CYRIL GEORGE HOPKINS

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In Memoriam

Cyril George Hopkins

Eighteen Hundred and Sixty-Six
Nineteen Hundred and Nineteen

1922

BY this record of the Memorial Exercises following the passing of Doctor Hopkins, the University of Illinois pays lasting tribute to the character, the scholarship, and the service of one of the most distinguished members of its faculty.

BIOGRAPHICAL SKETCH

YRIL GEORGE HOPKINS was born upon a farm near Chatfield, Minnesota, on July 22, 1866. As a small child he moved with his parents to South Dakota, where, as he grew up, he lived the life of the pioneer. While teaching country school as a means of earning money for a college course, he nearly lost his life in a blizzard when caring for the children under his charge, a loss he would have cheerfully met rather than abandon his duty, as his later life abundantly testified.

He was graduated from South Dakota Agricultural College, at Brookings, in 1890, obtained his state teacher's certificate in 1891, earned his master's degree at Cornell in 1894, and his doctor's degree in 1898. A year later, 1899-1900, he studied agricultural chemistry at Göttingen.

Doctor Hopkins began his college service immediately after graduation, serving as Assistant in Agricultural Chemistry in his Alma Mater from 1890-1892, then in Cornell during 1892-1893, returning to Brookings as Acting Professor of Pharmacy during 1893-1894. In May, 1893, he married Emma Matilda Stelter, of Brookings.

In the autumn of 1894, he was appointed Chemist of the Agricultural Experiment Station of the University of Illinois. This responsible position he held continuously thereafter. In accepting the appointment, Doctor Hopkins made a reservation covering his purpose to work for the doctorate, and this he secured at Cornell four years later, offering as a thesis his famous treatise "The Chemistry of the Corn Kernel," reporting a piece of work which he had begun at the University of Illinois.

It was the desire to prosecute further studies with starch that took him to Germany a year later; and while there, he was appointed Professor of Soil Fertility and Head of the newly organized Department of Agronomy of the University of Illinois in 1900, a position tendered and accepted by cable, and one which he held until his death. In 1903 he was appointed Vice-Director of the Agricultural Experiment Station.

It was characteristic of the man that he said long afterward, "I accepted the position to head the agronomy interests, not because I coveted prominence and responsibility or because I felt myself qualified, but because such men as President Draper, Doctor Burrill, Professor Forbes, and the Dean of the College considered that I was the best available man; and whenever four equally good men feel that another is better qualified, then I am ready to surrender the position at any time." And in this statement he was perfectly sincere.

He threw himself at once and unreservedly into the problems of the department. In attempting to discover its field of service to the Commonwealth he organized a soil survey of the state, the most comprehensive ever undertaken, and he studied the problem of production from the standpoint of maintaining unimpaired the power of the soil to produce crops. His textbook, "Soil Fertility and Permanent Agriculture," embodies the results of his studies both scientific and philosophical, and has long been recognized as a classic.

Doctor Hopkins lost no opportunity to preach the doctrine of soil conservation and this disposition to serve, combined with a desire to broaden his experience, led him in 1913 to accept for one year the position as Director of the Southern Settlement and Development Organization with headquarters at Baltimore.

It is needless to observe that it was as Professor of Soil Fertility that Doctor Hopkins performed his great service to mankind. This is not the place to speak of that service further than to say that he literally put his life into the problem

of permanent agriculture, holding himself at any time ready to meet any sacrifice in the line of duty, and no martyr ever journeyed where duty led more cheerfully than did he.

It was this spirit that took him to Greece in an effort to do something that might help to heal the wounds of a war that he bitterly deplored and whose methods of combat he vigorously resented. It was during this year's service that he contracted the ailment that cost his life and deprived the world of one of its most valuable scientists and benefactors in the very zenith of his powers. He worked cruelly hard in Greece, in company with his old friend and student, Dr. George Bouyoucos, of Michigan. He collected and analyzed hundreds of samples of soil, drew his conclusions, made complete reports, was decorated by the King with the rarely bestowed Order of Our Saviour, and sailed for home in what seemed to be a perfect state of health, only to be stricken four days later with an attack of malaria, from which he died at the British Military Hospital at Gibraltar on October 6, 1919.

Memorial exercises were held at the University of Illinois on January 22, 1920, of which this little volume is the record.

So closed the career of one of the noblest characters the world has ever known; a scientist of the highest order and a benefactor to mankind; a firm friend and a courteous Christian gentleman.

EUGENE DAVENPORT

ORGANIZATIONS OF WHICH DOCTOR HOPKINS WAS A MEMBER

Doctor Hopkins was a member of the following organizations: American Chemical Society; Association of the Official Agricultural Chemists (President, 1905-06); American Society of Agronomy; American Breeders' Association; Illinois Corn Breeders' Association; fellow in the American Association for the Advancement of Science; Illinois State Academy of Science; Sigma Xi; Phi Lambda Upsilon; Alpha Zeta.

ADDRESSES DELIVERED AT THE MEMORIAL EXERCISES

THE EARLIER YEARS OF DOCTOR HOPKINS' SCIENTIFIC CAREER

By LOUIE HENRIE SMITH
Professor of Plant Breeding, University of Illinois

THE importance and the renown of Doctor Hopkins' great work in the field of soil fertility has naturally tended to overshadow his other scientific accomplishments, and it is doubtless true that thousands of people who knew Doctor Hopkins well as a great soil expert have no knowledge whatever of his valuable work along other lines. It would be a mistake indeed if on this occasion these other scientific accomplishments were to be overlooked. To me, therefore, has been assigned the privilege of calling attention briefly to some of these earlier activities of Doctor Hopkins before he entered upon that field that finally claimed him for his great life work and for which he will always be known.

Perhaps my purpose can best be accomplished by recounting in somewhat narrative form certain of the more interesting events of the earlier years of Doctor Hopkins' connection with the University of Illinois.

Doctor Hopkins came to Illinois in 1894 to take the position of Chemist of the Agricultural Experiment Station. He had been graduated from the College of Agriculture of South Dakota and had been an assistant to Doctor Shepard, the chemist of that station. He had also had some experience in college teaching, having conducted the course in pharmacy. He had not, however, completed his education to his satisfaction and one of the conditions of acceptance of his new position was a provision for leave of absence to pursue graduate study. He had already spent some months at Cornell University and in two periods of leave from Illinois he returned to Cornell and finished first the work for his master's degree and finally the work for his doctor's degree.

One of the first problems that Doctor Hopkins took up after his arrival at Illinois, as indicated by the title of the first publication of the Experiment Station to bear his name, was a study of the composition and digestibility of corn ensilage, cowpea ensilage, soja bean ensilage, and corn fodder.

My own earliest recollection of Doctor Hopkins is in connection with this work, and I picture in my mind now the old-fashioned mercury air-pump in his laboratory up there on the third floor of what was then the Chemistry Building, but which now shelters the College of Law, where hour after hour we worked on that everlasting job of crude-fiber determination, he with his characteristic patience and accuracy carefully washing out the fiber from the acid and alkali extractions, and I cranking that old mercury pump. The routine nature of this kind of laboratory work did not demand such strenuous mental application but that there was some opportunity for conversation. That opportunity, I may say, was not neglected, and so chemistry, agriculture, politics, religion, and philosophy were freely discussed and at times even a late story was exchanged. Those were rare days, and many a time in later years when responsibilities multiplied and departmental affairs became so intricate that the opportunity for a short, necessary conference with the Doctor sometimes required days of waiting, I have looked back to those old days with some regret, and with great appreciation, for the opportunity they afforded in the intimate contact with this great master of science, an opportunity that has not been possible in later years.

The investigation referred to above was a digestion experiment conducted by the method well known to students of agriculture in which a given feedstuff of known composition is fed to an animal in known amount and the amount and composition of the excreta are determined, and from these data the proportion of the various food nutrients retained by the animal body is found and the digestibility of the feedstuff in question thus determined.

It is quite impossible in the time allotted to go into details of these investigations, but one point in passing is of interest as illustrating the truly scientific instinct of this man as an investigator. The bulletin reporting the above experiment states that four high-grade steers were used, altho, it is noted, "usually digestion experiments are made with not more than two animals and often with only one." Altho the error due to "individuality" in animals in this sort of work has been well recognized in these later years, it seems not to have been taken into account in those days. But Doctor Hopkins' keen scientific judgment, which seemed with him to be an intuition, did not allow him to overlook this point. This was characteristic. It was with this same scientific instinct that he fortified all his work against critical attack, and it was this same characteristic that enabled him to make such discriminative analysis of the data of others. "Presumably we should accept the data of others," he was wont to say, "but we are in no way bound to accept their conclusions." I well recall some of these lessons from him in what might be called scientific judgment—how he used to point out the absurdity of carefully carrying out figures to the third and fourth decimal place when perhaps the error in sampling might be many times as great as the difference in the figures; or of exercising undue precision at one point in a process when it might be offset many times by some gross error at another point.

The next work of Doctor Hopkins recorded in bulletin form was an investigation of the sugar beet in Illinois, a work undertaken jointly with Professor Holden. The question of the production of sugar in this country thru the introduction of the beet was at that time a live problem. To answer the quesion for Illinois, sugar-beet seed was distributed in the spring of 1897 to all sections of the state and samples from the resulting crop were returned for inspection. The results showed that sugar beets of acceptable quality and in profitable quantity can be grown in the northern and central portions of

this state. The problem of sugar-beet production in Illinois was thus proven to be of an industrial nature rather than cultural.

It was quite natural in a state like Illinois, where the interest is so largely centered in the corn crop, that the chemist of the experiment station should be attracted to the chemical problems of the corn plant, and so we find Doctor Hopkins soon becoming deeply engrossed in the chemistry of this great crop.

"The Chemistry of the Corn Kernel" was the title of the next bulletin of Doctor Hopkins to appear. It is of interest to note that this publication served as the thesis for his doctor's degree at Cornell, a large portion of the work being done in the laboratories of that institution. This investigation went more completely into the chemistry of the different substances that make up the corn kernel than had any work hitherto done. Aside from the valuable information there given, our present interest in this work lies in the fact that it served as the basis of that great research which has come to be regarded as a classic in plant breeding, namely, the breeding of corn to influence its chemical composition.

This breeding work grew out of suggestions made in conference with Doctor Burrill and Dean Davenport. Recognizing the fact that corn is put to such a great variety of uses, it was proposed to investigate the possibility of modifying the composition of the grain in order to adapt it to various purposes, whether for feeding or for manufacturing. Accordingly, in 1896 a common variety of corn was taken and selection of seed was made in four directions; namely, high protein, low protein, high oil, and low oil. Each of these lots of seed was planted by the ear-to-the-row method in an isolated breeding plot in order that it might not become mixed with other kinds. At harvest, representative samples were collected and analysed and further selection made along the respective lines. Repeating this process year after year resulted in the gradual develop-

ment of four distinct strains of corn corresponding to the selection of the seed.

Doctor Hopkins described this work in his bulletin entitled, "The Improvement in the Chemical Composition of the Corn Kernel," giving the results of the first two generations, which had been completed at that time. This work has been continued up to the present time so that now there are unbroken pedigree records running back thru twenty-three consecutive generations, thus constituting the longest continued corn-breeding experiments in existence. The progress has been such that it may be stated that starting with a single ordinary variety of corn in 1896, it has been possible, thru this method of selection and breeding, to produce four distinct kinds of corn with respect to composition, so that now one strain is twice as rich in protein as another, and another strain is now five times as rich in oil as its corresponding opposite.

In the year 1900 Doctor Hopkins obtained a leave of absence to study and travel in Europe. The main portion of this time he spent at the University of Göttingen with the renowned chemist Tollens, working on the chemistry of the carbohydrates. Upon his return he came into the position of Professor of Agronomy. It was then that he began his investigations in soil fertility, and as he became more and more engrossed in this subject, and as administrative duties connected with affairs of a growing department multiplied, he was obliged to gradually relinquish his activities in these other lines of which I have attempted to speak.

The point that I should like to emphasize in this brief review is the substantial character of the research work of this great scientist. Thoroness and accuracy characterized all these investigations, and it was these qualities that Doctor Hopkins injected into his subsequent work on soils and that have made his teachings command the respect and confidence of scientists and farmers alike. It is more of this substantial kind of investigation that agriculture needs for its future development.

