tical side, and constitute an important bond between mathematical science and its applications. The alternative geometrical interpretation of coefficients of correlation for the special case of normal correlation, already referred to, involves an interesting application of the theory of quadratic forms. And the whole theory of approximation represents only a part, though in its widest scope a not inconsiderable part, of modern mathematics. Many other topics could be named as of common interest to students of mathematics and of statistics. There will inevitably be a shifting of emphasis as time goes on. It appears likely that the further development of the theory of probability in the next few decades may turn out to be a major chapter in the history of science. And if this prediction is to be verified, one may further surmise that its realization will demand the profoundest insight of the professional mathematician, and will result in an unprecedented extension of exact knowledge of the material world and of the workings of human society.

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THE INCREASED EFFICIENCY OF AMERICAN AGRICULTURE[1]

FOOD is the first and most urgent requirement of life. How to provide an adequate supply has been in the past the fundamental problem of mankind. From the dawn of history to our present highly developed western civilization, the food problem in one aspect or another has demanded public recognition. Ancient civilization developed only under conditions favorable for the production of food. Even so, a major portion of the population was engaged in its production. Only a few had leisure to devote to other occupations. Ancient civilization always declined when the production or the securing of food became difficult.

The food problem in one form or another has been to the fore in our own country from the first starvation winter of our Pilgrim Fathers to the present time, when the economic status of the food producer is one of our most urgent national problems. During this period there has taken place a fundamental change in the position which food supply occupies in the consciousness of the nation. In colonial times, nearly the entire attention of the population was devoted to food production. More than 95 per cent. of all producers were farmers. The entire family worked on the land. And yet there was produced scarcely more than enough to feed and clothe the people. The per capita exports in relation to those engaged in farming were far less than they are to-day.

Beginning with a condition when almost the entire population was rural and when the entire family worked on the farm, the efficiency of American agriculture has increased gradually until to-day less than one third of our population is rural, women and small children no longer work in the field, the length of the working day on the farm has been greatly reduced, exports of food and clothing products have increased and the problem of how to avoid the production of a surplus of agricultural products resulting in the lowering of the economic status of the producer is one of our urgent national problems.

The rapidity with which the proportion of rural to urban population has declined is strikingly shown by the census reports. Thus in 1790 rural people (those who live on farms or in towns of 2,500 or less) made up 96 per cent. of the total population; in 1880, 71 per cent.; in 1890, 65 per cent.; in 1900, 60 per cent.; in 1910, 50 per cent.; and in 1920, 48 per cent.[2] The U. S. Department of Agriculture has estimated that on January 1, 1927, only 27,892,000 persons out of a total population of about 119,000,000, or less than 24 per cent., were actually living on farms. In other words, one family living in the country produces the raw material for food and clothing for three families living in towns and cities. In addition the exportable surplus of agricultural products has increased greatly. Thus with the exception of the period of the World War a larger volume of agricultural products was exported in the five-year period 1921–25 than for any similar period in the history of our country.[3]

At no time has agricultural progress as measured by production per man been more rapid than within the past few years. Dr. O. E. Baker, agricultural economist of the U. S. Department of Agriculture, in an address before the joint session of the Farm Economics Association and the Rural Section of the American Sociological Society in 1927 said:

> Agricultural production as a whole was over 14 per cent. greater in the period 1922–26 than in the period of 1917–21, whereas population increased less than 9 per cent. between the midyears of these two five-year periods; in other words, the increase in agricultural production was over 50 per cent. greater than the increase in population.

More surprising than this rapid increase in production and the resultant surplus, however, is the fact that this

[1] Address of the vice-president and chairman of Section O—Agriculture, American Association for the Advancement of Science, New York, N. Y., December 28, 1928. Contribution No. 41, Office of Director, Agricultural Experiment Station of Kansas.

[2] Census Monograph VI, Farm Population of United States for 1920.

