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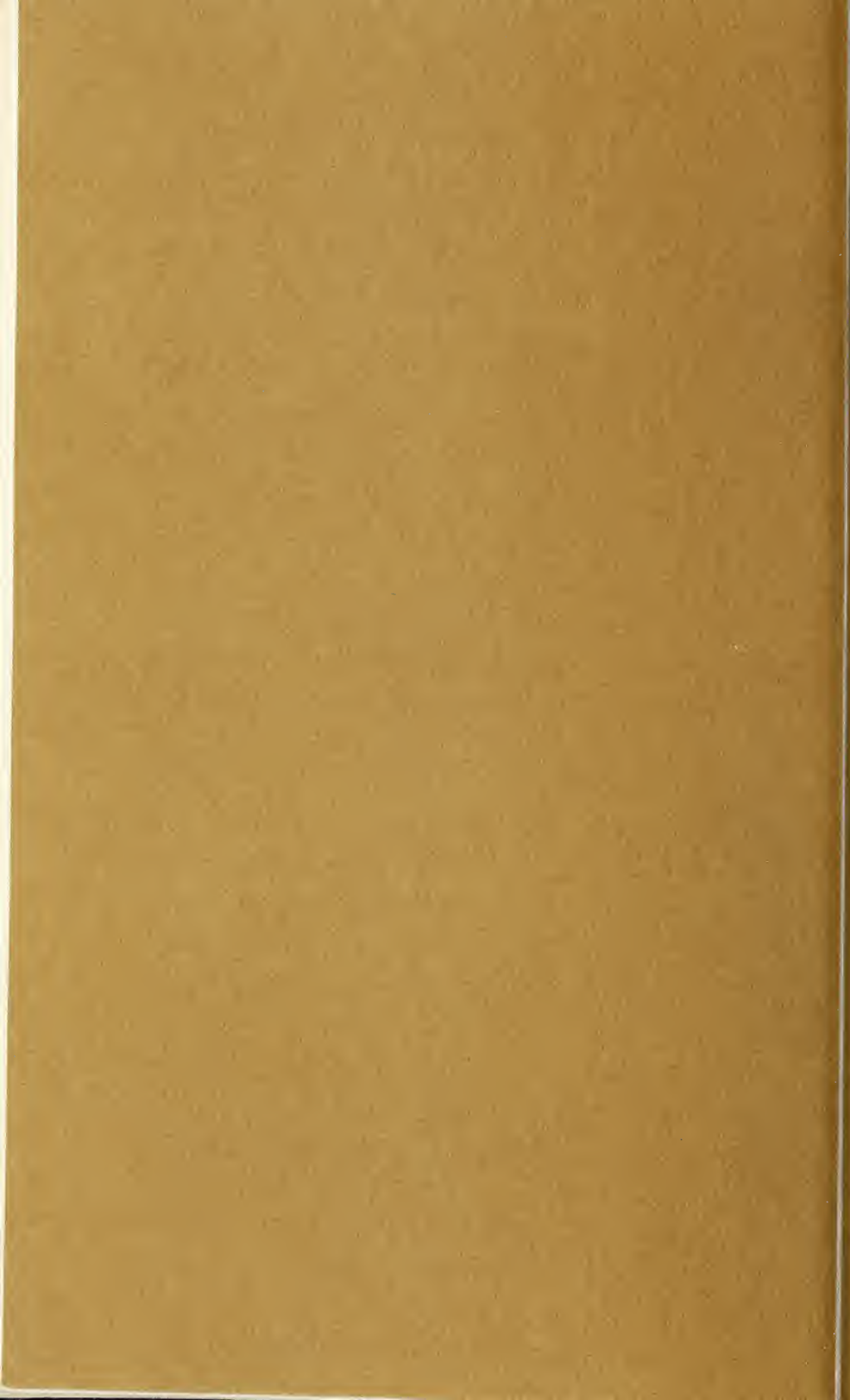


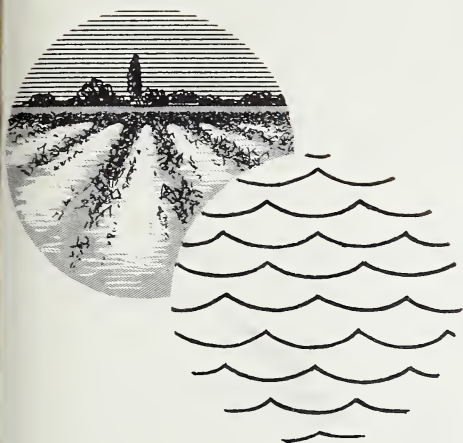


**DRAINAGE OF  
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LAND-A Bibliography  
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# **DRAINAGE OF AGRICULTURAL LAND-A Bibliography of Selected References**

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## SOURCES CONSULTED

### Card Catalogs:

U. S. Department of Agriculture Library.

### Indexes and Abstracting Journals:

Agricultural and Horticultural Engineering Abstracts, 1950-1954.  
Agricultural Index, 1936-1955.  
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Bibliography of Agriculture, 1942-1955.  
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Current Literature in Agricultural Engineering, 1936-1942.  
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Vertical File Index, 1936-1955.

### Bibliographies:

Graf, D. W. Irrigation, a Selected Bibliography. Washington, U. S. Bur. of Agricultural Engineering, 1938. 631 p.  
Israelsen, O. W. Published References Regarding Drainage. n.p. 1953. 23 p.  
National Research Council. Highway Research Board. Survey and Treatment of Marsh Deposits. Natl. Res. Council Highway Res. Bd. Bibliog. 15,95 p. 1954.  
U. S. Soil Conservation Serv. Annotated Bibliography on Sedimentation. 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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# CONTENTS

	Page
GENERAL.....	1
Research.....	4
Soil Science in Relation to Drainage.....	7
Hydrology in Relation to Drainage.....	20
LEGISLATION AND FINANCE.....	29
SPECIAL PROBLEMS IN DRAINAGE.....	33
Irrigated Lands.....	33
Peat and Muck Soils.....	44
Forests.....	49
Mosquito Control.....	52
DRAINAGE PRACTICES.....	56
Surface Drainage.....	71
Open-ditch Drainage.....	79
Subsurface Drainage.....	86
Pump Drainage and Wells.....	103
Dams, Dikes, and Levees.....	109
Equipment.....	111
DRAINAGE NEEDS AND EFFECTS.....	121
PROJECTS AND PROGRAMS.....	129
North America.....	129
U. S. A.....	129
Canada.....	137
Greenland.....	137
Mexico.....	137
Central America and the West Indies.....	138
South America.....	139
Continental Europe.....	139
British Isles.....	147
Africa.....	151
Asia.....	151
Australia, New Zealand, and the Pacific Islands.....	153
INDEX.....	155



DRAINAGE OF AGRICULTURE LAND  
A Bibliography of Selected References

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Elizabeth Gould Davis  
and  
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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

Reclamation and drainage from Sumerian times to the present.

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.

Section heads include: Distribution of wet lands; The purpose of drainage; State ownership and regulation; Growth of organized drainage; Drainage in the Great Lakes region; Lower Mississippi Basin region; Gains and losses from drainage.

Also in Parkins, A. E., and Whitaker, Jr., ed., Our natural re-



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.

21. ROE, H. B., and AYRES, Q. C. Engineering for agricultural drainage. New York, McGraw-Hill, 1954. 501 p., illus., maps, tables. 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

Section heads include: Extent of drainage; Drainage enterprises; Land in need of drainage; Soil Conservation District program; Special State programs; Drainage and flood control; Drainage requirements of culverts and bridges; Tile drainage.

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

24. U. S. BUR. OF THE CENSUS. Sixteenth Census of the United States: 1940. Drainage of agricultural lands; land in drainage enterprises, capital invested, and drainage works. Washington, 1942. 683 p., maps, tables. 157.4 C167A

25. U. S. SOIL CONSERVATION SERV. Report of the Chief, 1935-53. Washington, 1935-53. 19 v., illus., maps, tables. 1.6 S3R

Reports before 1939 included watershed and hydrologic studies, sedimentation and hydraulics, flood control, diversion ditches, water-conservation dams, gully control, etc. Beginning in 1939 each report contains a section devoted to drainage.

26. WEIR, W. W. Irrigation and land drainage. In his Soil science, rev. ed., p. 247-267, illus., Philadelphia, Lippincott, 1949. 56 W43

Includes a history of land drainage since prehistoric times, and presents a summary of drainage practices in the world today. Types of drains, drain construction, reasons for drainage, and results of good land drainage on both irrigated and nonirrigated soils are discussed.

27. WILLIAMS, P. C. Land reclamation and drainage. Land Agents' Soc. J. 50:119-121. Mar.1951. 282.9 L22

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.

32. BOUMANS, J. H. Het bepalen van de drainage-afstand met behulp van de boorgatenmethods. Landbk. Tijdschr. 65:82-104,illus. Feb./Mar.1953. Ref. 105.2 Or3

Determination of the drainage distance by means of the borehole method. Discusses the physico-mathematical solution of drainage problems based on the derivation of formulae relating to flow equilibria, the determination of drainage norms, and the determination of soil permeability by the borehole method.

33. BOUWER, H., and others. Drainage research methods on stony soils. Agr. Engin. 36:591-592,594,illus. Sept.1955. Ref. 58.8 Ag83

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

Research in connection with drainage of heavy clay soils in humid climates, and with similar soils in arid climates after irrigation.

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

A discussion of the value of piezometers for studying the flow of ground water and as an aid in determining the actual permeabilities of soil strata.

37. COLMAN, E. A. A laboratory study of lysimeter drainage under controlled soil moisture tension. Soil Sci. 62:365-382,illus., tables. Nov.1946. 56.8 So3

On the basis of the present study, drainage of lysimeter soils under controlled moisture tension offers a possible solution to the problems of the removal of abnormal moisture usually found in those gravity-

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

Material based largely on studies made over a period of years in Imperial and San Fernando Valleys in California. Covers ground-surface investigations, soil investigations, water-table investigations, water-source surveys, and types of drainage systems and structures.

39. FIALKOVSKII, P. G., and SHRAG, V. I. Problems and objectives of soil investigations in marshy and swampy territories for the purpose of planning drainage measures. (In Russian.) Pochvovedenie 4:82-84. Apr. 1955. 57.8 P34

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

Technical exposition of a method of soil-moisture measurement based on the considerations that hydrogen is the only material that will slow fast neutrons, and that hydrogen in soils is present almost entirely in the form of water.

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.

Research apparatus.

42. GAY, C. B., and THORNTON, J. F. Drainage and use of soils along the south Atlantic coast. (Abs.) Assoc. South. Agr. Workers Proc. 48:170-171. 1951. 4 C82

The work of the Southeastern Tidewater Soil Conservation Experiment Station in Georgia will stress the importance of drainage in the southern Tidewater. Investigations will include ditch spacings, variable depth ditches, tile drainage, mole drainage, and surface disposal.

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

Investigations into the several trends in the phosphate status of soils of different drainage conditions, conducted by the Macaulay Institute for Soil Research, Aberdeen.

44. HENDRICK, J., and WELSH, H. D. Further results from the Craibstone drain gauges. Highland & Agr. Soc. Scotland Trans. (5th ser.) 50:184-202, tables. 1938. 10 H536

Lysimeter investigations in Scotland.

45. HESTER, J. B. The fate of phosphate soil supplements. Amer. Fert. 109(13):7-9, 24; 110(1):11, 24, 26, tables. Dec. 25, 1948 - Jan. 8, 1949. Ref. 57.8 Am3

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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

Data collected in a three-year experimental study of seepage losses from typical canal sections. Includes studies of flow of ground water.

47. JAMSON, 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

Pressure-control apparatus and pressure-plate cells used for tension studies of the soils as well as soil-tension columns used in drainage studies are described. From the data one should expect all



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

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Research in the field of drainage. Includes the piezometer method and the auger-hole method.

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50. KOHNKE, H., DREIBELBIS, F. R., and DAVIDSON, J. M. A survey and discussion of lysimeters and a bibliography on their construction and performance. U. S. D. A. Misc. P. 372, 67 p., tables. May 1940. Ref. 1 Ag84M

Includes a history of lysimeter studies and a tabulated record of lysimeters constructed since that of De la Hire in 1688 and up to 1939.

51. KRIMGOLD, D. B. Kostiakov on prevention of waterlogging and salinity of irrigated land. Agr. Engin. 26:327-328. Aug. 1945. 58.8 Ag83

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52. LUTHIN, J. N. An electrical resistance network solving drainage problems. Soil Sci. 75:259-274, illus. Apr. 1953. Ref. 56.8 So3

A resistance network employing variable resistors or rheostats is described. The network is capable of solving Laplace's equation and hence is of use in analyzing drainage problems.

53. LUTHIN, J. N. A piezometer method of measuring soil permeability and application of permeability data to a drainage problem. Iowa State Col. J. Sci. 24:79-80. Oct. 1949. 470 Io9

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.

54. POTTER, W. D. Use of short-term runoff records in probability studies. Assoc. Internatl. d'Hydrol. Assemblée Gén. 3:240-251. Ref. 1951. 292.9 As7A

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.

57. RICHARDS, L. A. Hydraulics of water in unsaturated soil. Agr. Engin. 22:325-326, illus. Sept. 1941. 58.8 Ag83

The use of the concepts and methods of hydraulics in attacking certain moisture-movement problems connected with irrigation and drainage research.

58. SALTER, R. M., and KELLEY, O. J. Research, a key to the future. U. S. D. A. Ybk. Agr. 1955:694-700. Ag84Y

Needed research in water problems, including drainage.

59. SKOV, K. S. Försøgsmaessig underbygning af draeningsarbejder. Danske Hedeselsk. Hedeselsk. Tidsskr. 76:27-30. Feb. 15,

1955. 11 H35

Drainage research in Denmark.

60. SMITH, C. A. Note on the setting up of a battery of small lysimeters. New Zeal. J. Sci. Tech. 35A:394,illus. Dec.1953. 514 N48A

A simple method of removing intact soil cores and installing them to form a battery of small lysimeters is described.

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.

62. STOLP, D. W., and KNOPPIEN, P. Een hydrologisch onderzoek in het waterschap Vleuten. Netherlands. Dir. van de Tuinbouw. Meded. 17:37-48,illus. Jan.1954. 86 N384

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 EDMISTER, 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. Internatl. 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 streamlines 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. Internatl. 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. Internatl. 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. 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. 1 Ag84F

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

111. HOOGHOUT, 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. HOOGHOUTD, 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 Landbk. 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. Internatl. 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.) Vsesoiuzn. 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 Mex.* 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 erosion-al 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. *Internatl. Cong. Soil Sci.* 4th Trans. 3:13-17, illus. 1950. 56.09 In844

Contents 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 humeuzes 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.

145. NEAL, J. H. Relation of drainage to erosion control. *Minn. Agr. Engin. News Let.* 78, 1 p. Sept. 15, 1938. 287.29 M66Ag

A well drained soil will lose by surface runoff only one-third as much as a saturated soil. Both tile and terrace drainage are discussed.

146. NELLER, J. R., and FORSEE, W. T., JR. Installation of lysimeters in the peat soil of the Florida Everglades. *Soil Sci. Soc. Fla. Proc.* 3:102-106, illus. 1941. Ref. 56.9 So32

Details of the installation are given, including a subirrigation device which provides the type of subirrigation at controlled water-table levels practiced in cultivated lands of the Everglades.



147. NELSON, L. B., and MUCKENHIRN, R. J. Field percolation rates of four Wisconsin soils having different drainage characteristics. Amer. Soc. Agron. J. 33:1028-1036, illus., tables. Nov. 1941. Ref. 4 Am34P

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#### LEGISLATION AND FINANCE

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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.

319. FERGUSON, F. L., and DOWNING, C. G. E. Farm drainage and drainage acts in Ontario. Agr. Engin. 32:39-40,43. Jan.1951. 58.8 Ag83

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329. ISRAELSEN, O. W., MAUGHAN, J. H., and HANSEN, E. G. Drainage under the Utah drainage district law. Utah Farm & Home Sci. 7(3):5,16-17,illus. Sept.1946. 100 UtlF

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337. MINNESOTA. LEGISLATIVE INTERIM COMMISSION. Report on water conservation, drainage and flood control. St. Paul,1955. 51 p. 292 M666

338. NATIONAL RESOURCES COMMITTEE. WATER RESOURCES COMMITTEE. New water laws needed in the West. Reclam. Era 30:18-19. Jan.1940. 156.84 R24

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339. NORTH DAKOTA. LAWS, STATUTES, ETC. North Dakota conservation laws: drainage, irrigation, water conservation, miscellaneous. Bismarck?1939. 188 p. 280.7 N81Nd

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340. PAYING for water—a new formula. Farm Mangt. 2(8):45-47. July 1953. 281.8 F2225

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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.S04

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 canaveira 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. FUHRMAN, 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

Discusses the effects of salinity on various crops and plants, and states that over-irrigation in arid regions "may accelerate the rise of the water table unless provision is made for adequate drainage," p. 3-4.

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. Internatl. 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. Internatl. Soc. Soil Sci. Comn. 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. MCLAUGHLIN, 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). Internatl. 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. Un-saturated 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 un-saturated 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.

457. ROGERS, H. Get the jump on drainage. Farm Managt. 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 hydrautomats, 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 Utl

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.) Vsesoiuzn. 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 torriagning—torvjordarnas godaling. *Svenska Vallioch 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. DOGETT, 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.) Vsesoiūzn. Akad. Sel'skokhoz. Nauk im. V. I. Lenina. Dok. 15(2):43-47. 1950. 20 Ak1

500. GOLIAKOV, 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 draitiles 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 KOLLMORGEN, 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. IANGOL, A. M. Mole drainage in peat soils. (In Russian.) Vsesoiūzn. 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 myrskultivering 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.) Dostizheniia Nauk. i Peredovogo Opyta v Sel'sk. Khoz. 3:87-88. Mar. 1952. 20 D742

512. LUKKALA, O. J. Soiden turvekerroksen painuminen ojituksen 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. MALMTROM, 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. Kompleksnafa mekhanizatsiia osusheniia bolot i zagotovki torfa na udobrenie. Minsk, Akademii 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-Traktornafa Stat. 13(4):3-5. Apr. 1953. 58.8 M11

516. M'LAREN, J. The carse 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

Results for 1931-1940 from drainage experiments at the Karelian Experiment Station of the Finnish Peat Society. With a drain distance of 20 cm., covered drains produced a slightly lower yield of pasture than did open drains.

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. SHAFER, 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



Intended for the use of engineers and others who are called upon for assistance in planning controlled drainage on peat and muck soils.

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.

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

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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.) Vsesoiuzn. Akad. Sel'skokhoz. Nauk im. V. I. Lenina. Dok. 17(5):24-30. 1952. 20 Ak1

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539. WARE, M. Maan vesisuhteista ja viljelyskasvien sadoista maasojan vesitaloudellisella koekentalla vuosina 1939-1944. Maa- ja Vesitek. Tutkimuksia 5, 240 p., illus., tables. 1947. Ref. 56.8 M11

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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, Goslestekhzdat, 1945. 375 p., illus. 290 D852G

Hydrotechnical reclamation of forest lands in Russia.

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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. 99.8 F768

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545. HEIKURAINEN, L. Havaintoja metsäojituksen vaikutuksesta turpeen lampöälouteen. *Metsätaloudellinen Aikakauslehti* 1:31-34. 1954. Ref. 99.9 F49

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Ditch drainage by blasting.

547. JAHN, G. Aktuelle T A N-probleme. *Wald* 2:47-51, illus. Feb. 1952. 99.8 W143

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548. JUNGSTEDT, B. O. Rensningar och kompletteringsarbeten å skogsdikningsfronten. *Svenska Skogsvårdsför. Tidskr.* 44:29-48. 1946. 99.8 Sk5

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554. LINDBERG, K. Modern skogsdikning. Svenska Skogsvårdsför. Tidskr. 49:67-80,illus.,tables. 1951. 99.8 Sk5

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

The danger of the transformation of forests into swamps as a result of increased bog formation in Norway. Recommends drainage by ditching.