THE SCIENTIFIC BASIS OF THE ILLINOIS SYSTEM OF PERMANENT SOIL FERTILITY

By ROBERT STEWART
Chief in Soil Fertility, University of Illinois[1]

SIXTY years ago Liebig, the father of agricultural chemistry, made the following statement: "Agriculture is, of all industrial pursuits, the richest in facts, and the poorest in their comprehension. Facts are like grains of sand which are moved by the wind, but principles are these same grains cemented into rocks." The great contribution made to American agriculture by the late Doctor Hopkins was the gathering together, classifying, interpreting, and unifying, by his own investigations, the known facts of agriculture into a definite whole as practiced and taught by him in a system of permanent soil fertility.

Many of the facts upon which the Illinois system is based have been known for many years and even centuries, and have been developed by other men in other institutions and in other times. It remained, however, for Doctor Hopkins to bring together and to unify these isolated facts into a definite workable system, the keynote of which is permanency, and by his own investigations to demonstrate clearly that the system could be understood and used by the average farmer on his own farm, with profitable results. In his interpretation of the facts upon which this system is based all men have not agreed, and some even still do not agree with him. But the system rests on the sure foundation of facts supported by an abundance of experimental data now available from the fields and laboratories of the University of Illinois operated under his direction.

[1]Now Dean of the College of Agriculture, University of Nevada.

PERMANENT SOIL FERTILITY

The Illinois system of permanent soil fertility recognizes six positive factors of crop production. These may be designated briefly as seed, temperature, moisture, light, a home for the plant, and food for its use. No one of these factors is more essential than another in the production of crops, but since they are not equally susceptible of control certain of them are more often the limiting factors. It is impossible, for example, to change the temperature conditions of winter so as to make that season suitable for crop production, and the practical means available for modifying the temperature conditions of the soil during the growing period of the crop are very limited. Of all six factors that of plant food is the most completely within the control of the farmer, for it is fully possible for him to completely change in an economic way the amount of food available within the soil for the plant. Yet it is frequently true that the food supply of the soil is the limiting factor of crop production, especially under humid conditions such as prevail in Illinois. It is therefore to this factor that Doctor Hopkins has given large consideration in developing a system of permanent soil fertility.

There are ten essential elements of plant food in the absence of any one of which the plant cannot function normally and produce good yields. These elements are: carbon, oxygen, hydrogen, iron, sulfur, calcium, magnesium, potassium, nitrogen, and phosphorus. The great bulk of the plant—approximately 96 percent—consists of three elements, carbon, oxygen, and hydrogen. The supply of these elements, however, as Doctor Hopkins pointed out, is automatically taken care of by nature, the carbon and oxygen being obtained by the plant directly from the carbon dioxid of the atmosphere and the hydrogen obtained from the soil moisture, which in turn is, under humid conditions, constantly being replenished by the rainfall. The farmer, therefore, need not concern himself with these three elements.

Iron is used by the plant in such extremely minute quantities, and the supply in the soil is so large, that it need never be added to the soil as a plant food. While the plant requirements for sulfur are rather large and the supply in the soil comparatively small, the amount added to the soil by rainfall is adequate, not only to meet the needs of the plant but also to offset the loss in the soil thru drainage.

There remain, then, as Doctor Hopkins stated, five elements of plant food which must receive careful consideration by the farmer in the construction of any system of permanent soil fertility that may be proposed. These are calcium, magnesium, potassium, phosphorus, and nitrogen. Since there is no natural provision for the restoration of these elements to the soil when once removed by crops, a system which assumes to be permanent must provide for their return, unless as sometimes happens, they are present in the soil in unusual quantities sufficient to provide for the maximum production of crops for indefinite periods of time.

The inorganic plant foods—calcium, magnesium, potassium, and phosphorus—are removed by the plants in comparatively large quantities. Chemical analyses have shown that an ordinary rotation of wheat, corn, oats, and clover removes, per acre, in the maximum production of crops, 77 pounds of phosphorus, 320 pounds of potassium, 68 pounds of magnesium, and 168 pounds of calcium. Since these elements are obtained by the plant entirely from the soil, Doctor Hopkins recognized the fundamental importance of knowing the amounts of these materials which occur in the soil and of determining their relation to the requirements of crops.

Various chemical methods have been proposed from time to time for analyzing the soil. Most of these have been based upon the fantastic claim that they determine the **available** plant food in the soil. Doctor Hopkins, however, early realized the futility of such a claim, and concerned himself only with the determination of the **total** amount of plant food in

the soil. He used chemical analysis as a means of taking invoice, as he was wont to say, of these substances within the soil just as the merchant takes an invoice of the goods upon his shelves. Whether or not the proper use is made of this plant food depends largely upon the kind of farming the farmer carries on, just as it depends upon the business ability of the merchant whether or not his business is successful. Again and again Doctor Hopkins urged that an accurate invoice of stock with which to work is as absolute a necessity for the farmer as it is for the merchant.

The chemical analysis of the soils of Illinois made with this idea in mind at once showed a marked variation in the amount of the various essential plant foods present in the soil. Phosphorus, for instance, as measured in a typical area of brown silt loam in the corn belt was found to be the most limited element, not only as measured by the absolute amounts present but also as measured by crop requirements. While the supply of calcium present was found to be sufficient, as Doctor Hopkins expressed it, for the production of a 100-bushel crop of corn annually for ninety centuries, the supply of magnesium sufficient for thirteen centuries, and the supply of potassium sufficient for eighteen centuries, the supply of phosphorus was found to be sufficient for only sixty-two years. Such illustrations are very significant in their emphasis of the importance of providing for prosphorus in a system that is to insure permanent and maximum crop production.

The problem connected with the fifth element, nitrogen, is, in the words of Doctor Hopkins, "the most important practical problem confronting the American farmer." Nitrogen is required by crops in large quantities, while the supply in the soil is markedly limited, and this element, if purchased on the markets of the world, is the highest priced of all the plant-food materials. A hundred pounds of nitrogen is required for every 100 bushels of corn, and nitrogen at present sells for thirty cents a pound. At such a prohibitive price the farmer

cannot afford to purchase commercial nitrogen for the production of his common farm crops. Doctor Hopkins therefore taught the necessity of depending upon legume nitrogen, which is obtained by clovers, alfalfa, soybeans, etc., by the aid of symbiotic bacteria from the inexhaustible supply in the air, provided the soil conditions are favorable to their growth and development. In the Illinois system of permanent soil fertility he provided not only that a legume occur in each rotation but that the legume hay or chaff produced be carefully conserved and returned to the soil, either as farm manure or green manure crops. Further, he urged that the utmost use be made of legume cover crops grown in connection with the production of wheat and other cereals.

In the development of this use of legume cover crops the research work of Doctor Hopkins is particularly outstanding. Sweet clover was a favorite crop with him for this purpose and he was among the first to call attention to its great possibilities.

Unfortunately, legumes, so essential for soil improvement, cannot be successfully grown on many soils in Illinois, as they now exist, because of their acid condition, the acidity frequently being so great as to prevent absolutely the growth of legumes. Limestone is of fundamental importance in soil fertility. That a limestone soil is a rich soil is an age-old truth. Thruout the world soils that have become famous for their persistent fertility are limestone soils. This is true of the soils of the far western United States, of the blue-grass regions of Kentucky, of the valley of the Nile, and of the black soils of India and Russia. Unfortunately, limestone is of all soil constituents probably the most readily lost in drainage water, and hence humid soils are as a rule deficient in this essential constituent. The first principle of soil fertility is that limestone must be added to those soils in which it is not already present. While the limestone is added primarily for the purpose of creating conditions favorable to the growth of the necessary legume crops, it also has markedly favorable

action in increasing the yields of the cereal crops in the rotation. In addition to overcoming the acidity of the soil, limestone provides the necessary calcium and magnesium as plant foods.

Various forms and kinds of limestone materials are available, but the work of Doctor Hopkins has clearly demonstrated that the most economic form to use is the finely ground natural limestone—the natural material occurring in the soil. The abundance of data obtained by him from various experimental fields, particularly in southern Illinois, provides the best information the world now affords regarding the great benefit from the use of limestone for the production of common farm crops.

In most normal soils, such as the brown silt loam of the corn belt, potassium occurs in such large quantities that it will be sufficient for the maximum production of crops for indefinite periods of time. Hence in the case of potassium Doctor Hopkins has pointed out that the problem of the farmer is not one of addition, but rather of the liberation of this element from the insoluble compounds contained in the soil. In both the live-stock and the grain systems of farming, his provision for the turning under of freshly decomposing organic matter insures, in normal soils, a sufficient amount of available potassium to meet the requirements of crops for this element. The results obtained from various experimental fields have shown clearly that when used on such soils potassium not only does not pay for itself but gives little actual increased yield.

Certain abnormal types of soil, however, are deficient in potassium. Such soils are peaty soils and soils deficient in organic matter. On peaty soils, potassium is the limiting element of plant food and is often the limiting factor of crop production. The addition of potassium, therefore, on such soils is an absolute necessity. On soils deficient in organic matter, such as many of those occurring in southern Illinois, potassium may be used with profitable results until the soil has been built up in its organic-matter content.

On normal soils phosphorus is frequently the limiting element of crop production. Various forms of phosphorus are available for supplying this deficiency, such as barnyard manure, steamed bone meal, basic slag, acid phosphate, and raw rock phosphate. In the Illinois system of permanent soil fertility, Doctor Hopkins provided for the abundant use of finely ground rock phosphate, since a wealth of experimental data from the fields maintained by the University has proved conclusively that, except under special conditions, this form may be used with considerable profit and with much less expense than the other forms, altho there may be special conditions under which some of the other forms are desirable.

There are two well defined types of farming occurring in Illinois, the grain system and the live-stock system. Both of these are perfectly legitimate, proper, and profitable systems of farming. Both of these types, moreover, are absolutely essential to the development of the highest stage of civilization; as long as man demands bread, butter, meat, and milk, and until we are willing that our standards of living should be lowered, both types must exist. Doctor Hopkins recognized this fact, and in the Illinois system of permanent soil fertility made provision for the maintenance of fertility on a permanent and profitable basis on both the live-stock and the grain farm. In either type of farming, limestone and phosphates must be used in order that the growth of legumes, so essential both in soil improvement and in the feeding of live stock, may be made possible.

While Doctor Hopkins took particular pains to point out and emphasize the possibility of maintaining the fertility of the soil on the grain farm on a permanent and profitable basis, he also made important contributions to our knowledge regarding methods of maintaining the fertility of the live-stock farm. His teachings in this respect are of tremendous importance since they provide for the extension of live-stock farming to large areas where heretofore the proper feeds could

not be produced. On all the experimental fields of the University just one-half of the work is devoted to the maintenance of soil fertility in live-stock farming. The live-stock farmers of Illinois should have a deep sense of gratitude to Doctor Hopkins for his work in their behalf.

If a system is to be permanent, the materials removed from the soil must be returned at least in the proportion in which they are removed by natural processes, including the amount removed by the crop and the amount lost in the drainage water. This would seem to be such a simple axiomatic truth that it need not be dwelt on; however, it is a point which must be constantly emphasized. For years Doctor Hopkins has protested against the use of the complete commercial fertilizer to supply soil deficiencies. He pointed out that the use of two or three hundred pounds of an ordinary commercial fertilizer of a 2-10-2 grade, which adds only five or six pounds of nitrogen, could act only as a soil stimulant; for, if increased crops are obtained by its use, they can be had only at the expense of the nitrogen already in the soil, since the requirement for a 100-bushel crop of corn is 100 pounds of nitrogen. The Illinois system of permanent soil fertility, therefore, condemns in unmeasured terms the use of such soil stimulants, among which must be classified ordinary commercial fertilizers and gypsum.

In the briefest way possible, the very essential points underlying the Illinois system of permanent soil fertility as worked out by Doctor Hopkins have thus been merely touched upon. But it is the desire at this point to emphasize the fact which Doctor Hopkins reiterated that the Illinois system of permanent soil fertility rests upon a sane and safe scientific basis, and, because it makes abundant use of cheap, natural, raw products, such as legume nitrogen and finely ground limestone and rock phosphate, it is both a permanent and profitable system of soil fertility. This is the heritage to the Illinois farmers left by him in whose memory we have met to-day.

