DRY-FARMING IN AMERICA.

BEING A REPORT PRESENTED TO THE TRANSVAAL GOVERNMENT

BY WILLIAM MACDONALD, M.S.Ag., Sc.D., Ph.D., F.R.S.E., Editor, Agricultural Journal, and Dry-Land Agronomist; Foreign Vice-President of the American Dry-Farming Congress and Corresponding Secretary for South Africa.

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REPORT ON DRY-FARMING IN AMERICA.

Sir,

I have the honour to submit my report on Dry-farming in America for transmission to the Right Hon. the Minister of Agriculture. At the same time I should like to express my appreciation of the personal interest you have taken in the progress of this new movement, as well as for the opportunity afforded me by the Department of Agriculture of pursuing these investigations. My thanks are also due to my two colleagues, Mr. Joseph Burtt-Davy, F.L.S., and Mr. Barend Enslin, who so kindly took charge respectively of the Agricultural Journal and the Dry-land Experiment Station during my absence in the United States.

I have the honour to be,

Sir,

Your obedient servant,

William Macdonald,
Editor, Agricultural Journal, and Dry-land Agronomist.
PREFACE.

This report contains an account of a tour undertaken with the special object of finding out what progress had been made in Dry-farming in the United States, and whether it was likely to become an established practice. The conclusion drawn from these investigations will be found in the closing pages of the report. As there is still some uncertainty in the minds of many as to the real meaning of the term dry-farming, I have inserted a short paper dealing with this matter in the Appendix, together with an account of the methods adopted in the different States. Land settlement has also been briefly touched upon, because the successful cultivation of the dry-lands of South Africa must ultimately pave the way for a practical and comprehensive scheme of National Land Settlement for the whole of South Africa. Other matters of general agricultural interest, noted in this tour, will be discussed in subsequent numbers of the Agricultural Journal.

The writer's hearty thanks are due to the Government and the people of the Transvaal for their sympathetic interest in this mission, which he trusts he has carried out to their satisfaction. He is also indebted to the Imperial Government for the honour conferred upon him in appointing him to represent the Colonial Office at the Trans-Missouri Dry-farming Congress; and he earnestly hopes that the information gained may be of some practical value in the agricultural development and colonisation of other parts of the Empire. Nor must he fail to thank his many friends, both old and new, in the United States for their ready help and warm-hearted welcome.

DEPARTMENT OF AGRICULTURE,

Pretoria, 12th October, 1909.
I left Pretoria on the 11th of January, and two days later sailed by the Walmer Castle. The voyage was exceptionally calm and pleasant, and we arrived in Southampton on the 30th January. I spent two weeks in London and left Liverpool for New York on Saturday, 13th February, at 5 p.m., by the Mauretania. The second day at sea this wonderful vessel broke all previous Atlantic records, doing 671 knots or 773 land miles from noon of Sunday till noon on Monday, and so we passed the Ambrose Channel Lightship off New York on Thursday, the 18th, at 9.55 p.m.—after having come through a terrific gale—in four days, seventeen hours, and six minutes, the fastest voyage* ever made. The Mauretania is a splendid triumph of British shipbuilding, because even at her great average speed of 25.55 knots per hour, or, in other words, one land mile every two minutes, it is hard to realise that you are at sea, so slight is the motion of the vessel.

I arrived in New York City at 10 o’clock on the morning of the 19th and left the same afternoon at 3.45 by the Congressional Limited for Washington. This is the smoothest running train in America and one of the most rapid. It is run in two sections which follow one another at an interval of five minutes. Each consists of four Pullman cars. Thus instead of one long train, two are run on the same track, ensuring great speed and smoothness. The broad gauge, viz., 4 feet 8½ inches, has been adopted on this line. We arrived at Washington sharp on time, having traversed a distance of 325 miles.

At 10 o’clock next morning I called at the Embassy and was most cordially received by the British Ambassador. We at once stepped into his motor car and drove to the Department of State where the Committee for the “Conservation of Natural Resources” was in session. Here I met the Hon. James Wilson, United States Secretary for Agriculture; the Hon. Sydney Fisher, Minister of Agriculture for the Dominion of Canada; and Mr. Gifford Pinchot, Chief of the Bureau of Forestry.

Through the courtesy of Mr. Bryce, at 12.30 p.m. of the same day I had the honour of being received by the President of the United States, Mr. Roosevelt, who welcomed me with the greatest cordiality, and asked me to present his hearty personal greeting of good-will to the Right Hon. the Prime Minister of the Transvaal, and to say how interested he was in South African affairs, and how heartily he wished all success to those who dwell in South Africa. The President also said that he was very much interested in the development of dry-farming, as he had much to do with irrigation and kindred matters in the semi-arid regions of the semi-arid regions of the

* This record has since been broken.
Western United States, and therefore felt a particular interest in these regions. He also fully realised the very great importance of such problems.

Amongst ninety million people in the United States, Theodore Roosevelt for several years has been, and still is, the most commanding personality. To meet him is to understand how he both inspires and dominates his fellow-countrymen. His rugged vitality, boyish enthusiasm, and cheering grip have charmed and won the West; while the East has long since capitulated to the restless energy, tireless industry, and driving courage of Harvard's most gifted graduate. Morley has said of Gladstone that he was a Highlander in charge of a Lowlander. With equal truth one might say that Roosevelt was a Westerner in the care of an Easterner. During his tenure of office he proved a real and helpful friend of the farmer, and the various agricultural commissions which he called together on irrigation, natural resources, and country life have already had a profound effect on the welfare of the whole nation.

Mr. Roosevelt always took very seriously this cartoon of the old farmer reading the President's Message. The original of it, framed, hung over the mantel in his private study. He considered this farmer with the firm mouth and the patched trousers to be a representative of the mass of the American people—stable-minded, plain, patriotic, and endowed with common sense. To one who urged him to accept a third term Roosevelt said: "This man wouldn't like it." To Lord Curzon, on a visit to the White House, frankly asking the source of the President's power, Roosevelt said: "That is the man I'm working for."—From Collier's Weekly, 6th March, 1909.

No apology is therefore needed—even in a dry-farming report—to insert the vivid impression of the greatest Dutchman in America from the pen of the brilliant English novelist Mrs. Humphry Ward*:

"Washington, at this time of the world's history, was the scene of one of those episodes—those brisker moments in the human comedy—which every now and then revive among us an almost forgotten belief in personality, an almost forgotten respect for the mysteries behind it. The guests streaming through the White House defiled past a man who.
in a level and docketed world, appeared to his generation as the reincarnation of forces primitive, overmastering, and heroic. An honest Odysseus!—toil-worn and stormbeaten, yet still with the spirit and strength, the many devices of a boy; capable, like his prototype, in one short day of crushing his enemies, upholding his friends, purifying his house; and then, with the heat of righteous battle still upon him, with its gore, so to speak, still upon his hands, of turning his mind, without a pause and without hypocrisy, to things intimate and soft and pure—the domestic sweetness of Penelope, the young promise of Telemachus. The President stood, a rugged figure, among the cosmopolitan crowd, breasting the modern world, like some ocean headland, yet not truly of it, one of the great fighters and workers of mankind, with a laugh that pealed above the noise, blue eyes that seemed to pursue some converse of their own, and a hand that grasped and cheered, where other hands withdrew and repelled. This one man's will had now, for some years, made the pivot on which vast issues turned—issues of peace and war, of policy embracing the civilised world; and here, one saw him in drawing-rooms, discussing Alaric's campaigns with an Oxford professor, or chatting with a young mother about her children.

On leaving White House, Mr. Bryce and I lunched with Mr. Fisher. The Ambassador was exceedingly kind, and although very busy, placed the best part of a whole day at my service. At 5.45 on the same afternoon, in company with three agricultural experts from the National Department of Agriculture, Messrs. Chilcott, Jardine, and Briggs—who were also journeying to the Congress—I left Washington for Chicago on the Pennsylvania Express. Next afternoon at 4 p.m. on the very minute of time, we drew into the Chicago depot, having done a distance of almost 900 miles. And two hours later I boarded the Overland Limited for Cheyenne. Next morning we crossed the Missouri River at Omaha. It was frozen solid, and all day we rushed through the snow-clad plains of Nebraska. Towards evening we encountered a blinding blizzard; a hurricane of snow and sleet swept along the line, and finally our train slowed down and stopped. All night long the storm raged; and as the dawn broke we could just make out, massed on a short side track beside us, three great transcontinental trains with their engines buried in snow and ice from cow-catcher to coal-box. The Union Pacific Company has adopted the electric block system by which at every half-mile signals rise and fall, and red lights change to green, at the touch of the passing engine; and there is but little doubt that to this marvellous device was due our safety in the midst of a blinding snowstorm, on a single line, crowded with tremendous traffic. That same day, at noon, on the 23rd February, we reached Cheyenne, the Capital of the State of Wyoming, which lies roughly 2,000 miles from New York.

Half an hour later the third annual meeting of the Trans-Missouri Dry-farming Congress was opened by His Excellency Governor Bryant B. Brooks of Wyoming, in the Capital Avenue Theatre, in the presence of a large and varied gathering. The proceedings were marked by great enthusiasm and sustained interest. Over 500 delegates were present. A great many more, however, were expected, but were delayed by the snowstorm. It is worthy of note that the first dry-farming congress was held in the City of Denver where, curiously enough, the first National Irrigation Congress also met. This first congress started as a sort of side show to the National Live Stock Association, but it was soon seen
that many more farmers were interested in dry-farming than in pedigree stock. The second congress held in Salt Lake City was still more successful; whilst the third* or Cheyenne Congress drew men from all parts of America and several from foreign countries.

During the three days the congress lasted practically every phase of dry-farming was discussed, and the proceedings demonstrated, beyond all doubt, that this practice is now as firmly established as that of irrigation. Furthermore, it has now been placed on a thoroughly sound basis and the early sensational elements have been eliminated. At Cheyenne I had exceptional opportunities of meeting all sorts of men who are engaged in dry-land farming—scientists, land agents, experiment station experts, as well as practical farmers—and what struck me most of all was their unbounded faith in the movement. I also had a long and interesting conversation with Mr. W. H. Campbell—the author of the Campbell system of Dry-farming—and inspected his machine, the Campbell subsurface packer, which was on view. An instructive exhibit of agricultural implements and various crops which had been grown on dry-lands was shown in a hall close by. It would take too much space to speak in detail of the various papers read at the congress, and I shall merely give their titles.

Papers were read on dry-farming in Russia, China, Australia, Canada, Turkey, Brazil, and the Transvaal, and also concerning the following States:—Utah, Texas, Colorado, New Mexico, Wyoming, Nebraska, Kansas, Oklahoma, Oregon, Montana, Idaho, and South Dakota. Special articles were also contributed on:—The Development of the West: The Dry-farmer and Stock-grower; Seed-breeding and its relation to Dry-farming; Practical Dry-farming; The Relation of Dry-farming Development to Colonisation in the West; The Legitimate Land Agent versus the Speculator Type; Effect of Climate on Crops; Government Experiments in Wyoming; Scientific Agriculture and its Effects on the West; Dry-farming and Live Stock Fattening; Dry-farming and Railroad Development; Dry-land Agricultural Investigations; Physical Problems in connection with Dry-farming; Adaptation of Dry-land Grain to local conditions; Dry-farming on a Homestead—the last paper being read by a woman who had successfully established a homestead on the dry-lands of Colorado.

Owing to the immense amount of business to be transacted during the nine sessions of the congress the Programme Committee made the excellent rule that no address or paper should exceed twenty minutes in delivery; and speeches from the floor were limited to five minutes each.

The work of the congress may be summarised as follows:—

I. It demonstrated that the practice of dry-farming is attracting world-wide attention.

II. That the recent agricultural prosperity in the United States is mainly due to the successful development of the semi-arid regions by dry-farming.

III. That the two great problems in dry-farming are the conservation of moisture and the maintenance of fertility. It was

* The fourth Dry-Farming Congress will be held at Billings, Montana, on the 26th, 27th, and 28th October, 1909.
Instructive to note, however, that while the speakers from the East and the Great Plains area—the Dakotas, Kansas, and Nebraska—emphasized the need of fertility and the rotation of crops, those from the Far West or Great Basin area—Utah, Idaho, and Nevada—spoke altogether on the subject of the conservation of moisture by means of the summer fallow.

IV. That in dry-farming not only rainfall but also evaporation must be carefully studied. This most important point was brought out by Dr. L. J. Briggs, Physicist to the National Department of Agriculture.

V. That the dry-farm is largely a live stock problem, and that agricultural farming and stock farming should be combined as much as possible.

VI. That irrigation—by means of windmills and small dams—should be allied to dry-farming whenever practicable.

VII. That the study of dry-farming is lending new interest, hope, and dignity to western agriculture.

During the congress a resolution was passed condemning all dishonest advertising, several speakers stating that the cause had been damaged by unscrupulous agents booming worthless land. Further, the name Trans-Missouri was dropped in view of the fact that the congress had now become an international affair, and the simple term "Dry-farming Congress" was adopted. Arid farming which is largely used in Utah was also rejected, as well as the term Scientific Soil Culture.

The following foreign delegates were present and a whole evening was devoted to their papers. Senator James H. McColl, of the Commonwealth of Australia, was unanimously elected Chairman, and worthily upheld the parliamentary traditions of the British Empire.

(1) H. W. Fairfield, Esq., Dominion of Canada.
(2) Senor Romulo Escobar, Mexico.
(3) Joseph A. Rosen, Esq., Russia.
(4) Dr. Lawrence Baeta-Neves, Brazil.
(5) Dr. William Macdonald, Transvaal and British Colonial Office.
(6) Senator James H. McColl, Commonwealth of Australia, Chairman of Congress.
(7) D. W. Warner, Esq., Province of Alberta.

President Roosevelt's telegraphic message to the congress ran thus:

"I wish to extend to you greetings and congratulations upon your third annual meeting. I am deeply interested in the progress of your work. Any organization having for its purpose the development of the agricultural resources of the great semi-arid sections of the United States should have the hearty support of all good citizens. I am in full sympathy with your efforts and appreciate hardships, privations, and difficulties with which the pioneers among the mountains and on the great plains have to contend. Rest assured that so far as lies within my power, everything that can be done to aid you will be done. The reclamation of our lands through irrigation, the conservation of our forests, and other natural resources, and the development of our semi-arid lands by such methods as you are now advocating, all tend to insure the growth and well-being of this country. I trust that your meeting will be a great success and will
result in action that will command the confidence and support of the home builder, the man for whom we are all working."

I delivered the following messages, which were warmly received, and at the request of the President of the Congress, the entire audience rose and gave three hearty cheers for the Transvaal and the Empire. Thereafter, I read a paper on "Dry-land Farming in the Transvaal," and had the honour of being elected a Foreign Vice-President of the Congress and Corresponding Secretary for South Africa.

Chairman:

His Excellency, Bryant B. Brooks,
Governor of Wyoming and President of the Dry-farming Congress.

Your Excellency, Ladies and Gentlemen,

With your permission, I shall read three messages, which I have the honour to lay before this Congress.

The first is from General the Right Hon. Louis Botha, P.C., M.L.A., Prime Minister of the Transvaal and Minister of Agriculture.

LETTERS.

No. 1.

South African National Convention, Capetown,
13th January, 1909.

To the Delegates of the Trans-Missouri Dry-farming Congress.

Gentlemen,

I have instructed Dr. William Macdonald to convey to you on behalf of the Government of the Transvaal our most cordial good wishes for the success of your congress, and to assure you that the people of the Transvaal will follow your deliberations with much interest.

The scientific study and utilisation of the dry-lands are subjects of the highest importance to the whole of South Africa, and the great advances which have been made in the United States of America have encouraged us to hope that the same results may be obtained in South Africa.

Believe me,

Gentlemen.

Yours sincerely,

Louis Botha,
Prime Minister of the Transvaal and Minister of Agriculture.

The second message I have been requested to convey to you is from His Excellency, the Earl of Selborne, P.C., Governor of the Transvaal and High Commissioner for South Africa.

No. II.

High Commissioner's Train, De Aar,
12th January, 1909.

Dear Dr. Macdonald,

I think we have every reason to feel gratified for the kindness and courtesy of the Secretary of the Department of State in inviting the British Colonies in South Africa to take part in the Dry-farming Congress.
which is to take place at Cheyenne at the end of February next, and for the great care which has evidently been taken by the board of control to make this Congress a success. You will be able to tell the gentlemen who receive you how much this courtesy is appreciated in South Africa and what great importance we attach to the success of this congress, for dry-farming is a scientific problem which it is as much to the interests of South Africa to solve as of the United States of America.

Wishing you all success.

Believe me,
Yours very truly,
Selborne,
Governor of the Transvaal
and High Commissioner for South Africa.

The third message which I have been commissioned to lay before you is from the Right Hon. the Earl of Crewe, P.C., M.A., Secretary of State for the Colonies. Sir Francis J. S. Hopwood, G.C.M.G., K.C.B., Permanent Under Secretary of State for the Colonies, writes as follows:—

No. III.
Colonial Office, Whitehall, London,
9th February, 1909.

Dr. William Macdonald,
Langham Hotel, London.

