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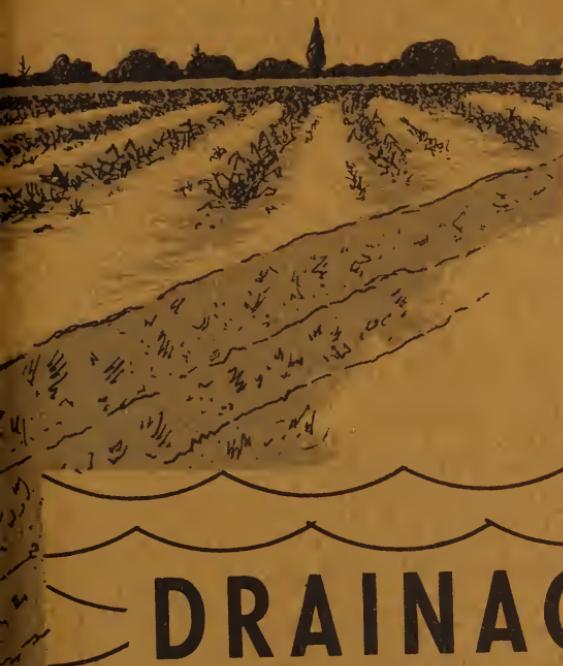
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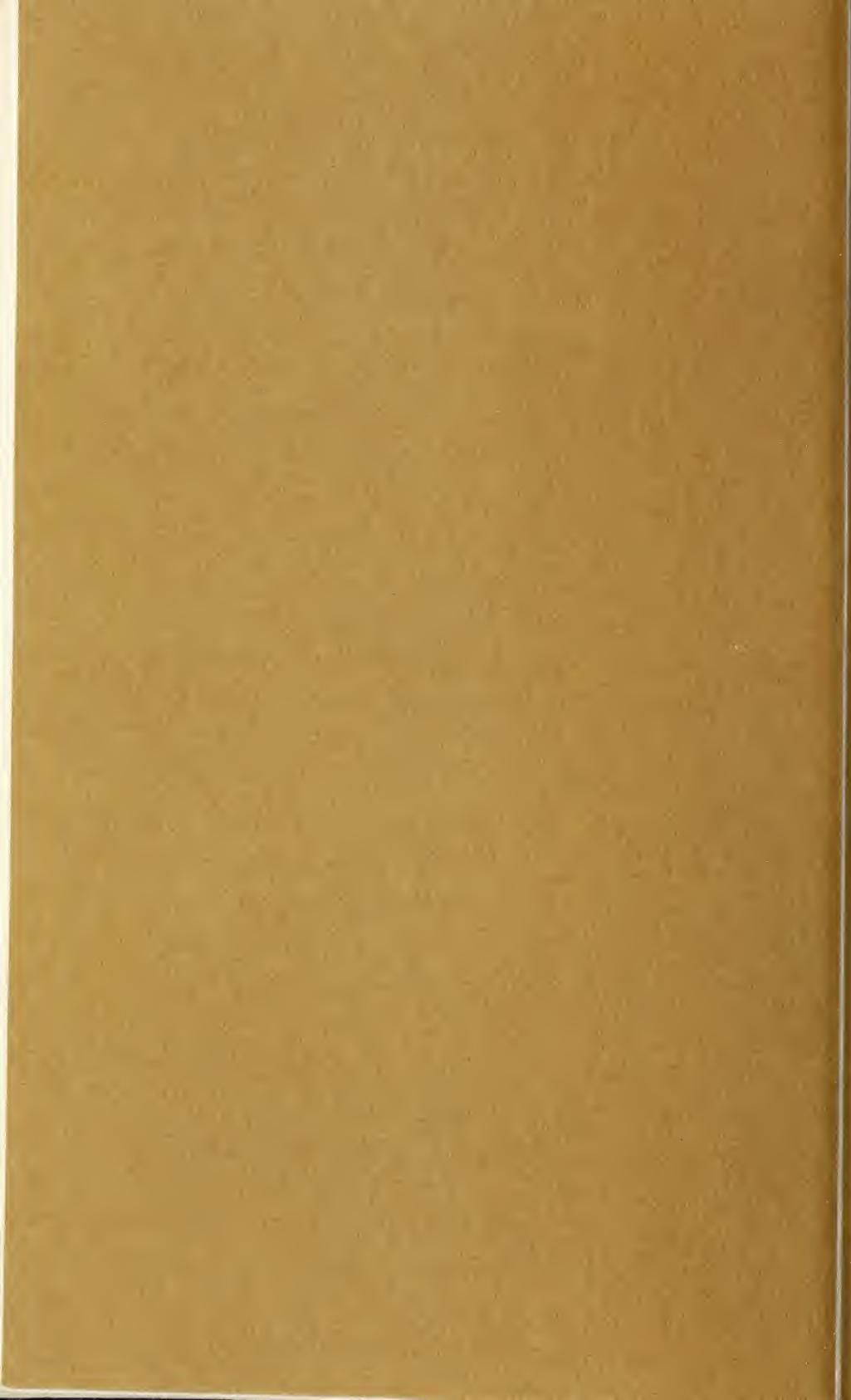
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**DRAINAGE OF  
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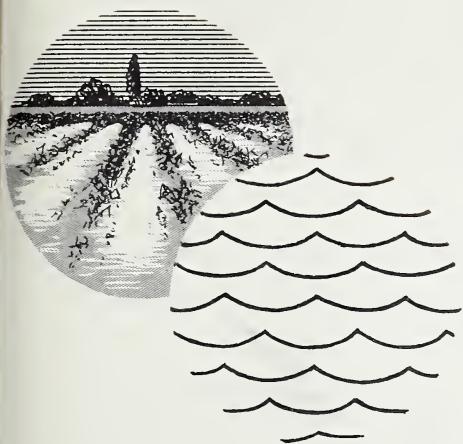
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# DRAINAGE OF AGRICULTURAL LAND-A Bibliography of Selected References

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## SOURCES CONSULTED

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### Indexes and Abstracting Journals:

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Israelsen, O. W. Published References Regarding Drainage. n.p.  
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U. S. Soil Conservation Serv. Annotated Bibliography on Sedimenta-  
tion. U. S. Soil Conservation Serv. Sedimentation B. 2, 351 p.  
Feb. 1950.

## PREFACE

This bibliography contains selected, annotated references to the literature published between 1936 and 1955 on the drainage of land for farming. Subjects included are methods and techniques, equipment, soil science and hydrology as related to drainage problems, needs and effects of drainage, descriptions of specific projects in many different countries, and drainage law and financing of drainage projects in the United States. Drainage for mosquito control and drainage of forests have been included, but references on drainage of land for nonagricultural uses such as roads and airports have been omitted except when techniques described are specifically applicable to agricultural projects. Because of the importance of the ground-water problem in the Western States to drainage questions, references on ground water in this area have been included, even when they do not themselves relate specifically to drainage.

Material in languages other than English has been limited to the practical aspects of drainage. Such references are cited in the vernacular with either a translation of the title into English or a brief abstract in English, except that for languages not using the Roman alphabet, titles of journal articles are given only in translation.

The bibliography is arranged according to a subject classification, and is provided with a combined author, subject, and geographic index. Because of the preponderance of material relating to the United States, this term has not been used in the index. Names of individual States and groups of States, however, will be found in the index.

For literature published before 1936 the reader should consult Bibliography on Land Drainage, by Dorothy W. Graf, published in 1936 by the Bureau of Agricultural Engineering of the Department of Agriculture, now out of print, but available in many libraries.

The Library acknowledges gratefully the assistance of Mr. John G. Sutton of the Soil Conservation Service, who helped in the formulation of the bibliography, answered many technical questions as it progressed, and advised on the inclusion of doubtful references.

All references except those marked with an asterisk have been examined by the compilers. Call numbers following the body of the citation are those of the Library of the Department of Agriculture. The location in another library of the copy used has been shown in the case of publications not available at the Department of Agriculture.

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DRAINAGE OF AGRICULTURE LAND  
A Bibliography of Selected References

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Elizabeth Gould Davis  
and  
Marie L. Gould  
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GENERAL

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A source book of material on drainage and land improvement in various countries, including Finland, the Netherlands, Austria, the Soviet Union, the United States, Switzerland, Egypt, the Sudan, Morocco, India, Australia, and China.

2. AYRES, Q. C., and SCOATES, D. Land drainage and reclamation. Ed.2. New York, McGraw-Hill, 1939. 496 p.,illus.,maps, tables. Ref. 54 Ay7

Partial contents: Ch. 11, Drainage properties of soils; Ch. 13, Open-ditch design; Ch. 17, Drainage districts; Ch. 19, Explosives and their use; Ch. 22, Terracing; Ch. 24, Subsurface drainage; Ch. 25, Location of tile drains; Ch. 26, Design of tile drains; Ch. 27, Selection of tile; Ch. 28, Installation of tile; Ch. 29, Drain-tile accessories; Ch. 30, Estimating cost of tile drainage; Ch. 31, Special methods of drainage.

3. CHAMBERS, T. B. Engineering in soil and water conservation. Soil Conserv. 4:153-156. Jan. 1939. 1.6 So3S

General discussion of land drainage from the engineer's standpoint.

4. CLYDE, G. D. Water use and disposal with particular reference to irrigation, drainage, and reclamation in the United States of America. Interamer. Conf. Agr. 4th. U. S. Paper 3,20 p. Dec. 1950. Ref. 5 In8204

Discusses drainage of humid regions as well as drainage of irrigated arid areas of the United States.

Also in Conserv. Amer. 9:3-15. Apr. 1951. Ref. 279.8 C767

5. DEWHIRST, J. F. Land and water conservation and development. In his America's needs and resources; a new survey, p. 513-574. New York, Twentieth Century Fund, 1955. Ref. 280.12 D512

Includes drainage enterprises and programs, drainage possibilities, and costs of farm drainage.

6. ETCHEVERRY, B. A. Land drainage and flood protection. Stanford University, Calif., Stanford U. Press, 1940. 327 p.,illus.,tables. Ref. 54 Et1

Partial contents: Ch. 3, Harmful effects of lack of drainage; Ch. 4, Volume of drainage water; Ch. 5, General operations for the drainage of large areas and drainage by open channels; Ch. 6, Underdrainage; Ch. 7, Special cases of drainage problems; Ch. 8, Properties of drain tile, construction and maintenance of tile drains; Ch. 9, Drainage of

irrigated lands; Ch. 13, Drainage and reclamation districts.

7. FREVERT, R. K., and others. Soil and water conservation engineering. New York, Wiley, 1955. 479 p., illus., maps. Ref. 56.7 F89

G. O. Schwab, T. W. Edminster, and K. K. Barnes, joint authors.

Covers infiltration, runoff, soil physics, erosion, contouring, terracing, grassed waterways, grassed outlets, gully control, open-ditch drainage, subsurface drainage design, mole drains, tile drains, selection of tile, installation of mole and tile drains, pumps and pump drainage, and the drainage of peat and muck soils.

8. GAIN, E. W. Land drainage in Great Britain. J. Soil & Water Conserv. 1(1):5-10. July 1946. 56.8 J822

History and legislation are given. Pump drainage in the Fens, various types of ditches on clay soils and mole drains are discussed. Underdrainage includes stone drains; trenches filled with gravel, brush, or sod; brick drains; and clay pipes.

9. HUDSON, A. W., and HOPEWELL, H. G. The draining of farm lands. Massey Agr. Col. B. 18, 184 p., illus., tables. June 1950. Ref. 109 M38B

Contents: Ch. 1, The soil and the characteristics of soil water and its movement; Ch. 2, Surveying for the drainage system; Ch. 3, Open drains; Ch. 4, Tiles and other covered drains; Ch. 5, Mole drainage; Ch. 6, Farm drainage machinery; Ch. 7, The financial aspects of farm drainage; Ch. 8, Land drainage by pumping; Ch. 9, The drainage of peats and loams. New Zealand.

10. IDAHO STATE PLANNING BOARD. Drainage basins in Idaho. Boise, 1937. 248 p., maps, tables. (Water resources of Idaho, v. 1) 280.7 Id1W

National Resources Committee cooperating.

Includes material on ground water and artificial drainage, for which the index should be consulted.

11. ISRAELSEN, O. W. The historical background of reclamation. Agr. Engin. 32:321-324, illus. June 1951. Ref. 58.8 Ag83

Includes a history of drainage in England and Wales since 1252 A. D., in Italy since Julius Caesar's time, and in the United States since 1835.

12. JONES, L. A. Drainage as a conservation practice. Agr. Engin. 23:97-98, illus. Mar. 1942. 58.8 Ag83

The part played by land drainage in the development of American agriculture.

13. LEOPOLD, L. B., and MADDOCK, T. The flood control controversy: big dams, little dams, and land management. New York, Ronald, 1954. 278 p., illus., tables. Ref. 290 L55

Includes terracing, drainage, channel engineering, and Government participation in flood-control operations.

14. LOWDERMILK, W. C. Conquest of the land through seven thousand years. U. S. D. A. Agr. Inform. B. 99, 30 p., illus. Aug. 1953. 1 Ag84Ab

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15. LYRA, I. DE A. A drenagem. Pernambuco. Sec. de Agr., Indus. e Com. B. 13:34-47. Jan./Mar. 1946. Ref. 9.2 P423

Includes a history of agricultural drainage since Roman times, and methods and advantages of drainage. Brazil.

16. MILLER, G. J. Reclamation of wet and overflow lands. In Smith, G.-H., ed. Conservation of Natural Resources, p. 145-159, maps, tables. New York, Wiley, 1950. Ref. U. S. Dept. Interior Libr.

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sources and their conservation, ed. 2, p. 152-168, maps, tables. New York, Wiley, 1939. 279 P22

17. NICHOLSON, H. H. The principles of field drainage. Cambridge, U. Press, 1953. 163 p., illus., tables. Ref. 54 N52

Partial contents; Ch. 2, The history of field-draining developments in Great Britain; Ch. 8, Ditches; Ch. 9, Tile draining; Ch. 10, Mole draining; Ch. 11, The way in which drains work; Ch. 14, Field drainage—present position and progress.

18. PICKELS, G. W. Drainage and flood-control engineering.

Ed. 2. New York, McGraw-Hill, 1941. 476 p., illus., tables. Ref. 54 P58

Partial contents; Ch. 5, Flow of water in open channels; Ch. 6, Flow of water in tile drains; Ch. 7, Land drainage by open channels; Ch. 9, Underdrainage; Ch. 10, Pumping plants for drainage districts; Ch. 11, Flood protection by channel improvement; Ch. 14, Drainage law.

19. RAGGIO, J. L. Hidraulica agrícola. Buenos Aires, El Ateneo, 1947. 563 p., illus., maps. Ref. 290 R123

Drainage, p. 443-472.

20. RAO, K. M. G. Principles of irrigation and drainage. Bangalore, Bangalore Printing & Pub. Co., 1945. 49 p., illus. Ref. 55 G96

Covers history of drainage, surface drainage, subsurface drainage, open drains, pole drains, stone drains, tile drains, benefits of drainage, and effects of drainage on soil.

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Ref. 54 R62

Partial contents: Ch. 2, Soils in relation to drainage; Ch. 6, Major types of drains and drainage problems; Ch. 7, Design of open ditches; Ch. 8, Open-ditch construction; Ch. 9, Open-ditch maintenance; Ch. 10, Location and design of underdrains; Ch. 11, Drain tiles: kinds, classes, established sizes, and standards of quality; Ch. 12, Construction of under drains; Ch. 13, Drainage of irrigated lands; Ch. 14, The soil-moisture control problem on peat and muck lands; Ch. 15, Cost of drainage; Ch. 16, Drainage administration and law.

22. SUTTON, J. G. Drainage in the humid areas of the United States. Amer. Soc. Civ. Engin. Proc. 80 (Separate 460), 18 p., maps, tables. July 1954. 290.9 Am3Ps

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23. U. S. BUR. OF THE CENSUS. 1950 census of agriculture. Volume IV, Drainage of agricultural lands. Washington, 1952. 307 p., tables. 157.41 C332

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25. U. S. SOIL CONSERVATION SERV. Report of the Chief, 1935-53. Washington, 1935-53. 19 v., illus., maps, tables. 1.6 So3R

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A brief résumé and criticism of the literature of land drainage, particularly in England, since 1646.

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Experiments at the U. S. Salinity Laboratory.

29. ARIZONA AGRICULTURAL EXPERIMENT STATION. Groundwater studies. In its Annual report 47-51, 1935/36-1940/41. Tucson,1936-41. 6 v. 100 Ar4

30. BARNES, C. P. What research is doing on problems of water in agriculture. U. S. D. A. Ybk. Agr. 1955:685-693. Ref. 1 Ag84Y

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31. BENDIXEN, T. W., HERSHBERGER, M. F., and SLATER, C. S. A basis for classifying soil permeabilities. J. Agr. Res. 77: 157-167,illus.,tables. Sept.1,1948. 1 Ag84J

Measurements of amount of pore space drained in one hour under 60 cm. of water tension and of percolation rates was used as a basis. Various soil types were used.

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P. J. Zwerman, H. E. Gray, and G. Levine, joint authors.

Techniques developed on the stony, glacial,till soils of central New York, for measuring water-table elevations, ground-water pressures, and soil permeability in connection with subsurface drainage.

34. BRETTING, A. E. Hydraulics, irrigation and drainage, reclamation and water-power plants. In The humanities and the sciences in Denmark, p. 708-711. Copenhagen,Munksgaard,1943. Ref. 330 H882

A résumé of the drainage investigations in Denmark between 1940 and 1945.

35. CHILDS, E. C. The movement of water in heavy soils after irrigation. Soil Sci. 46:95-105,illus. Aug.1938. Ref. 56.8 So3

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36. CHRISTIANSEN, J. E. Ground-water studies in relation to drainage. Agr. Engin. 24:339-342,illus. Oct.1943. Ref. 58.8 Ag83

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drained lysimeters in which seepage water must cross a soil/air interface.

38. DONNAN, W. W., and BRADSHAW, G. B. Drainage investigation methods for irrigated areas in western United States. U. S. D. A. Tech. B. 1065, 45 p., illus. Sept. 1952. Ref. Ag84Te

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40. GARDNER, W., and KIRKHAM, D. Determination of soil moisture by neutron scattering. Soil Sci. 73:391-401, illus., tables. May 1952. Ref. 56.8 So3

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41. GARSTKA, W. U. Design of the automatic recording in-place lysimeters near Coshocton, Ohio. Soil Sci. Soc. Amer. Proc. 2:555-599, illus. 1937, pub. 1938. 56.9 So3

Details with diagrams and photographs.

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43. GLENTWORTH, R. Distribution of the total and acetic acid-soluble phosphate in soil profiles having naturally free and impeded drainage. Nature 159:441-442. Mar. 29, 1947. 472 N21

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46. ISRAELSEN, O. W., and REEVE, R. C. Canal lining experiments in the Delta area, Utah. Utah Agr. Expt. Sta. B. 313, 52 p., illus., tables. June 1944. 100 Ut1

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47. JAMISON, V. C., REED, I. F., and PEARSON, R. W. The use of soil-tension columns and a modified form of the back pressure well in studying porosity and drainage properties of tillage testing soils. Soil Sci. Soc. Amer. Proc. 13:56-61, illus., tables. 1948, pub. 1949. Ref. 56.9 So3

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but dispersed clays to drain to optimum plowing moisture at a tension of one atmosphere or less.

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Abstract of thesis - (Ph.D.) Iowa State College, 1949.

A field method of measuring the soil permeability beneath a water table, in relation to placement of drainage tiles.

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55. REEVE, R. C., and JENSEN, M. C. Piezometers for ground-water flow studies and measurement of subsoil permeability. *Agr. Engin.* 30:435-438, illus., tables. Sept. 1949. Ref. 58.8 Ag83

In Gem County, Idaho, small-diameter piezometers were used to investigate flow of ground water in area of open drain.

56. REGER, J. S., and others. Techniques for drainage investigations in Coachella Valley, Calif. *Agr. Engin.* 31:559-564, illus. Nov. 1950. Ref. 58.8 Ag83

A. F. Pillsbury, R. C. Reeve, and R. K. Peterson, joint authors.

With the completion of the Coachella branch of the All-American Canal, "there is evidence that ... water tables will rise and may cause serious drainage difficulties in the future. ... It is the purpose of these investigations to obtain such information ... as will lead to early detection and delineation of drainage problems," p. 559.

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1955. 11 H35

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61. STEARNS, L. A. Symposium on water management and drainage for mosquito control; introductory statement. N. J. Mosquito Extermin. Assoc. Proc. 38:64-66. 1951. Ref. 420 N46

Brief résumé of drainage literature since 1904.

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English summary, p. 48.

Hydrological research in the Vleuten drainage district, Netherlands.

63. U. S. BUR. OF AGRICULTURAL ENGINEERING. Report of the Chief, 1936-41. Washington, 1936-41. 6 v. 1 En3

Each report contains a section, Drainage investigations.

64. WALKER, J. P., and EDMINSTER, T. W. Techniques of drainage research in Virginia—typical of the Southeast. (Abs.) Assoc. South. Agr. Workers Proc. 48:174. 1951. 4 C82

Describes the drainage design methods employed by the Virginia drainage research project.

65. WALLIHAN, E. F. An improvement in lysimeter design. Amer. Soc. Agron. J. 32:395-404, illus., tables. May 1940. 4 Am34P

The application of slight suction by means of a tensiometer cup brought about improved drainage. The resulting moisture and soil conditions more nearly resembled those occurring in naturally well-drained soils than do the conditions present in ordinary lysimeters.

### Soil Science in Relation to Drainage

66. ALDERFER, R. B., and FLEMING, H. K. Soil factors influencing grape production on well-drained lake terrace areas. Penn. Agr. Expt. Sta. B. 495, 24 p., illus., tables. Mar. 1948. Ref. 100 P381 Pennsylvania.

67. ARNDT, F. R. Removal of seepage waters by plant growth. (Abs.) S. Austral. Dept. Agr. J. 39:1316, illus. June 1936. 23 So84

Except where large accumulations of drainage water bring too much salt to the surface for plants to grow.

68. ARONOVICI, V. S., and DONNAN, W. W. Soil-permeability as a criterion for drainage-design. Amer. Geophys. Union. Trans. 27: 95-101, illus., tables. Feb. 1946. Ref. 330.9 Am3

The application of the coefficient of permeability in the analysis of a drainage problem of facility is outlined, and a formula for the spacing of tile drains utilizing the coefficient of permeability is presented.

69. ASGHAR, A. G., and DHAWAN, C. L. The quality of the drain, river and canal waters of the Punjab. Indian J. Agr. Sci. 17: 377-388, illus., tables. Dec. 1947. 22 Ag831

Drains remove tons of salts per year from the soil. Increase in the salt content of the drainage water decreases the flora infesting the drains.

70. BARRON, R. A. The efficacy of toe drains in controlling seepage uplift in layered pervious foundations. Internat. Conf. Soil Mechs. & Found. Engin. 3rd. Proc. 2:195-197, illus. 1953. 290.9 In863

Mathematical solutions are obtained for the problem of seepage through a 2-layered pervious foundation. For cases where the lower layer is more pervious than the upper, the efficacy of the toe drain is seriously reduced.

71. BEDELL, G. D., KOHNKE, H., and HICKOK, R. B. Improved practices reduce loss of available nutrients by run-off. Ind. Agr. Expt Sta. Mimeo. 61, 4 p., tables. Dec. 1944. 100 In2Agr

U. S. Bur. of Agricultural Engineering, cooperating.

During a three-year rotation with maize, wheat, and meadowgrass, there was less drain of nutrients from the soil with contour cultivation than with prevailing methods of cultivation.

72. BEEKOM, C. W. C. VAN, and others. Reclaiming land flooded with salt water. Netherlands J. Agr. Sci. 1:153-163; 225-244, illus., tables. Aug.-Nov. 1953. 12 N3892

C. van den Berg, T. A. de Boer, W. H. van der Molen, B. Verhoeven, J. J. Westerhof, and A. J. Zuur, joint authors.

Includes drainage.

73. BENNETT, H. H. Engineering in soil conservation. Agr. Engin. 28:559-562. Dec. 1947. 58.8 Ag83

Includes drainage in the United States.

74. BENNETT, H. H. Soil conservation. New York, McGraw-Hill, 1939. 993 p., illus., tables. 56.7 B43S

Partial contents; Ch. 8, Infiltration in relation to runoff; Ch. 20, Terracing; Ch. 21, Runoff-disposal channelways and outlets.

Consult index for drainage.

75. CHILDS, E. C., and COLLIS-GEORGE, N. The control of soil water. Advn. Agron. 2:233-272, illus. 1950. Ref. 30 Ad9

Discusses the results of drainage in lowering the water table, and considers the potential flow in drains, the causes for increase in drainage rate, and measurements of permeability.

76. CHILDS, E. C. Stability of clay soils. Soil Sci. 53:79-92, illus., tables. Feb. 1942. 56.8 So3

Experiments in England to determine the suitability of soil for mole drainage.

77. CHILDS, E. C. The water table, equipotentials, and stream-lines in drained land. 1-6. Soil Sci. 56:317-330; 59:313-327, 405-415; 62:183-192; 63:361-376; 71:233-237, illus. Nov. 1943, Apr.-May 1945, Aug. 1946, May 1947, Mar. 1951. 56.8 So3

Three sets of experiments are presented to show (a) how the water table falls with increase of drain diameter; (b) the relation of water-table height to rate of rainfall; and (c) the influence of the depth of the impermeable floor below the drains.

78. CLARK, M. W. Water management for the farm; conserving soil and water for efficient production of crops and livestock. Mo. Agr. Ext. C. 433, 11 p., illus. Aug. 1941. 275.29 M69C

Ditches and terraces to conserve excess rainfall while preventing soil erosion due to runoff.

79. COLMAN, E. A. The dependence of field capacity upon the depth of wetting of field soils. Soil Sci. 58:43-50, illus. July 1944. 56.8 So3

A tentative explanation is presented, relating the field-capacity values to the water supply available for drainage and the distribution of permeability and moisture potential gradients through the wet zone at the time when the drainage rate has become insignificantly small. The study suggests that shallow field irrigations or the irrigation and drainage of short soil columns in the laboratory do not necessarily provide valid measures of the field capacity of a soil

80. CRANFIELD, T. H. Damage to agricultural land resulting from flooding with sea water. Gt. Brit. Min. Agr. Agriculture 45:11-15. Apr. 1938. 10 G79J

Tests made after the Essex and Humber floods of 1897 and 1921 showed that salt water destroyed the natural drainage of land.

81. CROMPTON, E. Some morphological features associated with poor soil drainage. J. Soil Sci. 3:277-289, illus. July 1952. Ref.

## 56.8 J823

Some morphological features of profiles showing various degrees of hydromorphism are described from soils under permanent pasture in northwest England. It is suggested that certain basic patterns are discernible in most gley soils, and the modifications resulting from variations in texture, structure, and position of the water table in the profile are discussed.

82. DAHL, N. J., and JUUSELA, T. Dränering. Nord. Jordbr-forsk. 1948:657-672, illus. 11 N752

The hydraulic basis for calculating distance between drainage pipes, by N. J. Dahl, p. 657-663; Heat and moisture conditions in drained and open ditch fields, by T. Juusela, p. 663-670. Discussion, p. 670-672.

83. DAIGH, F. C., and STEARNS, L. A. Effect of ditching for mosquito control on the pH of marsh soils. N. J. Mosquito Extermin. Assoc. Proc. 26:39-43, tables. 1939. 420 N46

A study conducted at the Delaware Agricultural Experiment Station shows that the pH of marsh soils increases somewhat in proportion to the extent of drainage.

84. DAVISON, B., and ROSENHEAD, L. Some cases of the steady two-dimensional percolation of water through ground. Roy. Soc. London Proc. A. 175:346-365. 1940. 501 L84A

Mathematical solutions are presented for percolation through a broad embankment with vertical faces, and for percolation from a dyke of rectangular section into the surrounding soil. The motion of water outside a number of parallel draining tubes is investigated.

85. DAY, P. R., and LUTHIN, J. N. Sand-model experiments on the distribution of water-pressure under an unlined canal. Soil Sci. Soc. Amer. Proc. 18:133-136, illus., tables. Apr. 1954. 56.9 So3

A study of the seepage of water by capillary flow, as an aid in the understanding of seepage in irrigation and drainage engineering.

86. DELOFFRE, G. The leaching of chlorides in the regions of Dunquerque and Le Verdon flooded with salt water in 1944. Internat. Cong. Soil Sci. 4th Trans. 1:408-411. 1950. 56.09 In844

The efficient network of drainage in the Dunkirk area hastened the leaching process. In the Le Verdon area the slow leaching was due to poor drainage.

87. DEMOLON, A., and BASTISSE, E. M. Études lysimétriques appliquées à l'agronomie. Paris. Min. Agr. France, 1942. 48 p., illus., tables. Ref. 56.43 D39

Lysimetric studies applied to agronomy. Report of 10 years of research at Versailles. The composition of drainage water is discussed, and the degrees of progressive exhaustion of bare and cultivated soils are compared.

88. DEVEREUX, R. E., STEELE, F., and TURNER, W. L. JR. Permeability and land classification for soil and water conservation. Soil Sci. Soc. Amer. Proc. 15:420-423. 1950, pub. 1951. 56.9 So3

Studies made by the Virginia Agricultural Experiment Station and the U. S. Soil Conservation Service, to evaluate the relative success of existing drainage systems, and to design new drainage systems on the basis of information secured in the study.

89. DOMINGO, W. R. De physische rijping van de jongere Zuiderzee-afzettingen in de Noordoostpolder. Van Zee tot Land 2, 18 p., illus. 1951. Ref. 54.8 V26

The physical maturing of the younger Zuiderzee deposits in the Northeast Polder. Includes drainage conditions.

90. DOUGALL, H. W. Factors concerned in the reclamation, poldering, and fertility of certain riverain soils in Sierra Leone. Internat. Cong. Soil Sci. 4th Trans. 2:250-253, illus. 1950. 56.09 In844

Drainage, leaching, irrigation, and soil fertility problems.

91. DOUGALL, H. W. A note on the reclamation of soils inundated with sea water. Internat'l. Cong. Soil Sci. 4th Trans. 1:407-408. 1950. 56.09 In844

Includes drainage.

92. DREIBELBIS, F. R., and POST, F. A. An inventory of soil water relationships on woodland, pasture, and cultivated soils. Soil Sci. Soc. Amer. Proc. 6:462-473, illus., tables. 1941. Ref. 56.9 So3

Research by the U. S. Soil Conservation Service in Ohio.

A study of soil moisture conditions under different land use practices and their relationship to precipitation, runoff, percolation, evaporation-transpiration, and storage of water in the soil.

93. DREIBELBIS, F. R. Soil type and land use effects on percolation of soil water through monolith lysimeters. Soil Sci. Soc. Amer. Proc. 18:358-362, illus., tables. Oct. 1954. 56.9 So3

A summary of data on percolation of soil through monolith lysimeters with an 8-foot profile covering the period 1938 to 1953. The effects of soil type and land use on percolation are stressed.

94. DREIBELBIS, F. R. Some plant nutrient losses in gravitational water from monolith lysimeters at Coshocton, Ohio. Soil Sci. Soc. Amer. Proc. 11:182-188, illus., tables. Ref. 1946, pub. 1947.

56.9 So3

Plant-nutrient losses in drainage water.

95. EDMINSTER, T. W., and VAN SCHILFGAARDE, J. Technical problems and principles of drainage. U. S. D. A. Ybk. Agr. 1955: 491-498. I Ag84Y

Discusses soil structure, soil temperature, the water table, and the degree, length, and frequency of fluctuations of the water table, the Laplace equation, and the mathematical, hydrograph, and relaxation methods of solving drainage problems.

96. EDMINSTER, T. W., and others. Tests of small core samplers for permeability determinations. Soil Sci. Soc. Amer. Proc. 15: 417-420, illus., tables. 1950, pub., 1951. 56.9 So3

W. L. Turner, J. H. Lillard, and F. Steele, joint authors.

Tests showed that although there was no significant difference in the amount of water percolated through 3-inch and 4-inch cores, the former gave higher values of water drained in 15 minutes and in 15 hours.

97. ENGELUND, F. Mathematical discussion of drainage problems. Danish Acad. Tech. Sci. Trans. 3, 61 p., illus. 1951. 330.9 Ak1

Partial contents: Ch. 2, Example of flow on a horizontal, impervious layer; Ch. 4, Tile drainage of homogeneous soil; Ch. 6, Drain-flux in anisotropic soil.