THE PRACTICAL SIGNIFICANCE OF THE ILLINOIS SYSTEM OF PERMANENT AGRICULTURE

By RALPH ALLEN
Member of the University Soil Advisory Committee

TO help us realize the magnitude of Doctor Hopkins' work in investigation, let us make a little comparison. Before his time the great source of agricultural knowledge was at Rothamsted; and when we consider that here the soil investigation was virtually confined to one farm of less than sixty acres, that before this time investigations had been practically limited to two or three men, that the Rothamsted investigation was in one place and in one climate, and yet produced results which changed agricultural thought and agricultural advancement; and then when we consider the scope of Doctor Hopkins' researches, that they involved not the soils of a farm but of a great state, of a varied climate, that they included the soils of almost the extremes in type, from sand to peat and from the rich, black soils found in the corn belt of this state to the other extreme of what are known as the post-oak soils of the south almost devoid of fertility, that his researches covered the physical as well as the chemical and even the biological phases of the soil, that his fields of investigation were located on lands so eroded that they were practically abandoned for agriculture, that they involved soils which were almost impossible of drainage, and from those extremes to the very best land of Illinois—then we find the great range of the research within which Doctor Hopkins' fields brought him.

Doctor Hopkins not only covered this wide field, but he undertook what no other man had attempted—he undertook to show the farmer how he could make practical use of all that had been learned from the study of soils. He taught him the various elements of fertility of the soil and how some of them are found in the air, and some in the soil upon his

own farm, and others at remote places; and he showed the farmer how these could be brought together and utilized for the increase of crops. He instituted a system of chemical analysis of soils which made it possible for every farmer in the state to know the chemical analysis of the soils on his farm, even tho his farm might contain as many as three or four different kinds of soil; and having this knowledge, he could then restore the lacking elements of fertility.

Doctor Hopkins went further than this. He established in Illinois a series of experiment fields for the purpose of investigating the problems of soil fertility. These fields were not only a means of investigation but they served also as a means of demonstration to the farmers of the state. They were located on every large type of soil in Illinois—on the sandy soils, on the peaty soils, on black clay loam, and in fact on every kind of soil found in any large area in this state.

The experiments carried out in these fields have proven different things. They have proven the possibility of permanent agriculture. They have proven that land which is not treated—not rationally treated—and which is cropped year after year, gradually grows poorer and poorer the longer it is farmed. On the other hand, these fields have proven that these lands, when properly treated by the addition of the elements of fertility which are not supplied in any other way except by the effort of man, gradually grow more and more fertile with each rotation the longer the system of soil feeding is continued. I have visited these fields at the beginning of the undertaking, and in some of them it seemed almost hopeless that profitable crops could be raised; and then with the next rotation of crops I would see an improvement in those parts of the fields properly treated; and with succeeding rotations I would see them becoming still better until they were large-yielding and profitable fields.

Another thing these fields have shown is that a rational soil treatment is a sort of insurance of crops; that is, they

have shown that in bad seasons a crop may be grown on a well treated field, whereas on a poorly treated or untreated field no crop, or at most a very poor crop, will be grown. It seems almost incredible that soil treatment could act as an insurance against insects, drouth, and even against storms; and yet I have seen fields in which the untreated parts were so infested with insects that the normal yield was practically cut in two, whereas on the treated fields—the properly treated fields—a normal crop was produced. On fields on which there had been almost no rainfall I have seen the crop entirely dead on those parts of the field which had had no soil treatment, whereas on those parts of the field which had received a rational soil treatment the crop was not only living but was producing a good yield. And following the hard wind and rain storms we have in Illinois which beat the crops flat to the ground, I have seen the crops on those parts of the fields which received no treatment so flattened down that they could never rise, while on those parts of the field which were receiving treatment the crops, while somewhat beaten down, straightened up and made a good yield. I have seen these things.

One other line of activity was taken up by Doctor Hopkins in his soil investigations, and that was the soil survey of Illinois. Among the first questions which arose when the soil investigations were begun were: What are the soils of Illinois? What are the different kinds that are found here? Where are the different kinds found, and what makes the difference between one kind and another? In order to answer these questions the soil survey of the state was begun. County by county the soils have been analyzed, the various types located, and their boundaries definitely defined, and in the reports of this survey is the key to the farmer to all the information obtained by Doctor Hopkins in his investigations. Soil maps have been made which are so accurate that, knowing the range, the section, and the fraction of the section

which describes his farm, the farmer can refer to the map of his county and learn the types of soil on his farm and their exact boundaries. In fact, these maps are so accurate that one had better trust them than his own judgment in the purchase of a farm. I know I would a great deal rather. In these reports he will find the chemical composition of his soils—of the surface soil, of the subsurface, and even of the subsoil. Not only that, he can learn the treatment which these different kinds of soil require for the maximum production of crops. I might say that before the soil survey was begun, before the farmers knew how to distinguish between the soil of one farm and that of another, there was great confusion. For instance, if a farmer was recommended to put potassium on his land he might do so and get immediate results, a thing which has been done, but that fact would be published far and wide—not the fact that potassium should be put on peat land but that potassium was a good fertilizer. Then one hundred others would apply potassium and get no result. But now if a farmer has peaty land he knows what to apply to get results in increased yields but he does not apply potassium to sandy or clay land. He knows enough to distinguish between the one and the other.

The best part of all this soil investigation is this: that as a result of it the farmers themselves are putting into practice the very things that Doctor Hopkins has recommended, and are getting identically the same results that he got on the experimental fields. What does this mean? The flight of imagination cannot express what it means. It means, in a word, increased crops to the farmer, but that is not all. It means more food for those who are not farmers. Every excess bushel of wheat that is produced by you on your farm means the pushing back farther and farther of the famine area.

So firm was Doctor Hopkins in his conviction that the poorest land could be made to yield large and profitable crops that he hunted out the most barren piece of land in the state

that he could find—a farm in southern Illinois which had been abandoned for five years—purchased it, and named it "Poorland Farm." I discussed with him at the time the profitableness of the venture, arguing that he would make a good deal more money if he would buy a farm in central Illinois, but he had a different idea. He asserted that he would make that farm produce yields equal to those of the corn belt. This was a great boast to make for southern Illinois lands, but he made it good. Ten years later he had produced thirty-five bushels of wheat to the acre and it was then that he wrote that great circular "Bread from Stones." It was literally true that he had grown bread from stones, for it was a yield which was due alone to the application of the raw rock phosphate of Tennessee and the limestone of Illinois. Since then these yields have been surpassed by those of which any corn-belt farmer would be proud. But it is not just what Doctor Hopkins has done on this one farm that is of so much value, but rather the possibilities it has shown to the many. By following the practices put into effect on Poorland Farm, any other man on the same kind of land can secure the same results. I know of one man in southern Illinois who has put the teachings of Doctor Hopkins into practice and has got over fifty bushels of wheat to the acre, a yield which would be a credit to any farmer in Illinois.

When I speak of these things—of what Doctor Hopkins has done and the farmers who have practiced his teachings have done—you can begin to see the possibilities and significance of his work. I have become convinced that there is not a foot of the ground in Illinois or perhaps anywhere else but that could be made to produce the very largest crops and made to produce them profitably to the farmer. As I think of these possibilities, it seems to me that the only limit to food production and the human life resulting from food production is simply this—the limits of human knowledge and human labor, and to both of these how largely has our Doctor Hopkins contributed.

DOCTOR HOPKINS, THE TRUE TEACHER OF THE SCIENCE OF AGRICULTURE

By BROTHER LEO
Superintendent of the Farm, University of Notre Dame

WE, the farmers of the middle western states are in deep mourning. In the death of Doctor Cyril G. Hopkins we have lost our greatest agricultural teacher and scientist. A great servant of the people has passed away. A man with a noble soul, a broad mind, wholly unselfish, a true friend of the farmers, and a deep thinker, he fearlessly spoke the truth in defiance of opposition. As he once said, "You may trample the truth into the earth but it will rise again."

I knew Doctor Hopkins personally; the news of his death is grief to me. I was the recipient of his valuable knowledge relative to building up depleted lands.

It has been said that from a productive standpoint some men are too scientific to be practical. This was not true of Doctor Hopkins. While he was deeply scientific, his scientific knowledge was applicable to all. His profound simplicity coupled with accuracy was one of his many outstanding virtues. A self-sacrificing, untiring worker, he labored to the very end. The state of Illinois, and other states as well, have been made richer in agricultural knowledge brought about by the persistent experiments and study of Doctor Hopkins.

While Illinois had the first right to the use of the services of Doctor Hopkins, Indiana has also come in for her fair share of the fruits of the practical and workable facts pertaining to soil fertility and crop production, first promulgated by him.

Doctor Hopkins' life work is ended. We bow our heads in humble submission to the providential decree of God who has called from this life a humble servant of the people. May his soul rest in peace.

THE CULMINATING YEAR IN THE LIFE OF DOCTOR HOPKINS

By GEORGE BOUYOUCOS
Michigan Agricultural College. Captain in American Red Cross Commission to Greece

ON September 20, 1918, I received a letter from the one whom we commemorate today, informing me that he had accepted a call to go to Greece to help rejuvenate the agriculture of that country and asking me if I would join him. You can all imagine, of course, what my answer was. A few days later I received a telegram requesting me to prepare to meet him in Chicago after two days. When I met him in Chicago I found him very serious but full of joy and enthusiasm, the reasons for which he soon confided to me. They were two: first, that he had an opportunity to take a more active and direct part in helping win the war; and second, that he was going to study the soils of that old country which have been farmed for thousands of years, to ascertain in what condition they were and to see what he could do to make them produce more quickly and permanently.

Doctor Hopkins immediately applied himself to learning the Greek language with a rare enthusiasm and great intensity, and by the time we arrived in Greece he had already made notable progress in it.

On our arrival in Greece he entered upon his work at once with a boundless enthusiasm and interest, passionate devotion, intense concentration, and ceaseless labor.

His greatness as a scientist, his love for the truth, his conscienciousness and practicability are further revealed by the plan he followed in performing his monumental work in Greece. He absolutely refused to give advice or to make recommendations regarding the soils of Greece until he had made a thoro and scientific investigation of them. Accordingly, he instituted as thoro and extensive scientific study of the soils of

the country as the time at his disposal permitted. He applied four different methods in examining the soils of the country: (1) personal examination, (2) chemical analysis, (3) pot-culture experiments, and (4) field experiments. He visited and examined personally all the most important soil areas in Greece, collected over three thousand single soil samples, which were combined into about one hundred composite samples and were analyzed chemically, and he conducted many series of pot-culture experiments and several field experiments in different parts of the country. After he had obtained scientific results from these various studies and had acquired a practical knowledge of the agricultural conditions of the country he wrote a little book containing advice to the farmers and giving recommendations to the Government. This book was sent free to nearly all the farmers in Greece. Almost two hundred thousand copies were printed and distributed.

He outlined to the farmers systems of agriculture by which their land could be made to produce infinitely more and permanently and at the same time permanently retain its fertility. He recommended to the Government educational systems of agriculture and ways in which it could render direct and immediate help to the farmers. This report is a masterpiece. He poured into it the cream of his wonderful knowledge and rich experience. It is his culminating work and will always stand as one of the greatest monuments to him.

He did all this tremendous amount of work in the short space of ten months. It was a gigantic task; one that only Doctor Hopkins could have performed, for he was blessed with perfect health and a remarkable power of endurance both physical and mental. He was possessed of a wonderful ability for mental concentration, with remarkably efficient methods of work, with a great love for work, and with the most magnificent spirit, love, and ambition for rendering service. He worked unceasingly and with intensity and never seemed to

be fatigued. His endurance, energy, and activity seemed to be without limit, and always he seemed under inspiration.

The conditions under which he performed his notable work were very strenuous, trying, and full of discomfort, but he never complained. Whenever I complained, he would say, "They could be worse." Never was he melancholy, unhappy, or pessimistic. He was a real and true soldier.

Doctor Hopkins was a great lover of nature, a keen and inquisitive observer, and was endowed to a high degree with a sense of humor. Amid his labors he took time to climb many mountains and delighted his heart with the works of nature. He was always alert and observed everything. He was quick and keen to see the humorous side of life and took great delight in telling humorous stories. I have never known a man who had such an inexhaustible supply of stories of the highest quality. I believe there was nothing he said which he could not illustrate with a story.