Sir,

I am requested by the Secretary of State for the Colonies to ask you to convey to the President and Members of the Trans-Missouri Dry-farming Congress, which meets at Cheyenne, his most cordial good wishes for the success of their deliberations. Lord Crewe desires me to add that he has followed with keen interest the splendid progress which has been made in the reclamation and settlement of the arid lands of Western America; and he is confident that the scientific study of the potentialities of those regions in which the rainfall is small and irregular will do much to promote the agricultural prosperity both of the United States and the British Empire.

I have the honour to be, Sir,
Your obedient servant,
Francis J. Hopwood,
Under Secretary of State for the Colonies.

Lastly, I am desired by the British Ambassador at Washington, the Right Hon. James Bryce, O.M., P.C., to convey to you his best wishes for the success of this conference and to assure you of the great interest he takes in the agricultural development of Western America.

As already mentioned, during the congress I had the pleasure of meeting Mr. Hardy W. Campbell, of Lincoln, Nebraska. Mr. Campbell is widely known throughout the west as the author of what is commonly called the Campbell Method of Dry-farming. As this practice has been both praised and censured it is rather hard to form a fair estimate of its real value. But during my last tour I have come to the following conclusion.* Mr. Campbell has done much to advertise and popularise the

* In this estimate of Campbell's work I am supported by Mr. Joseph A. Rosen, Chief of the Russian Bureau of Agriculture, of Ekaterinoslav, and by Mr. William M. Jardine, Agronomist to the National Department of Agriculture, Washington, D.C.
system which bears his name; but he has not succeeded as an experimentalist and he has few experiments to justify his assertions. The contention that his method of dry-farming is the only proper one has not been sustained—for example in Utah it is practically unknown; while his statements at times are unreliable and misleading. The term "Scientific Soil Culture," which is so earnestly advocated by Campbell, is much too cumbersome and will assuredly not be accepted by the farming community as a substitute for the simple phrase dry-farming.

The machine called the Campbell sub-surface packer, under certain conditions, gives good results; but it must be used with care. Furthermore, it is seldom of much use on soil that has had time to settle and become packed. It is therefore more valuable on spring than on fall or autumn ploughing. Where loose manure has been applied to the land it may be used to advantage, but on wet clayey ground it may seriously injure the mechanical and physical texture of the soil. In short, the Campbell sub-surface packer cannot be said to be essential to success in dry-farming, although under certain conditions it is decidedly beneficial.

Nevertheless, it is not fair to disparage Campbell's missionary efforts amongst the farmers of the west. It is often said, and truly so, that Jethro Tull was the first exponent of the so-called Campbell system of soil culture; but it should not be forgotten that Tull did not work under semi-arid conditions, and secondly, that although his practice was successful, his theories were erroneous. Be that as it may, the fact remains that a large number of western farmers believe in Campbell's teaching, and many have followed his system or like methods with success.

At the end of this Chapter the well-chosen motto of the Congress—conservation, cultivation, education—has been sketched, and I shall now close with a short extract which is taken from a personal letter from His Excellency Edwin L. Norris, Governor of Montana, and President of the Fourth Dry-farming Congress which sums up its purpose and scope:—

"The Dry-farming Congress, while American in its inception, knows no country, it's one object being the 'further development of agriculture throughout the world by the utilisation of scientific and sensible methods of conservation and cultivation where irrigation is impracticable or impossible.' To the accomplishment of this object the congress is bending every energy, and in the three years of its history it has done an amount of good that cannot be computed in mere figures. It aims to bring together, from every country on the globe, the leaders in a movement that is fraught with so much importance to the people of all lands. It purposes to hasten in every way possible the day when the application of scientific methods to agriculture will add countless millions of acres to the areas now under cultivation, and so contribute tremendously to the world's supply of breadstuffs and to its wealth."

From Cheyenne I returned eastwards through Sioux City to St. Paul where I called on Mr. J. J. Hill, who is popularly known as the "Empire Builder of the West." Besides being the foremost railroad director in America, Mr. Hill has also won a wide reputation as an agricultural economist. He was born in the year 1838 on a small farm in Canada; and has recently given the sum of half a million dollars to endow a Roman Catholic Seminary in St. Paul. Half a century ago two farm lads started out to win fame and fortune. The one, a Canadian—James J. Hill—became the railroad builder of the American North-west; the other an
James J. Hill,
"The Empire-BUILDER of the West."
American—Sir Thomas Shaughnessy—crossed over into Canada and to-day controls the destinies of the Dominion's greatest railroad. Mr. Hill received me with the utmost cordiality and gave me the greater part of a forenoon to the discussion of rural problems. He is a profound believer in the necessity of conserving the natural resources of the State, and lays special emphasis on the value of small farms and the maintenance of fertility by the rotation of crops; and his words "Show me a large farm and I will show you a farm full of weeds and badly cultivated," seem deserving of our attention. His agricultural gospel may be summed up in a single sentence: Small holdings, well tilled, and the maintenance of fertility by manure. In England, Denmark, and Holland where the farms are small and well cultivated the yields are high; but in the United States, Russia, and Australia where too often the ground is merely scratched the average yield per acre is lamentably low. Speaking of agricultural education, Mr. Hill said: "You can't bring all farmers to an agricultural college; therefore you must train men to go out amongst them to make experiments in growing seeds, breeding new plants, and feeding animals and the like, things a farmer cannot well do by himself. I have advocated the taking over of fifty agricultural counties in the State of Minnesota and placing them under the care of graduates of the State College of Agriculture. Each expert could take charge of ten or twelve farms and prepare, say, one or two acres on each farm for seeding to wheat. Give the farmer the purest seed and show him how to raise thirty bushels of wheat to the acre in place of the 8-12 bushels of the Red River Valley, and so on with other crops. But use acre plots, not anything less."

Touching land settlement, Mr. Hill laid great emphasis on the value of the Homestead Act in the development of America, notwithstanding the abuses which have arisen in connection with its administration. Then turning to South Africa he said: "Offer free land to settlers, but look well to the character of your immigrants. Consider quality rather than quantity. The stream will never rise above its source. If you poison your country with an inferior class of settlers the whole land will ultimately become infected."

Hill was the first to formulate the now widely accepted railroad policy of the West. That is to say, he never waited for population, but boldly pushed his lines across the deserts to the Pacific Coast,* and is to-day reaping the rich reward of his courageous enterprise in enormous freight and passenger traffic. So he laid the Great Northern rails for a thousand miles over the prairies of the North-West and then sent his immigration agents far and wide throughout the world to bid the poor but sturdy peasant "welcome" to the free lands beyond the sea.

I have already written in the pages of the Transvaal Agricultural Journal of the great work which has been done by the Agricultural School and College of the University of Minnesota. But two things impressed me during this last visit. In the first place, I happened to be present at the annual Alumni banquet of the School of Agriculture and listened that evening to three Senators discoursing on the agricultural bills which

* On 10th May, 1909, forty years had elapsed since the rails of the Union Pacific moving westward met the rails of the Central Pacific moving eastward, at Promontory Point, near Oglen, Utah, and the first transcontinental railway was completed. Six railroads now span the United States, and 250,000 miles, or 47 per cent. of the railway system of the entire world, have been built.
they would shortly introduce in the Legislative Assembly. Senator J. M. Hackney spoke on his bill for establishing a system of rural instruction by correspondence in connection with the School of Agriculture. Senator A. D. Stephens spoke on his bill for establishing a new Agricultural High School at Crookston, and Senator J. T. Elwell spoke on his bill for the enlargement of the Campus. When politicians take such a profound and practical interest in an agricultural college, it is small wonder that its progress and growth are very rapid. Secondly, I witnessed an instructive example of the way in which the Minnesota agricultural experts are carrying the gospel to the farmer. Some thirty miles from Minneapolis is the village of Elk River. To this place I journeyed in order to be present at the last Farmers' Institute of that season. The meeting started at 10 a.m. and went on till 4 p.m., with an interval of one hour. Mr. Forest Henry, the farmers' representative, opened the discussion with an address on "clover," and he was followed by Mr. A. R. Kohler who spoke on "potatoes." It was interesting to note how these two men kept the grip of the audience for four solid hours; each speaking for about ten minutes at a time. I was specially struck with the good-fellowship which prevailed between the experiment station expert and the conductor of the institute. Mr. Henry oftentimes interrupted "brother" Kohler with a call for a clearer explanation, but the latter never failed to respond with the utmost patience and most perfect good humour, although this constant catechising at times broke the thread of his discourse. I have elsewhere pointed out* how the Farmers' Institutes bridged the gulf which prevailed between the University and the people of Minnesota, and my visit to Elk River reaffirmed my faith in a great and powerful College of Agriculture as the best means of transmitting the message of the Experiment Station and the laboratory to the hearths and homes of the farming community.

Dry-Farming Congress.

TO THE NATIONAL DEPARTMENT OF AGRICULTURE.

From Minneapolis I journeyed to Ithaca where I spent some time at Cornell, and thence to Columbia. Thereafter I returned to Washington where I spent ten days in the National Department of Agriculture. It is just seventy years since the first steps were taken in the United States to aid agriculture through the Federal Government. And in the summer of 1839 an appropriation of $1,000 was set aside for the purpose of distributing seed and collecting agricultural statistics. What a wonderful growth has been made in these seventy years! For we find that the last annual appropriation for this department alone was almost $13,000,000, while the staff numbers 10,186. To-day the efforts of the department are being mainly directed to the conservation of the national resources of the country, while at the same time increasing the productivity of the field. The alpha and omega of this great organisation is the practical application of modern science to the service of the farmer. It can perhaps be best summed up in a homely remark of the honoured Secretary,* who, on assigning new duties to an expert said: "Don't tell me now about your laboratories. Tell me what you are doing for the man at the plough, out in the fields, with his coat off."

In such a department it is plainly impossible, even if one had several weeks for the purpose to see one tithe of the work of the different divisions, and so I concentrated my attention entirely on those branches which bear specially on dry-farming.

In Washington I had the pleasure of again meeting Mr. E. C. Chilcott, Agriculturist in charge of Dry-land Agriculture Investigations, under the Department of Agriculture. Before coming to Washington, Mr. Chilcott was Professor of Agriculture and Geology in the South Dakota Agricultural College and had a long and wide experience in dry-farming in the Great Plains area. Mr. Chilcott was appointed to his present position in July, 1905, and so the work of the National Department in dry-land agriculture may be said to have begun at that time. Under Mr. Chilcott's direction this work has expanded in a remarkable manner, and already we find that eleven dry-land experiment stations have been established, and several more will be started in the course of the next year or so. The area over which these operations extend is truly enormous and may be said to reach, roughly, from the Mississippi westward to the Sierra Nevada mountains in California, and the arid valleys of Oregon and Washington, and from the international boundary line southward to the Panhandle of Texas—in all a tract of country comprising about one million square miles.

The policy of the department is to work in cordial harmony with the various State Governments and to supplement, but not to interfere with, any work which may already be in progress. Thus we find that dry-land experiment stations have now been established at the following points in conjunction with the various States:—In North Dakota, at Williston, Dickinson, and Edgeley; in South Dakota, at Bellefourche; in Nebraska.

* The Hon. James Wilson who has been Secretary of Agriculture for a period of twelve years, serving continuously under three Presidents.
at North Platte; in Kansas, at Hays and Garden City; in Colorado, at Akron; in Texas, at Amarillo and Dalhart; and in Montana, at Judith Basin. Of these stations four, viz., Bellefourche, Akron, Amarillo, and Dalhart, are entirely operated by the National Department.

To understand the scheme adopted we may take as an example the three North Dakota stations. The United States Department affords the following co-operative assistance:—First, in paying the salary and travelling expenses of the expert appointed to take charge of this work. But it is of interest to note that this expert is usually a graduate of the State Agricultural College, recommended by the local authorities and approved by the Secretary of Agriculture. This official therefore becomes a civil servant. He is usually engaged on probation at a salary of $720 (£144) per annum, and if he proves satisfactory rises by annual increases until he receives from $1,400 (£280) to $1,500 (£300), and in addition the sum of from $300 to $400 for travelling and incidental expenses.

Secondly, the National Department assists in the purchase of any special machinery which the State farm may require, as, for example, the small threshing machine* used for threshing the harvest of the experimental plots.

The figures† which I am able to print below, through the courtesy of Mr. Chilcott, show the amount set aside for each dry-land experiment station. It must be remembered that these sums do not indicate the total moneys expended or used by these stations. Take, for illustration, the station Bellefourche with an allotment of $4,200 (£840). Here Mr. C. S. Scofield, the expert in charge of the Western Extension Investigations, has been granted a sum of $2,000 (£400) to carry on certain experiments, and it is impossible to say exactly how much money is expended on a particular set of experiments, as the teams, ploughs, and hired men are lent by mutual agreement among the different officers of the State and National Department. Again, it should be noted that where the National Government takes all the burden of the maintenance of the station, as, for example, at Bellefourche, Akron, and Dalhart, the amount expended is much greater. It may be said, however, roughly, that to run a station alone without the assistance of the State authorities necessitates the annual expenditure of $5,000 (£1,000) after the station is established. This amount is, of course, noticeably reduced when the State bears its share of the financial burden. Furthermore, the cost of maintenance will depend also on the nature of the soil. At Dalhart, Texas, where the soil is light and sandy three horses are required to do the work; but at Bellefourche six are usually employed owing to the heavy clay land which is found in that region. With regard to revenue, it may be stated that it has never been the intention of the Government to make money out of these stations. In a word, they are soil and plant laboratories, established to assist the farming population.

Touching results: The time since these stations were started is too short to speak with any certainty as to the ultimate results likely to accrue. But one thing is certain, that in emphasizing the need of better

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* These machines cost about $125, and can be bought from the A. B. Farquhar Company, of York, Pennsylvania.

† For the sake of accuracy I have set down the figures of expenditure on Experiment Stations or cost of implements in American money ($4.84 cents = £1); dividing by 5 will give the approximate equivalent in English coinage. For example three hundred dollars—written $300.00 $5 = £60, approximately.
tillage and the necessity for conserving the moisture and fertility of the soil they having already had a great and far-reaching influence for good.

**Annual Expenditure on Dry-Land Experiment Stations.**

Name. | Allotment.
---|---
Williston, North Dakota | $300.00 = £60 0 0
Dickinson, North Dakota | 1,300.00 = 240 0 0
Edgeley, North Dakota | 1,500.00 = 300 0 0
Bellefourche, South Dakota | 4,300.00 = 840 0 0
North Platte, Nebraska | 1,700.00 = 340 0 0
Hays, Kansas | 1,050.00 = 210 0 0
Garden City, Kansas | 1,000.00 = 200 0 0
Akron, Colorado | 4,527.00 = 905 8 0
Amarillo, Texas | 1,000.00 = 200 0 0
Dalhart, Texas | 4,000.00 = 800 0 0
Judith Basin, Montana | 1,850.00 = 370 0 0
One Travelling Field Assistant | 4,000.00 = 800 0 0
Office Expenses | 5,439.25 = 1,088 0 0

Total | $31,766.35 = £6,353 8 0

[approximately.]

Another official who took a great deal of time and trouble to make my stay in the Capital profitable was Mr. W. M. Jardine, Agronomist in Charge of Experiments with Dry-land Grains. Mr. Jardine has had a long experience in connection with dry-land farming operations. He was born in southern Idaho in a dry-farming zone, and from thence he went into Utah where for some time he was manager of a large arid farm, situated in the Dog Valley, some eight miles from the town of Nephi, a well-known dry-farming section. In passing it should be said that Utah is the State which has done more than any other in the United States to advance the practice of dry-farming. Jardine’s special work is in connection with the development of new types of grains especially adapted to dry-land conditions, giving particular attention to the small grains, wheat,* oats, and barley. He is a strong advocate of the need of one particular variety of wheat in place of the great number of different sorts which have been previously grown.

He recommends for a winter variety for the dry-lands of the west, the Turkey Red, Kharkov, and Crimean wheats—the group commonly known as Crimean wheats because they were introduced into the United States from the Crimea. Winter wheat is planted from the 15th of August to the 15th of October and is harvested from the 1st of July to the 1st of August. The above named wheats have proved to be the best varieties for years past when grown as winter wheat. It should also be stated that winter wheat is much more profitable and gives a much larger yield per acre on the dry lands than spring wheat, and is therefore grown wherever possible. With regard to spring wheats on dry lands, that is, wheat planted in April or May, the hardiest varieties undoubtedly are those of the Durum group, which were introduced into the United States in 1902.

Jardine has done a great work in teaching the dry-farmer of the west the absolute necessity of organisation for the production of one uniform

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* It is worthy of remark that the wheat grown in California is a soft variety and is, therefore, not suitable when used alone for milling purposes. It has been found that the introduction of wheat from Kansas and Utah, which is of a harder type, is very beneficial in strengthening the weaker qualities of the California wheat.
type of grain—just as has been done in connection with the citrus fruit industry of California, which is the most conspicuous example in modern horticulture of co-operation in the production of one particular product, namely, the Navel orange.