A study of the influence of precipitation, the permeability and capillarity of the soil, the drain-distance, the drain diameter, and the pressure in the drains.

98. EVANS, D. D., KIRKHAM, D., and FREVERT, R. K. Infiltration and permeability in soil overlying an impermeable layer. Soil Sci. Soc. Amer. Proc. 15:50-54, illus. 1950, pub., 1951. 56.9 So3

Describes a preliminary experiment designed to furnish information pertinent to the establishment of a controlled drainage experiment in which plots were tiled and flooded. A discussion on permeability and infiltration-rate relationships is given also.

99. FREE, G. R., BROWNING, G. M., and MUSGRAVE, G. W. Relative infiltration and related physical characteristics of certain soils. U. S. D. A. Tech. B. 729, 52 p., illus., tables. July 1940. Ref. 1 Ag84Te

The data are from 68 sites representative of most of the climatic provinces of the United States.

100. GARDNER, W. The influence of soil characteristics on drainage and irrigation practices. Soil Sci. Soc. Amer. Proc. 1:383-

392, illus., table. 1937. Ref. 56.9 So3

Mathematical discussion of some aspects of the physics of soil moisture.

101. GEORGE, N. C. Soil-water relationships in soils and sands, with relation to drainage problems. (Abs.) Cambridge, U. Abs. Diss. 1947/48:16-17. 1949. 241.8 C14

Abstract of thesis (Ph. D.)— Cambridge University, England.

102. GUSTAFSON, A. F. Drainage, plowing, seedbed preparation and cultivation in New York. N. Y. Agr. Col. Cornell Ext. B. 183, rev., 32 p., illus. Mar. 1945. 275.29 N48E

The subjects discussed under drainage are: Granulation, aeration, absorption of water, erosion, heaving, soil temperature, available moisture, and preparation of plant nutrients.

103. HANKS, R. J., HOLMES, W. E., and TANNER, C. B. Field capacity approximation based on the moisture-transmitting properties of the soil. Soil Sci. Soc. Amer. Proc. 18:252-254, illus., table. July 1954. Ref. 56.8 So3

A new field capacity approximation is reported as the result of tests made in connection with irrigation, hydrologic, and drainage investigations at the University of Wisconsin.

104. HARPER, H. J., and ROSE, L. E. Effect of silt on natural vegetation and drainage in the flood plain of Deep Fork of the North Canadian River, Lincoln County, Oklahoma. Okla. Acad. Sci. Proc. 24:80-82, table. 1943. 500 Ok42

105. HARROLD, L. L., and DREIBELBIS, F. R. An accounting of the daily accretion, depletion, and storage of soil-water as determined by weighing monolith lysimeters. Amer. Geophys. Union. Trans. 26:283-297, illus., tables. Oct. 1945. Ref. 330.9 Am3

Discussion, p. 292-297.

Data from two soil types are given for a one-year period. Graphs of daily precipitation and condensation are presented as a measure of accretion, and graphs of daily evapotranspiration, percolation, and runoff present data of the depletion process.

106. HARROLD, L. L. Land-use practices on runoff and erosion from agricultural watersheds. Agr. Engin. 28:563-566, illus., tables. Dec. 1947. 58.8 Ag83

Drainage conditions included.

107. HARROLD, L. L. Use of soil porosity for water conservation. Agr. Engin. 33:287-289, 292, illus., tables. May 1952. 58.8 Ag83

Discusses the effect of drainage on storage capacity of soils and the effect of pore characteristics on the drainability of soils.

108. HEATHCOTE, W. R. A soil survey of Warpland in Yorkshire. J. Soil Sci. 2:144-162, tables. July 1951. Ref. 56.8 J823

Drainage by ditch and tile must be efficient to prevent the accumulation of surface water and the development of surface gley (mud).

109. HOBBS, H. W. Rates of runoff in the coastal plains of New Jersey, Delaware, and Maryland. U. S. Soil Conserv. Serv. SCS-TP-60, 60 p., illus., map, tables. July 1946. 1.96 Ad6Tp

For use in planning for drainage of small areas.

110. HOCKENSMITH, R. D., and STEELE, J. G. Classifying land for conservation farming. U. S. D. A. Farmers' B. 1853, 46 p., illus., tables. Feb. 1943. I Ag84F

The principal factors are erodibility, slope, natural drainage, permeability, liability to overflow, and natural fertility.

111. HOOGHOUTD, S. B. *Bijdragen tot de kennis van eenige natuurkundige grootheden van den grond. 7. Algemeene beschouwing van het probleem van de detailontwatering en de infiltratie door middel van parallel loopende drains, greppels, slooten en kanalen.* Netherlands. Dir. van de Landb. Verslagen van Landbk. Onderz. 46(14)B:

515-707, illus., tables. 1940. 105.2 V61V

Contributions to knowledge of some natural properties of soil. 7. General consideration of the problem of local draining of soil, and of infiltration from parallel running drains and open drain furrows, ditches, and drainage channels. Netherlands.

112. HOOGHOUT, S. B. Bijdragen tot de kennis van eenige natuurkundige grootheden van den grond. 8. De bodemgesteldheid van de Veenkoloniën; de doorlatendheid van de watervoerende laag tot maximal 20 M. onder het maaiveld, en de daaruit af te leiden algemeene conclusies met betrekking tot de ontwatering van de Veenkoloniën. Netherlands. Dir. van de Landb. Verslagen van Landb. Onderz. 49(16)A:721-914, illus., tables. 1943. 105.2 V61V

The composition of the soil of the Fen counties; the permeability of the water-bearing stratum to a maximum depth of 20 metres under the meadow, and the conclusions to be drawn therefrom regarding the drainage of the Fens.

113. HUBERTY, M. R. The drainage and permeability characteristics of soils on which avocado tree decline and collapse are prevalent. Calif. Avocado Soc. Ybk. 1943:38-40. 81 C128

Surface drains and subdrains, or both, can be used in reducing excessive moisture in soils of reasonable depth.

114. HURSH, C. R., HOOVER, M. D., and FLETCHER, P. W. Studies in the balanced water-economy of experimental drainage-areas. Amer. Geophys. Union. Trans. 23:509-517, illus., tables. Nov. 1942. 330.9 Am3

Discusses the problem of keeping accounts of the essential water-cycle factors for experimental drainage areas.

115. IRMAY, S. Saturated steady flow in non-homogeneous media and its applications to earth embankments, wells, drains. Internat'l. Conf. Soil Mech. & Found. Engin. 3rd. Proc. 2:259-263, illus. 1953. Ref. 290.9 In863

A formula is developed for a horizontal drainage ditch and found to be identical with that for homogeneous soils with average resistivity. When two ditches drain a uniform rainfall, the water table is no longer elliptic.

116. JAKOVLEV, B. I. Soil permeability over drains and between drains. (In Russian.) Vzesoiuzn. Akad. Sel'skokhoz. Nauk im. V. I. Lenina. Dok. 3:44-48, tables. 1940. 20 Ak1

The soil above drains has greater permeability at all times than the soil between the drains.

117. JONES, L. A. Drainage in relation to soil and moisture conservation. Washington, U. S. Soil Conserv. Serv., 1939. 9 p. 1.96 R31J

Paper presented before the Soil and Water Conservation Division of the American Society of Agricultural Engineers, Chicago, Dec. 7, 1939.

118. KIDDER, E. H., and LYTLE, W. F. Drainage investigations in the plastic till soils of northeastern Illinois. Agr. Engin. 30:384-386, 389, illus., tables. Aug. 1949. Ref. 58.8 Ag83

Both surface and tile drainage are discussed. Investigation indicates that considerable variation in the permeability rates may exist in the same soil type.

119. KIRKHAM, D., and GASKELL, R. E. The falling water table in tile and ditch drainage. Soil Sci. Soc. Amer. Proc. 15:37-42, illus. 1950, pub., 1951. Ref. 56.9 So3

An equation for the rate of fall of a water surface is derived in terms of the hydraulic head function, the slope of the water table, the soil permeability, and drainable porosity. The computation method developed requires considerable labor to obtain accurate results when the spacing between drainage facilities is large.

120. KIRKHAM, D., and ZEEUW, J. W. DE. Field measurements for tests of soil drainage theory. *Soil Sci. Soc. Amer. Proc.* 16: 286-293, illus., tables. July 1952. Ref. 56.9 So3

Measurements are reported for water-table heights, rainfall, permeability, and of ditch and drain tile outflow, for tile drains and ditch drains in replicated plots in the recently reclaimed Northeast Polder of the Netherlands. It was found that tiles kept the water table lower at all times than did the ditches.

121. KIRKHAM, D. Reduction in seepage to soil underdrains resulting from their partial embedment in, or proximity to, an impervious substratum. *Soil Sci. Soc. Amer. Proc.* 12:54-59, illus. 1947. Ref. 56.9 So3

Concludes that drains should not be placed too near, on, or in an impervious layer if a rapid initial drawdown of the water table is desired.

122. KIRKHAM, D. Seepage into ditches in the case of a plane water table and an impervious substratum. *Amer. Geophys. Union. Trans.* 31:425-430, illus. June 1950. Ref. 330.9 Am3

Seepage of water into drain tubes. Streamlines, distribution of hydraulic head, and the seepage rate into unit length of ditch are computed.

123. KIRKHAM, D. Seepage into drain tubes in stratified soil. *Amer. Geophys. Union Trans.* 32:422-442. June 1951. Ref. 330.9 Am3

Expressions for drain flow, surface inflow distribution, and flow nets are derived for surface water seeping into drain tubes embedded in water-saturated soil. Drains both in and below the surface stratum are considered.

124. KIRKHAM, D. Seepage of artesian and surface water into drain tubes in stratified soil. *Amer. Geophys. Union Trans.* 35:775-790. Oct. 1954. 330.9 Am3

The problem of simultaneous upward seepage of water from an artesian basin and downward seepage from a ponded surface source into drain tubes is analysed for soil consisting of two horizontally stratified layers, each of different permeability, overlying artesian gravel. Theoretical formulas for hydraulic head, drain flow, and surface inflow distribution are given.

125. KIRKHAM, D. Studies of hillside seepage in the Iowan Drift area. *Soil Sci. Soc. Amer. Proc.* 12:73-80, illus. 1947. Ref. 56.9 So3

Drainage studies of three hillside problem areas typical of the region—a hillside, a tiled area, and an artesian area. It was found that hillside drainage difficulties were due to upward movement of the water resulting from artesian pressure developed by downward seepage over the upper portion of the hill.

126. KNOBLAUCH, H. C., and HAYNES, J. L. The effect of contour cultivation on runoff. *Washington, U. S. Soil Conserv. Serv.*, 1940. 12 p., illus. 1.96 R31Ef

New Jersey Agricultural Experiment Station, cooperating.

Facts to be considered in planning erosion and flood control measures for watersheds or for individual farms. Hydrographs are presented showing comparison of rate of flow, surface detention, and depression-storage of contoured up-and-down tillage practices under various conditions of soil moisture.

Also in *Amer. Geophys. Union. Trans.* 21:499-504, illus., tables. July 1940. 330.9 Am3

127. KNOBLAUCH, H. C., RICHARDS, S. J., and LINT, H. C. Soil moisture tension under various conservation practices. *Soil Sci. Soc. Amer. Proc.* 4:433-437; 6:480-483, illus., table. 1939, 1941. 56.9 So3

Effect of terracing given.

128. KOHNKE, H. Runoff chemistry, an undeveloped branch of soil science. *Soil Sci. Soc. Amer. Proc.* 6:492-500, illus. 1941. Ref. 56.9 So3

Discusses the loss of nutrients involved in ground-water runoff and tile-drainage water.

129. KRIMGOLD, D. B., and BEENHOUWER, O. Estimating infiltration. *Agr. Engin.* 35:719-725, illus., tables. Oct. 1954. Ref. 58.8 Ag83

Mathematical formulas for estimating the moisture in soils in connection with drainage, irrigation, runoff, and tillage.

130. LAMBERT, J. M. A survey of the Rockland-Claxton Level, Norfolk. *J. Ecol.* 36:120-135, illus., maps, tables. July 1948. 450 J829

Vegetation, soils, and drainage conditions of an embanked and drained grazing area in the Yare Valley of England.

131. LEMBKE, W. D. The mathematical analysis and experimental tests of a tile drainage model. *Urbana, Ill.*, 1952. 47 p., illus., tables. Ref. U. Ill. Libr.

Typewritten.

Thesis (M. S.)- University of Illinois, 1952.

Southwell's relaxation method is used to solve soil profiles with variable permeabilities. The effects of drain diameter, unsymmetrical drain sections, and the position and thickness of a slowly permeable layer are discussed also.

132. LEVI, E. Coeficiente de riego y coeficiente de drenaje. *Ingen. Hydraul. en Méx.* 5(1):9-19, illus. Jan./Feb./Mar. 1951. 290.8 In43

Technical discussion of irrigation, drainage, runoff and ground water in Mexico.

133. LOWDERMILK, W. C. Land-use and flood-flows. *Amer. Geophys. Union Trans.* 19:508-515, illus. Aug. 1938. 330.9 Am3

Concentrations of unabsorbed waters of drainage channels into trunk streams under variable rain patterns and the accumulation of erosional debris in stream channels.

134. LUTHIN, J. N., and GASKELL, R. E. Numerical solutions for tile drainage of layered soils. *Amer. Geophys. Union Trans.* 31: 595-602. Aug. 1950. Ref. 330.9 Am3

Discussion in *Amer. Geophys. Union Trans.* 32:779-780. Oct. 1951. 330.9 Am3

The problem of tile drainage of uniform soil lying above an impermeable layer. Tile drainage of 2-layered soil with surface soil used for trench backfill is dealt with numerically.

135. LUTHIN, J. N., and MILLER, R. D. Pressure distribution in soil columns draining into the atmosphere. *Soil Sci. Soc. Amer. Proc.* 17:329-333, illus. Oct. 1953. Ref. 56.9 So3

Columns of soil were wetted and then allowed to drain, while measurements were made of the pressure distribution in the soil and of the rate at which the water drained out. The experimental results emphasize the importance in drainage of the tension required to produce entry of air into the soil surface.

136. LUTHIN, J. N. Proposed method of leaching tile-drained land. *Soil Sci. Soc. Amer. Proc.* 15:63-68, illus. 1950, pub., 1951. Ref. 56.9 So3

Where soils are drained by tile, it is difficult to leach all of the soils adequately. It is proposed that a diking arrangement be used so that certain selected surface areas can be ponded while other surfaces remain dry.

137. LYON, A. V. Irrigation and drainage investigations. *So. Austral. Dept. Agr. J.* 44:732-734. July 1941. 23 So84

The nature of the soil profile controls the depth of drains which are seated if possible on clay subsoil. In soils with a free-textured subsoil drains are usually five to six feet deep. Spacing of drains is determined by recording the fluctuations of the water table in a line at right angles to the drains. On heavy soils it is found that surface drainage gives better results.

138. MACINTIRE, W. H., and others. Effect of fluorine carriers on crops and drainage waters. *Indus. & Engin. Chem.* 43:1797-1799, tables. Aug. 1951. Ref. 381 J825

S. H. Winterberg, I. B. Clements, L. S. Jones, and B. Robinson, joint authors.

Concludes that rational uses of fluoric insecticides do not induce significant enhancement in fluorine content of vegetation, nor do such uses impart to ground water a harmful concentration of fluorides.

139. MARIMPIETRI, L. A new conception of land tillage, settlement and drainage. *Internat'l. Cong. Soil Sci.* 4th Trans. 3:13-17, illus. 1950. 56.09 In844

Contends that ditch drainage has no bearing on water in the soil if subsoil is not settled or if walls of the ditch are sound.

140. MASCLEE, J. A. *De ontwateringseisen van humueze gronden.* Landbk. Tijdschr. 65:402-410, illus. July 1953. 105.2 Or3 English summary, p. 410.

The optimal drainage depth of humus-containing sandy soils.

141. MEINZNER, O. E., and others. The channel-storage method of determining effluent seepage. *Amer. Geophys. Union Trans.* 17: 415-418. July 1936. 330.9 Am3

R. C. Cady, R. M. Leggette, and V. C. Fishel, joint authors.

The results of an investigation on a small drainage basin in Virginia.

142. MERRILL, L. P. Some agricultural engineering problems in soil and water conservation. *Agr. Engin.* 32:481-482, illus. Sept. 1951. 58.8 Ag83

Water-disposal system for sloping cultivated land in the Western Gulf region (Texas, Oklahoma, Arkansas and Louisiana.) Chiefly runoff from terraces.

143. MOLEN, W. H. VAN DER. *Bepaling van drainafstanden door een morphologische beoordeling van het bodemprofiel.* Landbouwk. Tijdschr. 65:105-113, illus., tables. Feb./Mar. 1953. 105.2 Or3

Determination of drain spacing by a morphological evaluation of the soil profile. Drainage calculation methods used for sandy soils of the Zuiderzee are outlined.

144. MORGAN, M. F., JACOBSON, H. G. M., and LECOMPTE. S. B. Drainage water losses from a sandy soil as affected by cropping and cover crops. *Conn. (New Haven) Agr. Expt. Sta. B.* 466, 32 p., illus., tables. Oct. 1942. Ref. 100 C76St

Lysimeter studies involving the effects of cropping, cover crops, and nitrogenous fertilizers with reference to drainage water losses and the removal of various constituents by crops and soil changes.

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Appendix 8, Statement of Task Committee No. 8 on Land Drainage, p. 177-187, discusses legislation, policy, and costs, and makes recommendations for future policy in relation to land drainage.

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New Mexico, Colorado, Utah, Nevada, and California.

345. TOLMAN, C. F., and STIPP, A. C. Analysis of legal concepts of subflow and percolating waters. Amer. Soc. Civ. Engin. Trans. 106:882-933,illus. 1941. Ref. 290.9 Am3

Discussion, by D. M. Baker, S. C. Wiel, H. Forbes, R. B. Harris, E. F. Treadwell, O. E. Meinzer, M. R. Lewis, B. F. Snow, H. Conkling, C. F. Tolman, and A. C. Stipp, p. 902-933.

Discusses some of the erroneous legal concepts resulting from inadequate comprehension of geologic and hydrologic factors governing occurrence and movement of water underground. Ground-water laws in western United States are referred to.

346. U. S. CONGRESS. HOUSE. COMMITTEE ON AGRICULTURE. Rehabilitation of drainage works; acquisition of land in Ottawa National Forest, State of Michigan. Hearing, 76th Cong., 1st sess., on H. R. 3747 and 931, May 3 and 4, 1939. Washington,1939. 44 p. 280.12 Un332

Hearings on a bill (H. R. 3747) to appropriate \$10,000,000 per year for 4 years "to provide for the conservation of agricultural land resources by assisting in the repair, reconstruction, rehabilitation, and improvement of drainage works maintained and operated by an organized public drainage district or similar public body," p. 1.

347. U. S. CONGRESS. HOUSE. COMMITTEE ON IRRIGATION AND RECLAMATION. Amending Reclamation Act to include logged or cut-over lands and swamp lands. Hearings, 78th Cong., 2d sess., on H. R. 3787. Dec. 7, 1944. Washington,1945. 23 p. 54 Un3

Hearings on the advisability of amending the Reclamation Project Act of 1939 to include drainage of wet lands and reclamation of cut-over lands, as well as irrigation of dry lands, as part of the work of the Reclamation Bureau.

348. U. S. CONGRESS. SENATE. COMMITTEE ON AGRICULTURE AND FORESTRY. Construction of drainage works in the United States. Hearings, 78th Cong., 2d sess., on S. 1289, June 5-6, 1944. Washington,1944. 65 p. 54 Un32

A bill to provide that the Department of Agriculture cooperate with districts authorized under State laws to finance, construct, operate, and maintain drainage improvements.

349. U. S. DEPT. OF AGRICULTURE. OFF. OF THE SOLICITOR. Legislative history of the Watershed Protection and Flood Prevention Act (Public Law 566, 83d Congress). Washington,1954. 74 p. A290.So4

The Act is reproduced on p. iv-vii.

350. U. S. LAWS, STATUTES, ETC. Federal reclamation laws annotated. Ed. 2. Washington,1947. 766 p.,map. 156.85 F317

Includes legislation concerning drainage, for which the index should be consulted.

351. U. S. NATIONAL RESOURCES COMMITTEE. WATER RESOURCES COMMITTEE. Drainage policy and projects. Washington, 1936. 22 p.,illus.,maps. 173.2 N214D

The nature of Federal drainage activities, purposes and methods of land drainage, and construction requiring subsequent drainage. Recommends the establishment of a Federal committee, headed by a civilian consultant, to coordinate drainage activities in the United States.

352. U. S. SOIL CONSERVATION SERV. SOUTHEASTERN REGION. General outline for review and study of drainage laws and phy-

sical drainage problems in Georgia. Spartanburg?S. C., 1949. 4 p.

1.9602 G28

Prepared at the request of the Georgia Association of Soil Conservation District Supervisors, "that, as a result of this review, any recommendations regarding changes in the present Georgia State Drainage Law be promptly referred to the Legislative Committee of the Georgia Association ... for any action deemed necessary," p. 1.

353. U. S. SOIL CONSERVATION SERV. SOUTHWEST REGION. Legal status of New Mexico drainage basins. Albuquerque, 1947. 6 p. 1.9608 L52

Contains a list of adjudication decrees, hydrographic surveys, and interstate compacts in New Mexico.

354. WERNIMONT, K., AULL, G. H., and CLARK, O. M. Agricultural drainage administration in South Carolina; a proposed post-war drainage program. S. C. State Planning Bd. 13, 39 p. 1943.

280.7 So8292B

Includes legislative history and current law, pertaining to drainage, financing, and maintenance problems.

355. WILLIAMS, M. B. Water laws in the United States of America relating to water rights, irrigation, conservation drainage, and flood and overflow protection for agricultural lands; a selected reference list of publications with some reproductions, basic excerpts, and lists of contents of special interest. Washington, Food & Agr. Organ. United Nations, 1948. 168 p. 241 F732W

356. WINTON, G. H., JR. Drainage and improvement districts. Calif. Mosquito Control Assoc. Proc. & Papers 20:76-78. 1952.

428 C763

Formation of drainage districts, and a discussion of drainage legislation.

357. YOUNG, G. E. Nature and extent of U. S. Department of Agriculture programs contemplated under the Watershed Protection and Flood Prevention Act. Assoc. West. State Engin. Proc. 27:49-53. 1955. 290.9 As76

A discussion of P. L. 566, 83d Congress, 2d session, 1954.

358. YOUNG, G. E. Watershed protection and flood prevention policies. Washington, U. S. Soil Conserv. Serv., 1955. 6 p.

1.941 A2Y82

Speech at the Northeastern Extension Directors Conference, New York City, Mar. 8 and 9, 1955.

A discussion of P. L. 566, 83d Congress, the Watershed Protection and Flood Prevention Act.

## SPECIAL PROBLEMS IN DRAINAGE

### Irrigated Lands

359. ALBUQUERQUE, H. C. DE. Irrigação e drenagem na zona canavieira de Pernambuco. Lavoura 51:58-61. Dec. 1947. 9.2 L39

Irrigation and drainage in the sugarcane region of Pernambuco.

360. ALL-AMERICAN Canal progress. Engin. News-Rec. 118: 258-261, illus. Feb. 18, 1937. 290.8 En34

Includes discussion of drainage outlets.

361. ALLISON, L. E., and CHRISTIANSEN, J. E. Report on salinity and water table conditions in grapes and dates on Desert Sun Ranch, Coachella Valley, California. U. S. Region. Salinity Lab. Res. Rpt. 8, 14 p., tables. 1944. 1.965 A2R31

The increasing development of problem areas in the irrigated fruit ranches of the valley led to an investigation by the Salinity Laboratory to determine whether the trouble was caused by high salinity, poor

drainage, or both.

362. AMEMIYA, M., ROBINSON, C. W., and COWLEY, E. W. Reclamation of a saline-alkali soil in the Upper Colorado River Basin. *Agron. Abs.* 47:12. 1955. 241 Am39

363. ANDERSON, T. C. Drainage reclaims Pease bottom farms. *Soil Conserv.* 17:247-249,254,illus. June 1952. 1.6 So3S

Drainage of irrigated lands in Montana by means of open ditches.

364. ARNDT, F. R. Thirty years of irrigation. *So. Austral.* *Dept. Agr. J.* 46:357-366,illus. July 1943. 23 So84

Includes plans for surveys of drainage reserves for the location of a future main-drainage system for the removal of seepage waters. Tile or concrete drains are recommended for heaviest types of land. Depth of drain and type of pipes are discussed.

365. AYERS, H. D. Soil permeability as a factor in the translocation of salts on irrigated land. *Sci. Agr.* 31:383-395,illus. Sept. 1951. Ref. 7 Sci2

Canal lining and interception drainage are recommended to prevent excessive seepage and high water tables on soils of low permeability.

366. BAILY, P. J. Drainage on irrigated swamp areas. *So. Austral. Dept. Agr. J.* 44:443. Mar.1941. 23 So84

Primarily mole drainage.

367. BARTELS, L. C. Grading land for irrigation. *Victoria Dept. Agr. J.* 43:321-327,illus. Aug.1945. 23 V66J

Includes construction and operation of drainage ditches on irrigated land. Australia.

368. BARTRAM, R. Overirrigation plagues Manson district. *West. Fruit Grower* 10(8):23-24,illus. Oct.1954. 95.8 G762

Includes tile drainage of irrigated orchards in Washington.

369. BENNETT, H. Improved drainage in the Imperial Valley, California. *Soil Conserv.* 16:135-138. Jan.1951. 1.6 So3S

Research on an unsuccessful project was followed by installing tile drains. Accomplishment is estimated in dollars per acre based on land values for abandoned land, virgin wet land, and cultivated land. Increase in crop production due to drainage is estimated at \$30 an acre.

370. BENNETT, H. Water in the ground: too much or too little? *Soil Conserv.* 16:153-157,illus. Dec.1950. 1.6 So3S

Drainage and levelling of irrigated lands in New Mexico and Colorado. Includes the Rio Grande Drainage District and its program.

371. BIXBY, F. S. Draining cotton fields the easy way. *Excavating Engin.* 36:196-198,illus. Apr.1942. 290.8 Ex2

Tractor digging of a 14-foot wide drainage ditch 5 miles long in Arizona irrigated land.

372. BLOODWORTH, M. E., and ROSS, P. E. Drainage of irrigated lands in the Lower Rio Grande Valley of Texas. *Agr. Engin.* 32: 669-671,673,illus. Dec.1951. Ref. 58.8 Ag83

Unwise use of irrigation water has contributed to salinity. Recommendations for preventive and relief measures are given.

373. BLOODWORTH, M. E. General aspects of drainage and irrigation in the Lower Rio Grande Valley of Texas. *Lower Rio Grande Val. Citrus & Veg. Inst. Proc.* 3:2-6. 1948. 81 L95

Six relief measures are listed for the local drainage and salinity problems.

374. BOL'SHAKOV, A. F. Soils of the saline complex in the northwestern part of the near-Caspian Lowlands and methods for their reclamation. (In Russian.) *Pochvovedenie* 11:1-13. Nov.1954. Ref. 57.8 P34

Irrigated soils.

375. BRENNER, W. W. Storm drainage structures, Gila Gravity Main Canal. *Reclam. Era* 35-36,illus. Feb.1941. 156.84 R24

Description of several automatic spillways, wasteways, and over-chutes for disposal of storm waters of creeks and washers.

376. CAMERON, A. E. Over-watering citrus trees. *Citrus News* 23:45. Mar. 31, 1947. 80 C494

Even after tiles have been installed, occasional soil auger checks are necessary to detect waterlogging of citrus roots.

377. CHAPPLE, L. A. Drainage. *So. Austral. Dept. Agr. J.* 46: 333-334. June 1943. 23 So84

Under a community system of irrigation at Berri soil deterioration has been caused by faulty drainage and land has gone out of production through salt accumulation. An effective system of main drains is necessary to take water right away after tile drainage. Recommendations are made for establishing proper drainage systems on different types of soils.

378. CHRISTIANSEN, J. E. Some permeability characteristics of saline and alkali soils. *Agr. Engin.* 28:147-150, illus., tables. Apr. 1947. 58.8 Ag83

The success of drainage and leaching of irrigated soils is dependent upon the permeability of the soil and subsoil materials.

379. CLYDE, G. D. Relating basic resources in irrigation research. *Agr. Engin.* 33:277-278, illus. May 1952. 58.8 Ag83

Includes drainage of irrigated lands. Excess applications of irrigation water, together with seepage from canals and natural channels, causes waterlogging or salt accumulation.

380. DEBLER, E. B. Conveyance losses in irrigation canals. *Civ. Engin.* 11:584-585, illus. Oct. 1954. 290.8 C49

Artificial drainage may provide a remedy for loss due to seepage.

381. DIEBOLD, C. H. Permeability and intake rates of medium textured soils in relation to salt content and degree of compaction. *Soil Sci. Soc. Amer. Proc.* 18:339-343, illus., tables. July 1954. Ref. 56.9 So3

Experiments conducted in Arizona, Colorado, New Mexico, and Utah from 1948 through 1953 in order to aid in the design of effective drainage systems for irrigated lands.

382. DONNAN, W. W., and BRADSHAW, G. B. The disposal of seepage and waste water. *U. S. D. A. Ybk. Agr.* 1955:557-564.

1 Ag84Y

Drainage of irrigated lands in the Western States.

383. DONNAN, W. W. Model tests of a tile-spacing formula. *Soil Sci. Soc. Amer. Proc.* 11:131-136, illus., tables. 1946, pub., 1947. 56.9 So3

Formula applicable to drainage of irrigated lands, California.

384. DONNAN, W. W., ARONOVICI, V. S., and BLANEY, H. F. Report on drainage investigation in irrigated areas of Imperial Valley, California. Los Angeles, U. S. Soil Conserv. Serv., 1947. various pag-ing, illus., tables. Ref. 1.96 R31Red

The objectives of the study were to: "Establish criteria by which the feasibility of drainage on any lands within the Imperial Irrigation District may be determined; where drainage is feasible to establish methods of designing and installing practical drainage facilities; and to develop techniques for improving irrigation practices," Summary, p. xiv.

385. DOWD, M. J. Silt problems of Imperial Irrigation District as affected by completion of Boulder Dam. *Civ. Engin.* 9:609-611. Oct. 1939. 290.8 C49

Growth of moss in drainageways has increased and may become a problem, while erosion due to seepage is increasing. California.

386. DUMM, L. D. Drain-spacing formula. *Agr. Engin.* 35:726-730, illus. Oct. 1954. 58.8 Ag83

A new formula for determining depth and spacing of subsurface drains in irrigated lands.

387. DUNNEWALD, T. J. Removal of alkali by drainage and leaching; restoring fertility of alkali soil by means of drainage and leaching at moderate cost, in Fremont County, Wyoming. Wyo. Agr. Expt. Sta. B. 276, 28 p., illus., tables. June 1946. 100 W99

388. DUNNEWALD, T. J. Salinity conditions in the Big Horn River during the years 1938 and 1939. Wyo. Agr. Expt. Sta. B. 240, 28 p., tables. July 1940. 100 W99

A study made by the Montana and Wyoming Agricultural Experiment Stations in cooperation with the U. S. Geological Survey in order to ascertain the quantities of dissolved salts in irrigation waters in the area and the originating points of the salts, in connection with planning for the improvement by drainage of the existing irrigated lands.

389. EMERSON, W. O. Imperial digs out. Country Gent. 106(12):12-13, 84-85, illus. Dec. 1936. 6 C833

Concerned primarily with irrigation, the All-American Canal, and the flooding of the Colorado River in 1905-7. The need for proper drainage to correct the errors of over-irrigation is pointed out.

390. FITZHUGH, E. A. Goldbergian gadget may boost Valley's output. Soil Conserv. 9:228-231, illus. Apr. 1944. 1.6 So3S

An apparatus for taking soil cores as a first step in search of solutions to the drainage problems in the irrigated Imperial Valley of California.

391. FLOTEN, C. G. Use of dynamite in constructing drainage ditches. Agr. Educ. Mag. 19:178. Mar. 1947. 275.8 Ag8

In irrigated land in Oregon, where the saturated condition of the soil would not support heavy ditching equipment.

392. FUHRIMAN, W. U., BLANCH, G. T., and STEWART, C. E. An economic analysis of the agricultural potentials of the Weber Basin Reclamation project, Utah. Utah. Agr. Expt. Sta. Spec. Rpt. 7, 39 p., map, tables. Dec. 1952. 100 Ut1Sp

The Utah Agricultural Experiment Station and the U. S. Bureau of Agricultural Economics, cooperating.