[3] Statistical Abstract of the United States, 1926, p. 470.

condition has developed despite a decreased or at least a stationary acreage of crop land. The census of 1925 shows a decrease of about 13,000,000 acres in the area of crops harvested between 1919 and 1924, the first decrease shown by any census in our national history, while the average of estimates of the Division of Crop and Live Stock Estimates (U. S. Department of Agriculture) for the five-year period 1917–21, as compared with 1922 to 1926, indicates a decrease of 1,000,000 acres.

This increase in agricultural production that has taken place gradually through several generations but which has been accelerated since the close of the World War, is a measure of the increased efficiency which has taken place in American agriculture and which, it seems to me, is the result in a large measure of the application of science to American farming, and of industrial education to American farm life.

The application of science to farming has found expression in many ways. It has expressed itself in exploration, bringing to this country many new varieties of crop plants which have made possible a profitable agriculture in regions considered to be poorly adapted to agricultural purposes. It has expressed itself in the application of mechanical power to farm work, and it has further expressed itself in the protection and improvement of both plants and animals, which have prevented loss, eliminated waste and led to more efficient production.

The fruits of scientific discovery and invention could not have been applied to American agriculture —in fact it is doubtful whether much progress in scientific discovery and invention would have been made—if at the same time the American agricultural producers had not received an education that enabled them to take intelligent advantage of the discoveries and inventions as they were made. One discovery or invention frequently called attention to the need for others and thus served as a stimulus for further improvement. In fact, because of the high average intelligence and education of the American agricultural producing classes, discoveries and inventions for the facilitation of agricultural production have been made in many instances by the farmers themselves.

Let us now consider for a few minutes how each of these factors, namely, (1) the discovery and introduction of new crop plants, (2) the aid of mechanical invention and power, (3) the application of science to the production, improvement and protection of plants and animals and (4) the education of the American farmer and his family, has contributed to the present efficiency of American agriculture.

INTRODUCTION OF CROP PLANTS

Our country was settled for the most part by people who emigrated from northwestern Europe. They found in New England and on the Atlantic coast agricultural conditions in general similar to those of their native land. The crops which they had grown at home and the agricultural practices which had been followed were successful in the new world. As the settlements in the new world developed and the pioneers pushed westward across the Appalachian mountains into Ohio, Michigan, Indiana and Illinois, they found conditions still so similar to the more fertile parts of northwestern Europe that the varieties of crop plants which had been brought by the colonists from western Europe and the agricultural practices of the old world modified to meet American conditions gave satisfactory results. There was no need as yet for distinctly different kinds and varieties of crop plants, or for a distinctly American type of agriculture.

When, however, they pushed still farther westward and attempted to settle the drier territory of the Great Plains, an area which had been described by explorers and historians as the Great American Desert, the old world crops were found to be decidedly unadapted and the old world methods unsuccessful. Before this area could become one of the leading grain-producing regions of the world, it was necessary to introduce crops unknown to the western European or the American colonial farmer and to develop a type of extensive agriculture based upon the maximum output of crop per man, a distinctly American contribution.

It would be difficult to overestimate the value of the immigrant crop plants in the development of this territory. They have come from every continent that contains large areas having natural conditions similar to those in the Great Plains. These crops have come partly as a result of emigration of settlers from these countries. But they have been introduced chiefly as a result of the far-sighted policy of the nation in establishing through the federal Department of Agriculture and the state agricultural experiment stations a policy of exploration for the discovery and introduction of new kinds and varieties of crop plants. This policy has included also the establishment of a system of field experiment stations where new introductions may be tested and, when proved of value, distributed through the territory to which they are adapted.

One of the earliest and most valuable introductions from the standpoint of acreage and aggregate value is hard red winter wheat from Russia. This valuable plant immigrant was first brought to this country by Mennonite farmers who emigrated to Kansas in 1873. Additional importations have been made since by the U. S. Department of Agriculture, mills, individual farmers and other agencies. These imported strains have been further improved by scientific plant breeding by the U. S. Department of Agriculture and several of the state agricultural experiment stations as well as by a few interested progressive farmers. More than 12,000,000 acres of this type of wheat are now sown annually in the three states of Kansas, Nebraska and Oklahoma. A very large acreage is also grown in Texas, Colorado, Illinois and Montana. More than 50 per cent. of the total production of winter wheat in America is of this type. The substitution of this kind of wheat for spring wheat and soft red winter wheat, the only kinds available before the introduction of the Crimean type, has made wheat growing dependable where it was undependable before, and has extended wheat growing into parts of the United States entirely unadapted to less hardy varieties.