Doctor Hopkins was a modest, unselfish, and democratic man. The Greek Government offered to set aside a special car for him to travel and the municipal authorities in the different cities of Greece requested the Government to notify them what day Doctor Hopkins would arrive at their respective cities so that they could receive him officially and entertain and honor him. Doctor Hopkins, however, always declined these and similar offers. He would go quietly into a region, do his work, and when he was ready to leave he would go and pay his respects to the mayor or governor and then depart.

Doctor Hopkins was a kindly man, gentle, sympathetic, considerate, courteous, congenial, tolerant, lovable, and a most wonderful companion. His moral and ethical standards were unexcelled. He was clean, straight, sincere, loyal, and honest. He always followed and practiced the motto never to do anything that he could not honestly justify. The people of Greece admired him, loved him, idolized him, and worshipped

him. They thought that he was not a man, but a god and a saint.

Doctor Hopkins' work is of incalculable value to Greece. Its effects and possibilities are great and profound. Greece is essentially an agricultural country, its prosperity mainly depending on its agricultural products, and yet its land has become so poor and unproductive that most of the time it does not produce even the seed sown, and the nation is compelled to import from other countries most of its cereal grains for bread. Doctor Hopkins was the first man in the history of the nation to study its soils. He discovered by scientific methods the cause of the infertility and unproductivity of these soils, and with his rare ability, remarkable knowledge, and great practicability, he worked out methods of agriculture by which these soils could be made fertile and productive, to remain so for all time to come. He has thus made it possible for the Greek nation to produce its own food to feed its people, and to be prosperous and happy thru the coming generations. His work and its benefits will be permanent and lasting. Considering what agriculture is to a nation and especially to Greece, Doctor Hopkins' service to Greek agriculture will make his name go down in Greek history as one of the greatest if not the greatest benefactors of Greece.

The Greek people and the Government recognized and appreciated his lasting service with grateful hearts. The Government conferred upon him the highest decoration in its power to bestow, that of the Order of Our Savior, and sought to retain his services for a number of years. The Greek Prime Minister, who was at that time attending the Peace Conference in Paris, sent three different telegrams to his Government requesting it to try to secure the services of Doctor Hopkins for a number of years under any terms.

Great is his loss to this country and especially to Illinois. Still greater it is to Greece because she needed him more.

DOCTOR HOPKINS, THE PUBLIC SERVANT

By DAVID KINLEY
Acting President, University of Illinois

THE common test of greatness is power. When the world records its estimate of a man's greatness it has usually, whether expressly or by implication, whether consciously or unconsciously, sought an answer to its question by asking a second question—What was the extent of his authority or power?

Look thru the pages of history, as history is usually written, for the names of those who in the past have been esteemed great and you will find a record of conquerors and slaves and devastators; of men who have built up great personal power on the basis of force which in some way or other has come under their command. It is the conquering kings of Assyria and Babylonia and Egypt; it is Darius and Xerxes and Alexander; Caesar, Napoleon, and Marlborough and their like whose names are written in large letters on the records of mankind as making up the category of the great. We have measured their greatness by the number of people whose lives and actions they could control, by the territory they conquered, by the number of those whose lives they were able to direct, and, indeed, to destroy. It is true that many of these so-called great, in exercising their power and establishing their authority over their fellowmen, have been inspired by beneficent purposes and have actually accomplished beneficent results. Yet it is only in moments of repose or pleasant rumination that we think of the beneficent results of their actions as the cause or evidence of their greatness instead of the extent of their authority. We class Alexander and Caesar among the great, but we do not class with them—certainly not in the same sense—Aristides or Pasteur. We admit, of course, that they were great men, but only in the sense that they were distinguished men. The word "great" in cases like theirs has no

significance. In short, we have been so long accustomed to associate the idea of greatness with extent of mere authority or power over men that we have difficulty in associating it closely with the idea of service to men.

Yet true greatness is to be determined in character and measured in extent by the amount of service which a man in his life work renders to humanity. True, we will all agree in a measure with the thought when thus broadly put. We admit, when pressed, that to call those who have had extensive authority, great for that reason alone, is savage, if not wicked. But all thru the years and the generations and the centuries this idea of greatness because of service has had only a dim and wavering and interrupted acceptance in the minds of men. Its recognition is clearer and wider today than it ever was before, yet we cannot be sure even now that this wider recognition and readier acceptance of the idea will be any more permanent than in previous generations. We hope so. If it is not, it will mean that the progress of mankind is checked again so far as the attainment of cultural and civilized ideals is concerned.

The explanation of the anomaly in our moral attitude, as described above, is of course not far to seek. The beneficial results of the service of man to his kind are likely to be seen only after his own generation has passed away. The effects of the exercise of power and authority, on the other hand, are evident in the present. We see and feel them before we see and feel the effects of good service. We can measure the effects of true greatness only after the lapse of a long period; yet the estimate of the character and attribute of an individual is usually determined, in the first instance at any rate, by the people of his own generation. The slowly accumulating benefits of goodly influence and quiet service make less impression in the minds of men than does the spectacular and startling immediate display of power.

Not unconnected with the line of thought that I have just brought out is the common attitude of the citizens of a democ-

racy toward its servants. In a democracy jealousy of the growth and exercise of power by individual citizens not infrequently prevents the community from securing the services of people best fitted to render them, and always finds expression in distrust, suspicion, and depreciation of those who serve them. The statement, if not the belief, that every public officer should be distrusted, that he is out for his own advantage, that he will utilize his office for his personal gain, and that he will not render honest service, is too common to need proof. Indeed, so common are the statement and belief that sometimes decent men hesitate to put themselves in the service of the public.

This same fear of the people of a democracy that some individuals will become too prominent, or too powerful, has led the people to be content too often with the services of inferior men. We are not willing to pay enough in most public offices to get first-class men. The view is too commonly held that the public officer in receiving his salary is a beneficiary of the taxpayers. The view is wrong to the officer and to the people, and insulting to the intelligence of both. A public officer is no more the charitable beneficiary of the taxpayers than is the manager of a cotton mill the charitable beneficiary of its owner. He draws his pay because he gives an equivalent for it; in many cases he gives far more than an equivalent, especially if the service he renders is a service that he loves.

What I have said regarding the public servant applies in the double sense in which the phrase may be used. We commonly think of a public servant as one who is in the official employ of the government—that is to say, of the people in the government. With reference to Professor Hopkins, however, I am using the term in a somewhat double sense. He was a public servant in that he was an employe of a state institution; he was a public servant in the unofficial sense that he was in a real way a servant of the people. One does not need to be an officer of the government in order to be a servant of the

people, altho every officer of the government is, and ought to be, a servant of the people in the sense that he renders them service. It is with the work of Professor Hopkins as a servant of the people that I am concerned tonight. It is because he has given service of high character, wide in its influence, promoting the welfare of his fellow men that, for my present purposes, I call him a servant of the people, rather than because he was an officer in a state college or a state experiment station. Had he had no such official connection, he might have been a servant of the people. Being a servant in both senses, he is a conspicuous example of the public officer, the individual commonly criticized, depreciated, discounted, and attacked, who, notwithstanding these disadvantages, loyally discharges his duty and quietly, cheerfully, and gladly gives his fellow men the benefit of the talent that he has. It is with this thought that I am chiefly concerned at present, and with the lesson that it has for you and me.

You have listened to an account of the greatness and importance of Professor Hopkins' work from the scientific point of view, and from the point of view of the public welfare. You have been told and have thought about the addition to the wealth of the state, or the prevention of loss to the people of the state, which his scientific discoveries and his practical applications of them have brought. In your minds you have measured, in bushels of corn per year for a generation, the additions to, or the prevention of the loss of, the fertility of the flat prairie soil of Illinois. You have counted up, in your minds, the abandoned lands that Hopkins' studies have enabled, or will enable, the state and the world to restore to fertility. You have imaged the teeming thousands yet unborn who will have a source of livelihood from those added acres, or from the prevention of the destruction of the fertility of acres now being used in Illinois, in America, in Greece, in the world. For there will, in the future, be many a man and woman living whose existence will have been made possible

by the maintenance of fertility or by its increase. On the basis of the present value of corn, you have calculated in millions of dollars the annual addition to our state income thru Hopkins' discoveries. You have seen the corn kernel modified as a result of his studies so as to give us a product varying in character according to our wishes, and so have seen, in your minds, the needs of men better met as a result.

But with all this I propose tonight to have nothing to do, and about it I have nothing to say. My purpose is only to fix your attention as members of a democratic people upon the attitude, the frame of mind, the spirit that Professor Hopkins brought to his work, and in which he did his work. For the cultivation and extension of that spirit among the members of a democracy so that it shall become the general attitude and the general spirit, will, in the long run, be of greater advantage than will all the material results of the scientific achievements of Cyril G. Hopkins. So far as his influence and example lead us to adopt his attitude and spirit and method, he will be doing his countrymen and the world still another service of a different character from, but no less important than, the service that he rendered thru his scientific achievements. For his attitude, his spirit, and his example loudly proclaim to us the necessity of substituting the ideal of service for the ideal of personal gain in our dealings with our fellow men.

What, then, was this spirit of service as shown in Professor Hopkins' career? As a servant of the people he was a teacher and an investigator. In his research work he subordinated his own gain to the love of his work and the good he was trying to do. Undoubtedly he could have made a large income if he had been willing to put his talents at the service of private individuals or corporations, but he thought of the good of the community. His fellow citizens were dear to him; he wanted them to live well; he wanted the next generation to enjoy the benefit of the natural wealth that God has given this generation. To that end he sacrificed his personal ambition

so far as that might have been gratified by fortune. Like others who are moved by this spirit, he was the object of criticism and attack by individuals whose private interests were crossed by his plans for public benefit. As is not unusual in the experience of men, even those whom he sought to benefit were at times indifferent, at times scornful, of what he was trying to do for them, but he labored on in the faith that his work would be justified in the end. In the end he won recognition, affection, praise, esteem, distinction. That we are here tonight is evidence of the truth of this statement. Our meeting is testimony to the truth of the proposition that a life of service is, after all, when its purpose, its spirit, and its fruits are understood by the people, a life of greatness. Our meeting is testimony of our belief that, in a democracy at any rate, the truest and greatest individual is the one who most truly serves. For it is a great sociological and economic truth, as well as a spiritual one, that in our relations with one another "he that seeketh his life shall lose it, and he that loseth his life" for the sake of his fellow men, shall save it, and he that would be greatest among us, must be the servant of us all.

The promotion of the spirit of service was never more important in the history of human affairs than it is today. We are told that the present generation is having a new outlook on life; that there is a changed spirit in the world. We are told that we are in the midst of a great revolution in our aims and ideals and spirit. For myself I do not think so, if by that statement is meant that we are having a new spirit or new ideals or new aims. The spirit and aims and ideals of men have always been for the uplifting of one another, but the means that they have chosen at one time have differed from those they have chosen at another time. Under some conditions the greatest progress in civilization was made by the stimulation of individual ambition for personal gain; under others, the greatest progress is made by greater recognition of the mutual dependence of men on one another. As eco-

nomic and political conditions have changed, the emphasis has been thrown from one point of view to another. Today we are throwing the emphasis from the point of view of the individualistic philosophy of the nineteenth century to that of the philosophy of greater interdependence and the necessity of greater mutual service. For there is an eternal conflict between individual selfishness and duty to one's fellow men. We have been long accustomed to think that we were serving our fellow men by pushing forward our own personal ambitions. In a sense, this is true, but there is a limit to the truth of the statement. It is also true, and under the conditions that obtain in the world today it is truer, that each of us will gain, or at least is more likely to gain, our greatest individual success in proportion as we contribute largely to the general welfare. In other words, the motto on which we must lay our emphasis today is "Success thru service." The teacher, the investigator, the lawyer, the merchant, the farmer, the doctor, and the preacher must all recognize the necessity of giving their best efforts and their greatest service to their communities if they are to reap the richest rewards in individual fortune, individual distinction, and individual esteem.

The spirit of Hopkins, then, is the spirit that the problems of the day are calling on us to show. The time of the sway of the legal phrase "Let the buyer beware" must pass away and be succeeded by the time in which each bargainer and each worker in common shall recognize it as his duty and as the path to his highest individual fortune and distinction to contribute as largely as he can to the common weal. It may be only by honest work of an ordinary kind. It may be by the exercise of unusual talent and the contribution of some new idea or matter or method to human progress, as in the case of Hopkins. However our contribution is made, it must be first of all a contribution that promotes the interest of all, and our share of the welfare will be greater the greater the measure of our contribution.