During my stay at Washington, I had also the pleasure of renewing my acquaintance with Dr. L. J. Briggs, the Physicist in Charge of Dry-land Investigations. Briggs, although still a young man, has already won distinction by reason of his researches in soil physics and more especially for the ingenious instruments which he has devised for automatically recording precipitation and evaporation. Special attention is being given to the study of the moisture relations under different methods of cultivation, different crops, and different climatic conditions. The moisture content of each foot of soil is determined by sampling with a soil-tube, drying each sample, and then weighing it and noting the difference in weight. These soil tubes are made of cold rolled seamless steel tubing and are so constructed that samples can be taken to a depth of fifteen feet if necessary. A comparative study of soil temperatures in lands giving different methods of treatment is also in progress. That is to say, the temperature of the seed-bed under summer fallow, fall (autumn) and spring ploughing is being carefully studied. The worth of these matters is too plain to need any emphasis; but they all go to show how profound and varied are the problems which come under the head of dry-farming. Summing up it may be said that the main efforts of the Department of Agriculture in dry-land agriculture are to be found along the following lines:—Soil management, cereal investigations, plant breeding, soil moisture determinations, meteorological research, and lastly, but by no means least, bacteriological studies. And when it is remembered much of the work is done in the Bureau of Plant Industry—a division that now numbers 1,058 persons—the number of experts at the service of the dry-farmer will be more readily realised.

Mr. Gifford Pinchot, Chief of the Bureau of Forestry, kindly gave me the following information in regard to forest planting in the semi-arid regions and the influence of windbreaks upon the surrounding crops.

The semi-arid plains of the United States are almost wholly lacking in native timber. With the gradual settlement of this region, however, considerable planting has been done for protection against wind, for the production of farm material, and for decorative purposes. Hardy drought-resistant trees, such as honey locust, Russian mulberry, black locust, green ash, hackberry, box elder, yellow pine, Scotch pine, and jack pine have been most frequently used. Cottonwood, silver maple, and lombardy poplar have been planted to some extent in moister localities. *Thorough and frequent cultivation to check evaporation of moisture from the soil is necessary for successful tree growth on the semi-arid plains.*

The deodar cedar and coulter pine have been planted experimentally by the Forest Service in the semi-arid mountain regions of southern California. Although the experiments have been conducted but for a short time, the results indicate that both of these trees can be successfully grown under rather trying conditions in that region. Other species which are being planted on the National Forests in regions of deficient rainfall are yellow pine, jack pine, Douglas fir, and Engelmann spruce.
Careful investigations of windbreaks and their influences in the States of Iowa, Nebraska, and Kansas point toward the following general conclusions:

Windbreaks inevitably damage crops immediately adjacent to them in three practical ways:—(1) By sapping moisture otherwise available for the agricultural crops; (2) by shading; and (3) by subjecting adjacent crops to damage from frost, due to stagnation of the air in their lee.

On the other hand, windbreaks directly benefit crops (1) by retarding dry winds and thus decreasing evaporation; (2) by impeding cold winds and thus modifying the average temperature; and (3) by breaking the force of severe winds which would otherwise break down and injure portions of the crop.

For all crops the advantages of good windbreaks far outweigh their objectionable features. The beneficial effects extend to a considerable distance—ten or more times the height of the trees—from the windbreak, while the injurious effects are for the most part quite closely confined to the immediate vicinity of the windbreak. Actual measurements show that the yield of crops protected by windbreaks, while considerably less where close to the trees, is well above the normal yield of unprotected crops for a great distance out from the windbreak. The increase takes the form of a curve, lowest near the windbreak, rapidly reaching a crest at a distance from the windbreak of about one or two times the height of the trees, and gradually tapering off to a normal yield at a point usually over eight or ten times the height of the trees. So great is this increase that it has been reliably estimated that a shelter-belt twice as wide as the trees are high will pay for itself in the increased productivity of the protected field, without taking into account the value of the wood produced. The damage from shading and sapping varies with the kind of crop, but the protective influence is felt by all crops.

In the Western States it is recommended that windbreaks be always planted in an east and west direction, since in this position they are most likely to retard the prevailing winds. The composition of windbreaks is of considerable importance. Windbreaks of cottonwood trees are on the whole the best, since they attain a good height without causing excessive damage from shading. Osage orange, honey locust, silver maple, and a number of harder conifers such as Scotch pine and white spruce have also proved very satisfactory for windbreak purposes. Windbreaks should always be made up of several rows of trees, since a single row is much less efficient as a protection from wind, while the damaging effect to the crops is practically the same.

I next proceeded to the Department of the Interior, where I called upon the Commissioner of Lands, Mr. Fred. Dennett, in connection with a subject in which I have long been interested, viz., Land Settlement. The Commissioner spoke eloquently of the free homestead in the development of America; but emphasised the need of a strict residential clause to prevent fraud. In answer to the question: "What should be the size of a farm in the dry regions," he replied: "A family unit, or, in other words, the smallest area that will support an average-sized family. There should be no hard and fast rule as so much depends on the locality. As far as possible, land laws should be treated as local or State problems. In the past the United States Government made the serious mistake of applying the same unit to all States which came under the Homestead Act."
Now an effort is being made to take into account the essential differences of climate and soil, an idea which has been followed in the recent Mondell Bill which is only applicable to dry-farming regions.” Speaking of the section, Mr. Dennett remarked: “The section has proved an excellent unit in land settlement. As you are aware it contains 640 acres and is one mile square. Consequently, it is a very convenient number to subdivide, and may be measured in several different ways. Further, it is just as convenient for small irrigation projects of forty acres as for large dry-farms of 640 acres as under the Kinkaid Act in Nebraska.”

I shall now briefly touch on the Homestead Act, the Mondell Land Bill, and the Tree Claim Act. Of all nations the United States stands pre-eminent as the one which, having early been confronted with the great problem of land settlement, has mastered it in a most marvellous manner. It would take too long to sketch the steps which led up to the Homestead Act of 1862, but it may be said that this law was the result, in part at least, of the agitation of a political body then termed the Free Soil Democrats. They maintained “that the public lands of the United States belong to the people, and should not be sold to individuals, nor granted to corporations, but should be held as sacred trust for the benefit of the people, and should be granted in limited quantities, free of cost, to landless settlers.” This was the origin of the famous law which enables landless farmers to secure a quarter section, viz., 160 acres of land, and to acquire a title to the same by residing and cultivating the land for a continuous period of five years. I have not the latest statistics by me, but in the year 1904 over 233,000,000 acres had been entered. And there can be no doubt that this magnificent law has done more than anything else to fill the United States with a free, prosperous, and contented people. Unhappily, abuses crept into the administration of the Act in the more sparsely populated centres, and the chief of these was due to what was termed the Commutation Clause, whereby it was possible for a settler to commute his homestead at the end of fourteen months on payment of $1.25 per acre. This led to grave abuses, as the first six months was merely a nominal residence, or, in other words, a settler could, by residing for a period of eight months, obtain a free homestead. This clause was severely condemned by the recent Public Lands Commission, appointed by President Roosevelt to enquire into these matters. Other abuses were common in the pioneering days, such as a ranchman persuading his cowboys “to prove up”—that is to file a claim—on quarter sections for a certain remuneration in order to obtain for him several sections for grazing purposes. Notwithstanding all these frauds the Homestead Act of 1862—like the Morrill Act† of the same year—will stand out for ever as a noble and enduring piece of legislation.

Let us now turn to the Mondell Land Law. This Act, which was approved 19th February, 1909, provides for an enlarged free homestead. That is to say, a settler can acquire an area of 320 acres or less of non-mineral, non-timbered, non-irrigable public land in the States of Colorado, Montana, Nevada, Oregon, Utah, Washington, Wyoming, and in the Territories of Arizona and New Mexico. This Act is construed to mean land which requires the application of dry-farming methods to make it produce agricultural crops. Final proof must be made as in the ordinary homestead, and, further, at least one-fourth of the whole area must be shown.

—Free homesteads of one section can be obtained on the dry sand-hills of western Nebraska.

†Act establishing colleges of agriculture and mechanic arts in the United States.
to have been continuously cultivated to agricultural crops other than native grasses, beginning with the third year of the entry and continuing to date of final proof. Furthermore, commutation is expressly forbidden. An interesting additional clause is inserted in this Act in regard to the State of Utah, to the effect that on lands which have not sufficient water upon them for domestic purposes, continuous residence is not necessary, but the entryman may reside at such distance as will enable him to farm successfully, as the case may be. Moreover, he must show that he has cultivated not less than one-half of the total area during the fourth and fifth years after entry.

Finally, the Tree Claim Act. From 1873 until 1891—the year in which it was repealed—a Timber Culture Act, or what was more widely and popularly termed the Tree Claim Act, was in force. This Act, as first passed, enabled every person to obtain not more than 160 acres of land by planting 40 acres of timber and properly caring for it during ten years. Later, the number of acres of timber required was reduced to ten, and the period of cultivation to eight years. This law proved a failure so far as the growing of trees was concerned; but over 44,000,000 acres of land were entered by this method. The Tree Claim Act was finally abandoned on account of the numerous frauds which were found to have occurred in connection with it. Settlers too often swore that their trees were growing when they were all dead through lack of care, or killed by frost, and so obtained the title-deeds to their homesteads. Nevertheless, I am convinced that this law should never have been repealed. Surely honest experts attached to the Land Department could have been detailed to see that the trees were properly cared for? To-day many progressive farmers are planting trees for shelter and shade around their homesteads; but even the kindest critic must feel that the Federal Government has failed lamentably in not doing more to encourage the planting of shelter belts in the great semi-arid regions of the West. In closing a most instructive interview, the United States Commissioner of Lands remarked that, if a Tree Claim Law could be enacted on the treeless zones of South Africa, with proper restrictions, it would doubtless prove of untold value to the dry-land settler as well as to the country at large.

CHAPTER III.

TO THE DRY FARMS OF THE WEST.

From Washington I returned to Chicago, where I visited the University of that city and then returned to Minneapolis. My next journey was to the dry-farms of the West.* I left Minneapolis en route for Texas, on the North-western railroad, reached Omaha the same night, and Kansas City, in Missouri, the following morning. It had been a week of snow and slush in the North-west, and I was glad to find much milder weather in Kansas, where the grass was green and the trees in blossom. For a whole day we traversed the fertile State of Kansas, and I was much struck with the evidence of agricultural prosperity. This is the more remarkable

* I am indebted to Mr. E. C. Chilcott, Agriculturist in Charge of Dry-Land Investigations, United States Department of Agriculture, for the admirable itinerary which he kindly planned for me and to which I closely adhered.
when it is remembered that twenty years ago Kansas was best known as a land of abandoned homesteads, droughts, and hot winds. To-day, it is not uncommon to see farmers bringing their produce to the market in motor-cars. This change in conditions is chiefly due to the rise in land values. At the time I have mentioned land could be bought at 75 cents per acre; now it can readily be sold at $5, $10, and $20 per acre.

Another reason is undoubtedly that better methods of tillage have been adopted, largely due to the teaching of the Agricultural College and the influence of the Experiment Stations. Possibly the most striking thing is the widespread cultivation of alfalfa (lucerne). You see it everywhere—vast fields of vivid green, patches in gardens, clumps by the roadside. It is not too much to say that the recent agricultural transformation of Kansas is mainly due to the culture of lucerne. Cattle are pastured on it, and hogs are turned loose to graze at will. Corn (maize), of course, is a great crop also, and does excellently on the deep black loam. It is generally planted with a listing plough. The tilth of the fields was very fine and mellow. The Poland China type of hog is chiefly raised. After being fed on lucerne for a year or so, they are fed on corn (maize) for about sixty days and shipped to market.

The fields were also green with winter wheat, which is largely grown. It is sown in the fall (autumn), and during the winter months cattle are grazed on it. This wheat is harvested in June and July. Sheep are not raised in this part of the West, farmers holding that sheep injure the pasturage for cattle.

The subject of prohibition may not at first sight seem to come within the scope of an agricultural report, but to my mind there is no doubt that the dry-town has had a beneficial effect on the dry-farmer. The State of Kansas has gone solid for prohibition, with the result that whereas in the city of Wichita, with a population of 50,000, where formerly there were fifty saloons, there are none to-day. The law is now being rigorously enforced, not by the local but by the State authorities. In short, the hard-won earnings of the farmer and the mechanic, which formerly were too often dissipated in the down-town saloon, are now being expended in better food and clothes for themselves and their families. It would be outside my province to enter into a discussion of the pros and cons of this great problem, but I would merely say that the American farmer has added to his industry, his courage, and his intelligence the sterling virtue of sobriety. And in modern competition it is sheer folly to minimise the driving force and staying power of a water-drinking people.

During the evening we passed through the north-west corner of Oklahoma, and next morning we were speeding through the flat sandy plains of the Panhandle of Texas.

Texas, the Lone Star State, has many curious laws. Take the question of railroads. You may enter the State on the "Santa Fe Railway"; a little later you find yourself on the "Southern Kansas of Texas," and finally on the "Pecos and Northern Texas"—but still all under the Santa Fe system. I was told that the Texas Railroad Commission demands that every railway entering the State must maintain separate administration and clerical establishments within the State, under distinct names, otherwise it might be possible to operate a great railway such as the Santa Fe directly from an office in Chicago, one thousand miles away.

* See description on page 32.
A short sketch of the Panhandle, which has recently become so noteworthy as a dry-farming country, may be of interest. Twenty years ago the nearest railroad point was 500 miles away, and this region was best known as being the greatest ranching country in the world. It was here that the cattlemen and cowboys of the famous "X.Y.Z." ranch rounded up their vast herds every spring. This ranch consisted of 3,000,000 acres, and one line of fencing extended for 127 miles. The reader may ask how such a huge tract of land happened to come under the management of one company. It was in this wise:—

The late Mr. Abner Taylor, of Chicago, an architect, got a concession of 3,000,000 acres of land from the State of Texas at one dollar per acre on condition that he built a State Capitol at Austin. That is to say, the State did not contribute one cent towards this project, but simply gave this vast tract of land, and Mr. Taylor had to try as best he could to raise three million dollars. Failing to raise sufficient funds in the United States, Mr. Taylor called in three English capitalists and secured them as the trustees of this enormous estate, which was then incorporated under the name of the "Capitol Freehold Land and Investment Company, Ltd." For a long time this land was considered worthless, except for grazing purposes, and could not be sold at fifty cents (2s.) an acre. To-day a portion of this property has passed into the hands of an American syndicate, and is now being sold to actual settlers at from $10 (£2) per acre and upwards. Two reasons may be given for this rise. In the first place it is due to the high price now being given for land in the Eastern States, where farmers can easily dispose of their farms at $150 per acre. Leaving the crowded and worn-out fields of the Atlantic States, they can come to the sunlit plains of Texas, where land is one-tenth or less than the price of their old farms. Take a farmer with 100 acres in the East; he can easily change that for a holding of 1,500 acres in the Panhandle, more than enough for himself and his family.

Secondly, the development of dry-farming all over the West has stimulated the immigration of settlers into this region. To-day there are few or no free homesteads to be had in the State of Texas, and the intending settler has to purchase raw unbroken prairie at an average price of $7.50 per acre. In the early days a section (640 acres) of land could be purchased at one dollar (4s.) per acre from the Government, payable over a period of forty years, with a merely nominal residence. But with the gradual settlement of the State land can no longer be had on these terms.

I stepped off at Amarillo, the chief town in the Panhandle region. Amarillo is a Mexican word meaning "Yellow City." The name, however, does not indicate the presence of gold dust. Here you find a town of about 15,000 inhabitants, which is the distributing point of four railroads. The chief crops raised in the vicinity are Kaffir corn, milo (sorghum), wheat, oats, alfalfa (lucerne), and corn (maize). A large packing house has just been erected. The raising of hogs is becoming a great industry, but as yet there are few sheep on these plains. Horses do excellently, and Texas mares have been mated with English thoroughbreds with good results.

Amarillo has always been an important cattle shipping depot, and in the early days the long-horned Texas steers were rounded up in thousands to this centre, for a radius of over 200 miles. But the big-horned ox, like the buffalo, has entirely disappeared from the plains of the Panhandle, and his place has been taken by the placid
dehorned white-face Hereford. Indeed, all over the prairies of the West and the plains of the South-west the Hereford is the dominant breed, and is now largely displacing the shorthorn. The Hereford has been found to mature earlier, has proved a better rustler, and seems to stand the long hot days of summer better than the shorthorn. The entire Panhandle may be characterised as a dry-farming country, there being few streams of any note. Water is obtained by boring, and is generally struck at depths of from 100 to 300 feet, but it seldom rises more than a few feet. The soil in general is a loam of three to five feet in depth, resting on a limestone formation. The grass is short and wiry, but succulent, and consists mainly of buffalo grass and grama.

The Dry-land Experiment Station established by the National Department of Agriculture is situated one mile and a half from the centre of the town. The superintendent, Mr. John F. Ross, was good enough to spend a whole afternoon in showing me over the station. Mr. Ross worked on his father's farm until he was 25 years of age, and then entered the Kansas State College of Agriculture and graduated Bachelor of Science in Agriculture. Entering the Civil Service, he was first appointed Instructor in Agriculture to the Indians in the Department of the Interior, and later transferred to his present post.