Farther north in the spring wheat belt, the introduction of durum wheat by the U. S. Department of Agriculture and of Marquis wheat from Canada has made possible a successful wheat industry in this territory. These introduced varieties have been further improved through plant breeding by workers in the U. S. Department of Agriculture, the Canada Department of Agriculture and the agricultural experiment stations in the northern Great Plains states.

Another large group of plants which deserve special mention because of the contribution they have made to the southern Great Plains region is the sorghums. This group contains numerous varieties used for many purposes. Some are grown chiefly for forage, others for grain, others for sirup and still others for broom making. While the introduction of the sorghums dates back in this country more than two centuries, those varieties which have been of greatest agricultural value have been introduced within the past fifty or sixty years. Several of the best ones have been produced in this country within the past twenty-five years by selection and breeding of sorghums introduced by the U. S. Department of Agriculture. They have come from places in Asia and Africa where natural conditions are essentially the same as those in the sorghum-growing regions here, that is, where summer temperatures are high and where periods of drought are of frequent occurrence. This crop, which is now successfully grown on millions of acres in Kansas, Oklahoma and Texas, and less extensively grown in New Mexico, Arizona and California, is making an important contribution to the development of the agriculture of these states.

One of the urgent needs of the early settlers of the Great Plains was for a leguminous forage crop that would take the place of red clover in the agriculture with which they were familiar. Red clover which had been introduced from western Europe and which had proved satisfactory in the east central and Atlantic coast states failed completely in all but the more humid sections of the Great Plains. The need for a leguminous forage crop was largely met by the introduction of two plant immigrants, alfalfa and sweet clover. The former is one of the oldest forage crops. It has been cultivated for centuries in Asia and southern Europe, and was introduced a number of times in the Atlantic coast states without success. It reached the farmers of the west by the way of California, where it had been introduced as early as 1854 from the west coast of South America. It was quickly recognized as a valuable crop for this region since it had the ability to withstand the extremes of both heat and cold and yet was capable of producing large yields of highly nutritious hay under favorable conditions. The crop promptly received the endorsement of the U. S. Department of Agriculture, the state agricultural colleges and the state departments of agriculture. The publicity which the crop received brought it rapidly to the attention of progressive farmers, by whom it was quickly accepted. It is now grown on nearly 2,500,000 acres in Kansas, Nebraska and Oklahoma, and on large areas under irrigation throughout the western half of the United States. It has filled an urgent need in the live-stock industry of this territory and has contributed much to an efficient agriculture for the central and western United States.

Sweet clover has become a valuable supplementary crop to alfalfa. It was brought to this country more than two centuries ago but for many years it was regarded as a dangerous weed. It is only within the past forty years that it has been recognized as one of the most valuable pasture and soil-improving crops. Sweet clover is now grown on many thousands of acres and within the past few years is even replacing red clover to some extent in rotations in the corn belt.

These are but a few of the new crops and crop plant varieties that have come to this country as immigrants. Many more valuable ones could be mentioned, but this number will suffice to illustrate the point that I wish to make, namely, that introduced crop plants have contributed in an essential way to the development of one of our most important agricultural regions, especially important because it is capable of being farmed in an extensive manner. It is in this region, perhaps, as nowhere else in the United States that the American type of extensive farming with a maximum output per man has been developed. It has been this type of farming that has made possible the present high state of agricultural production in the United States. Thus plant immigrants have contributed materially to the increased efficiency of modern American agriculture.

