

HOME COURSE IN SCIENTIFIC AGRICULTURE

NINTH ARTICLE — AGRI- CULTURAL DUTY OF WATER.

By W J M'GEE, Late Soil Water Expert
Bureau of Soils, United States De-
partment of Agriculture.

THE experience of the farm in every country and age has shown that the fruitfulness of soil depends on adequate water supply; no water, no crops, no animals no human life—indeed, no soil.

Soil is of three parts—one solid, an other fluid and the third gaseous. The solid part consists of mineral and organic matter in fragmentary or granular condition. It forms the stable body of the soil. The fluid part is a solution consisting of water carrying mineral and organic matter. It forms the circulatory medium of soil and plants. The gaseous part consists of air (nitrogen and oxygen) mixed with aqueous vapor, carbon dioxide, hydrogen dioxide, etc. It permeates the body of the soil, moving with the movement of the circulatory fluid, changes in temperature and barometric pressure, etc. The three parts are conveniently known as soil body, soil fluid and soil gas.

Much of the substance of plants is taken directly and that of animals is directly from the soil, and soil grows largely through the return of substances from plants and animals in more highly differentiated or richer form, and the chief source of vital energy in soil (expressed by its own functioning and measured by its fertility) is derived from the growth and decay of plants and animals. Thus potash and nitrates are elaborated and concentrated by plants and phosphates by animals and returned to the soil, which is thereby enriched and rendered more effective in sustaining both plants and animals.

While the interdependence of soil and organisms extends to all the materials and powers of both, it operates



Photograph by Tennessee agricultural experiment station.

DITCHING TO PREVENT WASHING OF SOIL chiefly through the peculiarly potent substance water, of which large quantities exist in the soil and pass thence into the plants and animals, and the vital energy of organisms, like that of soil, is maintained largely by the circulation of their fluid portions, which consist chiefly of water. In most animals genera the circulation is fairly uniform throughout life. Among most kinds of plants it varies widely with the season, while in soil the circulation depends largely on climate and season, especially as these are related to plant growth. Other things equal, the internal work or functioning of soil is determined by its capacity for conserving water and conveying it to growing plants.

The fresh water entering soil is derived from rain or melting snow either directly or through overflow or underflow by irrigation or otherwise. The water within the soil may be or may not be efficient in circulation or in soil functioning, according to its quantity in relation to the soil texture, for with its quantity its condition may be said to vary from, first, static to second, dynamic—that is, it may be either inert or active.

The full capacity of a given soil for water ranges with its texture or porosity from some 30 per cent to over 50 per cent of its volume. This may be denoted the water of saturation. It completely fills the interstices among the soil grains, displacing the soil gas, and ordinarily moves hydrostatically under the impulse of gravitation. It impedes or prevents normal functioning of the soil and remains in a virtually static condition until the excess is removed by drainage, etc.

The water required to form soil fluid (or to furnish the most effective soil moisture) ranges with the texture of the soil body from, say, 10 per cent for sand to 40 per cent for fine clay and much more for muck. The quantity suffices to form a film surrounding each soil grain in such manner as to permit capillarity to act throughout the mass and yet leave space for air (or soil gas) within the interstices.

While ordinary annual crop plants root within the first foot from the surface, the underlying three feet of subsoil forms a reservoir whence they de-

rive much of the moisture required for their growth. Now, the mean moisture of average soil when in good condition approaches 25 per cent, while the mean moisture when plant growth ceases by reason of exhaustion of the soil fluid is probably less than 10 per cent, and the difference measures the store of water additional to the current rainfall on which the plants may draw. This difference (15 per cent of four feet, or 7.2 acre inches—816 tons per acre) may be denoted the effective soil fluid of average soil.

The rate of soil plant circulation and the quantity of water passing through soil and plants during the growing season are indicated by the exhalation from growing plants. A grass plant will in the course of a hot day exhale its own weight of water, and a young leaf of wheat or rye exposed to the sun may even exhale its own weight in an hour.