556. LUKKALA, O. J. Metsäojien kunnossapito. Die instandhaltung der waldgräben. Finland. Metsätieteellisen Tutkimuslaitoksen. Julkaisu. 36(1):1-64,illus.,tables. 1948. Ref. 99.9 F493

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560. ORLOV, P. N. Mechanization of drainage work—a method for increasing the productivity of forests. (In Russian.) Lesn. Khoz. 4(9):53-57,illus. Sept.1951. 99.8 L5622

561. PLAISANCE, G. Les assainissements en forêt par les moyens mécaniques. Rev. Forest. Franc. 10:553-563,illus. Oct.1950. 99.8 R329

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562. PRUITT, A. A. A study of the effects of soils, water table, and drainage on the height growth of slash and loblolly pine plantations on the Hofmann Forest [N. C.]. (Abs.) J. Forestry 45:836. Nov.1947. 99.8 F768

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564. SALWEN, N. Modern skogsdikning. Skogen [Stockholm] 38:83-84,illus. Aug.15,1951. 99.8 Sk51

Modern forest drainage in Sweden.

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

On the use of dynamite in blasting forest ditches. Technique of blasting for drainage in Norway.

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

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573. WILSON, E. Warning. Forêt Québécoise 14:310-311. May/June 1949. 99.8 F79

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Draining the Moro Cajo Slough in California, by means of ditches, culverts, and tide gates to control flooding by rainwater, for mosquito control.

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

Drainage of a low-lying swamp by enclosing it by a seawall, and directing the water through a series of channels to a sluice gate which controls its flow into the creek.

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

Describes the design of a concrete box culvert in connection with a

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

Concrete linings for mosquito control drainage ditches in eastern Virginia.

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

Discussion, p. 89-91.

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. NAJERA 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. RAINEY, 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 agonomic 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. *Internatl. 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.

627. BOWLER, D. G. Drainage for the dairy farm. *Massey Agr. Col. Dairyfarming Annu.* 1954:63-67. 44.9 M382

Costs, equipment, and types of drainage suitable for New Zealand dairy farms. Mole and tile drainage are discussed, together with subsidiary surface drainage by means of grassed waterways.

628. BRANT, E. H. Land drainage in north Bucks. *Gt. Brit. Min. Agr. Agriculture* 61:497-501. Jan. 1955. 10 G79J

Costs of drainage of heavy-clay farmlands in England.

629. CANALINI, G. La bonifica integrale nel sistema del nuovo Codice Civile. *Ital. Agr.* 78:647-656. Sept. 1941. 16 It1

Irrigation, drainage, and other forms of land improvement.

630. CIOLINA, F. La maîtrise et utilisation agricole des eaux aux Etats-Unis. *Agron. Trop.* 6:186-188. Mar./Apr. 1951. 26 Ag86

Drainage in the United States with a view to its application in Africa.

631. CLARK, M. W. Planning farms for management of runoff water. *Agr. Engin.* 24:197-198, illus. June 1943. 58.8 Ag83

Includes provision for drainage in Missouri.

632. CONTACTGROEP OPVOERING PRODUCTIVITEIT. Uitvoering van cultuurtechnische werken in de Verenigde Staten. 's-Gravenhage, 1954. 70 p., illus., map. 54 C769

English summary, p. 57-60.

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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

Types of drainage described are: Interceptor type; thorough draining on heavy land; deep drains, laid wide apart; mole drains. Tile drainage is discussed in connection with deep drainage and "thorough" drainage. Mechanical aids are the steam drainer, mole plow, bulldozer unit, and a combined trench digger and tile layer.

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

Some of the topics discussed are ditching, present progress in field draining, drainage runoff, percolation, tile draining, mole draining, and the historical development of field drainage in Great Britain.

734. NICHOLSON, H. H. The present condition of drainage as a limiting factor in productivity. *Agr. Prog.* 14:234-240. 1937. 10 Ag86  
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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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England.

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

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

Drainage experiments on marshland in Denmark.

738. ODLE, M. Does your farm need a drainage system? *Purdue Agr.* 46(5):4-5,14, illus. Feb.1955. 6 P97

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739. OLIVEIRA E SOUSA, E. S. D.' O enxugo das terras por meio de drenos. *Lisbon Inst. Super. de Agron. An.* 18:171-287, illus. 1951. Ref. 105.7 L682

The drying out of soils by means of drainage. Includes dimensions and declivity of drains, and spacing and depth.

740. OVERHOLT, V. Climate, topography and drainage. In *America Institute of Real Estate Appraisers. Real Estate Appraisal*

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742. PETTERSSON, B. Verkmyr; ett gotländskt utdikningsprojekt i kritisk belysning. *Sveriges Natur* 37(1):9-34. 1946. 410 Sv2  
Drainage of marshland in Gotland.

743. PHILLIPS, F. A. Hydraulic length in drainage design. *Commonwealth Engin.* 37:364-366. Apr.1,1950. 290.8 C73

Formula and chart development for determination of hydraulic length to be added to physical length to equalize losses in drainage systems.

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

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745. PIATIN, M. V. Efficiency in excavation work for swamp drainage. (In Russian.) *Lesn. Khoz.* 6(2):75-76. Feb.1953. 99.8 L5622

Includes equipment.

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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747. PIJLS, F. W. G. Waarop letten bij ontwatering in de fruitteelt? *Fruitteelt* 44:184-185, illus. Feb.20,1954. 86 N28

Drainage of orchards in the Netherlands.

748. POIREE, Le drainage. *Rev. Agr. France* 71:254-257. June 1939. 14 R325

Drainage in France.

749. POWERS, W. L., and KING, A. S. Drainage practices for Oregon. *Oreg. Agr. Expt. Sta. B.* 492, 35 p., illus., tables. Nov.1950. 100 Or3

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751. RASMUSSEN, P. B. Draening. *Dansk Landbr.* 66:100-101. Mar.27,1947. 280.28 V91

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752. RIEDEL, D. Die moordrängung. *Deut. Agrartech.* 2:108-115, illus., tables. Apr.1952. 58.8 D482

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753. ROBERTS, R. H. Soil drainage and utilization of vleis. Rhodesia Agr. J. 35:195-207. Mar.1938. 24 R34  
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759. SCHOKLITSCH, A. Hydraulic structures; a text and handbook. New York,Amer. Soc. Mech. Engin.,1937. 2 v. Ref. 290 Sch62H  
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760. SCHWAB, G. O., FREVERT, R. K., and BARNES, K. K. Manual of soil and water conservation engineering. Dubuque,Brown, 1950. 222 p.,illus. 56.7 Sch92  
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762. SCHWEICHER, F. Das wasser in der landwirtschaft. Wasser u. Boden 3:219-225. Oct.1951. 56.8 W28  
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763. SETINSKY, V. Über die bestimmung de dränentfernung. Internatl. Cong. Soil Sci. 3rd. Trans. 3:163-164, 1936. 56.09 In843  
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766. SLUIS, P. M. VAN DER. Open sloten of samengestelde drainage. Nederland. Heidemaatsch. Tijdschr. 64:125-127. May 1953. 12 N282

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769. SMITH, E. G. Importance of farm drainage. New Zeal. J. Agr. 74:583. June 16, 1947. 23 N48J

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780. SUTTON, J. G. Field drainage and water disposal systems; their repair and maintenance. Washington, U. S. Soil Conserv. Serv., 1945. 8 p. 1.96 Op2Sut

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782. SUTTON, J. G. Outlet ditches, slopes, banks, dikes, and levees. U. S. D. A. Ybk. Agr. 1955:521-528, illus. Ref. 1 Ag84Y

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Depth and spacing, correct fall, laying tiles, and considerations for deciding on open or covered drains are discussed. Pole drains are considered.

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787. TIUNEEV, N. A. Agricultural utilization of marshes in Moscow Region. (In Russian.) Zemledelie 2(12):57-65. Dec. 1954. 20 Z44

788. TONELLI, A. Limites de possibilités et d'utilité du drainage souterrain en Italie. Congrès Internatl. de Génie Rur. Actes. 4: 245-262. 1951. 290.9 C765

Ditching is recommended for plains. Prices of different systems of drainage are compared: Open ditch, gravel, brick, reedgrass, pipe. Prices of underground drainage, are compared for 1900-1910, 1920-1925, 1950. Durability of underground drainage is considered.

789. TSAREVSKII, A. Drainage and reclamation of marshes and swampy lands. (In Russian.) Kol'hoz. Proizvodstvo 13(12):20-23, illus. Dec. 1953. 281.8 K83

790. ULICH, W. L. Surveying farm drainage systems. Tex. Agr. Ext. Serv. B. B-248, 8 p., illus. 1955? 275.29 T312

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792. U. S. SOIL CONSERVATION SERV. UPPER MISSISSIPPI REGION. Schematic drawing of drainage profiles. La Crosse, 1947. 1 p. 1.9605 Sch2

793. U. S. SOIL CONSERVATION SERV. UPPER MISSISSIPPI REGION. Simple drainage practices boost yields. Milwaukee, 1942. 4 p., illus. 1.9605 Si5

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Chiefly maintenance of ditchbanks and tile outlets.

796. VEENENBOS, J. S., and SCHUYLENBORGH, J. VAN. Het knip- of knikverschijnsel van kleigronden. Boor en Spade 4:24-39, illus., tables. 1951. 56.9 B64

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797. VERINK, J. B., and VISSER, W. C. De eisen betreffende de ontwateringsdiepte bij grasland. Netherlands. Landbvoorlichtingsdienst. Maandbl. 9:73-77, illus. Feb. 1952. 12 N383M

Requirements in regard to depth of grassland drainage.

798. WEBB, R. Some hints on finding and clearing old drainage systems. Worcestershire Agr. Chron. 11:267, 269. Aug. 1943. 10 W892

799. WEIR, W. Drenaje de tierras agrícolas. Agrotecnia 3(3): 57-79. June/July 1949. 8 Ag825

Costs, types, and systems of surface and underground drainage in Cuba.

800. WEIR, W. W. Drainage on the farm. Calif. Agr. Expt. Sta. C. 304, 30 p., illus., tables. Rev. June 1939. 100 C12S

Covers benefits of drainage, outlets, types of drains, tile drains, surveys and design of systems, design, construction and maintenance of open-ditch drainage systems, location, spacing, depth, and slope of tile drains, sizes of tile, kinds of tile, construction of tile-drainage systems, trench digging, tile laying, and backfilling. Box drains, vertical drainage, costs of drainage, drainage of peat, marsh, and irrigated soils are discussed also.

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803. WELLINGTON, M. S. Improving water quality by reservoir cleaning and swamp draining. Water & Sewage Works 97:367-368. Sept. 1950. 290.8 M92

804. WESTERMANN, T. Draining; udarbejdet paa foranledning af det Kgl. drnske landhusholdningsselskat. Kobenhavn, Frederiksberg bogtrykheri, 1936. 207 p., illus., diagrs. 54 W52

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805. WHITLEY, F. H. The sanitation, maintenance, and control of watersheds. Pub. Works 72(8):17-38, illus. Aug. 1941. 290.8 M922

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806. WHITLOCK, R. The farmer's water supply. Field 202:327-328, illus. Aug. 20, 1953. 10 F45

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807. WIEGERING, G. Drenaje de los suelos mineralizados. Agronomía [Lima] 12(50):49-102, illus. Apr./May 1947. 9.8 Ag83

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808. WILCOX, E. V. Drainage, fertilizers, irrigation, soils, etc. In his Modern farmers' cyclopedia of agriculture, p. 421-442. New York, Judd, 1944. Ref. 30.1 W65M

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811. WOODWARD, L. There's a right way to drain. Soil Conserv. 19:44-46, illus. Sept. 1953. 1.6 So3S

In Utah.

Drainage problems are widely varied, and each system must be installed scientifically to meet the individual needs of the land.

Examples of varied drainage problems in Utah are given.

812. ZUUR, A. Inpoldering en verziltig in de Verenigde Staten. Tijdschr. v. Econ. en Sociale Geog. 43:258-260. Oct./Nov. 1952. 280.8 T44

Drainage and silting in the United States.

### Surface Drainage

813. AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS. COMMITTEE ON SOIL EROSION CONTROL. Controlling erosion in farm drainageways. Agr. Engin. 23:136-137. Apr. 1942. 58.8 Ag83

Seeding, mulching, and sodding are discussed, and types of vegetation for grassed waterways are recommended.

814. BANFIELD, G. L. Surface drainage. New Zeal. Grassland Assoc. Proc. 15:112-116. 1953. 60.19 N48

Tells when to use surface in preference to underground drainage, and describes the construction of surface drains.

815. BANFIELD, G. L. Surface drainage on the Hauraki Plains. New Zeal. J. Agr. 87:345, 347-348, illus. Oct. 15, 1953. 23 N48J

Grassed surface waterways in the sheeplands of New Zealand, where the clayey condition of the soils precludes underground drainage. Includes equipment.

816. BEASLEY, R. P. The Missouri farm water-management plan. Agr. Engin. 32:541-543, illus. Oct. 1951. 58.8 Ag83

Drainage by terracing.

817. BEAUCHAMP, K. H. Surface drainage of tight soils in the Midwest. Agr. Engin. 33:208-212, illus., map. Apr. 1952. 58.8 Ag83

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818. BOBST, H. G. High-velocity outlet channels. Soil Conserv. 15:126-128, illus. Jan. 1950. 1.6 So3S

Concrete channels to supplement grassed waterways.

819. BORDEN, J. W. Land drainage by grading and smoothing.

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820. BRINK, W. Water put to work. Soil Conserv. 13:123-129, illus. Jan.1948. 1.6 So3S

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Canals, laterals, and farm ditches.

821. BROWN, G. Spreading water in the East. Soil Conserv. 2: 143-145,illus. Jan.1937. 1.6 So3S

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822. BUCHELE, W. F., COLLINS, E. V., and LOVELY, W. G. Ridge farming for soil and water control. Agr. Engin. 36:324-329,331, illus.,tables. May 1955. Ref. 58.8 Ag83

Use of the moldboard plow in ridge (contour) farming and its effect on drainage and crop yields.

823. BUIE, T. S. Physical methods of soil conservation. United Nations Sci. Conf. Conserv. & Util. Resources. 6:2-6. 1949,pub.,1951. Ref. 279.9 Un32P

"Basic" and "fertility" methods of conservation include terracing, contour tillage, and drainage.

824. CARNES, A. Maintenance of the drainage-type terrace. Soil Conserv. 4:165-169,illus. Jan.1939. 1.6 So3S

Includes the use of vegetation and its placement as an aid in preventing silt from reaching the terrace channel.

825. CASSON, P. B. Some observations on mound ploughing in the establishment of radiata pine. Austral. Forestry 11:40-43,illus. 1947. 9918 Au74

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

826. CLARK, M. W. Diversion dikes and channels for saving soil. Mo. Agr. Ext. C. 434,8 p.,illus,tables. Sept.1941. 275.29 M69C

Discusses the proper uses of terraces versus diversion ditches, silt basins in channels, and the grading of diversion channels.

827. COOK, H. L., and CAMPBELL, F. B. Characteristics of some meadow strip vegetations. Agr. Engin. 20:345-348,illus.,tables. Sept.1939. 58.8 Ag83

Tests made at the Spartanburg Outdoor Hydraulics Laboratory of the Soil Conservation Service in 1937 to determine the effectiveness of three common forage crops in preventing scour in meadow-strip and other channels. The water-carrying capacities of channels lined with these vegetations is discussed.

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

An improved layout for contour tillage is described, permitting continuous drainage of each interval and avoiding reversal of gradient. It is especially recommended for tobacco in the Southeastern United States.

829. COPLEY, T. L. Row grades and row layouts for bright tobacco fields. Agr. Engin. 27:313-315,illus.,tables. July 1946. 58.8 Ag83

Furrow drainage.

830. CORMACK, R. M. M. The mechanical protection of arable land. Rhodesia Agr. J. 48:135-164,illus.,tables. Mar./Apr.1951. 24 R34

Storm drains, contour ridges, and grassed waterways in Rhodesia.

831. COX, M. B., and PALMER, V. J. Results of tests on vegetated waterways and methods of field application. Okla. Agr. Expt. Sta. Misc. P. MP-12,43 p.,illus.,tables. Jan.1948. 100 Ok4

Results of four years of research on the use of vegetation as a pro-



protective lining of farm waterways, pond spillways, terrace outlets, and drainageways.

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833. CUBA, P. Canais de escoamento e culturas em faixas. São Paulo, Dir. Pub. Agr., 1944. 31 p., illus., tables. 56.7 C892

Runoff drainageways and strip cultivation in Brazil. Includes construction, size, and maintenance of drainageways, and vegetation of waterways.

834. DAVIS, P. W. Contour bunding and trenching as counter erosion measures on the Nilgiris. Indian Forester 73:537-538. Dec. 1947. 99.8 In2

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835. DOGGETT, J. F. Sod field waterways. N. C. Agr. Ext. C. 303, 8 p., illus. Sept. 1947. 275.29 N811

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1042. CALAMINUS, U. Maulwurfsdränung lohnt sich. Deut. Landwirt.-Gesell. Mitt. 70:815-817, illus. Aug. 4, 1955. 18 N39

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1043. CANTERBURY CHAMBER OF COMMERCE. Mole drainage. Canterbury Chamber Com. Agr. B. 169, 4 p., Aug. 1943. 23 C162

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1044. CHILDS, E. C. The mechanics of mole-draining. Empire J. Expt. Agr. 10:169-181. June 1942. 10 Em7

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

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

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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 drainage diepte. *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. FRIDSTRÖM, 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.) Vsesoŭzn. 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. HAEGERMARCK, F. Ingen lantbrukare här angrat att han tackdikar 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 åkerjord. 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. HALLGREN, 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 in to 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 drain-buizen en de berekening van hun afvoer. Gent. Landbhogesch. 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. HOOGHOUT, 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 trencher 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. LANGOL, A. M. Moistening reclaimed marshes with the aid of mole drains. (In Russian.) Vsesoŭzn. 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 forandring 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 kayttomahdollisuuksista suomessa. Suomen Maataloustiet. Seura. Maataloustiet. Aikakausk. 22:152-163. 1950. Ref. 20 Su7M

English summary, p. 163.

On the possibilities of using mole draining in Finland.

1110. JUUSELA, T. Salaojasyvyyskysymyksen selvittelyä. Suomen Maataloustiet. 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. Salaojituskoetoinnasta suomessa. 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. Salaojitusmenetelmistä. 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 draintile.

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 maulwurfflug. *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. LUEBCKE, 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, Soiuznikhi, 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 drain tile manufacture.

1149. MILLER, D. G., and MANSON, P. W. Longtime performance of some clay drain tile. 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 drain tile" 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 drain tiles made with portland cement and with alumina cements.

1151. MOHRMAN, K. J. M. Draineren. 1-3. Nederland. Heide-maatsch. 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 drain tiles, 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 I162C

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 drain tile.

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 Maulwurfsdränung. 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. Schreihe. f. die Landwirt. Produkgenos-sensch. 10,18 p.,illus. 1953. 18 D48253

Planning and maintaining agricultural installations in agricultural production cooperatives. Primarily tile drainage systems.

1187. SHAFER, F. F. Causes of failure in tile drains. Agr. En-gin. 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 cor-rugated 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.) Nogiyodoboku-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 equip-ment 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 ac-cording 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. Wash-ington,U. S. Soil Conserv. Serv.,1942. 11 p.,illus. 1.96 Op2Ho

Address prepared for the American Society of Agricultural Engi-neers, 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.) Sotsialist. 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 constant; 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. Heidemaatsch. 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 täckdikesledning. 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 radial 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.

1247. GARDNER, W., and PETERSON, A. H. Well battery design. Agr. Engin. 17:293-295, illus. July 1936. 58.8 Ag83

Mathematical calculations for the design of a well battery intended for drainage.

1248. GOTTLIEB, W. H. Diesel-pump team cuts drainage costs. Pub. Works 80(11):34, 36, illus. Nov. 1949. 290.8 M922

Diesel-engined drainage pumps in use in the South River Drainage District, Missouri.

1249. GOTTLIEB, W. H. Farming a lake thanks to diesel-pump team. Diesel Prog. 16:51. Jan. 1950. 291.8 D56

Pump drainage in Illinois.