The work in dry-farming under the auspices of the Department of Agriculture was begun in the Panhandle in 1903, and two years later Mr. Carlton, United States Cerealist, established this station. It was taken on a five years' lease, and at the time of my visit was about to be vacated, as the owner, an Amarillo citizen, had decided to resume his property and cut it up into town lots. The station comprises 100 acres, of which 60 are in cultivation. It is purely a dry-land station—no stock being kept. Water is purchased at the rate of 15 cents per barrel, being hauled out of town and delivered at the station for that price. Fortunately, it is only needed for drinking and domestic purposes, and to supply the evaporation tank, of which I shall speak later.

This station is subsidised by the Federal Government, which spends on its upkeep about $4,000 per annum. The State, as yet, has not contributed anything to its support. The staff consists of a superintendent, and two hired unskilled labourers at $50 (£10) per month (without board). Teams have to be hired for ploughing, harvesting, etc. This costs $5 (£1) per day for two horses and a driver.

The average precipitation (rain, snow, hail) at Amarillo for the last seventeen years has been 22.03 inches. The rain falls mostly from April to October inclusive—that is, during the growing season (spring and summer). In winter very little rain falls, and during the past seven months only 2.4 inches fell.

The soil is a chocolate coloured clay loam to three and a half to five feet deep, resting on a limestone formation of one to two feet thick, below which is a compact clay. Moisture does not seem to rise by capillarity from the deeper layers below.

The main lines of work at this station consist in varietal tests with grains, manner of cultivation, ploughing tests, seeding tests, effect of environment, sorghum smut experiments, nursery work with selected grains, and rotation of crops—in a word, the growing and adaptation of dry-land cereals to the Panhandle country. In the selection of grain the method is simple. A single head is selected, increased year by year for a period of three years. If after three years' test it gives promise of
success, it is then planted in the field, and finally distributed in small quantities free to the farmers.

With regard to rotation experiments—nine three-year rotations and eleven four-year rotations are being carried on side by side with continuous cropping experiments. Let us take a typical three and two four-year rotations—

(a) Corn, oats, wheat.
(b) Wheat, corn, oats, cowpeas.
(c) Cowpeas, winter wheat, milo, oats.

The summer fallow has been found to give from two to three bushels more per acre than where the land is cropped every year. To understand the practice let us take two plots, A and B. Plough both in the fall (autumn) and harrow both, that is, make a fine seed bed. Sow plot A with wheat. Leave B bare. Winter passes. Next spring A with young wheat is harrowed. The bare fallow is also harrowed, not once, but several times, depending on the rainfall. Next on plot A the wheat is harvested about the 1st of July. Then both plots are disced, ploughed a little later, and finally both are planted with wheat. It will thus be seen that a whole year is wasted so far as plot B is concerned, and the increase is only from 2-3 bushels per acre over plot A according to the experiments at Amarillo. Mr. Ross does not believe in the summer fallow method for the Panhandle, and prefers rotation, or even continuous cropping, to the fallow system in a region where the rainfall comes during the summer or growing season.

Soil moisture determinations are taken (a) under the ordinary methods of cultivation as practised by the average farmer; (b) conservation methods as ought to be practised. Concerning crops, the following have given the best results: Turkey Red (winter wheat), Durum (spring wheat, Red Algerian oats, Tennessee winter barley, black winter Emmer, and various sorghums. Paths of five links* divide each tenth acre plot, and paths of thirty links broad separate the acre lots. The experiments are kept in an orderly series, as, for example, all selection tests are kept together; and all rotation experiments in another block. At the time of my visit the land was in very good tilth and showed evidence of having been thoroughly worked; but the crops had suffered from drying winds and an unexpected frost. In respect to the equipment of the station, the ordinary agricultural implements were in use. This machinery was much worn and could hardly be called of the best or latest type. It was, however, housed in a shed. There was only one building on this station, namely, the office and seed store, a wooden building.

The station sells all discarded or unselected grains. This is the only source of revenue, and amounts to about $100 per annum. This sum is utilised in the repair of fences and building in accordance with the contract. The Department buys and keeps in repair all machinery and agricultural implements, etc.

Results.—So far the work at the Station has established the following:

I. That fall (autumn) ploughing gives better results than spring ploughing.
II. That deep ploughing gives better results than shallow ploughing.
III. That the quicker the ground is ploughed after harvest the better.

* 5 links = 3.30 feet.
IV. That late winter seeding, that is November, is better than early winter seeding, that is September.

V. That thin seeding is better than heavy seeding for the dry Panhandle region.

The New Station.—In company with Mr. Ross, I drove out to the new Dry-land Station which is being established two and a half miles from town. It has been acquired on a twenty years' lease. The owner gave the land free of charge for a period of twenty years at a merely nominal rent; the Commercial Club of Amarillo raised $5,000 to erect buildings and fences, and the Government pays all other expenses such as salaries, labour, field tests, etc. At the end of twenty years the buildings and land revert to the owner; the machinery and equipment belong to the Government. This farm consists of 120 acres; the land has been laid off in acre plots and will then be cut up into tenth-acre plots with small plots between the smaller divisions, large paths separating the acre plots. A comfortable house is being erected for the superintendent and his family.

Review.—The Dry-land Station at Amarillo is simple, inexpensive, and well suited to the purpose of testing drought-resistant cereals, rotations, and tillage. But in my opinion it is most unfortunate that the original land should have been acquired on so short a period as five years, and still more so that a new station should have also been acquired on merely a twenty year lease. In work of this kind the longer experiments are in progress on the same class of soil the more valuable they become. If the United States Government grants free homesteads to thousands of unskilled settlers, I fail to see why the Secretary of Agriculture with the Legislatures of the different States should not acquire a small portion of land forever, even if it has to be abandoned at some future period. This method would give fixity of tenure and render the station independent of local land booming or local depression.

Again, I am rather inclined to think that too many lines of work are being attempted. Six carefully chosen and persistently followed lines of investigation will ultimately give better results than a large range which cannot be properly looked after by one man. I was surprised to see no attempt had been made to plant trees, another reason for the avoidance of a short lease. Nevertheless, with these reservations, the work of the station cannot be too highly commended.

The Dry-land Experiment Station at Dalhart is situated about four hours from Amarillo, and is on much the same lines as at the latter place. This station is under the immediate control of the Department of Agriculture—Office of Dry-land Investigations—and is located upon a farm of 160 acres which the citizens of Dalhart donated to the Government on a ninety-nine year lease for the purpose of establishing and maintaining an Experiment Station. They further contributed $4,000 ($800) to the equipment of this station. The station is located on sandy land, and is representative of a large area of land in north-western Texas and Oklahoma. Experiments are in progress with winter wheat, winter rye, corn (maize), kaffir corn, and cowpeas.

I left Amarillo at 11.55 p.m. on the Colorado and Southern Railroad, and reached Denver the next afternoon at 4.45 p.m. We traversed a
portion of New Mexico which is not unlike the Transvaal high veld, although much more broken and rugged. All along the route you see Mexican navvies who live in trucks and work for $1.25 per day. Close to the State line we reached the highest point, that is, Palmer Lake—7,324 feet above sea-level—and then descending slightly we passed into Colorado where the glorious “Spanish Peaks” seemed waiting to bid us welcome to this wonderful land of sunshine, deserts, and snow.

At Pueblo I was happy in again meeting Mr. Wilhelm K. Winterhalter, Consulting Agriculturist to the American Beet Sugar Company, who was a delegate to the Dry-farming Congress at Cheyenne. I was specially interested to meet Mr. Winterhalter because he had been operating the Fowler double engine steam tackle for several years past in southern Colorado. He spoke in terms of the highest praise in regard to the Fowler system; only he stated that he had just purchased a still more efficient and economical tackle made by a Breslau firm which works with superheated steam. Mr. Winterhalter kindly promised me a report on this new outfit within the next year. Mr. Winterhalter is an interesting example of a German-American. Born in the old world, after completing a college career, he migrated to America, and in order to gain a thorough insight into irrigation he worked as a day labourer in the ditches in California at 75 cents (3s.) per day for a period of three years. He then took a post-graduate course in the University of California in chemistry and allied subjects under his distinguished fellow countryman—Professor Hilgard—who is also a German-American. With such a training it need not be wondered at that his rise was rapid, and to-day he is consulting agriculturist for six large sugar beet factories. Mr. Winterhalter’s field of operations is at Rocky Ford in the Arkansas Valley of Colorado. Nine years ago there were only some 4,000 acres under sugar beets, now there are 65,000 in this region alone. Six factories have been established having a daily slicing capacity of 5,000 tons of sugar beets, which is equal to 1,500 tons of refined sugar.

Mr. Winterhalter does not favour the growing of sugar beets on dry-lands, but he was much interested when I remarked that I believed that the Transvaal had a good future before it as a sugar-beet country. And he agreed that if the three essential factors (1) sunshine, (2) good deep loamy soil, and (3) water were present, there would be every likelihood of success in this enterprise in South Africa: although ‘t is doubtful if beet sugar will ever seriously compete with the cane-sugar industry of Natal and Zululand.

In Denver I had the pleasure of again meeting Mr. John T. Burns, Secretary to the Dry-farming Congress, and spent a most interesting and profitable time with him. Leaving Denver at 2.15 p.m., I journeyed to Akron which I reached at 5.30 the same day—a distance of ninety miles. This village is on the direct route of the Burlington Railroad to Chicago where a hundred snow-capped peaks sentinel the surrounding plains. Next day along with Mr. John Cole, Field Assistant of the United States Department of Agriculture, who so kindly came out from Denver as my guide, I drove out to the Akron sub-station. This station is situated four miles from the village of Akron, which has a population of 500 inhabitants. The Burlington Railroad runs through the station. The station comprises an area of 67 acres—all of which has been ploughed—
and which was donated by Washington County to the National Government for experimental work. The citizens of Akron and other interested persons raised a sum of $3,000 (£600) for the erection of buildings on the station. The equipment and other necessaries were put up by the Department of Agriculture. The sum expended annually is roughly $6,000 (£1,200) including salaries, labour, new equipment, repairs, and improvements.

The staff of the station consists of the superintendent, the specialist in grain investigations, a foreman, and two hired men at $50 (£10) per month without board. The Superintendent, Mr. J. E. Payne, was brought up on a farm in eastern Kansas, and graduated as Master of Science from the Kansas State Agricultural College. It was of interest to learn that Mrs. Payne was also a graduate of this institution, having taken the same degree as her husband. Besides the 67 acres above mentioned, an additional 160 acres, owned by the State of Colorado, is being used conjointly by the United States Forest Service and the Bureau of Plant Industry. It will thus be seen that this station holds its land in fee simple which, as I have already observed, is of the greatest importance in experimental work.

Work was started on 21st June, 1907, when the prairie sod was first turned over. The average rainfall varies from fifteen to eighteen inches. No irrigation is possible, and it is in every sense of the word a dry-farm. The soil is a sandy loam with a sandy subsoil. Water has been struck at 90 feet on the station. The general plan of work comprises cereal work, breeding by selection, crop rotation, horticulture and forestry, drought-resistant plants and forage crops adapted to the country, together with various meteorological studies, and work in soil physics.

At present there have been erected a six-roomed dwelling, a barn, seed house and laboratory, a blacksmith shop, and a machinery shed. I found the same implements here as at the Amarillo Station, with one or two extra, such as a John Deere sulky plough, with a harrow attachment, a Demster five-disc drill for seeding between corn-rows (maize-rows). This drill is widely used in western Kansas for seeding wheat between the rows in corn (maize) fields before the stalks are removed.

Another implement worth noting is the lister. The practice of listing is very common in Kansas and Nebraska and other Western States. A lister is a double mould-board plough with the land sides set together. The seed is sown directly in the furrow made by this plough. I am now speaking of old land after the sod has been broken up. Consequently with a good team and one lister, a man can plough and plant nine acres per day; whereas he could only plough two to three acres per day with an ordinary mould-board plough. Later, the ridges left by the lister are gradually levelled. Listing is of advantage in enabling the crop to root more deeply and so withstand the drought better. It is not practicable north of Nebraska, because the deep planting results in too late harvests, which are apt to be frosted. No live stock are kept on this station except five work horses and some fowls.

Revenue.—A little wheat and forage is sometimes sold; but no revenue is expected. The period is too short to speak of results. The work so far was simply preparing the ground and getting ready for experiments. However, it may be said that the Durum wheat (Beloturka and Kubanka) have given the best results, the Kherson and Sixty-day oats and Hull-less barleys. Of the sorghums, Early Amber, Minnesota Amber (black), and Red Amber have proved the main forage
Senor Romulo Escobar, Mexico.

Dr. Lawrence Baeta-Neves, Brazil.

W. H. Fairfield, Esq., Dominion of Canada.

Joseph A. Rosen, Esq., Russia.

Dr. William Macdonald, Transvaal and British Colonial Office.

Senator James H. McColl, Commonwealth of Australia, Chairman of Congress.


Foreign Delegates at the Dry-Farming Congress.

Third Annual Dry-Farming Congress, Cheyenne, Wyoming.
and the best drought-resistant crops. The Kaffir corns are too late ripening for this locality. So far corn (maize) has not done well on account of the altitude (5,000 feet), cold nights in summer, and the drought.

The station is well situated, and when trees are planted will have a pleasing aspect. In the State of Colorado the typical dry-land sections are to be found between the Platte and Arkansas River, an area of about 16,000,000 acres. Here the rainfall varies from 13 to 20 inches per annum.

Leaving Akron, I returned to Denver by the 2:15 p.m. train, and left next morning for Utah. It would be a great convenience, both for the staff and visitors, if the Akron Station had telephonic communication with the railroad station—a distance of only four miles.

During my visit the Mondell Bill came into force, which gives 320 acres to each settler who resides for a period of five years in this part of the State, and the Land offices were crowded with eager applicants. There is but little doubt that this whole country will be rapidly developed by these settlers, who, for want of funds, have been unable to get a foothold in the wealthier sections of America.

Through the Deserts of Utah.—I left Denver at 8 a.m., on the Denver and Rio Grande. It was a clear, crisp morning, and the journey all day was most enjoyable. Shortly after noon we reached Cañon City and entered the Royal Gorge. It is indeed a worthy name for a mountain glen of such grandeur. The towering rocks which hung trembling in mid-air seemed ready at the merest touch to dash the train into the stream below. At Tennessee Pass we gained the highest point on the railroad—10,240 feet above sea-level—and all day were in full view of the sublime snow-mantled peaks. Then descending we traversed the sage-brush deserts of Utah and passed through the glittering Watsatch mountains into the famous Salt Lake Valley. It would be hard indeed to find a more lovely farming region in the whole world. It was here that the Utah pioneers made first use of those waters which come from the eternal snows, and it is here that they have developed the science of irrigation to a high degree. Fat cattle, green alfalfa (lucerne) fields, blossoming orchards, well-tilled lands, and thrifty homesteads all testify to the agricultural prosperity of this region.

I reached Salt Lake City about 1 p.m., and the same day sought out Professor Lewis A. Merrill, who, along with Dr. Widtsoe, has done so much to promote the arid-farm movement in Utah. Mr. Merrill is the editor of the Deseret* Farmer, manager of the Utah Arid-farm Company, superintendent of the State Experimental Arid-farms, Director of the State Farmers' Institutes, and formerly Professor of Agronomy in the State Agricultural College. It will thus be seen that he is a man of wide and varied activity. Mr. Merrill is a native of Utah, and a graduate of the Utah and the Iowa State Agricultural Colleges.

In the pages of the Transvaal Agricultural Journal I have previously spoken of the splendid pioneering work in dry-farming which has been done by the people of Utah during the past twenty odd years: so at the present time I need only allude to the experimental work on the State farms. Six arid experimental farms have now been established on the

* A Mormon word meaning 'little desert.'
desert lands of Utah. Originally, these stations comprised only forty acres each, but of late the tendency has been to increase the acreage of one or two, notably Nephi. The combined State and Federal grant only amounts to the paltry sum of $12,500 (£2,500) per annum, and it is wonderful to reflect what a magnificent work has been accomplished in agricultural development by these stations for this small sum of money.

In Utah the Durum variety of wheat has given very good results as a drought-resistant crop, but its cultivation has not been encouraged, as winter varieties, such as Turkey Red, Gold Coin, and Kufoid, give larger yields. The desert vegetation mainly consists of sage-brush, grease wood, and rabbit-brush. Sage-brush is usually considered a sign of good dry-farming land, but both grease wood and rabbit-brush generally indicate an excessive amount of alkaline salts in the soil, which prevents these lands from responding readily to tillage. I was surprised to find so few trees on the dry farms of this State, but, apparently, drought-resistant hardy types have not yet been developed.

The usual method of reclaiming desert land is as follows:—The first operation consists in grubbing, viz., tearing out or cutting the sage-brush. The ground is then ploughed to a depth of six inches. The first ploughing is done shallow in order to avoid turning under too much of the undecomposed brush. The relics of the sage-brush are raked together by means of a harrow, and the land is left idle until the fall (autumn) of the year. It is then harrowed several times with a disc and steel-tooth harrow, and made as far as possible into a good seed bed. In the month of October it is seeded to wheat at the rate of from 30 lbs. to 40 lbs. per acre. In the springtime the young grain is harrowed to conserve moisture, kill weeds, and break up any crust which may have formed on the surface. Immediately after the first harvest the land is again ploughed, but deeply this time—to a depth, if practicable, of ten inches, and it is then left in the rough furrow—to collect the snow and rain—until next spring, when it is harrowed several times with the steel tooth and disc harrow. That is, after each rain during the spring and summer, a light harrow is used, and so on until the seeding time in October. By this method of growing a crop one year and allowing the land to rest during the next, viz., summer fallowing, the Utah farmer obtains from twenty to thirty, and even forty, bushels of wheat year after year, without the use of manure,* and his whole object in this treatment of the soil is simply and solely the conservation of moisture from one season to the next.