The maintenance of the soil plant circulation required for crop production generally involves repeated additions of water during the growing season, for the effective soil fluid within four feet of the surface would at the observed rate of plant transpiration suffice for but a meager yield even if the entire quantity were utilized. In ordinary farming the water is not fully conserved and applied to plant growth, so that practically the 7.2 acre inches of effective soil fluid growth would not suffice to produce a crop or even permit any yield whatever from most types of soil, though under certain conditions water may be drawn from greater depths in the subsoil than four feet. If properly cultivated and watered the average acre foot of soil, weighing some 2,000 tons (including the contained water), retains efficiency for centuries, but to be even moderately productive this soil must convey to the crop plants fully 1.5 acre feet of water, or an amount equivalent to its own weight, during each growing season.

To become effective in plant growth water must enter the soil body, take up both mineral salts and organic substances in solution and pass thence into the plants and on into the air. This is the normal course of soil plant circulation, and the relative quantities of the solid and fluid parts of the soil involved in plant growth probably correspond fairly with the strength of the solution, or one to several hundred. Pending precise determinations, it may be assumed that the strength of the solution forming the soil fluid and the ratio of the solid and fluid parts required to maintain efficiency are about equal and something like 1 to 1,000.

In nature the flora varies with the rainfall from sparsely distributed cacti and other desert plants to luxuriant forests, and as lands are brought under cultivation the crop yields vary from place to place and from season to season with the rainfall or with the water supplied by irrigation. Generally throughout the United States the actual yield per unit of water is considerably less than the ratio of dry matter to water determined by plant exhalation. A fair to good crop from an acre (i. e., an acre foot) of fertile soil supplied with four acre feet of water during the year may be put at a ton of grain and three tons of stover and stubble, or four tons in all—equivalent to 1-1200 of the weight of the water. With lessening of the aggregate water supply (which of course includes rainfall, accumulated ground water, subsurface flow and irrigation) the yield diminishes more rapidly than the quantity of water, virtually ceasing when the supply falls below an acre foot, while with augmented supply the yield increases more rapidly than the water so long as the tillage and character of crop are adapted to full use of the entire supply.

With present knowledge the ratio is, of course, but a rough approximation. Measurements are vague and experiences variable, soils differ both in composition and in the texture controlling circulation, and the yield of succulent vegetables or of juicy fruits or fresh forage may be several times that of grain, nuts or dry forage, so that it will probably be found needful in time to work out ratios for particular crops, just as it is now convenient to reckon yields per acre in different averages for the several crops.

In the course of his work on irrigation Powell recognized the necessity for determining "the amount of water which is needed to serve an acre of land" and spoke of this service as the "duty" of water measurable in acre feet, and irrigators have frequently applied the phrase to the measure of the water rather than of the service performed by the water—a service susceptible of useful measurement only in terms of what the water does in that production which furnishes food for man and forms the foundation for human industries and institutions. So, pending more precise determinations, the agricultural duty of water may be defined as the production of one one-thousandth part of its weight in average plant crop or one four-thousandth of its weight in grain.

Naturally the coefficient for plant yield will not apply to general farm production, including crops of meat, eggs, wool, hides, etc., for not only do animals drink many times their weight in water annually, but they consume indirectly in their feed the equivalent of that much larger quantity required for the growth of the vegetal tissue of which the feed consists. The human consumption is still larger. The 5,000,000,000 acre feet (or, 215,000,000,000,000 cubic feet) constituting the total yearly water supply of mainland United States would suffice for a population of about 1,000,000,000.

In a broad way it may be said that the final duty of water is to sustain a human life a year for each five acre feet used effectively in agriculture.



"Aren't you afraid I'll be drowned?"
"Oh, you see, I have a buoy to put around you in case of danger!"—Pete Mele.