THE CONTRIBUTION OF MECHANICAL POWER AND INVENTION

While the development of a highly efficient American agriculture has been dependent in part upon the introduction and production of adapted varieties of crop plants, it has also been dependent upon the development of efficient machinery with which to grow and harvest these crops and upon an economical source of power to operate the machinery. Three types of power have been and are still utilized in American agriculture, namely, human, animal and mechanical.

Human power has been important in agriculture throughout the ages. Until less than one hundred years ago it was the chief source of power. While agriculture depended for power primarily upon human energy little progress could be expected. Such power is inefficient and expensive. It is impossible for a human being to develop much energy through a long sustained period of work. When used as a motor, it has been estimated that a man will not develop more than one sixth to one tenth of a horse power of energy. He is, therefore, capable of doing only a very limited amount of work. Furthermore, the human being requires a high grade of food for sustenance. When human labor was the chief source of power it required almost the entire time of those engaged in the industry to produce the food that they consumed. Hence it was necessary for practically the entire population to devote its energy to food production. This condition prevailed in 1790, when 96 per cent. of our entire population was rural.

Late in the eighteenth and early in the nineteenth century marked changes in agricultural methods were brought about. The plow was improved. Simple tillage tools were perfected, and it was not long until the first harvesting machines were invented. Such implements could not be operated efficiently by human power; they were built for operation by animal power. It was not, however, until after the middle of the last century that horse-drawn harvesting implements fully replaced hand implements and the "machine age" in agriculture really began.

The use of the horse increased the power under the control of man from six to ten times for each animal employed. A man with a two-horse team and a simple machine was capable of doing twelve to twenty times as much work as he could do by hand. Teams of from four to six animals are now common units on the large farms of central United States, and as many as sixteen to twenty animals are sometimes used as a unit. The use of animals, increasing as it did the power available for the individual worker, greatly increased the area of land that he could handle. Thus it made possible the production of crops on large areas with a limited amount of human labor and marked the beginning of extensive agriculture.

The transition from animal power to mechanical power began with the introduction of the internal combustion engine shortly before the close of the last century. It was not, however, until the last decade that such power was used extensively in agriculture. The tractor, the combine harvester-thresher, and the truck, all driven by internal combustion engines, have now become thoroughly established farm machines. The rapidity with which they have been accepted is evidenced by the change that has taken place in such agricultural states as Kansas where the number of tractors increased from 5,400 in 1918 to over 50,000 in 1928 and the number of combine harvester-threshers rose from fourteen in 1918 to a number estimated to be not less than 20,000 in 1928. This change is typical of that which has taken place in the principal agricultural regions of America. Thus, not only has more power been made available for agriculture, but there has been released for other uses fifteen to twenty million acres of crop land formerly required to feed the animals which have been replaced by mechanical power.

Seventy-five years ago, when most of the operations on the farm were performed by human labor or at most with the power unit consisting of two horses, and when the walking plow, the spike tooth harrow, the scythe and the cradle were the most efficient farming tools, it was possible for the average farm laborer to care for only about twelve acres of crop land. Now with modern farm equipment he tills thirty-four acres of land. This represents an increased efficiency of nearly 300 per cent. In some of the more important agricultural states where most of the land is level and easily tilled and where large power units are operated and the latest labor-saving equipment is used the average area cultivated by each farm worker is one hundred acres. Moreover, on some individual farms in these states where conditions are especially favorable and where labor-saving equipment is more fully utilized as much as 300 acres is sometimes cultivated by each laborer. One laborer on such a farm to-day tills as much land as was cultivated by twenty-five average farmers seventy-five years ago.[4]

The value of modern harvesting machinery and mechanical power in increasing the efficiency of labor in harvesting the Kansas wheat crop has been well stated by Professor H. B. Walker, formerly head of the department of agricultural engineering at the Kansas State Agricultural College. He says:

> If it had been necessary to harvest the 1926 Kansas wheat crop by the method of one hundred years ago when

[4] U. S. Department of Agriculture Bulletin No. 1348.

the cradle and hand binding were in vogue, it would have required 775,000 harvest hands working twenty days to cut, bind and shock our last year's crop. If Kansas had been called upon to do this titanic task by these ancient methods it would have required all of the male population of the state between the ages of fifteen and sixty, and then in addition all of the women of the state between the ages of twenty and thirty-seven would have been necessary to complete a full harvest crew.

