having been made by her savants, members of the French Academy in 1736–43. Circumstances prevented any active work until 1898, when the discussion of the subject was renewed in the same Association as the result of a motion offered by the Delegate of the United States (Mr. E. D. Preston, Assistant Coast and Geodetic Survey).

The Association voted in favor of the proposition to remeasure the Arc and the French Delegates undertook to bring the matter to the attention of their government and to have an examination made, so that they could report to the next meeting of the Association at Paris during the present year.

Captains Maurain and Lacombe of the Geographic Service of the French Army left Paris in May, 1899, and remained in

* The information is derived from the *Comptes Rendus, hebdomadaires des Scances de l'Académie des Science*, No. 26, June 25, 1900 (page 1740), and the *Bulletin de la Societé de Géographie*, No. 7, July 15, 1900 (page 1).