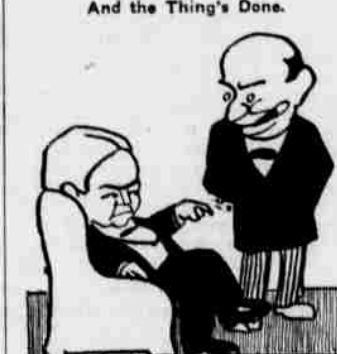
Hubby—What in thunder does this bill mean, Matilda? It says, "Automobile coat, \$150; trimmings, \$3,000."
Wifey—Yes; it's all right, dear. You see, the item "trimmings" is an automobile ordered to match the coat.—St. Louis Post-Dispatch.



"Does Thompson bear a good reputation?"
"Let me see—Thompson?"
"Yes."
"No, I don't think so."
"Why?"
"He ran for office once."



Angier (instinctively)—Something tells me that there are fish about here!—Sydney Bulletin.



"I wish I were popular."
"That's easy."
"How easy?"
"Just buy a cottage in the country and serve chicken suppers to your friends."



"He comes to see her every night in the week."
"That is nice for her."
"Yes, but wearying."
"She should put up with it, though. A girl should see as much of her future husband as possible before marriage, for after that he may not be around evenings."

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Of Prineville, Oregon**

RESOURCES	LIABILITIES
Loans and Discounts..... \$294,805 05	Capital Stock, paid in..... \$ 50,000 00
United States Bonds..... 12,500 00	Surplus fund, earned..... 50,000 00
Bank premises, etc..... 12,540 12	Undivided profits, earned..... 37,734 56
Cash & Due from banks..... 250,924 04	Circulation..... 8,500 00
	Deposits..... 285,009 63
\$527,424 19	\$527,424 19

B. F. Allen, President
Will Wurzwiler, Vice-President
T. M. Baldwin, Cashier
H. Baldwin, Asst. Cashier

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Between Prineville and Redmond

Leave Prineville, daily - 5:00 a. m.
" " " " - 3:00 p. m.
Leave Redmond, daily - 8:00 a. m.
" " " " - 7:45 p. m.

Fare, \$3.00 5-22 1mp Round Trip, \$5.50

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Notice for Publication
(Not Coal Land)
Department of the Interior
U. S. Land Office at Lakeview, Ore.
June 3, 1913.

Notice is hereby given that
Horace Brookings
of Hampton, Oregon, who, on December 4, 1909, made homestead entry No. 02802 for sw $\frac{1}{4}$ sw $\frac{1}{4}$, section 8, s $\frac{1}{2}$ s $\frac{1}{2}$, section 7, n $\frac{1}{2}$ n $\frac{1}{2}$, s $\frac{1}{2}$ n $\frac{1}{2}$, s $\frac{1}{2}$ s $\frac{1}{2}$, section 18, township 22, south, range 21, east, Willamette Meridian, has filed notice of intention to make final three-year proof, to establish claim to the land above described, before U. S. Commissioner A. S. Fogg, at Hampton, Oregon, on the 23d day of July, 1913.

Claimant names as witnesses: C. F. Stauffer, T. C. Ewing, James Brickey and Bert M. Meeks, all of Hampton, Oregon.
A. W. ORTON, Register.

Notice for Publication.
(Not Coal Land)
(Department of the Interior)
U. S. Land Office at Lakeview, Ore.
June 3, 1913.

Notice is hereby given that
Mary S. McMillan
of Hampton, Oregon, who on December 18, 1909, made homestead entry No. 02808, for lots 2 and 3, s $\frac{1}{2}$ n $\frac{1}{2}$, s $\frac{1}{2}$ n $\frac{1}{2}$, n $\frac{1}{2}$ s $\frac{1}{2}$, e $\frac{1}{2}$ s $\frac{1}{2}$, section 7, township 22 south, range 21 east, Willamette meridian, has filed notice of intention to make final three-year proof to establish claim to the land above described, before U. S. Commissioner A. S. Fogg, at Hampton, Oregon, on the 23d day of July, 1913.