In order to visit the central part of the State I left Salt Lake City on the San Pedro, Los Angelos, and Salt Lake City Railroad. I traversed the beautiful Salt Lake Valley, and, close to Provo, entered a second valley, the Utah Valley, which is famed for fruit-growing, sugar beet, and cattle raising. This is all under irrigation. I reached Nephi at about noon, and was most courteously welcomed by Mr. Grace, the Mayor of the town, Mr. Paxman, the President of the Juab Stake,† and Mr. Stephen Boswell, foreman of the State Experiment Station. "Show him a hospitality as broad as our valley," was the message telephoned by Professor Merrill, of Salt Lake City, to his fellow-churchmen of Nephi, and I was received with unbounded hospitality. These three gentlemen are the best

* A similar method was practised in England by Jethro Tull (1674-1740).
† The word "Stake" means a district of the Mormon Church.
known dry-farmers in Juab County. Mr. Boswell was the first to file a homestead on the dry lands of this county twelve years ago. I arrived on a Fast Day, and, although church services were in progress, I was driven out to the State Dry-farm. Another well-known citizen, Senator J. A. Hyde, also accompanied us. Previously, each of the six Government farms received practically the same sum, viz., an appropriation of $1,000 each. It was soon seen, however, that this sum was insufficient to do the work, and it is now thought best to concentrate more attention on one central farm, namely, Nephi, and so spend less money on the outstations. It is also worth remembering that the college farm at Logan, in the northern part of the State, is a stock farm, and grain and feeding tests relative to the dry-farms are made there.

Nephi is a picturesque town of 3,000 inhabitants, situated at the base of Mount Nebo (12,000 feet). The Dry-farm Experiment Station is situated six miles from town and lies alongside the railroad. It consists of 100 acres (40 being the original grant and 60 more having been lately added). This is enclosed in a woven wire rabbit-proof fence, costing $1 per rod (16½ feet). The land of the farm belongs to Juab County. The main lines of experiment consist of various tests with dry-farm cereals and tillage methods for the conservation of moisture, besides experiments with forage crops. I was much struck with the excellent tilth of the soil and the results which have been gained by the use of moisture-saving fallows. All the grain looked particularly well, and was a wonderful ocular demonstration of the success of the methods adopted. The rainfall varies from fifteen to eighteen inches at the station, and comes mainly during the winter months and very early spring. Most work is being expended on wheat and lucerne, the two main crops of this section. The three wheats which have given the best results here are the Kufoid, Turkey Red, and Gold Coin. The Kufoid is a native of Utah, and is the best drought and frost resisting wheat in the State; but for five years out of six Turkey Red has out-yielded the Kufoid. The Turkey Red has a smaller, harder berry than the Kufoid, and yields even a finer flour. The dry-land farmer of Nephi is never troubled with rust; but it is not so on irrigated farms. Two years ago all the wheat under irrigation was ruined, and the irrigators, like the foolish virgins of the Holy Writ, had to purchase a fresh supply, not of oil, but of flour and seed wheat from the dry-farmers. Here it is a common belief that in the near future all the wheat of Utah will be raised on the dry-farms. Dry-land wheat sells at from 5 cents to 10 cents per bushel (60 lbs.) more than irrigated wheat. You get more flour and less bran from the dry-land wheat. In short, the dry-land farmers of Utah do not fear rust; and they are convinced that the spread of rust is largely favoured by excessive moisture, a stagnant soil, heavy seeding, and lack of ventilation.

Touching alfalfa (lucerne), forty-eight different strains were being tested, and all looking well. Of grasses, Bromus inermis has given the best result, and keeps green throughout the winter. The staff of the station consists of a superintendent, and a foreman and unskilled hired help. The State Government has appropriated $10,000 for two years for this dry-farm (the Legislature meets biennially). The National Govern-

* On a certain day each month only one meal is taken, and the equivalent of the two forfeited meals is given to the poor of the Mormon Church.

† Named after a Danish farmer, who found some grains of wheat in a prehistoric Mexican mound. The best bread I tasted in America was made from locally-grown Gold Coin wheat in Nephi.
ment co-operates in this work and supplies the superintendent with various scientific implements and new seeds.

Concerning equipment, water for domestic purposes has to be hauled from town every day, a distance of six miles. The foreman lives in town; but he camps on the station ground during the busy season. The superintendent likewise resides in Nephi. There is an office and laboratory, a machine shed, and outhouse on the station. A sage-brush grubber was the only unfamiliar implement to me. Mr. Boswell favours a press-shoe-drill over the disc-drill, as it presses down the seed better. The best harvests have been obtained with 45 lbs. of seed wheat put into the ground about three inches deep. There is only a small revenue, namely, about $200, from the sale of the grain. There are no wind-breaks about the station. Trees have not been successful, and even the hardy locust tree succumbs to the drought.

Leaving Nephi I travelled back to Logan, in the north. The agricultural valley which stretches from Salt Lake City through Ogden to Logan, and which has been developed both by dry-farming and irrigation, is one of unrivalled beauty. Here you see the great irrigation works of the Bear River, watering 150,000 acres, most of which is laid down to sugar beets. It is interesting to learn that the sugar beets of Utah give the highest sugar content of any State in the Union. As I said before, wheat is now grown only on dry-lands, whereas sugar beets are grown entirely under water. That evening I called on Dr. John A. Widtsoe, President of the State Agricultural College, and author of "The Arid-farm Bill of Utah." Dr. Widtsoe was born on the Island of Froyen, off the coast of Norway, in the year 1872. Coming out to the United States in 1883, he entered the Brigham Young College, Utah, and later graduated from Harvard, Gottingen, and Zurich. In 1900 he was elected Director of the Utah Experiment Station and Professor of Chemistry in the Agricultural College at Logan, and seven years later was appointed to his present post. Mr. Widtsoe is a member of the Church of Jesus Christ of Latter Day Saints—Mormon Church—and is married to a granddaughter of Brigham Young.

In Utah, Dr. Widtsoe was the first to publicly advocate the reclamation of the deserts by the scientific study of the soil, so he may well be termed the father of the modern dry-farming movement in this State. His gospel of dry-farming may be tersely stated as follows:—

(1) Plough deep.
(2) Plough in the fall (autumn); there is no need for spring ploughing.
(3) Cultivate the soil in early spring, and as far as possible, after every rain.
(4) Grow crops that are drought-resistant.
(5) To make dry-farming successful among practical men, stick to a few staple crops, such as wheat, oats, barley, rye, and lucerne, and when these are established go on to others.

In his discussion with me on dry-farming, Dr. Widtsoe said: “In Utah it has been demonstrated, beyond all doubt, that dry-farming is possible where there is a rainfall of twelve inches per annum and where the soils are of moderate fertility. It is sometimes said, ‘Why fallow?’ Out here, our conclusion is that the rest afforded by the fallow, combined
with the customary tillage, results in the release of plant food. If we were to preach any other doctrine but that of the moisture-saving fallow on the deep fertile soils of Utah, Nevada, Idaho, and Arizona, it would mean that our farmers would be ruined. In short, the summer fallow stores up moisture and liberates plant food, making it possible for the crop to develop to the fullest extent with a limited supply of moisture. There is, therefore, a double reason for the summer fallow. Ultimately, there will come a time that we must apply plant food in some direct form, such as by green manuring; but the soils of Utah, by the methods just mentioned, have been producing large yields for the past quarter of a century, and are still far from being exhausted. In my opinion, commercial or artificial fertilisers will never be practicable on our large dry-farms, and we must resort to natural or barnyard manures."

In the Cache Valley.*—Next day, accompanied by Professor Hogenson, I drove through the famous Cache Valley, the most renowned dry-farming region in America. The winter wheat—Gold Coin—was about six inches high, and was in excellent condition. What rather surprised me was the number of cattle that were grazing over these wheat lands. Mr. Hogenson said that this was the common custom in this part of Utah. It tended to make the grain stool out, manured the fields, gave the animals green feed, and did not materially injure the land, except to compact it if there was too much tramping. The cattle are put on just after the ground is hard enough in the spring-time, and are kept on for about six weeks. It was also most interesting to see everywhere examples of the summer fallow method; that is to say, you could see the vivid green of a field of 100 acres side by side with the bare brown fallow of another field of the same size. We stopped at the farm of Mr. G. L. Farrell, who came to this region in the year 1869. Here I saw a field which had been forty years under wheat, without any rotation, without any manure, and is to-day yielding as much as ever, viz., 35 bushels to the acre. This field is summer fallowed every second year, as it is the usual custom in Utah. The soil is a deep clay loam with here and there patches of alkali. This farmer has 200 acres under wheat; the soil mulch was one inch thick, and the seed bed moist and mellow. The Cache Valley is fifty miles long by twelve miles broad, and consists of a deep alluvial clay loam. The native vegetation consists mainly of sage-brush, rabbit-brush, shad-scale, and grease wood. The last two desert plants indicate the presence of alkali, and consequently these lands are usually avoided in the selection of a dry-farm. I was informed that a certain Mr. Ecklund, a Swedish farmer, following the methods advocated by the College authorities, is now raising 60 bushels of wheat per acre.

Fall or autumn ploughing is the common custom in dry-farming in Utah. The reasons given for this practice are as follows:—It allows the rain and the snow to collect in the rough furrows during the winter-time. It permits the weathering of the soil. It creates a natural reservoir for the storage of water. It tends to make the land mellow. It liberates plant food.

* The Valley of the Hidden Treasure. So called because the pioneer explorers hid their treasure in this valley. They never found it, but their children discovered that the valley was one of the most fertile in the whole of America.
In this valley the only special implements which I noticed were a lucerne renovator and a Henderson smoothing disc harrow. The renovator is used for cleaning lucerne fields, and is useful in splitting the crown of the plant and so making the crops stool out better. The smoothing disc is a useful implement for making a fine mulch. The Superior drill is widely used.

In the further part of the Cache Valley the wheat was looking even better, and mile after mile of green fields mixed and mingled with the fallow lands. Last season the wheat crop was heavy, and averaged 45 bushels per acre over the whole valley. Rotation has not been practised in this region. I was much struck with the cleanness of the wheat fields, and, with the exception of bunches of volunteer wheat from the previous season, few or no weeds could be seen. The dry-farmer in the Cache Valley is therefore in a happy position of being largely free from weeds and rusts. I was much interested in, and have never seen before, so much dry-land lucerne. It is sown at the rate of 8 lbs. per acre, and with this thin seeding there is a tendency for it to grow in clumps; thus, in looking over a field of dry-land lucerne, it seems to be growing in isolated bunches. Later, however, these clumps stool out, and the whole field becomes a vivid luxuriant green. Should it become weedy the disc harrow or lucerne renovator is run over it, and that is all the treatment it ever gets. The dry-farmer of the Cache Valley does not believe much in the practice of green manuring, because, should he wish to renovate his soil, he would prefer to feed his stock on these wheat lands, and obtain natural manure, because it decomposes more readily than the green manure. Besides, the capillary rise of moisture is not broken, as sometimes happens where an undecomposed mass of matter is left in the soil. Furthermore, the dry-farmer here does not believe in the Campbell method of surface packing. Campbell states that the ploughed stubble should be packed, but in Utah it has been found that fall ploughing produces a sufficient degree of packing. And the land, by the spring-time, is nice and mellow, the stubble having largely decomposed. Some native grasses, such as bunch grass, blue grass, and wheat grass, are regarded as indicators of good dry-land. Here in the Cache Valley dry-farming has never been a mere theory, but an actual fact, and, what is more important, a most profitable practice for the last forty years.

The Dry-farms of Montana.—After bidding Professor Hogenson good-bye, I left for Butte, Montana, that same afternoon. Traversing the State of Idaho I arrived at Butte—400 miles to the north—the following morning. Butte is the most important town in Montana, but on a raw, cold morning, it certainly looked a forbidding mining camp. It was now time to begin my long eastward journey, and I reached Bozeman, Montana, at 1.35 p.m. the same day. Here the State Agricultural College is located, while the State University is situated at Missoula. In passing I may remark that this seems to me another unfortunate example of the divorcing of the Agricultural College from the State University. This is also seen in Kansas, Colorado, and Utah.*

The Agricultural College of Montana is finely situated, with a background of majestic snow-capped mountains. Over 500 students-

* Examples of the benefit of union of State College with State University are to be strikingly seen in the case of the three greatest agricultural colleges in America, viz., Cornell, Wisconsin, and Minnesota.
are in attendance, and the campus consists of half a section—320 acres of land. I was cordially welcomed by Dr. J. M. Hamilton, President of the College, Mr. F. B. Lindfield, Director of the Experiment Station, and Mr. A. Atkinson, the Professor of Agronomy. The average rainfall for the whole State of Montana is sixteen inches per annum, and it comes mainly during the months of April, May, and June (spring and early summer). The soil varies from five to forty feet in depth, and is chiefly a sandy loam underlaid with gravel. The dry-farmer of Montana, in seeking for a sign, believes that, generally speaking, where the buffalo grass and the blue joint thrive there is good land, but where he finds cacti the soil is apt to be shallow and dry. The great benefit derived from the summer fallow in Montana is believed to be not so much from the conservation of soil moisture as to the increase in the fertility of the soil by reason of the release of plant food and the activity of the nitrifying bacteria. Two days before I reached Bozeman there had been a heavy fall of snow, but at the time of my arrival it was rapidly melting away, although, as the Canadians quaintly put it, "I carried my homestead on my feet" all day.

Montana is the third largest State in the Union—Texas and California being bigger—and has an area of 147,000 square miles, or 93,000,000 acres. Of this amount 36,000,000 approximately are level enough to farm, the remainder being mountainous or broken land. Five years ago the outlook was very dismal; the stock ranges had been over-grazed, and the cattle and sheep men were selling out. They supposed that their lands were quite worthless; and the railroads were glad to sell their lands at 50 cents per acre. The credit of being the first to advocate the utilisation of the level range for grain raising belongs to Senator Paris Gibson, of Great Falls. His faith has been amply justified, and the extraordinary development of this State within the last three years can be traced entirely to the dry-farming movement. Settlers are pouring in to take up farms on the dry-lands, and instead of 50 cents per acre land is now selling at $5 to $10 per acre. Professor Lindfield, now Director of the State Experiment Farm, had seen the magnificent results of dry-farming in Utah, and on coming to Montana advocated making a start in this direction, while his colleague, Professor Atkinson, began an active campaign on his arrival some two years ago. It is of interest to know that both these gentlemen are graduates of the Ontario Agricultural College in Canada.

The first dry-farm investigations in the State were started in 1905. The Federal Government contributed $2,000, the Northern Pacific Railroad Company $2,000, and the State of Montana $500. Next year the Federal Government ceased to contribute, and these experiments were continued with the sum of $2,500 from the Northern Pacific, $500 from the State, and $2,000 from the Great Northern. On 1st March, 1909, the appropriation was as follows:—The State gave $16,250, the Northern Pacific Railroad $5,000, the Great Northern Railroad $2,000, and the Chicago, Milwaukee, and St. Paul Railroad $2,000, the Federal Government $2,500, making a total of $37,750 for aid in dry-farming. Now, it is a most interesting fact to note the cordial co-operation of the railroad systems with the State Agricultural College. It benefits both parties.
The Northern Pacific* has $8,000,000 worth of land to sell. When they
built their railroad they got a grant from the National Government of
every odd section for forty miles on each side of the railway clear across
the State. The other two railroad companies did not get an acre of land,
and their co-operation with the State Experiment Station in this matter
is simply to increase their freight and passenger business. The money
given by the railroad companies is employed to hire men, buy equipment,
and pay the travelling expenses of the agricultural experts. It is not
permitted to be used for administrative work, or the publication of
bulletins or reports.

The following dry-farms have already been established:—(1) Glendive, (2) Terry, (3) Forsythe, (4) Billings, (5) Lewiston, (6) Great Falls, (7) Chester, (8) Harlem, (9) Round-up, (10) Baker. These are
cheap stations, consisting for the most part of forty acres each, divided
into one-acre plots. The staple crops are tested as well as different
methods of cultivation. The college possesses two small threshing outfits,
which are shipped around the State. These stations are well advertised,
and the farmers are brought together. In regard to the staff, it may be
said that the foreman gets $600 (£120) for his work during the summer,
and nothing for winter, viz., from April to September. He has to furnish
horses and ordinary farm machinery, and is permitted to work on his
own homestead.