A century ago, an able-bodied man could cradle two acres of wheat in a day and it took two other men to bind and shock what he had cut. Or in other words it required three men to cut, bind and shock two acres of wheat in a day. With the present-day harvesting machines, that is, a 20-foot combine pulled by a modern tractor and with a farm motor truck for hauling grain, an equal number of men in a western Kansas wheat field can cut, thresh and deliver to market a distance of two miles forty-five acres of wheat in a day. This is fifteen times the acreage cut, bound and shocked by the three men of a century ago. Moreover, the work of the present-day harvest hand is less arduous and much more interesting.[5]

This increase in the efficiency of farm labor so well illustrated in the Kansas wheat harvest is typical of the change that has taken place in many other farm operations, although perhaps to a less marked degree. Mechanical power is being rapidly adapted to all kinds of farm operations including even farm chores and household work. Thus the gas engine and electric motor have been set to work not only in the field but in the farm yard—grinding feed, pumping water, milking cows and separating milk; and in the house washing clothes, sweeping floors, operating refrigerators, lighting buildings and doing many other tasks which have either not been done in the past or done less easily and conveniently by human or horse power. This transition has had a tremendous influence. It has not only increased the productive capacity of the farm worker but has likewise increased the standards of living of rural folks. It has made an important contribution to the efficiency of modern agriculture and to the enjoyment of country life.

THE CONTRIBUTION OF SCIENCE

While science has contributed in no small way to the efficiency of agriculture by the introduction of better crops and modern farm machinery, it has made its greatest contribution in the assistance it has afforded in the production, improvement and protection of domestic plants and animals. Agricultural progress has been coincident with increased scientific knowledge. The art of agriculture is old. It antedates written history. Progress, however, that resulted solely from the improvement in the art was meager and slow. The application of science to agriculture is new. All the sciences upon which agriculture is based are young. Chemistry is less than 150 years old, and modern chemistry in its application to agriculture is much younger. It has been only within the last fifty years that botany and zoology have contributed much to agriculture, while bacteriology in its application to agriculture is still younger. Without these sciences there is no basis for scientific agricultural progress. Without chemistry an understanding of the composition of feeds and the process of digestion is impossible. Without bacteriology and botany the diseases of plants and animals can not be comprehended. Without the application of biology and chemistry, the recent discoveries of food constituents necessary for the health of animals could not have been made.

The intensive application of science to the solution of live-stock feeding problems within the past fifteen years has resulted in a marvelously rapid increase in definite knowledge relating to an adequate diet for live stock. A great flood of new scientific evidence has shown the nutritive deficiencies of many of the rations that have been fed in the past. Many rations formerly considered adequate are now known to be deficient in mineral nutrients or vitamins or in the quality of the protein they contain. Thousands of young animals are now known to have been sacrificed simply because they or their mothers were not supplied with an adequate diet. The need of vitamins, the importance of sunlight as an aid to the assimilation and utilization of calcium by the young growing animals, and the importance in the diet of some of the less common elements such as iron, iodine, copper and manganese, are all recent discoveries made possible because of the application of science to the problems of nutrition. These new facts have revolutionized feeding methods and live-stock management. At no time in the history of the world has so much accurate information been available to the live-stock feeder and breeder as at the present time. This information has added greatly to the efficiency of live-stock production.