Claimant names as witnesses: C. F. Stauffer, T. C. Ewing, James Brickey and Bert M. Meeks, all of Hampton, Oregon.
A. W. ORTON, Register.

Notice for Publication.
Department of the Interior,
U. S. Land Office at Burns, Oregon,
May 2, 1913.

Notice is hereby given that
Ferdinand M. Smith
whose postoffice address is Paulina, Oregon, did, on the 10th day of April, 1913, file in this office sworn statement and application No. 06673, to purchase the s $\frac{1}{2}$ s $\frac{1}{2}$, section 24 and n $\frac{1}{2}$ n $\frac{1}{2}$, section 25, township 18 south, range 25 east, Willamette Meridian, and the timber thereon, under the provisions of the act of June 3, 1878, and acts amendatory, known as the "Timber and Stone Law," at such value as might be fixed by appraisal, and that, pursuant to such application, the land and timber thereon have been appraised, in the aggregate \$350.00; that said applicant will offer final proof, in support of his application and sworn statement on the 30th day of July, 1913, before T. E. J. Duffy, U. S. Commissioner, at his office at Prineville, Oregon.

Any person is at liberty to protest this purchase before entry, or initiate a contest at any time before patent issues by filing a corroborated affidavit in this office, alleging facts which would defeat the entry.
5-8-10tp Wm. Farrer, Register.

Sheriff's Sale of Real Estate Under Execution in
Foreclosure.

In the circuit court of the state of Oregon for the county of Crook.
J. M. Conklin, Plaintiff,
vs.
James McElroy, Defendant.

By virtue of an execution issued out of the above entitled court on the 23rd day of May, 1913, in favor of the above named plaintiff, J. M. Conklin, and against the above named defendant, James McElroy, upon a judgment against the defendant, for the sum of eight hundred (\$800.00) dollars with interest thereon from the 1st day of April, 1911, at the rate of 10 per cent per annum and \$75.00 attorney's fees, and the further sum of \$10.00 costs, which judgment was enrolled and docketed in the clerk's office of said court in said county, on the 12th day of May, 1913; and whereas, it was further ordered and decreed by the court that the west half of the southwest quarter of section 35, township 11, south, range 14 east, and lots 3 and 4 of sec. 2, range 14 east of the Willamette Meridian, Crook county, Oregon, be sold in the manner prescribed by law, notice is hereby given that I have levied upon and I will, on

The 28th Day of June, 1913,
at the north front door of the court house, in Prineville, Oregon, at the hour of two o'clock in the afternoon of said day, sell all the right, title and interest the said defendant, James McElroy, had in and to the above described real property, to the highest bidder, to satisfy said judgment, interest, costs, and accruing costs, subject to redemption according to law.

First publication May 29, 1913.
FRANK ELKINS,
Sheriff of Crook County, Oregon.
By D. H. PEOPLES, Deputy.

Notice for Publication
Department of the Interior,
Land Office at The Dalles, Oregon,
May 17th, 1913.

Notice is hereby given that
Charles A. Stevenson,
of Held, Oregon, who on June 20, 1907, and May 8, 1911, made homestead No. 15306, serial Nos. 04141 and 08889, for w $\frac{1}{2}$ s $\frac{1}{2}$, sec. 25, e $\frac{1}{2}$ s $\frac{1}{2}$, sec. 28, and s $\frac{1}{2}$ n $\frac{1}{2}$, w $\frac{1}{2}$ s $\frac{1}{2}$, n $\frac{1}{2}$ s $\frac{1}{2}$, e $\frac{1}{2}$ s $\frac{1}{2}$, section 35, township 19, south, range 14, east, Willamette Meridian, has filed notice of intention to make final five-year proof, to establish claim to the land above described, before the county clerk, at his office, at Prineville, Oregon, on the 28th day of June, 1913.

Claimant names as witnesses: Charles Parrish, of Held, Oregon; Harry Barnes, Fisher, C. Logan and Otis Logan, all of Barnes, Oregon.
C. W. Moore,
Register.