Land classification, drainage, irrigation, and water requirements.

393. GAINES, H. F. Managed water brings good times. Soil Conserv. 19:250-251, illus. June 1954. 1.6 So3S

Irrigation and drainage in Washington.

394. GARDNER, R. Some soil properties related to the sodium salt problem in irrigated soils. U. S. D. A. Tech. B. 902, 28 p., tables. Sept. 1945. Ref. 1 Ag84Te

Drainage to remove accumulated salts is a necessary step in the improvement of saline soils. Treatment to improve the permeability of the soil may be necessary before drainage can be undertaken.

395. GEDDES, J. A., FREDERICKSON, C. D., and BERGESON, E. C. Drainage and irrigation, soil, economic, and social conditions, Delta area, Utah. Division 4, Social conditions. Utah. Agr. Expt. Sta. B. 288, 93 p., illus., tables. June 1939. 100 Ut1

Divisions 1, 2, and 3 appeared as Bulletins 255, 256, and 273. Apr.-May 1935, Oct. 1936.

396. GONZALEZ, R. A. Irrigation in Puerto Rican cane fields. Facts Sugar 35:52-55, illus. Feb. 1940. 65.8 F11

Drainage ditches are needed where water is applied by partial flooding.

397. GREGOR, H. F. The Southern California water problem in the Oxnard area. Geog. Rev. 42:16-36, illus., maps, tables. Jan. 1952. Ref. 500 Am35F

Primarily irrigation, but includes drainage of irrigated lands, and ground water.

398. HARDMAN, G., VENSTROM, C., and MASON, H. G. Irri-

gated lands of the Humboldt River area. Nev. Agr. Expt. Sta. Irrig. B. 1,36 p.,illus.,maps,tables. May 1939. 100 N415

Includes underground water in Nevada, and drainage of irrigated lands.

399. HART, R. A. The drainage of irrigated farms. U. S. D. A. Farmers' B. 805, 32 p.,illus. Rev. Dec. 1937. 1 Ag84F

Covers open-ditch and tile drainage, depth, spacing and location of tile drains, flumes, wells, inlets, and outfalls, beneficial effects on crops of drainage, maintenance of the drainage system, and costs.

400. HART, R. A. Need for drainage of irrigated farms. Irrig. Farmer 3(5):3, 5, 10-11. Sept. 6, 1945. 55.8 Ir78

For prevention of waterlogging and of accumulation of alkali.

401. HAYWARD, H. E. The control of salinity. U. S. D. A. Ybk. Agr. 1943/47:547-553. 1947. Ref. 1 Ag84Y

Good drainage is essential. Where artificial drainage is necessary, three methods are used—tile systems, open drains, and pumped wells. In many places drainage water pumped from wells is mixed with irrigation water and used over again.

402. HAYWARD, H. E., and WADLEIGH, C. H. Plant growth on saline and alkali soils. Advn. Agron. 1:1-38. 1949. Ref. 30 Ad9

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403. HAYWARD, H. E., and MAGISTAD, O. C. The salt problem in irrigation agriculture. U. S. D. A. Misc. P. 607, 27 p.,illus. Aug. 1946. 1 Ag84M

Stresses the importance of good drainage of irrigated lands.

Publications of the U. S. Regional Salinity Laboratory, p. 25-27.

404. HOLBROOK, W. Irrigation from pumped wells; underground water sources increasing in importance as unappropriated surface supplies dwindle. Civ. Engin. 7:473-474, illus. July 1937.

290.8 C49

Describes a drainage system to collect surface water for a well in a shallow deposit.

405. HUBBLE, G. D., and CROCKER, R. L. A soil survey of the Red Cliffs Irrigation District, Victoria. Austral. Council Sci. & Indus. Res. B. 137, 63 p.,illus.,maps, tables. 1941. 514 Au72B

Includes drainage of irrigated lands, and salt removal.

406. HUBERTY, M. R., and PILLSBURY, A. F. Reclamation of saline soils in Coachella Valley, Calif., U. S. A. Internat. Cong. Soil Sci. 4th. Trans. 1:383-385, table. 1950. 56.09 In844

Leaching experiments on trial plots indicate that only through careful irrigation and drainage practices will a proper salt balance be maintained in the valley.

407. ISRAELSEN, O. W. Drainage in the Lewiston area, Utah. Utah. Agr. Expt. Sta. Spec. Rpt. 9, 25 p.,illus.,maps,tables. Ref. 1953. 100 Ut1Sp

Studies made by the Utah Agricultural Experiment Station with the purpose of developing improvements in the design, placing, and maintenance of tile drains, and to find the conditions under which, and the extent to which, drainage by pumping may be preferable to drainage by gravity, in a subirrigated area.

408. ISRAELSEN, O. W. Drainage of irrigated lands. In his Irrigation principles and practices, ed. 2, p. 268-283, illus.,tables. New York, Wiley, 1950. Ref. 55 Is7

Section heads include: Benefits of drainage; Required water-table depths; Lowering the water table; Design of open drains; Construction methods and costs; Tile drainage systems; Installation of tile drains; Maintenance of drains; Drain depths, spacing, and ground-water flow; Pumping for drainage; and Drainage enterprises.

409. ISRAELSEN, O. W., and STEWART, C. D. Draining Lewis-ton flats will improve land conditions in Cache County [Utah]. Sugar Beet 9(8):10-13, 29, illus. Dec. 1950. 66.8 Su34B

For growing sugar beets. Open-ditch, underdrainage with tile and control gates, and shallow-well pumping are used. Tile drainage is considered most satisfactory here.

410. ISRAELSEN, O. W., PETERSON, D. F., JR., and REEVE, R. C. Effectiveness of gravity drains and experimental pumping for drainage, Delta area, Utah. Utah. Agr. Expt. Sta. B. 345, 64 p., illus. Feb. 1950. Ref. 100 Ut1

U. S. Regional Salinity and Rubidoux Laboratories, cooperating.

Results of studies made on eight irrigated experimental sites between 1945 and 1948.

411. ISRAELSEN, O. W., MAUGHAN, J. H., and SOUTH, G. P. Irrigation companies in Utah; their activities and needs. Utah. Agr. Expt. Sta. B. 322, 62 p., illus., maps, tables. Mar. 1946. 100 Ut1

One of the most needed improvements in irrigation is the draining of saturated soil formations to stabilize canal beds.

412. ISRAELSEN, O. W. Problems peculiar to irrigation farming. Agr. Engin. 18:437-439, illus. Oct. 1937. 58.8 Ag83

Includes alkali control and drainage.

413. ISRAELSEN, O. W. Water application efficiencies in irrigation and soil conservation. Agr. Engin. 20:423-425, illus. Nov. 1939. 58.8 Ag83

Drainage is considered. Utah.

414. JESSUP, L. T. Irrigated lands require drainage. Internat'l. Soc. Soil Sci. Comm. Trans. 6B:271-274. 1937, pub., 1938. 56.9 In833

Salinity of irrigation waters and the need for drainage of irrigated land.

415. JONES, B. J. Irrigated pastures in California. Calif. Agr. Col. Ext. C. 125, 47 p., illus., tables. Oct. 1942. Ref. 275.29 C12C

Includes cost of drainage.

416. KAHAWITA, R. Waterlogging of irrigated lands and remedial measures. Trop. Agr. 95:278-287. Nov. 1940. 26 T751

The importance of drainage in irrigation schemes is stressed. Drainage of surface flow, control of subsoil flow, and prevention or reduction of soil alkalinity by drainage are considered. Rhodesia.

Also in Rhodesia Agr. J. 38:302-313. June 1941. 24 R34

417. KELLEY, W. P. Alkali soils; their formation, properties and reclamation. New York, Reinhold, 1951. 176 p., illus., tables. Ref. 56.33 K28

Selected bibliography, p. 163-170.

Reclamation of alkali soils, p. 131-161.

Drainage by open ditches, tiles, and pumping from wells, is discussed.

418. KELLEY, W. P. Permissible composition and concentration of irrigation water. Amer. Soc. Civ. Engin. Trans. 106:849-861. 1941. 290.9 Am3

Discussion, by C. S. Scofield, W. W. Weir, R. S. Stockton, L. D. Batchelor, and E. B. Debler, p. 856-861.

Since it is necessary to apply saline irrigation water in quantities in excess of crop requirements, in order that some leaching of the root zone will take place, the maintenance of good drainage conditions in the soil is very important.

Also in Amer. Soc. Civ. Engin. Proc. 66:607-613. Apr. 1940. Ref. 290.9 Am3P

419. KELLEY, W. P. The reclamation of alkali soils. Calif. Agr. Expt. Sta. B. 617, 40 p., illus., tables. Dec. 1937. Ref. 100 C12S

Experiments on over-irrigated soils of the Western States include drainage and the application of gypsum.

420. KOSTIAKOV, A. Drainage on irrigated lands. (In Russian.) Khlopkovodstvo 1:70-76. Jan.1952. 72.8 K522

421. LARSON, C. A. Reclamation of saline (alkali) soil in the Yakima Valley, Washington. Wash. Agr. Expt. Sta. B. 376,39 p.,illus., tables. July 1939. 100 W27E

Insufficient subsoil drainage had caused deposits of salts from irrigation water in certain areas of the valley, which could not be removed by later installed drains because the salts that had accumulated in the root zone were not leached out after drainage was provided.

422. LEWIS, M. R. Practical irrigation. U. S. D. A. Farmers' B. 1922,69 p.,illus.,tables. Jan.1943. 1 Ag84F  
Drainage, p. 68-69.

423. LUNDGREEN, W. K. The human dragline. Reclam. Era 41:65-66,illus. Aug.1955. 156.84 R24

Hand-digging of drainage ditches to relieve seepage due to irrigation on Nebraska farms.

424. LUTHIN, J. N., and BIANCHI, W. Alfalfa and water table levels. Calif. Agr. 8(5):4-5,illus. May 1954. 100 C12Cag

Tile drainage was necessary to counteract the effects of overirrigation and of seepage from the Sacramento River before adequate yields of alfalfa could be achieved.

425. LYON, A. V., and TISDALL, A. L. Production of dried grapes in Murray Valley irrigation settlements. 2. Irrigation, drainage, and reclamation. Austral. Council Sci. & Indus. Res. B. 149,35 p.,illus.,tables. 1942. Ref. 514 Au72B

Discusses drainage systems: surface drainage, pumping schemes, gravitational schemes, dual-purpose drains, external and internal drains, drain depth, and distance between laterals. All in relation to soil profile and texture.

426. MCALLISTER, L. Drainage and irrigation in the Willamett Valley. Reclam. Era 34:175-177,illus. Sept.1948. 156.84 R24

Oregon.

427. MCCORMICK, J. A., and NAPHAN, E. A. Improving saline and alkali soils in Nevada. Nev. Agr. Expt. Sta. C. 1,11 p.,illus. Aug. 1952. 100 N41S

Drainage and leaching of irrigated soils.

428. MCCLAUGHLIN, W. W. Irrigation and the conservation of the range. Soil Conserv. 4:175-177. Jan.1939. 1.6 So3S

Includes drainage and drainage ditches.

429. MAGISTAD, O. C., and CHRISTIANSEN, J. E. Saline soils, their nature and management. U. S. D. A. C. 707,32 p.,illus. Sept. 1944. Ref. 1 Ag84C

One of the first steps in reclamation of saline soils is good drainage. Tile, open drains, and pumped wells are mentioned.

430. MAIERHOFER, C. R. The drainage of irrigated lands. Agr. Engin. 32:613-614. Nov.1951. 58.8 Ag83

Chiefly in the Western States. Basic principles are considered. Includes determination of the amount of artificial drainage needed.

431. MAIERHOFER, C. R. Drainage problems in the Rio Grande Valley. Reclam. Era 34:116-118. June 1948. 156.84 R24

The water table, and accumulations of salt in the soil. A four-point program towards solving the problems is suggested, including education of the landowners in the benefits of drainage, and research into the depth, spacing, and type of drains for best results.

Also in Lower Rio Grande Val. Citrus & Veg. Inst. Proc. 2:22-30. 1947, pub.,1948. 81 L95

432. MAIERHOFER, C. R. Some aspects of drainage in reclamation. Internatl. Comm. Irrig. & Drain. Annu. B. 2:83-86. 1953. 55.9 In8A

Speaks of the drainage of irrigated lands in the Western United States, and the function of drainage in removing salts as well as excess water.

433. MALHOTRA, S. L. Nangal Dam and Canal. Punjab (India). Internat'l. Comn. Irrig. & Drain. Annu. B. 1:67-76, illus., maps, tables. 1952. 55.9 In8A

Includes drainage of irrigated lands.

434. MANLY, G. W. Storm-drainage structures on the All-American Canal. Reclam. Era 29:302-305, illus. Nov. 1939. 156.84 R24

435. MAUGHAN, J. H., and ISRAELSEN, O. W. Management of irrigation and drainage enterprises in Utah, with special reference to the northern Cache Valley area. Utah Agr. Expt. Sta. B. 349, 49 p., illus., maps, tables. June 1951. Ref. 100 Ut1

Covers relations of irrigation and drainage, drainage methods, drainage enterprises, drainage districts, and landowners attitudes towards irrigation and drainage organizations.

436. MILLER, C. K. Drainage in the Big Horn Basin. Soil Conserv. 20:135-139, illus. Jan. 1955. 1.6 So3S

Drainage of 10,000 irrigated acres in Wyoming by open ditches 30 feet wide and 7 to 8 feet deep cost only 18 dollars per acre.

437. MOSS, H. C. Soil surveys of Saskatchewan irrigation projects. Sci. Agr. 20:170-174. Nov. 1939. 7 Sci2

The surveys included drainage and topographic conditions as related to soils, and vegetation and land use as related to soil and drainage conditions.

438. NOTES on waterlogging and land reclamation in the form of a questionnaire. India. Cent. Bd. Irrig. P. 17, 41 p. Sept. 1938. 55.9 In222

Principles of and data on reclamation of waterlogged irrigated lands, and methods of determining suitability of land for reclamation, with special reference to experience in various sections of India.

439. OVER-irrigation. Reclam. Era 26:297. Dec. 1936. 156.84 R24

"All irrigated areas require drainage of some kind, either natural or artificial, surface or subsoil, varying only in method and degree."

440. PARIS, R. G. Comprehensive drainage in the River Murray irrigation areas. So. Austral. Dept. Agr. J. 55:571-579, illus., June/July 1952. 23 So84

Includes the Waikerie system, "external" and "internal" drainage, design and layout, construction, costs, sumps and outlets, size of main drains, block connections, and pumping and outfall mains.

441. PENNY, J. M. Irrigação e drenagem. Lav. Arroz. 5(52): 9-10. Apr. 1951. 59.8 L39

Irrigation and drainage of rice in Brazil.

442. PETERSON, D. F., JR., and ISRAELSEN, O. W. Performance of existing gravity drains. U. S. Region. Salinity Lab. Res. Rpt. 25(Pt. 1), 10 p. Apr. 1948. 1.965 A2R31

In order to study the effectiveness of the present system of gravity drains in the Utah Delta area, piezometers for determining the elevations of the water table were installed at four locations where new open drains were being constructed. The paper describes results of the investigation. A continuation of the studies described in item 449, by Reeve, R. C., and Allison, L. E.

443. PILLSBURY, A. F. Drainage and reclamation; network of observation wells in Coachella Valley permits anticipation of possible drainage problems. Calif. Agr. 8(3):3-4, illus. Mar. 1954. 100 C12Cag

Coachella County, the U. S. Departments of Agriculture and the Interior, and the University of California cooperate in studies to devise methods of observing ground-water conditions so that drainage problems in the irrigated valley may be forecast in time to prevent serious

damage to land and crop.

444. POE, E. J. Water problems in the Southwest. *Soil Conserv.* 13:142-144, illus. Jan.1948. 1.6 So3S

Bad irrigation and undiscovered clay substrata have caused water-logging of soils in New Mexico, Utah, and Colorado. Deep drainage has been the answer.

445. POWERS, W. L. The drainage of irrigated lands. n.p., 1941? 5 p. 55 Or34

Oregon Agricultural College and U. S. Department of Agriculture, cooperating.

Contents: Lands of the arid region needing drainage; Drainage practice in the West; Treatment of drained land; The relation of economical irrigation to drainage.

446. RAE, R. Land drainage in low-rainfall areas. *Allahabad Farmer* 28:215-219. Nov.1954. 22 A15

Drainage of irrigated lands and of flat areas and depressions in low-lying river beds in arid and semiarid regions. Discusses open ditches, covered drains, and pole, brush, rock, cobble, and tile drains.

447. REEVE, R. C. Factors influencing drainage design in irrigated areas. *Agr. Engin.* 34:88-90,illus. Feb.1953. Ref. 58.8 Ag83

Drainage requirements, water-transmission properties of soil, and boundary conditions.

448. REEVE, R. C., ALLISON, L. E., and PETERSON, D. F. JR. Improvement of saline soils by leaching. U. S. Region. Salinity Lab. Res. Rpt. 25(Pt. 2),14 p. Apr.1948. 1.965 A2R31

Studies in Utah indicate that adequate drainage is necessary for leaching, and that leaching without sufficient drainage may be detrimental rather than beneficial.

449. REEVE, R. C., and ALLISON, L. E. Performance of gravity drains and leaching of impaired Delta area soils. U. S. Region. Salinity Lab. Res. Rpt. 21:35-54. Feb.1947. 1.965 A2R31

Investigations at the Regional Salinity Laboratory to determine: (1) The actual depths and seasonal fluctuations of the water table in drained areas compared with areas without drains; (2) The effect of the construction of additional drains on the water table in their vicinity; and (3) The lateral extent to which drains are effective.

450. REEVE, R. C., PILLSBURY, A. F., and WILCOX, L. V. Reclamation of a saline and high boron soil in the Coachella Valley of California. *Hilgardia* 24:69-91. Sept.1955. Ref. 100 C12H

Flushing and leaching irrigated soils.

451. REEVE, R. C., ALLISON, L. E., and PETERSON, D. F. JR. Reclamation of saline-alkali soils by leaching—Delta area, Utah. *Utah Agr. Expt. Sta. B.* 335,52 p.,illus.,tables. Dec.1948. 100 Ut1

Drainage conditions are an important consideration in leaching saline soils, as, if drainage is restricted, leaching may raise the water table and its subsidence may be so delayed that waterlogging results and salinity conditions are greatly aggravated.

452. REGER, J. S. The Coachella drainage investigations. 1. Forewarned is forearmed. 2. Investigating the underground. 3. Using the evidence. *Reclam. Era* 38:106-108, 134-136, 160-162,illus. May-July 1952. 156.84 R24

The work of the Coachella Valley Cooperative Drainage Investigations in detecting and correcting adverse drainage conditions before the land irrigated by the All-American Canal should become seriously damaged by excessive salinity.

453. RICHARDS, L. A.,ed. Diagnosis and improvement of saline and alkali soils. U. S. D. A. Agr. Handbk. 60,160 p.,illus.,tables. Feb.1954. 1 Ag84Ah

Literature cited, p. 148-153.

Drainage of irrigated lands in relation to salinity control, p. 41-48. Describes the reclamation of irrigated soils, which have become saline or alkali, by means of deep open ditches, tile lines, or pumping from wells.

Replaces publication of same authorship and title, issued by the U. S. Regional Salinity Laboratory, 1947. 157 p.,tables. Ref. 1.965 A2D542

454. ROBINS, J. S., PRUITT, W. O., and GARDNER, W. H. Unsaturated flow of water in field soils and its effect on soil moisture investigations. *Soil Sci. Soc. Amer. Proc.* 18:344-347, illus., tables.

July 1954. Ref. 56.9 So3

An experiment conducted in an attempt to measure the effects of unsaturated flow on the distribution of water following irrigation and of the field capacity of soils.

455. ROE, H. B. Moisture requirements in agriculture; farm irrigation. New York, McGraw-Hill, 1950. 413 p., illus., maps, tables. Ref. 55 R62

Partial contents: Ch. 4, Interrelation of irrigation and drainage; Ch. 5, Fundamental principles of irrigation and problems of agriculture under it.

456. ROGERS, F. Irrigation is good crop insurance. *Fla. Grower* 48(5):14. May 1940. 80 F6622

Describes a system of artesian well subirrigation which can be turned into a drainage system in wet weather. Terra cotta pipe is used used.

457. ROGERS, H. Get the jump on drainage. *Farm Mangt.* 4:12-14, 16-17, illus. Jan. 1955. 281.8 F2225

Drainage of irrigated lands in California.

458. ROMERO M., A. La irrigación y el drenaje en la industria azucarera. *Agr. Trop.* 10(5):25-34, tables. May 1954. 26 Ag8

Irrigation and drainage in sugar culture in Colombia.

459. SCOFIELD, C. S. The Pecos River Joint Investigation, 1939-1940; soil salinity investigation. Washington, U. S. Bur. Plant Indus., 1941. 191 p., tables. 1.965 I2P33

Excessive salinity in the irrigated soil of the Pecos Valley in New Mexico and Texas is caused primarily by the irrigation water. Among the remedies recommended is the construction of artificial drainage outlets.

460. SCOFIELD, C. S. Salt balance in irrigated areas. *J. Agr. Res.* 61:17-39, tables. July 1, 1940. 1 Ag84J

The relation between the quantity of dissolved salts delivered to an irrigated area with the irrigation water and the quantity removed from the area by the drainage water.

461. SCOFIELD, C. S. Soil, water supply, and soil solution in irrigation agriculture. *U. S. D. A. Ybk. Agr.* 1938:704-716. 1 Ag84Y

Lack of appreciation of the need for effective drainage is one of the factors leading to declining crop yields in irrigation agriculture.

462. SCOFIELD, C. S., and HOWE, O. W. Water input used for field crops at the United States Scotts Bluff (Nebr.) Field Station, 1941-44. *U. S. D. A. C.* 777, 18 p., tables. July 1948. 1 Ag84C

Drainage conditions included.

463. SHARMA, K. R. Drainage works across canals. *Indian Engin.* 103(2):49-50, illus., tables. Feb. 1938. 290.8 In2

Technical discussion of suction hydraulots, aqueducts, level crossings, and siphons.

464. SHELAEV, A. Biological drainage in the control of soil salinity in the Main Turkmen Canal zone. (In Russian.) *Khlopkovodstvo* 3:57-67. Jan. 1953. 72.8 K522

Tree planting to control salinity.

465. SPECIAL problems of the Bonneville Basin with reference to ground water. *Utah Econ. & Business Rev.* 13:(1A):51-56. Oct.

1953. 280.8 Ut1

Extensive areas of the basin's lowlands are unfit for cultivation because of the accumulations of salt. Much of this land can be reclaimed by the quick flushing of fresh water over the surface, dissolving the salts and draining them off to low depressions where they could evaporate.

466. STAFFORD, H. M., and HUBERTY, M. R. Soil characteristics and salinity in relation to irrigation and drainage. United Nations Sci. Conf. Conserv. & Util. Resources. Proc. 4:357-362. 1949, pub. 1951. 279.9 Un32P

Two methods of salinity control— one by a physical salt-water barrier, and the other by the repelling action of augmented streamflow—are described. The river discharge for the latter method is indicated and comparison of the two methods as to supplemental water requirements and costs is made.

467. STAMPE, W. Irrigation from the ground water for stimulating food production in desert areas. Empire J. Expt. Agr. 16:47-54. Jan. 1948. 10 Em7

Includes schemes for lowering the flood levels in low areas of India by means of drainage pumping.

468. THOMAS, E. E. Reclamation of white-alkali soils in the Imperial Valley. Calif. Agr. Expt. Sta. B. 601, 15 p., illus., tables. July 1936. 100 C12S

Due to faulty drainage the seepage from irrigation canals has tended to accumulate above the slowly pervious subsoil layers. The consequent high water table has brought the soluble salts to the surface where they have accumulated.

469. THOMAS, J. E. An investigation of the problems of salt accumulation on a Mallee soil in the Murray Valley irrigation area. Austral. Council Sci. & Indus. Res. B. 128, 90 p., illus., maps, tables. 1939. Ref. 514 Au72B

Drainage, p. 19-20, 34-38, 48.

470. THOMAS, SIR R. Land drainage in West Pakistan. Agr. Pakistan 1:146-149. 1950. 22 Ag832

Waterlogged lands and saline soils, the result of poor drainage of irrigated lands, are a major problem in Pakistan. Article reviews practices of United States and Egypt.

471. THORNE, D. W., and PETERSON, H. B. Drainage. In their Irrigated soils; their fertility and management, p. 123-129, illus. Philadelphia, Blakiston, 1949. Ref. 56.7 T393

Discusses the need for draining irrigated land, planning a drainage system, depth and spacing of drains, open-ditch, mole, tile, and pump drains, and the design and construction of a drainage system.

472. THORP, J., and SCOFIELD, C. S. Drainage in arid regions. U. S. D. A. Ybk. Agr. 1938:717-722, illus. 1 Ag84Y

Drainage of irrigated lands. Discusses tile drains, knifing, open ditches, and drainage wells, in connection with the character of the soil and the topography.

473. TISDALL, A. L. Drainage of sub-soil water through bores to limestone beds. Commonwealth Engin. 27:59-61, illus., table. Sept. 1, 1939. 290.8 C73

A method for draining irrigated areas by means of a shaft drilled down to tertiary limestone strata, where the water is absorbed in the limestone.

474. TISDALL, A. L. Internal drainage investigation in South Australian irrigation districts. So. Austral. Dept. Agr. J. 45:398-402, illus. Feb. 1942. 23 So84

Research of major soil types to determine response to agricultural drainage, comparison between drains laid across and laid down the

main slope, depth and spacing of laterals.

475. TISDALL, A. L. A note on the use of drainage water. Austral. Council Sci. & Indus. Res. J. 14:260-263, illus. Nov.1941. 514 Au72J

Australia faces the problem of converting drainage water from the underground tiles of irrigated lands to newly developed agricultural lands in the Murray Valley where water for irrigation is lacking. The drainage waters must first be made salt free.

476. UNIQUE method of drainage devised by San Fernando grower. Calif. Citrog. 24:120, illus. Jan.1939. 80 C125

Stones and straw overcome poor drainage conditions in an over-irrigated lemon grove.

477. U. S. DEPT. OF AGRICULTURE. The salt problem in irrigation agriculture; research at the United States Regional Salinity Laboratory. U. S. D. A. Misc. P. 607, 27 p., illus. Aug.1946. Ref. 1 Ag84M

Good drainage is absolutely essential in removing soluble salts from the soil and in restoring alkali lands to production. Drainage implies a relatively permeable soil and the absence of a water table within a depth where it would influence the water retained in the root zone.

478. VLADIMIROV, A. G. Empirical formula for calculating the distances between drains in irrigated districts. (In Russian.) Vsesořuzn. Akad. Sel'skokhoz. Nauk im. V. I. Lenina. Dok. 17(9):44-48. illus., tables. 1952. Ref. 20 Ak1

479. WALKER, A. W. Drainage of irrigated lands. Civ. Engin. 8:733-734. Nov.1938. 290.8 C49

Drainage to prevent the accumulation of soluble salts that render land sterile.

480. WARDLAW, H. H., and MASON, F. R. An account of irrigation and drainage control on an area of dwarf coconuts. Malayan Agr. J. 24:421-431, illus., tables. Sept.1936. 22.5 F312

Includes planning of a drainage system, and depth and spacing of drains.

481. WARNICK, F. M., and GREENHALGH, W. H. Ground water and drainage problems of the Weber Basin project. Utah. Amer. Soc. Civ. Engin. Proc. 81(Separate 619), 7 p. Feb.1955. 290.9 Am3Ps

Excessive irrigation has caused drainage problems to develop in the lower areas of the Weber River Basin.

482. WEIR, W. W. Drainage in the San Joaquin Valley as it may be affected by the Central Valley project. Amer. Geophys. Union. Trans. 22:45-49. July 1941. 330.9 Am3

Old drainage situations, now partially alleviated by extensive pumping, will be aggravated to the point where they will again become serious. The whole drainage problem could be solved by withholding late-season gravity water to the extent that 25 or 30 percent of the annual requirement be pumped from deep wells.

483. WOOD, M. N. Almond culture in California. Calif. Agr. Ext. Serv. C. 103, 96 p., illus., tables. Jan.1937. 275.29 C12C

Water for irrigation is obtained by pumping from drainage ditches. The importance of well-drained soil in irrigated fields is discussed.

#### Peat and Muck Soils

484. ADAM, J. A modern approach to peat reclamation. New Zeal. Grassland Assoc. Proc. 15:166-173. 1953. 60.19 N48

Tile, mole, and open-ditch drainage of peat lands in New Zealand.

485. ALBERT, A. R. Status of organic soil use in Wisconsin. Soil Sci. Soc. Amer. Proc. 10:275-278, tables. 1945. 56.9 So3

Wisconsin has over two million undeveloped acres of peat and muck soils, and 429,000 acres of drained and developed peat and muck.

486. CARNES, A. Agricultural drainage and land use problems in the Southeastern region. *Agr. Engin.* 27:74-76, illus. Feb. 1946. 58.8 Ag83

The overdrainage of organic (peat) soils in Florida, Virginia, North and South Carolina, Georgia, Alabama, Mississippi, Kentucky, and Tennessee, has resulted in excessive subsidence and the actual burning of the soil. Drainage of inorganic soils is discussed also, and the necessity for making detailed studies of needs and methods before undertaking drainage jobs is stressed.

487. CARPENTER, J. C., and BARBER, E. S. Vertical sand drains for stabilization of muck-peat soils. *Amer. Soc. Civ. Engin. Proc.* 79(Separate 351), 17 p., illus. Nov. 1953. Ref. 290.9 Am3Ps

Primarily for road construction.

488. CLAYTON, B. S., NELLER, J. R., and ALLISON, R. V. Water control in the peat and muck soils of the Florida Everglades. *Fla. Agr. Expt. Sta. B.* 378, 74 p., illus., maps, tables. Nov. 1942. 100 F66S

The U. S. Soil Conservation Service and the Florida Agricultural Experiment Station, cooperating.

Covers pumping plants and their operating costs, farm ditches and subdrainage, mole drainage, and water-table studies.

489. CLAYTON, B. S. Water control in the peat soils of Florida. U. S. D. A. Mimeo. Rpt. 1077, 22 p., illus., tables. Feb. 1938. 1.9 En35Wa

Florida Agricultural Experiment Station and the U. S. Soil Conservation Service, cooperating.

To secure data applicable to peat land in Florida an area bordering Lake Okeechobee on the south was studied with respect to fluctuations of the water table, and amount and rate of subsidence of the land due to drainage.

490. DACHNOWSKI-STOKES, A. P. Peat land in the Pacific Coast States in relation to land and water resources. *U. S. D. A. Misc. P.* 248, 68 p., illus., maps, tables. Oct. 1936. Ref. 1 Ag84M

Drainage of peat land in the Western States has helped to lower the water table and added greatly to an ever-increasing demand for irrigation.

491. DAVIS, J. F., and HARRISON, C. M. Drainage ditchbank stabilization for organic soils. *Soil Sci. Soc. Amer. Proc.* 14:283-285, illus. 1949. 56.9 So3

Experiments with grasses and legumes as stabilizers of drainage ditchbanks in peat and muck soils, at Michigan State College's Muck Experiment Farm.

492. DAVIS, J. H. The peat deposits of Florida; their occurrence, development, and uses. *Fla. Dept. Conserv. Geol. B.* 30, 247 p., illus., maps, tables. Dec. 1946. Ref. 406 F66B

Drainage has decreased the area and the depth of peat and muck in the northern and central sections of the Everglades to an appreciable extent.

493. DJURLE, O. *Torvjordarnas sättning och torriagnings-torvjordarnas godalning.* Svenska Valli och Mosskultför. Kvrtlskr. 8:248-254, tables. July 1946. 11 Sv27

Drainage, settling, and fertilization of marshland in Sweden. Subsidence of drained peat lands is often so rapid that a second set of drains must be installed almost immediately after the first.

494. DOGGETT, D. Controlled drainage, *Outdoor Ind.* 17(6):14-15, illus. June 1950. 279.8 Ou82

Drainage to control the water table in muck and peat soils of Indiana.

495. DRISKELL, B. N., and LYTLE, S. A. Peat and muck types in the lower Mississippi Delta. (Abs.) *Assoc. South. Agr. Workers Proc.* 50:53-54. 1953. 4 C82

Investigations of the soil types in order to determine the suitability of various areas for drainage.

496. DUFFY, M. Mechanising peat handling. *Agr. Mach. J.* 8(8):37, illus. Aug. 1954. 58.8 Ag86

Equipment for draining peat soils in Ireland.