Another way in which science has been of service is in the assistance that it has given in the control of the pests of agriculture such as weeds, insects and plant and animal diseases. These pests have increased tremendously in number and virulence as agriculture has developed. Science has discovered practical means of preventing losses from most of them. Thus the discovery of anti-hog cholera serum and blackleg vaccine brought under control two of the most destructive animal diseases. It is estimated that before the discovery of blackleg vaccine the annual loss from this disease in single states frequently exceeded one and

[5] Report of Kansas State Board of Agriculture for the quarter ending March, 1927. "The Combine a Factor in Wheat Production," by H. B. Walker.

one half million dollars. Likewise the loss from hog cholera before preventive measures were discovered amounted to many millions of dollars. The control of these diseases by vaccination is now so successful that any appreciable loss from them can be attributed only to gross carelessness upon the part of producers. Without these preventive measures, losses to-day would probably be much greater than formerly, since these pests tend to increase in number and virulence as agriculture becomes more intensive.

The service of science in developing methods for the control of plant diseases has been equally valuable. Such plant diseases as the kernel smuts of wheat, oats, barley and sorghums can be effectively controlled by proper seed treatment. The formaldehyde vapor method of treating seed oats and the copper carbonate method of treating wheat and sorghum seed are not only simple and inexpensive but highly effective.

Science also has come to the aid of the farmer by developing methods for the control of insects. The poison bran mash developed for the control of grasshoppers has proved so effective when properly used that it would be safe to predict that there will never be another serious grasshopper plague in this country. Methods for effective and practical control have been developed for the Hessian fly, chinch bug, potato beetle, boll weevil, army worm, corn root louse, codling moth and numerous other field crop, orchard and garden insects. The saving which has resulted from the application of this knowledge amounts to millions of dollars annually.

Science has aided further by developing methods for the control of animal parasites. Detailed studies of the biology of parasitic worms, especially the parasitic worms of chicken and swine, have contributed information that has made possible the development of methods of flock and herd management which successfully control these pests.

The foregoing are but a few of the contributions of science to agriculture. Many others might be cited. These examples, however, will serve to illustrate the many ways in which scientific knowledge has aided in the solution of agricultural problems. The solution of these problems has contributed greatly to the efficient production of farm products both plant and animal. Thus, within the past ten years, an increase of only 4 per cent. in dairy cows and heifers in the United States has given a 20 per cent. increase in milk production. Approximately the same number of breeding hogs on farms has given a 25 per cent. increase in pork and lard slaughtered under federal inspection. Likewise during this period, crop products increased about 5 per cent., while the aggregate acreage of crops decreased slightly.[6]

THE INFLUENCE OF INDUSTRIAL EDUCATION

The remarkable increase in the efficiency of American agriculture, which has been most rapid within the past ten years, can not be attributed alone to scientific discovery, mechanical invention and crop plant introductions. These accomplishments, which have contributed so much to our present efficiency, would not have been made if the farm population of this country had not been composed largely of people of western European origin, capable of receiving instruction in science and willing to follow and be guided by the results of scientific research. It was the desire of American rural people for education and for definite information about farm problems that brought about the passage of the Land-Grant College Act in 1862, providing for the establishment of agricultural colleges, and the passage of succeeding acts making possible the establishment of the agricultural experiment stations and providing for agricultural extension education and vocational agricultural education. The creation of these educational and research agencies is merely the expression of the interest of the people in agricultural education and scientific research. But the creation of these facilities has made available facts and made possible the instruction that has led to the present efficient state of agricultural production.

The agricultural experiment stations and the U. S. Department of Agriculture have been in part responsible for the introduction and chiefly responsible for the improvement and dissemination of the new, introduced varieties of crop plants that have contributed so extensively to a successful agriculture in the central and western states. These agencies have also provided many of the scientists who have developed and applied scientific information which has made possible the solution of many of the perplexing problems of agriculture. They have also contributed liberally to the information necessary for the invention of modern farm machinery. Not the least of their contributions, however, has been their influence upon the older, established sciences of the country in calling attention to the need for the application of these sciences to the problems of the farm.