1250. GOTTLIEB, W. H. Keeping Corpus dry. Diesel Prog. 17(8):48-50, illus. Aug. 1951. 291.8 D56

Diesel pumping plants handle drainage in Corpus Christi, Tex., when tides block the normal outflow and when rainfall is too heavy for normal gravity flow.

1251. GREENE, M. T. Men against the sea in Holland. Contemp. Rev. 183:278-283. May 1953. Libr. Cong.

Construction of the Netherlands polders by diking and pumping, and finally by the digging of drainage ditches. Describes the electrically-driven pumps capable of removing 250,000 gallons a minute, and the diesel-operated pumps which lift 120,000 gallons a minute. Tractor-driven plows that dig drainage ditches ten feet deep are also discussed.

1252. HARRISON, G. R. Small muck drainage outfit. Elect. Farm 22(5):20-21. May 1949. 335.8 EL27

A 2-hp. electric pump-lifts water from a lateral ditch in the muck area of Indiana up over the bank into the main canal.

1253. HELLINGA, F. Water control. Soil Sci. 74:21-33, illus. July 1952. 56.8 So3

Drainage by windmill, ditch, and pumping station, in the Netherlands. Emphasis is on main drainage in open waterways.

1254. HIDVEGHY, L. A belviz-ategmelotelepek által szállított vízmennyiségek folyamatos merese. Vízügyi Közlem. 30:470-480, illus. 1948. 290.9 H89

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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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Description of the pumping equipment used to drain the peat soils of England's Fens.

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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 Valcheren (Paye-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

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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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1311. HARKER, D. Concepts of modern farm drainage. Purdue

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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

Estimated loss of agricultural produce in the Netherlands, and proposed reclamation of agricultural lands through drainage and dike repair.

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1319. SMITH, L. J. Drainage and dyking in western Washington. West. Wash. Reclam. Inst. Proc. 6:22-23. 1946. 54.9 W52

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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. Heidemaatsch. 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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1325. WOOLEY, J. C., CLARK, W. M., and BEASLEY, R. P. The Missouri soil saving dam. Mo. Agr. Expt. Sta. B. 434,23 p.,illus., tables. Oct.1941. 100 M693

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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

Construction and operation of a mole plow.

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

An account of construction and use of a simple modification to the grader blade, enabling contour ridges with wide banks and wide shallow-water channels to be efficiently formed without recourse to subsequent trimming.

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. Crevice 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

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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-

\*Not examined.



ditching machines. Ames, 1948.

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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.

Includes costs.

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

A mechanical ditching machine in Germany.

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

Roteho 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 ditcher 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.

Thesis (M.S.) - Iowa State College, 1951.

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

Mole drainage in England. Includes descriptions of various mole-draining implements - excavators, bulldozing attachments, and the Hendon mole plow.

1350. DONNAN, W. W., and BRADSHAW, G. B. Tile effluent measuring devices. Agr. Engin. 30:134-136, 140, illus. Mar. 1949. 58.8 Ag83

Drainage research project in Imperial Valley, Calif. One device is

\*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. DUBEIKOVSKII, 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. 290.8 G362

1353. DUBKOV, S. N. From the practices of the machinery-equipped reclamation squads of MTS. (In Russian.) Gidrotekh. i Melior. 5(7):61-64. July 1953. 290.8 G362

1354. DUNCAN, A. A. Drainage of swamp land in Waimarino County. New Zeal. J. Agr. 88:467-468, illus. May 15, 1954. 23 N48J  
Description of a ditchdigger for use on swampy land.

1355. ELSTON, J. A progress report on the Connecticut power ditcher. N. J. Mosquito Extermin. Assoc. Proc. 37:61-62. 1950. 420 N46

The "Scavel", its uses and costs in drainage work for mosquito control in Connecticut.

1356. ELTISLEY, LORD. Land reclamation for food growing. Country Life 87:111-113, illus. Feb. 3, 1940. 80 C83

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1357. EMERSON, A. W. More investigational equipment for drainage. Impl. & Tractor 63(12):52-53, illus. June 12, 1948. 58.8 W41

Technical description of an inexpensive test-hole-drilling unit developed in South Dakota by Soil Conservation Service Engineers.

1358. ENSTONE, R. B. Land drainage in Worcestershire. Worcestershire Agr. Chron. 19:263-265, 267, 269, 273, 275, 277, 279, 281, 283, illus. Aug./Nov. 1951. 10 W892

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1359. EYLANDS, A. G. Eitt rekur sig á annars horn. Freyr 40:123-125. Aug./Sept. 1945. 11 F89

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1360. FOLSOM, O. H. Fast way to lay pipe in a wet trench. West. Constr. 26(8):57-58, illus. Aug. 1951. 290.8 W522

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1361. GALPIN, A. J. Demonstrations of drainage machinery. New Zeal. J. Agr. 74:78-79, 81, 83-87, 89, illus. Jan. 1947. 23 N48J

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1362. GALPIN, A. J. V-drains cut with a bulldozer on light country in Manawatu. New Zeal. J. Agr. 80:338-339, illus. Apr. 1950. 23 N48J

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1364. GUTBERLET, F. Erfahrungen mit raupenbaggern bei arbeiten für die entwässerung und landgewinnung. Wasser u. Boden 2:47-49, tables. Mar. 1950. 56.8 W28

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1365. HANRAETS, J. M. J. Mechanisatie in de ontginningstechniek. Landbk. Tijdschr. 62:924-933, illus. Nov. 1950. 105.2 Or3

Mechanization in land reclamation technique. Drainage and drainage

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1366. HAUGEN, O. Maskiner for grøfting. Norsk Landbr. 18: 76-79, 97-99, illus., tables. Feb. 29, Mar. 14, 1952. 11 N8122

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1367. THE "HENDERSON" drainage machine's convincing demonstration. Farm Impl. & Mach. Rev. 69:903-904, illus. Mar. 1, 1944. 58.8 Im72

A ditching machine developed in Scotland.

1368. HIGGINS, F. H. Plastic surgery on the soil: twenty thousand watch \$ 200,000 worth of tractor-powered farm machines prepare water-logged land for farming. Impl. Rec. 47(7):22-23, 56. June 1950. 58.8 Im73

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Describes an apparatus for molding and laying tile drains and irrigation pipes.

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Description of a trenching machine used in England.

1372. HOW THE "BADGER" ditcher has been improved. Farm Impl. & Mach. Rev. 68:143-144, illus. June 1, 1942. 58.8 Im72

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1375. ISLER, D. A. Equipment for maintaining small drainage channels. Agr. Engin. 20:65-66, 70, illus. Feb. 1939. 58.8 Ag83

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1376. JAKOBSEN, I. M. Kan man grave draen med maskine? Hedeselsk. Tidsskr. 67:243-245. Oct. 15, 1946. 11 H35

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1379. JUUSELA, T. Om maskinell täckdikning i Finland. Nord. Jordbrforsk. 33:760-764. 1951. 11 N752



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1383. KENDALL, R. G. The ideal drainage machine. Power Farmer 6(3):20-22, illus. Mar. 1951. 58.8 P872

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1396. LUK'IANCHIKOV, S. N. Bulldozer for digging drainage ditches. (In Russian.) Lesn. Promysh. 11(5):19-20, illus. May 1951. 99.82 L56

1397. LYNCH, E. E. The use of the road disk and other special equipment used in Delaware. N. J. Mosquito Extermin. Assoc. Proc. 35:117-122, illus. 1948. 420 N46

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1402. MATSEPURO, M. E. Equipment for drainage and reclamation of marshy and swampy lands. (In Russian.) Dostizheniia Nauk. i Peredovogo Opyta v Sel'sk. Khoz. 4:69-75, illus. Apr. 1952. 20 D742

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1406. MINOLTS, Die bekanntesten graben-unterhaltungsmaschinen. Landwirtbl. Weser-Ems 101:46-48, illus. Jan. 14, 1954. 18 L2345

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A mechanical ditching machine in France.

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1412. MUGUET, M. Les travaux d' assainissement et de drainage. Sol 1949:79-85, illus. 14 So4

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1413. MULHERN, T. D. A further development in machinery for digging and cleaning salt marsh ditches. N. J. Mosquito Extermin. Assoc. Proc. 29:48-50, illus. 1942. 420 N46

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1414. MULHERN, T. D., and HART, J. T., JR. A low cost, light weight excavator for digging or cleaning mosquito control ditches. Mosquito News 8:137-139, illus. Dec. 1948. 421 M85

Specifications, mode of operation, and costs of a machine designed for the Morris County, N. J. Mosquito Extermination Commission, for digging and maintaining marsh-drainage ditches.

1415. MULHERN, T. D., and LAFFERTY, O. W. A machine for digging new or recutting old salt marsh ditches in Cape May County. Mosquito News 7(1):1-4, illus. Mar. 1947. 421 M85

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1416. MULHERN, T. D. Mosquito ditching machine possibly of use in cranberry or blueberry drainage. Amer. Cranberry Growers' Assoc. Proc. Ann. Mtg. 78:40-41, 44-47, illus. 1948. 81 Am35M

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Machines for digging and cleaning drainage ditches in salt marshes and in other areas where mosquitoes breed. Specifications and construction directions are given.

1418. MULHERN, T. D. New Jersey and New York mosquito control executives witness demonstration of "jeep-a-trench" excavator. Mosquito News 8:166-167, illus. Dec. 1948. 421 M85

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A ditch cleaner developed in England.

1420. A NEW principle of mole draining. Farm Impl. & Mach. Rev. 69:470-471, illus. Oct. 1, 1943. 58.8 Im72

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The Aveling-Barford trench cutter.

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1423. NICHOLSON, H. H. Heavy land and the mole plough. Power Farmer 10:44-46, illus., map. Feb. 1953. 58.8 P872

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1424. OHLSON, N. E. Tackdikesgrävning med dikesplög. Lantmannen 34:187-188, illus. Mar. 11, 1950. 11 L234

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1426. AN OPEN drainage plough demonstrated. Farm Impl. & Mach. Rev. 70:995-996, illus. Apr. 1, 1945. 58.8 Im72

The Cuthbertson drainage plow, for digging open ditches on hilly land in Scotland.

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1431. PEARSRO, Q. Affossatori. Agr. Ferrarese 57:13-15, illus. Jan. 31, 1953. 16 Ag87

Ditch-digging equipment used in Italy.

1432. PEASRO, A. Kostnaden för maskingrävda täckdiken. Lantmannen 34:465-466, illus. June 10, 1950. 11 L234

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1433. RAGUE BOTEY, F. Drenaje mecánico para galerías. Cult. Mod. 29:373-374, illus. Oct. 1946. 15 C89

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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

Discussion, p. 89-90.

Machines for digging drainage ditches in salt- and fresh-water marshes. Includes costs.

1435. REILEY, F. A. A new ditching machine. N. J. Mosquito Extermin. Assoc. Proc. 35:113-114. 1948. 420 N46

A machine devised by the Atlantic County, N. J., Mosquito Extermination Commission to clean 10- by 24-inch drainage ditches at an average of 10,000 feet per day, or to cut new ditches at a rate of 5,000 feet per day.

1436. REILEY, F. A. A new salt marsh ditching machine. N. J. Mosquito Extermin. Assoc. Proc. 36:60-62, illus. 1949. 420 N46

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1439. RIDIGER, V. R. Attachment for constructing mole drainage. (In Russian.) Vinodel. i Vinograd. SSSR. 11(9):53-54, illus. Sept. 1951. 95.8 V77

1440. RIDIGER, V. R. Subsoil mole drain irrigation and its mechanization. (In Russian.) Vsesoiuzn. Akad. Sel'skokhoz. Nauk. im. V. I. Lenina. Dok. 18(4):42-48, illus. 1953. Ref. 20 Ak1

1441. ROY, P. E. Travaux d'amélioration et de drainage des terres avec tracteurs déblayeurs. Agriculture [Quebec] 5:258-268, illus. Sept. 1948. 7 Ag82

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1442. SABINSKII, G. B. Machinery for drainage of swamps and reclamation of virgin lands. (In Russian.) Dostizheniya Nauk. i Pervodovogo Opyta v Sel'sk. Khoz. 8:71-76, illus. Aug. 1954. 20 D742

1443. SAMMIS, R. H. Ten years experience with the mole plow on the Nassau County marshes. N. J. Mosquito Extermin. Assoc. Proc. 29:53-54, illus. 1942. 420 N46

Description and operation of equipment used in mosquito extermination in New Jersey's marshes. Mole drains installed in 1932 were found 10 years later to be functioning satisfactorily in most cases.

1444. SAVESON, I. L. Machinery aspects of land drainage. Agr. Engin. 34:303-306, illus. May 1953. 58.8 Ag83

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"It is the intent of this paper to review the land drainage problem in light of the machinery aspect, since the advancement and maintenance of drainage is dependent on machines applicable to the work required," p. 303.

1445. SCHNITTGER, H. G. Drainagemaschinen für moore. Wasser u. Boden 4:284-285, illus. Sept. 1952. 56.8 W28

Machines for the drainage of marshlands. Ditching equipment and mole plows in Germany.

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

Discusses Rotary diggers, hydraulic back-acters, drain-cleaning machines, excavators, and ditch-cutting devices.

1449. SHEARER, M. N. Make ditch cleaning easy with an easy-to-clean concrete check. Oreg. State Col. Ext. C. 575, folder, illus. Nov. 1954. 275.29 Or32C

Instructions for construction and use.

1450. SHIPMAN, R. C., and COLE, R. O. Building terraces with the moldboard plow. Agr. Engin. 25:15-16. Jan. 1944. 58.8 Ag83

The plow is simple to use for efficient formation of drainage-type

terraces having the broad water channel and ridge with gentle slopes that offer little interference with the subsequent operation of field machinery. Two methods of moving soil with a plow are described.

1451. SIMPLIFIED mechanization of earth moving and trenching. Farm Impl. & Mach. Rev. 69:647-648, illus. Dec. 1, 1943. 58.8 Im72  
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1453. STANGLE. Kleinbagger zum ausheben von dränggräben. Wasser u. Boden 4:236-237, illus. Aug. 1952. 56.8 W28

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1454. STJERNDAHL, H. Maskinell täckdikning. Älvsbergs Läns Norra Hushållssk. Tidskr. 60:12-14, illus. 1953. 11 AL82

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1455. SWEDEN. KOMMITTEN FOR MASKINELL TÄCKDIKNING. Maskinell täckdikning. Uppsala, Almqvist & Wiksells, 1950. 135 p., illus., tables. Ref. 58 Sw32

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1456. THOM, W. A light weight tractor-operated scoop for cleaning ditches. N. J. Mosquito Extermin. Assoc. Proc. 34:148-149. 1947. 420 N46

The Cletrac scraper for cleaning drainage ditches for mosquito control in New Jersey.

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

Trenching equipment used in England.

1459. TILE drainage trenches cut and backfilled by machinery. Impl. & Mach. Rev. 67:791-792, illus. Jan. 1, 1942. 58.8 Im72

An attachment fitted to a cable cultivator used in England for back-filling drainage ditches after installation of tile.

1460. TIULENEV, N. A., and RUDICH, S. I. A five-disk machine for laying out an aerate mole drain. (In Russian.) Sel'khoz mashina 1950(4):32. Apr. 1950. 58.8 Se42

1461. TIULENEV, N. A. The question of the further improvement of the fertility of peat soils. (In Russian.) Vsesoyuzn. Akad. Sel'skikh. Nauk im. V. I. Lenina. Dok. 16(8):3-9. 1951. 20 Ak1

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1462. TRENCHING machine for agricultural drainage. Engineering 161:127, 132, illus. Feb. 8, 1946. 290.8 En322

The Henderson agricultural drainage machine in use in England.

1463. A USER designed drainage excavator. Power Farmer 13: 85, illus. Aug. 1954. 58.8 P872

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'khoz mashina 4:3-6. Apr. 1954. 58.8 So42

Drainage machines.

1466. VOIGT, O. Mechanische gräbenreinigung. 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. ANNETT, 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. Overdrain- ing 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.) Dostizheniia Nauk. i Peredovogo Opyta v Sel'sk. Khoz. 4:72-73. Apr.1953. 20 D742

1480. CHILDERS, 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-hyrotechnische ergebnisse von dränungsversuchen auf tonböden. Internatl. Cong. Soil Sci. 3d. Trans. 3:164-168. 1936. 56.09 In843

Agricultural-hyrotechnical 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. Torrlägningsgrad 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 torrlägningsoch 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. HOGGLUND, 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 torrlägningsarbetena. 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. MCCRORY, 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 draintile 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 So3S

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 M66Ag

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. Génie 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. Internatl. 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. NITSSENKO, 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 subsoil 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. Internatl. 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 på myrmark. Forsk. - och Försöksresultat 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. Geregelt wasserwirtschaft grundlage jeder ertragsleistung. 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 kostprijen. *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.* Rprtr. 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, Mississippi.

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.

1565. WESTON, A. D. The drainage of low lands, and malaria. Boston Soc. Civ. Engin. 25:476-483,map,tables. Oct.1938. 290.8 B65

Drainage of the Charles River Basin has decreased the incidence of malaria in Boston and Cambridge materially since 1915.

1566. WOOD, I. D. The engineering revolution in agriculture.

Agr. Engin. 33:613-616,626,illus. Oct.1952. 58.8 Ag83

Includes drainage. One hundred and three million acres of land "once water-logged through centuries with rainfall or spoiled by overirrigation or seepage are now in high production through the magic of drainage," p. 614.

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

Requires drainage, clearing, and large-scale irrigation projects.

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

The economy of adequate drainage extends through all phases of citrus grove operations from planting to picking. The deeper rooting made possible by good drainage is the chief factor of benefit.

Also in Citrus Indus. 32(12):10-12. Dec.1951. 80 C49

## PROJECTS AND PROGRAMS

1569. HUBERTY, M. R. Some irrigation and drainage problems of Mediterranean and Middle East countries. Amer. Soc. Civ. Engin. Proc. 79(Separate 319),10 p.,illus. Oct.1953. 290.9 Am3Ps

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

Text in Spanish and English.

Drainage and health in the Caribbean area. Drainage projects for malaria control in Cuba, Puerto Rico, Southern United States, Panama, Venezuela, Haiti, Mexico, the Virgin Islands, Guatemala, El Salvador, and Costa Rica.

## North America

### U. S. A.

1571. ACTIVITIES of the National Water Resources Committee. Civ. Engin. 7(3):167-177,illus. Mar.1937. 290.8 C49

A survey of drainage district projects and problems from regional and national viewpoints.

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



Discusses drainage districts in Tennessee.

1573. ANDERSON, C. A. Middle Rio Grande District concludes basic program. West. Constr. News 11(7):229-231,illus.,map. July 1936. 290.8 W522

Irrigation, drainage, and flood control in New Mexico. The project includes 334 miles of drains and 1,000 miles of ditches.

1574. AUGUSTADT, W. W. Drainage in the Red River Valley of the North. U. S. D. A. Ybk. Agr. 1955:569-575. 1 Ag84Y

History of drainage for flood control and agricultural production in North Dakota.

1575. BARNARD, J. W. Working shoulder to shoulder in the Old Line State. Soil Conserv. 20:84-90,illus. Nov.1955. 1.6 So3S

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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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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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1582. BURNS, B. E. Artificial drainage in Blue Earth County, Minnesota. Lincoln, 1954. 241 p.

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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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1585. CHAPMAN, P. W. Taming the Tropics at home. Country Gent. 116(9):23,80,82-83,illus. Sept.1942. 6 C833

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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

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1588. COLEMAN, W. H. Eight farmers drain land. Soil Conserv. 16:226-227. May 1951. 1.6 So3S

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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. EDMISTER, 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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1597. EMERSON, A. W. North Dakota "does something" about flood waters. Farm Impl. News 67(8):50-52,90, illus. Apr.11,1946. 58.8 F22

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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

How to organize a drainage cooperative, with the "Roberson ditch" in the Knox County, Ind., Soil Conservation District, as a sample.

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

Central and southern Florida. Drainage chiefly in connection with flood control. Mentions other drainage projects in progress.

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

Drainage program in Crawford and Venango Counties, Pa. Includes dynamiting.