497. ELLIS, N. K., and MORRIS, R. Preliminary observations on the relation of yield of crops grown on organic soil with controlled water table and the area of aeration in the soil and subsidence of the soil. *Soil Sci. Soc. Amer. Proc.* 10:282-283, illus., tables. 1945. 56.9 So3

Problems of drainage of muck soils.

498. ELVEVE, J. T. The Florida Everglades— a region of new settlement. *J. Land & Pub. Util. Econ.* 19:464-469. Nov. 1943. 282.8 J82

Includes drainage of the region, which has permitted 110,000 acres of former muck and peat to be transformed into productive agricultural land.

499. GEITMAN, B. G. Relation of degree of peat bog drainage to climatic factors. (In Russian.) *Vsesoiuzn. Akad. Sel'skokhoz. Nauk im. V. I. Lenina. Dok.* 15(2):43-47. 1950. 20 Ak1

500. GOLIKOV, N. M. Peculiarities of the salt regime of peat and marshy Solonchak soils of Baraba in connection with drainage. (In Russian.) *Pochvovedenie* 6:338-347, tables. June 1951. Ref. 57.8 P34

Drainage by open drains.

501. HAGERUP, H. Forsøk med ulik sterk grøfting av myrjord. *Forsk. og Forsøk i Landbr.* 4:185-232, tables. 1953. Ref. 11 F772

Experiments with various degrees of drainage of peat soil in Norway. The effects of spacing and depth of daintiles on crop yield are discussed for several types of bog.

502. HARKER, D. H. Controlled drainage. *Agr. Engin.* 22:139-142, illus. Apr. 1941. 58.8 Ag83

A discussion of the distinction between controlled drainage and sub-irrigation, tile drainage and stopwells, with special reference to muck lands in Michigan and Indiana.

503. HARMER, P. M. Muck soil management for sugar beet production. *Mich. Agr. Expt. Sta. C. B.* 187, 20 p., illus., tables. Apr. 1943. 100 M58S

Includes drainage of muck lands.

504. HARMER, P. M. The muck soils of Michigan; their management and uses. *Mich. Agr. Expt. Sta. Spec. B.* 314, 128 p., illus., tables. Dec. 1941. 100 M58S

Includes a discussion of proper drainage, effects and prevention of excessive drainage, drainage outlets, and the use of tile drains.

505. HARRISON, R. W., and KÖLLMORGEN, W. M. Past and prospective drainage reclamations in the coastal marshlands of the Mississippi River Delta. *J. Land & Pub. Util. Econ.* 23:297-320, maps. Aug. 1947. Ref. 282.8 J82

Drainage of the peat soils of Louisiana for cultivation often causes shrinkage of the soil which results in reducing the elevation of already low areas to such an extent that levees are required to protect the reclaimed land from flooding.

506. İĀNGOL, A. M. Mole drainage in peat soils. (In Russian.) *Vsesoiuzn. Akad. Sel'skokhoz. Nauk im. V. I. Lenina. Dok.* 12:26-32, tables. 1940. 20 Ak1

Experiments with the effect of mole drainage at different depths and with varying distances between the drains on crop yields.

507. JONGEDYK, H. A., HICKOK, R. B., and MAYER, I. D. Changes in drainage properties of a muck soil as a result of drainage

practices. *Soil Sci. Soc. Amer. Proc.* 18:72-76, illus., tables. Jan. 1954. Ref. 56.9 So3'

Results of studies conducted at the Northern Indiana Muck Experiment Farm, Walkerton, Ind.

508. JONGEDYK, H. A., and others. Subsidence of muck soils in northern Indiana. *Ind. Agr. Expt. Sta. C.* 366, 11 p., illus., tables. Nov. 1950. 100 In2P

R. B. Hickok, I. D. Mayer, and N. K. Ellis, joint authors.

Tests on the minimization of subsidence by controlled drainage, at Northern Indiana Muck Experiment Farm.

509. KOLENCHENKO, D. High yields on reclaimed peat bogs. (In Russian.) *Kolkhoz. Proizvodstvo* 13(8):17-19, illus. Aug. 1953. 281.8 K83

510. LIE, O. *Torvindustri og myrkultivering i Skottland og Irland. Norske Myrselsk. Meddel.* 52:107-118, illus. Aug. 1954. 11 N813

The peat industry and bog culture in Scotland and Ireland. Includes drainage.

511. LUBKOV, A. I. Mechanization of work in drainage and reclamation of peat bogs and marshy lands. (In Russian.) *Dostizheniya Nauk. i Perekovogo Opyta v Sel'sk. Khoz.* 3:87-88. Mar. 1952. 20 D742

512. LUKKALA, O. J. *Soiden turvekerroksen painuminen ojittuksen vaikutuksesta.* Finland. *Metsätieteellisen Tutkimuslaitoksen Julkaisu.* 37(1), 67 p. Ref. 1949. 99.9 F493

On the settling of peat bogs as a result of drainage.

513. MALMTRÖM, C. *Skogedikning i Sverige.* K. Lantbrakad. *Tidskr.* 85:315-333, illus., tables. 1946. 104 Sw3

English summary.

Forest drainage in Sweden. Discusses conditions for successful drainage of peatland for afforestation.

514. MATSEPURO, M. E., and ZHILIN, A. P. *Kompleksnaya mehanizatsiya osushenija bolot i zagotovki torfa na udobrenie.* Minsk, Akademija Nauk BSSR, 1954. 186 p. Ref. 58 M42K

Complex mechanization of peat bog drainage and extraction of peat for fertilizer.

515. MATSEPURO, M. Mechanization of work in drainage and utilization of peat bogs and marshy lands. (In Russian.) *Mashinno-Traktornaya Sta.* 13(4):3-5. Apr. 1953. 58.8 M11

516. M'LAREN, J. The curse of Stirling. *Scot. Agr.* 33:13-16. Summer 1953. 10 Sco82So

Drainage problems in the peat soils drained by the Forth in Scotland.

517. MORRIS, R. E. Practical aspects of controlled drainage. *Agr. Engin.* 30:280-284, illus. June 1949. 58.8 Ag83

Includes discussion by D. H. Harker.

Results of controlled drainage experiments in muck soils of Indiana; ground-water movement in organic soils; controlled drainage practice; control structures.

518. NELLER, J. R., and FORSEE, W. J., JR. A lysimeter for organic soils. *Amer. Soc. Agron. J.* 34:345-352, illus., tables. Apr. 1942. Ref. 4 Am34P

In peat and muck soils, the proximity of the soil water table makes impractical the conventional method of collecting the percolate. Accordingly the lysimeters described in this paper were installed above the surrounding soil surface in a structure that was filled with soil.

519. NICHOLSON, H. H., ALDERMAN, G., and FIRTH, D. H. An experiment in the control of the ground water level in a Fen peat soil. *J. Agr. Sci.* 41:149-162, illus., tables. Jan. 1951. Ref. 10 J822

The effective control of ground-water level on a field scale requires deep commodious ditches and frequent large underdrains.

520. O'CONNOR, R. Bogs and their reclamation. *Agr. Ireland*

7:177, 179-180. Aug. 1950. 10.5 Ag8

Converting peat bogs to productive agricultural land in Ireland by drainage.

521. OGG, W. G., and ROBERTSON, I. M. The reclamation of moorland. 1-2. Empire J. Expt. Agr. 2:163-173; 8:56-64. Apr. 1934, Jan. 1940. 10 Em7

Drainage of peat soils in Scotland by means of open ditches, and by tile, box, and faggot underdrains.

522. OGG, W. G., and ROBERTSON, I. M. The reclamation of peat land in Lanarkshire. The Carnwath experiment. Scot. J. Agr. 23:56-62, map. July 1940. 10 Sco82So

An account of the character of the peat and the operations carried out, such as draining, liming, manuring, cultivation, and cropping.

523. PAIS, E. A. Ditch blasting reclaims swamp area. Explosives Engin. 29:148-149, 155-156, illus. Sept./Oct. 1951. Libr. Cong.

Wet, mucky bottom land in West Virginia is made useful by blasting with dynamite.

524. PUUSTJARVI, V., and JUUSELA, T. On rust precipitates present in drainage pipes and on the means of preventing their formation. Acta Agr. Scand. 2:131-152, illus., tables. 1952. Ref. 11 Ac82

Technical discussion of field and laboratory trials of drainage on peat soils in Finland.

525. ROE, H. B. The soil moisture and cropping problem of peat and muck lands in the northern United States. Minn. Agr. Expt. Sta. Sci. Paper 2032, 72 p., illus., tables. Jan. 1943. Ref. 1.9605 So38

Minnesota Agricultural Experiment Station and the U. S. Soil Conservation Service, cooperating.

Covers drainage of shallow peat over sand, silt, and clay; deep peat over silt, sand, or clay; treatment of free water under pressure beneath peat; spacing and depth of tile drains in deep peat; drainage outlets in peat soil; drainage of peat-swamp forest; mapping the drainage system; and tile used in peat soils.

526. ROE, H. B. A study of influence of depth of ground-water level on yields of crops grown on peat lands. Minn. Agr. Expt. Sta. B. 330, 32 p., illus., tables. Aug. 1936. Ref. 100 M66

Determination of the degree of drainage necessary for the production of the best practical results with field and horticultural crops in Minnesota peat.

527. RUSSELL, M. B. Predicting changes in water-table elevation in peat land. Agr Engin. 26:292, illus. July 1945. Ref. 58.8 Ag83

A method of calculating the rise or fall of the water table in peat soils following the addition or removal of a known amount of water from the profile. This information is useful in designing drainage or irrigation systems.

528. SALOHEIMO, L. Resultaten för åren 1931 - 1940 från avdikningsförsöken på kärrjord vid Finska Mosskulturföreningens Karelska försöksstation. Finska Mosskultfor. Årsb. 43:77-193, illus., tables. 1939, pub. 1940. 20 F493

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529. SEVERSON, H. Muck makes millions. Banking 40(2):50-51, 119-120. Aug. 1947. 284.8 Am3

How drainage has wrested thousands of acres of profitable agricultural land from the swamps of Florida's Everglades.

530. SHAFFER, F. F. The problems of controlled drainage for muck and peat lands. Milwaukee, U. S. Soil Conserv. Serv., Upper Miss. Region, 1946. 26 p., illus. Ref. 1.9605 P9422

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531. SKOROPANOV, S. G. Osushenie i sel'skokhoziaistvennoe osvoenie bolot v Belorusii. Moscow, Gosudarstvennoe Isdatel'stvo Sel'skokhoziaistvennoi Literatury, 1954. 130 p. 54 Sk5

Drainage and agricultural utilization of peat bogs in Belorussia.

532. STEPHENS, J. C. Drainage of peat and muck lands. U. S. D. A. Ybk. Agr. 1955:539-557. 1 Ag84Y

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533. SUBKOV, A. I. Mechanized drainage and reclamation of peat bogs and swampy lands. (In Russian.) Dostizheniya Nauk. i Peredovogo Opyta v Sel'sk. Khoz. 3:87-88, illus. Mar. 1952. 20 D742

534. SVADOVSKY, E. G. Deposition of peat and diminution of the depth of drainage canals in marshlands. (In Russian.) Vsesofuzn. Akad. Sel'skokhoz. Nauk im. V. I. Lenina. Dok. 23/24:56-59. 1939. 20 Ak1

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535. THOMPSON, F. B., and ELLIOTT, I. L. The development of peat land. New Zeal. J. Agr. 80:101-108, illus. Feb. 1950. 23 N48J

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536. THOMPSON, F. B., ELLIOTT, I. L., and ADAM, J. The development of peat soils. New Zeal. J. Agr. 84:4-5, 7-9, 10. Jan. 15, 1952. 23 N48J

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537. TIULENEV, N. A. Utilization of aeration drainage against dying out of legumes on drained peat soils. (In Russian.) Vsesofuzn. Akad. Sel'skokhoz. Nauk im. V. I. Lenina. Dok. 17(5):24-30. 1952. 20 Ak1

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538. VEEENENBOS, J. S. Infiltration in peat soils. Internat. Cong. Soil Sci. 4th Trans. 2:199-203, illus., table. 1950. Ref. 56.09 In844

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Soil-water conditions and crop yields on the experimental plots at Maasaja in 1939-44. Finnish research on the effects of open-ditch and underground drainage of peat soils on crop yields.

540. WILDE, S. A., TRACH, J., and PETERSON, S. F. Electro-chemical properties of ground water in major types of Wisconsin organic soils. Soil Sci. Soc. Amer. Proc. 14:279-281, illus., tables. 1949. Ref. 56.9 So3

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542. DUBAKH, A. D. Gidrotekhnicheskie melioratsii lesnykh zemel'. Moskva, Goslestekhizdat, 1945. 375 p.,illus. 290 D852G

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543. GAISER, R. N. Relation between soil characteristics and site index of loblolly pine in the Coastal Plain region of Virginia and the Carolinas. J. Forestry 48:271-275,illus.,tables. Apr.1950.

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Hand care of drainage ditches in Swedish forests.

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555. LØDDESØL, A. Forsumpingsfare i skogen som følge av myrenes vekst. Tidsskr. f. Skogbruk 57:166-169. May/June 1949. 99.8 T432

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565. SANTALIN, K. V. Drainage of swampy forest areas by the underground method. (In Russian.) Lesn. Khoz. 6(5):75-76. May 1953. 99.8 L5622

566. SCHLAUDT, E. A. Drainage in forestry management in the South. U. S. D. A. Ybk. Agr. 1955:564-568, illus. 1 Ag84Y

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567. STONE, E. L., MORROW, R. R., and WELCH, D. S. Wet sites and red pine. *Soc. Amer. Foresters. N. Y. Sect. N. Y. Forester* 8(2):9-11,illus. May 1951. 99.9 So13N

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568. THURMANN-MOE, P. *Aktuelle problemer i skoggrøftingen.* *Tidsskr. f. Skogbruk* 62:53-62,illus. Feb.1954. 99.8 T432

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569. THURMANN-MOE, P. *Mere fart i skoggrøftingen?* *Tidsskr Skogbruk* 58:24-26,tables. Jan./Feb.1950. 99.8 T432

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570. THURMANN-MOE, P. *Okt interesse for skoggrøfting.* *Skogieren* 38:198-199,tables. Dec.15,1951. 99.81 Sk5

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571. THURMANN-MOE, P. *Om bruk av grøftedynamitt til sprengning av skogsgrøfter.* *Norsk. Myrselsk. Meddel.* 46:134-140, illus.,tables. Dec.1948. 11 N813

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572. THURMANN-MOE, P. *Sprengning av skoggrøfter.* *Skogbrukeren* 24:78-79. Apr.15,1949. 99.8 Sk54

Experiments in blasting forest ditches in Norway.

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575. CAMPBELL, G. A. Anti-malaria drainage in Trinidad. *Engin. J.* 28:695-702,illus.,tables. Nov.1945. 290.9 En3

An account of drainage structures built at Point Fortin as a malaria control measure. Costs are included.

576. CARTER, A. N. Mosquito control practice in Panama. *Engin. News-Rec.* 133:560-563,illus. Nov.2,1944. 290.8 En34

Drainage of swamps by lined ditches.

577. CHWATT, L. J. *Anopheles gambiae melas* control by swamp drainage in a coastal zone of Nigeria, British West Africa. *Mosquito News* 9:56-68,illus.,tables. June 1949. Ref. 421 M85

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578. CLARKE, J. L. Inland control methods. *Engin. News-Rec.* 117:266-269,illus. Aug.20,1936. 290.8 En34

Drainage of swamp areas in the United States for mosquito control.

579. CONANT, V. Tide-gates on Bergen County marshes. *N. J. Mosquito Extermin. Assoc. Proc.* 37:194-198. 1950. 420 N46

Tidal marsh drainage in New Jersey.

580. CULVERTS for mosquito control. *Engin. News-Rec.* 124: 602-603,illus. Apr.25,1940. 290.8 En34

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mosquito-control drainage system in Tennessee.

581. DAVIS, H. E. Drainage canals aid mosquito control in TVA reservoir areas. *Engin. News-Rec.* 135:229-231, illus. Aug. 23, 1945. 290.8 En34

Swamps along edges of lakes, as well as depressions within fluctuation zones of impounded waters, are connected with deeper parts of reservoirs by drainage canals. Methods used in digging these canals are described, and unit costs are given.

582. DORER, R. E. Ditch lining in Virginia. *N. J. Mosquito Extermin. Assoc. Proc.* 26:152-154, illus. 1939. 420 N46

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583. GIES, R. W. Control technique and organization. *Engin. News-Rec.* 117:225-228, illus. Aug. 13, 1936. 290.8 En34

Drainage for mosquito control in New Jersey and New York.

584. GILROY, A. B., and CHWATT, L. J. Mosquito control by swamp drainage in the coastal belt of Nigeria. *Ann. Trop. Med. & Parasitol.* 39:19-40, illus., maps. May 31, 1945. Ref. 448.9 L75A

Reclamation of mangrove tidal swamps by diking and drainage is described.

585. HALL, T. F. Water level management for the control of *Anopheles quadrimaculatus* in the Tennessee Valley. *N. J. Mosquito Extermin. Assoc. Proc.* 38:84-91. 1951. Ref. 420 N46

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586. HAY, A. K., and TWINN, C. R. Mosquito control in the Ottawa district. *Water & Sewage* 78(7)12-13, 48-50, illus. July 1940. 290.8 C16B

Draining and spraying wet mosquito-breeding spots to control disease.

587. HENDERSON, J. M. Minor residual drainage. *Calif. Mosquito Control Assoc. Proc. & Papers* 17:78-81. 1949. 428 C763

Drainage for mosquito control.

Discusses grade of ditch bottom, slope of ditch banks, and avoidance of erosion and silting within the ditch cross section by means of grassing and lining.

588. HENDERSON, J. M. Mosquito-control practice with DDT. *Engin. News-Rec.* 140:1034-1037, illus., tables. June 24, 1948. 290.8 En34

Effect of DDT compared with the efficacy of drainage.

589. HENDERSON, J. M. Principles of minor drainage for mosquito control. *N. J. Mosquito Extermin. Assoc. Proc.* 36:104-114, illus. 1949. 420 N46

Since mosquito control drainage generally seeks only to remove water from the ground surface, it differs from most agricultural drainage which seeks to lower the ground-water table. Principal considerations in mosquito drainage are grade of ditch bottom, slope of ditch banks, and avoidance of erosion and silting in the ditch, all of which factors are discussed in detail.

590. HESS, A. D., and LUDVIK, G. F. Mosquito control by the Tennessee Valley Authority. *N. J. Mosquito Extermin. Assoc. Proc.* 36:91-97, illus. 1949. 420 N46

Includes control of the water level in rivers by the construction of drainage ditches connecting marginal depressions and swampy areas to the main river reservoir.

591. JOBBINS, D. M. The relationship of water management and drainage to other forms of mosquito control. *N. J. Mosquito Extermin. Assoc. Proc.* 38:66-71. 1951. 420 N46

592. JOINT COMMITTEE OF THE NATIONAL MALARIA COMMITTEE AND THE SANITARY ENGINEERING DIVISION OF THE

AMERICAN SOCIETY OF CIVIL ENGINEERS. Malaria control for engineers. Amer. Soc. Civ. Engin. Proc. 65:229-274. Feb. 1939. Ref. 290.9 Am3P

Includes drainage for malaria control, ditching specifications, ditch lining, culverts, filling, ponds, ditch construction, barricades, and explosives.

593. JONES, G. P. Mosquito source reduction in the Marin County Mosquito Abatement District. Calif. Mosquito Control Assoc. Proc. & Papers 20:65-66. 1952. 428 C763

Marshland drainage in California.

594. LAFFERTY, O. W. A successful outlet for drainage channels through sand beaches. N. J. Mosquito Extermin. Assoc. Proc. 31:68-72, illus. 1944. 420 N46

595. LEPRINCE, J. A. Malaria and the Mississippi Valley. Engin. News-Rec. 117:404-405. Sept. 17, 1936. 290.8 En34

Includes drainage by ditching. Ditch maintenance is discussed.

596. LUDWIG, B. H. Dynamite spells doom for insect menace. Explosives Engin. 25:119, illus. July/Aug. 1947. Libr. Cong.

Blasting ditches to drain stagnant pools in Utah for mosquito control.

597. MYERS, L. E., JR. The relationship of agricultural drainage to mosquito control. Calif. Mosquito Control Assoc. Proc. & Papers 20:75-76. 1952. 428 C763

Good mosquito control is difficult in any agricultural area where poor drainage conditions exist.

Discusses surface drainage for drying up wet spots on farms where mosquitoes breed, as well as subsurface drainage for lowering the water table in irrigated lands and in swamps.

598. NÁJERA ANGULO, L. A luta anti-larvar: agentes biológicos e recursos simili-naturais. Inst. de Med. Trop. (Lisbon) An. 2: 275-327, illus. Dec. 1945. Ref. 448.9 L68

Control of mosquito larvae by ditch drainage, with examples from many parts of the world.

599. PARKER, W. V., and JOHNSON, H. A. A universal type concrete slab for precast ditch linings. Pub. Health Rpts. 60:582-587, illus. May 25, 1945. 151. 65 P96.

Developed at the National Institute of Health, Malaria Investigations, Memphis, Tenn., with three objectives in view: (1) To produce a universal slab that would fit into the usual plan of linings; (2) To make the slabs of such size and shape that one man could handle them; and (3) To form a joint surface on the slab that would discourage the penetration of vegetation.

600. PITMAN, E. P. Developments projected by the Port of New York Authority which may influence the mosquito work in the Newark Bay region. N. J. Mosquito Extermin. Assoc. Proc. 35:105-109. 1948. 420 N46

Sand drains to be constructed in the marshy lands between Elizabeth and Newark, N. J., for the purpose of enlarging the Newark Airport, will serve to ameliorate the mosquito menace in the area.

601. POWERS, G. E. Mosquito control on an enclosed salt marsh. N. J. Mosquito Extermin. Assoc. Proc. 38:76-80. 1951. 420 N46

Year-round program for maintaining ditches and drainage pumps in Union County, N. J.

602. PRECAST liners for drainage ditches. Engin. News-Rec. 123:231-232, illus. Aug. 17, 1939. 290.8 En34

A precast slab for lining ditches, easy to make and install, is developed in Florida for mosquito control.

603. PRICE, M. The effects of the September hurricane on mos-

quito ditches. N. J. Mosquito Extermin. Assoc. Proc. 26:125-127. 1939. 420 N46

Repairing ditches after the hurricane cost the State of Rhode Island \$25,000.

604. RAINES, M. B. Good irrigation vital in mosquito control. Agr. Engin. 36:185-187, 191, illus. Ref. Mar. 1955. 58.8 Ag83

Stresses the importance of proper drainage of irrigated lands to prevent the collection of stagnant irrigation water where mosquitoes might breed.

605. RECTOR, N. H. The use of ditch linings, underground drains, and sanitary fills for malaria and mosquito control. Calif. Mosquito Control Assoc. Proc. & Papers 13:96-106, 1944. Ref. 428 C763

606. REILEY, F. A. Water management and drainage in open salt marsh areas for mosquito breeding control. N. J. Mosquito Extermin. Assoc. Proc. 38:71-76. 1951. 420 N46

Experience of the Atlantic County, N. J., Mosquito Extermination Commission, in digging and maintaining drainage ditches in swamps.

607. ROBERTSON, J. L., and others. Observations on experimental malaria control drainage ditch linings. Pub. Health Rpts. 57: 451-463, illus. Mar. 27, 1942. 151.65 P96

J. A. LePrince, H. A. Johnson, and W. V. Parker, joint authors.

Results of a study conducted by the Office of Malaria Investigations of the Public Health Service. Discusses plain and reinforced monolithic concrete linings, precast concrete slab linings, brick and brickbat linings, and sodding the ditchbanks above the linings.

608. SMITH, E. A. Drainage for mosquito source reduction. Calif. Mosquito Control Assoc. Proc. & Papers 20:62-63. 1952. 428 C763

The Merced County, Calif., Mosquito Abatement District enlists the aid of farmers in reducing mosquito breeding places in irrigated fields.

609. THOM, W. A permanent improvement in the drainage of Dismal Swamp. N. J. Mosquito Extermin. Assoc. Proc. 35:95-97. 1948. 420 N46

A new method, using scoops and a muck pump, of cleaning, digging, and maintaining drainage ditches for mosquito control in New Jersey's Dismal Swamp.

610. THE USE of precast concrete ditch lining for malaria control in Chatham County, Georgia. Amer. City 56(10):42-43, illus. Oct. 1941. 98.58 Am31

Installation and maintenance costs of drainage ditches lined with concrete.

611. VANNOTE, R. L. Fresh water swamps with reference to surface drainage. N. J. Mosquito Extermin. Assoc. Proc. 38:80-84. 1951. 420 N46

Properly executed and maintained drainage forms the backbone of the mosquito-control program either by permanently removing breeding waters, or by so reducing their scope as to make more temporary methods of chemical control effective.

612. WILLIAMS, L. L. Effective malaria control. Engin. News-Rec. 117:341-343, illus. Sept. 3, 1936. 290.8 En34

Drainage of ponded swamps chiefly by means of ditches.

613. WILMOT, R. S. Malaria control in Assam. Civ. Engin. 16(2):60-61. Feb. 1946. 290.8 C49

Drainage operations are described.

614. WILSON, R. J. Experiences in the U. S. Public Health Service and in mosquito control in California. N. J. Mosquito Extermin. Assoc. Proc. 36:101-104. 1949. 420 N46

Primarily the control of mosquitoes in the New Orleans, La., area,

by the construction of levees, the installation of culverts, and the dynamiting of miles of ditches.

Compares the problem in Louisiana to that in California, where drainage is a less practical method of mosquito control.

### DRAINAGE PRACTICES

615. ARNOULD, C. L'assainissement agricole et le drainage. Chambres d'Agr. 25(49):3-8. Apr. 1, 1954. 14 T69  
 Agricultural improvement and drainage in France. Includes drainage technique and costs.

616. AVERIANOV, S. F. A system of drainage construction. (In Russian.) Vsesoiuzn. Akad. Se'skokhz. Nauk im. V. I. Lenina. Dok. 13(2):40-45. 1948. 20 Ak1

617. AYRES, Q. C. Relationship between engineering and agro-nomic practices in soil and moisture conservation. Agr. Engin. 19: 167-169. Apr. 1938. 58.8 Ag83  
 Drainage is considered, and the preparation of newly drained land for crop production is discussed.

618. BAIJOT, S. Le drainage. Soc. Cent. d'Agr. de Belg. J. 100(5), 28 p. 1952/53. 13 So1  
 Section headings include: What is drainage?; Advantages of good drainage; When to drain; Drainage systems; Mechanized drainage; Costs.

619. BANTING, A. Drainage problems in land use. Agr. Inst. Rev. 9(2):54-56, illus. Mar./Apr. 1954. 7 Ag8  
 Tile and surface drainage.

620. BARNES, A. C. Field drainage for sugar cane lands an important aspect of cultivation. So. African Sugar J. 35:389, 391, 393. June 1951. 65.8 So8  
 Describes equipment for and method of testing for moisture in the soil, and discusses all types of drainage in use in other countries with a view to their possible application in the sugarcane fields of Natal and Zululand.

621. BENDER. Dränung auf schweren böden. Hannoversche Land. u. Forstwirt. Ztg. 108:1051-1052; 1085-1086; 1116, illus. July 23-30, Aug. 6, 1955. 18 H194  
 Drainage of heavy soils in Germany.

622. BLOOM, A. Drainage and irrigation. Garden 1:635-636. Feb. 1955. 80 G1637  
 Drainage of small garden plots by ditching and tile.

623. BOER, T. A. DE. Restoration of inundated grasslands. Internat'l. Grassland Cong. Rpt. 5:166-171. 1949. 60.19 In85R  
 Includes discussion.  
 Land flooded by salt water in the Netherlands.  
 Describes the steps needed in reclamation of each species of grass considered. In most cases the first necessity is drainage, followed by tillage and extra manuring.

624. BORDEN, J. W. Grading and smoothing for land drainage. Sugar 49(2):31-33, illus. Feb. 1954. 65.8 F11  
 Grading and smoothing correct excess surface water conditions but must be supplemented with adequate ditching or tile systems for effective year-round drainage.

625. BOURQUE, L. Les terres noires et l'humidité (le drainage—l'irrigation). Agriculture [Montreal] 4:265-271, illus., tables. Sept. 1947. 7 Ag82  
 Drainage experiences in New York, New Jersey, and Ohio are cited as examples for the improvement of the black agricultural lands of Quebec.

626. BOWDEN-SMITH, E. C. Tidal sluice gates for sea-walls and land drainage. *Engineer* 195:240-242, illus. Feb. 13, 1953. Libr. Cong.

Tidal sluice gates constructed by the English monasteries in the Middle Ages are still doing service as aids in land drainage.

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Drainage experiments at the Escola Superior de Agricultura at Minas Gerais will include drainage systems, spacing and dimensions of ditches, types of drains, and the biological, chemical, physical, and economic effects of drainage.

729. NICHOLSON, H. H. Field drainage and increased production. *Roy. Agr. Soc. Eng. J.* 109:212-221, tables. 1948. 10 R81

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730. NICHOLSON, H. H. Fundamental problems of land drainage. *Power Farmer* 9:156-158, illus. Nov.1952. 58.8 P872

Discusses the merits of tile, mole, and surface drainage from the standpoint of maintenance.

731. NICHOLSON, H. H. Groundwater control in reclaimed marshland. *World Crops* 3:251-254, illus. July 1951. 281.8 W892

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732. NICHOLSON, H. H. Land drainage. In Hunter, H., ed. *Farming handbook No. 3*, p. 26-28, illus. Norwich, Jarrold, 1945. 10 F2272

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733. NICHOLSON, H. H. Modern field drainage. *Roy. Agr. Soc. Eng. J.* 104:118-135. Dec.1943. 10 R81

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735. NICHOLSON, H. H. The problem of field drainage. Farmers' Club, London. J., 1947(4):44-57. 10 L84

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736. NIELSEN, K. M. Det mindre landbrugs draeningsproblemer. *Husmandshjemmet* 47:16, illus. Nov.20, 1951. 11 H963

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737. NIELSEN, V. Draeningsforsøg på marskjord, 1937-1948. *Tidsskr. f. Planteavl.* 55:621-644, tables. 1952. 11 T439

Drainage experiments on marshland in Denmark.

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Drainage of marshland in Gotland.

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H. F. McColly, L. L. Scranton, and G. C. Cook, joint authors.

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746. PICHLER, J. On the control of surface waters in Hungary. (In Hungarian.) *Vizugyi Kozlem* 4:451-466. Ref. 1954, pub., 1955. 290.9 H89

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In Utah.  
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A system of plowing is described which serves as a drainage system on badly drained land in Australia.

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828. COPLEY, T. L. Improved row system for terraced fields. Agr. Engin. 23:95-96, illus. Mar. 1942. 58.8 Ag83

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Methods of mole and tile drainage are discussed and a new type of plow for laying tile drains is described. Describes also a dragline digger for cleaning outfalls of open drainage systems.

1050. DAHLGREN, N. Tackdikning med dikosplög. *Lantmannen* 28:394. Apr. 22, 1944. 11 L234

Subsoil drainage with ditch plows. Mole drainage in Sweden.

1051. \*DEEMTER, J. J. VAN. Results of a mathematical approach to some flow problems connected with drainage and irrigation. *Appl. Sci. Res. A2(1):33-53.* 1949.

1052. DENISENKO, T. A. The influence of subsoil water pressure on the flow of underground drains. (In Russian.) *Vzessofuzn. Akad. Sel'skokhoz. Nauk im. V. I. Lenina. Dok.* 16:18-21, tables. 1940. 20 Ak1

1053. DESIGN and construction of tile drains in humid areas. *Agr. Engin.* 34:472-480, 485, illus., tables. July 1953. 58.8 Ag83

ASAE recommendation prepared as a guide to engineers in the design and construction of tile drains, particularly as a basis for writing detailed specifications for a particular job. Not applicable to drainage of irrigated lands.

1054. DRAINING sandhills swamps. *Land Impr.* 2(5):12-14, illus. May 1955. 282.8 L224

Tile drainage of marshes in the cattle-raising region of Nebraska.

1055. DRAINING swamp lands with vertical drains. *Contract. & Engin. Mon.* 33(5):5, 26, illus. Nov. 1936. 290.8 C765

California experiments with gravel and rock-filled vertical and horizontal drains in reclaiming swamps north of Oakland.