The desire of the rural folk for agricultural education, which expressed itself in the creation, first, of the agricultural college, then of the extension service,

[6] O. E. Baker, "Population, Food Supply and American Agriculture." U. S. D. A., Bur. of Agr. Econ. Address before the joint session of the Farm Economic Association and the Rural Section of the American Sociological Society, in Washington, December 29, 1927.

and finally resulted in the establishment of instruction in vocational agriculture in the high school, insured the success of these institutions. The agricultural college was slow in developing. Definite information relative to agriculture was meager when these institutions were started. This deficiency was to a large degree remedied by the establishment of the agricultural experiment stations, whose function it was to secure facts relating to agricultural problems. With these facts available, the colleges grew in importance and began to influence agricultural practice. It was, however, only after the creation of the extension service which carried the results of the scientific investigations of the agricultural experiment stations and the teachings of the agricultural colleges to the people that the influence of agricultural instruction upon the efficiency of production was markedly manifest.

The extent to which the extension service is influencing production practices was indicated in a recent report by C. W. Warburton, director of extension of the U. S. Department of Agriculture.[7]

This report states that during 1928, as a result of extension influence, over 4,100,000 instances were recorded of the adoption of improved practices on the farms and in the farm homes of the United States. Among the instances reported were 57,000 farmers who adopted improved practices in the production of alfalfa; nearly 30,000 who planted certified potato seed; 38,000 who treated seed wheat for smut; 418,000 who adopted improved dairy practices; and 424,000 who improved their marketing methods. These are but a few examples of the many ways in which adult education by the extension service contributed directly in a single season to a more efficient agriculture.

There should also be mentioned the educational work of the boys and girls through the 4-H clubs and vocational schools. Over 586,000 farm boys and girls were enrolled for instruction in 41,000 local 4-H clubs in 1926. These club members cultivated and owned 80,306 acres of field, truck and orchard crops; had 87,207 head of high quality live stock, and 1,329,200 standard bred fowls. Over 13,000 teams of club members were trained to give public demonstrations as a means of influencing more people to adopt improved agricultural practices. Formal agricultural instruction was also given to over 85,000 boys in the vocational agriculture classes in the high school. Thus in a single year these agencies trained an army of more than 600,000 young people in modern, advanced methods of farming. It is the influence of educational work of this character, started with the establishment of the Land-Grant Colleges in 1862, expanded as the vision of industrial education developed until it reached the magnitude described above, that has made possible the application of the results of scientific investigation and led to the present efficient state of agricultural production. In no other section of the world has agricultural education been made as easily available to the producing classes, and in no other country has agricultural production reached so high a state of efficiency.

The job of educating the agricultural producers of this country has just begun. The establishment of the first agricultural college is within the memory of men still living. The agricultural experiment stations are less than fifty years of age. Extension work in its modern conception was not started until 1914. Junior extension work has reached large numbers of boys and girls only within the past few years. Few who have received vocational agriculture instruction in the high schools have as yet become farm managers and operators. When all these agencies have had an opportunity to exert their full influence upon agricultural practices and rural life, a still further marked improvement in the efficiency of American agriculture can be confidently expected.

L. E. Call
Kansas Agricultural Experiment Station

[7] Report of the director of the extension service, U. S. Department of Agriculture, for the fiscal year ending June 30, 1927.

THE WORLD'S TWO GREATEST PETRIFIED FORESTS

"Leaving this island," said Sinbad—(for Scheherazade, it must be understood, took no notice of her husband's ill-mannered ejaculation)—"leaving this island, we came to another where the forests were of solid stone, and so hard that they shivered to pieces the finest tempered axes with which we attempted to cut them down." Thus, Edgar Allan Poe in the "Thousand and Second Tale"; and then he says in lucid footnotes, adding a strange literary touch, that an account at first discredited has since been corroborated, to the effect that "there is a completely petrified forest near the headwaters of the Chayenne, or Chienne river, which has its source in the Black Hills of the Rocky chain."

Told with the prescience of unapproachable genius, there was in all the known world no other forest turned to stone, the equal of this of the "Chayenne." There were stems, crowns of fronds, flowers by the tens of thousands, ripened fruits, all stained in stone by nature, in faultless perfection. Those unimpeachable records had awaited throughout the ages the processes of erosion that should again bring them to