These dry-farms are planted in places to attract settlers; for example
the Forsythe Station was started in the spring of 1906. The first
settlers came in two years later, and this year all the land has been
taken up. Settlers are now coming very rapidly, and the policy in the
future will be to endeavour by encouragement and advice to make those
colonists stay. The cost of these dry-farms on an average is about
$2,000 per annum for a forty-acre station. The dry-farm at Harlem is
twenty-five miles from the railroad, where as yet there is not a single
homestead in the whole district. Here the superintendent receives
$1,000 for six months in order to induce him to remain in that unsettled
country. The largest State dry-farm is 160 acres, of which 80 acres are
laid out in plots. In Montana it is usual to sow half-acre plots rather
than one-tenth acre, so as to appeal more to the farmer. The Lewiston
Station is twenty-two miles west of that town on the Great Northern
Railroad. Here the staff consists of a superintendent, a plant breeder, and
two workmen. This station costs annually $4,500, of which the State
gives $2,000 and the Federal Government $2,500.

In Montana eighteen officials are actively engaged in the dry-land
propaganda. This number includes two professors, three assistant pro-
fessors, two superintendents, and eleven farm foremen. Each of the
smaller type of dry-farm station possesses simply ordinary farm
machinery and a team of horses, whereas the larger stations have
each a soil laboratory, a full set of meteorological apparatus, a seed house,
a house for the superintendent, also one for the workmen. Regarding
machinery, the sub-surface packer has been used on the dry-farms of
Montana, but it is considered an unnecessary implement in this State
and too hard on horses for the amount of work which it does. The
ordinary disc harrow is used both for surface pulverising and sub-surface
packing. The Superior press drill and the lucerne renovator are tools

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* I was told on good authority that Northern Pacific lands have increased in value to
the extent of $10,000,000 during the past five years owing to the rise and progress of dry-
farming.
which have been used with marked success. In this State I was told that $6\frac{1}{2}$ might be taken as the cost per acre of producing wheat on an average dry-farm. This sum would include ploughing, harrowing, and harvesting.

During my journey through the West, I made enquiries in regard to steam cultivation, and on several occasions saw traction ploughing. In Montana, Professor Atkinson, whom I interviewed on this matter, said:—

"In regard to steam cultivation we advertised for breaking up and double-discing two sections—1,200 acres—and the bids ranged from $41\frac{1}{2}$ to $8 per acre with ordinary ploughmen and teams. We then decided to buy a traction gasoline outfit: Hart-Parr engine (Charles City, Iowa), 22 horse-power, costing $2,250 cash; and an Emerson 14-disc plough (Emerson Company, Springfield, Illinois), costing $450, and a tank at $75; including freight the total cost of this outfit was $3,054. We broke and disced 900 acres at a cost of $2.16 cents per acre, and we are now doing it for under $2 per acre. This machine is giving entire satisfaction. We ploughed four and five inches deep, but later we intend to buy mould-board ploughs and go down six and seven inches. This type of traction engine moves over the ground at the rate of two miles per hour and does twenty acres per day, and burns sixty gallons of gasoline daily. The tank is filled once a day and costs 22 cents per gallon. The gasoline is delivered at the farm once a week. We could not afford to use coal as it is too far to haul, but we believe there is a great future for the gasoline traction engine on the dry-farms of Montana."

I left Bozeman on the Union Pacific at 7.20 p.m. and arrived at Forsythe, Montana, at 3 a.m. Next morning Mr. J. B. Nelson, Superintendent of the State Dry-farms, very kindly accompanied me. We drove out to the Forsythe Station, which is situated six miles from the railway. The soil is a good loam, two to five feet in depth, resting on a clay subsoil. This farm consists of forty acres, which is held on a five years' lease. The land belongs to a neighbouring farmer, who, in consideration of taking charge of the farm, receives a grant of $75 per month from the railroad company, and in addition he obtained his own section of land—640 acres—from this company at a greatly reduced rate, that is $3.50 per acre. This farmer carries out the instructions given him by the State Superintendent of Farms. At the time of my visit the experiments in progress were principally connected with tillage, such as methods of fallow for the conservation of moisture, the growing of drought-resisting cereals, and a determination of rates of seeding. The aim is rather to concentrate on a few main points of dry-farm practice than to dissipate over too many—in a word, to be able to tell the farmer, as soon as possible, one or two things of practical value to him. At this station, the land was in good tilth, but the wheat was backward owing to the inclement spring. As yet, no trees have been planted, and there is only one small building on the place—that is a soil laboratory.

I examined a steam-ploughing outfit—direct traction—near by, which was engaged in breaking up five sections of land (5 x 640 = 3,200 acres). It seemed to be giving great satisfaction. The engine—22 horse-power—was drawing twenty-two disc ploughs, which were cutting from three to five inches deep. I saw 600 acres of fall wheat on land which had been broken up by this outfit, and it was doing nicely. After ploughing the land is disced, harrowed, and levelled, and then seeded. The engineer in charge—a bright young fellow—seemed to know his
business. He informed me that there had been no breakdown since he
started in the spring-time.

*Across the Prairies of North Dakota.*—At 11 o'clock I left on the
Union Pacific for Dickinson, North Dakota, which I reached the same
evening at 8 p.m. Close to Medora, in North Dakota, we entered the
famous Pyramid Park, or the region of the Bad Lands. Not far away,
in the valley of the Little Missouri River is the ranch upon which ex-
President Roosevelt lived for a number of years. Next morning, Mr. O. G.
Grace, Superintendent of the Dickinson Experiment Station, kindly drove
me out to the farm. The weather was bitterly cold, and I confess I longed
for a mid-summer day in Pretoria. Even at this late date, 14th May,
a large number of people were wearing buffalo robes. In fact, Mr. Grace
informed me that the Russian settlers, of whom there are a large number
in this locality, wear fur coats more or less all through the year, which
indicates the rigorous nature of this climate. Four dry-farming stations
have already been established in North Dakota, namely at (a) Dickinson,
(b) Edgeley, (c) Williston, (d) Fargo.

The station at Dickinson is within two miles of the city limits—a
regulation as to distance having been inserted by the legislature. There
are 160 acres on this station. The ground was given by the people of
the town and the surrounding county. The annual appropriation from
the State Government is $5,000, and this is expended in salaries, running
expenses, and wages. The Federal Government simply assists in the
matter of experts. The staff consists of the superintendent and two or
three hired men. This station is co-operating with the United States
Department of Agriculture, which furnishes two experts, one of whom
has charge of the dry-land work, and the other plant breeding. There is
a handsome eight-roomed house for the superintendent, a commodious
barn, and machinery shed. The revenue from the sale of seed grain
amounts to $400 per annum. The average rainfall at Dickinson is sixteen
inches per annum. This station has been in operation for a period of
four years. The work may be summed up as follows:—The summer fallow
has been given a thorough test and it has been found that an intertilled
crop, such as corn (maize), gives as good a result. Canadian field peas
and sweet clover have proved of special value for green manuring.
Experiments are going on in grain investigation, variety tests, rate of
seeding, and crop rotation. There is also considerable work in connection
with lucerne. Tests are being made with trees for this part of the prairie,
such as different varieties of pines, cottonwood, and box-elder. In regard
to wheat, the fife and blue stem varieties, the well-known hard spring
wheats, are mainly grown, but Durum wheat is being grown more and
more. No winter wheat is sold, as the climate is too severe. It is of
interest to note that North Dakota, at the present moment, is in a
transition state, that is, it is passing from ranching to small farming.
The Hereford, Shorthorn, and Aberdeen Angus, the Merino and
Shropshire are the prominent breeds of cattle and sheep respectively in
this section. In the neighbourhood of Dickinson I saw more steam
traction and gasoline engines for ploughing than I had seen anywhere else
during my tour, and I was informed that a very large percentage of the
prairie land of West and North Dakota will be broken up and seeded to
wheat by these engines this coming season.

The following notes may therefore be of interest:—All sorts of traction
engines are used for ploughing. However, those intended for both
ploughing and threshing are made stronger in the traction gearing and also in the boiler, and cost about $450 more than the ordinary traction threshing engine. In North Dakota the fuel used is lignite and costs from $2 to $3 per ton, depending on the distance from the mine. A 25 horse-power engine will use about four tons per day. Such an engine, equipped for ploughing, costs about $2,000, while the ploughs, say, six 14-inch, cost from $125 to $600, depending on the quality. Such an engine will average from 13 to 14 acres per day, ploughing three to five inches deep. Four men are usually employed on this outfit; the engineers receiving $3.50 to $4.50 per day, the other men from $1.25 to $1.50. The usual price charged for breaking up virgin prairie is $3.50 per acre, or $4.35 for ploughing, discing, and seeding. The daily expense for such an engine may be put down at $20—a sum which would cover the cost of fuel and wages of the men. These ploughing outfits are only used for a period of five or six months and they usually are expected to turn over about 1,500 acres in the season. Steam power is not used nearly so extensively in the eastern part of the State, as the land has more stone on it, and also more swampy spots, which would greatly interfere with the use of an engine.*

I left Dickinson at 11.5 a.m. and reached Minneapolis next morning at 8.50 a.m.

On Friday, 28th May, I left Minneapolis by the 10.20 p.m. train on the North-western Railway and arrived next morning at Madison, where the University of Wisconsin is located, which lies 120 miles to the west of Chicago. After studying the wonderful agricultural extension work of this splendid institution I journeyed to Moline, Illinois. Moline is a pretty town on the banks of the Mississippi River, situated 170 miles to the south-west of Chicago. It is purely a manufacturing town of some 25,000 inhabitants. In connection with dry-farming, I had always wished to see the making of ploughs in a modern factory, and I spent a most interesting and instructive forenoon in the workshops of the John Deere Company, the largest steel plough factory in the world. The President of the Company, Mr. William Butterworth, received me most courteously, and detailed his technical manager to show me the factory. The magnitude of the operations and the labour-saving devices filled one with amazement. The machines are almost human in their marvellous ingenuity. Each part of the plough is made separately by the thousand, and then all are welded or bolted together, as the case may be. The care taken in polishing and smoothing the share so as to get a perfect adjustment is truly wonderful. After the plough is put together it is hung up to the ceiling and travels around the building on an iron rail, never touching the ground until it is sold. It is painted in three seconds and varnished with the same lightning speed—a clutch is released and two ploughs at a time are dropped into a paint tank and swung up to dry. The pounding each steel part receives by the huge electric hammers is simply terrific and makes you wonder how a plough could ever break. Besides an enormous trade in ploughs this company has also made a speciality of corn planters and disc harrows, and I saw hundreds of these implements in the process of manufacture. Here, too, I was interested

* The following are some of the firms manufacturing steam engines used for ploughing:—Avery Manufacturing Company, Peoria, Illinois; J. I. Case Company, Racine, Wisconsin; Minneapolis Threshing Machine Company; Hopkins, Minnesota; and Reeves & Company, Columbus, Indiana.
to note a new machine—mealie planter—which is being made to suit South African conditions, with a special device for sowing Hickory King maize. I was struck with the intelligent and contented appearance of the men, mostly Swedes, who were working with great rapidity. There was no loafing, and I was informed that they are paid by piece-work and earn on an average $2.50 per day. No trade union men are admitted to this factory.

From Chicago I took the train on the New York Central, and twenty-four hours later, sharp on time, sped into the Grand Central Depot, in the heart of the great metropolis. The whole of the Hudson Valley was wrapped in a glorious green, and even the shimmering waters seemed touched with the magic of spring. I sailed from New York on the Lusitania, of the Cunard line, on 9th June, and arrived in Liverpool, 15th June, having made the passage in five days two hours and five minutes, and sailing from Southampton on the Kinfauns Castle, 26th June, reached Pretoria on the 15th of July.

CONCLUSION.

In a journey covering over 11,000 miles throughout the different sections of America, I have been afforded an exceptional opportunity of studying every phase of dry-farming, and of meeting all sorts and conditions of persons actively engaged, either directly or indirectly, in this work—western farmers, departmental officials, experiment station experts, land agents, and business men; and my investigations lead me to the following conclusion:—Dry-farming has proved to be a profitable practice, and has taken a firm hold on the American people. The proof of this statement will at once be evident from a consideration of five great movements: (a) The Annual Dry-farming Congress; (b) the Dry-land Experiment Stations established by the National Department of Agriculture; (c) the State dry-farms in the West; (d) the recent remarkable development of dry-farming in the whole semi-arid region of Western America; and lastly (e) the action of the Federal Government in passing the Mondell Homestead Bill, which is specially designed for the dry-farmer. In a word, dry-farming is destined, in the immediate future, to play a far more important rôle in agricultural development than even the great art of irrigation. This being so, it is almost superfluous to urge the necessity of its application to the Transvaal, and of a systematic study of the special problems involved, without further delay. In view of what I have recently seen in America, I respectfully submit the following recommendations:—

I. That a Dry-farming Division be at once established in the Department of Agriculture to foster and to promote this new branch of agricultural science, comprising the following staff:

(a) Dry-land Agronomist—having a special knowledge of the science and practice of dry-farming, combined with a wide knowledge of agriculture.

(b) Assistant in Soil Physics—having special qualifications in physics and chemistry and a general knowledge of agriculture.

(c) Assistant in Soil Bacteriology—having a special knowledge of bacteriology applied to soils, combined with a sound scientific training.
(d) Assistant in Plant Breeding*—having a special knowledge of plant physiology combined with a knowledge of agricultural botany.

(e) A Superintendent and foremen for the Dry-land Stations which may from time to time be established.

II. That five Dry-farms†—Dry-land Experiment Stations—be established for the study of problems relating to tillage, the conservation of moisture and the cultivation of drought-resistant plants. Preference should be given to the driest regions of the Transvaal. In the beginning, these stations should be dry-farms in the strict sense of the word—not stock farms—in order that they may not be unduly expensive.

III. That extension work be begun amongst the farmers to arouse their interest and to help them in this matter. This can best be done by dry-land publications, lectures, and practical demonstrations on Government Dry-farms.

IV. That a Dry-farming Congress‡ be called together once a year to discuss this subject.

V. That the Government purchase or acquire a steam or gasoline direct traction engine for the use of the Division of Dry-farming. It is essential that farmers and prospective settlers, and agricultural societies, be supplied with reliable data regarding the cost per acre of producing crops on dry-land by means of power engines. No reliable statistics exist relative to this matter. Such an engine might be employed in ploughing up Government land.

VI. That a Dry-land Station be attached to every community of settlers which may hereafter be established on the dry-lands of the Transvaal, and that the foreman of this Station be instructed to give advice and assistance to the settlers.

I submit these recommendations to the earnest consideration of the Government and the people of the Transvaal in the confident belief that the money necessary for the carrying out of this work will be amply repaid by increased harvests and the general agricultural prosperity of our Colony.

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* To avoid duplication of effort, the Division of Botany would doubtless co-operate in supplying this official.
† This cannot be called a large number when it is remembered that a mining state, such as Montana, with a population of 300,000, has already established eleven dry-land stations.
‡ I would suggest that this Congress be called together by the Rt. Hon. the Minister of Agriculture, and that invitations be extended to all the Colonies of South Africa, the Dominions of the Empire, and the United States.
ITINERARY IN AMERICA.

Distance Travelled.

Washington to Chicago (Illinois) .......... 888 "
Chicago to Omaha (Nebraska) .............. 496 "
Omaha to Cheyenne (Wyoming) ............. 516 "
Cheyenne to Omaha ......................... 516 "
Omaha to Minneapolis (Minnesota) ....... 381 "
Minneapolis to Chicago .................... 421 "
Chicago to New York ....................... 960 "
New York to Washington .................... 226 "
Washington to Chicago .................... 888 "
Chicago to Minneapolis ................... 421 "
Minneapolis to Kansas City (Missouri) ... 560 "
Kansas City to Amarillo (Texas) .......... 586 "
Amarillo to Denver ......................... 469 "
Denver to Provo (Utah) ..................... 697 "
Provo to Nephi (Utah) ...................... 41 "
Nephi to Salt Lake City (Utah) .......... 88 "
Salt Lake City to Cache Junction (Utah) 49 "
Cache Junction to Logan (Utah) .......... 16 "
Logan to Cache Junction ................... 16 "
Cache Junction to Butte (Montana) ....... 348 "
Butte to Minneapolis ...................... 1,118 "
Minneapolis to Chicago .................... 421 "
Chicago to Moline (Illinois) ............. 179 "
Moline to Chicago ......................... 179 "
Chicago to New York ....................... 960 "

Total ......................... 11,666 miles by rail.
APPENDIX I.

WHAT IS DRY-FARMING?

BY WILLIAM MACDONALD, Sc.D., Dry-land Agronomist.

It is rather surprising that although much has been written about dry-farming during the past few years no clear explanation has yet been given of this term and, consequently, a good deal of mystery still exists as to the nature and scope of this type of farming. At the outset it may be said that dry-farming differs very little from the ordinary farm practice which has been followed by the best and most successful farmers in all parts of the world since time immemorial, save that special stress is laid upon the conservation of soil-moisture and the growth of drought-resistant crops. But although the principles of dry-farming have been known and practised for many centuries, it is only lately that it has aroused a widespread interest amongst all sections of the agricultural community. It is sometimes supposed that the success of dry-farming depends upon a particular sort of soil. This is not so. For in the United States dry-farming has proved profitable on the deep clay loams of Utah, on the shallow sandy soils of the Panhandle of Texas, as well as on the heavy gumbo soils of the Missouri Valley. Of course, on deep rich loams larger yields will naturally be expected. Again, some farmers seem to think that this new practice depends on the possession of special agricultural machines. But this is not the case; the four essential implements being the plough, harrow, cultivator, and drill. Naturally, with more machinery, and especially harrows, the farmer will be better able to pulverise the soil and secure a good seed bed, which is most important. The only new implement specially devised for dry-farming is the "Packer." But this is not essential and a disc harrow will do instead. It will thus be seen that the equipment for dry-farming is well within the means of the majority of farmers.