In our haste to win what we think success, most of us take the direct method and the short road. Putting the matter extremely, it is quicker to steal a fortune than to produce one. It is quicker to get rich by sharp practices and unscrupulous business methods than by friendly practices and honest methods. But we must realize more and more that, in a democracy at any rate, the largest rewards will come to be given more and more—rewards both of fortune and reputation—to those who are the greatest servants of all. Therefore, he who would succeed most largely must choose the indirect method himself, serve his fellow men, and get his personal gain as a reward instead of seeking to achieve it without rendering service, or at least, without rendering as great a service as he can.

The spread and continuance of this spirit of service will be the best solution for the discontent and the excitement of our day. Broadly speaking, the present conflict of ideas, the present agitation in our country and others, the present attempts made to substitute class domination for the general will, can be cured permanently only by the adoption by all of us, or by the majority of us, of the spirit of service as our ideal of life. That adoption will be hastened in proportion as the public gives a larger meed of recognition and reward to those who do the largest service, whatever the line of their activity. If democracy is to continue, it must more and more recognize the spirit of service in its members. It must be ready to reward that spirit of service with a generous recognition in those matters that are regarded as individual success, as well as in matters of reputation. The process of change will be long and its accomplishment will be difficult, but until this spirit becomes the general spirit of the people, efforts of one class or another to get domination over all are sure to continue. We need an abiding faith in the ultimate triumph of righteousness. That faith will be justified and strengthened in proportion as the spirit of service spreads and receives recognition. For that reason the recognition that we are giving our quiet, gentle

scholar is a cheering sign. Yet how much better would it have been could it have been given in larger measure while he was still living! It is so easy to love our prophets after we have stoned them to death, and so much cheaper! Undoubtedly the world will continue to stone its prophets and to recognize them as such only after they have passed away where they cannot appreciate the warm glow of sympathy and admiration which, in due time, the world will feel and try to express. But it is only in the spread of this spirit and the acceptance of this doctrine that we can find the ultimate salvation of a democratic society.

To my mind the contribution which Professor Hopkins, by his life, his attitude of mind and spirit, and his doctrine of service, has made to our practical social philosophy is as important as—aye, more important than—his contribution to agriculture. For without the growth of the spirit that he has shown, democracy cannot endure and improvement in agriculture will be of little moment.

While the attitude of the members of a democratic society must be, as I have indicated, generous and tolerant towards those who are seeking to serve it, those servants who in serving it are its leaders need always to remember, as Professor Hopkins did, that they are but instruments to be used until broken and then to be replaced. That was his spirit. In that spirit he went on his great duty to Greece; in that spirit he set his face westward on his homeward return. He cared little what became of himself so that his work was done. In research, as in other lines of service for the people, the watchword for everyone who would be of use is "Spend and be spent." This is the record of those heroes and leaders who, in their long fight for righteousness, have lifted up the torch of courage to light the path of their fellow men. As another great leader has said: "It is a little matter whether any one man fails or succeeds, but the cause shall not fail, for it is the cause of mankind." In this spirit must each one of us make his contribu-

tion. In this spirit must each one of us seek to do his service. In this spirit must each one of us do his life work, content that whether distinction comes to us or not, is a matter of little moment so long as God's work is done.

Finally, the duty is incumbent upon us all in a democracy to see to it that the society is true to itself and serves its own ideals. A democracy that is rent by factions is a democracy without the spirit of public service. It will fail. A democracy that permits itself to be exploited by the strong, whether individuals or groups, will fail, because the spirit of service is lacking in those individuals and groups. A democracy that casts obloquy upon those who serve it and discredits them as self-seekers, will fail, because in the long run it will kill the spirit of service in those of its members who seek to do good. There is no way of success for democracy excepting in the wider application and practice of this spirit of service to one another. We have been accustomed to say: "I will achieve individual success, in making a fortune or what not, and thereby make my contribution to the general welfare." We must now say: "I will make my contribution to the general welfare by serving my fellow men to the best of my ability in the line of my chosen work, and have faith that in the recognition of my obligation, adequate rewards of fortune and name will come to me."

The two ideals are not incompatible; the latter is the harder path to follow and the harder height to attain. In the long upward walk of men, only a few of each generation have chosen that latter way and walked that harder path. But, thank God, the number has been an increasing one as the generations have passed, and it is larger today than it ever has been before. It will be larger tomorrow than it is today; it will be larger tomorrow and more powerful tomorrow because Cyril G. Hopkins set so shining an example of that spirit and attitude and ideal in his own life.

THE SIGNIFICANCE OF THE WORK OF DOCTOR HOPKINS

By E. W. ALLEN
Chief, Office of Experiment Stations, United States Department of Agriculture

IT is said, "There is no joy the world can give like that it takes away." The taking away of an illustrious public servant in the full vigor of his career arouses not only a sense of irreparable loss but a first feeling that his passing was premature, that his work had not been finished, that he was needed to carry it forward. We may forget that life is measured not by its length but by its accomplishment, that the most that can be expected of any man is that he "will stir a few grains of sand on the shore" of knowledge—that his greatest service may be to supply a new vision or set in motion a movement so far-reaching that it will require time and others to complete its fulfillment. The larger the idea or the greater its reach the more rarely can he see it thru. The work of a man who has been a great constructive force lives on after he has passed, marking a definite step in human progress and gaining strength with perspective.

In the death of Doctor Hopkins not only Illinois and the Central West, but the country, agricultural science, and the American experiment station system, loses one of its foremost students and one of its most conspicuous examples of a life of service in science for agriculture. He belonged to all of us. He was a powerful champion of the underlying purpose of agricultural investigation, and he was a great stimulating influence in giving it direction. He dealt with subjects of fundamental importance in a manner which was at once scientific and practical; and by the clearness of his thinking, the perseverance of his efforts, and the vigor with which he expounded his conclusion, he made a nation-wide impress.

SIGNIFICANCE OF HIS WORK

I have thought to consider briefly the broader aspects of Doctor Hopkins' career as illustrating the qualities and requirements of experiment station work and some of the lessons which his activity affords. This may be done under three general heads: first, his work as an investigator—the example of concentration, of work shaped and guided in accordance with a clear purpose and a broad fundamental idea; second, his work as an interpreter and demonstrator of investigation—an expounder of the results of science in popular form; and finally, as a product of both, the forceful illustrations he gave of the application of science to the most practical operations of agriculture and the far-reaching conviction he aroused in its usefulness.

Doctor Hopkins' guiding purpose may be found in the Biblical command that, as wisdom is the principal thing, "therefore get wisdom and with all thy getting get understanding." Aye, this is the chiefest aim of all, for understanding is the basis of reason and intelligence, and without these what we designate as plain common sense loses its force and reliability. First and always he sought wisdom and the understanding of things, to direct him in his search and to safeguard him in interpretation.

One of the most important lessons which the past quarter of a century has impressed upon this country is that agriculture is just as susceptible of investigation and of understanding in all its processes as is engineering or medicine or any other form of human activity, and that thorogoing research is the most effective means for determining safe and sane methods for its advancement.

Doctor Hopkins' career was an example of the truth of this. He never doubted the power of science to benefit agriculture in practical ways. His first interest in it was in its applications, the use to which he could put it in solving practical everyday questions or in leading to a clear comprehension of their meaning. He did not hesitate to make these applications

of science, for he had both courage and faith in them and he was not deterred by quibbles and doubts.

He employed science as a means rather than an end. He sought its practical applications in explaining the meaning and the true significance of facts. He himself quoted the great chemist Liebig, who said: "Agriculture is of all industrial pursuits the richest in facts and the poorest in their comprehension. Facts are like grains of sand which are moved by the wind, but principles are the same grains cemented into rocks." He sought diligently the comprehension of these facts and their development into principles of action.

To this faith in science and courage in its application he added the vision and imagination essential to any epoch-making or revolutionary effort. His view of practical questions was not warped or foreshortened by temporary advantage; but enabled him to see them in their true perspective in the light of permanent benefits or effects. And so he early discerned some of the typical problems of his state and saw the drift of the method of farming in the Middle West in its ultimate effect. Selecting a few lines which could be studied thoroly in all their relations, he threw the whole force of his energy and enthusiasm into their pursuit, holding on with bull-dog pertinacity to a phase of the problem which for the time being baffled him, or to a proposition which he was striving to advance. An obstacle was to him something to be overcome and turned into a stepping-stone to progress.

Perhaps his strongest trait as an investigator and that which teaches the most powerful lesson was his devotion to an idea, his concentration of effort on its development and substantiation. It gave purpose and direction to all his work. He refrained from undertaking too many unrelated things at once. He paid little attention to experiments which were merely comparative or to narrowly limited trials. His effort was wide in range and variety, but it dealt with large rather than trivial or disconnected matters—never with the commonplace or scat-

tered. It was concentrated and consciously aimed. His extensive field tests, his more refined experiments, and his laboratory investigations, whatever their grade, were parts of a greater whole which centered in some phase of a broad, general problem. They aimed at developing a method, a system, a principle.

This was indeed an important quality of his activity, and well illustrates an attribute of thorogoing investigation which itself imposes quite definite limitations on the output. It was a quality which enabled him in the end to accomplish so much that was worth while. It showed the breadth and depth of his view, an intelligence about his whole subject which was not vaporized in the pursuit of small, disconnected parts. The man who has no vision beyond unrelated comparisons of this treatment with that, measurement and quality of soil particles, composition and form of materials, but becomes lost in their study for themselves, fails to see the forest on account of the trees. The conspicuous names in agricultural investigation are of those who have had a broad, philosophical grasp of their subject, as had Doctor Hopkins, which guided every step and molded the product into a symmetrical whole.

While Doctor Hopkins was interested in the practical applications of knowledge, he was not concerned in merely practical work without knowledge. This is an important distinction which marks the man of science. He sought first the truth, and he adopted every known means to insure it. He was content, furthermore, to make haste slowly if safely. As it is a function of science to interpret human experience, he gave close study to the practices and views of leading farmers, and he took account of their experience in relation to current views. Such an interpretation requires a high degree of skill and caution, for while, rightly interpreted, all experience is useful, it may be potentially a source of grave error. He had keen insight and powers of observation, and an analytical mind which subjected every result to critical scrutiny. He usually

got all there was to be derived from an observation or an investigation, either in deduction or suggestion.

His study extended far beyond the range of his own efforts. He was by no means narrow or self-centered, or engrossed in his own theories. He followed closely the work of others, built upon it, and embodied it where it served his purpose. For he was a master in marshaling and weighing the evidence and in weaving it into a theory or a system he was elaborating. Few men in his line have ever drawn so copiously from the work of Rothamsted and other long-time experiments, from census data, and from records of various kinds which bore upon his thesis. Little that was current escaped him or his searching analysis.

This is the true method of progress in science—to build on what has gone before. An eminent French scientist once said: "If we are able to add something to the common domain in the field of science or art or morality, it is because a long series of generations have lived, worked, thought, and suffered before us." The wholly new contributions which any man can make are relatively small compared with the infinity of knowledge. All we know at present is a mere fragment of what will ultimately be found out.

New knowledge is built up by a constructive process, usually the product of many minds. Chance discoveries of great moment are rarely made at random. Piece by piece new truths must be found and fitted together. Each investigator must rest his work on that of others. He must "stand upon the shoulders of the past" if he is to look far into the future. To know what has gone before is as essential as to know how to add to it.

Slow as discovery may seem to be by this method, it is after all relatively rapid when we think of the vast changes in which Doctor Hopkins has had a part in the twenty-five years of his service. Farming on the basis of science-teaching is progressing relatively fast. Our power over nature is increas-

ing, and prediction of what will follow a certain course of action can be made far more accurately than ever before. What this means to agriculture is emphasized by the statement of one of our most experienced station directors that "the success of the farmer consists not so much in the skill of his hands as in his ability . . . to avoid the isolation of natural law." The force of this Doctor Hopkins well understood, and his work was directed to interpreting those laws and influences so that the farmer might better understand how to avoid violating them and how properly to employ them.