1056. EDMINSTER, T. W., WALKER, J. P., and LILLARD, J. H. Tile drainage under quicksand conditions. (Abs.) *Assoc. South. Agr. Workers Proc.* 48:176. 1951. 4 C82

Experiments undertaken in Virginia to develop satisfactory methods of overcoming problems of installation and maintenance of tile drains in quicksand are described.

1057. EGGERS, H. W. T. Laying tile drains. *New Zeal. J. Agr.* 77:373-374, illus. Oct. 1948. 23 N48J

Certain principles in hydraulics must be observed if tile drainage is to be successful. Discusses hand-constructed drains laid during winter, and machine laying of tiles during dry weather.

1058. ELECTRICAL drainage of fine soils. (Abs.) *Pub. Works* 73(9):40. Sept. 1942. 290.8 M922

An electro-osmotic process for draining fine loess, silt, and clay, developed in Hanover, Germany.

1059. ENGELHARDT, J. H. Het probleem van de drainagediepte. *Overijsselsch Landbbl.* 33(1592):12, illus. Feb. 17, 1951. 12 Ov2

The problem of drainage depth. Tiles are discussed.

1060. EVDOKIMOVA, V. I. Strengthening the walls of mole drains by physico-chemical methods. (In Russian.) *Gidrotekh. i Melior.* 4(3):48-61, illus., tables. Mar. 1952. Ref. 290.8 G362

1061. FEIX, E. Das graben von rohrentwässerungen. *Bauer* 5(39):9-11, illus. Nov. 8, 1952. 19 B32

Ditches for drainage pipes in Austria.

1062. \*FERGUSON, F. L. Farm underdrainage. *Ontario Agr. Col. B* 360 rev., 21 p., illus. 1946. 101 On8B

1063. FRIDSTROM, A. E. Dränering—ett viktigt arbete.

\*Not examined.

Sveriges Pomol. För. Fruktodlaren, 6:178-179, illus. 1947. 86 Sv2F  
 Drainage of orchards in Sweden by tile drains and wells.

1064. FURNEAUX, B. S., Land draining. Country Landowner 6:169-174. June 1955. 10 C836  
 Covers pipe, or tile, drainage, and mole-drainage practices in England. Building of outfalls and their maintenance, and maintenance of tile and mole systems are discussed.

1065. GALLETTI, A. C. Qualche cosa di nuovo sulla "fognatura" del terreno. Colt. e Gior. Vinic. Ital. 98:367-368, illus. Sept. 1952. 16 C72  
 Something new in the drainage of land. An inexpensive method of draining with baked earth in Italy.

1066. GALPIN, A. J. Quality in drain tiles. New Zeal. J. Agr. 79:24, July 15, 1949. 23 N48J  
 Strength is more important than porosity.

1067. GARBOUA, M. Importance du drainage en Egypte. Egypte Agr. 50:161-168. Sept./Oct. 1952. 24 Un32  
 The superiority of covered to open drains in Egyptian agriculture.

1068. GARDNER, C. H. Market gardening on heavy land. Gt. Brit. Min. Agr. Agriculture 53:389-392. Dec. 1946. 10 G79J  
 The aeration of heavy land by mole drainage to a depth of two feet keeps the topsoil well drained while providing adequate reserves for drier periods, so great is the storage capacity of a 2-ft. soil.

1069. GAYFORD, G. W. Orchard drainage. Victoria. Dept. Agr. J. 42:147-149, illus. Apr. 1944. 23 V66J  
 Recommends tile drainage, and discusses details of construction.

1070. GERMANY. REICHSMINISTERIUM FÜR ERNÄHRUNG UND LANDWIRTSCHAFT. Anweisung für die Planung, Ausführung und Unterhaltung von Dränanlagen. Ed. 6. Berlin, Springer, 1941. 70 p., illus., tables. 54 G312  
 Drainage of marshlands, and types of drainpipe required.

1071. GLOTOV, M. N. Efficiency of mole drains. (In Russian.) Vsesofuzn. Nauk im. V. I. Lenina. Dok. 2:43-48, tables. 1940. 20 Ak1  
 Experiments in maintaining satisfactory moisture conditions in the soil in wet and dry weather with mole drainage.

1072. GT. BRIT. MINISTRY OF AGRICULTURE AND FISHERIES Drainage of the farm homestead. Gt. Brit. Min. Agr. L. 21, 19 p., illus., tables. June 1954. 10 G7944  
 Includes drainage of surface water from the farmyard by means of underground pipes.

1073. GROUT, A. R. Tile drainage for Pennsylvania farms. Pa. State Col. Agr. Ext. C. 413, 20 p., illus., tables. Mar. 1953. 275.29 P38C  
 Discusses underdrainage, tile drainage, installation of tile, cutting laterals, protection of outlets, surface inlets, and pipelines.

1074. HAEGERMARK, F. Ingen lantbrukare här angrat att han tackdikat sin gård. Lantmannen 28:318-319, illus. Apr. 1, 1944. 11 L234  
 No farmer regrets having inaugurated subsoil drainage. Tile drainage in Sweden.

1075. HAGEM, K. Grøfting og grøftepriser. Norsk Landbr. 13: 411-414, illus. Oct. 10, 1947. 11 N8122  
 Ditches and cost of ditches in Norway.

Considers pipe, tile, and wood underdrains, and mole drains, and concludes that mechanical ditching for subsurface drainage is cheaper than hand labor in Norway.

1076. HAKANSSON, A. Tubuleringsmetoden vid dränering av akerjord. Svensk Jordbrforsk. 1951:25-33, illus. 11 J763  
 The tubulation method in the drainage of arable land. Mole drainage, its history, cost, equipment, and suitability on marshland in Sweden.

1077. HALLGRÉN, G. De statliga dräneringsförsöken. Svensk Jordbr. Forsk. 1948:17-28, illus. 11 J763

The state drainage experiments, Sweden. The research has to do with alterations in the depth and distances of tile drains and their effect on yields.

Also, with title Försöksverksamheten på täckdikningens område, in Lantmannen 32:351-352, illus. May 22, 1948. 11 L234

1078. HAMBLYN, C. J. Mole drainage. New Zeal. J. Agr. 70: 363, 365-373, illus. Apr. 16, 1945. 23 N48J

Practical details of a technique evolved by a North-Island farmer that is efficient and has made durable drains. The mole is pulled to and from the outlets. Provision of proper connections between subsidiary mole drains acting as outlets is an important feature. Equipment and costs are discussed.

Also in New Zeal. Dept. Agr. B. 170, 15 p., illus. 1945. 23 N48Bu

1079. HAMBLYN, C. J., and GALPIN, A. J. Mole drainage in the Manawatu. New Zeal. J. Agr. 55:230-242, illus. Oct. 20, 1937. 23 N48J

Covers layout, drawing the moles, linking outlet drains with intermediate mole drains, permanent outlets, renewal of mole drains, depth of drains, the time to drain, and costs.

1080. HAMBLYN, C. J. Trials with shallow, smallbore mole drains. New Zeal. J. Agr. 80:534, illus. June 1950. 23 N48J

The smaller mole proves successful under certain conditions in New Zealand. The drains are shallow. The smaller bore can be used with lighter tractor equipment.

1081. HARBORD, W. L. The mole or plough drain. New Zeal. J. Agr. 58:432-433, illus. May 1939. 23 N48J

Discusses the construction of mole drains, their depth, and costs of mole drainage.

1082. HARDING, S. W., and WOOD, J. K. Model tests of flow into drains. Soil Sci. Soc. Amer. Proc. 6:117-119, illus. 1941. 56.9 So3 Research at the Utah Agricultural Experiment Station.

1083. HART, R. A. Profundidad de los drenajes de "la hacienda". Campesino 71:72-76, illus. Feb. 1939. 9.3 So12

Soil factors affecting the optimum depth for tile drains in Chile.

1084. HARVEY, N. Relics of a great achievement; some veteran deep-drainage schemes. Land Agents' Soc. J. 54:475-477, Oct. 1955. 282.9 L22

An account of stone and tile drainage systems, laid down in the 19th century, which are still doing service in England.

1085. HASWELL, J. R. Drain the wet spots. Pa. Agr. Ext. C. 112, rev., 34 p., illus. May 1943. 275.29 P38C

Covers: The selection of tile for efficiency, size, and quality; the spacing and depth of tile drains; construction of the drainage system; cost of tile drains; ditching equipment; outlets; and Pennsylvania drainage laws in force.

1086. HASWELL, J. R. Principles of tile drainage. Agr. Engin. 21:310, 316, illus. Aug. 1940. 58.8 Ag83

Deals with random drainage where each foot of tile is laid to secure maximum returns. Describes a drainage-depth-demonstrator device.

1087. HASWELL, J. R. Some tile drainage experiences. Agr. Engin. 30:81-83, 85, illus. Feb. 1949. 58.8 Ag83

Dynamite ditching and other phases of tile draining in Pennsylvania since the First World War.

1088. HEIMPEL, L. G. Underdrainage. Macdonald Col. J. 4(1): 4-5, 11, illus. Sept. 1943. 101 M144

Tile drainage in Quebec.

1089. HERRMANN, H. Die durchführung von moormeliorationen. Allgäuer Bauernbl. 17:534-535. Sept. 22, 1949. 18 AL53

Drainage of marshland in Germany is possible with woodbox drains. Pipes are more expensive.

1090. HEYNDRICKX, G. A. De stroming van het water in drainbuizen en de berekening van hun afvoer. Gent. Landbhugesch. Meded. 19:271-309. June 1954. Ref. 105.1 G344

English summary, p. 308-309.

The flow of water in tile drains and the computation of their discharge.

1091. HOCK, O. W. Now they are using moles to drain farm lowlands. Better Farming Methods 27(6):28-29, illus. June 1955.

58.8 B46

Mole drainage of heavy muck soils in Florida and heavy clay and gumbo soils in Louisiana and Minnesota.

1092. HOOCHOUT, S. B. Tile drainage and sub-irrigation. Soil Sci. 74:35-48, illus., tables. July 1952. Ref. 56.8 So3

Discusses practical operation of tile drainage and the relation of tile and mole drainage to precipitation, relation of soil permeability to water control, and determination of layout of drainage in the Netherlands.

1093. HOPEWELL, H. G. Mole drainage investigations in New Zealand. 2. Report on investigations of some methods of connecting minor mole drains to major mole drains. New Zeal. J. Sci. & Technol. 35A:237-244, illus., tables. Oct. 1953. Ref. 514 N48A

Four methods were studied, of which the McLeod method proved most effective. It involves pulling the major mole drain across the minors at the same depth and at right angles.

For Pt. 1 see item 1101.

1094. HOPEWELL, H. G. Mole drainage investigations in New Zealand. 3. Investigation to determine the effect of increasing the thickness of the mole plough blade or knife. New Zeal. J. Sci. & Technol. 35A:245-248, tables. Oct. 1953. Ref. 514 N48A

1095. HOPEWELL, H. G. Tile drainage investigations in New Zealand. 1. Interim report on investigations into the effect of various methods of refilling tile trenches. New Zeal. J. Sci. & Technol. 35A: 249-261, illus. Oct. 1953. Ref. 514 N48A

Report of a drainage experiment in which four different methods of refilling tile drain trenches were compared on the basis of drain outflows.

1096. HORE, E. R., and KIDDER, E. H. Water table drawdown characteristics. Agr. Engin. 35:396-398, illus., tables. June 1954. Ref. 58.8 Ag83

A comparative study of four field methods of water-table observation in clay loam soil. An evaluation and discussion of a new depth and spacing formula for lateral tile drains is presented also.

1097. HOWALD, R. Maulwurfs-drainage. Grüne 77:635-643. June 17, 1949. 17 Sch9

Mole drainage in Switzerland.

1098. HUDSON, A. W. Drainage as a factor in increasing production. New Zeal. Grassland Assoc. Proc. 13:139-148, illus. 1951. 60.19 N48

Recommends tile draining over open-ditch draining for grasslands of New Zealand, as ditches are dangerous to livestock and are expensive to maintain. Discusses costs and returns from tile drainage, and describes a drainage-ditch trowel and excavator suitable for use in Taranaki.

1099. HUDSON, A. W. Even at present costs drainage can pay off handsomely as long term investment. New Zeal. Dairy Exporter 27(8):31, 33. Feb. 1952. 44.8 N484

Costs and financing of draintiles in New Zealand, and how to estimate the net return to be expected from draining wet land.

1100. HUDSON, A. W., and HOPEWELL, H. G. Mold drainage in New Zealand. Massey Agr. Col. B. 11, 91 p., illus. Dec. 1940. Ref. 109 M38B

Covers: History of mole drainage; types, operation and maintenance of mole plows; soils suited to mole drainage; inflow and outflow of water in drains; depth, size, length, and spacing of mole drains; and direction and gradient of drains.

1101. HUDSON, A. W., and FIFE, C. V. Mole drainage investigations in New Zealand. 1. The profiles of some mole-drainage soils and their relation to the depth of mole drains. New Zeal. J. Sci. & Technol. 42A:197-208, illus. Dec. 1940. Ref. 514 N48A

Results of experiments give emphasis to the necessity of studying the soil profile and underlying parent material when planning drainage.

1102. FANGOL, A. M. Moistening reclaimed marshes with the aid of mole drains. (In Russian.) Vsesofiuzn. Akad. Sel'skokhoz. Nauk im V. I. Lenina Dok. 20(2):35-40. 1955. 20 Ak1

1103. ILLINOIS. UNIVERSITY. COLLEGE OF AGRICULTURE. EXTENSION SERV. Physical requirements for drain tile. Ill. Agr. Col. Ext. A Eng 605, 3 p., tables. Oct. 18, 1949. 275.29 IL62Pa

ASTM specifications for draintile (C4-24).

Includes formulas for number of acres that can be drained per 100 feet of tile by size.

1104. JACOBSEN, J. Wooden drain pipes. Mon. B. Agr. Sci. & Pract. 27:197. May 1936. 28 In8Mo

A Danish invention expected to be effective in Finland.

1105. JACOBSEN, P. Keep your tile drains working. U. S. D. A. L. 347, 8 p., illus. Jan. 1954. 1 Ag84L

Cleaning outlets, controlling tree roots and small animals, repairing blowouts, and mapping the tile system.

1106. JENSEN, H., and JAKOBSEN, J. M. Om forandringer af okkerdannelse i draenrør ved hjælp af kobber. Hedeselsk. Tijdschr. 67:81-86, illus., table. Apr. 20, 1946. 11 H35

On the change of ocher formation in drainage pipes through the aid of copper. Danish research to determine the effect of water on drain pipes.

1107. JOFFE, J. S., and KRUEGER, W. C. Surface swamping and its treatment. N. J. Col. Agr. Ext. B. 215, 7 p., illus. Feb. 1940. 275.29 N46

Vertical drains made by digging, boring, or blasting.

1108. JONES, H. I. Tackling the problem of underground seepage. Soil Conserv. 20:130-131, 134, illus. Jan. 1955. 1.6 So3S

Deep tile drainage of three crop farms in Colorado promises to increase yields in years to come.

1109. JUUSELA, T. Myyraojituksesta ja sen käytäntöihollisuuk-sista suomessa. Suomen Maataloustiet. Seura. Maataloustiet. Aika-kausk. 22:152-163. 1950. Ref. 20 Su7M

English summary, p. 163.

On the possibilities of using mole draining in Finland,

1110. JUUSELA, T. Salaojasyyvyyksymyksen selvittelyä. Suomen Mattaloustiet. Seura, Maataloustiet. Aikakausk. 19:60-68, table. 1947. Ref. 20 Su7M

Pipe drainage methods in Sweden and Finland. Covers size and depth of pipe.

1111. JUUSELA, T. Salaojituskoetoiminnasta sumoessa. Suomen Maataloustiet. Seura. Maataloustiet. Aikakausk. 25:113-135, illus., tables. 1953. Ref. 20 Su7M

English summary, p. 132-135.

Deep drainage trials in Finland. Investigations were concerned with different drainage methods, drain depth, and numbers of drains per area unit.

1112. KAITERA, P. Peltojen salaojituksesta, 1-2. Suomen Maataloustiet. Seura. Maataloustiet. Aikakausk. 23:1-31; 24:79-84, illus., tables. 1951-1952. Ref. 20 Su7M

English summary.

On the underdrainage of fields. Finland. The author points out that the cost of drainage in Finland, particularly of tiles, and the scarcity of drainage machinery, has hindered the progress of agricultural drainage. An inexpensive method of drainage with sifted gravel for mineral and peat soils is described in Pt. 1.

1113. KANNENBERG, H. Über die maulwurfsdrainage und ihre auswirkungen. Landwirtbl. Weser-Ems 96:203-204. Mar. 24, 1949. 18 L2345

On mole drainage and its effects in Germany.

1114. KARSTENS, G. A., and HARKER, D. H. Farm drainage in ten easy lessons. Purdue Ext. B. 269, 16 p., illus., table. 1950. 275.29 In2E

Depth and spacing of tiles, slope of drains, headwalls, surface inlets, laying the tile, backfilling, and maintenance of the drainage system.

1115. KESO, L., and KAITERA, P. Salaojitusmenetelmästä. Suomen Maataloustiet. Seura. Maataloustiet. Aikakausk. 23:164-181; 24: 79-84. 1951, 1952. Ref. 20 Su7M

English summary at end of each part.

On methods of underdrainage in Finland. Deals with the determination of fall, depth of drains, and choice of drain tile.

1116. KIDDER, E. H., and CUTLER, W. A. It pays to buy good drain tile. Mich. State Col. Agr. Ext. Folder F-166, 8 p., illus., table. Feb. 1952. 275.29 M58Ex

Clay versus concrete tile, and ASTM standards.

1117. KING, J. A., and LYNES, W. S., Tile drainage. Ed. 4. Mason City, Iowa, Mason City Brick & Tile Co., 1946. 129 p., illus. 54 K582

Covers history, costs, and benefits of tile drainage, and discusses the drainage of peat soils, types of outlets, location, size, type, depth and spacing of tile drains, and tile trenching machines.

1118. KIRKHAM, D. The artificial drainage of land; the artesian basin. 1-3. Amer. Geophys. Union Trans. 20:677-680; 21:587-593; 26:393-406, illus. Aug. 1939, July 1940, Dec. 1945. Ref. 330.9 Am3

Demonstration and analysis of the case of flow into horizontal, equally spaced drains, first, when the water originates solely from an artesian aquifer below the drains, and, second, when both artesian and surface water are flowing into the drains.

1119. KIRKHAM, D., and SCHWAB, G. O. The effect of circular perforations on flow into subsurface drain tubes. 1.-2. Agr. Engin. 32: 211-214, 270-274, illus. Apr.-May 1951. Ref. 58.8 Ag83

Pt., 1, Theory; Pt. 2, Experiments and results.

Includes mathematical equations.

The order of the authors' names is reversed in Pt. 2.

1120. KIRKHAM, D. Flow of ponded water into drain tubes in soil overlying an impervious layer. Amer. Geophys. Union. Trans. 30:369-385, June 1949. Ref. 330.9 Am3

On the assumption that uniform, water-saturated soil covered by ponded water, and overlying an impervious layer is drained by equally spaced circular drain tubes at equal depth, two sets of expressions for the velocity potential, stream potential, the drain flux, and the surface inflow distribution are derived. The results are of practical interest in the problem of artificial drainage of land and in the problem of leaching.

1121. KIRKHAM, D. Potential flow into circumferential openings in drain tubes. J. Appl. Phys. 21:655-660, tables. July 1950. 334.8 P563

A theoretical analysis of the effect of the spaces between drain tube units as used in the artificial drainage of soil is given.

1122. KIRKHAM, D. Pressure and streamline distribution in water-logged land overlying an impervious layer. *Soil Sci. Soc. Amer. Proc.* 5:64-68, illus. 1940. 56.9 So3

Some concepts of flow into drains, illustrated by experiments with models. Research in Utah.

1123. KRIVONOSOV, I. M. Drainage of swampy mineral soils with draining tiles combined with mole drains. (In Russian.) *Gidrotekh. i Melior.* 6(4):15-23. Apr. 1954. 290.8 G362

1124. KUPPER. Entwässerung mit dem maulwurpfleg. *Landwirt. Z. der Nord-Rheinprov.* 119:850-851, illus. Aug. 9, 1952. 18 L2344

Drainage with the mole plow. Discusses costs and construction.

1125. KUUM, IU. Method of constructing closed drainage in Estonian SSR with the aid of a trench digger. (In Russian.) *Gidrotekh. i Melior.* 6(12):54-55. Dec. 1954. 290.8 G362

1126. LALLOY. Drainage et sous-solage. *Génie Rur.* 45:155-158, illus. May 1952. 58.8 Au8

Ditching and mole drainage in France. Describes equipment.

1127. LAPIDES, YITZHAQ, and BAUM, U. A mole drainage experiment at Hazorea settlement. (In Hebrew.) *Hassadeh* 24:290-292, illus. May 1944. 26 H27

Israel.

1128. LARSON, C. L. How to judge drain tile quality. *Minn. Farm & Home Sci.* 11:5, 9, illus. Oct. 1953. 100 M668

To be rated as extra-quality, drain tile must support at least 1,600 pounds per foot, and have an absorption of 8 percent or less.

1129. LARSON, J. E. Construction of underdrains. n.p., 1946. 5 p., table. 54 L32

Details of construction in western Oregon.

1130. LEVITT, E. C. Irrigation and drainage in coastal citrus orchards. *Agr. Gaz. N. S. Wales* 58 (1):21-22. Jan. 1, 1947. 23 N472

Tile pipes are recommended for underdrainage. Interception and "spot" drains are explained, and spacing and depth of tile are discussed.

1131. LUECKE, H. N. Special drainage along Ohio Turnpike to protect farm tilling. *Roads & St.* 96(7):73-76, 79-81, illus. July 1953. 288.8 R536

Supplemental design criteria pertaining to: The alterations and reconstructions of existing agricultural drainage systems affected by the construction of the Ohio Turnpike; the consideration which must be given to the design of turnpike drainage ditches when agricultural drainage is an influencing factor; and provisions which must be made for future agricultural drainage.

1132. LYNES, W. S. Concrete bulkheads for outlet protection. *Agr. Engin.* 27:459-460, illus. Oct. 1946. 58.8 Ag83

Tile drainage outlets. A survey of drainage systems in Webster County, Iowa.

1133. MCCLURG, V. O. Heavy-duty clay tile drains. *Engin. News-Rec.* 131:263, illus. Aug. 12, 1943. 290.8 En34

Tiles of 3,600 pounds per linear foot crushing strength were produced to withstand heavy equipment at a building site in Ohio.

1134. MCCULLOCH, R. Bog reclamation in Galway. *Agr. Ireland* 9:225-227. Oct. 1952. 10.5 Ag8

Mole drainage.

1135. MCCULLOCH, R. Mole draining. *Irish Agr. & Creamery Rev.* 14(138, n. s.):13-15. June 1945. 44.8 C866

Tile drainage costs are compared with those of mole drainage and the systems are described. For land unsuitable for mole draining,

excavators or trench cutters are recommended.

1136. MACPHERSON, H. N. Creosoted wood-stave drainage pipes on George VI Highway. Roads & Bridges 79(12):19, 54, illus. Dec. 1941. 290.8 C16A

Particulars of a 1200-foot creosoted wood-stave pipe installed in existing side ditches to enable the road to be widened to four lanes. British Columbia.

1137. MALYGIN, V. S. A deep closed drainage system. (In Russian.) Tashkent, Sovuznizhni, 1939. 122 p., illus., tables. 54 M29

English summary.

Depth and spacing of drains in Turkestan.

1138. MANSON, P. W., and MILLER, D. B. Essential characteristics of durable concrete drain tile for alkali soils. Agr. Engin. 29: 485-487, 489, illus., tables. Nov. 1948. 58.8 Ag83

Admixtures and coatings were found to be inadequate for the protection of concrete in alkali soils in experiments conducted by the University of Minnesota Department of Agricultural Engineering. Tests showed that curing in water vapors at temperatures in excess of 212° F. increased the sulfate resistance of concrete.

1139. MANSON, P. W. Importance of drain tile testing. Minn. Farm & Home Sci. 12(20):14, 17, illus. Feb. 1955. 100 M668

Clay and concrete tiles tested by the State of Minnesota for use in different types of soils.

1140. MANSON, P. W., and MILLER, D. G. Making durable concrete drain tile on packer-head machines. Minn. Agr. Expt. Sta. B. 426, 16 p., illus., tables. May 1954. 100 M66

Appendix regarding supporting strengths of drain tile, p. 14-16.

1141. MANSON, P. W., and MILLER, D. G. Practical aspects of drain tile durability. Agr. Engin. 35:717-718, 725, illus., tables. Oct. 1954. Ref. 58.8 Ag83

Recommendations for tiles subject to freezing, alkali, or acid conditions.

1142. MANSON, P. W. Sulphate resistance of 94 commercial cements. Agr. Engin. 21:135-137, illus., tables. Apr. 1940. 58.8 Ag83

Studies to determine the extent of sulphate resistance of 94 brands of concrete drain tile.

1143. MARKWICK, A. H. D., and DOBSON, A. F. Application of electroosmosis to soil drainage. Engineering 163:121-123, illus. Feb. 7, 1947. 290.8 En322

Research into a method of drainage of silty soils.

1144. MAYO, K. L. Installation of effective mole drainage. New Zeal. J. Agr. 90:395-399, illus. Apr. 15, 1955. 23 N48J

On clay soils in New Zealand. Mole plows, depth and distance apart of mole drains, life of drains, effects of drainage, and costs, are discussed.

1145. MILLER, D. G., and MANSON, P. W. Durability of concretes and mortars in acid soils with particular reference to drain tile. Minn. Agr. Expt. Sta. Tech. B. 180, 80 p., illus., tables. June 1948. Ref. 100 M66

Partial contents: Ch. 2, Experimental drain tile in peats and mineral soils; Ch. 3, Experimental concrete and mortar cylinders in peats and mineral soils; Ch. 4, Comparison of results of drain tile and cylinders

1146. MILLER, D. G., and MANSON, P. W. Essential characteristics of durable concrete drain tile for acid soils. Agr. Engin. 29: 437-441, illus., tables. Oct. 1948. 58.8 Ag83

Tests of some 1,100 commercial and experimental tiles made in peat soils of Minnesota and Wisconsin, and in an acid mineral soil in North Carolina.

1147. MILLER, D. G., and SNYDER, C. G. Expansion of clay and concrete drain tile due to increase of temperature and moisture

content. Agr. Engin. 25:179-180, illus., tables. May 1944. 58.8 Ag83  
Studies show that clay tile is affected not at all by moisture and temperature, and concrete only slightly.

1148. MILLER, D. G. Improving drain-tile resistance to alkali conditions. Agr. Engin. 17:513-515, 544, illus., tables. Dec. 1936. 58.8 Ag83

Cement curing in draintile manufacture.

1149. MILLER, D. G., and MANSON, P. W. Longtime performance of some clay draintile. Agr. Engin. 32:95-97, 100-101, tables. Feb. 1951. 58.8 Ag83

Report on tests of frost-resisting properties of clay tile installed at shallow depths in farm drainage systems in the Upper Mississippi Valley. "Clay draintile" means burned product of clay or shale.

1150. MILLER, D. G., and MANSON, P. W. Long-time tests of concretes and mortars exposed to sulfate waters. Minn. Agr. Expt. Sta. Tech. B. 194, 111 p., tables. May 1951. Ref. 100 M66

Gives results of tests of draintiles made with portland cement and with alumina cements.

1151. MOHRMAN, K. J. M. Draineren. 1-3. Nederland. Heidermaatsch. Tijdschr. 58:338-340, 362-367; 59:3-7, illus. Nov. 1947-Jan. 1948. 12 N282

Pts. 2-3 have title Drainage.

Discusses the drainage layout in the Netherlands. Cost, equipment, laying and selection of tiles, depth and spacing of draintiles, equipment for hand labor, and trenching for tile drains.

1152. MOLE drainage. New Zeal. J. Agr. 73:253, 255, illus. Sept. 1946. 23 N48J

Use of small plugs at shallow depths for draining seasonal wetness from New Zealand fields.

1153. MOLE drainage procedure. Agr. Mach. J. 8(3):46, 54. Mar. 1954. 58.8 Ag86

Its effectiveness depends on the quality of the soil, the quality of the bore of the mole, and the grading of the channel.

1154. MORRIS, W. Tile drainage in the U. S. A. Farm Mech. 4: 354-356, illus. Sept. 1952. 58.8 B722

Includes equipment.

1155. MUIRHEID, B. F. Buying good drain tile. Ill. Agr. Ext. C. 696, 6 p., illus., table. July 1952. 275.29 1162C

Judging soundness, regularity, density, and strength.

1156. MURAYAMA, S. J. Drenos de bambus. Rev. de Agr. [Piracicaba] 22:323-325. Nov./Dec. 1947. 9.2 R324

The use of bamboo drains in Brazil.

1157. NICHOLSON, H. H. Drainage development in Britain. Worcestershire Agr. Chron. 11:323, 325, 327, 329, 331. Nov. 1943. 10 W892

History of drainage since 1750, and the evolution of draintile.

1158. NICHOLSON, H. H. Field drainage; its fundamental importance. Times Trade & Engin. (n.s.) 48(924):28. Feb. 1941. 286.8 T482  
Renovation of old tile drains, and mole draining in England.

1159. NICHOLSON, H. H. Field drainage problems. 1-8. Estate Mag. 43:211-212; 237-238; 258-259; 289-290; 318-320; 44:12-14; 41-43; 69-70. Aug. 1943-Mar. 1944. 10 Es8

Pt. 2, The design of field drainage systems; Pt. 3, Drain tiles; Pt. 4, Tile draining; Pt. 5, The mole plough; Pt. 6, Mole draining; Pt. 7, The scope of mole draining; Pt. 8, The best time for draining work.

1160. NICHOLSON, H. H. The importance of mole draining in present circumstances. J. Min. Agr. Agriculture 46:671-676. Dec. 1939. 10 G79J

Drainage and food production — costs, methods, and equipment.

1161. NICHOLSON, H. H. Mole drainage for heavy land. Gt. Brit.

Min. Agr. "Growmore" L. 44, 8 p., illus. 1940? 10 G79Gr  
 Includes equipment, costs, the mole plow, and installation of mole drains.

Slightly condensed in Worcestershire Agr. Chron. 9:145, 147, 149, 151, 153, illus. Aug. 1941. 10 W892

1162. NICHOLSON, H. H. Some problems in field drainage. Scot. J. Agr. 25:213-219. Jan. 1946. 10 Sco82So  
 Includes historical matter as well as modern methods of mole and tile drainage in Great Britain.

1163. NICHOLSON, H. H. Tile draining; sit back for a season and watch. Power Farmer 10:126-128, illus. Apr. 1953. 58.8 P872  
 Locating and renovating old tile systems and giving them a chance to work, before installing new systems. Relates to England.

1164. OLSEN, J. T. Orchard drainage. Fruit Grower 58:10, 19, 23, illus. Apr. 1938. 80 G85  
 Discusses tile drainage, surface inlets, and the problem of roots clogging drains. Includes testing for drainage by soil borings.

1165. OVERHOLT, V. Farm drainage. Farm Q. 2(1):40-45, 103-104, illus., tables. Spring 1947. 6 F22995  
 Covers planning the drainage layout, depth and spacing, hand and traction ditching, grading for a tile line, installing the tiles, drainage outlets, and maintenance of the system.

1166. PEARCE, O. W. M. Nitrogen and drainage. So. African Sugar Technol. Assoc. Proc. 24:77-82. 1950. 65.9 So83  
 Includes discussion.  
 French drains remove the minimum of plant nutrients from the soil. Their construction is described and their merits compared with those of shallow open drains.  
 Also in So. African Sugar J. 34:387-393. 1950. 65.8 So8

1167. PEARSON, C. H. O. Mole drains and their uses; their practicability in the Sugar Belt. So. African Sugar J. 35:625, 627, 629, illus. Oct. 1951. 65.8 So8  
 Mole drains are preferred to open ditches for draining valley bottoms and clay lands. Layout, equipment, and depth of the drains are discussed.

1168. PIJLS, F. W. G. Drainage in de tuinbouw. Netherlands. Dir. van de Tuinbouw. Meded. 12:709-716. Aug./Sept. 1949. 86 N384  
 English summary, p. 716.  
 Drainage in horticulture. Recommends pipe drainage.

1169. PIPE drains stop an earth slide. Engin. News-Rec. 128: 539-540, illus. Apr. 9, 1942. 290.8 En34  
 Drainage of an earth slide near San Francisco by putting down vertical holes from which perforated drainpipes allow escape for ground water.