1603. HARRISON, R. W. Drainage reclamation in the Yazoo-Mississippi Delta, a drainage handbook. Miss. Agr. Expt. Sta. M. R. 9,260 p.,maps,tables. July 1952. 100 M69Mr

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.

Problems peculiar to the drainage of swamps and bayous, and an explanation of why so little has been accomplished in land reclamation in the swamplands of Louisiana and Arkansas. Includes drainage districts.

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.

Drainage research in the Delta falls into three fields: (1) A study of the present status of drainage organizations; (2) an examination of the history of the drainage movement; and (3) an evaluation of methods for local, State and Federal contributions to agricultural drainage work.

1605. HARRISON, R. W. Louisiana's State-sponsored drainage program. South. Econ. J. 14:387-403,tables. Apr.1948. 280.8 So84

Outlines the plans and objectives of the program and attempts to show how drainage planning at the State level may serve as an important coordinating link between local drainage organizations and Federal agencies.

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

U. S. Soil Conservation Service, cooperating.

Includes a history of drainage activities since 1901, and a history of the Everglades Drainage District and its achievements.

1610. KING, B. Drainage for Coastal Plains area. Soil Conserv. 8:228-230, illus. Apr. 1943. 1.6 So3S

Recommends the combination of a sound drainage program with the development of complete conservation plans for individual farms in the Southeastern States, including assistance to farmers in planning their farm drainage.

Examples from South Carolina.

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

U. S. Department of Agriculture and the Commonwealth of Puerto Rico, cooperating.

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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

Organization of the Grant Township Drainage District, Kansas, and the drainage system in the area.

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

Section headings include: The drainage needs of farmlands in Utah; drainage organization; financing Utah drainage districts; design, construction, operation and maintenance of drainage systems; reclamation of land; and recommendations and suggestions.

1620. MAYO, N. Possibilities of the Everglades. Fla. Dept. Agr. B. (n.s.) 61, 94 p., illus., map. Aug. 1938. 2 F66B  
Includes drainage.

1621. MERRICK, C. P. Maryland's public drainage program. Agr. Engin. 35:106, 108. Feb. 1954. 58.8 Ag83  
Farm drainage.

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. 3, Reference data.

Includes flood control and artificial farm drainage.

1623. OREGON. STATE PLANNING BOARD. Land development in Oregon through flood control, drainage and irrigation. Portland, 1938. 221 p., illus., maps. 280.7 Or33Pr

Includes drainage of swamps and tidelands by ditches and pumping.

1624. OTTO, W. S., and HANNAMAN, D. A. After 100 years. Soil Conserv. 12:125, illus. Jan. 1947. 1.6 So3S

The Pocomoke project, a 20-mile channel to drain 100,000 acres in Maryland and Delaware, was inaugurated in the 1840's.

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

Constructing 1400 feet of 24-foot canal through an area of hydraulic fill, in the U. S. Navy's mosquito-elimination program.

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

Drainage and water control in the Everglades and in the Okeechobee area of Florida since the arrival of the first white settlers.

1628. SHAFER, F. F. Functions of the soil conservation districts in drainage. Agr. Engin. 26:456-458. Nov. 1945. 58.8 Ag83

Figures illustrate the importance of drainage in the Upper Mississippi Valley, and the accomplishments in drainage in the region.

1629. SHAFER, 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  
Upper Mississippi Valley.

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

Paper prepared for the American Society of Agricultural Engineers Annual Meeting, Philadelphia, June 25, 1947.

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.

9 p. 1.96 Op2Sut

Presented before the Third Annual Conference of the State Soil Conservation Committee at Medford Lakes, N. J. on Oct. 9, 1945.

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. 4 C82

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.

1649. WALLIS, W. T. The history of Everglades drainage and its present status. Soil Sci. Soc. Fla. Proc. 4A:29-33. 1942. 56.9 So32

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

de aguas y drenaje en la República Mexicana. Ingen. Hidrául. en Méx. 1(1):42-44. Jan./Mar.1947. 290.8 In43

Construction of new irrigation and drainage works in the Republic of Mexico.

1664. BISTRAIN, P. Desecación y drenaje de terrenos. Ingen. Hidrául. en Méx. 3(3):67-77,illus.,tables. July/Sept.1949. Ref. 290.8 In43

Covers numbers of farms and acres drained in Mexico, projected drainage works, a brief history of the development of agricultural drainage, methods, and maintenance of drainage systems.

1665. GODINEZ NORIEGA, M. Mejoramiento de los suelos per medio del drenaje. 1-2. Germinal 1(6):6; (7):6,illus. July-Aug.1948. 8 G312

Improving the soil by means of drainage in the Rio Bravo Valley of Mexico.

1666. ST. ALBANS, M. Mexico de-waters Tabasco. Excavation Engin. 48(5):24-27,illus. May 1954. 209.8 Ex2

The Mexican Government is reclaiming the fertile land of the State of Tabasco through construction of drainage canals, spillways, retaining walls, etc.

### Central America and the West Indies

1667. CALDWELL, J. D. Malaria control in the Dominican Republic. Mosquito News 6:90-95. June 1946. Ref. 421 M85

Includes drainage projects and their costs.

1668. COFFEY, P. J. Nicaragua experiences big dividends from malaria campaign. Engin. News-Rec. 135:722-725,illus. Nov.29,1945. 290.8 En34

The antimalaria fight included the installation of permanent drainage structures — open ditches as well as underground pipe.

1669. FLANAGAN, J. E., and CABEZAS R., R. Drenaje de tierras agrícolas. Cent. Nac. de Agron. C. Agr. 6,4 p. June 1950. 8 Sa54C

Drainage of agricultural lands in El Salvador.

1670. HARGREAVES, G. H. Irrigation and drainage problems in Haiti. Amer. Soc. Civ. Engin. Proc. 81(Separate 729),13 p.,map,table. June 1955. 290.9 Am3Ps

Includes the Artibonite River project and the Trois Rivières project.

1671. LAGOS, U., J. A. El mejoramiento de los suelos. Agr. Costarricense 9:4,6. Jan.1951. 8 Ag895

Includes drainage.

1672. NADLER, H. A., and DELGADO MARQUEZ, R. Drainage of sugar cane lands. Facts Sugar 35(2):56-57,illus. Feb.1940. 65.8 F11

Drainage in the Pasto Irrigation project, Puerto Rico. Discusses ditches and pumping plants.

1673. STERLING, C. I. Notes on malaria control in Managua, Nicaragua. Mosquito News 6:96-98,illus. June 1946. 421 M85

Cleaning and regrading 11,034 feet of drainage channel built in 1890, and installing 10,000 feet of subsurface drains, a 650-foot retaining wall, culverts, paved chutes, bridges, and masonry inlet boxes.

1674. VAN HOVENBERG, H. W., and MITCHELL, R. D. Irrigation and drainage for malaria control combined in El Salvador. Civ. Engin. 15:326-327,illus. July 1945. 290.8 C49

1675. WILSON, C. M. Good earth from bad rivers. Nat. Hist. 61:366-371. Oct.1952. 500 N483J

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### South America

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	<u>Item</u>					<u>Item</u>			
Ableiter J K				1469	American Institute of Real				
Adam J	484			536	Estate Appraisers				740
Adams M J				1013	American Society for Test-				
Adolfsson T				1014	ing Materials	1018-1020			1103
Africa	630			636		1116	1199		
Ahlstrom B				1686	American Society of Agricul-				
Ahmed A A				1834	tural Engineers	1053			1487
Ahuriri Lagoon project						1504	1505	1634	
(New Zealand)				1867	Committee on Soil Erosion				
Aiken W C				914	Control				813
Airports	690	926	931	1038	Drainage Committee				1470
1192					Anaya M				1663
Akademie für Raum-					Andalucia la Baja Swamps				
forschung und Landesplanung				1	(Spain)				1722
Akishin F D				1015	Anderson C A				1573
Alabama	486			914	Anderson J R				1499
Albert A R				485	Anderson T C				363
Alberta				342	Anderson W L				1471
Albrecht W A				915	Andrews D A				191
Albuquerque H C de				359	Andrews L W				1021
Alderfer R B				66	Anemiya M				362
Alderman G				519	Angle dozers	1343			1399
Alexander W H Jr				190	Angola				1838
Alfalfa				424	Angola Reclamation				
Algeria	1835			1840	project				1838
Alim-du-Din M				1845	Annett H E				1472
Alkali soils SEE Saline-alkali					Anthony H G				867
soils					Appalachian region				200
All-American Canal		56		360	Appropriations	330			346
389	434	452			Argentina		19		1683
Allison L E		28	361	448	Arizona	29	191	192	225
449	451					273	274	344	371
Allison R V	488			1242	1258				
Allred C E				1572	Arizona Agricultural Experi-				
Alluvial soils					ment Station				29
Australia				1871	Arizona Underground Water				
Gt Brit				1820	Commission				192
Mississippi Delta				1643	Ark-La-East Texas				
New Zealand				662	Sandy Lands Conservation				
Oregon				1623	Experiment Station				308
Tonga				1873	Arkansas	142	298	308	
Trinidad				944	1603A				
Almena soils				909	Armco Drainage Products				
Almlof E	1016	1017	1326	1687	Association				938
Ambatalempahala project					Armitage J				1792
(Ceylon)				1862	Arndt F R		67		364

	<u>Item</u>					<u>Item</u>			
Arnould C				615	Baker V W				1474
Aronovici V S	68			384	Bakker J				1338
Arrhenius O				1473	Baldwin O J				316
Arrhigi M				1688	Balearic Islands				656
Arrhigi de Casanova J				1689	Bamberg K K				1331
Artesian water	229			1118	Bamboo drains				1156
Arthur H A				1327	Bananas				1675
Artibonite River project (Haiti)				1670	Banfield G L	814			815
Asghar A G				69	Banks H O				1223
Association of Southern Agricultural Workers				1641	Banting A				619
Atkins S W				1572	Banting A E				1025
Atkinson H B				227	Barba L della				1690
Atkinson W S				916	Barber E S				487
Atlantic County (N. J.)					Barker A				1026
Mosquito Extermination Commission				606	Barnard J W				1575
Augustadt W W				1574	Barnes A C				620
Aull G H				354	Barnes C P	30			1469
Australia	1	137	172	364	Barnes K K	7			760
366	367	377	405	440	Barr H T				1333
469	474	475	478	692	Barrakette A E				1854
770	809	825	840	842	Barrett L A G				1334
845	868	894	905	910	Barron R A	70			1224
977	992	1038	1069	1130	Barrows S B				194
1195	1213	1287	1551	1871	Bartels L C				367
1872					Bartram R				368
Austria	1	650	666	725	Basse N	1691-1693			
1061	1171	1541	1753	1777	Bastisse E M				87
Averianov S F			616	1022	Batchelor L D				418
Avis J H				1023	Bates G H				1475
Avocados	113	1493	1536	1539	Baum R O				212
Ayers F P				1328	Baum U	1127			1846
Ayers H D				365	Baumann H				1694
Aylen D				1329	Bayer L D				148
Ayres Q C	2	21		617	Bayous SEE Bogs and swamps				
					Bazlen K A				1695
					Beach W E				1335
					Bear F E				884
					Beasley R P	816			1325
					Beauchamp C E	1476			1477
Backfilling	592	664	744		Beauchamp K H	817	1027		1028
800	1114				Bechuanaland				636
by hand				1203	Beck W D				917
equipment		1361		1459	Bed drains	664			893
Gt Brit				1459	Midwestern States				817
Greece				1724	North Carolina				930
New Zealand	1095	1175		1361	Trinidad				898
research				134	Wisconsin				909
Sweden				1016	Bedell G D				71
Utah				1185	Beekom C W C van				72
Backstrom C C				1330	Beenhouwer O				129
Baijot S				618	Belgium	618	663	776	1708
Baily P J				366	Belio F				195
Baird W W				1303	Bell J E				1029
Baked-earth drains	457			1065	Bell R				1225
Baker D M	206			345	Bender				621
Baker F J				1792	Bendixen T W				31
Baker M N				193	Bennett H	369	370	1576	1578
Baker R W				1024	Bennett H H		73	74	1577





				<u>Item</u>					<u>Item</u>
Bouma H				1338	Buchele W F				822
Boumans J H				32	Buerkle A F				922
Bourget F				1339	Buie T S				823
Bourgoin Marshes					Bulldozers				1421
(France)	1703			1704	Gt Brit			732	1349
Bourque L				625	Netherlands				1365
Boush Creek Drainage project					New Zealand				1362
(Va.)				1626	Quebec				1441
Bouwer H	33	1035		1036	U S S R				1396
Bouwman L H				1037	Burky C R				923
Bowden-Smith E C				626	Burleigh H P				203
Bowler D G	627	1038		1865	Burma				1859
Box drains	521	785		1089	Burnet G				924
Bozanski A				162	Burns B E				1582
Bradley J A				206	Burress C G				1032
Bradshaw G B	38	382		1350	Burt M				1041
Bragee A				920	Burton C J				925
Brakman project (Netherlands)					Busby C E			312	313
1754					Bushnell D H				314
Brant E H				628	Busquet J C				1228
Bravo River Valley project					Bussells F R				926
(Mexico)				1665	Butler C				1229
Brazil	15	359	441	728					
833	957	1156	1676		Cabezas R R				1669
Breed J				1698	Cady R C				141
Breeding S D	201	202		217	Calaminus U				1042
Brenner				1340	Caldwell J D				1667
Brenner W W				375	Caldwell L M				1534
Bretting A E				34	California	198	211	215	219
Brick drains	8			788	232	234	248	258	259
Bridges T W				244	275-	277	283	286	288
Briggs R C				248	289	290	291	292	299
Brink W				820	325	326	340	344	361
British Columbia	184			342	369	383-	385	389	397
1136					406	415	443	450	452
British Guiana				1678	457	468	476	482	483
British Standards Institute				1039	574	593	608	614	756
British West Indies				899	801	1055	1169	1172	1223
Broadhurst W L	202			305	1258	1302	1493	1536	1564
Brosna Catchment Drainage					1581	1583	1625	1652	
project (Ireland)				1810	California Div of Water Re-				
Brouwer A R H				1848	sources				299
Brown G				821	California University				443
Browning G M	99			185	Camargo F C de				1676
Bruns V F				921	Camargue project (France)				1689
Bruscalupi G				1699	Cambodia				1860
Brush drains					Cameron A E				376
Denmark				649	Campbell F B				827
Egypt				702	Campbell G A				575
Gt Brit				8	Campbell M				795
India				446	Campbell R D			1230	1231
Netherlands				1212	Canada	242	541	573	625
New Zealand	662	699		711	652	1244	1658		
712	769				SEE ALSO names of Provinces				
North Africa				675	Canada Dept of Agriculture				
Scotland				521	Prairie Farm Rehabilitation				
Bryan L L				279	Br				1658
Bryson J L				1040	Canalini G				629

				<u>Item</u>						<u>Item</u>	
Canals and ditches				21	74	Canals and ditches---Cont.					
78	85	428	644	672		Gt Brit	8	17	700	701	
744	782	791				729					
Australia				910		India			433	956	
Brazil			728	957		Indiana				923	
Brit West Indies				899		Italy		873	982	1776	
California				574		linings	365	592	605	990	
Canada				652		brick				607	
cleaning	781	793	958	975		concrete		582	599	602	
costs				1413		607	610	855	918	990	
Delaware				937		1302	1684				
Finland				556		Panama				576	
Gt Brit				1001		Peru				1684	
New Jersey				609		Puerto Rico				918	
Nicaragua				1673		research				46	
North Carolina				929		U S S R				1005	
Ohio				937		vegetative		491	587	607	
U S S R				1006		781	859	918	952	958	
SEE ALSO Ditch cleaners						988	1005				
construction	408	587	589			Madagascar				927	
592	671	694	741	791		maintenance and repair				18	
869	907					671	694	713	781	791	
Australia			367	894		795	869	939	945	958	
Brazil				957		963	1560				
California				801		Australia				894	
Canada				652		Belgium				1708	
Delaware				1617		California				801	
Florida			1310	1438		Delaware			937	1617	
France				1704		Denmark				691	
Germany				547		equipment		609	1375	1467	
Indiana				922		Finland				556	
Kenya				852		Florida				1587	
Maryland				1617		France			1704	1708	
New Jersey			606	609		Georgia				610	
Tennessee Valley				581		Germany				547	
Virginia				1626		Gt Brit		643	1049	1467	
SEE ALSO Ditching						1793	1803	1814			
costs	581	603	619	922		Great Plains				1002	
deepening				929	1006	Iceland				953	
Denmark	649	1261	1693	1713		India				947	
depth and spacing			42	563		Iowa				959	
750	898					Italy				1401	
in peat and muck soils				534		Kansas			991	1002	
research			42	728	916	Louisiana		887	917	970	
design	13	408	652	671		Maryland				1617	
946	950	960	999			Mississippi Valley				595	
California				801		Netherlands			936	1708	
handbooks				1003		New Jersey	601	606	609		
India				896		Nicaragua				1673	
Ohio				1131		North Carolina				929	
Sweden				955		Ohio				937	
Egypt				1839		Puerto Rico				918	
erosion	587	589	915			Rhode Island				603	
control	853	910	937			Sweden				548	
958						Mexico				1666	
Netherlands				189		Missouri				915	
Florida	488	648	677			Netherlands	111	750	863		
grading			826	1399		1008	1757				



	<u>Item</u>								<u>Item</u>
Canals and ditches---Cont.					Ceylon	1561	1850	1855	1861
networks	912	966		982	1862				
New Mexico				1573	Chambers T B				3
New Zealand				1867	Channels SEE Canals and				
Puerto Rico				966	ditches				
Scotland				665	Chapman J R				1341
size	671	728		960	Chapman P W				1585
slope	587	589	741	956	Chapple L A				377
960					Charles J R				206
South Carolina				820	Charles River Basin project				
specifications				592	(Mass.)				1565
Sweden		563		961	Chatskii P V				1479
Syria				1848	Chen R				1207
Tennessee Valley				581	Chen Ts Sh				1307
Trinidad				898	Childers N F				1480
types				1000	Childs E C	35	75—	77	1044
U S S R		534		912	1045	1342			
Utah				411	Chile		794	1083	1685
weed control	599	781		917	Chimbote project (Peru)				1684
921 984 993					China			1	654
chemical		939		945	Chiodi A				1481
Columbia				1010	Chowdhury S				1482
Delaware				937	Christiansen J E			36	258
Egypt				1839	361	378	429	1046	
India				947	Chwatt L J			577	584
Louisiana				970	Ciolina F	630	927	1836	
Ohio				937	Citrus	376	476	675	677
widening				929	692	1551	1568		
Yugoslavia				1732	Clarenbach F A				1586
SEE ALSO Diversion ditches;					Clark C O				1323
Laterals; Trenches					Clark M W	78	631	826	895
Candida A F di			1700		Clark O M				354
Canterbury Chamber of					Clark R G			928	1232
Commerce				1043	Clark W M				1325
Carah W M				1583	Clarke J L				578
Carnes A	486		824		Clarke T				1343
Carnwath project (Scotland)			522		Classen A G				1233
Carpenter J C			487		Clay C				1234
Carpenter R W			1584		Clay drains			8	741
Carr W A C			1794		Clay soils	35	696	796	1027
Carroll M B Jr			1260		1058	1296			
Carter A N			576		Germany				621
Caryl N R			315		Gt Brit		8	76	628
Casson P B			825		Idaho				1215
Catch basins			679		Minnesota				1091
Catchments					Netherlands			189	1216
Gt Brit			1801		New Zealand			815	1144
Ireland			1810		Philippines				864
Cedergren H R			1312		research		100	1096	1489
Central and South Florida					Australia				137
Flood Control District			1596		Union of South Africa				1167
Central Piedmont Soil and					U S S R				710
Water Conservation Station					Washington				1215
(N. C.)			226		Claypan soils		169	794	1498
Central States			223		Clayton B S		488	489	1587
Central Valley project (Calif.)					Clements I B				138
211 482					Clover			537	1521
Cereal crops			1202		Clyde				379