The term dry-farming originated in Western America, and may be defined as the conservation of soil moisture during long periods of dry weather by means of tillage, together with the growth of drought-resistant plants. It is not, of course, farming without moisture, for that would be plainly impossible. The phrase is now widely and loosely applied to farming in all places where the normal rainfall ranges from 10 to 25 inches per annum. In the words of the American Dry-farming Congress dry-farming is farming where "irrigation is impracticable or impossible." In selecting land for dry-farming the most important point is the depth of the soil. This can easily be found out by digging pits five to ten feet in depth, or by looking at cuttings, wells, and embankments. In a new country it is well to take careful note of the growth and root system of native trees, shrubs, grasses, pod-bearing plants, etc. In South Africa mimosa trees and antheaps are usually safe guides to a good deep soil. The reason why a field of deep uniform soil generally produces a far better crop than a shallow soil is that it is possible to store a much larger amount of water in the former, and, further, the soil moisture rises much more freely from great depths to the root system of the growing crop. Given a good soil, therefore, the dry-farmer has simply to prepare his ground to receive all the rain which falls upon it, and, secondly, to prevent the loss of soil water through evaporation.
in dry-land farming the most important problem is naturally the amount and distribution of the rainfall. The rain falling in the course of a year is usually measured in the form of inches. This amount ranges all the way from nothing or a mere fraction of an inch, as in the Andes and the great African and Asian deserts, to as much as 600 inches, or 50 feet, at Cherapundji, in Eastern India. In studying a rainfall map of the world, it will be seen that a large portion of the earth's surface is arid. This term is commonly meant to imply an annual average of less than 20 inches. The arid region thus defined would include, in the United States, most of the country lying west of a line drawn through North Dakota and Texas, extending north-west into Canada and southwards into Mexico; while in South Africa it would be found in the Kalahari Desert, the Karoo, and some portions of the Transvaal.

Dr. Briggs, of the National Department of Agriculture, Washington, was the first to call attention to the enormous importance of evaporation in relation to dry-farming. And this is a matter of equal, if not greater, importance to the South African farmer in our land of hot suns, bare veld, and dry, sweeping winds. To watch a terrific thunderstorm, to see rivers of water pouring over the land, and a few hours later to walk over perfectly dry ground is a phenomenon familiar to every farmer. This appalling waste is mainly due to hard impenetrable soil; in a word, to surface run off, and, secondly, to the sucking power of a summer sun.

Evaporation, therefore, is a factor which should not be ignored in passing judgment on the agricultural productiveness of any region. By the term evaporation is meant the number of inches of water which evaporises or evaporates from a clean water surface in a freely exposed open tank during a given period. Thus the annual evaporation is the total number of inches of water which evaporates during the year, just as the precipitation is measured by the total number of inches of water falling into a tank, as rain, sleet, or snow during the year.

Evaporation depends upon the temperature of the evaporating surface, the dryness of the air, and the velocity of the wind. The hotter the day, the greater the evaporation; the drier the day, the greater the evaporation; the harder the wind blows, the greater the evaporation—a ceaseless sucking up of moisture. The amount of evaporation from an open tank of water is thus a measure of the evaporation of that locality. A series of evaporation determinations has been made recently by the United States Department of Agriculture at various points throughout the West during the months of spring and summer. These tests were made by means of a freely exposed tank set in the soil, and some remarkable results were obtained. At North Dakota, with a summer rainfall of 13 inches, the evaporation from the tank was 30 inches, and at Amarillo, Texas, during the same period, with a summer rainfall of 13 inches, the evaporation was 54 inches. Summarising these experiments, Briggs says: "In other words, with the same rainfall in North Dakota and at Amarillo during the growing season, the man at Amarillo would be working under conditions which are practically twice as severe as those in North Dakota." The prospective dry-land farmer must therefore realise that the annual rainfall is not the only factor to be considered in selecting his homestead, since the greater the evaporation in any given locality, the harder will it be for him to conserve enough moisture to produce his crops.

How then can moisture be conserved? The answer is: by deep ploughing, constant cultivation, and the prevention of evaporation. Ploughing is the most important operation in dry-farming, and upon it will mainly depend the success or failure of the crop. The dry-land
A Moisture-saving Fallow.
Montana Experiment Station.

On the left: Summer-fallow cultivated. On the right: Summer-fallow uncultivated, showing volunteer crop.
farmer often asks, "How deep should I plough?" and again "What is deep ploughing?" Usually deep ploughing means anything from seven to ten inches and over. In dry-farming deep ploughing is strongly to be recommended for several reasons; it increases the water-holding capacity of the soil, admits sunlight and air, extends the root feeding area, prevents light land from being blown away, encourages the growth of soil bacteria, prevents surface washing after heavy rains, and, lastly, enables plants to successfully withstand long periods of drought. Broadly speaking, a soil that is best suited to dry-farming is also one that may be ploughed deeply, but the best results have so far been obtained on deep uniform sandy loams.

Now, let us suppose that we have stored practically the whole of the last heavy downpour in our deep mellow ploughed lands. How can it be kept within the soil for the use of the crop? The reply is: with the harrow and cultivator. The moment the ground is dry enough to be worked, go over it with a harrow when the field is bare or with a cultivator if in crop. Oftentimes, a growing crop may be harrowed with great advantage, as for example, wheat or maize while the plants are still young and flexible. The result of stirring the soil in this manner is to form a soil-mulch which very effectively prevents loss of water, that is, evaporation from the surface of the soil. Any material which is spread upon the soil to shade the surface from the sun, and so check evaporation, is termed a mulch. A soil-mulch is therefore merely a soil-mantle. In gardening operations, leaves, manure, coarse hay, straw, and grass are commonly used. Such mulches are very effective—even more so than a mulch of fine earth—but they hinder the continual stirring of the land, which allows the air and sunlight to penetrate into the soil and set free plant food. Accordingly, the most useful and practical mulch in dry-farming is that which is made of loose dry soil. This brings us to the moisture-saving fallow. Formerly, the fallow was meant to designate a piece of land left without a crop for a year or may be more. It was allowed to "weather." This untilled land often became hard and baked, and weeds of every sort grew merrily upon it. Now weeds are the robbers, not only of plant food, but also of moisture, and a hard soil means that the rain cannot penetrate, while the loss of soil moisture through evaporation is very great. But in dry-farming the conservation of moisture is the all important problem, and this led to the adoption of moisture-saving fallows, deeply ploughed in the first instance, and constantly stirred thereafter to prevent the formation of a soil crust. These well tilled weedless lands will retain the rain for an indefinite period and so insure the dry-farmer of a sufficient supply of moisture for his future crops. Thus, side by side with his growing crops, the dry-farmer should lay off moisture-fallow which may be maintained for periods of three months, six months, or one year. The tilling of these fallows results in four things:—(a) Storage of rainfall; (b) destruction of weeds; (c) admission of sunshine and air; (d) encouragement of beneficial soil germs.

This practice is not new. More than a century ago a clergyman (the Rev. Mr. Smith) at Lois Weedon in Northamptonshire, England, started a system of alternate bare-fallowing and wheat cropping which he carried on for over thirty years with perfect success, raising the yield of wheat from sixteen bushels to thirty-four. His plan was simple. The land was laid off in narrow strips, each alternate one was summer-fallowed, and the others cropped with wheat—changing about each year. In short, only half of each field was in wheat, the other half in fallow,
yet the total yield was heavier than the average yield of the neighbourhood. In this rotation of wheat and bare-fallow* the ground was frequently and deeply stirred. This system is practically the same as that advocated by Campbell, and so successfully practised by the dry-farmer of Utah, and which I earnestly hope will be widely adopted throughout the Transvaal.

Two arguments are sometimes urged against the use of moisture-saving fallows. Firstly, that the increased crop does not pay for the trouble involved in tilling the land so frequently, and, secondly, that constant cultivation is apt to exhaust the soil of its nitrogen content as has happened notably in the orchards of California. The first objection usually comes from the farmer, the second from the agricultural chemist. This is therefore one of these matters which each individual must determine for himself; but the writer does not hesitate to state in the strongest terms that since the conservation of moisture is the alpha and omega of dry-farming, the use of the moisture-saving fallow is absolutely essential for the best results. Moreover, a soil might be full of plant food, but without sufficient moisture it would be useless for all practical purposes. Again, there are few soils in South Africa that will not yield their hundred fold if supplied with sufficient moisture. But perhaps the chief argument in support of the moisture fallow is that it teaches, as nothing else can, the value of good tillage and the inherent fertility of land properly treated. The most fatal error in modern farming is the careless preparation of the ground. Poor shallow ploughing and the lack of after-cultivation of the soil are the two factors to which crop failure is largely due. It is impossible for any plant to withstand a severe drought when its roots lie in hard, dry soil. But put the same seed in deep, mellow earth, with a moisture-saving mantle, and it remains green after weeks of rainless weather. In the past the great mistake in South African agriculture has been over-irrigation, with little or no cultivation, and the soil soon becomes stagnant with a surplus supply of water. Sunshine and air are excluded, the fertility of the land impaired, and the root system of the crop often permanently injured. When farmers realize that most crops can be successfully grown on dry-lands merely with good cultivation, they will hesitate before embarking upon expensive irrigation schemes and will seriously study the problem of better tillage.

Turn now for a moment to the question of fertility. It is not hard to repair an exhausted soil by means of green manures or better still by the natural manure of the farm (kraal manure). The reason why the addition of humus (i.e. vegetable or animal matter) to any soil is so valuable in dry-farming is that land well supplied with this constituent more readily absorbs and retains moisture than that which lacks nitrogenous matter—the so-called vegetable mould. In America the most successful dry-land farmers are those who are engaged in mixed farming—that is, growing grain and raising stock at the same time. When crops are fed to stock on the farm, and the manure and refuse, such as maize stalks, returned to the land, the loss of soil fertility is comparatively small. The feeding of cattle, sheep, and pigs on the dry-farm will bring in to the energetic farmer ready money, while the manure will help to improve his soils and sustain his crops in seasons of drought. But the dry-farmer should never lose sight of the fact that the problem of moisture is far more important than the question of fertility.

A word now in regard to drought-resistant crops. These can be obtained by selection, by breeding, and by exploration. The most notable

* In place of the old term bare fallow the writer prefers to speak of "moisture-saving" or "moisture-fallow."
example of the last-mentioned method is to be found in the recent intro-
duction of the Durum wheats into the United States from the semi-arid
regions of Russia. These wheats have done very well on the dry-lands
of the West, and last year's harvest yielded over sixty million bushels.
Another matter of importance is thin seeding. Most farmers sow far too
much seed, forgetful of the fact that every superfluous plant is robbing
the land of moisture. It is plain that thick seeding, such as ninety pounds
per acre, will call for three times the amount of water as thin sowing of,
say, thirty pounds. Moreover, where the seed is too thickly sown all the
moisture is liable to be used up near the surface, with the result that the
tender plants are burned up before they have had time to send their root-
lets into the deeper earth. Further, few varieties. In the Transvaal the dry-
farmer grows too many different sorts of grain. A vigorous effort should
therefore be made to eliminate as quickly as possible all inferior types
and to concentrate upon one or two. The dominant dry-land winter
wheat of Western America is Turkey Red, while the Durum varieties are
the dominant spring types for dry-lands. So it behoves the farmers
throughout South Africa to agree upon a few dominant types, to keep
them pure, to plant only selected seed, and thereby establish a high grade
uniform standard for both maize and wheat. Finally, it may be said that
success in dry-farming will depend mainly on six factors:—(1) Deep
ploughing; (2) thin seeding; (3) frequent harrowing; (4) weedless
lands; (5) few varieties; (6) moisture-saving fallows.
APPENDIX II.

DRY-FARMING IN WYOMING.

By Dr. V. T. Cooke, State Director of Dry-farming Experiments in Wyoming.

The dry-farming system recommended for Wyoming is that which has been practised in the arid portions of the West Coast States, for more than a generation, with such modifications as are adapted to our different conditions of soil, climate, and rainfall.* It consists in holding two years' moisture for one big crop. There are quite a number who misunderstand when we speak of getting a crop every other year. It is true we only get a crop off the same land every other year, or under favourable conditions, say two years out of three, but we must recollect that we get crops by this method when the seasons are dryer than usual and that we get one big crop with one ploughing, one seeding, several cultivations, practically two years' moisture, and one harvesting. The farmer simply divides his land into two portions, on one-half raising crops, the other half being summer fallowed. By this method, which is easily understood and carried out, the farmer has a long season instead of a short one, and drives his work instead of being driven by it.

Ploughing.

The ploughing must be deep. The plan recommended in this State is to plough old ground eight or nine inches deep. It is always better to plough in the fall (autumn), where possible, in order that the ground may absorb the winter's moisture, the sod become decomposed, and the soil sufficiently compacted, so that a good seed bed can be formed for spring planting.

Harrowing.

All spring and summer ploughing should be thoroughly harrowed the same day it is ploughed. It takes just as much time to harrow the ploughed ground to-day as it does to-morrow or next day, other things being equal, but it makes much difference in the conservation of the moisture when harrowing is done. If possible, harrow (and drill as well) diagonally or at right angles to the way in which the prevailing winds blow. The object in doing this is to prevent the land from drifting or blowing; to hold the snow which falls on the ploughed ground or winter grain, and to prevent the particles of soil or snow from injuring the young grain in the drill furrows by being carried along these furrows by the wind. Others have strongly recommended that those who are summer fallowing their ground should get on to it with the drag harrow immediately after any rain or snow. This is not always necessary, but what we must do is to get on to the ground as soon as it is dry enough after every heavy rain or big snow. This harrowing must not be deferred too long, because if we wait the surface of our soil will become very dry and is more liable to drift when we cultivate. The farmer must use his judgment, and get on to the ground as early as conditions are favourable to doing good work.

* The average rainfall of Wyoming for a period of thirty-four years is 13.58 inches per annum, most of which comes during the summer season.
MAINTAINING THE SOIL MULCH.

The soil mulch is one of the most important factors in our success as dry-farmers. It is by the soil mulch that we are able to conserve the moisture, prevent its loss by evaporation and absorbing all that comes to the soil by precipitation or from dews or other moisture in the air. The summer-fallowed ground should be in a granular form of small lumps, but care should be taken not to get it too fine. The object of cultivating the summer-fallowed soil is to prevent the formation of a crust; to allow the proper action of the sun and air; to break up the capillaries and prevent the moisture rising to the surface and evaporating, and to intercept the growth of weeds. The moisture in the soil goes up and down by capillary movement, and we keep our soil cultivated to break the upper connection and to prevent this loss of moisture.

SOWING THE CROP.

Winter grain should be sown early, say not later than the end of August or beginning of September. This will give the grain a good start and it will be in better condition to stand the winter. Spring grain should be sown as early in the spring as the ground can be put in good condition and danger of hard freezing of the soil is past. It has become a recognised fact that we have been in the habit of making the very serious mistake of sowing too much seed per acre. The experience of the most intelligent and up-to-date farmers shows that by sowing thirty to forty pounds of wheat per acre in the fall, better results will be obtained than with more seed. One of the advantages of sowing a minimum amount of good seed on summer-fallowed ground and sowing it early in the fall is, that we make a long season of a short one, and, other things being equal, the earlier the grain is sown the greater is its chance of stooling. For the same reason we should sow a larger proportion of seed when we are late with the work in the spring. If the season is well advanced and the ground moist and warm, the grain starts and grows so rapidly that it does not take time to stool. Another thing of vital importance in any kind of farming is to see that the seeds are planted properly, and, in the opinion of the writer, there is no greater mistake made than to practise broad-casting, either by hand or by a machine. When broad-casted the ground is harrowed or cultivated unevenly—some of it is too deep, some of it is not deep enough—and no doubt many failures are due to this method of sowing. The press drill is one of the essential implements for the dry-farmer. It puts the grain in in proper shape and to the right depth, pressing the soil around the seed, which insures moisture to cause it to germinate, and there is much satisfaction in knowing that our work is done properly. We gain, in this way, a week or ten days by putting the grain into moist ground at a uniform depth. There is a large saving of seed also, and, where we are farming extensively, this is quite an important item, especially when we consider what first-class seed costs. The man who sows alfalfa (lucerne) broadcast generally puts in from twenty to forty pounds of seed per acre, when if he uses a press drill, ten to twelve pounds of seed will be sufficient, either under irrigation or dry-farm practice.

SEED TO USE.

There is no greater mistake made, and one for which there is no excuse, by the man who wants results (and that is what we are all after) than to use any but the best seed obtainable. Like produces like. Be
sure and use those seeds that are raised without irrigation if it is possible to obtain them. It is most important to get seed which is thoroughly clean, free from weed seeds, and all other impurities. The cost of such seeds is of very little importance compared with the results which the best is sure to give.

Cultivating.