1170. POWERS, W. L. The durability of concrete drain pipe. Agr. Engin. 29:77. Feb. 1948. 58.8 Ag83  
 The effect of alfalfa roots and of acid soil on concrete.

1171. RAMSAUER, B. Die Maulwurfdränung. Bodenkultur 6: 170-195, illus., tables. 1952. Ref. 19 B635  
 Mole drainage in Austria. Technique, machinery, and layout in relation to soil type are discussed.

1172. RECORD well-point installation used to drain exposition site. West. Constr. News 13(6):209-212, illus. June 1938. 290.8 W522  
 The salt-water level over 300 acres was lowered by drainage preliminary to landscaping the site of the Golden Gate International Exposition.

1173. RESHETKINA, N. Vertical drainage of saline lands of Uzbekistan. (In Russian.) Khlopkovodstvo 5(5):47-50. May 1955. 72.8 K522

1174. RIDDOLLS, A. W. Mole drainage. Canterbury Chamber Com. Agr. B. 264, 4 p., illus. July 1951. 23 C162  
 Discusses the mole plow, conditions suitable for mole drainage, action of mole drains, spacing, diameter, and depth of mole drains, and economic factors in mole drainage.

1175. RIDDOLLS, A. W. Tile drainage. Canterbury Chamber. Com. Agr. B. 297, 6 p., illus. Apr. 1954. 23 C162  
 Covers materials for drains, action of tile drains, diameter, fall, depth, and distance apart of tile drains, laying the tiles, backfilling, surface inlets, outlets, joining mole drains to tile drains, and tile drainage systems, costs, and returns.  
 Also in Power Farming Austral. & New Zeal. 63(7):11, 133-135, illus. July 1954. 58.8 P87

1176. RIDIGER, V. Mineralization of excreta in mole drains. (In Russian.) Vsesofuzn. Akad. Sel'skokhoz. Nauk im. V. I. Lenina. Dok. 10(9/10):34-38. 1945. 20 Ak1  
 To enable the sewage water to be used direct in mole drains without preliminary purification, for manuring fields.

1177. RIDIGER, V. R. The use of mole drains without reinforced walls in the leaching of saline soils. (In Russian.) Vsesofuzn. Akad. Sel'skokhoz. Nauk im. V. I. Lenina. Dok. 12(1):38-41. 1947. 20 Ak1

1178. RIDIGER, V. R., and DOLGOV, S. I. Utilization of deep mole drains in the improvement of saline soils. (In Russian.) Vsesofuzn. Akad. Sel'skokhoz. Nauk im. V. I. Lenina. Dok. 17(8):44-46, illus. 1952. 20 Ak1  
 Excavation by traction through the soil, in sawlike fashion, of a steel cable between two boreholes followed by attachment of the mole to the cable.

1179. SAVESON, I. L. Some factors affecting mole drains. Agr. Engin. 27:316, 320, illus. July 1946. 58.8 Ag83  
 Paper presented at the meeting of the Southwest Section of the American Society of Agricultural Engineers, Ft. Worth, Tex., Apr. 1946.  
 Observations on mole-drained sugarcane areas in Louisiana in 1944.

1180. SCHILDKNECHT, H. Reclamation in Switzerland. Reclam. Era 34:65-66, 76, illus. Apr. 1948. 156.84 R24  
 Tile drainage of swamps for food production during the war.

1181. SCHMITT, E. A., and MACQUEEN, P. O. Perforated-pipe underdrains for rapid sand filters. Amer. Waterworks Assoc. J. 34: 857-876, tables. June 1942. 292.9 Am32J  
 Discussion by E. A. Hardin, p. 875-876.

1182. SCHROEDER, G. Die dränung. In his Landwirtschaftliche wasserbau, p. 186-234, illus., tables. Berlin, Springer, 1937. 290 Sch72  
 Includes drainage of mineral and marsh soils, tile and mole drainage, and costs in Germany.

1183. SCHWAB, G. O. Plastic tubing for subsurface drainage. Agr. Engin. 36:86-89, 92, illus. Feb. 1955. Ref. 58.8 Ag83  
 A five-year research study points up the feasibility of perforated plastic tubings in mole drains at a cost as little as 30 percent of the cost of tile drains.

1184. SCHWAB, G. O. Subsurface drainage with small perforated flexible tubes in mole drains. Iowa State Col. J. Sci. 26:285-286. Jan. 1952. 470 Io9  
 Abstract of thesis (Ph.D.) — Iowa State College, 1951.  
 Experiments with perforated polyethylene drain tubes indicate that in general tile drains would be required for main and subdrains, while plastic tubes would be suitable for laterals.

1185. SEARLE, K. D., and STEWART, D. Land reclamation on the shores of the Great Salt Lake. Land Impr. 2(7):16-17, illus. July 1955. 282.8 L224

Laying 6- and 8-inch tile in a single operation that includes digging the trench, laying the tile to grade, and providing the gravel envelope around the tile.

1186. SEIDEMANN, J. Planung und erhaltung der kulturtechnischen anlagen in den landwirtschaftlichen produktionsgenossenschaften. Deut. Akad. Landwirtwiss. Schrreihe. f. die Landwirt. Produkgenos-sensch. 10, 18 p.,illus. 1953. 18 D4825S

Planning and maintaining agricultural installations in agricultural production cooperatives. Primarily tile drainage systems.

1187. SHAFER, F. F. Causes of failure in tile drains. Agr. Engin. 21:17-18,20. Jan.1940. 58.8 Ag83

Among the causes of failure are the quality of the tiles themselves, improper design of ditches, faulty laying of tile in the ditches, lack of inspection and maintenance of the system, and quality of the soil.

1188. SHAFER, G. E., and KROFF, W. J. Probable life of corrugated culverts. Engin. News-Rec. 135:504-506,illus. Oct.18,1945. 290.8 En34

Corrugated pipes and arches for use in drainage structures.

1189. SHOJI, H., and MORISHIMA, S. On the past and present under-drain at Kyushu. (In Japanese.) Nogyodoboku-Kenkyu 16:2-9, illus. Oct.1948. Ref. 290.8 N68

1190. SISSON, D. R. Tiling for 30,000. Land Impr. 2(11):15,35, illus. Nov.1955. 282.8 L224

The Indiana Drainage Contractors Association demonstrates equipment and methods for draining seventeen acres of poorly drained clay farmland.

1191. SLATER, C. S. The depth and spacing of tile drains. Agr. Engin. 31:448-450,illus. Sept.1950. Ref. 58.8 Ag83

A formula is derived for the calculation of drain spacing.

1192. SPANGLER, M. G. The structural design of flexible pipe culverts. Iowa Engin. Expt. Sta. B. 153,84 p.,illus.,tables. Dec.1941. Ref. 290.9 Io9

For underground drainage of airports, roadbeds, and highways.

1193. STEIN, C. Die beherrschung des wasserhaushalts im boden durch eine kombinierte untergrund-ent-und -bewässerungsanlage. Deut. Landwirt. 2:259-263. May 1951. 18 D4822

Discusses depth of pipe drains in respect to future maintenance. Bitumen pipes are preferred because they can be nearer the surface of the soil.

1194. STEIN, C. Nene gesichtspunkte bei der landwirtschaftlichen ent- und bewässerung. Wasser u. Boden 2:209-212,illus. Oct.1950. 56.8 W28

New viewpoint on agricultural drainage and irrigation in Germany. Describes method for connecting pipe with asphalt.

1195. STRINGER, N. E. Mole ploughing as applied to irrigated swamp areas. So. Austral. Dept. Agr. J. 45:283-286,illus. Dec.1941. 23 So84

Mole drains may be used in swamp areas provided the soil is plastic enough to hold the drain. Depth and spacing of the moles varies according to the type and condition of the soil. Benefits and costs are discussed.

1196. SUBDRAINAGE with Toncan drainage products. Cleveland, Toncan Culvert Mfg. Assoc.,1939. 31 p. 54 T61

Requirements of pipes for farm drainage included.

1197. SUTTON, J. G. How to plan a tile drainage system. Washington,U. S. Soil Conserv. Serv.,1942. 11 p.,illus. 1.96 Op2Ho

Address prepared for the American Society of Agricultural Engineers, Southwest Section, Shreveport, La., Apr. 3, 1942.

Covers location of tile lines, capacity of tile drains, depth and spac-

ing of tiles, computation of flow in drains, surface inlets, outlet protection, and tile drains on irrigated lands.

1198. SUTTON, J. G. How to plan a tile drainage system. Washington, U. S. Soil Conserv. Serv., 1948. 17 p., illus., tables. 1.96 Op2Ho

Includes benefits of tile drainage, surface drains, location and capacity of tile lines, depth and spacing of tile drains, alignments and connections, joints, trenching, blinding, outlets, and supplemental structures.

1199. SUTTON, J. G. Tile drainage. Washington, U. S. Soil Conserv. Serv., 1954. 9 p. Ref. 1.96 OP2Sut

A discussion prepared for training meetings of the Engineering Division of the U. S. Soil Conservation Service, May 1954.

Discusses benefits of and need for tile drainage, planning the system, depth and spacing of drains as related to soil permeability, quality of tile, ASTM specifications, and visual inspection of tile.

1200. TAMAYO, J. L. Algunas ideas sobre la conservacion de obras de riego. Irrig. Mex. 22:155-175, 427-465, illus., tables. Mar./Apr., Nov./Dec. 1941. 55.8 Ir76

Some ideas on the maintenance of irrigation works. Includes a discussion of drainage structures, especially pipes in Mexico.

1201. TATARINOVA, N. K. Mole drainage on meadows of excessively mineral soils in the non-Black soil area. (In Russian.) Sotsfalist. Zhivotnovod. 12(6):15-19, illus., tables. June 1950. 49 So71

1202. TRUSS, P. Effect of mole drainage and subsoil plowing on water-salt process in soils, and yields under conditions of Baraba. (In Russian.) Pochvovedenie 4:62-68. Apr. 1955. Ref. 57.8 P34

Cereals.

1203. U. S. SOIL CONSERVATION SERV. Laying tile by hand. U. S. Soil Conserv. Serv. J. S.-40, 2 p., illus. June 1953. 1.9605 J11

Setting crossbars, digging trenches, laying the tile, and filling the trench.

1204. VALENTIN, J. Assainissement des terres dans la région de l'ouest. Potasse 20:153-154, illus. May 1946. 57.8 P84

Land drainage in the west of France. Primarily tile drainage.

1205. VAN BAVEL, C. H. M. Will this soil drain? Crops & Soils 2(7):10-11, illus. Apr./May 1950. 6 W55

Determining soil permeability for spacing of drain tiles.

1206. VAN SCHILFGAARDE, J. Analytical and empirical evaluation of water table behavior as affected by drainage systems. (Abs.) Iowa State Col. J. Sci. 29:524-525. Feb. 15, 1955. 470 Io9

Abstract of Thesis (Ph.D) — Iowa State College, 1954.

A field laboratory investigation of the effect of the depth and spacing of tile drains on the rate of drawdown of the water table.

1207. VAN SCHILFGAARDE, J., FREVERT, R. K., and SCHLICK, W. J. Effect of present installation practices on drain tile loading. Agr. Engin. 32:371-374, 378, illus., tables. July 1951. 58.8 Ag83

Most of the tile installed with modern equipment is at moderate depths not subject to excessive loading.

Comment on this article by R. Chen in Agr. Engin. 32:600. Nov. 1951. 58.8 Ag83

1208. VAN SCHILFGAARDE, J., FREVERT, R. K., and KIRKHAM, D. A tile drainage field laboratory. Agr. Engin. 35:474-478, illus. July 1954. Ref. 58.8 Ag83

Discusses an attempt to find an empirical criterion for the appropriate selection of the depth and spacing at which tile lines should be placed in different soils. Methods and equipment used in the study are described.

1209. VAN VLACK, C. H., and NORTON, R. A. Tile drainage for increased production. Iowa Agr. Expt. Sta. B. P65, 31 p., illus. June 1944. 100 Io9

Practical details of all aspects of tile drainage including notes on management practices which improve drainage conditions. Sketches and illustrated descriptions of layouts, operations, implements, outlets, and a surface inlet are given.

1210. VILLENEUVE, G. O. *L'utilité du drain. Forêt Québécoise* 14:231-232. Apr. 1949. 99.8 F79

Necessity of tile drains to lower a high water table. Some directions for selecting and laying tile are given. Recommends grading to a slope for the tile system.

1211. VISSER, W. C. Tile drainage in the Netherlands. Netherlands J. Agr. Sci. 2:69-87, illus., tables. May 1954. 12 N3892

Section headings include: Physical determination of the permeability content; Pedological assessment of permeability; Physical determination of correct distance between the drains; Planning a tile-drainage system; Tile diameter; Type of tile; Hydraulic gradient; Composite drainage; The criterion of discharge; Execution; Maintenance; and Future development.

1212. VOGELZANG, H. *Ontwatering van grasland. Nederland. Heidemaaitsch. Tijdschr.* 62:290-293, illus. Nov. 1951. 12 N282

Drainage of grasslands. Brush, pipe, and mole drains are discussed, and a trenching machine is described.

1213. WAGNER, V. J. Drainage problems — how to tackle. Queensland Fruit & Veg. News 5:390-391. Apr. 1, 1954. 280.38 Q3

Cost of mole and tile drainage in Australia.

1214. WALKER, C. Management of poaching soils. New Zeal. J. Agr. 78:365-367, illus. Apr. 1949. 23 N48J

Drainage of muddy soils in New Zealand. Underground drainage, tile or mole, is recommended.

1215. WEBB, C. T., and HICKMAN, W. D. Tile solves problem in Palouse. Soil Conserv. 19:283-285, illus. July 1954. 1.6 So3S

Tile drainage of hard clay soils in Washington and Idaho.

1216. WESSELING, J., and WIJK, W. R. VAN. Optimal depth of drainage. Netherlands J. Agr. Sci. 3:106-118, illus. May 1955. Ref. 12 N3892

A technical discussion of tile drainage depth in clay and sand soils for maximum crop production in the Netherlands.

1217. WESSELING, J. Tile drainage research. Netherlands J. Agr. Sci. 2:254-259, table. Nov. 1954. Ref. 12 N3892

A résumé of tile-drainage research covering spacing, depth, effect on soil temperature and moisture evaporation, and agricultural effects of drainage.

1218. WIANCKO, A. T., WALKER, G. P., and ROBBINS, C. The tile drainage experiment. Ind. Agr. Expt. Sta. C. 244:5-6, tables. May 1939. 100 In2P

An experiment designed to determine the value of tile drainage, and the most practical size, depth, and spacing, of tiles in this Indiana soil.

1219. WIKLANDER, L. *Om järnutfällning i täckdikesledningar. Lantbr. Akad. Tidskr.* 84:358-367, tables. 1945. Ref. 104 Su3

German summary.

Oxidation of divalent iron and subsequent precipitation in drainpipes may seriously disturb the operation of drainage installations. The harmful effects of iron bacteria can be minimized by sloping the conduits at a steep angle, by putting the mouth of the drain below the water table, or by using copper nets in the pipes or copper casings at the pipe joints, thereby poisoning the iron bacteria.

1220. WOODWARD, G. O., and MILLER, W. MCN. A study of soil-water movement by electroosmosis. Agr. Engin. 34:29-33. Jan. 1953. Ref. 58.8 Ag83

"This paper was prepared for the purpose of assimilating the major-

ity of published references dealing with the electrical treatment of soils. It is intended as general information for persons who may become associated with what appears to be a developing interest in the possibility of electrical drainage of agricultural lands," p. 29.

1221. ZWERMAN, P. J. Problems of drainage in a soil and water conservation program. *J. Soil & Water Conserv.* 6:185-186, 199, illus. Oct. 1951. 56.8 J822

The most intensively drained areas in the United States are discussed in general, with particular attention to Tiffin, Ohio. Details of a tile drainage system are given, including depth and spacing of tiles, and the effect of poor drainage on crops.

### Pump Drainage and Wells

1222. AUGMENTED Fen drainage scheme. *Oil Engine & Gas Turbine* 18:88-90, illus. July 1950. Libr. Cong.

Gwynne flow pumps in England.

1223. BANKS, H. O., and RICHTER, R. C. Sea-water intrusion into ground-water basins bordering the California coast and inland bays. *Amer. Geophys. Union Trans.* 34:575-582, map. Aug. 1953. Ref. 330.9 Am3

The erection of dikes and pumping stations is among the solutions offered for the salinification of ground water in California.

1224. BARRON, R. A. Consolidation of fine-grained soils by drain wells. *Amer. Soc. Civ. Engin. Proc.* 73:811-835, illus. June 1947. 290.9 Am3P

Complete formulas for consolidation by vertical and radical flow to wells, for cases with or without peripheral smear and drain-well resistance, are presented..

Discussed in *Amer. Soc. Civ. Engin. Proc.* 74:153-158, 707-710, 875-878. Jan., May-June 1948. 290.9 Am3P

1225. BELL, R. A new approach to drainage. *Ga. "Ag. Engin."* 24:15, 28-30. 1953. 290.9 G29

Drainage of low-lying lands in Georgia by means of dug wells 200 feet deep.

1226. BISAL, F. Siphon drainage in the Hyde-Park-Benson area, Cache Valley, Utah. *Soil Sci.* 67:395-401, illus. May 1949. 56.8 So3

Proposed siphon-connected well-drain system for relieving hydrostatic pressure of an artesian aquifer.

1227. BOONENBURG, K. De windmolens van Nederland. *Tijdschr. v. Econ. Geog.* 37:300-307, illus., tables. Oct. 15, 1946. 280.8 T44 Windmills on the Netherlands polders.

1228. BUSQUET, J. C. Large pumps for drainage and irrigation. *Way Ahead* 5:24-29, illus. 1955. 280.8 W362

Centrifugal pumps, propeller pumps, and pumping stations in the Netherlands.

1229. BUTLER, C. Problems of a present day homesteader. *Natl. Reclam. Assoc. Proc.* 18:72-76. 1949. 55.9 N212

Includes drainage by sump wells drilled through lava rock until a crack is found that will carry off the waste water.

1230. CAMPBELL, R. D. Eldred Drainage and Levee District installs two more diesels. *Diesel Power* 18:855-858. Oct. 1940. 291.8 D562

Eldred, Ill. Drainage pumps.

1231. CAMPBELL, R. D. Keach Drainage and Levee District. *Diesel Prog.* 6(12):34-35, 48-50. Dec. 1940. 291.8 D56

Drainage pumping plant in Illinois.

1232. CLARK, R. G. St. Germans sluice and pumping station. *Inst. Civ. Engin. J.* 6:377-392. Apr. 1936. 290.9 In74J

Revamping old drainage works in Cambridgeshire in England's Fens, and the construction of sluiceways and three new pumping units.

1233. CLASSEN, A. G. Practical aspects of flood control and reclamation of overflowed lands. *Tex. Reclam. Dept. B.* 27,80 p.,illus. Dec.1935. Ref. 54.9 T31

Includes drainage, sluice gates, and pumping plants.

1234. CLAY, C. Pumping stations, with special reference to land drainage and storm-water disposal. *Inst. Civ. Engin. J.* 5:35-58,illus. Mar.1945. 290.9 In74J

Describes functions and operations, with costs, of axial-flow and centrifugal drainage pumps in use for land drainage in England by the Catchment Board of the Ministry of Agriculture. Also gives a brief history of agricultural drainage in England, and outlines the benefit to agriculture of planned drainage.

1235. COFFEY, J. H. Vertical pump applications. *Amer. Water Works Assoc. J.* 31:1684-1690,illus. Oct.1939. 299.9 Am32J

Includes the use of vertical turbine pumps in booster service and in drainage pumping plants.

1236. CRAWFORD, A. Development of derelict land. *New Zeal. Farmer* 71(6):3-4,illus. May 11, 1950. 23 N484

In New Zealand, drainage water from developed land is pumped by a gasoline-powered pump to irrigate dry land.

1237. DIESEL-pump team cuts drainage cost. *Diesel Power* 29(2):42-43. Feb.1951. 291.8 D562

Diesel drainage pump on farmlands in the South River Drainage District, Missouri. Includes cost.

1238. DIESELS help hold back the river. *Diesel Power & Diesel Transportation* 17:964-965,illus. Dec.1939. 291.8 D562

Diesel-driven pumps of the Henderson County, Ill., Drainage Districts Nos. 1 and 2 maintain the water level of the district's rich bottom lands to prevent the highly cultivated fields from reverting to swamps.

1239. DRAINAGE in East Anglia. *Elect. Rev.* 121:400,illus. Sept.24,1937. 335.8 E122

Wind pumps have been supplanted by electric pumps in the drainage of England's Fens.

1240. DRAINING the Fens; gradual change-over to electric pumping. *Elect. Rev.* 148:421-425,illus.,map. Mar.2,1951. 335.8 E122

Description of the pumps used to drain the 240 square miles covered by the South Holland Drainage Boards, England.

1241. ESTATE power supplied by many engines. *Oil Engine & Gas Turbine* 19:266-268,illus. Nov.1951. Libr. Cong.

Describes drainage pumps on an 8,000-acre potato farm in England.

1242. EVANS, C. B., and ALLISON, R. V. The soils of the Everglades in relation to reclamation and conservation operations. *Soil Sci. Soc. Fla. Proc.* 4A:34-46,illus.,maps,tables. 1942. 56.9 So32

It is recommended that a unit plan of development be adopted with principal reliance placed upon pumping units rather than gravity drainage in order to provide greater flexibility in water control.

1243. FEN ENGINE experiences. *Oil Engine & Gas Turbine* 15:24-25. May 1947. Libr. Cong.

Despite immersion by the floods of 1947 in England, the medium and small diesel Fen-drainage pumps were not harmed.

1244. FILMAN, C. C., TRUSCOTT, J. H. L., and GOODWIN-WILSON, R. A. 5,000 acre water garden? *Better Crops* 32:15-18,46,illus.,tables. Apr.1948. 6 B46

Drainage of marshes in Canada by means of pumps. Includes an analysis of drainage water.

1245. FULLERTON, W. H. Recovery of Louisiana bayou farm-

land. Diesel Prog. 13(10):40-41,illus. Oct.1947. 291.8 D56

Reclaiming the bayous with ditches, levees, and diesel pumps.

1246. GARDNER, W., and ISRAELSEN, O. W. Design of drainage wells. Utah Engin. Expt. Sta. B. 1,15 p.,illus. Dec.2,1940. Ref. 290.9 Ut12

The paper presents a design to increase the effective diameter of shallow wells by using a central well together with a number of feeder wells in circular arrays.

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1248. GOTTLIEB, W. H. Diesel-pump team cuts drainage costs. Pub. Works 80(11):34,36,illus. Nov.1949. 290.8 M922

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1249. GOTTLIEB, W. H. Farming a lake thanks to diesel-pump team. Diesel Prog. 16:51. Jan.1950. 291.8 D56

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1250. GOTTLIEB, W. H. Keeping Corpus dry. Diesel Prog. 17(8):48-50,illus. Aug.1951. 291.8 D56

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1253. HELLINGA, F. Water control. Soil Sci. 74:21-33,illus. July 1952. 56.8 So3

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1254. HIDVEGHY, L. A belvize-ategnelotelepék által szállított vizemnyiségek folyamatos merese. Vízügyi Közlem. 30:470-480,illus. 1948. 290.9 H89

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1256. IHRIG, D. A belvizatemelo telepek vízhozamanak merese. Vízügyi Közlem. 30:436-444. 1948. 290.9 H89

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1263. LARSON, C. L. Your drainage system needs a good outlet! Minn. Farm & Home Sci. 9(2):13. Feb.1952. 100 M666

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1273. MONSON, O. W., and MURDOCK, H. E. A homemade centrifugal pump and other water-lifting devices. Mont. Agr. Expt. Sta. B. 324, 51 p., illus., tables. Aug. 1936. 100 M76  
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1277. PETERSON, D. F., and others. Drainage by pumping from wells. U. S. Region. Salinity Lab. Res. Rpt. 25(Pt. 3), 18 p. Apr. 1948. 1.965 A2R31  
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1287. SHOWELL, J. L. Possibilities of drainage by deep-seated bores. *So. Austral. Dept. Agr. J.* 54:602-603. July 1951. 23 So84

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1288. SIX OF the world's largest pumps protect Cincinnati against floods. *Power* 90:511-513, illus. Aug. 1946. 290.8 P87

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1291. SULZER BROTHERS. Modern developments in land drainage and irrigation pumping installations. *Internat'l. Comm. Irrig. & Drain. Annu. B.* 1:32-35, illus. 1952. 55.9 In8A

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1292. SUTTON, J. G. Design and operation of drainage pumping plants. *U. S. D. A. Tech. B.* 1008, 81 p., illus., tables. May 1950. Ref. 1 Ag84Te

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1297. TWO-PUMP station for land drainage. *Oil Engine & Gas Turbine* 18:384-385, illus. Apr. 1951. Libr. Cong.

1298. VANDERWERKER, R. J. A high capacity low-lift pump. *N. J. Mosquito Extermin. Assoc. Proc.* 35:98-102, illus. 1948. 420 N46

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1300. WELCHES Dam pumping station for Fen drainage. Engineering 166:631-633, 636, illus. Dec. 31, 1948. 290.8 En322

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1301. WOLFE, J. W. A pumping manual for irrigation and drainage. Oreg. Agr. Expt. Sta. B. 481, 39 p., illus., tables. Aug. 1950. 100 Or3

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The linings help to solve drainage problems of seepage in California, but drainage by pumping is still necessary.

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1304. BIGORGNE, O. L'aménagement hydraulique d'un grand casier dans la delta Tonkinois. Ann. des Ponts et Chaussées 108:353-397. Mar. 1938. 290.8 An7

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1305. BIJLS, A. La submersion de l'Île de Walcheren (Pays-Bas). Génie Civ. 123(19):257-259. Oct. 1, 1946. 290.8 G29

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1306. BLEIN ZARAZAGA, F. Utilidad de los mechinales. Montes 3:157-162, illus. Mar./Apr. 1947. 99.8 M763

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1307. CHEN, TS. SH. Filtration calculations of vertical drainage in the foundation of earth dams. (In Russian.) Gidrotekh. i Melior 7(4):40-50. Apr. 1955. Ref. 290.8 G362

1308. DESPLANQUE, C. De dykelands in de Maritieme Provincies van Canada. Nederland. Heidemaatsch. Tijdschr. 63:14-20, illus. Jan. 1952. 12 N282

The dykelands in the Maritime Provinces of Canada. Construction of the drains and dikes is described.

1309. FERGUSON, D. S. Construction of coastal bunds in Malaya. Malayan Agr. J. 34:3-12, illus. Jan. 1951. 22.5 F312

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1310. FLORIDA. BOARD OF CONSERVATION. DIV. OF WATER SURVEY AND RESEARCH. Information & progress on the central & southern Florida flood control project. Fla. Div. Water Survey & Res. Water Survey & Res. Paper 10, 73 p., illus., maps, tables. June 30, 1953. 292.9 F66

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1313. KHOPERSKII, I. S. Construction of agricultural dams with the aid of hydromechanics. (In Russian.) Gidrotekh. i Melior. 5(4):55-62, illus. Apr. 1953. 290.8 G362

1314. MORGAN, J. H. The Monmouthshire moors. U. Col. Wales. Agr. Soc. J. 35:17-20. 1954. 10 Un3

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1315. ROBERTS, J. A. Beef or back to the sea? MacDonald Farm J. 15(7):6-7, illus. Mar. 1955. 101 M144

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1316. SHRAG, V. I. In regard to diking of flood plains. (In Russian.) Pochvovedenie 8:20-27. Aug. 1953. Ref. 57.8 P34

1317. SMALL, C. J. The floods and the farmer. Foreign Trade 13(322):10-13, illus. Feb. 28, 1953. 286.8 C162

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1318. SMITH, D. D. A 20-year appraisal of engineering practices in soil and water conservation. Agr. Engin. 33:553-556, illus. Sept. 1952. 58.8 Ag83

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1320. SPARF, C. R. Levee construction through Florida's Everglades. Explosives Engin. 30:175-179, illus. Nov./Dec. 1952. Libr. Cong.

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1321. TITOV, N. M. In regard to the problem of increasing the fertility of flood plain lands. (In Russian.) Gidrotekh. i Melior. 5(7): 3-10, illus. July 1953. 290.8 G362

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1322. TUINSTRA, U. De oude dijken in Friesland en Groningen. Nederland. Heidemaaitsch. Tijdschr. 66:128-131, illus. May 1955. 12 N282

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1323. WILLIAMS, G. R. Drainage of leveed areas in mountainous valleys. Amer. Soc. Civ. Engin. Proc. 68:3-16, illus., tables. Jan. 1942. 290.9 Am3P

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#### Equipment

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English summary.

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1327. ARTHUR, H. A. Mole-drain plough modified for operations by one man. New Zeal. J. Agr. 85:20-21,illus. July 1952. 23 N48J  
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1328. AYERS, F. P. The efficiency and economy of mechanized equipment versus hand work in Ocean County. N. J. Mosquito Extermin. Assoc. Proc. 39:98-100. 1952. 420 N46

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1329. AYLEN, D. A new ditcher. Rhodesia Agr. J. 38:8-14,illus. Jan.1941. 24 R34

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1330. BACKSTROM, C. C. Dikning med mullskopa. Lantmannen 32:252,illus. Apr.10,1948. 11 L234

Ditching with a soil scoop in Sweden.

1331. BAMBERG, K. K. Crevise drainage and deepening of arable layer of the soil with crevices. (In Russian.) Latv. PSR Zinatnu Akad. Vest. 9(74):31-38. 1953. 511 R442

Drainage equipment in Latvia.

1332. BARFORD drainage machines. Power Farmer (n.s.) 3:393, 396,illus. Nov.1949. 58.8 P872

A trenching machine for operation on difficult terrain digs 30-inch-deep drainage ditches at a rate of 5 feet per minute.

1333. BARR, H. T., and TURNBULL, J. A new implement for mole drainage. Agr. Engin. 24:417-418,illus. Dec.1943. 58.8 Ag83

A "home-made" machine weighing only 500 lb. and running on two 10-foot skids is described, together with the conditions for operation of the machine. Drains up to 4 inches in diameter at depths of from 18 to 48 inches can be drawn.

1334. BARRETT, L. A. G. Letting machines do it; farm drainage work mechanised. Rhodesia Agr. J. 44:62-63,illus. Mar./Apr.1947. 24 R34

Description of a combination trench-digging and tile-laying machine, and two ditchdiggers for use in New Zealand's swamplands.

1335. \*BEACH, W. E. Factors affecting performance of tile-

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1336. THE "BLOOMFIELD" tile draining attachment. Farm Impl. & Mach. Rev. 68:135-136, illus. June 1, 1942. 58.8 Im72  
 A tile-laying device.

1337. BOTSFORD, R. C. The power Scavel, a new salt marsh ditch cleaning device. N. J. Mosquito Extermin. Assoc. Proc. 36:114-116. 1949. 420 N46  
 Discussion, p. 115-116.  
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1338. BOUMA, H., JELIES, H., and BAKKER, J. De greppel snijder. Drentsche Landb. 2:126-127. Apr. 17, 1947. 12 D81  
 A ditch cutter developed in the Netherlands for use in maintaining as well as constructing drainage ditches. It can be powered by jeep or by draft horse.

1339. BOURGET, F. Le drainage mécanique et la productivité; une expérience. Sol 69:289-297, illus. 1952. 14 So4  
 Mechanical drainage and productivity. Description and photographs of various ditching machines in France.

1340. BRENNER. Grabenfräse. Landbforsch. Völkenrode 2:32-34, illus. Apr. 1952. 18 L2353  
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1341. CHAPMAN, J. R. Self-cleaning bucket for hydraulically operated trench diggers. New Zeal. J. Agr. 87:273-274, illus. Sept. 15, 1953. 23 N48J

1342. CHILDS, E. C. What should be the length of a mole plough beam? Farm. Impl. & Mach. Rev. 68:895-896, illus. Mar. 1, 1943. 58.8 Im72  
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1343. CLARKE, T. Men and machines. Field 191:42, illus. Jan. 10, 1948. 10 F45  
 Rotoho trench excavator, angle-dozer, and the Miles mole plow at work on an English farm.

1344. CRANDELL, H. A. Jeep-mounted scoop digs and cleans ditches. Engin. News-Rec. 141:79, illus. July 22, 1948. 290.8 En34  
 Description of a new drainage dumper and cleaner.

1345. DALIN, A., and SERDECHNYI, A. New equipment for the improvement of meadows and pastures. (In Russian.) Kolkhoz. Proizvodstvo 12(2):51-52, illus. Feb. 1952. 281.8 K83  
 Land clearing and drainage.