	<u>Item</u>					<u>Item</u>			
Clyde G D				4	Cook G C				744
Coachella Valley (Calif.) Co-					Cook H L				827
operative Drainage Investiga-					Cools R H A				1701
tion				452	Cooper T	633			1048
Cobble drains	446			990	Copais Lake (Greece)				1705
Coconuts				480	Copley T L	828			829
Code W E	204			205	Corfitzen W E				1838
Coeytaux A				1837	Cormack R M M	830			1484
Coffee				967	Corn	930	1532	1535	1544
Coffey J H				1235					1557
Coffey P J				1668	Corn Belt				175
Cole G				1795	Corniani project (Italy)				1761
Cole R O				1450	Costa Rica				1570
Coleman N H				1363	Costs 5 21 24	318			399
Coleman R				1483		466	800	1486	1527
Coleman W H				1588		1594	1648	1653	
Collins E V				822	Algeria				1835
Collis-George N				75	Australia	440			842
Colman E A		37		79	Belgium				618
Colombia	458	684	1010	1682	California				415
Colombo South Drainage					Ceylon				1861
Scheme (Ceylon)				1861	Cuba				799
Colorado	204	205	249	301	Denmark				736
	344	370	444	1578	Dominican Republic				1667
Colorado River Basin				362	Finland				1112
Colorado Water Conservation				465	France				1516
Board				249	Gt Brit	628			786
Comacchio Valley project					Greece				1705
(Italy)				1711	Iceland				697
Complex drainage				766	Italy				788
Compound drainage	658			1211	Japan				1526
Conant V				579	Louisiana				1548
Conkling H	206	316		345	Netherlands	768	1552		1754
Connecticut				1355					1768
Conover C S				207	New Zealand	9	627		1099
Conservation	1221	1519		1594	Scotland				1805
	1654				Switzerland				549
Contactgroep Opvoering					Texas				1606
Productiviteit				632	Virginia				1558
Contour drainage	7	71		126	Washington				1558
	760	772	822	823	Wyoming				387
Australia				842	SEE ALSO UNDER specific				
British West Indies				899	subjects				
claypan soils				169	Cote R R				634
Corn Belt				175	Cotton				371
India				834	Coulson H J W				324
Italy				866	Cowley E W				362
Nyasaland				897	Cox M B		831		832
Rhodesia	830			1329	Craig A L				1290
Southeastern States				828	Crandall L	279-			281
Tasmania				856	Crandell H A				1344
Trinidad				898	Cranfield T H				80
Union of South Africa				865	Crawford A				1236
	900				Crivellari D				1702
Controlled drainage				502	Crocker R L				405
Florida				1587	Crompton E				81
Indiana	494	508		517	Crosby I B				206
peat and muck soils				530	Cross-drains	251	463		649

	<u>Item</u>					<u>Item</u>			
Cross-drains---Cont.						Davis J F	491	1589	
817 893 966						Davis J H		492	
Crossbars				1203		Davis P W		834	
Cuba P				833		Davison B		84	
Cuba	799	1476	1477	1570		Davison J R		1551	
Cultivators			1370	1459		Day C W R		541	
Culverts	22	592	668	859		Day J R		247	
Australia				992		Day P R		85	
California				574		Dean A J		1705	
concrete			580	983		Debenham F		636	
corrugated				1188		Debler E B	380	418	
design	580	923	971	1004		Deemter J J van	637	1051	
1192						Definition		1525	
India				896		De La Valette J		1706	
Louisiana				614		Delaware	83 109 916	937	
Nicaragua				1673		1397 1615 1617 1624			
wooden				938		Delaware Agricultural Experi-			
Cuthbertson J A				1049		ment Station		83	
Cutler W A				1116		Delgado Marquez R		1672	
						Deloffre G	86 1707	1708	
Dachnowski-Stokes A P				490		Demolon A		87	
Dahl N J				82		Denisenko T A		1052	
Dahlbeck N				1485		Denks		638	
Dahlgren N				1050		Denmark	34 59 649	691	
Daigh F C				83		709 736 737	751	804	
Dairy farms	627		992			1106 1261 1376	1389	1390	
Dale O C			208			1513 1691-1693	1713	1733	
Dalin A			1345			1749 1788			
Dalrymple T		209	210			Desilting basins		873	
Damodar Valley project						Desplanque C		1308	
(India)			1847			Devereux R E		88	
Dams 13 25 759 772			1311			Devon Valley project (Scotland)			
Ceylon			1850			1820			
construction			1313			DeVries L L		1346	
costs			1313			Dewhirst J F		5	
Denmark			1749			Dhawan C L		69	
earthen	846		1312			Dibbits H A M C		1709	
France			1740			Dickey P		639	
India	433		1847			Dickinson P		211	
Indo-China			1304			Diebold C H		381	
Iowa			1324			Dijkstra J		640	
Israel			1854			Dikes		782	
Missouri			1325			British Guiana		1678	
Norway			1265			California		1223	
research			1318			construction		1308	
Sahara Desert			1842			Denmark	649	1713	
Spain			1306			Florida	648	677	
Syria			1848			Gt Brit	130 1797	1803	1827
U S S R	1307		1313			history		1803	
Danike G N			1659			India		834	
Darby H C			1796			Malaya		1309	
Darcy's law	182		229			Maritime Provinces		1303	
David A	1703		1704			1308 1315			
Davidson J M			50			Netherlands	863 902	1251	
Davis C			316			1317 1322 1697	1698	1701	
Davis C V			635			1750			
Davis E H			1486			Nigeria		584	
Davis H E			581			repair	1317	1697	



	<u>Item</u>			
Dikes----Cont.				
Spain				1306
U S S R	1316			1321
Wales				1314
Washington	639			1319
Diseker E G	929			930
Diserens A				1710
Dismal Swamp (N. J.)				609
Dismal Swamp (Va.)	1589			1656
Ditch blasting	546	760		926
931 948 962		963		1486
Alabama				914
alluvial soils				1871
Australia	977			1871
bogs and swamps	523			546
973 997 998	1871			
costs				1007
for mosquito control	596			614
forests 553 554	558			569
571 572				
Iowa		964		989
irrigated soils				391
Louisiana	614			934
methods				1012
Mississippi				986
North Carolina	929			930
Norway 558 569	571			572
968 1775				
Ohio		932		973
Oregon	391			749
peat and muck soils				1871
Pennsylvania				1087
Solomon Islands				1866
Sweden 553 554	919			954
Switzerland				972
Utah				596
Washington				997
West Virginia	523			925
Ditch cleaners				1344
construction 1374	1375			1392
1449				
costs	1337	1375		1414
for bogs and swamps				1413
1414 1415 1417				
for clay soils				1373
Germany				974
Gt Brit 1001 1388	1398			1419
1467				
Italy				1401
mechanical	974	1388		1398
1448 1467				
Netherlands				1373
New Jersey	609	1414		1415
1435 1456				
New Zealand		1447		1448
Ditchers 926	1344	1363		1418
Connecticut				1355
costs	1355	1414		1434

	<u>Item</u>			
Ditchers----Cont.				
for bogs and swamps				
Germany				1445
New Jersey	1414			1415
1436 1457				
New Zealand	1334			1354
U S S R				745
France				1126
Germany				1453
Gt Brit 732 1351	1372			1468
horse-drawn				1338
Iceland				1359
Italy	1401			1431
mechanical				1389
Denmark				1376
France 561 1339	1377			1410
Germany 1340	1406			1408
1428 1466				
Gt Brit				1405
Italy				1467
Netherlands 1338	1393			1348
New Zealand				1407
Spain				1448
Sweden				1433
Netherlands 1251	1338			961
1378 1783				1432
New Jersey				1251
New Zealand 1362	1386			1414
Ontario				1447
Rhodesia				1429
Scotland				1329
Sweden				1367
types	1326			1330
U S S R				1416
SEE ALSO Trenchers				1396
Ditches SEE Canals and ditches				
Ditching				
Arizona				371
by hand				423
Canada				569
costs	408	610	1413	541
1468				1432
France				
Georgia				1126
Gt Brit				610
Greece				641
mechanical				1724
Nebraska				920
Netherlands 995	1751			943
Norway				423
Sweden				1783
SEE ALSO Trenching				569
Dittmer H L				920
Diversion ditches 25	826			1432
907 908 946				
Djurle O				932
Dobson A F				859
Doggett D				493
				1143
				494



	<u>Item</u>			
Draintile-----Cont.				
concrete	364	702	1032	1047
1116	1140	1145	1147	1170
tests	1138	1139	1142	1146
1150				
costs				1539
density				1155
durability		1141	1145	1146
1149	1170			
expansion				1147
for acid soils	1141	1145	1146	
1170				
for alkali soils		1138	1141	
1148				
for mineral soils		1145	1146	
for peat and muck soils			1145	
1146				
Gt Brit		1157	1159	
history			1157	
inspection			1199	
loading			1207	
manufacture		1140	1148	
materials		800	1211	
mortar		1145	1150	
Netherlands			1211	
perforated			1184	
porosity	1047	1066	1128	
properties			6	
quality	664	738	1032	1066
1085	1103	1128	1155	1187
1196	1199			
research			1047	
resistance to frost		1141	1149	
resistance to heat			1147	
resistance to moisture			1147	
resistance to sulfates			1138	
1142	1150			
selection	7	754	760	1028
1032	1085	1116	1155	1560
Canada				652
Denmark				804
Finland				1115
Netherlands				1151
Oregon				749
Quebec				1210
shape				664
size	664	785	800	1085
1211				
standards			1018-1020	
1103	1116	1199		
strength		1066	1128	1133
1140	1155			
Tasmania				785
tests	1139	1147	1149	1150
SEE ALSO Drainpipes				
Drainwater				6
analysis	87	94	128	138
1244				

	<u>Item</u>			
Drainwater-----Cont.				
analysis-----Cont.				
Norway				150
Venezuela				149
chemistry				230
discharge				1211
for irrigation	401			1486
Australia				475
California				483
Florida				648
New Zealand				1236
Rumania				1279
U S S R	706			889
India				69
measurement				1090
Nevada				167
quality			69	167
salinity	67	69	460	475
Drake R R				212
Dredges and dredging				1364
1392	1814	1820		
Dreibelbis F R	50	92	—	94
105				
Drill barge				1438
Driskell B N				495
Drummond G B				206
Dubakh A D				542
Dubeikovskii I I				1352
Dubkov S N				1353
Duffy M				496
Dumm L D				386
Duncan A A				1354
Dunnewald T J	387			388
Durand W F				935
Dushinske R L				1488
Dutch Moorland Reclamation Society				640
Duyrn J				936
Dykes J C				317
Eads R B				1866
Eakin T E				246
Eames H F		1592		1593
Eastern States	222	257		821
837	1517			
Ebert F				1713
Eckel E B				225
Economic Cooperation Admin				720
Economic effects	668			1657
Austria				1541
Brazil				728
Florida				529
France				1516
Minnesota				1582
Norway				1496
Washington				393



					<u>Item</u>						<u>Item</u>
Ecuador					1679	Effects on crops---Cont.					
Edminster T W	7	64			95	peat and mu'ck soils					497
96	837	1056	1594			Southern States					1506
Edmonston A D					213	Sweden	1077				1473
Edwards H C					644	Turkey					1264
Edwards H G					1595	U S S R	506	509			537
Effects	6	16	26		408	1479					
618	664	671	760		800	Wales		734			1529
1470	1471					Wisconsin					909
Australia					842	Effects on farm wells					1524
Ceylon					1861	Effects on fish					1562
France					1525	Effects on floods					
Gt Brit					1234	Gt Brit					1530
Idaho					1514	Effects on health	803				805
India					20	Caribbean region					1570
Midwestern States					1507	Italy					1481
Minnesota					1582	Peru					1684
Netherlands					1217	Effects on land values					1588
New Zealand	699				1144	1614					
North Carolina					562	Effects on plant disease					567
Oregon					1474	1478 1482 1536 1540					
Texas		1514			1606	Effects on soil nutrients					71
Virginia					1558	94 128 144 1472					
Washington					1319	Corn Belt					175
Effects on crops	162	399			793	Norway					150
822	1221	1480	1486		1494	Venezuela					149
1502	1504	1505	1520		1527	Effects on soils		83			183
1540	1542	1553-1555			1560	186 1472 1483 1498					1509
1567						Finland		545			1508
Australia		770			1551	Florida					1537
Austria					725	Gt Brit	700	1475			1490
California	369	424			1493	India					20
1536						Minnesota					1543
Ceylon					1561	Netherlands		764			1217
Colorado					1108	Norway	82	1496			1509
Cuba	1476				1477	Sweden					1495
Denmark	804				1513	U S S R		1321			1531
Finland	539				1545	Effects on wildlife		1471			1488
Florida					1568	1512 1547					
France					1491	Southern States					566
Germany					1549	Sweden					1485
Gt Brit	729	734	1528		1529	Texas					1550
Gulf Coast States					1500	Egaaens project (Denmark)					
India					1482	1691					
Iowa		1535			1544	Eggers H W T					1057
irrigated lands					461	Egypt	1	470	645		702
Kentucky					1534	1067 1834 1839					
Louisiana					1548	Egypt Dept of Public Works					645
Maryland		1557			1584	1839					
Michigan					1501	Eijsvoogel W F					1714
Midwestern States					1507	Eldred (Ill.) Drainage and					
Minnesota					526	Levee District					1230
Mississippi Valley					1519	Electro-osmosis	1058				1220
Netherlands	764	1478			1515	research					1143
1538 1552						Elephant Butte Irrigation					
North Carolina					930	District (New Mex.)					207
Norway					501	Ellerbe C M					646
Ohio					1532	Elliott I L		535			536

				<u>Item</u>					<u>Item</u>
Ellis N K				497	Erosion---Cont.				
Ellison W				647	New York				102
Ellison W D				937	Norway				1562
El Salvador	1570	1669		1674	Escritt L B				1801
Elston J				1355	Estes H				1598
Eltisley Lord				1356	Estonia	1758	1759		1769
Elveve J T				498	Etcheverry B A				6
Elwell G				1596	Europe				1782
Elwell H M				838	Evans C B				1242
Emerson A W	839	1357		1597	Evans D D		48		98
Emerson W O				389	Evans L S				939
Engelhard J				1715	Evdokimova V I				1060
Engelhardt J H				1059	Everglades (Florida)		488		492
Engelund F				97	498 529 648 677				1242
Engineers Joint Council					1320 1438 1576 1579				1585
National Water Policy Panel					1587 1590 1591 1596				1609
318					1620 1627 1631 1632				1649
Enstone R B		1358	1800		1650				
Equipment	632	781	819		Everglades Drainage District				
1326-1468					1579 1585 1590 1609				
Australia				678	Everglades Experiment				
Belgium				663	Station				1290
Denmark	649		736		Ewan J W				1802
for bogs and swamps			1402		Excavators		1414		1418
1403					construction		1374		1375
Germany			1380		costs				1375
Gt Brit			1351		Gt Brit	1343			1349
Greece			1759		Ireland				1135
Ireland			496		Netherlands				1365
Latvia			1331		New Zealand	1098			1448
mechanical					U S S R				1178
costs			1328		Exmoor Marshes (England)				
France			1412		1808				
Gt Brit	1356	1387	1388		Explosives	2			948
Netherlands			1404		in mosquito control				592
New Jersey			1328		Iowa				959
New Zealand			1361		Pennsylvania				1602
Sweden			1455		Sweden				553
U S S R	1353	1442	1465		tests				962
New Zealand	9	627	815		SEE ALSO Ditch blasting				
1865					Eylands A G	1359			1716
Quebec			1441						
Scotland			665		Farm ponds	592	701		708
U S S R	706	745	1345	1402	760 858 860				
1403					Farm woodlands		92		914
Washington			1368		SEE ALSO Forests				
SEE ALSO kinds of equipment;					Farmyards				1072
and UNDER specific drainage					Farrell B H				1867
practices					Fascine drains SEE Brush				
Erosion	7	78	106	110	drains				
153 888					Fasken G B				1027
control			126	145	Feilberg A		649		940
727 813 859					Feilberg C L		649		940
India				834	Feix E		650		1061
research				880	Fens (England)	8	112		519
Corn Belt				175	647 1232 1239 1240				1243
Mississippi				1497	1285 1300 1475 1528				1792
Missouri				915					

	<u>Item</u>					<u>Item</u>			
Fens (England)--Cont.				1796	Flood control--Cont.				
1797 1798 1803 1806				1807	legislation				355
1819 1821-1823 1827					Louisiana	3			505
Ferguson D S				1309	Midwestern States				1629
Ferguson F L	319	651		652	Minnesota				337
1062					Mississippi Delta				1603
Fernandez de L G A				653	Nebraska				969
Ferrara project (Italy)				1760	New England States				1622
Ferris J G				214	New Mexico				1573
Ferron				1717	New York				1622
Fertilizers				1176	North Dakota	1574			1597
Fialkovskii P G				39	Ohio				1288
Field J E				316	Oklahoma				862
Field crops				1518	Oregon				1623
SEE ALSO names of specific					Pakistan				1845
crops					Portugal				1738
Fife C V				1101	Texas				1233
Fiji Islands				1869	Trinidad				944
Fill Lake (Denmark)				1733	U S S R				1316
Filman C C				1244	Uruguay				1680
Finance	314	330	332	346	Floods	133	194	293	310
348 1640					Arkansas				298
Florida				1632	California	248	290		293
Mississippi Delta				323	Central States				223
South Carolina				354	Denmark				1788
Tennessee				1642	Eastern States		222		257
Utah			686	1619	Gt Brit	1510			1793
Finland	1	512	528	539	Great Plains				1002
545 550 556 557 559					Hawaii				293
698 1109-1112 1115 1379					Kansas		298		1002
1430 1508 1545 1730					Minnesota				293
Finska Mosskulturforeningens				528	Missouri				298
Firkins B J				1544	Missouri River Basin				294
Firth D H				519	Nebraska		293		298
Fishel V C				141	Netherlands	1317			1745
Fitton A H				1802	Nevada				293
Fitzhugh E A				390	New England States				221
Flanagan J E				1669	New Mexico				209
Fleming H K				66	New York				239
Fletcher P W				114	North Atlantic States				297
Floodkvist H				1489	North Dakota				293
Flood control		6	13	18	Oklahoma				298
22 25 126 173 174					Oregon		256		293
194 1618 1641 1647					Pennsylvania				239
Austria				666	Red River Basin		293		295
California				1652	South Dakota				293
Ceylon				1862	Southeastern States				296
costs				343	Texas		201		210
Denmark				1691	Washington				256
Florida	648	1310	1320	1438	Winnipeg River Basin				293
1601					SEE ALSO Inundated soils				
France				1740	Florida	456	486	488	489
Gt Brit	1280	1814	1816	1820		492	498	602	648
1822						677	1091	1310	1438
Hungary				746		1537	1568	1576	1579
India	467	1847	1864			1585	1587	1590	1591
Iraq		1856	1863			1596	1601	1609	1620
						1627	1632	1649	1650



	<u>Item</u>			
Florida Agricultural Experiment Station	488	489	1609	
Florida Board of Conservation				
Div of Water Survey and Research			1310	
Florida Everglades Drainage District Act of 1941			1649	
Floten C G			391	
Flow of water	637	859	1011	
1051				
calculation			771	
in canals and ditches			18	
115 935 949 956			960	
990 994 1009				
measurement			981	
in drains			75	
formulas			763	
in grassed waterways			868	
881 883 891 979			987	
in laterals			1489	
in mole drains			1100	
in soils 35 115 164			454	
in subsurface drains			1052	
in tile drains 18 97			175	
940 1090 1197 1350				
into drains 100 123			1118	
1119-1122				
research			115	
tests			1082	
Flumes 399 980 981			1318	
Fluorides			138	
Folsom O H			1360	
Fong K L			654	
Food for Freedom program			1556	
Foote M V			840	
Forbes H 206 215 288			345	
Forbes U A			324	
Forests			546 567	
Australia			825	
Canada			541 573	
Finland 545 550 556			557	
559				
France			561 1740	
Germany			547	
Italy			1702	
Latvia			551	
Michigan			552	
North Carolina			543 562	
Northern States			525	
Norway 555 558 568—			572	
Ontario			157	
South Carolina			543	
Southern States			566	
Sweden 513 548 553			554	
563 564				
Switzerland			544 549	
U S S R	542	560	565	