Doctor Hopkins was a keen critic, and in this rôle, again, he rendered conspicuous service, because his criticism was honest and was tempered by real desire for the truth—not by any sordid motives or purpose to break down. The watchfulness he maintained of the publications in his field had a wholesome influence, for criticism which is sound and constructive is the life of progress in investigation. It guards against error in deduction and it leads to a strengthening of the evidence.

Criticized himself, he stood firmly for his views and defended them tenaciously when he felt that he was in the right, but he did not fail to profit by questionings in reinforcing his position. He differed often and honestly with others, but if I view him aright he did not bear malice or personal feeling, and the vigor of his contentions expressed the force of his nature. He was sure of himself, as he had a right to be. Difference of opinion was with him a question of facts and their meaning, not a personal matter.

The influence of such a man on the progress of thought and investigation is not easily estimated. And yet he was not often seen at meetings of scientific men, altho honored by membership in many scientific organizations. He lacked the time, apparently. More often he was to be found in the meetings of farmers, who were his real clientele. He did not need the inspiration of personal contact with men of science, for he himself felt the infusion of the divine fire, and he imparted it to those who came in contact with him.

But his writings commanded attention, and it was thru these that his broader impress was made. Not to read them was to omit keeping abreast of the times, for his bulletins and circulars and his published papers always carried a message, usually a stimulating thought. Because he was known to be doing things, a bulletin by him was opened with expectation; and the plain, straightforward, vigorous style in which his results were presented and his theories expounded was the stamp of a clear and forceful mind.

Doctor Hopkins' career typified service in the best sense. He was actuated by a desire to do something which would benefit humanity, something which would endure. For he was "working for the man with his coat off," as a former Secretary of Agriculture used to say. He was not satisfied with investigation for itself, but he demanded to see it crystallized in action. He realized that it is not what a man knows that makes him of value to the community, but rather the use he can make of his knowledge in serving the human race.

He put his knowledge to use. He was a demonstrator; to an extent, a middleman in science. In some respects this was his most powerful rôle. He was not merely a compiler, a purveyor, but a digester and interpreter of investigation. He translated the results into terms of practical farming, and he demonstrated the lessons and expounded them to wide audiences with power and with far-reaching effect. He was a vigorous advocate.

It seems to require some master of the art of forceful presentation, from time to time, to arouse the public to the full meaning of what investigation is teaching—some one with genius for popularizing science without distorting it, and for bringing it into homely everyday use. He was such a master.

The man who would make two blades of grass grow where one grew before, if he is to be the human benefactor that Dean Swift pictured him, must understand all the factors that are involved and take account of the ultimate effects, or he may

prove to be a prodigal son instead. It was because the production of the one blade was often at the expense of the future that Doctor Hopkins' voice was raised and a crusade conducted with all the rugged force and enthusiasm of his personality.

He taught, as you well know, that agriculture based on the provident use of the soil is the foundation of national welfare, and that the maintenance of fertility is the basis of permanent agriculture. He looked upon the soil as a legacy, one of the greatest natural resources, which after supplying our present needs should be transmitted unimpaired if not enhanced in fertility and productiveness.

He did not stop with the advocacy of this thesis, but he set about developing a practical system for carrying it out. It was not merely a theory with him; it was a feasible, practical method of farming. When he said in one of his later bulletins —"Every farmer should practice a high-grade system of permanent agriculture. This is made possible by good crop rotations and the application of materials economically supplementing soil deficiencies," he spoke without reservation and from the depth of his convictions. The idea was not wholly new, but he gave new force to it, basing it on work which was both intensive and extensive.

Undoubtedly more than any other man he was responsible for impressing upon the farmers of the Middle West the inevitable result of continued overdraft on soil fertility, and the idea of permanent fertility. When he first undertook this, his was like "the voice of one crying in the wilderness," but instead of being deterred by apathy he was spurred on. He couldn't be stilled. He was an evangelist preaching the gospel of soil fertility and permanent agriculture, to an audience that broadened and widened until it included the whole country. And he moved them, he put his message across; his theory became accepted in principle, if not indeed in every detail.

Because he was successful and had such a far-reaching influence, this work constituted one of the most striking dem-

onstrations to be found of the value of science in agriculture; and the result of it was felt in an enlarged appreciation and support for research. We cannot too often remember what such an influence has meant.

The manner of conducting the soil survey, with its study of the soils in the field, in the laboratory, and in pot cultures, later supplemented by lysimeters, need not be mentioned further than as an example of the thoro and systematic manner in which he brought to bear every known method for the study of soils. Here again he sought to bring the work to a point where it had real, practical use.

His corn-improvement study, demonstrating in so striking a manner how far the individual fluctuations could be seized upon and used to advantage, aroused wide attention at the time and lent a great stimulus to improvement, adaptation, and seed selection, which have become widely established in theory and practice.

It was not necessary for Doctor Hopkins to wait until his career was closed to receive the tribute of success. He lived and worked to a great purpose. Not only did he accomplish things of large import, but his work was recognized, as the work of few has been, while he was engaged in it; and he had the gratification of knowing that it was effective and was appreciated. He had the satisfaction that comes from doing a task well, and the additional joy of so doing it as to render an enduring service. What he has meant to Illinois, to the Central West, to the country, and to the cause of permanent agriculture, history will record in grateful recognition.

"We glory in the man who can;
We glory in his might and mastery.
We glory that within the sullen clod
His eyes have read the secrets of our God;
That his own hands have grappled with the key,
For fellowmen to set those secrets free.
We glory of his deeds to tell;
And it is well."

DOCTOR HOPKINS, THE MAN

By EUGENE DAVENPORT
Dean of the College of Agriculture and Director of the Agricultural Experiment Station, University of Illinois

A GREAT character has gone from among us. I can hardly reconcile myself to the loss of him. It seems quite impossible. He is away upon a journey and some day will come into my office again with his accustomed smile and hearty greeting and we shall fall again to discussing ways and means of insuring for all time the producing power of Illinois soils. It is only my reason that corrects my vision of his coming.

Others have spoken of the work of Doctor Hopkins and of what it has meant and will mean to the state and to the world. It is therefore my present purpose to speak of the man, rather than of what he accomplished—of his methods of work, his ideals, his visions, and his peculiar personal qualities that stood as a background to give supreme value to all that he did. It is important, I take it, that this rich mine of human excellence should not be left untouched until those who knew him intimately have themselves passed to their reward and it shall be too late. It shall therefore be a duty as well as a labor of love to set down as impartially as I am able the leading personal qualities of this great man as they appeared to me who lived in almost daily contact with him for nearly a quarter of a century.

HIS METHODS OF THOUGHT AND WORK

Doctor Hopkins' methods of work proceeded from his methods of thought, for nothing was artificial with him. He did nothing for effect. His only object was "truth" and in its quest neither time nor labor counted in the balance.

He was born as well as trained a chemist; that is to say, his habits and methods of thought were analytical. Yet was

he not satisfied with mere analysis—with taking things apart simply for the sake of laying out and naming the pieces. His only interest in the analysis of things was to find out how they were made, by what principles they were actuated—all for the sake of making use of their service and of insuring their perpetuity.

He was eminently a practical man, and he continually refused to draw any line between science and practice. "Science is truth," he often said, "and practice to be successful must be based upon truth"; and he continually insisted that no basic difference existed between those forms of truth that have become familiar thru long acquaintance and those newer forms that are but just discovered, or even those that still remain to be elucidated.

To him, therefore, the world with all that it contains was but a great assemblage of truths held together by essential principles that have all the force of immutable law. Some of these truths and principles lying on the surface, so to speak, have long since been discovered and passed into practice; others lying deeper or held in more complicated bonds, are more difficult of discovery and application, requiring special methods. It is the reduction of this class of knowledge that is the special business of science and of the scientist. But once discovered these truths are no different than are any others. All truth is truth, and that is all that can be said about it.

I have said that Doctor Hopkins had a deeply analytical mind. It was this that would not let him stop with the analysis of corn as corn, but led him to analyze different ears to see if they were all alike. Finding them different, he must needs know whether that difference resided in the tip, the butt, or other part, and whether the kernel might be the real unit of variability.

Finding the substantial differences to reside in the ear as a whole, his mind would not rest until he determined whether

and to what extent these differences were hereditary and capable of piling up in the distinct strain of high or low protein, oil, or starch. The result was one of the world's most significant breeding experiments, the first in which the chemical constitution of a seed had been altered by systematic selection. And yet Doctor Hopkins was not a geneticist; he simply followed his own mind and methods in logical steps and to logical conclusions.

The same mental logic compelled him to say that you cannot compound a fertilizer or otherwise prescribe treatment for a soil until you know its special composition, any more than can a physician prescribe a remedy until he has first diagnosed the disease that is troubling the patient. It was the same logic that made him oppose the phraseology "phosphoric acid" when it was phosphorus and not acid of any kind that was meant. He considered it illogical to advise farmers with one breath to apply lime to the soil to correct acidity, and with the next to apply an acid, when all acids are harmful and when there was not necessarily any acid in the material applied, necessitating an explanation that would hardly suffice.

He reasoned also that it is more than folly to buy limestone by the carload to correct acidity, then to use fertilizers loaded with sulphuric acid to half their full weight, only to increase the freight and to make necessary still heavier applications of limestone.

It was this same analytical and logical habit of mind that led him to ultimate conclusions in fertility matters where other men—I had almost said all other men—stopped part way and with immediate results. He saw clearly what stands to reason; namely, that no matter what the system or how immediately successful, the application of plant food must be not only equal but somewhat in excess of that removed by cropping, else the farmer is guilty of "soil robbery" and the end would be exhaustion and abandonment, which, when it had gone far

enough, would undermine and destroy civilization by cutting off the means of supporting life comfortably if at all.

In proof of this he cited not only the inexorable logic of mathematics, particularly of subtraction, or rather division, carried to the nth degree, but he also pointed to the extensive regions of the world the soils of which are practically exhausted, and to the fact that thousands of our own once productive areas are already abandoned.

He was at first opposed by the farmers who averred that they were now getting larger yields than when the country was new. He met this by calling attention to the better seed, better tools, and generally better methods now in vogue, and when he called attention to the fact that America has abandoned lands of her own, the answer was, "Oh, they never were very good." Confronted with the fact that some of our abandoned lands, as in Virginia, were once very fertile, the whole subject was dispatched with, "Oh, they have been farmed a long time." And Doctor Hopkins would say, "What is two or three hundred years in the life of a people, and where shall we find new lands when we have done with our old what the Aryan has always done to his ground—treated it not as a living organism, but as a mine to be worked out, then abandoned?"

Doctor Hopkins was even scoffed at as a prophet of evil, and by others educated as he had been in the best laboratories, showing that man may make scientists, but only God makes the prophet. He was confronted by the fact that civilizations have existed in certain regions from the remotest antiquity. In reply he was forced to call attention to the fact that such civilizations had either long since retreated to river valleys fed from vast interiors, as in China and Egypt, or else were subsisting by the hardest labor, as in many parts of India, where as reported by Dean Vivian of Ohio, one good meal in every two days is accounted satisfactory even to the farmer,

the "good meal" consisting of all the corn cake a man's appetite would demand, with no accessories.

His logic and his invincible arguments gradually won a large and intelligent following and in this regard Doctor Hopkins reversed the ancient and honorable saying that a prophet is not without honor save in his own country. It was in his own state that he first won a following by means of his irresistible logic, his experiments and his demonstrations, all pointing to the same thing, namely, the reasonableness of his doctrine of the need and the methods of securing a permanent agriculture.

And they came from the ends of the earth to study with him—from Egypt, from China, from India, from Assyria, and even from Nazareth. Finally, he was called to the seat of modern civilization, and stood with Paul on Mars Hill, declaring the duty of man to the soil upon which he subsists, and its full discharge as a necessary means of beating his way upward to his God.

HIS IDEALS

Doctor Hopkins had but one purpose in life, and that was service, particularly along the lines in which he had special training. He was not one who assumed that all his obligations could or should be discharged by his scientific achievements—far from it. He was a good citizen, interested in the details of community and public life. He accepted and discharged all the ordinary duties of citizenship, and when time passed with no family, he invited into the full privileges of his home two boys who were homeless, and to them he gave all that he had beyond the devotion which he felt and lavished upon her whom he had asked to share his labors and his fortunes. He gave liberally to worthy enterprises, and from a young man he tithed all his earnings: one tenth went regularly to the Lord. His life was clean in the strictest sense. He had an especial abhorrence of drugs in any form, hence his aversion to tobacco and liquor, which in a way he classed

together because of their subtle influence, an impression formed in part from his studies in pharmacy, but mainly constitutional.