1346. \*DE VRIES, L. L. Performance and operating costs of tile trenching machines. Ames, 1951.  
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1347. DIRECT tractor mole draining simplified. Farm Impl. & Mach. Rev. 68:229, illus. July 1, 1942. 58.8 Im72  
 Suckling's direct tractor mole drainer.

1348. DOMENIGHETTI, C. Macchina per lo scavo dei canali. Macch. e Motori Agr. 6:257-263, illus. June 1948. 58.8 M13  
 A machine for digging ditches is described.

1349. DOMINY, J. N. Land drainage in the winter. Country Life 94:997, illus. Dec. 3, 1943. 80 C83  
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1350. DONNAN, W. W., and BRADSHAW, G. B. Tile effluent measuring devices. Agr. Engin. 30:134-136, 140, illus. Mar. 1949. 58.8 Ag83  
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\*Not examined.

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1351. THE DRAINAGE of agricultural land. Engineering 147:71-72. Jan. 20, 1939. 290.8 En322

A discussion of drainage and ditching equipment in England.

1352. DUBEIKOVSKI, I. I. Machine-reclamation stations and their role in the utilization of bogs and marshy mineral lands. (In Russian.) Gidrotekh. i Melior. 4(5):49-58, illus. May 1952.

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1427. PANARIN, M. N. Irrigation and ventilation mole drainage of market gardens in regions of unstable precipitation. (In Russian.) *Vsesofiuzn. Akad. Sel'skokhoz. Nauk im. V. I. Lenina. Dok.* 4(5/6):41-44. 1939. 20 Ak1  
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Ditch-digging equipment used in Italy.

1432. PEASRO, A. Kostnaden för maskinrävda täckdiken. *Lantmannen* 34:465-466, illus. June 10, 1950. 11 L234  
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1434. REILEY, F. A. Development and maintenance of machinery and equipment. *N. J. Mosquito Extermin. Assoc. Proc.* 39:86-90. 1952. 420 N46  
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1442. SABINSKII, G. B. Machinery for drainage of swamps and reclamation of virgin lands. (In Russian.) Dostizheniia Nauk. i Perevodovogo Opyta v Sel'sk. Khoz. 8:71-76, illus. Aug. 1954. 20 D742

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1446. SCHROEDER, E. W. An experimental mole ditcher. Agr. Engin. 28:493-494, 502, illus. Nov. 1947. 58.8 Ag83

1447. SCOTT, D. F. Drain cleaning attachment for a tractor. New Zeal. J. Agr. 90:491, illus. May 16, 1955. 23 N48J

For cleaning and digging open drainage ditches.

1448. SCOTT, D. F. Possibilities of drainage by mechanical means in Northland. New Zeal. Grassland. Assoc. Proc. 15:98-104. 1953. 60.19 N48

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1457. THOM, W. A season's use of a Scavel plow by the Middlesex County Mosquito Extermination Commission. N. J. Mosquito Extermin. Assoc. Proc. 37:209-212. 1950. 420 N46

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1458. THREE new draining outfits. Farm Impl. & Mach. Rev, 68(811):560-562, illus. Nov. 1, 1942. 58.8 Im72

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1461. TIULENEV, N. A. The question of the further improvement of the fertility of peat soils. (In Russian.) Vsesojuzn. Akad. Sel'skohoz. Nauk im. V. I. Lenina. Dok. 16(8):3-9. 1951. 20 Ak1

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The Henderson agricultural drainage machine in use in England.

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A trencher developed in England cuts 6-foot ditches at a rate of speed to suit the speed of a tile-laying crew.

1464. VINCENT, A. E. The use and construction of boning rods. Agr. Gaz. N. S. Wales 58:482-483, 486, illus. Sept. 1947. 23 N472

Drainage equipment to determine any unevenness of a slope. Used in connection with trench excavations for lines of pipes where an even fall is essential.

1465. VOIDA, A. N. Machines for reclamation of virgin lands. (In Russian.) Sel'khozmashina 4:3-6. Apr. 1954. 58.8 So42

Drainage machines.

1466. VOIGT, O. Mechanische gräbenreingung. Landmasch.-

Rundschau 2:246. Dec.1950. 58.8 L237

Mechanical ditch digging in Germany.

1467. WARDROP, G. Drainage machines face tough test. Farmer & Stock-Breeder 68(3363):8485,illus. Apr.6/7,1954. 10 F228

Ditchdiggers and equipment for digging and maintenance of ditches in England.

1468. WRIGHT, S. J., and BLACKABY, J. H. Modern drainage and ditching equipment. Impl. & Mach. Rev. 64:993-994. Feb.1,1939. 58.8 Im72

Mole drainage and ditching equipment and costs, Great Britain.

#### DRAINAGE NEEDS AND EFFECTS

1469. ABLEITER, J. K., and BARNES, C. P. Soil productivity ratings. Internatl. Cong. Soil Sci., 4th, Trans. 1:360-364. 1950.

56.09 In844

Estimated average acre-yields of crops on some soils. Includes drainage needs.

1470. AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS. DRAINAGE COMMITTEE. Problems and needs in agricultural drainage. St. Joseph, Mich.,1946. 11 p. 54.9 Am3

Partial contents: Some benefits of drainage; Principal areas of drainage; Some reasons for failures; Assistance by soil conservation districts; Summary of requirements for successful drainage; Research needs; Drainage of irrigated lands; Programs to aid in drainage.

Summary in Agr. Engin. 27:554-558,illus. Dec.1946. 58.8 Ag83

1471. ANDERSON, W. L. Drainage—Dr. Jekyll or Mr. Hyde. Outdoor Amer. 12(8):4-5,illus. Sept.1947. 410 Iz1

Bad drainage is defined as that which deprives wildlife of its natural habitat without adding materially to crop acreage. The author believes that only highly fertile land that can be drained economically should be converted to cropland.

Also in Mich. Conserv. 17(2):10-11,illus. Feb.1948. 279.9 M582

1472. ANNELL, H. E. Loss of soil nutrients in drainage. Spec. Conf. Agr. Proc. 1949:244-245,tables. 1951. 395 Sp3P

Figures are tabulated for drainage and losses of nutrients in pounds per acre.

1473. ARRHENIUS, O. Skörder i södra Sverige. Socker 1(10):231-243,illus.,maps. Mar.1945. 65.8 So1

English summary.

Includes discussion.

Crops in southern Sweden. Discusses drainage, irrigation, and crop yields.

1474. BAKER, V. W. Eight years of progress in dairying. Soil Conserv. 17:109-112,illus. Dec.1951. 1.6 So3S

Pasture improvement in Oregon. Includes drainage.

1475. BATES, G. H. The Black Fen. Roy. Agr. Soc. Eng. J. 106:75-84. 1945. 10 R81

Presents arguments for and against draining the Fens. Overdraining may cause blowing of the soil and shrinkage of the peat.

1476. BEAUCHAMP, C. E. Influencia del drenaje sobre el rendimiento de azúcar de la caña. Inst. Cubano de Suelos y Abonos. Inform. Téc. B. 54:1057-1061. Feb.1949. 65.9 H29

The effect of drainage on the yield of sugarcane in Cuba.

1477. BEAUCHAMP, C. E. Influence of drainage on the yield of sugar from cane. Assoc. de Téc. Azucareros de Cuba. Proc. 21:99-101. 1947. 65.9 As5

Cuba.

1478. BOS, J. Ziekten in de fruitteelt, die een gevolg zijn van een slechte ontwatering. *Landbouwk. Tijdschr.* 58:651-652. Dec. 1946. 105.2 Or3

Fruit diseases caused by poor orchard drainage in the Netherlands.

1479. CHATSKII, P. V. High yields on [reclaimed] marshy soils. (In Russian.) *Dostizheniya Nauk. i Peredovogo Opyta v Sel'sk. Khoz.* 4:72-73. Apr. 1953. 20 D742

1480. CHILDEERS, N. F., and WHITE, D. G. Some physiological effects of excess soil moisture on Stayman Winesap apple trees. *Ohio Agr. Expt. Sta. Res. B.* 694, 35 p., illus., tables. June 1950. Ref. 100 Oh3S

1481. CHIODI, A. *Apaestum la bonifica riporta il lavoro e la vita.* *Agricoltura* 1(11):40-44, illus. Nov. 1952. 16 Ag8226

Irrigation and drainage for malaria are bringing back labor and life to Paestum, Italy.

1482. CHOWDHURY, S. Heart or stem rot of pineapple. *Indian J. Agr. Sci.* 15:139-140, illus. June 1945. 22 Ag83I

Control of the disease was effected by improved drainage.

1483. COLMAN, R. Nutrients, drainage, texture, all required for soil productivity. *Miss. Farm Res.* 4(7):1-2. July 1941. 100 M69Mj

In order to determine accurately the need for drainage, the subsoil, as well as the topsoil, must be examined.

1484. CORMACK, R. M. M. The causes of, and remedies for, waterlogging of crops. *Rhodesia Agr. J.* 50:213-222, illus. May/June 1953. 24 R34

1485. DAHLBECK, N. Skall halva Uppland törrlaggas? *Sveriges Nat.* 42:85-89, illus. 1951. 410 Sy2

Shall half of Uppland be drained? Effect of drainage on wildlife and scenic beauty in Sweden is discussed.

1486. DAVIS, E. H. Irrigation and adequate drainage are good insurance against low yield. *Contact* 12(2):1, 5. June 1946. 80 C76

Improving natural drains by blasting. Costs are considered.

1487. DRAINAGE and irrigation recommendations. *Agr. Engin.* 26:120, 124, 205-206. Mar., May 1945. 58.8 Ag83

Recommendations offered by the American Society of Agricultural Engineers.

1488. DUSHINSKE, R. L. Drainage and subsidy payments. *No. Amer. Wildlife Conf. Trans.* 18:73-80. 1953. 412.9 N814

The Government, in encouraging farmers to drain for increased cropland, is contributing to the demise of wildlife in swamps and marshlands.

1489. FLODKVIST, H. Agronomisch-hydrotechnische ergebnisse von dränungsversuchen auf tonböden. *Internat. Cong. Soil Sci.* 3d. Trans. 3:164-168. 1936. 56.09 In843

Agricultural-hydrotechnical results of drainage of clay soils. Discusses depth and spacing of lateral drains and speed of flow in them.

1490. FURNEAUX, B. S. Field drainage and its effect upon soil fertility. *Country Landowner* 4:91-94. Apr. 1953. 10 C836

In Great Britain.

1491. GIRARDIN. Comment augmenter le rendement des sols humides par la pratique du drainage. *Génie Rur.* 36:10-11, illus. June 1943. 58.8 Au8

How to increase the yield of humid soils by the practice of drainage in France.

1492. GORRIE, R. M. Drainage-basin management; water control through watershed management. *United Nations Sci. Conf. Conserv. & Util. Resources. Proc.* 4:174-177. 1949, pub. 1951. 279.9 Un32P

Includes need for field drainage.

1493. HAAS, A. R. C. Growth of avocado seedlings as affected by the rate of soil drainage. Calif. Avocado Soc. Ybk. 34:139-143, illus. 1949. 81 C128

Tests at the Citrus Experiment Station, Riverside, Calif., show that avocados grow best when drainage is neither too rapid nor too slow.

1494. HALEY, L. Proper drainage needed for good crop yields. Purdue Agr. 39(2):5,21,illus. Nov.1947. 6 P97

Field crops.

1495. HALLGREN, G. Torrläggningsgrad och markvärde. Jord-Groda - Djur 11:49-58. 1955. 11 J763

Drainage and soil fertility in Sweden.

1496. HALLIN, S. Aktuella problem vid värdering av jordförbättring och skada torrläggningsoch vattenregleringsföretag. Nord. Jordbrforsk. 33:745-747. 1951. 11 N752

Problems in connection with the evaluation of soil improvement and damage caused through drainage and water regulation in Norway. Considers the economic advantage of covered over open drains.

1497. HAPP, S. C. Fertile valleys laid waste by upland erosion. Soil Conserv. 2:194-198,illus. Mar.1937. 1.6 So3S

Causes and effects of deposition of sediment in streams and valleys, and the need for drainage in the Wells Drainage District, Mississippi, to counteract the clogging of stream channels by sand due to erosion in the uplands.

1498. HARPER, H. J. The effect of terrace ridges on the production of winter wheat. Soil Sci. Soc. Amer. Proc. 6:474-479,illus., tables. 1941. 56.9 So3

On claypan soils with slight slope the upper terrace channel must be drained during periods of excessive rainfall to prevent damage to wheat.

1499. HARRISON, R. W., and ANDERSON, J. R. Drainage can play big role in future land development. Agr. Situation [Washington] 37(7):5-7, map,tables. July 1953. 1 Ec7Ag

Approximately 20 million acres of totally undeveloped land, mostly in the Lower Mississippi Valley and in the Southeastern States, are in need of drainage if farming land is to be made of it. Another 50 million acres of partly cultivated land is in need of drainage if it is to be put to full agricultural use.

1500. HAUGER, R. L. Soil conservation; drainage solves surplus moisture problem. Coastal Cattleman 10(12):16,18,50-51,illus. Feb. 1945. 43.8 C63

Ditch drainage is recommended. Increased crop yields due to drainage are given in bushels per acre on the gulf coastal prairies.

1501. HOGLUND, C. R. Investments in drainage pay off. Sugar Beet J. 20(9):1,4,illus. June 1955. 66.8 Su38

Crop yields on 40 farms in Michigan were increased 50 to 75 percent as a result of tile drainage. Includes costs.

1502. JOFFE, J. S. Keep your soil well drained. N. J. Ten-Ton Tomato Club. Rptg. 1946:25-27,illus. 81 T253

The importance of good drainage in tomato culture.

1503. JOHNSON, E. A. G. Land drainage in England and Wales. Inst. Civ. Engin. Proc. 3:601-651,illus.,maps. Dec.1954. Ref.

290.9 In74P

Discussion, p. 629-651.

Drainage to obviate or relieve flooding, as well as to lower the water table to provide proper conditions for agricultural production.

1504. JONES, L. A. Drainage as a tool for increased crop production. Washington, U. S. Soil Conserv. Serv.,1952. 8 p. 1.96 R31Dra

Paper presented at the American Society of Agricultural Engineers' Soil and Water Program, Centennial of Engineering, Chicago, Sept.9, 1952.

Includes a brief history of drainage in the United States, some results of drainage, and future developments.

Also in Agr. Engin. 34:239-242, 250. Apr. 1953. 58.8 Ag83

1505. JONES, L. A. Effects of drainage on agricultural production. Agr. Engin. 33:415-416, illus. July 1952. 58.8 Ag83

"It would seem that there are some 30 to 40 million acres of land now in cultivation on which crop yields could be increased 50 percent or more by farm drainage work," p. 416.

1506. JONES, L. A. Interrelation of drainage and soil conservation practice. (Abs.) Assoc. South. Agr. Workers Proc. 43:32-33. 1942. 4 C82

Guidance is needed to prevent costly failures in drainage enterprises, and to prevent the drainage of soils that prove infertile. Many farms in the South have poorly drained spots that reduce the overall yield.

1507. JONES, L. A. What drainage has accomplished. Washington, U. S. Bur. Agr. Engin., 1938? 3 p. 1.9 En35Wh

Compares the agricultural productivity of the Midwest today with the swampy conditions found west of Pennsylvania by Long's Expedition in 1823.

1508. JUUSELA, T. Täckdikningens inverkan på jordens vattenhalt, tjälbildning och temperatur. Prakt. Försöksverks. 5:47-48. May/June 1948. 20 P88

Effect of drainage on soil-moisture content, frost formation, and temperature, in Finland.

Also in Svensk Jordbrforsk. 1948:29-34, illus., tables. 11 J763

1509. KAITERA, P. Om uppskattning av markytans sättning vid torrläggningsarbetena. Nord. Jordbrforsk. 36:532-537, illus. 1954. Ref. 11 N752

Estimation of land surface settling in drainage.

1510. KEEN, B. A. Land drainage: the area of benefit. Gt. Brit. Min. Agr. Agriculture 43:521-526. Sept. 1936. 10 G79J

Effects of flood, and need for drainage on the higher unflooded surrounding land.

1511. KEILHOLZ, F. J. Drainage needs a doctor. Country Gent. 115(5):18, 42-43, illus. May 1945. 6 C833

"Approximately 50,000,000 acres — enough to make a 49th State — can be brought into more profitable use with the weapons we have at hand," p. 18.

1512. KENNEY, F. R., and MCATEE, W. L. The problem: Drained areas and wildlife habitats. U. S. D. A. Ybk. Agr. 1938:77-83, illus. 1 Ag84Y

Mistaken drainage of soils fundamentally unsuited to farming has been the cause of much wildlife despoliation. Also, overdrainage of peat soils, as in Minnesota, has caused the peat soil to dry out and become a fire hazard. Peat fires in various parts of the country have destroyed the topsoil down to impervious rock.

1513. KLESTRUP-HANSEN, F. Draening og hvorfor. Dansk Landbr. 69:242-243, May 4, 1950. 280.28 V91

Drainage, and why. Its effect on crops in Denmark.

1514. KOHLER, K. O., and MUNCEY, J. A. The water-facilities program. Soil Conserv. 5(7):175-178, 195, illus. Jan. 1940. 1.6 So3S

Two Texas farms and an Idaho community benefit from improved water facilities, including drainage.

1515. LIERE, W. J. VAN. De afwatering en de drainage in het Westland. Tuinbouw 2:39-41. Feb. 1947. 80 T815

Discusses the effect of drainage on crops in market gardens in the Netherlands.

1516. LOURDIN, L. Économie du drainage. Chambres d'Agr. (Tech.-Agr.) 25(49):9-13. Apr. 1, 1954. 14 T69

Economic aspects, objectives, costs, and returns in France.

1517. MCCRRORY, S. H. Water and the land. *Reclam. Era* 28:184-186, illus. Sept. 1938. 156.84 R24

Includes the need for drainage not only in the humid areas of the East, but in the irrigated areas of the West.

Also in *Agr. Engin.* 19:519-522, illus. Dec. 1938. 58.8 Ag83

1518. MANSON, P. W. Drainage requirements of crops. *Minn. Agr. Engin. News Let.* 102, 1 p., table. Sept. 15, 1940. 275.29 M66 Ag

Compares depth of root zone of various field, vegetable, and fruit crops, to ideal depth of drain tile for each type.

1519. MANSON, P. W., and ROST, C. O. Farm drainage—an important conservation practice. *Agr. Engin.* 32:325-327, illus. June 1951. 58.8 Ag83

Covers theory of farm drainage (hygroscopic, capillary, and gravitational), effects of drainage on crop yields, drainage and ground-water levels, and the importance of drainage in conservation.

1520. MANSON, P. W., and ROST, C. O. Farm drainage can increase the size of your farm. *Minn. Farm & Home Sci.* 8:12-13, illus. Oct. 1950. 100 M668

By making more land suitable for cultivation, and by increasing the productivity of cultivated land.

1521. MANSON, P. W. A laboratory study of the drainage requirements of sweet clover. *Minn. Agr. Expt. Sta. Tech. B.* 144, 28 p., illus., tables. June 1940. Ref. 100 M66

The purpose of the study was to determine the optimum soil-moisture requirements of a given crop, especially in those areas in need of sub-drainage, and the minimum rate at which the removal of a saturated condition of the soil must be accomplished to obviate serious injury to the crop.

1522. MARTIN, H. B. A blotter for the Pelican State. *Soil Conserv.* 13:212-214, illus. May 1948. 1.6 So33

There are nearly seven million "wet" acres in Louisiana which can be put in full production by proper drainage.

1523. MEASURES needed to manage watersheds. *J. Soil & Water Conserv.* 10:237-240, illus. Sept. 1955. 56.8 J822

Includes drainage measures such as the construction and rehabilitation of natural and artificial drainage channels, open or covered drains, and control structures such as gates, pumps, drops, and flumes.

1524. MILLER, D. G. Effect of drainage on water levels of farm wells. *Minn. Agr. Engin. News Let.* 87, 1 p., tables. June 15, 1939. 275.29 M66 Ag

Because drainage enterprises cover less than 5 percent of the total area of the Mississippi Valley, any effect on water levels of farm wells is local and of small economic importance.

1525. MOREL, C. Pour rénover le sol français. *Le drainage; définition, historique, effets et résultats.* *Genie Rur.* 39(11):16-18. Nov. 1946. 58.8 Au8

Definition, history, and effects of drainage in France.

1526. MOTOOKA, T. Some economic characteristics and problems of land reclamation by drainage. (In Japanese.) *Nogyo Keizai Kenkyu* 27:6-19. Mar. 1955. 281.8 N68 Japan.

1527. NICHOL, G. E. Tile drainage is profitable. *Sugar Beet J.* 19(10):1, 3, illus. July 1954. 66.8 Su38

Tile drainage increases sugar-beet yield by more than three tons per acre for an average monetary gain of 48 dollars per acre.

1528. NICHOLSON, H. H. The control of ground water level in crop production. *Internat. Hort. Cong.* 13th. Rpt. 2:904-912, illus. 1952. 90.09 C7613

## The drained lands of England's Fens.

1529. NICHOLSON, H. H. Field drainage and increased production. *Roy. Agr. Soc. Eng. J.* 109:212-221, tables. 1948. 10 R81

Between 1939 and 1948 the British Government aided farmers of England and Wales in the draining, by tile and mole, of more than 5,000,000 acres of farmland. The results in increased crop production are discussed.

1530. NICHOLSON, H. H. Some aspects of field drainage. *Agr. Prog.* 20:65-69. 1945. 10 Ag86

During the five and one-half years of war the areas scheduled for ditching, mole draining and tile draining in England and Wales were extensive. It is believed that these large-scale drainage operations have promoted floods and adversely affected public water supplies.

1531. NITSENKO, A. A. Observations on changes in the vegetative cover effected by drainage [of marshes]. (In Russian.) *Bot. Zhur.* 36:349-355. July/Aug. 1951. Ref. 451 R923

1532. O'BRIEN, H. R. Surface drainage can double yields; when tile failed to drain their flat land effectively, farmers on hardpan in Ashtabula County, Ohio, perfected an old drainage method with surprising results. *Country Gent.* 120(11):26-27, 71-72, illus. Nov. 1950. 6 C833

## Grassed shallow waterways in cornfields.

1533. OGG, W. G. Improving soil productivity: temperate climates. *United Nations Sci. Conf. Conserv. & Util. Resources* 6:209-213. 1949, pub. 1951. 279.9 Un32P

## Includes the necessity for drainage in some areas.

1534. OLNEY, A. J., LOWRY, S. J., and CALDWELL, L. M. Effect of cover crops and tile drainage on growth and yield of peaches. *Ky. Agr. Expt. Sta. B.* 547, 8 p., tables. May 1950. 100 K41

## Experiments at the Western Kentucky Substation.

1535. PALMER, L. Less water, more corn. *Soil Conserv.* 14: 267-268, 279, illus. July 1949. 1.6 So3S

## Drainage in Iowa for increased corn yields.

1536. PARKER, E. R., and ROUNDS, M. B. Avocado tree decline in relation to soil moisture and drainage in certain California soils. *Amer. Soc. Hort. Sci. Proc.* 44:71-79, illus. 1944. Ref. 81 So12

Removal of rainwater by means of broad, shallow furrows located between the tree rows, and by means of tile drains appeared to benefit tree condition. The planting in deep tree holes blasted out of clay sub-soil was observed to have resulted in the formation of basins in which free water accumulated and caused decline.

1537. PARKER, G. G. Salt water encroachment in southern Florida. *Amer. Waterworks Assoc. J.* 37:526-542, illus., tables. June 1945. Ref. 292.9 Am32J

The drainage program of southern Florida has upset the delicate balance between salt water and fresh water by lowering the water table to sea level. Unless water levels are restored to proper heights irreparable damage will be done to the soil by salt.

1538. PIJLS, F. W. G. Irrigation investigations in Dutch fruit growing. *Internat'l. Hort. Cong.* 13th Rpt. 2:925-934, illus. 1952. Ref. 90.09 C7613

Intense drainage of the lowlands has necessitated irrigation of higher land in the Netherlands.

1539. PILLSBURY, A. F., and HUBERTY, M. R. Drainage of avocado orchards. *Calavo News* 18(3):5, 8-11, illus. Oct./Dec. 1944. 280.28 C12

Discusses ground-water conditions, the means of determining the need for drainage, surface drains in terraced orchards, installation of tile drains, and costs and quantities for drain tile.

1540. PONNAMPERUMA, F. N. The chemistry of submerged soils in relation to the growth and yield of rice. Ithaca, 1955. 427 p. Thesis (Ph.D.) — Cornell University, 1955.

Abstract in Diss. Abs. 15:931-932. 1955. 241.8 M58

A combination of low Ph and high organic matter, causing "mentek" disease in rice, may be corrected by subsoil drainage and an application of sodium nitrate.

1541. RAMSAUER, B. Die bedeutung der meliorationen für land- und volkswirtschaft. Agr. Rundschau 8:42-47. Summer 1952.

280.8 Ag82

Irrigation and drainage in Austria. Importance of reclamation in land and political economy.

1542. ROE, H. B. Farm drainage in relation to drought. Minn. Agr. Engin. News Let. 61,1 p. Apr.15,1937. 275.29 M66Ag

Good tile drainage forces the root system of plants to reach to the lowered water table while they are still immature, thus spreading the roots so that when drought comes they have an increased area from which to draw the decreasing water supply.

1543. ROE, H. B. Some soil changes resulting from drainage. Soil Sci. Soc. Amer. Proc. 4:402-409,illus. 1939. Ref. 56.9 So3

A critical discussion of chemical and biological changes, with special reference to the removal of alkali, and of changes in permeability, for which the evidence is suggestive but not conclusive; and an account of subsidence in drained peat bogs. Tile drainage was used for these experiments in Minnesota.

1544. RUSSELL, M. B., and FIRKINS, B. J. Few farms well drained. Farm Sci. Rptr. 5(3):10-11,illus.,table. July 1944.

275.28 F22

Effect of poor drainage on corn crop losses in Iowa.

1545. SALOHEIMO, L. Den lampliga tegbredden pa myrmark. Forsk. - och Försoksresultat 2:59-62,tables. Dec.15,1950. 20 F77

Drainage for grain planting in Finland. Research on drainage by open and covered ditches and its effect on crop yield.

1546. SALTER, R. M. The engineer's job in developing America's capacity to produce. Agr. Engin. 34:83-87,illus. Feb.1953. 58.8 Ag83

Address before the special meeting of the American Society of Agricultural Engineers, Chicago, Sept. 1952.

Includes drainage.

1547. SALTER, R. M. Wildlife and our soil conservation objectives. No. Amer. Wildlife Conf. Trans. 18:81-93. 1953. 412.9 N814

Discussion, p. 91-93.

The Soil Conservation Service has assisted in the drainage of over 7,000,000 acres, of which less than 1 percent was marsh or swamp-land. The SCS encourages farmers to create wildlife refuges on damp ground that is unsuitable for either cropland or pasture.

1548. SAVESON, I. L. Drainage research for sugarcane land in southern Louisiana. Sugar J. 10(7):7-8,15,illus. Dec.1947. 65.8 Su391

Includes land grading for drainage, mole drainage, and construction and maintenance of lateral ditches. Gives increased returns in dollars per acre due to drainage and increased yields in pounds of sugar per acre.

1549. SCHEROTZKI. Geregelte wasserwirtschaft grundlage jeder ertraggsleistung. Landwirtbl. Weser-Ems 98:140-142. Feb.15,1951. 18 L2345

A regulated water economy is the basis for profitable yields. Drainage in Germany.

1550. SINGLETON, J. R. Coastal drainage problems in relation to waterfowl. Tex. J. Sci. 1(3):25-28. Sept.30,1949. 470 T31

Drainage of uplands on the Texas gulf coast is destroying the wild-

life refuges by filling the marshes with fresh water during the rainy season and drying them out during periods of drought.

1551. SKEPPER, A. H., and DAVISON, J. R. Economics of sub-soil drainage dependent on improving reduced yields from suitable soils. *Citrus News* 31:26-27. Feb. 28, 1955. 80 C494

Tile drainage of citrus orchards in Australia.

1552. SMITS, J. Kwaliteit tegen lage kostprijs. *Betuws Tuinbouwbl.* 9(2):4. Mar. 17, 1951. 80 B464

Quality versus cost. The effect of drainage on the quality of fruit in Netherlands orchards.

1553. SUTTON, J. G. Drainage as an aid to increased food production. *Agr. Engin.* 24:327-329, 331, illus. Oct. 1943. 58.8 Ag83

Also separate, 8 p. Jan. 1944. 1.96 Op2Dr

1554. SUTTON, J. G. Farm drainage to increase wartime production. *Soil Conserv.* 8:195-199, 214, illus. Mar. 1943. 1.6 So3S

Discusses drainage projects essential to the war effort, and suggests principles and methods of carrying out these projects under conditions at that time. Increased yields per acre of corn, soybeans, hay, and sugarcane are given for the United States as a whole.

1555. TILE drainage and its effect on plants. *Horticulture* 18: 453-454, illus. Nov. 15, 1940. 80 H787

Drainage lowers the water table, deepening the soil and permitting the roots to penetrate to a point of safety in time of drought. Spacing of drains is discussed.

1556. TURNBULL, J. Drainage and the Food for Freedom program. *Soil Conserv.* 7:265-266, illus. May 1942. 1.6 So3S

It is estimated that over 31 million acres of cultivated farmland are in need of improved drainage to realize potential maximum of production.

1557. UHLAND, R. E. Drainage doubles yields on Maryland's Eastern Shore. *Soil Conserv.* 9:221-223, 231, illus., table. Apr. 1944. 1.6 So3S

Farmers of three east Maryland counties have reduced the acreage of nonproductive land from 1,945 to 80 by drainage. Tables show increase in yield of corn, wheat, and hay in bushels per acre after drainage.

1558. ULRICH, R. Relative costs and benefits of land reclamation in the humid Southeast and the semiarid West. *J. Farm Econ.* 35:62-73. Feb. 1953. 280.8 J822

Drainage in Mecklenburg County, in the Virginia Piedmont, and irrigation in the Columbia River Basin, Washington.

1559. U. S. NATIONAL RESOURCES PLANNING BOARD. Drainage in the river valley of the lower basin. *In its* The Pecos River joint investigation, p. 231-243, illus., tables. Washington, 1942.

173.2 N214Pec

"Without effective artificial relief to supplement the good natural underground drainage into Pecos River, agriculture could not continue successfully in the areas worst affected," p. 231.

1560. VAN VLACK, C. H. We need more drainage. *Farm Sci.* Rptr. 5(1):11-14, illus. Jan. 1944. 275.28 F22

Recommended as one way to increase acreage and yield. Discusses outlets, location, depth and spacing, selection and laying of tile. Maintenance is considered for open ditches as well as tile.

1561. VERMAAT, J. G. Observations on drainage conditions of Ceylon paddy soils with particular reference to those of the low-country wet zone. *Trop. Agr. (Ceylon)* 109:279-286. Oct./Dec. 1953. Ref. 26 T751

For optimal production of rice, paddy requires subsoil and surface drainage to balance the water supply with water consumption.

1562. VIK, K. Nytte og skade ved felles tørrleggingstiltak. Nord. Jordbrforsk. 33:748-751. 1951. 11 N752

Benefits and disadvantages of joint drainage enterprises in Norway. Discusses erosion of land by drainage water, and the injury to fishing caused by the lowered water table.

1563. WALTON, L. Drainage for oats studied in Black Belt. Miss. Farm Res. 13(8):4,table. Aug.1950. 100 M69Mi

Experiments at the Black Belt Branch Experiment Station, Mississipi.

1564. WEIR, W. W. Drainage for orchards. West. Fruit Grower 8(5):15-16,illus. May 1954. 95.8 G762

Drainage of almond, walnut, pear, and peach orchards in California.

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1566. WOOD, I. D. The engineering revolution in agriculture. Agr. Engin. 33:613-616,626,illus. Oct.1952. 58.8 Ag83

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1567. WOOTEN, H. H., and LEE, A. T. M. Costly development is needed for most potential farm land. Agr. Situation 33:6-7. Jan. 1949. 1 Ec7Ag

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1568. YOUNG, T. W. The economy of adequate drainage for citrus in Florida coastal areas. Fla. State Hort. Soc. Proc. 64:60-64. 1951. 81 F66

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Includes drainage projects in Yugoslavia, Turkey, Pakistan, and India.