	<u>Item</u>			
Forests--Cont.				
Virginia			543	
Wisconsin			157	
Forman J			1803	
Forsee W T		146	518	
Fort Hays Conservation Experiment Station			212	
Foss H			655	
Foster G M			656	
Fouquet C			1739	
France	561	615	681	714
722 723 748 755			1126	
1204 1339 1377 1410			1412	
1491 1516 1525 1688			1689	
1703 1704 1707 1708			1710	
1712 1715 1717 1734			1739	
1740 1741 1746-1748			1763	
1764 1780				
Francis C J			1599	
Frandsen P E			1607	
Franke A		657	658	1718
Fredenhagen V B			841	
Frederickson C D			395	
Fredholm O			659	
Free G R			99	
French R J			842	
French drains			753	1166
Frevort R K		7	48	98
760 1207 1208				
Freyburger E			843	1600
Fridstrom A E				1063
Frodsham Marshes (Gt Brit)				1794
Fruit SEE Citrus; Orchards; Vineyards				
Fugetta P				1699
Fuhriman W U				392
Fujisaki M				1849
Fullerton W H				1245
Furneaux B S			1064	1490
Furrows and furrowing				829
Australia			770	842
British West Indies				899
California				1536
Kenya			716	852
Latvia				1331
Netherlands				111
New Zealand				769
U S S R				913
Fussell G E				660
Gain E W			8	1804
Gaines H F				393
Gaiser R N				543
Gale H S			259	303
Galletti A C				1065
Galpin A J		1066	1079	1361
1362				

	<u>Item</u>					<u>Item</u>			
Garboua M				1067	Gottlieb W H	1248			1250
Garcfa Atance J				1719	Goudie A G				692
Gardens SEE Small farms and gardens					Gourley H J F				316
Gardner C H				1068	Gowla Reclamation project (Ireland)				1828
Gardner H H				843	Grading and leveling	624			727
Gardner R				394		760	819	885	1165
Gardner W	40	100		1246	Australia				678
1247					Canada				652
Gardner W H				454	Colorado				370
Garstka W U				41	Eastern States equipment	885	887		1399
Gasconne Moors (France)				1717	Louisiana		837		1548
Gaskell R E	119			134	New Mexico				370
Gasparetto A				1699	Quebec				1210
Gasparetto F				1699	Wisconsin				1630
Gay C B				42	Grain				1545
Gayford G W				1069	Grande Covian R	1722			1723
Geddes J A				395	Grant A				1805
Gee H C				1601	Grant Township Drainage District (Kans)				1613
Gee W L				1363	Grassed waterways		7		664
Geiszler G N				844		813	818	836	839
Geitman B G	499			661		878	888	952	987
George N C				101	Australia		840	868	910
George W O				216— 218	Brazil				833
Georgia	352	486	610	1225	Canada				652
1633					construction	760	835		841
Georgia State Drainage Law				352		843	846	849	851
Germany	547	621	638	682		854	861	868	
	703	704	752	761	design	841	861	868	874
	974	996	1042	1058	946				
	1089	1113	1124	1182	fertilizing		835	843	854
	1193	1194	1340	1364		895	908		
	1395	1406	1408	1428	Guinea				871
	1445				Kansas				861
Germany Reichsministerium für Ernährung und Landwirtschaft				1070	location	835	868		875
Geytenbeek P E				845	maintenance	760	824		840
Ghab project (Syria)				1848		841	843	854	875
Ghetti A				1737	904				895
Ghisleni P L				1720	Michigan				491
Gies R W				583	mulching	813	843		854
Gilroy A B				584	Nebraska				861
Girardin				1491	New Zealand	627	662		815
Glanville E B				662	North Carolina				835
Glentworth R				43	Nyasaland				897
Gley soils SEE Bogs and swamps					Ohio				1532
Glotov M N				1071	peat and muck soils				491
Godinache J				663	research				988
Godinez Noriega M				1665	Missouri		882		890
Gokhale V K				947	Oklahoma	831	832		838
Goliakov N M				500		883	891		
Goncalves P A				941	South Carolina		827		881
Gonzalez R A				396		882	891	987	
Goodman A M				664	retardance	882	883		979
Goodwin K R				1409	Rhodesia				830
Goodwin-Wilson R A				1244	South Australia				845
Gorrie R M	1492			1850	width				895

				<u>Item</u>
Grasslands	92	428		696
1000				
Australia		842		905
California				415
Eastern States				821
Finland				528
Gt Brit	81	130		721
Ireland				1824
Maritime Provinces				1315
Netherlands	623	797		1212
New Zealand	815	1038		1098
Oregon				1474
Switzerland		705		775
Gravel drains	8	788		1055
1112				
Gravity drains	410	425		442
449				
Gray H E				33
Gt Brit	8	11	17	27
76	80	81	108	112
130	151	154	155	324
333	626	628	633	641
643	647	660	669	701
721	729	732	735	798
806	928	1001	1024	1026
1033	1040	1045	1048	1049
1064	1068	1084	1157	1163
1222	1239	1241	1243	1255
1280	1282	1285	1291	1300
1332	1343	1349	1351	1356
1370	1372	1382	1387	1388
1398	1400	1405	1419	1420
1423	1451	1459	1462	1463
1467	1468	1475	1490	1503
1510	1528	1530	1781	1792
1793	1804	1806	1809	1811
1812	1823	1826	1827	1829
1830	1833			
Gt Brit Dept of Agriculture for Scotland				665
Gt Brit Ministry of Agriculture Grant Aid Scheme				1799
Gt Brit Ministry of Agriculture and Fisheries				1072
Gt Brit War Agricultural Execu- tive Committee				
Land Drainage Dept				1800
Great Lakes States	16			1655
Great Plains	284	1002		1655
Greece	1705	1724	1759	1773
Greene M T				1251
Greenhalgh W H				481
Greenland				1662
Gregor H F				397
Griffiths J A				1660
Ground water	128	195		196
242	277	302	312	1013
1539				

				<u>Item</u>
Ground water--Cont.				
analysis	157	218		540
Arizona	29	191	192	225
273	274			
California	198	215		232
234	237	258	259	275
276	277	283	286	288
289	299	397	443	1223
characteristics				214
chemistry	198	217		230
Colorado	204	205		245
249	301	1578		
conservation	196	255		283
285	300			
consumption		199		255
control		316		321
depletion	105	203		276
for irrigation		203		205
hydraulics	36	46		55
186	229	237	250	262
269	281	288	408	517
1220	1278			
Idaho	10	55	279	281
legal aspects			316	321
legislation			313	327
Arizona				344
California	325	326		340
344				
Colorado				344
Idaho				326
Nevada				344
New Mexico	322	325		326
344				
Texas		325		326
Utah		325		344
Western States		328		338
345				
measurement		33		236
Mexico				132
Nevada	167	246		398
New Mexico		207		301
North Dakota				253
Oklahoma				301
Oregon		220		260
peat and muck soils				517
pumping		1258		1269
quality				300
recharge	236	237		269
286	284			
research				36
salinity	218	288	465	1223
situation and outlook				254
sources	193	215	236	300
686				
Southwestern States				203
storage	92	105	160	206
224	262	278		
California	283	291		292



	<u>Item</u>					<u>Item</u>			
Ground water--Cont.					Handbooks--Cont.				
storage--cont.					Denmark				804
Western States				206	Mississippi Delta				1603
Texas	190	202	208	216	U S S R				719
217	218	238	243	244	SEE ALSO UNDER specific				
247	267-	269	300	303	subjects				
304-307					Hane-Ko project (Japan)				1857
Utah	233	241	282	481	Hanks R J				103
686					Hannah H W				320
Washington			252	261	Hannaman D A				1624
Western States			38	159	Hanraets J M J				1365
197	255	287	1270		Hansen V E		224		1278
Wyoming				266	Hanson E G		329		1619
SEE ALSO Water table					Happ S C				1497
Grout A R				1073	Harbord W L				1081
Grout R				1602	Hardin E A				1181
Grover N C			221-	223	Harding S T				321
Gruber J W				1851	Harding S W				1082
Grubinger H				666	Hardman G				398
Gryonne Valley project (Switzer-					Hardman J A				1381
land)				549	Hardpan soils		858		1532
Guatemala				1570	Hardy F				944
Guinea				871	Hargrave J				669
Gulf States				1500	Hargreaves G H				1670
Gullies				25	Harildstad E				670
control	7	839	904	1318	Harker D				1311
Nyasaland				1844	Harker D H		502	517	671
Spain				1306	1114				
Gustafson A F				102	Harmer P M		503		504
Gut R C				544	Harper H J		104		1498
Gutberlet F				1364	Harrell M A				225
Guyton W F				306	Harris C D				322
Gypsum	419	796	884		Harris L E		1806		1807
					Harris R B				345
Haarer A E				1852	Harrison C M				491
Haarlem Sea project (Nether-					Harrison G R				1252
lands)				1774	Harrison R W		323	505	1499
Haas A R C				1493	1603-1605				
Habbaniyah Lake (Iraq)				1856	Harrold L L		105-	107	226
1863					Hart J T				1414
Habib J				681	Hart R A		399	400	1083
Hadjinicolaou J				1724	Harvey N				1084
Haegermark F				1074	Hastings W W				217
Hagem K				1075	Haswell J R		672	1032	1085
Hagerup H		501	942	1725	1086	1087			
Hahn J H de				1677	Haugen O				1366
Haiti				1570	Hauger R L			1500	1606
Hakansson A				1076	Haverlee A H				945
Haley L				1494	Hay A K				586
Hall L S				316	Hay R C				904
Hall T F				585	Hay		537	1554	1557
Hallgren G			943	1077	Haynes A R				1809
Hallin S			1496	1727	Haynes J L				126
Hamblyn C J			1078-	1080	Hays J B				1854
Hamid K B				1853	Hays O E				227
Hamid M A				667	Hayward H E		401-		403
Hamilton C L			847-	851	Hazorea project (Israel)				1127
Handbooks	668	744	759	760	1846				

	<u>Item</u>					<u>Item</u>			
Headwalls				1114	History--Cont.				
Heathcote W R				108	Iraq		1851	1863	
Hedge cutters				1452	Ireland			1824	
Hedges	643	700		701	Italy	11	1737	1779	1781
Heesterman J E				1678	Manitoba				1660
Heikurainen L				545	Mexico				1664
Heimpel L G				1088	Minnesota				1582
Hellinga F		1253		1728	Mississippi		1595	1603	1604
Helseth T P				639	Netherlands		1695	1696	1700
Henderson G R				852			1701	1735	1744
Henderson J M		587-		589			1770	1781	1782
Henderson County (Ill) Drainage					New Zealand				1100
District				1238	North Dakota				1574
Hendrick J				44	Sweden				1076
Hendricks H A J				1677	Tennessee				1642
Hendrix W E				1572	Virginia				1589
Herborn A W				853	Wales		11		1314
Herrera L				1840	Western States				810
Herrmann H				1089	SEE ALSO UNDER specific				
Hershberger M F				31	subjects				
Hess A D				590	Hobbs H W				109
Hester J B				45	Hobday S R				324
Heuser J F				304	Hock O W				1091
Hewes L	673	674		1607	Hockensmith R D				110
Heyndrickx G A				1090	Hoene J V				546
Hibon J				675	Hoenshel P				677
Hickman W D				1215	Hoglund C R				1501
Hickok R B	71	507		946	Holbrook W				404
Hidinger L L				1608	Holmes W E				103
Hidveghy L				1254	Honduras				1675
Higgins F H				1368	Hooghoudt S B	111	112		1092
Hill R A				206	Hooper W T				1255
Hilly regions		946		1323	Hoover M D				114
drainability				1036	Hopewell H G	9	1093-	1095	
Gt Brit		633		786					1100
India				1847	Hopfen				1369
Iowa				125	Hore E R				1096
Netherlands				757	Horn				1662
Scotland				1426	Horner G M				228
Hissink D J				676	Horner W W				1323
History	11	14	26	193	Horth C J				678
	668	1504	1616	1656	Horton R E				193
Argentina				1683	Horton R K				1684
Balearic Islands				656	Howald R				1097
Brazil				15	Howe O W				462
California				1652	Hubbert M K				229
Egypt				702	Hubble G D				405
Europe				1782	Huberty M R	113	198		230
Florida	1576	1590	1609	1627		235	406	466	1539
	1632	1649			Hudson A W		9	680	1098
France				1525		1099-1101	1868		
Gt Brit	8	11	17	27	Huff L C				231
	626	660	733	1157	Hugues L				681
	1234	1781	1796-1798	1802	Huisman L H				1373
	1803	1806	1807	1819	Huleh Lake (Israel)				1854
Greece				1724	Hungary	746	877	1254	1. 56
India		20		718		1276	1778		
Iowa				1607	Hunter H				732

	<u>Item</u>					<u>Item</u>			
Hursh C R				114	Inundated soils--Cont.				
Husemann C				682	Denmark				1788
Hutchins W A	316	325-		328	France			1707	1708
Hutchinson D E				854	Gt Brit	80	669	1793	1795
Hydraulics	19	25		34	1830	1832			
57	158	637	668	743	Japan				1849
759	851	999	1409		Kansas				991
handbooks				635	Madagascar				1843
SEE ALSO Flow of water					Netherlands	72	623		1305
Hydrology	25	62		190	1708	1745	1750	1751	1784
191-310	985				Texas				1233
Angol A M	506	683	1102		U S S R			156	1321
Iceland	697	953	1359	1716	Iowa	125	140	161	185
Idaho	10	55	279-	281	264	270	924	956	959
326	1215	1514			989	1184	1209	1324	1535
Idaho State Planning Board			10		1544	1607	1633		
Iglesias Benoit H			684		Iraq		1851	1856	1863
Ignatenok F B			685		Ireland	496	510	520	1134
Ihrig D			1256		1135	1791	1810	1824	1825
Illinois	118	176	320	1230	1828				
1231	1238	1249	1260	1633	Irmay S				115
Illinois University College of					Irrigated soils	4	6		21
Agriculture Extension Serv				1103	26	35	359-	483	604
Imperial Irrigation District					800	1197	1311	1470	1566
(Calif)			385		1636				
India	1	20	69	168	Arizona				371
251	433	438	446	463	Australia	364	366		367
467	613	834	896	947	377	405	425	440	469
956	1299	1482	1569	1847	474	1195			
1852	1858	1864			Brazil			359	441
Indian Grave (Ill) Drainage Dis-					California	56	258		361
trict			1260		369	383	384	389	397
Indiana	494	502	507	508	415	424	443	450	452
517	718	922	1190	1218	457	476	482	483	608
1252	1600	1633			1625	1652			
Indiana Drainage Contractors					Canada				1658
Association			1190		Colombia				458
Indo-China			1304		Colorado				370
Indonesia			1870		India	433	438	446	467
Infiltration	7	74	99		Montana			363	388
164	802				Nevada			398	427
estimates			129		New Mexico			370	459
peat and muck soils			538		Oregon	391	426		445
rates			98		Puerto Rico		396	1672	
research	49	111			research	79	379	402	
Ingerson I M			232		454				
Inglis C C			947		U S S R				51
Inlets	399	664	713	744	Utah				477
749	1673				Western States				38
Institute of Makers of Explo-					Rhodesia				416
sives			948		Saskatchewan		437	1659	
Interception drains			1130		Sierra Leone			90	
International Bank for Recon-					Southwestern States			444	
struction and Development			1855		Texas		372	459	
Inundated soils	86	91			U S S R		374	420	
Belgium			1708		478				
					Utah	392	407	409	411
					481				



	<u>Item</u>					<u>Item</u>			
Irrigated soils--Cont.						Jones G P			593
Washington	368	393	1558			Jones H I			1108
Western States		382	419			Jones J P			952
430 432 445	1517					Jones L A	12	117	330
Wyoming		388	436			331 332	694	695	1504
Iserre Valley project (France)						1505-1507	1587	1609	1656
		1712				1813			
Isler D A		1374	1375			Jones L S			138
Ismail H M			949			Jones W R			1259
Israel	879 1127	1846	1854			Jonge L J A			696
Israelsen O W	11	46	234			Jonge P de			1378
329 407-	413	435	442			Jongedyk H A			507
686 1246	1257	1258	1277			Jonsson A L	697		953
1278 1619						Jonsson P			954
Italy	11	629	788	866		Jourdan L			1729
873 886	976	982	1065			Jungstedt B O	548		955
1348 1401	1431	1481	1690			Jute			1676
1699 1702	1706	1711	1719			Juusela T	82	524	698
1720 1736	1737	1760	1761			1109-1111	1379	1508	
1776 1779	1781								
IUnevich D P			687			Kahawita R			416
Izzard C F			950			Kaitera P	1112	1115	1509
						Kalbermatten J de			549
Jack H W			1869			Kalweit H			1380
Jackson A E			1811			Kannenbergh H			1113
Jacobsen J			1104			Kansas	212 298	301	326
Jacobson H G M			144			861 991 1002	1613		
Jacobson P			1105			Karla Lake (Greece)			1773
Jacoby C E		688	689			Karstens G A			1114
Jacoby H			690			Kazmann R G			206
Jahn G			547			Keach (Ill) Drainage and Levee			
Jakobsen J M	691	1106	1376			District			1231
Jakovlev B I			116			Keen B A			1510
Jamison V C			47			Keilholz F J			1511
Japan	784	872	1189	1411		Kelley O J		58	1381
1526 1849	1857					Kelley W P		418	419
Jarrett G		951	1812			Kellogg F H			1312
Jarvis C S			206			Keltikangas V			550
Jarvis M W			692			Kemp W S			699
Jelies H			1338			Kendall R G	700	701	1382
Jennings D S			1381			1383 1384			
Jensen H			1106			Kenn River project (England)			
Jensen M C			55						1812
Jepson H G			855			Kenney F R			1512
Jessup L T			414			Kent River project (England)			
Jobbins D M			591						1815
Joffe J S	693	1107	1502			Kentucky	486	1534	1633
Johnson E A G		1377	1503			Kentucky Agricultural Experi-			
Johnson H A		599	607			ment Station			
Johnson H P			48			Western Kentucky Substation			
Johnston C N			235						1534
Joint Committee of the National						Kenya	716		852
Malaria Committee and the San-						Kerr H A			908
itary Engineering Div of the						Kershaw C J			856
Malaria Society of Civil Engi-						Keso L	1115		1730
neers			592			Khairy A			702
Jones B J			415			Khanna R K			956
Jones G H			236			Khoperskii I S			1313

				<u>Item</u>					<u>Item</u>
Kidder E H	118	175	1096	Land use---Cont.					
1116				Southeastern States					486
Kiehl E J			957	Landon I K					861
Kielman J A			1697	Lane D A					237
King A S			749	Lang J W			238		305
King B			1610	Langbein W B			239		1323
King J A			1117	Langley B C					240
Kinkham D	40	98	119	Laos					1860
120-125	1118-1122	1208		Lapides Y					1127
Kirwald E			703	Laplace equation	52	95			164
Klestrup-Hansen F			1513	Larroque J					1734
Klingebiel A A			176	Larsen C V S			1389		1390
Klingenhoff W			704	Larson C A					421
Klingner W H			1260	Larson C L			1128		1263
Klute A			164	Larson J E					1129
Knapp G S		316	1611	Larsson H					1391
Knifing			472	Laterals	820	887			1073
Knight E W			167	construction					1548
Knoblauch H C			127	depth and spacing		180			425
Knoppien P			62	474 671 1489					
Knox County (Ind) Soil Conserva-				maintenance					1548
tion District			1600	plastic					1184
Kobayashi T			1857	Latham E					1819
Koblet R			705	Latvia	551	1015			1331
Koenig N			1612	Laue W C					959
Köhler			551	Law F					960
Kohler K O			1514	Leaching	28	86	136		378
Kohnke H	49	50	71	418 449 1120		1177			1700
Kolenchenko D			509	Bonneville Basin					465
Kollmorgen W M	505		1603A	California			406		450
Kondratavichus V I			1731	Colorado					370
Koslow V S			707	Nevada					427
Kostiakov A M	51	420	706	New Mexico					370
Kotilainen M J			557	research	406	448			451
Kovacevic P			1732	Sierra Leone					90
Krekow E A			958	Utah		448			451
Kreuger W C		693	1107	Washington					421
Krijger P D			857	Wyoming					387
Krimgold D B	51	129	708	Leavitt E T					862
858- 860				Lebarron R K					552
Kristensen K J			709	Le Compte S B					144
Krivososov I M		710	1123	Lee A T M					1567
Kroff W J			1188	Legal aspects			337		353
Kunkel F			299	Leggette R M			141		241
Kupper			1124	Legislation	18	21	311		317
Kuum IU			1125	318 331 332			341		347
Kuvas K		1261	1733	348- 350 355			356		1632
				1641					
Lafferty O W	594	1262	1415	Canada					342
Lagos U J A			1671	Florida					1632
Lalloy			1126	France					723
Lambe T W			1312	Georgia					352
Lambert J M			130	Gt Brit		8	324		333
Lamont N	711	712	1385	Illinois			311		320
Land use	92	93	106	Maryland					336
1511 1641				Michigan					346
Pakistan			667	Minnesota					335
Saskatchewan			437	Mississippi Delta					1603