Under this system of farming a soil mulch must be maintained, not only on the fallow ground, where frequent harrowings will be all that is necessary, but also on the land which is raising the crop. In the spring thoroughly harrow your winter grain (or use a weeder), and remember that to do this properly the harrow teeth must be sharp. Harrow teeth like the top of a broom handle cannot do effective work. There are a large number of farmers who are actually afraid of harrowing their grain for fear of tearing out too much. We can only say, try it. The man who once harrows with a good team and sharp harrow teeth will not only have no cause to regret it, but will see that it is always done in the future. I wish to emphasize the importance of cultivating growing cereals with the harrow. Alfalfa (lucerne) and grass meadows should be thoroughly disced. After the second year there is little or no danger of injuring alfalfa with the disc, even though the surface soil is pulverized into a comparatively good seed-bed. Because lucerne permanently occupies the land, discing and harrowing is the only method by which the soil moisture can be properly saved, and this is one of the secrets of success in this kind of farming. Potatoes, corn (maize), and other rowed crops should be harrowed up to the time they get too large, and after that shallow level culture should be followed until the crop is laid by.

Harvesting.

Of course the harvest may be carried on by ordinary methods, but the soil should not be neglected at this time. Where our rainfall comes during the summer, discing the stubble after harvesting grain is important. After harvesting potatoes or sugar beets the drag harrow should be used to break up the lumps and re-establish the soil mulch. Barley or other grains that can be used for feed without threshing should be harvested when in the stiff dough. This prevents, in a measure, re-seeding the ground through the grain shattering out, for in this country all the ripe grain which drops on the ground in the fall comes up the next spring as a volunteer crop. If the grain can be fed without threshing it is marketed in the best possible way from the farm and saves the cost of threshing and handling.

Crops to Raise.

Those crops which are grown in rows and only occupy a part of the ground, like potatoes and corn (maize), where the season is long enough, will mature with the least use of moisture. Among our small grains the drought-resistant sorts are very important. Macaroni or Durum wheat is one of the best. Polish wheat is a drought-resistant sort and is good where it is to be used for stock feed. Spelt or emmer is a most excellent stock food and one of the best drought-resistant sorts. Barley, either the bald or hulless or the beardless brewing barley, for feed, is a short season crop which will mature with a minimum amount of moisture. Oats do well in all parts of Wyoming, the earlier varieties being best where moisture is scarce. Lucerne will succeed, and it is important to
get seed which is raised in the north where the seasons are short and in the arid country without irrigation. Where the season is long and warm, the sorghums make good crops. Brome grass is one of the best drought-resistant crops for pasture purposes, but it quickly gets sod-bound and it must be harrowed or disked to keep it producing well. White sweet clover is being tested by the Experiment Station and developed by one of our plant breeders to so improve it that it will become a valuable crop for dry-farming and an important feed with grain for use in fattening stock, especially lambs. French clover or sainfoin is a hardy drought-resisting clover at high altitudes. The winter grains are especially favourable for dry-farming, because the summer-fallow method properly prepares the ground for such seed and the spring rains are sufficient to mature the crop. Winter rye is one of the most successful dry-farm crops. Rye is not appreciated as it should be, for it is one of the best feeds for hogs that can be produced.

Mixed Farming.

The best paying dry-farms will be those in which a system of cropping and feeding stock is combined. Where the crops are fed to stock at the farm there is practically no loss of fertility. Manure is an important item to be added to arid soils as it increases their humus, making them more retentive of moisture as well as richer in plant food. As has been suggested also, where grains are raised for stock feed they may be cut early and fed in the bundle, which avoids the extra work of threshing and hauling to market. There are most excellent opportunities in Wyoming on account of our market facilities and favourable climate for finishing lambs or old sheep, cattle, and swine, principally hogs of the bacon type, and such system of farming will be sure to bring the largest profit.

Size of Farm.

One man with a small amount of extra help should be able to farm at least 160 acres by the summer-fallow method. This depends on his knowing how to take advantage of conditions and on having the proper equipment. Four-horse tools pay. A man or boy with four good horses and a three-section harrow can harrow thirty to thirty-five acres per day. Using twice the power, by having plenty of horses and double size machinery, enables one man to do two men’s work, which is the most economical method.

Equipment Needed.

Dry-farming does not require any special or new equipment. There are some things which are absolutely essential, however, if the dry-farmer is to make his business profitable. He should have four or six horses, a three-section drag harrow, a 12 or 14 inch gang plough, and a disc harrow. An Acme harrow is a valuable instrument for maintaining the soil mulch. The farmer will also need one or two good cultivators and, if he has a farm large enough to pay, he will require his own harvesting machinery. It is sometimes most economical for several farmers to club together and buy one harvesting machine rather than for each to have his own. The press drill is one of the essentials. This may be either of the shoe or the disc type. The disc drill has some advantages where there is much stubble or refuse, like coarse manure on the ground, but on well prepared summer-fallow ground the shoe drill with press wheels following to firmly pack the seed probably does the best work. There are places where there are heavy clay soils to contend with that a double press
wheel should be used instead of the single press wheel ordinarily placed on these drills. If the soil bakes the double press wheel will leave a crack or opening in the centre directly over the seed through which the germinating plantlets can push their way out of the ground. It is not necessary here to go into details of the farm buildings and fences required, for they are something to be worked out according to the capital and tastes of each individual farmer. The point I would make in speaking of necessary equipment is that it does not require any new or complicated or expensive machinery to do successful dry-farming under the best methods."

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**APPENDIX III.**

**DRY-FARMING IN MONTANA.**

The following is a summary of the results of dry-farming in Montana as given in Bulletin No. 74 of the Montana Agricultural College and Experiment Station:—

(1) That dry-farming may be carried on in many sections of Montana and will return reasonable profits on the money and effort invested. This means that much of the great level area of the State, which will never be irrigated, may be made to support comfortable homes and pay returns to the State sufficient to place the “dry-lands” amongst the State’s valued resources;

(2) that Turkey Red fall wheat has been the highest yielder of all crops grown. Fall (autumn) sown crops yield better on the average than spring sown crops, so we believe that fall wheat and fall rye will have a prominent place amongst the crops grown on the most successfully managed dry-farms;

(3) that while the experimental results have not been carried far enough to indicate positive conclusions, yet we feel safe in advocating the use of from three to five pecks (45 to 75 lbs.) of seed per acre with the different grains rather than a larger amount;

(4) that growing grain each alternate year, with a properly cultivated summer fallow between, will bring decidedly more profitable returns than growing grain every year on the same field;

(5) that it is important to keep the summer fallow cultivated during the season in order to keep down weeds and volunteer grain and maintain a soil mulch for the accumulation of moisture.

**Continuous Cropping versus Alternate Cropping and Fallow.**

The table presented herewith shows the average results from grain grown continuously on the same land and from grain grown on land that
had been summer-fallowed the year previous so as to keep down weeds and maintain a moisture conserving mulch. In the matter of ploughing and fall and early spring cultivation, both areas were handled in the same manner.

**Crops Grown Continuously on Same Land versus Crops Grown after Land Has Been Fallowed.**

*Average Results for all Years Tested.*

<table>
<thead>
<tr>
<th>Sub-station</th>
<th>Kubanka Spring Wheat</th>
<th>White Halless Barley</th>
<th>Sixty Day Oats</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Grown Continuously</td>
<td>After Fallow</td>
<td>Grown Continuously</td>
</tr>
<tr>
<td>Dawson County</td>
<td>15.18</td>
<td>17.57</td>
<td>15.97</td>
</tr>
<tr>
<td>Rosebud County</td>
<td>16.98</td>
<td>20.80</td>
<td>15.02</td>
</tr>
<tr>
<td>Yellowstone County</td>
<td>7.73</td>
<td>19.32</td>
<td>14.90</td>
</tr>
<tr>
<td>Chouteau County</td>
<td>14.18</td>
<td>17.35</td>
<td>13.29</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>13.52</strong></td>
<td><strong>18.76</strong></td>
<td><strong>14.79</strong></td>
</tr>
</tbody>
</table>

In humid sections serious objection is offered to the practice of summer-fallowing because of the loss of plant food by the leaching which occurs. In areas of light rainfall this objection does not apply, and until some crop rotation system is worked out, which includes the use of inter-tilled crops at the proper time, we believe that the summer-fallow will claim a place on many well managed dry-farms. The results given in the table show a much higher yield of the crops after the summer-fallow than for those grown continuously. A review of the tables given in the reports of the sub-stations shows that the yield on land continuously cropped is decreasing rapidly as the seasons advance. This suggests that after cropping has been continued over a longer period the yields will come to be very much less than half as large as those produced from land summer-fallowed the previous season. In connection with these tests, moisture and nitrate determinations were made throughout the season to find out, if possible, just why yields after a fallow should be so much higher than yields from land cropped the year previous. From accumulated data, yet unpublished, we find that there is upwards of three times as much moisture present in the first seven feet of a fallowed field as there is in a field on which a crop has been grown during the season. Again, nitrate determinations reveal the presence of a much higher percentage of nitrogen in the nitrate form in a fallowed soil than in a cropped area. This is because of the greater nitrate-forming activity made possible by the presence of sufficient moisture to make favourable conditions for the nitrate-forming organisms. These two conditions then—higher moisture content and more nitrogen in an available state—readily account for the high yields after the summer-fallow.
Cultivated versus Uncultivated Fallow.

Since the object in summer-fallowing the land each alternate year is to provide for increased yields the succeeding season, it is important that we adopt the proper methods in connection with the management of the fallow in order that the full benefits may be gained. During 1907 two pieces of like fallow were set aside and used for the purpose of determining the advantages of cultivating a fallow at the proper time during the season as compared with leaving it wholly without cultivation. In the spring of 1908, spring wheat was planted on the two plots. The harvested yields showed that the grain on the plot which has been cultivated as fallow produced three and one-half bushels per acre more than the grain on the uncultivated plot. We believe that the average difference will be greater than this reported for this year when the tests have been carried over a long period of years. However, the difference in the yield reported is sufficient to more than compensate for the cost of fallow cultivation and indicates the wisdom of caring for the fallow in such a way that the weeds are kept down and moisture accumulated.

APPENDIX IV.

METHODS OF DRY-FARMING IN UTAH.

The following is an extract from an address delivered by Professor Lewis A. Merrill at the Trans-Missouri Dry-farming Congress held at Salt Lake City, 22nd to 25th January, 1908. After dealing with the amount of water required by crops, Professor Merrill said:

"I want to object to the idea that has been advanced in this congress that we need to rotate our crops. If we grow a crop of corn (maize) on the land alternating with wheat, it simply means that that corn is going to take so much moisture out of the land. I want to say that the Utah method of fallowing the land, the practice of summer-fallowing, is not a question of fertility of soil, but simply a question of conservation of moisture. The great problem in Utah in relation to arid farming is the best way of conserving the moisture we have. That is our problem. It is not a question of the fertility of the soil. We know, for instance, over the State, that crops have been produced for forty to fifty years in succession without any diminution in the yield at all. But the simple problem is this, how can we best grow crops with the amount of moisture we have,* and I say that the only practice that can be followed successfully is the practice of summer-fallowing the land. In some parts of the State it may be best for the ground to be summer-fallowed only once in two years, and in other parts once in three years. In most parts of the State it is best to summer-fallow every other year. The arid farmer cannot succeed on the same amount of land used by the irrigating farmer, even if his crops were as large, because he requires double the amount of land because of the fact that half of the land must lie idle every year. It has been demonstrated time and again that a yield of 33 bushels of wheat can be produced on land fallowed every other year, but where it was continuously cropped the yield was cut down to 12, or 13, or 14 bushels.

* The average rainfall over the whole State of Utah is 12 inches.
and we were doing double the amount of work required to produce 12 or 13 bushels as was required to produce 33 bushels. So it has been demonstrated that our summer-fallowing is a matter of preserving the moisture.

"Further, it has been shown we can go for months without any rainfall at all, if we have the moisture stored in the soil. There are places in this State where they have been storing and conserving the moisture for ten and twenty years keeping it stored up in the soil, and then when the plant is put in the soil there is sufficient moisture to carry it through, whether they get any rain or not. That is the idea we are trying to follow in dry-farming in Utah. We believe in deep ploughing because we want this moisture to spread down around each one of the soil grains. When Bishop Farrell and Mr. Salisbury first started their experiments in Cache Valley, many years ago, they both had the same experience. They went out and sowed the same amount of seed on their land as they had been accustomed to sowing on irrigated land, a bushel and a half (90 lbs.) and two bushels and a half (150 lbs.), and as a consequence there wasn't sufficient moisture in the ground to nourish the plants. The plants came up, and there not being sufficient moisture in the ground to carry them through they wilted and died. And Mr. Salisbury said that his failures during the first three or four years were simply because he had not learnt the great lesson of simply putting sufficient seed on the land for the amount of moisture present to carry it through. So now it has come that in Utah we are advocating seeding with a small amount of seed. We don't lay down any set rules. We say about two pecks (30 lbs.) to four pecks of seed ought to be used. Now with reference to tilling our crops, we believe in constant cultivation. In the winter time, after the wheat is up, it is absolutely essential to harrow the wheat, two, three, four, or five times, in order to break up and destroy the crust so that the water will not come to the surface and evaporate. We believe in ploughing, harrowing, discing, and in doing anything and everything on the dry-farm to keep the rain stored up in the soil for the use of the plant."

The following is an extract from a speech made by Mr. George L. Farrell, a practical farmer, at the Cheyenne Dry-farming Congress:

"I began farming in Cache Valley in 1864, farming in the same manner I did in the region I came from. I failed miserably for two years. I always hated to be overcome, and I determined to either win out or 'go broke.' I had been ploughing 3 to 4 inches, but I tried ploughing down to 8 and more inches. I also sowed less than half the grain I had been sowing. The result was that I had something to harvest. I took encouragement, and, the following year, seeded 110 acres of deep, well ploughed land to wheat, using but 30 to 35 lbs. of seed per acre. I harvested exactly 40 bushels and 8 lbs. per acre. I found that by seeding on a better prepared seed bed, with less seed, I had larger heads and more rows of wheat kernels per head.

**Thin Seeding.**

"When we sow grain too thick on dry-farms it comes up so thick that it draws the substance and moisture out of the ground, until there is not enough moisture to support it and the grain fails to fill out—does not
mature. One year, I hired a Dane to seed my rye—100 acres. I required him to seed exactly one-half bushel (80 lbs.) per acre. He felt I made a very great mistake, for ‘back home,’ in Denmark, they seed 3 bushels (180 lbs.) per acre. He seeded 5 acres on his home farm, using 15 bushels of rye to seed it. I harvested 27 bushels per acre over my entire field; the Dane harvested 20 bushels from his 5 acres, only 5 bushels more than he seeded, one kernel of my rye would make twelve kernels of his rye.

"Our plan of cropping has always been to summer-fallow one year and crop the next. If possible, I plough in the fall (autumn); as a general thing we cut our grain stubble as high as possible, say 2 feet. When we turn that under, there is plant food to help the next crop.

"When the fall and spring rains come on well prepared ground, they go deep down. The next spring as soon as it is dry enough to work, we put our discs on the summer-fallow and work over the top; this conserves the moisture in the ground below and we continue to work that ground all summer to keep down the weeds. We keep the summer-fallow as clean as possible. Just before the seeding time, we thoroughly level the seed bed with the leveller. Every three years we find it wise to sub-soil 6 inches deeper than we plough. Do not throw the sub-soil dirt out, simply leave it loose in the furrow. By studying climate, seed, and soil conditions, no earnest worker need fail at dry-farming in Utah."

**Method of Summer-Fallowing.**

As soon as the crop is removed in the autumn, the land should be ploughed deep, from 8 to 10 inches. This land is then left rough (unharrowed) so that the natural unevenness of the soil will catch and retain the snow during the winter. In the spring time, as soon as the ground becomes sufficiently dry so that the soil will not cling to the disc, the disc harrow should be put on the soil and the land harrowed both ways. If there is any vegetation growing at this time, lapping the disc harrow half will generally remove all growth. In case the vegetation is thick, and it is impossible to cut it out with the disc harrow, it may be advisable to plough very shallow.

The value of this summer-fallow lies largely in the method pursued by which the moisture is conserved. It is essential therefore that the ground shall be kept entirely free from all growth. Weeds take moisture from the soil to as great and sometimes even greater extent than do ordinary crops, and the land might just as well be made to produce a crop of some economic importance. After each rainstorm it is essential that the ground be harrowed in order that an earth mulch be maintained to prevent the escape of moisture by evaporation.

Numerous experiments in Germany, Wisconsin, and in our own State have been made regarding the best methods of conserving moisture. It has been determined that the moisture cannot escape in very large quantities from the soil that has on it constantly a thick mulch of dry earth. For this reason it is essential that as soon as the ground becomes packed and baked some tillage implement be used by means of which this crust can be broken, and the soil mulch maintained. At the time of seeding there should be from 3 to 6 inches of dry earth on the surface, in order to conserve and hold the moisture in the ground and keep it for the use of the coming crop.
Summing up the advantages of summer-fallowing, it may be said that it clears the land of troublesome weeds; improves the physical condition of the soil, and makes available a larger amount of food and water supply. As to whether the fallow should come every second or third year will depend entirely on the character and condition of the land, and the moisture available. Every arid farmer will have to study his own conditions and determine his policy from a knowledge of his particular needs.—Utah State Farmers' Institute, 1907.