1570. MAGOON, E. H. Drenaje y salud en la zona Caribe. Salubridad y Asistencia Social B. Ofic. 48:57-213,217-404,407,614,illus., maps. Feb.-Oct.1945. 449.75 C892S

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1571. ACTIVITIES of the National Water Resources Committee. Civ. Engin. 7(3):167-177,illus. Mar.1937. 290.8 C49

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1572. ALLRED, C. E., ATKINS, S. W., and HENDRIX, W. E. Land drainage. Tenn. U. Rur. Res. Ser. Monog. 48:94-99,maps,tables. June 1937. Ref. 173.2 W89Co

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1575. BARNARD, J. W. Working shoulder to shoulder in the Old Line State. *Soil Conserv.* 20:84-90, illus. Nov. 1955. 1.6 So3S Group drainage projects in Maryland.

1576. BENNETT, H., and RULE, G. K. Men against the Glades. *Soil Conserv.* 17:129-135, illus. Jan. 1952. 1.6 So3S

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1577. BENNETT, H. H. Drainage of wet agricultural lands, for conservation and production. *Washington, U. S. Soil Conserv. Serv.*, 1946. 7 p. 1.96 R31St

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1578. BENNETT, H. H. Water in the ground; too much or too little. *Soil Conserv.* 16:153-157, illus. Feb. 1951. 1.6 So3S

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1579. BESTOR, H. A. The principal elements of a long time soil and water conservation plan for the Everglades. *Soil Sci. Soc. Fla. Proc.* 4A:90-99. 1942. 56.9 So32

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1580. BODDY, H. Drainage keeps Willow Grove "high and dry." *Soil Conserv.* 13:162-163. Feb. 1948. 1.6 So3S

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1581. BODDY, H. They all worked together. *Soil Conserv.* 20:40-43, illus. Sept. 1954. 1.6 So3S

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1583. CARAH, W. M. Pay dirt from Tule Lake. *Tractor Farming* 35(5):18, 20, illus. Sept./Oct. 1952. 58.8 T672

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1584. CARPENTER, R. W. Districts invoke drainage to increase crop-growing area. *Soil Conserv.* 8:275-277, illus. June 1943. 1.6 So3S

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The Florida Everglades, and the Everglades Drainage District.

1586. CLARENBACH, F. A. Putting order into drainage programs.

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1587. CLAYTON, B. S., and JONES, L. A. Controlled drainage in the northern Everglades of Florida. Agr. Engin. 22:287-288, 291. Aug. 1941. 58.8 Ag83

Description of the drainage system, maintenance of drainage ditches and pumping stations, subsidence of peat soils, mole drains, and levees.

1588. COLEMAN, W. H. Eight farmers drain land. Soil Conserv. 16:226-227. May 1951. 1.6 So3S

Cooperative project in Missouri to construct drainage ditches. Increased value of land in dollars per acre is given.

1589. DAVIS, J. F., and others. Wet lands of Virginia and community drainage enterprises. Washington, U. S. Bur. Agr. Econ. Appalachian Region, 1945. 26 p., maps. 1.941 L3W53

F. J. Marschner, R. McQuown, and A. J. McChesney, joint authors.

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1590. DOVELL, J. E. The Everglades — a Florida frontier. U. Fla. Econ. L. 6(5), 4 p.; (6), 4 p. Apr.-May 1947. 280.9 F663

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1591. DRAINAGE of Florida's Everglades. Engineer 165:444-446, illus., map. Apr. 22, 1938. Libr. Cong.

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1592. EAMES, H. F. Maryland's Eastern Shore revives. Soil Conserv. 20:114-119, illus. Dec. 1954. 1.6 So3S

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1593. EAMES, H. F. One needed practice led the way. Soil Conserv. 19:258-262, illus. June 1954. 1.6 So3S

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1594. EDMINSTER, T. W., WALKER, J. P., and LILLARD, J. H. Drainage in conservation farming. J. Soil & Water Conserv. 5:77-79, 93, illus. Apr. 1950. 56.8 J822

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1595. EDWARDS, H. G. Drainage puts fertile Delta lands to work. Soil Conserv. 9(1):7-14, illus. July 1943. 1.6 So3S

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1596. ELWELL, G. Secondary water control vital to 'Glades farming. Fla. Grower 61(4):15, 26, illus. Apr. 1953. 80 F6622

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1598. ESTES, H. Drainage construction. (Abs.) Assoc. South.

Agr. Workers Proc. 47:30. 1950. 4 C82

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1599. FRANCIS, C. J. Drainage in the Red River Valley of North Dakota. Agr. Engin. 33:787-788,790. Dec.1952. 58.8 Ag83

Covers the SCS drainage program, effect of climate on drainage, revision of drainage laws, technical standards, and farm drainage.

1600. FREYBURGER, E. Mutual drainage association speeds food production. Soil Conserv. 9:164-166,illus. Jan.1944. 1.6 So3S

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1601. GEE, H. C. What drainage and flood control mean to proper utilization of our land. (Abs.) Assoc. South. Agr. Workers. Proc. 45: 162-163. 1948. 4 C82

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1602. GROUT, R. Successful drainage is basic practice on wet land. Sci. Farmer (Pennsylvania) (n.s.) 2(1):6-7,illus. Summer 1954. 100 P381S

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Covers history of the drainage movement in the Mississippi Valley, drainage laws, the place of government in land drainage, how flood control has influenced drainage, and drainage districts of the Delta.

1603A. HARRISON, R. W., and KOLLMORGEN, W. M. Drainage reclamations in the Bartholomew-Boeuf-Tenas Basin of Arkansas and Louisiana. Ark. Agr. Expt. Sta. B. 476,68 p.,illus.,map,tables. Apr. 1948. 100 Ar42

U. S. Bureau of Agricultural Economics, cooperating.

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1604. HARRISON. R. W. Land economic research in the alluvial valley of the Lower Mississippi River. J. Farm Econ. 29:593-615. Aug.1947. 280.8 J822

Drainage, p. 608-612.

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1605. HARRISON, R. W. Louisiana's State-sponsored drainage program. South. Econ. J. 14:387-403,tables. Apr.1948. 280.8 So84

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1606. HAUGER, R. L. Drainage surveys in the Texas gulf coast area. Agr. Engin. 28:18,21, Jan.1947. 58.8 Ag83

Surveys undertaken in 1946 by Soil Conservation Service engineers in nine counties of east Texas, to determine: (1) The condition and capacity of existing drainage systems; (2) the needed improvements to existing systems; (3) the amount of additional drainage facilities needed; and (4) the costs and benefits of the drainage system. Includes drainage districts.

1607. HEWES, L., and FRANDSON, P. E. Occupying the wet prairie: the role of artificial drainage in Story County, Iowa. *Assoc. Amer. Geog. Ann.* 42:24-50, illus., maps, tables. Mar. 1952. Ref. 500 As73

Gradual transformation of the county from a semiswamp when the first settler arrived at the midnineteenth century to the productive agricultural land it is today.

1608. HIDINGER, L. L. Statewide drainage survey for Mississippi, 1938-1939. *Washington, Natl. Resources Planning Bd.*, 1939. 32 p., maps, tables. 173.2 N214Stw

The purpose of the survey was to develop plans for coordinating and rehabilitating the drainage systems of organized drainage districts. The method was to collect and compile data on surface drainage, to determine existing conditions in organized drainage districts, and to prepare plans for coordinating and rehabilitating organized public drainage systems in Mississippi.

1609. JONES, L. A. Soils, geology, and water control in the Everglades region. *Fla. Agr. Expt. Sta. B.* 442, 168 p., illus., maps, tables. Mar. 1948. Ref. 100 F66S

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1610. KING, B. Drainage for Coastal Plains area. *Soil Conserv.* 8:228-230, illus. Apr. 1943. 1.6 So3S

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1611. KNAPP, G. S. Water resources of the mid-continent area. *Civ. Engin.* 10:653-655, illus. Oct. 1940. 290.8 C49

Includes percentages of agricultural land in drainage enterprises.

1612. KOENIG, N. A comprehensive agricultural program for Puerto Rico. *Washington, U. S. Dept. Agr.*, 1953. 299 p., illus., map, tables. Ref. 1 Ag85Com

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1613. MCCLYMONDS, A. E. Other farmers liked what they saw. *Soil Conserv.* 17:244-246, illus. June 1952. 1.6 So3S

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1614. MCKINNON, A. D. Drainage in the Red River Valley. *Soil Conserv.* 12:104-107, 118, illus. Dec. 1946. 1.6 So3S

Organized drainage programs have increased the value of farmland in North Dakota.

1615. MAITS, B. Bring back your wet lands. *Country Gent.* 123(4):47, 101-103, illus. Apr. 1953. 6 C833

A community drainage program, Sussex County, Del.

1616. MANSON, P. W. Farm drainage in the future. *Agr. Engin.* 26:111-113, illus., tables. Mar. 1945. 58.8 Ag83

A brief review of the history of drainage in the United States is included. Recommends and predicts more farm drainage.

1617. MARYLAND and Delaware construct big drainage project. *Engin. News-Rec.* 139:628-629, illus. Nov. 6, 1947. 290.8 En34

Agricultural drainage by ditches. Construction and maintenance of ditches is discussed.

1618. MATSON, H. Soil and water management under the com-

plete watershed program. *Agr. Engin.* 33:625-626, illus. Oct. 1952. 58.8 Ag83

Includes the planning of structural works for flood prevention and drainage.

1619. MAUGHAN, J. H., ISRAELSEN, O. W., and HANSON, E. G. Drainage districts in Utah; their activities and needs. *Utah Agr. Expt. Sta. B.* 333, 64 p., illus., tables. Jan. 1949. Ref. 100 Ut1

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1620. MAYO, N. Possibilities of the Everglades. *Fla. Dept. Agr. B. (n.s.)* 61, 94 p., illus., map. Aug. 1938. 2 F66B

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1621. MERRICK, C. P. Maryland's public drainage program. *Agr. Engin.* 35:106, 108. Feb. 1954. 58.8 Ag83

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1622. NEW ENGLAND-NEW YORK INTER-AGENCY COMMITTEE. The resources of the New England-New York region. Boston, 1955. 3 pts. in 46 v. 173 N44R

Contents: Pt. 1, The general report; Pt. 2, The technical report; Pt. Pt. 3, Reference data.

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1623. OREGON STATE PLANNING BOARD. Land development in Oregon through flood control, drainage and irrigation. Portland, 1938. 221 p., illus., maps. 280.7 Or33Pr

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1624. OTTO, W. S., and HANNAMAN, D. A. After 100 years. *Soil Conserv.* 12:125, illus. Jan. 1947. 1.6 So3S

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1625. ROBINSON, E. C. Cooperative drainage between property owners, irrigation districts, and mosquito control. *Calif. Mosquito Control Assoc. Proc. & Papers* 18:87-88. 1950. 428 C763

The Modesto and Oakdale Irrigation Districts and the East Side Mosquito Abatement District in California cooperate in helping landowners drain their property.

1626. RUTH, P. W. The Boush Creek drainage problem at Norfolk, Virginia. *Mosquito News* 5:117-120, illus. Dec. 1945. 421 M85

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1627. SCOTT, H. A. Water control in central and southern Florida. *Amer. Soc. Civ. Engin. Proc.* 80(Separate 521) 20 p., maps, tables. Oct. 1954. 290.9 Am3Ps

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1628. SHAFFER, F. F. Functions of the soil conservation districts in drainage. *Agr. Engin.* 26:456-458. Nov. 1945. 58.8 Ag83

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1629. SHAFFER, F. F. Preliminary investigations for community drainage and flood protection projects. *U. S. Soil Conserv. Serv. Upper Miss. Region Tech. Note* 18, 6 p., illus. Aug. 3, 1944. 1.9605 T22  
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1630. SHERIDAN, C. M. Useless land in northern Wisconsin reclaimed by drainage, leveling program. *Land. Impr.* 2(9):12, 21, illus. Sept. 1955. 282.8 L224

Poorly drained and unproductive land in two counties on Lake Superior are being returned to productivity by an extensive program of

field drainage and leveling under the supervision of the U. S. Soil Conservation Service.

1631. SKERRETT, R. G. Farms for the Everglades. *Sci. Amer.* 158:325-327, illus., map. June 1938. 470 Sci25

Reclaiming the fertile farmlands by drainage.

1632. STEPHAN, L. L. Historico-economic aspects of drainage in the Florida Everglades. *South. Econ. J.* 10:197-211, map, tables. Jan. 1944. Ref. 280.8 So84

Federal and State legislation and financing of drainage and reclamation operations since 1847, with expenditures and tax rates. Points out the fact that the peat and muck soils are "highly susceptible to oxidation, shrinkage, and burning, when exposed to over-drained conditions," p. 210.

1633. SUTTON, J. G. Districts exchange water for land. *Soil Conserv.* 10:130-135, illus. Dec. 1944. 1.6 So3S

Drainage projects of soil conservation districts in Indiana, Wisconsin, Illinois, Iowa, North Dakota, South Carolina, Louisiana, Kentucky, Georgia, Oklahoma, and New York.

1634. SUTTON, J. G. Drainage operations of the Soil Conservation Service. Washington, U. S. Soil Conserv. Serv., 1947. 19 p., illus., maps, tables. 1.96 Op2Do

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1635. SUTTON, J. G. Engineering activities of the Soil Conservation Service. Washington, U. S. Soil Conserv. Serv., 1949. 10 p.

1.96 Op2Sut

Address before the Missouri Society of Professional Engineers, Cape Girardeau, Mo., Oct. 28, 1949.

Includes drainage activities.

1636. SUTTON, J. G. Nation-wide conservation drainage operations. *Agr. Engin.* 29:22-27, illus., tables. Jan. 1948. 58.8 Ag83

A review of drainage operations in different regions of the United States. Discusses drainage of irrigated lands, drainage of wet and muck lands, and different types of drainage resorted to.

1637. SUTTON, J. G. Our drainage problems. *Soil Conserv.* 5: 179-182, illus. Jan. 1940. 1.6 So3S

Summarizes drainage work by States, State organization of drainage enterprises, and the accomplishments of the CCC drainage camps.

1638. SUTTON, J. G. Problems in the drainage phase of the soil conservation program. Washington, U. S. Soil Conserv. Serv., 1945.

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1639. SUTTON, J. G. Relation of drainage to the Victory Program of agriculture. *Agr. Engin.* 23:249-250, 252, illus. Aug. 1942. 58.8 Ag83

Examples of the U. S. Department of Agriculture's work with farmers on their drainage problems. Includes comments on the drainage program in England.

1640. SUTTON, J. G. Status of land drainage in the United States. *Agr. Engin.* 18:455-457. Oct. 1937. 58.8 Ag83

A comprehensive report, with data on financing and work accomplished.

1641. SUTTON, J. G. What drainage and flood control mean to proper utilization of our land. (Abs.) Washington, U. S. Soil Conserv. Serv., 1948. 4 p. 1.96 R31Wh

Abstract of an address given before the annual meeting of the Association of Southern Agricultural Workers, Feb. 13, 1948.

Lists 12 causes for difficulties in drainage work, and discusses pro-

gress in drainage legislation and cooperative drainage enterprises in the United States.

Abstract in Assoc. South. Agr. Workers Proc. 45:168-169. 1948.  
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1642. TENNESSEE. STATE PLANNING COMMISSION. The Obion River and Forked Deer River watersheds; a report on drainage enterprises and land conditions within the area. Nashville, 1936. 17 p., illus., tables. 280.7 T250

Data on drainage, land use, financing, and drainage works in west Tennessee. Includes a history of drainage.

1643. U. S. BUR. OF THE CENSUS. Drainage of alluvial lands; a comparison of agriculture within and outside of drainage enterprises in the alluvial lands of the Lower Mississippi Valley. Washington, 1943. 97 p., maps, tables. 157.4 C167A

1644. U. S. CORPS OF ENGINEERS. Memorandum of understanding between Corps of Engineers, Dept. of the Army, and Soil Conservation Service, U. S. Department of Agriculture, with respect to drainage activities. Washington, 1948. 5 p. 152.26 M51

1645. U. S. DEPT. OF AGRICULTURE. Policies of the Department of Agriculture which concern water. Washington, 1954. 20 p. A292 Ag8

Policies concerning land-drainage enterprises, p. 16.

1646. U. S. NATIONAL RESOURCES COMMITTEE. Drainage basin problems and programs. Rev. ed. Washington, 1938. 154 p., maps, tables. 173.2 N214Dr

Land drainage, p. 131-134.

1647. U. S. NATIONAL RESOURCES COMMITTEE. Water planning and policy for drainage basins of the U. S. Washington, 1938. 40 p., maps, tables. Ref. 173.2 N214W

The program for developing river basins, under the Water Committee of the National Resources Committee, includes irrigation, flood control, and drainage.

1648. U. S. SOIL CONSERVATION SERV. Summary, group drainage work in Soil Conservation Districts with SCS assistance, calendar year 1953 and to date totals. Washington, 1954. 9 p., tables.

1.96 Op2Sug

Issued annually since 1946.

Partial contents: Job plans and cost estimates; Jobs completed and final costs; Practices included in job plans; Summary group enterprise plans (drainage, irrigation and other types) in soil conservation districts.

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From the U. S. Swamp and Overflow Land Grant Act of 1850, to the Florida Everglades Drainage District Act of 1941.

1650. WALLIS, W. T. The interrelationship of physical and economic factors in Everglades reclamation. Soil Sci. Soc. Fla. Proc. 4A:113-116. 1942. 56.9 So32

Includes economic arguments for and against the progressive drainage of the region as against immediate overall drainage.

1651. WARNE, W. E. Drainage and clearing — desirability and method. Reclam. Era 30:14-15. Jan. 1940. 156.84 R24

Suggests that the U. S. Bureau of Reclamation give more attention to the drainage of wet lands than has hitherto been the case.

1652. WEIR, W. W. Land drainage in California. Agr. Engin. 35: 482-485, illus. July 1954. 58.8 Ag83

Engineering history of drainage since the mideighteenth century. Covers drainage for flood control, drainage of irrigated lands, and tile drainage of the Imperial Valley in the recent past.

1653. WOLMAN, A. Drainage basin problems and programs. Engin. News-Rec. 118:476-479,illus.,tables. Apr.1,1937. 290.8 En34 Includes estimated cost of drainage projects in the United States.

1654. WOLMAN, A. Some recent Federal activities in conservation of water resources. Amer. Water Works Assoc. J. 28:1252-1292, Sept.1936. 292.9 Am32J

Includes Federal agencies interested in drainage.

1655. WOOTEN, H. H., and PURCELL, M. R. Farm land development, present and future, by clearing, drainage, and irrigation. U. S. D. A. C. 825,67 p.,illus.,tables. Oct.1949. Ref. 1 Ag84C.

Includes drainage in the Northeast, the Lake States, the Corn Belt, the Southeast, the Mississippi River Delta, Texas and the Southern Plains, and the Pacific Northwest.

1656. WOOTEN, H. H., and JONES, L. A. The history of our drainage enterprises. U. S. D. A. Ybk. Agr. 1955:478-491,illus., map,tables. Ref. 1 Ag84Y

History of drainage in the United States since the digging of the Dismal Swamp Canal in 1787 by Virginia and North Carolina.

1657. WOOTEN, H. H., and UTZ, E. J. Reclamation of new lands for agriculture — potentialities and problems in development by irrigation and drainage. United Nations Sci. Conf. Conserv. & Util. Resources Proc. 6:602-605. 1949, pub.,1951. Ref. 279.9 Un32P

States that more than 70,000,000 acres of improved farmland are in organized drainage enterprises in the United States, outlines the nature of future drainage programs in the country, and lists the results in increased crop yield per acre and enlarged farm incomes in the drained areas.

### Canada

1658. CANADA. DEPT. OF AGRICULTURE. PRAIRIE FARM REHABILITATION BR. Report on prairie farm rehabilitation and related activities, 1952-53. Regina,Sask.,1953. 78 p.,illus.,maps,tables. 281.13 C164

Includes drainage of irrigated lands.

1659. DANIKE, G. N. Development of irrigation projects in Saskatchewan. Agr. Engin. 20:474-476,illus. Dec.1939. 58.8 Ag83

Includes drainage.

1660. GRIFFITHS, J. A. The history and organization of surface drainage in Manitoba. Engin. J. 36:101-108,illus.,map. Feb.1953. 290.9 En3

A non-technical account of the evolution of Manitoba's scheme of land drainage.

1661. MCCUBBIN, G. A. Agricultural drainage in southwestern Ontario; its effect on stream discharge. Engin. J. 21:66-70,illus. Feb.1938. 290.9 En3

Describes the larger drainage schemes, and concludes that there is little or no indication of increasing flood discharge subsequent to the actual period of drainage construction in the area discussed.

### Greenland

1662. HORN. Das wasser spielt im Grünland eine grosse rolle. Landwirtbl. Weser-Ems 101:524-525. Apr.22,1954. 18 L2345 Drainage in Greenland.

### Mexico

1663. ANAYA, M. La construcción de nuevas obras de provisión

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Miller D B	1138	Moldboard plows	1363 1450
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1146-1150 1524		Australia	678 770 809
Miller G J	16	Austria	1171
Miller R D	135	bogs and swamps	
Miller W F	973	Australia	366 1195
Miller W McN	1220	Germany	1445
Milligan C H	1269	Gt Brit	1794
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Germany	1182	U S S R	1123
Peru	807	California	756
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1352 1789		costs	1183
Minnesota	335 337 526	Australia	1195 1213
901 1091 1543 1582		Germany	1124 1182
Minnesota Agricultural Experi- ment Station	525	Gt Brit	1160 1161 1468
Minnesota Legislative Interim Commission	337	Ireland	1135
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Minshall N E	708 858	Denmark	804
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Navuk Institut Melioratsii Vod- nogo i Bolotnogo Khoziaistva	719	equipment	1385
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Miramontes F C	1270	France	1126
Mission Française d'Outre- Mer	720	Gt Brit	1026 1048 1160
Mississippi	486 986 1047	1161 1349 1398 1468	
1497 1563 1595 1598 1608		Iceland	1359
Mississippi Agricultural Experi- ment Station		New Zealand	1078
Black Belt Br	1563	Sweden	1076
Mississippi Delta	16 323 495	Union of South Africa	1167
1483 1603 1604 1643 1655		U S S R	1439 1460
Mississippi Valley	227 595	Finland	1109
1519 1524 1628		Florida	677
Missouri	186 298 309 631	France	1126
816 882 890 915 1237		Germany	1042 1113
1248 1318 1325 1588		Gt Brit	17 700 701 729
Missouri Society of Professional Engineers	1635	732 733 1026 1048	1049
Missouri Valley Loess Region Conservation Experiment Sta- tion (Iowa)	270	1064 1068 1158 1160	1162
		1349 1529 1799 1804	
		history	
		New Zealand	1100
		Sweden	1076
		Ireland	1824
		irrigated soils	471
		Australia	366 1195
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		Louisiana	1091 1548
		mineral soils	1201
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Netherlands		1092		construction	1327	1461	
New Zealand	9	484	535	Denmark	649	1376	
536	627	699	711	design	1044	1342	
769	1038	1078	1079	Germany	1124		
1152				Gt Brit	151	633	1159
Norway			1075	1161	1343	1349	1356
Oregon			749	1388	1400	1420	1423
peat and muck soils		538	696	in mosquito control			1397
Florida		488	1091	maintenance			1100
New Zealand		484	535	Netherlands			1378
536				New Jersey			1443
U S S R	506	537	1461	New Zealand	536	1079	1094
research			1183	1144	1174	1327	1361
Georgia				Sweden	1017	1050	1378
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Iowa				U S S R			1100
New Zealand	1093	1094	1101	1427			1461
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Scotland				Molinelli J C			870
Sweden				Mollenkopf J F			975
Switzerland				Monhemius L			1271
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1201	1202			Montana			1273
Wales				363			388
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Germany				Moon C L			167
New Zealand		1043	1081	Moore R E			1409
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1100	1174			Brit)			1829
bogs and swamps				Morel C	722	723	1410
New Zealand		1043	1079	1746-1748			1525
1080	1081	1100	1101	Morestel Marshes (France)			1703
1174				Morgan A M			266
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Florida				Morgan M F			144
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1064	1161	1370		Morishima S			1189
Louisiana				Morocco			1
maintenance				Morris R			1837
Netherlands				517			497
New Jersey				Morris R E			517
New Zealand	1043	1080	1100	Morris W			1154
1144	1174			Morrow R R			567
size		1080	1100	Mors project (Denmark)			1692
slope			1174	Mortensen T			1749
strength and durability			1153	Mosquito control	61	574-	614
1045	1144	1153	1420	805	1392	1417	
strengthening				California	574	593	608
Union of South Africa				614	1625		
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1440				Connecticut			1355
Wales				Delaware		83	1397
Mole plows		1333	1347	Dominican Republic			1667
1446	1452			El Salvador			1674
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Italy	1481	pij	640
Louisiana	1761	Needs	472
Massachusetts	1565	22	461
Mississippi Valley	595	808	1469
New Jersey	583	1494	1470
606	600	1499	1487
1262	1274	1505	1511
1415	1416	1511	1517
1456	1457	1518	1556
New York	583	1521	1556
Nicaragua	1668	1533	1546
Nigeria	1673	1546	1556
Ontario	577	1560	1567
Panama	584	British West Indies	899
Peru	586	California	389
research	1684	Ceylon	1561
Portugal	598	Gt Brit	729
Rhode Island	603	Louisiana	1510
Solomon Islands	1866	Netherlands	1522
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Tennessee	580	New Zealand	1559
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Nebraska	161	1253	1271
298	861	1317	1322
423	969	1338	1365
		1378	1393
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		1478	1515
		1538	1552
		1698	1700
		1701	1708
		1714	1718
		1723	1728
		1735	1742
		1745	1750
		1750	1752
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New Jersey	109	579	583		942 965 968 1075 1265
	600	601	606		1366 1496 1562 1725 1775
	693	916	1262	1274	Nova Scotia 342
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New Mexico	207	209	301		Nyasaland 897 1844
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New York	33	102	239	583	Oats 1563
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North Africa			675		651 1062 1266 1289 1429
North Carolina	226	265	486		1661
	543	562	835	929	Open-ditch drainage 2 6
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North Dakota	253	271	339		664 671 754 759 800
	844	1574	1597	1599	808 893 999
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Norway	555	942	Florida	488
Oregon		1623	New Zealand	484
Rhodesia		753	Scotland	521
Brazil		957	U S S R	500
California		756	Puerto Rico	967
Canada	573	652	research	119
Ceylon		1855	Finland	1545
costs		399	Utah	442
Florida		690	saline-alkali soils	401
Netherlands		768	429	417
Wyoming		436	Gt Brit	1793
dairy farms		992	Netherlands	676
Delaware	916	1617	U S S R	902
Denmark	736	804	Scotland	500
design		1293	small farms and gardens	521
Egypt		702	736 901	1426
Finland		698	Spain	622
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Louisiana		614	Switzerland	659
Mississippi Valley		595	544 549	996
Nicaragua		1668	Tasmania	785
Tennessee Valley		590	Texas	867
forests		546	Trinidad	944
Germany		547	U S S R	706
Latvia		551	Utah	686
Norway	555	570	Orchards	361
Sweden		563	1164 1480	1518
France	722	1741	1539 1564	
Germany		996	Australia	678
Gt Brit	108	733	1799	1069
Gulf States		1820	1551	1130
Idaho		1500	California	483
India		55	Netherlands	1564
irrigated soils	399	20	747 1478	996
472		446	1552	1538
Arizona		453	New Zealand	699
Montana		471	North Africa	675
Nebraska		371	Sweden	1063
Puerto Rico	396	363	Tasmania	785
Wyoming		423	Washington	368
Italy	788	423	Oregon	220
Louisiana		436	231 256	260
Madagascar		982	391 426	1474
Maryland		941	445 749	1623
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Netherlands	916	1592	Oregon State Planning Board	445
767 773	1251	1617		1623
1757 1784	1253	1701	Orlov P M	560
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New Zealand	693	764	Otto W S	1624
769 783		1085	Outlets	644
North Africa		1253	74 360	644
North Carolina		1701	664 671	727
Oregon		1701	759 782	740
peat and muck soils	519	1623	800 888	744
Finland		696	1028	1028
	528	539	1085 1117	1165
			1198 1286	
			1560	
			Australia	440
			California	801
			Canada	652
			clay	1025
			cleaning	793 1049
			concrete	1105
				818 983

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construction	713	760	846	Parker E R		1536
983 1064	1385			Parker G G	254	1537
design		946	978	Parker W V	599	607
France			755	Parkins A E		16
grassed	7	708	836	Parshall R L	980	981
849 855	878			Parshall flume	980	981
British West Indies			899	Parsons O J		1275
Missouri			890	Pasini B	982	1760
Oklahoma			891	Pasto Irrigation project (Puerto Rico)		1672
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South Carolina			891	Pattantyus A G		1276
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India			896	Paukkonen N		1430
Iowa			1209	Paulsen C		255
maintenance and repair			760	Paulsen C G	256	257
795 846	851	958	991	Pearce O W M		1166
1025 1283				Pearson C H O		1167
Denmark		691	804	Pearson R W		47
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metal			1025	Peatfield A E		983
Michigan			504	Peat and muck soils	7	21
New Zealand	699	1078	1079	484—540	632	672
1175				800 1027	1117	1512
Ontario			1429	Australia		1871
Oregon			749	burning		1512
peat and muck soils			525	distribution		532
protection	793	831	851	Finland	524	528
878 1073	1105	1197		Florida	146	488
Denmark				529 1091	1438	1609
Iowa			804	Gt Brit	1475	1802
Netherlands			1132	Indiana	494	502
pump	1263	1283	1284	Ireland	496	510
size			1286	Louisiana		505
Southern States			892	Michigan		502—504
Tasmania			1013	Minnesota		526
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Overholt V		740	1165	New Zealand	9	484
Overy B B			151	Northern States		525
Pacific Northwest		228	1655	Norway		501
Pacific Northwest Conservation Experiment Station (Wash)			228	Ontario		157
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Pakistan	470	667	1569	Finland		539
1853 1858			1845	Indiana	507	508
Palmer L			1535	Michigan		491
Palmer V J		831	874	New Zealand		535
987			979	Scotland	510	516
Panama			576	subsidence	521	522
Panarin M N			1570	Finland		497
Pannwitz E			1427	Florida		512
Papaniko-Laou D L			1428	Gt Brit		489 1587
Paradis A			1759	Indiana		1475
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534 537 706 1461	peat and muck soils 696
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Peru 807 1684	New Jersey 1457
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451 1257 1278	Union of South Africa 900
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Australia 1287	1784
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Potatoes			1241	Puerto Rico	396 903 918
Pothole drainage		844	901	966 967 1570	1612 1672
Potter W D	54	263-	265	Pump drainage	7 408 694
Powell T			1842	759 1293	
Powers G E			601	alluvial soils	662 1623
Powers W L	445	749	1170	Australia	425
Pozo Rodriguez P del			1682	bogs and swamps	
Pratelli G			158	Canada	1244
Price M			603	Denmark	1261
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408 694 1470			1547	New Jersey	1262 1274 1298
1560 1577 1586		1616	1617	Oregon	1623
1628 1634-1640		1646	1651	Southeastern States	1294
1653 1654 1657				British Guiana	1678
California	593	608	1581	costs	1257
1625				Australia	1287
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Delaware			1615	Egypt	1839
Estonia		1758	1769	Florida	1242
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Great Plains			1655	Gt Brit	1806
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Manitoba			1660	irrigated soils	453 471
Maryland	1584	1592	1593	California	482 1302
1621				India	467
Midwestern States			1611	Puerto Rico	1672
Mississippi		1598	1608	Utah	407 409
Mississippi Delta		1603	1604	Italy	1711
1643 1655				Netherlands	802 1251 1698
Netherlands			1714	1757	
New Mexico			1573	New Zealand	9 662
New Zealand		1865	1868	Norway	1265
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Norway			1775	peat and muck soils	1252 1300
Pacific Northwest			1655	research	
Pennsylvania			1602	Utah	410 1257
Puerto Rico			1612	Rumania	1279
South Carolina	354	1610		saline-alkali soils	401 417
Southeastern States	1610	1655	429 1277		
Texas			1655	Switzerland	1281
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Florida	488	testing	1270
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1300 1816	1291	SEE ALSO Windmills	
Illinois	1231	Purcell M R	1655
Italy	1776	Pusic B	1732
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Netherlands	1228 1253	1271	
Puerto Rico	1672	Quebec 342 625 634	1088
Switzerland	1281	1210 1441	
Texas	1233 1250	Quicksand	644 1056
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Australia	440	Rae R	446
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