	<u>Item</u>				<u>Item</u>		
Legislation--Cont.				Louisiana--Cont.	1091	1245	
New Mexico		353		1522 1548 1603A	1605	1633	
North Dakota	339	1599		Louisiana Agricultural Experi-			
Ontario		319		ment Station		887	
Pennsylvania		1085		Lourdin L		1516	
Scotland		334		Love S K	263-	265	
South Carolina		354		Lovely W G		822	
Virginia		1589		Lowdermilk W C	14	133	863
Wales		333		Lowry S J		1534	
Legumes	491	537	988	Lubkov A I		511	
Legwen W A		1392		Ludvik G F		590	
Lehmann E W		713		Ludwig B H		596	
Lelydorp project (Surinam)		1677		Luebke H N		1131	
Lembke W D		131		Lugo Lopez M A	966	967	
Lenert L G		1392		Luk'fanchikov S N		1396	
Leopold L B		13		Lukkala O J	512	556	557
Le Prince J A	595	607		Lumby Strand project (Denmark)			
Le Ry J		714				1713	
Leur F H de		1393		Lund B		1265	
Leusen H J van		1735		Lunden B		968	
Levees	782	1259	1323	Lundgreen W		969	
California		215		Lundgreen W K		423	
construction		1310	1320	Luthin J N	52	53	85
Florida	1310	1320	1587		135	136	424
Indo-China		1304		Lynch E E			1397
Louisiana	505	614	1245	Lynes W S		1117	1132
Netherlands		1305		Lyon A V		137	425
New Zealand		1867		Lyra I de A			15
Levi E		132		Lysimeters		28	37
Levine G		33			87	93	105
Levitt E G		1130		bibliography			50
Lewis M R	345	422		construction			50
Lie O		510		design		41	65
Liere W J van		1264	1515	Gt Brit			154
Lillard J H	96	1056	1594	India			168
Lindberg K	553	554	715	installation			
919 961				peat and muck soils	146	518	
Lindenbergh D J		1394		research		50	
Linsley R K		242		Iowa		161	
Lint H C		127		Norway		150	
Lithuania		1772		Scotland		44	
Livestock		78	1098	Lytle S A		495	
Livingston L F		962	963	Lytle W F		118	
Livingston P	243	244	268				
Locks		766	1814	Maartmann K		558	
Løddesøl A		555		McAllister L		426	
Lodo M		1679		McAtee W L		1512	
Loam soils	9	692		Macaulay Institute for Soil Re-			
Loebell R		1395		search (Scotland)		43	
Loeltz O		245		McChesney A J		1589	
Loeltz O J		246		McClung V O		1133	
Loess soils		1058		McClymonds A E		1613	
Logsdon W T		964		McColly H F		744	
Loiseau J		1410		McCormick J A		427	
Lømsland D		965		McCrary S H		1517	
Lonsdale J T		247		McCubbin G A		1661	
Louisiana	142	308	505	McCulloch R	1134	1135	
887 917	934	941	970	McDougal O J		854	



	<u>Item</u>								<u>Item</u>	
McGeorge W G		1266							Maryland University	
McGlashan H D		248							College of Agriculture and	
MacGregor D R		1820							Home Economics	336
MacIntyre W H		138							Marzolo F	1737
Mackie J W		1399							Masclee J A	140
McKinnon A D		1614							Mason F R	480
McLaughlin T G		249							Mason H G	398
McLaughlin W W		428							Massachusetts	1565
McLean J L		1859							Materials	668 755 1319
McMillan J A		1821							Matsepuro M	515 1403
MacPherson H N		1136							Matsepuro M E	514 1402
MacQueen P O		1181							Matson H	970 1618
McQuown R		1589							Maughan J H	329 411 435
Madagascar	927	1836							1619	
Maddock T		13							Mavis F T	971
Magistad O C	403	429							Mayer I D	507 718
Magoon E H		1570							Mayer R	1738
Maher C		716							Mayo K L	1144
Maierhofer C R	430--	432							Mayo N	1620
Maillard J		1860							Mazzei E	866
Maits B		1615							Mechanization	1444
Malaya	480	1309							Belgium	618
Malfatti D		1699							costs	
Malhotra S L		433							Netherlands	750
Malmstrom C		513							Denmark	1389
Malygin V S		1137							France	1377
Mamisao J P		864							Gt Brit	732
Manitoba	342	1660							Netherlands	1365 1735
Manly G W		434							New Zealand	1334 1448
Mansfield G R		223							Rhodesia	830
Manson P W	335	1138-1142							Sweden	1455
1145 1146 1149	1150	1518							U S S R	511 514 515 533
1519-1521	1616								560 1352	
Mantello Reclamation project									Meinzner O E	141 250 345
(Italy)		1690							Mer R	1739
Mapham A L		865							Mercer W B	1794
Maraschi G		1401							Merrick C P	1621
Marchesaiz project (France)									Merrill L P	142
		1734							Messines J	1740 1741
Marillonnet L		717							Mesu F P	1742-1744
Marimpietri L		139							Metsanheimo U	559
Marin O		1699							Meuwissen P G	1745
Maritime Provinces	342	1303							Mexico	132 876 1200 1570
1308 1315									1663-1666	
Markwick A H D		1143							Michael S A	212
Marschall F		705							Michigan	214 346 491 502
Marschner F J		1589							503 504 552 1501	
Marshall plan									Michigan Dept of Conservation	214
Austria		1753								
Martin H B									Michigan State College	
Martine P		1841							Muck Experiment Farm	491
Martinez M B	966	967							Michigan State Soil Conservation	
Martinez Bula F		1680							Committee	875
Marvin V		1267							Middle Rio Grande Drainage	
Maryland	109 336	916 1557							District (New Mex.)	1573
1575 1584 1592 1593	1617								Midwestern States	673 674
1621 1624									817 1507 1611 1629	

	<u>Item</u>					<u>Item</u>			
Milhollin R M				867	Mitchell R D				1674
Miller A W				868	M'Laren J				516
Miller C K				436	Mohrman K J M				1151
Miller D B				1138	Moldboard plows	1363			1450
Miller D G	1140	1141		1145	Mole drainage		632		1044
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
Mills D R				1405	Ireland				1134
Milner R				869	New Jersey				1443
Minas Gerais Escola Superior					New Zealand				1214
de Agricultura				728	Rhodesia				753
Mineral soils					Sweden				1076
Finland				1112	U S S R				1123
Germany				1182	California				756
Peru				807	clay soils	1091			1144
U S S R	661- 687	1123		1201	costs				1183
1352 1789					Australia		1195		1213
Minnesota	335	337		526	Germany		1124		1182
901 1091 1543 1582					Gt Brit	1160	1161		1468
Minnesota Agricultural Experiment Station				525	Ireland				1135
Minnesota Legislative Interim Commission				337	New Zealand		1043		1078
Minnesota University Dept of Agricultural Engineering				1138	1079 1081 1144 1174				
Minolts				1406-1408	Sweden				1076
Minolts L R				974	Denmark				804
Minshall N E	708			858	Egypt				702
Minsk Belaruskaja Akademija					equipment				1385
Navuk Institut Melioratsii Vodnogo i Bolotnogo Khoziaistva				719	Austria				1171
Minsmere Level project (England)				1830	France				1126
Miramontes F C				1270	Gt Brit	1026	1048		1160
Mission Française d'Outre-Mer				720	1161 1349 1398 1468				
Mississippi	486	986		1047	Iceland				1359
1497 1563 1595 1598 1608					New Zealand				1078
Mississippi Agricultural Experiment Station					Sweden				1076
Black Belt Br				1563	Union of South Africa				1167
Mississippi Delta	16	323		495	U S S R		1439		1460
1483 1603 1604 1643 1655					Finland				1109
Mississippi Valley	227			595	Florida				677
1519 1524 1628					France				1126
Missouri	186	298		631	Germany		1042		1113
816 882 890 915 1237					Gt Brit	17	700	701	729
1248 1318 1325 1588					732 733 1026 1048 1049				
Missouri Society of Professional Engineers				1635	1064 1068 1158 1160 1162				
Missouri Valley Loess Region					1349 1529 1799 1804				
Conservation Experiment Station (Iowa)				270	history				
					New Zealand				1100
					Sweden				1076
					Ireland				1824
					irrigated soils				471
					Australia	366			1195
					Israel				1127
					Kenya				716
					Louisiana	1091			1548
					mineral soils				1201
					Minnesota				1091

	<u>Item</u>					<u>Item</u>			
Mole drainage--Cont.					Mole plows--Cont.				
Netherlands				1092	construction	1327	1461		
New Zealand	9	484		535	Denmark		649	1376	
536	627	699	711	712	design	1044	1342		
769	1038	1078	1079	1144	Germany			1124	
1152					Gt Brit	151	633	732	1159
Norway				1075	1161	1343	1349	1356	1387
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			42		Sweden	1017	1050	1378	1424
Gt Brit			151		types				1100
Iowa			1184		U S S R			1427	1461
New Zealand	1093	1094	1101		Molen W H van der		72	143	
saline-alkali soils	1177		1178		Molinelli J C			870	
Scotland			665		Mollenkopf J F			975	
Sweden			1050		Monhemius L			1271	
Switzerland			1097		Monnier G			871	
Union of South Africa			1167		Monson O W		1272	1273	
U S S R	1034	1071	1177	1178	Montana		363	388	
1201	1202				Montana Agricultural Experiment				
Wales			1529		Station			388	
Mole drains	7	664	672		Mookerjee D			251	
Austria			1171		Moon C L			167	
construction					Moore R E			1409	
Germany			1124		Moorhouse S			721	
New Zealand		1043	1081		Morecambe Bay project (Gt				
U S S R			1439		Brit)			1829	
depth and spacing	1043	1044			Morel C	722	723	1410	1525
1100	1174				1746-1748				
bogs and swamps			1195		Morestel Marshes (France)			1703	
New Zealand		1043	1079		Morgan A M			266	
1080	1081	1100	1101	1144	Morgan J H			1314	
1174					Morgan M F			144	
Union of South Africa			1167		Mori S			1411	
Florida			1587		Morishima S			1189	
Gt Brit	8	701	1033	1045	Morocco		1	1837	
1064	1161	1370			Morris R			497	
Louisiana			1179		Morris R E			517	
maintenance		730	1064		Morris W			1154	
Netherlands			1212		Morrow R R			567	
New Jersey			1443		Mors project (Denmark)			1692	
New Zealand	1043	1080	1100		Mortensen T			1749	
1144	1174				Mosquito control	61	574-	614	
size	1080	1100	1174		805	1392	1417		
slope		1100	1153		California	574	593	608	
strength and durability			1033		614	1625			
1045	1144	1153	1420	1443	Caribbean region			1570	
strengthening		1060	1384		Connecticut			1355	
Union of South Africa			1167		Delaware		83	1397	
U S S R	706	1031	1102	1176	Dominican Republic			1667	
1440					El Salvador			1674	
Wales			1033		equipment			1437	
Mole plows	1333	1347	1384		Florida			602	
1446	1452				Georgia			610	



	<u>Item</u>					<u>Item</u>			
Mosquito control--Cont.					Nebraska--Cont.				1054
Greece				1724	Nebraska Agricultural College				854
India				613	Nederlandsche Heidemaatschap-				640
Italy	1481			1761	pij				472
Louisiana				614	Needs	22	461	471	1487
Massachusetts				1565	808	811	1469	1470	1517
Mississippi Valley				595	1494	1499	1505	1511	1556
New Jersey	583	600		601	1518	1521	1533	1546	1556
606	609	1262	1274	1414	1560	1567			
1415	1416	1456	1457		British West Indies				899
New York				583	California				389
Nicaragua	1668			1673	Ceylon				1561
Nigeria	577			584	Gt Brit		729		1510
Ontario				586	Louisiana				1522
Panama				576	Netherlands				797
Peru				1684	New Mexico				1559
research					New Zealand				1868
Portugal				598	Quebec				1210
Rhode Island				603	Texas				1559
Solomon Islands				1866	Utah				1619
Spain				1721	Washington				639
Tennessee				580	Neetzel J R				552
Tennessee Valley	581			585	Nefedov V D				726
590					Neller J R	146	488		518
Trinidad				575	Nelson L B		147		727
Utah				596	Nelson W R				148
Virginia	582			1626	Nene River project (Gt Brit)				1814
Moss H C				437	Nery J M				728
Motooka T				1526	Netherlands		1	62	72
Motsereliia A V				724	89	111	120	143	178
Mozambique				1838	188	189	623	640	657
Mozambique Reclamation proj-				1838	658	676	717	747	750
ect				1838	757	764	768	773	776
Muckenhirn R J	147			909	797	802	857	863	902
Muguet M				1412	936	995	1008	1023	1030
Muirheid B F				1155	1037	1059	1092	1151	1168
Muksch L				725	1211	1212	1216	1217	1227
Mulhern T D	1413			1418	1228	1251	1253	1271	1305
Muncey J A				1514	1317	1322	1338	1365	1373
Munns E N				1750	1378	1393	1394	1404	1407
Murayama S J				1156	1478	1515	1538	1552	1695
Murdock H E	1272			1273	1698	1700	1701	1708	1709
Musgrave G W				99	1714	1718	1723	1728	1729
Myers L E				597	1735	1742	1745	1750	1752
Nadler H A				1672	1754	1755	1757	1762	1765
Naffziger L M				228	1766	1768	1770	1774	1781
Najera Angulo L				598	1782	1786	1790	1823	
Nakashima T				872	Netherlands Commissie voor				
Nangal project (India)				433	een Onderzoek Naar Nieuwe				
Naphan E A				427	Landbouwkundige Mogelijk-				
Narasimha A				1861	heden				1681
Natal				620	Netherlands Cultuurtechnische				1752
National Institute of Agricul-				1419	Dienst				
tural Engineering				1419	Netherlands Directie der Wieren-				
Neal J H	145			754	germeer Noordoostpolderwer-				
Neal O R				161	ken				1752
Nebraska	298	423	861	969	Neudecker J				1753

<u>Item</u>					<u>Item</u>				
Nevada	167	246	344	398	Northern Ireland Land Improve-				
427					ment Scheme				1824
Nevada State Engineer				246	Northern Ireland Ministry of				
New Brunswick				342	Agriculture				1824
New England-New York Inter-					Northern States				525
Agency Committee				1622	Norton R A				1209
New England States	221			1622	Norway	150	501	555	558
New Jersey	109			583	568—	572	655	670	920
600	601	606	609	625	942	965	968	1075	1265
693	916	1262	1274	1298	1366	1496	1562	1725	1775
1328	1414	1415	1416	1435	Nova Scotia				342
1436	1443	1456	1457		Noyes J R				1757
New Mexico	207			301	Nuts				1564
322	325	326	344	353	Nyasaland			897	1844
459	1559	1573			Nye S S				303
New York	33	102	239	583	Oats				1563
625	1418	1622	1633		O'Brien H R				1532
New Zealand	9	484	535	536	Observation wells		258		443
627	662	680	699	711	Ochoa A E				149
712	769	783	814	815	O'Connor R				520
1029	1038	1043	1057	1078	Odelien M				150
1079—1081	1093—1095	1098			Odle M				738
1099—1101	1144	1152	1174		Ogg W G		521	522	1533
1175	1214	1236	1327	1334	Ohio	41	49	92	94
1354	1361	1362	1386	1399	625	932	937	973	1131
1447	1448	1865	1867	1868	1221	1267	1288	1532	
Newcomb R C				252	Ohlson N E			1326	1424
Newhouse F				1822	O'Kelly E P				1825
Nicaragua			1668	1673	Oklahoma	104	142	272	298
Nichol G E				1527	301	831	832	838	862
Nicholson H H	17		519	729	883	891	1003	1633	
730—735	1157—1163	1423			Oklahoma Agricultural Experi-				
1528—1530	1823				ment Station				1003
Nielsen K M				736	Olafson E A				1277
Nielsen V				737	Oldham E T				977
Nigeria			577	584	Oliva A				873
Nikitin A A				1756	Oliveira e Sousa E S d'				739
Nitrates				181	Ollier C				1763
Nitrogen				1166	Olney A J				1534
Nitsenko A A				1531	Olsen J T			1164	1826
Noce G dalla				976	O'Neal A M				173
Noren D				302	Ontario	157	319	342	586
North Africa				675	651	1062	1266	1289	1429
North Carolina	226	265	486		1661				
543	562	835	929	930	Open-ditch drainage			2	6
North Dakota	253	271	339		7	18	139	408	624
844	1574	1597	1599	1614	664	671	754	759	800
1633					808	893	999		
North Dakota Laws Statutes etc				339	Alabama				914
North Dakota State Planning					alluvial soils			662	1623
Board				253	Australia	770	894	992	
Northeastern States	297			778	bogs and swamps				612
1655					Delaware				83
Northern Appalachian Conserva-					France				1704
tion Experiment Station				200	Iceland				697
Northern Indiana Muck Experi-					Louisiana				1245
ment Farm			507	508	New Jersey				606

	<u>Item</u>				<u>Item</u>		
Open-ditch drainage				Open-ditch drainage--Cont.			
bogs and swamps--Cont.				peat and muck soils--Cont.			
Norway	555	942	965	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		417
Netherlands			768	429			
Wyoming			436	Gt Brit			1793
dairy farms			992	Netherlands	676		902
Delaware	916		1617	U S S R			500
Denmark	736		804	Scotland	521		1426
design			1293	small farms and gardens			622
Egypt			702	736 901			
Finland			698	Spain			1433
for mosquito control			598	Sweden			659
Louisiana			614	Switzerland	544	549	996
Mississippi Valley			595	Tasmania			785
Nicaragua			1668	Texas			867
Tennessee Valley			590	Trinidad			944
forests			546	U S S R			706
Germany			547	Utah			686
Latvia			551	Orchards	361	1164	1480
Norway	555		570	1539 1564			
Sweden			563	Australia	678	1069	1130
France	722		1741	1551			
Germany			996	California			483
Gt Brit	108	733	1799	Netherlands	747	1478	1538
Gulf States			1500	1552			
Idaho			55	New Zealand			699
India		20	446	North Africa			675
irrigated soils	399	453	471	Sweden			1063
472				Tasmania			785
Arizona			371	Washington			368
Montana			363	Oregon	220	231	256
Nebraska			423	391 426	445	749	1129
Puerto Rico	396		1672	1474 1623			
Wyoming			436	Oregon Agricultural College			445
Italy	788	976	982	Oregon State Planning Board			
Louisiana			941				1623
Madagascar			927	Orlov P M			560
Maryland	916	1592	1617	Osmun J V			1274
Minnesota			901	Otto W S			1624
Netherlands	120	188	764	Outlets	74	360	594
767 773	1251	1253	1701	664 671	727	740	744
1757 1784				759 782	800	888	1028
New Jersey		693	916	1085 1117	1165	1198	1286
New Zealand	9	662	712	1560			
769 783				Australia			440
North Africa			675	California			801
North Carolina			930	Canada			652
Oregon			1623	clay			1025
peat and muck soils	519		696	cleaning	793	1049	1105
Finland	528		539	concrete		818	983