His abiding sense of service shut out all possibility of selfishness, even if it could have found lodgment in his nature, which I very much doubt. He was so intent upon accomplishing what he had undertaken, and working while it was yet day, that he utterly forgot himself. Indeed, here lay his one great fault as we could see it, and it was a grievous one —he never spared himself. Of robust constitution and of almost superhuman vigor and endurance, he labored continually, against the better judgment and the earnest solicitation of those of us who knew that every man has his limits. Day in and day out, month after month, and year after year he labored and dreamed for a better agriculture, and for one that should build up instead of exhaust the soil upon which races and nations are dependent for that comfortable existence that permits of progress.

He had a keen sense of humor and it stood him in excellent stead, for he was never angry, nor was he ever gloomy even when working upon his most difficult problems in the face of opposition. He was of the stuff of which martyrs are made, and in the end he was a martyr as truly as any other that gave his life for a cause or for the good that he could do.

HONESTY

Next to the spirit of service and his ideals of the responsibilities of life, Doctor Hopkins' most distinguishing characteristic seemed to be honesty. Not that ordinary honesty which distinguishes between mine and thine in matters material, but that deeper reverence for truth that refuses to deceive either others or itself by things which are not what they seem.

He talked much about "absolute truth," as if there could be any other kind. What he meant was to get at the real bot-

tom of things and be certain to distinguish clearly between fancy and fact, between the shadow and the substance. Upon such a man ordinary temptations did not operate but slipped off as does a garment that does not fit.

Hence it was that he borrowed money to help develop a phosphate mine for service to Illinois, not for the money that might be made out of it, but to convince people that he was honest in what he said about soil treatment. He said to me, "Nothing will convince like investing your money, especially when you borrow to do it." When it was decided that sound University policy did not permit of commercial investments in line with service, he readily understood that his motive might be misinterpreted and relinquished his interests. After that he put all his private energies and capital into the development of Poorland Farm, which he had chosen on the most badly worn soil that could be found in southern Illinois. This, too, he did as proof of the honesty of his intentions and the soundness of his doctrines.

And now came what to many would have been the supreme test. He was to develop a farm upon the poorest land in Illinois to show what could be done. Accordingly, sympathetic interests tendered him all kinds of fertilizer free of expense to help the good work along and money without stint. With appreciative thanks he declined while paying interest on the purchase money and running deeper into debt for what he needed in order to put the farm on a producing basis. He even refused to buy farmyard manure of the neighbors, saying flatly, "I am not going to develop Poorland Farm at the expense of neighboring farms, nor am I going to do anything that cannot be done upon any and every farm in the district."

This is high ground for our admiration, and we are all gratified that he lived to pay for the farm and to make it begin to yield a small profit, justifying his program of procedure in the slow and costly restoration of worn-out soils.

His greatest test came in turning aside matters and money that would have greatly enriched his department and its work upon the ground that Illinois did not want a "lop-sided" University. More on this point I cannot say without violating confidence.

LOYALTY

Only a few of the outstanding virtues of a man like Doctor Hopkins can be mentioned in so short a paper as the limits of the occasion impose, but his spirit of loyalty must not go unmentioned.

His nature was not fickle. Once an issue or an idea or a man was accepted, the new conception became a part of his very being and henceforth figured as a permanent element of his existence. He was loyal, therefore, not only to his family and immediate associates, of whom he conceived no evil, but he was loyal also to that multitude of men whom he came to know more or less intimately as students, and to that larger company of business men, particularly farmers, nation-wide, even world-wide in its extent. His interest in truth was such that he forgot both himself and the man, and therefore met governors and ministers and kings exactly as he would meet a forty-acre farmer on his farm in southern Illinois.

His loyalty was not limited to ideas and to immediate associates, but it extended widely to everybody and everything that might be involved. He served the University and the state of Illinois as few men have served anything outside themselves. He had declined repeated opportunities to enter more lucrative service, and when at last the most tempting proposition came, he wrote me substantially as follows:

"I want to do what good I can while I stay, and will accept detached service when possible. But I owe all that I am to Illinois and the University, and no place this side of Heaven shall take me away."

In a few weeks he was gone to his long home, but he went from Illinois as truly as if he had never sailed away.

THE SPIRIT OF PROPHECY

Doctor Hopkins was more than a scientist; he was a prophet. He valued science not for itself but for what it could be made to do, and he was a preacher in the matter of making it work.

He was a prophet, too, in looking beyond the immediate and into the future. He depended upon no impulses and he practiced no incantations, but armed with "absolute truth" derived from asking questions of nature, and fortified by irresistible logic, he thundered against the sins of the fathers as the prophets of old thundered against corruption.

I have heard him likened to Joseph, whose part he took in a play one time, and indeed he had the same prophetic vision in providing against the lean years. If we follow his teachings the lean kine will grow fat and never refuse to yield their sustenance.

I have heard him likened to Saint Paul, whose footsteps he literally retraced during the last few months of his life. And indeed the similarity is great. Like Saint Paul he gave most of his life to a work which was not of his choosing, but to which he was called—for the headship of the department and the professorship in which he rendered his great service were tendered him by cable when he was a young man studying the chemistry of starch three thousand miles away.

Like Saint Paul he entered into larger life and saw a vision of greater things than had been in the minds of the masters under whom he had sat. Like him he turned abruptly and gave all that he had to the new call, and like him he had a vision of a new heaven and a new earth. No wonder the common people of Greece, seeing him walking the fields and working wonders, called him a God.

Such was the man who walked and labored among us and who has gone to his reward. His place will not be filled, but will remain a blessed memory.

DOCTOR HOPKINS' WORK

By FRANK I. MANN
Member of the University Soils Advisory Committee

HUMANITY and civilization will not fully realize for another generation or more what was gained from the life of Doctor Hopkins, nor what was lost by his premature death. We may honor him now with our utmost reverence, but his greatest honors will be on the pages of the future, when the benefits that come from his having lived are more appreciated.

Great needs call out for great men; some come tardily, some come at first call, and some anticipate the call. Among the latter was Doctor Hopkins. He saw the need coming, and almost before the first call he was preparing himself to meet the great need. He saw the changing ratio between population and food production; he saw the occupation of the last large areas of productive land; he saw the reduction in food production on large areas; he saw abundant food as the foundation of a happy people and a higher civilization. What he saw gave him a life work; always with a love for humanity and a hope for higher civilization.

The principles of food production had been given scientific study for a few decades before Doctor Hopkins' time and a school of soil fertility had been developed. This old school was based on false teachings, procured only temporary results, and when carried out long enough, destroyed the productiveness of the land. It was advocated largely by commercial interests and for profit. It took the master mind of a man like Doctor Hopkins to separate the true from the false and to develop a school of soil fertility based on permanency, economy, and high productiveness; a system which leads to higher production the longer it is practiced; a school which considers and solves the food problem for many generations. The great minds of the world are those who have reduced complex propositions to simple equations; who have changed complexity of

thought to simplicity of thought. This Doctor Hopkins was able to do with the problems of food production.

His use of common natural raw materials in the production of food was strongly objected to by many who were directly or indirectly gaining profits out of the old-school systems, and many honorable and dishonorable efforts were used to discredit the more simple and truthful methods. Doctor Hopkins was always ready to take issue with the opponents of the new school of fertility; and being always sure of his ground, he was at his best when discussing points of controversy. In his strongest defense against critics he had no feeling other than a desire for justice.

Doctor Hopkins' love of humanity was his greatest emotion. While knowing full well the dangers that might come in his mission abroad, he did not hesitate to accept what he considered a duty to humanity.

One phase of his life work is done; another is left undone; and it must become the duty of the many who received inspiration and the light from Doctor Hopkins in his lifetime, to revere his memory and carry on the dissemination of his great principles, in the spirit he would have given—a love for humanity.

—Editorial in the Prairie Farmer, October 25, 1919.

EXTRACTS FROM LETTERS FROM COLLEAGUES AND FORMER STUDENTS

EXTRACTS FROM LETTERS FROM COLLEAGUES AND FORMER STUDENTS

"His going will be a great loss, almost an irreparable one as we think of it. He has done a wonderful work for the farmers of Illinois and for the whole country as well, and it is extremely regrettable that his life should now have been sacrificed in his high-minded purpose to bring aid to another country in time of distress."

E. W. Allen
Chief, Office of Experiment Stations

"I am shocked to read in *Science* of the death of Dr. Hopkins. This is a real calamity. You will have the sympathy of all the workers and friends in the field.

"I trust that the notes and studies of his observations in Greece are intact and will be available for publication."

L. H. Bailey

"Equipped for his life work with unusual physical and mental powers, which he kept in condition by an absolutely clean and religiously moral life; with a love for truth which could brook no departure from that standard; with an industry that took no account of the size of the task before him; with an altruism which placed the helping of others far above his personal comfort, he made for himself a place in the respect and esteem of his compeers and of his students, both those of the classroom and of the farm, that can never be measured by any money valuation.

"I count it one of the great privileges of my life to have had his friendship and his counsel."

Charles E. Thorne
Director, Ohio Agricultural Experiment Station

"I think it is not too much to say that among his contemporaries Dr. Hopkins was the greatest exponent of the science and practice of soil conservation in America. His reliance upon the importance of fundamental research, his remarkable judgment in applying discoveries of science to the practice of soil improvement, is a glowing example of the opportunity which awaits every young man of imagination who devotes himself with a single-minded purpose to the development of agriculture through scientific research."

F. B. MUMFORD
Dean of the Missouri College of Agriculture and Director of the Agricultural Experiment Station

"This, I feel, is a blow not only to the University of Illinois but to the agricultural world as well. Just before he left Greece he sent me some publications covering the work of his year in that ancient home of a classic people. He was acting and working in the interests of others even to the last and contracted the disease which caused his death because of his intense interest in science. Dr. Hopkins will long be remembered for his saneness in agricultural matters during an age when speculation and theorization seemed to run wild, and he has held us all along safe lines.

"I shall always look back with pleasure upon the very happy and profitable year that I had the pleasure of spending at the University of Illinois under the direction of this great teacher."

HENRY G. KNIGHT
Dean of the Oklahoma School of Agriculture and Director of the Agricultural Experiment Station

"He has rendered to the people of the United States a peculiar service which makes him a truly national figure. I have no doubt the work he has done in Greece will also have large results."

E. A. BURNETT
Dean of the Nebraska College of Agriculture and Director of the Agricultural Experiment Station

"While words are a poor solace at such a time as this, there must be some degree of satisfaction in knowing that your brother, Dr. Cyril Hopkins, had a wonderful career, a career of which you may feel very proud and to which we South Dakotans, especially those of us who have a personal connection with the State College, point with the greatest satisfaction. As a pioneer in the study of soils, he may almost be called the father of permanent agriculture. As a teacher and an inspirer of young people, he had no superior, and as a man, a *gentle* man, deeply interested in the personal problems of his pupils and filled with the spirit of serving them and helping them surmount their difficulties, I doubt whether he had an equal. I have heard many of his former pupils speak of him with the greatest reverence and affection.

"It seems to us that we cannot let him go. We can but wonder why a man like him should be stricken down when he was apparently at the height of his powers. But we *know* that the world is better because Cyril Hopkins lived."

ROBERT L. SLAGLE
President, University of South Dakota
(Written to Mr. H. L. Hopkins)

"Agricultural work in this country has lost one of its foremost workers, and he will be sadly missed in our agricultural work."

B. W. KILGORE
Director, North Carolina Agricultural Experiment Station

"I had considerable acquaintance with Dr. Hopkins and always admired his sturdy common sense and tenacity of purpose. His untimely death was a great shock and was a real loss to practical and scientific agriculture. Such men as he are far too few, and can be illy spared."

J. T. WILLARD
Vice-President, Kansas State Agricultural College
Vice-Director, Agricultural Experiment Station

CYRIL GEORGE HOPKINS

"I have been so intimately associated with Dr. Hopkins for more than a quarter of a century that I have come to regard him more as a brother than as a friend. The news of his untimely death so far from home is a dreadful shock to me.

"He not only was wise and practical, but he had a true vision of the future of agriculture. He hesitated not to speak his mind when convinced of the truth. He opposed error with as much vehemence as he espoused the cause of right. His was a giant figure in modern scientific agriculture.

HARVEY W. WILEY
Formerly Chief Chemist, United States Department of Agriculture

"We, in North Carolina, were greatly shocked to learn of his untimely death. We realize that the Nation has lost one of its greatest thinkers in agriculture. Dr. Hopkins, in the life he lived, exemplified his basic thought in permanent agriculture of returning more to the soil than was taken away. He gave more than he received."

W. F. PATE
Agronomist, North Carolina Agricultural Experiment Station

"In the passing of such a man as Hopkins in his prime, agriculture has lost a serving scientist whose plans were builded on the solid rock of truth.

"I doubt whether his associates at Illinois realize what an inspiration his leadership has been to the younger men in agronomy and soils science, but to me at least he has always stood out as a great exponent of the positive. Essentials always loomed large with him."

H. L. WALSTER
Chairman of the Department of Agronomy, North Dakota College of Agriculture and Agricultural Experiment Station

"His enthusiasm, painstaking labor in his search for truth, and his ability as a teacher both in the classroom and in the agricultural press were exceptional. Illinois has by his death lost one of her most useful citizens and American agriculture one of its men of highest mark."

WILLIAM FREAR
Vice-Director and Chemist, Pennsylvania Agricultural Experiment Station; Chemist, State Department of Agriculture

"We are extremely sorry to learn of the death of Dr. Hopkins and know that it is a great blow to Illinois. However, he had built up a lasting work and this work will continue to become of even greater importance."

H. H. LOVE
Professor of Plant Breeding, New York College of Agriculture and Agricultural Experiment Station

"The world has lost a strong man, one who has given much to the science and practice of agriculture. He died in service as he would want to and in a field of work near to his heart. I believe that I, having been over there, can see as but few others can the great mental strain that comes to a man who ventures assistance to those destitute, simple, but noble people."

C. P. BULL
Associate Agronomist, Minnesota College of Agriculture and Agricultural Experiment Station

"The cause of scientific agriculture has lost one of its foremost leaders, and on behalf of the farmers of the Middle West, I extend to you and your colleagues my heartiest sympathy."

H. J. WATERS
Editor, Kansas City Weekly Star

"The untimely death of Doctor Hopkins is a great state and national loss and a peculiarly poignant shock to those who knew him. Many years ago I saw a great deal of him and had an opportunity of learning something of the innate traits and characteristics which made him one of the outstanding figures among modern agricultural scientists. He was a lovable and noble character."

DEWITT C. WING
Editor, The Breeder's Gazette

"I am staggered by the news of Dr. Hopkins' death. I cannot see how we can get along without him: His family, the College and University, the people of Illinois, and the Nation are in need of his master mind. It makes the whole world seem dark. Personally I feel his loss as I would that of almost no one else. He was one of two men who exerted more influence on my life than all others; the other was a friend of my youth. I don't see how I can get along without Dr. Hopkins."

F. I. MANN
Member of University of Illinois Soils Advisory Committee

"I am not able to express the sorrow I feel, and wish to extend to yourself and his other co-workers in the College my sincere sympathy. The soil of Illinois has lost the best friend it has ever had, yet the farm homes over the state and the increased food that will be given to the world thru Dr. Hopkins' efforts will be a memorial that will keep him in mind for many generations.

"The Illinois Farmers' Institute has lost one of its best friends and ardent supporters. We shall miss him greatly, and I am certain I can speak for the entire Board in saying it is a personal loss to each one of us."

FRANK S. HAYNES
President, Illinois Farmers' Institute

"Let us hope that Greece is worthy the sacrifice and that the work which he did in the Cradle of Learning will become as common world property as are Vergil and Homer.

"We can replace captains of industry, judges, generals and even presidents, but how can Dr. Hopkins be replaced!

A. N. Abbott
Director, Illinois Farmers' Institute

"Permit me to pay this brief and incomplete tribute to a man whose service to agriculture did so much to make possible agriculture's ability to triumph over present obstacles and to insure humanity ample food under conditions which mean that the new era now in sight is to be the most glorious in the evolution of civilization."

Herbert Myrick
Editor-in-Chief, Farm and Home

"In Dr. Hopkins' untimely death, the state of Illinois, the nation, and yes, the world, loses its foremost authority on soils and crops. In my judgment, Dr. Hopkins has done more than any other man to help solve agricultural problems. While he was employed by the state of Illinois, his work was known all over this country and other countries. Wherever I have gone I have found that the people had confidence in Dr. Hopkins and were following his recommendations."

W. J. Kennedy
President, Purity Biological Laboratories

"The world is richer for his having lived and all humanity poorer by his having gone from among us."

P. G. Holden
Director of Agricultural Extension, International Harvester Company

"I never was impressed with the real greatness of Dr. Hopkins until that May morning in the driveway of Poorland Farm. There

I had a vision which will always be mine. He stood there with bared head and spoke words which thrilled me. Then I began to understand as never before. I never pick up that text "Permanent Agriculture," I never teach a class about soils, without that vision of the man, Dr. Hopkins, like a prophet of old, sending forth his message of "Permanency." A farmer who went with us all the day long made this remark to me, "Dr. Hopkins is worth his weight in gold to the farmers of Illinois." To this I could well agree; and I still believe it."

FRANK L. BENNETT
Former student of Doctor Hopkins

"Through his death, it is not only that the United States has lost a great scientist, and the University of Illinois has lost a great professor; but also that the soil fertility has lost its best friend. His work on permanent agriculture, his advocation of the use of limestone and rock phosphate, and his successful proof of the inoculation of alfalfa with the nodule germs of melilotus, make me feel that what he did for soil fertility is at least equal to, if not more than, what Dr. T. J. Burrill had done for plant disease. Indeed, he accomplished much, yet much more still we expected from him on account of his scientific genius, his good health, and his age. His death is totally out of our expectation. May God bless his family!"

S. S. CHEN
Former student of Doctor Hopkins

"Accept my deepest regrets and sympathies on the death of your eminent professor, Dr. Cyril G. Hopkins, whose name will remain immortal to the Greek agronomists for his most useful study. It is undoubtedly the foundation of scientific agronomy in Greece."

PERICLES CALLERGIS
Chemist, Agricultural Chemical Laboratory, Athens, Greece

"Professor Hopkins was a man whose qualities were universally admired by his associates in the American Red Cross, and by all the many Greeks with whom he came in contact. The service which he rendered to Greece is almost incalculable, for he worked with tireless energy and with a full understanding of what each situation required. Certainly Greece has acquired no more devoted or unselfish friend than Professor Hopkins, and his loss will be deeply mourned by the large number who have come into contact with him. He was a martyr to Greece, for the malaria which prostrated him must have been caught during his trips about the country where malaria is the curse of the people.

"For his work and for his supreme sacrifice I admire him, and I wish to join my tribute to the many he will receive from those who knew him and appreciated him. He died in service, after giving without stint everything he could give. He leaves the world a better world for his having lived.

"I send you my heartfelt sympathy for the loss which you have sustained."

MAJOR HENRY B. DEWING
Representing the American Red Cross in Greece

"Deeply regret to hear of the death of the distinguished Professor Hopkins. Greece loses a good friend whose valuable services she intended again to avail herself of in the future. Kindly convey to his family our heartfelt sympathy." (Cablegram)

K. SPIRIDIS
Minister of Agriculture, Greece

"The death of the American Major Hopkins, recently announced, has caused great grief to the Athens public. Our people have been quick to recognize and appreciate the worth of the man, his zeal, and the warm sentiments of friendship which he has displayed toward Greece in rendering his great and valuable service as a member of the American Red Cross in Greece.

"This splendid American officer rendered to the suffering population of Macedonia a service which was actually inestimable."

Translation of a notice appearing in Hestia, one of the newspapers of Athens, October 12, 1919

"It is with great sorrow that the Royal Agricultural Society has heard of the death of the eminent scientist, Dr. Hopkins, Professor of your University and a distinguished member of the American Red Cross in Greece.

"Our Society's Council board wishes us to express herewith its sincerest condolences for the loss of a man who extended his beneficent action beyond his country and worked with notorious zeal for the agricultural progress in Greece."

P. CALLIGAS, *Vice-President*
PH. G. PALIATSEAS, *Secretary General*
Royal Agricultural Society, Athens, Greece

"The city of Athens has been greatly saddened by the death of the ever memorable Cyril George Hopkins, whom it had the good fortune to know for a time. The Meropeon Society for the Training of Girls in Need hastens to extend to you its sympathy and bid you have courage and pride in your grief. Major Hopkins fell more gloriously than did any of the generals, and he left not only the splendor of glory but also the spirit of benevolence and of love, even as did the great general of peace and of love, the Christ."

ANNA P. THEODOROPOULOU
(*Translation of a letter written to Mrs. Cyril Hopkins*)

"On the occasion of the death of Cyril Hopkins, please accept the condolences of one who recognizes the value of the service which he rendered the Greeks as a director of this philanthropic organization in

Greece. The information has come to me thru the newspapers. I beg pardon for not using ink inasmuch as such a thing does not exist in this place."

ANTONIOS M. LIOSES
Seaman, Central Training School, Poros, Greece
(Translation of a letter addressed to the Director of the American Red Cross in Athens)

"Those who believed very deeply in Doctor Hopkins' work feel that our leader is taken away. His work amounted to a cause for all peoples, for human advancement must go forward by such work as was done by him. With him personally his work was part of an abiding faith that inspired others—to believe in the soil, as the basis of human life. His desire to preserve the land was his ruling passion.

"It is no sentimentality to say that the Great Spirit led him out to spend a year among those Grecian peasants, stricken by war, famine, starvation, pestilence—telling the Greeks how civilization must be rebuilt on the basis of knowledge about the land. He finished that report, and gave it to the Greeks; telling them again that peoples must learn to use the earth and not abuse it—for that is the law of life."

ALBERT NASH HUME
Agronomist and Superintendent of Substations,
South Dakota State College of Agriculture
and Agricultural Experiment Station
(Extract from an editorial in the Farmer and Breeder)

"Great as were his achievements in his chosen field, and their effects will be felt for generations, still to us he was greater as a man than as a scientist, for he had a breadth which was not always realized because of his earnestness in advocating his cause; he had a kindly, genial spirit though he did not advertise it; and he was the soul of honor and constancy. The country misses and mourns Doctor Hopkins as a scientist, a patriot, a diligent upbuilder of its fundamental

source of prosperity. We miss and mourn him thus, but first as a friend always loyal, helpful, hopeful, and kind."

E. S. BAYARD
Editor, National Stockman and Farmer
(*Extract from an editorial*)

"It was more than twenty-five years ago, and a very rough late October day, when the Associate Editor of the *Missouri Farmer* first met Cyril G. Hopkins, then a young man just beginning his work teaching Agricultural Science in the Illinois College of Agriculture. The ground was wet and frozen, but the young professor insisted that he accompany the plain farmer over the fields to show him the experiments in soil fertility then just well started, and which have since become world famous.

"He promised to keep that farmer advised as to the results of these experiments, and he did not forget that promise as many other busy men would have done. Every phase of it has been reported to him in bulletins, books and private letters.

"We have met in these fields a good many times since that cold day, and have seen the work of that one great man which has meant so much to those who have followed his teachings. A little more than two years ago, on a fine June day, I walked over these same fields with him the last time we ever met; two men who were getting gray and old, he to go, a famous man, into the Old World to help solve the war problems for them there as he had been assisting in solving those of our own farmers here so many years, I to go back to my farm and to my desk hoping to apply some of the things he had taught me and to spread the gospel of a better agriculture among my fellow farmers."

C. D. LYON
(*Editorial in the Missouri Farmer*)

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ΠΩΣ Η ΕΛΛΑΣ ΜΠΟΡΕΙ ΝΑ ΠΑΡΑΓΗ ΠΕΡΙΣΣΟΤΕΡΗ ΤΡΟΦΗ [How Greece Can Produce More Food]. (Translated into Greek by George Bouyoucos) *Pub. by The American Red Cross Commission to Greece.* To be reprinted in English by the University of Illinois.

NOTE.—In this compilation no attempt has been made to include the numerous contributions made by Doctor Hopkins in the form of articles, letters, and notes to the various newspapers and periodicals representing the agricultural press.