				<u>Item</u>				<u>Item</u>	
Outlets--Cont.									
construction	713	760	846					Park C F	260
983 1064 1385								Parker E R	1536
design		946	978					Parker G G	254 1537
France			755					Parker W V	599 607
grassed	7 708	836	846					Parkins A E	16
849 855 878								Parshall R L	980 981
British West Indies			899					Parshall flume	980 981
Missouri			890					Parsons O J	1275
Oklahoma			891					Pasini B	982 1760
research		890	891					Pasto Irrigation project (Puerto Rico)	1672
South Carolina			891					Patiala Drainage and Flood Protection Scheme (India)	1864
Gt Brit			700					Pattantyus A G	1276
India			896					Patty R L	152
Iowa			1209					Paukkonen N	1430
maintenance and repair			760					Paulsen C	255
795 846 851 958			991					Paulsen C G	256 257
1025 1283								Pearce O W M	1166
Denmark		691	804					Pearson C H O	1167
Gt Brit			1064					Pearson R W	47
metal			1025					Peasro A	1431
Michigan			504					Peatfield A E	983
New Zealand	699 1078	1079						Peat and muck soils	7 21
1175								484— 540 632 672	696
Ontario			1429					800 1027 1117	1512 1636
Oregon			749					Australia	1871
peat and muck soils			525					burning	1512
protection	793 831	851						distribution	532
878 1073 1105 1197								Finland	524 528 545 1112
Denmark			804					Florida	146 488 492 498
Iowa			1132					529 1091	1438 1609 1632
Netherlands			1697					Gt Brit	1475 1802 1813
pump	1263 1283 1284	1286						Indiana	494 502 1252
size		892 1013						Ireland	496 510 520
Southern States			906					Louisiana	505
Tasmania			785					Michigan	502— 504
tile			708					Minnesota	526
types		847 851	1283					Mississippi Delta	495
Overholt V			740 1165					Netherlands	1742
Overy B B			151					New Zealand	9 484 536
								Northern States	525
Pacific Northwest	228	1655						Norway	501
Pacific Northwest Conservation Experiment Station (Wash)	228							Ontario	157
Pai P P			1758					permeability	535
Pais E A			523					research	525 527
Pakistan	470 667 1569	1845						Finland	539
1853 1858								Indiana	507 508 517
Palmer L			1535					Michigan	491
Palmer V J		831 874	979					New Zealand	535
987								Scotland	510 516 521 522
Panama		576	1570					subsidence	497
Panarin M N			1427					Finland	512
Pannwitz E			1428					Florida	489 1587
Papaniko-Laou D L			1759					Gt Brit	1475
Paradis A			741					Indiana	508
Paris R G			440					Louisiana	505
Parish F J			1429					Minnesota	1543

	<u>Item</u>					<u>Item</u>			
Peat and muck soils--Cont.					Pipe drainage--Cont.				
subsidence--Cont.					Egypt				702
Southeastern States				486	Finland		524		1110
Sweden				493	Germany		1193		1194
U S S R				534	Gt Brit	700	701	1039	1794
Sweden				513	Italy				788
types				532	Mexico				1200
U S S R	499	500	506	509	Netherlands	676	802		1023
511	514	515	531	533	1168	1212	1698		
534	537	706	1461		peat and muck soils				696
West Virginia				523	Sweden	1014	1110	1219	1686
Western States				490	Pipe drains				
Wisconsin	157	485	540		depth and spacing		82		1110
Pecos River Joint Investigation					1193				
			459	1559	joints		1014	1194	1219
Peele T C				153	maintenance			691	1023
Penders J M A				1762	slope				1219
Penman H L			154	155	Piper A M		259-		262
Pennsylvania	66		239	1073	Pitman E P				600
1085	1087	1602			Pitzen T A				713
Penny J M				441	Plaisance G				561
Percolation	92		96	105	Plastic drains				1183
237	733	763			Plows		850	1369	1452
rates		31	147	153	Australia				825
research			84	93	Gt Brit			1049	1371
Perekhrest S M				156	Netherlands	1251		1378	1393
Perez Diaz D				876	1404	1751	1783		
Persson S				1432	New Jersey				1457
Peru			807	1684	Norway				1366
Peterson A H				1247	Scotland				1426
Peterson D F				1277	Sweden		1326		1391
Peterson D F Jr	410		442	448	Union of South Africa				900
451	1257	1278			U S S R				913
Peterson H B				471	SEE ALSO Moldboard plows;				
Peterson R K				56	Mole plows				
Peterson S F				540	Po Valley project (Italy)				1736
Pettersson B				742	Pocomoke project (U S)				1624
Philippines				864	Poe E J				444
Phillips F A				743	Poebing O				1279
Phipps L J				744	Poiree				748
Phosphates		43	45		Poiree M		1763		1764
Piatin M V				745	Polak B				1870
Pichler J		746	877		Poland J F				288
Pickels G W				18	Polders				
Pierce R S				157	Brit Guiana				1678
Piezometers	36		48	53	Gt Brit				1827
55	258	442			Japan				1857
Pijls F W G	747	1168	1538		Netherlands	89	120		188
Pillsbury A F	56	258	406		717	750	764	802	1227
443	450	1539			1251	1697	1698	1701	1723
Pineapple			1482		1728	1735	1743	1752	1755
Pipe drainage					1784				
Australia			1287		Sierra Leona				90
Austria			1061		Pole drains	20	446		783
costs					Polesje Swamps (U S S R)				1767
Germany			1089		Policies	318	341	351	1645
Denmark		649	691		Ponnamperuma F N				1540

	<u>Item</u>					<u>Item</u>			
Pontine Marshes (Italy)				1706	Programs--Cont.				
1719 1776 1779					Washington				1580
Portugal	598	739		1738	Wisconsin				1630
Post F A				92	Yugoslavia				1732
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
Price P M				906	Gt Brit		8		1794
Price W A				159	India				1299
Programs	5	16	22	24	Israel				1854
408 694 1470			1487	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
Canada				1658	New Jersey				1274
Corn Belt				1655	Ontario				1289
Costa Rica				1671	Denmark		1692		1693
Delaware				1615	Egypt				1839
Estonia		1758		1769	Florida				1242
Germany		1694		1771	France				1712
Gt Brit 1529 1530		1639		1799	Gt Brit	1280	1300		1827
1800 1822 1826					handbooks				1301
Great Lakes States				1655	history				
Great Plains				1655	Gt Brit				1806
Ireland	1810	1824		1825	India				1858
Louisiana				1605	Indiana				1252
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		1668	Norway				1265
North Dakota		1599		1614	Oregon				1623
Northeastern States				1655	Pakistan				1858
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
U S S R				1756	Turkey				1264
Utah		435		1619	U S S R				706
Virginia				1589	Utah	410	686	1257	1277
Wales	1529	1530		1826	Pumping plants	18	1292		1293
					1297				



	<u>Item</u>					<u>Item</u>			
Pumping plants--Cont.					Pumps--Cont.				
California				1223	selection				1293
design				1275	sizes				1286
diesel				1250	steam	1271	1282		1806
Florida	488			1587	testing				1270
France				1739	turbine	1235	1295		1301
Gt Brit	1232	1234	1285	1291	vertical		1235		1293
1300	1816				SEE ALSO Windmills				
Illinois				1231	Purcell M R				1655
Italy				1776	Pusic B				1732
maintenance				1587	Puustjarvi V				524
Netherlands	1228	1253		1271					
Puerto Rico				1672	Quebec	342	625	634	1088
Switzerland				1281	1210	1441			
Texas		1233		1250	Quicksand			644	1056
Pumps	7	772		1523					
Australia		440		1287	Rae R				446
axial-flow	1228	1234		1290	Raggio J L				19
1293-1295	1298	1301		1806	Rague Botey F				1433
California				483	Rainey M B				604
centrifugal	1228	1234		1272	Rainfall and runoff compilations				
1273	1274	1290		1293-1295	Appalachian region				200
1301	1806				Iowa		264		270
costs		1234		1268	Kansas				212
Denmark		649		1713	Missouri				309
diesel	1230	1238		1243	North Carolina		226		265
1249	1251	1271		1285	Oklahoma				272
costs		1237		1248	Pacific Northwest				228
discharge		1254		1256	Texas		240		308
electric	1239	1240		1252	Upper Mississippi Valley				227
1267	1299	1806			Washington				263
costs				1268	Rakover Y				879
installation				1268	Ramalingham A V	1861			1862
Florida		648		677	Ramsauer B		1171		1541
gasoline				1236	Ramser C E	880-	882		984
Gt Brit	1222	1234		1239	985				
1240	1241	1243		1255	Ranges SEE Grasslands				
1282	1285	1797		1801	Rantz S E				256
helical				1290	Rao K M G				20
Hungary	1254	1256		1276	Rapp J R				266
Illinois	1230	1238		1260	Rasmussen P B				751
India				1299	Ray C M				986
Indiana				1252	Rea D H				923
installation		1268		1287	Reclamation Act of 1939				347
Louisiana				1245	Rector N H				605
maintenance				601	Red Plains Conservation Experi-				
Missouri		1237		1248	ment Station (Okla)				272
mixed-flow	1293-1295	1301			Red River Valley of the North				1574
Netherlands	1228	1251		1271	Ree W O	883	987		988
1697					Reed I F				47
New Jersey	601	609		1262	Reed drains				788
1298					Reedy J				1766
New Zealand				1236	Reeve R C	28	46	55	56
Ohio		1267		1288	410	447-	451	1277	
oil				1806	Regel C				1767
Ontario				1266	Reger J S			56	452
propeller SEE axial-flow					Reiley F A	606	1434-	1437	
Rumania				1279					

				<u>Item</u>					<u>Item</u>
Rempt J D				1827	Rogers H				457
Research	28	30	33	65	Romero M				458
727					Rondeau L				755
Brazil				728	Rorden J W				885
California				756	Rose L E				104
Denmark			34	59	Rose N A				306
Louisiana				1548	Rosenhead L				84
needs			58	1470	Rosenthal E J B van				1768
New York				33	Ross P E				372
Utah		442	449	686	Rost C O			1519	1520
Virginia				64	Rostovtsev M I				1769
SEE ALSO UNDER specific					Roth W J				343
subjects					Rounds M B				1536
Reshetkina N				1173	Row crops		1000	1494	1518
Rhode Island				603	Rowlette M				1828
Rhodesia	416	636	753	830	Roy P E				1441
1329 1484					Rubidoux Laboratory SEE U S				
Rice				1540	Regional Salinity Laboratory				
Brazil			441	1676	(Riverside, Calif)				
Ceylon				1561	Rudich S I				1460
Fiji Islands				1869	Rule G K				1576
Japan				1857	Rumania				1279
Louisiana				941	Runoff 7 74 78 92				105
Madagascar				1843	106 126 128 129				142
Senegal				1841	145 153 174 262				733
Richards E V				1863	859 882 888				
Richards L A		57	160	161	California			291	292
453					Corn Belt				175
Richards S J				127	Mexico				132
Richardson H W				1438	Missouri				631
Richter R C				1223	rates			858	892
Riddolls A W			1174	1175	Delaware				109
Ridiger V			1176	1177	Maryland				109
Ridiger V R		1178	1439	1440	New Jersey				109
Riecken F F				185	records				54
Riedel D				752	research				708
Riegel R M				1312	South Australia				845
Riggs H C				256	Texas 190 202 217				867
Rinehart J C				884	U S S R				1031
Rio Grande Drainage District					SEE ALSO Rainfall and runoff				
(Colo)			370	1578	compilations				
Rivers			951	1824	Russell E W				163
Roach H L				989	Russell M B		161	164	527
Roads	487	741	931	950	1544				
1131 1192					Ruth P W				1626
Robbins C				1218	Ryan D M				1286
Roberts J A			342	1315	Sabinskii G B				1442
Roberts R H				753	Sahara Desert				1842
Robertson I M			521	522	Sahni P N				165
Robertson J L				607	St Albans M				1666
Robins J S				454	Saline-alkali soils			67	86
Robinson B				138	91 378 379 394				400
Robinson C W				362	401- 402 412 414				417
Robinson E C				1625	418 419 429 453				460
Robinson T W			259	260	461 466				
Roe H B	21	455	525	526	Australia			377	405 469
724 1283 1284 1542				1543	California 361			406	450 468
Rogers F				456					

					Item						Item
Saline-alkali soils--Cont.						Schofield R K					154
Colorado River Basin					362	Schoklitsch A					759
465						Schroeder E W					1446
Florida					1537	Schroeder G					1182
France					1689	Schukall G					1770
Gt Brit	80	669	1795		1830	Schuylenborgh J van					796
India			69		1858	Schwab G O 7 760 1119					1183
Italy					1690	1184					
Montana					388	Schwarz K					761 1771
Netherlands	72	623			676	Schweicher F					762
902 1700 1745						Scoates D					2
Nevada					427	Scobey F C					990
New Jersey					606	Scofield C S					418 459
New Mexico					459	460- 462 472					
New Zealand					1867	Scoops 609 1330 1344 1456					
Pakistan			470		1858	Scotland 43 44 334 510					
permeability					394	516 521 522 647 665					
research						1367 1426 1805 1820					
U S S R					51	Scott D F					1447 1448
Utah	448	449	451		477	Scott H A					1627
1277						Scranton L L					744
Rhodesia					416	Scrapers					1365 1456
Senegal					1841	Searle K D					1185
Texas	372	373	431		459	Seawalls					577 626 1801
Tonga					1873	Sedimentation					25 104 812
U S S R	374	464	500		912	862 924 1497					
1173 1177 1178						in canals and ditches					385 556
Washington					421	587 589 949 956 985					
Western States					432	1374					
Wyoming			387		388	Seepage					67 188 754 764
Saloheimo L			528		1545	1108					
Salter R M	58	1546	1547		1547	into drains					70 121- 124
Salwen N		563	564		564	of irrigation water					46 365
Salzmann R			705		705	379 380 382 385 468					
Sammis R H			1443		1443	1302					
Sand drains			600		600	research					46 85 125 379
Sand traps			713		713	Seidemann J					1186
Sandy soils	140	594	978		978	Selby W E					991
1027						Semple W J					992
Netherlands	143	764	1216		1216	Sen A					168
research			144		144	Senegal					1841
Gt Brit			101		101	Senegal Delta project					1841
Santalin K V			565		565	Serdechnyi A					1345
Sardo Q			886		886	Setinsky V					763
Saskatchewan	342	437	1659		1659	Settling basins					826 924
Saveson I L	756	887	893		893	Severson H					529
1179 1444 1548						Shafer F F 530 1187 1623 1629					
Sayre A N	267-	269	304		304	Shafer G E					1188
Schagen F van			757		757	Shannon W L					1312
Scharz K			1694		1694	Sharma K R					463
Scherotzki			1549		1549	Sharpe C F S					993
Schiff L			888		888	Shaumiàn V A					889
Schildnecht H	758	1180			1180	Shearer M N					1449
Schlaudt E A	166	566			566	Shelaev A					464
Schlick W J			1207		1207	Sheridan C M					1630
Schmitt E A			1181		1181	Sherman L K					1323
Schnittger H G			1445		1445	Shipman R C					1450
Schoenleber L H			270		270	Shoji H					1189 1411



			Item						Item
Showell J L			1287			Smith N M	770		1871
Shrag V I	39		1316			Smith R M			903
Shulits S			759			Smits H			696
Sieben W H			764			Smits J			1552
Sierra Leone			90			Snohomish County (Wash) Public			
Silt SEE Sedimentation						Utility District 1			252
Silt basins	652		664			Snow B F			345
Silty soils	1058	1143	1224			Snowy Mountain Hydro-electric			
Silvester R			994			Scheme (Australia)			1872
Simpson H E			271			Snyder C G			1147
Sine L			663			Snyder J H	275—		277
Singh R			1864			Sod drains			8
Singleton J R			1550			Sogamoso Valley project (Colom-			
Siphons	1004		1226			bia)			1682
Sipkes C			995			Soil borings	32	48	60
Sisson D R			1190			96 180 376			
Situation and outlook	1504		1616			equipment	390	1357	1381
1640						for tile drainage			1164
Egypt			645			Soil conservation	3	12	73
Finland			1112			74 78 117 173			617
Gt Brit	17		734			779 823 985 1506			1577
Midwestern States			674			1638			
Mississippi Delta			1604			Florida			1579
Sweden			715			Gulf States			142
Washington			639			Mexico			876
Siviero G			1699			Nyasaland			1844
Skepper A H			1551			Utah			413
Skerrett R G			1631			Soil conservation districts			22
Sklerius P TS			1772			1470 1633 1648			
Skoropanov S G			531			Maryland			1593
Skov K S			59			Mississippi Valley			1628
Slab drains	769		770			Soil moisture measurement			40
Slater C S	31		1191			129 170 620 1409			
Slosser J W			272			Soil temperature	82	95	700
Sluices						Finland		545	1508
Denmark			649	1713		Netherlands			1217
Gt Brit	626	928	1232	1814		New York			102
Netherlands			1697	1701		Soil tension	47	57	127
Nigeria				577		Soils		7	21
Texas				1233		analysis			162
Sluis P M van der	765		766			Australia			171
Smale A H			767			British West Indies			425
Small C J			1317			characteristics	95	99	899
Small farms and gardens			622			188 466 543			113
679						drainability 2	107	152	1205
Denmark			736			1594			
Germany			638			India			438
Gt Brit	1068		1072			South Carolina			166
Netherlands	1515		1785			for mole drainage			1153
U S S R			1427			Australia			1195
Smit A			768			Austria			1171
Smith C A			60			Gt Brit		76	151
Smith D D	169	890—	892	1318		New Zealand	1101		1174
Smith E A			608			for open-ditch drainage			
Smith E G			769			Gt Brit			108
Smith G E P	273	274	316			for pump drainage	407		1242
344						for terracing	185		187
Smith G-H			16			for tile drainage	97		1027
Smith L J			1319						

				<u>Item</u>					<u>Item</u>
Soils--Cont.					Sopp C W				206
for tile drainage--Cont.					Souhami M				1872
			1187	1208	South G P				411
Chile				1083	South Carolina	166	354	486	
Gt Brit				108	543 646 820 827				881
Illinois				176	882 891 1610 1633				
Iowa				185	South Maroochy Swamp Drainage				
Gt Brit			112	130	Scheme (Australia)				1871
India				20	South River (Mo) Drainage Dis-				
Netherlands	178	188		764	trict				1237 1248
New Zealand				1101	Southeastern States	296	486		
Pennsylvania				66	653 828 911 1294				1610
permeability	68	79		110	1655				
113 119	120	124	164		Southern States	566	880	906	
177 182	229	365	378		1294 1506 1570				
394 1199					Southwell P H				772
Coastal Plains				31	Southwestern States				203
determination	32	36	96		Soybeans				1554
173 1205 1211					Spain	1306	1433	1721	1722
Gt Brit				112	Spangler M G				1192
Illinois			118	176	Sparf C R				1320
Iowa				185	Speir W H				1290
measurement	33	48	53		Spillways	375	831	859	860
75 180					1666				
research		88	98	131	"Spot" drains				1130
148 153	381	1543			Springall G				1829
porosity	47	107	119	182	Staf C				773
profiles	81	153	425	696	Stafford H M	278	466		
1101					Stampe W				467
research	87	100	131	160	Stampfli A				996
454 1521					Standen J H				774
British Columbia				184	Stangle				1453
Gt Brit			154	155	Stauber H				775
Iowa			161	185	Stauffer R S				175
Minnesota				1543	Stearns H T	279--	281		
Missouri				186	Stearns L A	61	83		
Netherlands				111	Steelant L				776
Ohio			92	148	Steele F	88	96		
Scotland				43	Steele J G				110
Virginia				88	Steep Rock Lake (Ontario)				1289
Wisconsin				103	Stein C	1193	1194		
surveys	108	405	437	1264	Stephan L L				1632
types	93	110	124	160	Stephens J C	532	1290		
472 916					Sterling C I				1673
Australia			172	474	Stevens C P	997	998		
Gt Brit				641	Steward C D				409
Illinois				118	Steward W G	280	281		
Mississippi Delta				495	Stewart C E				392
New Zealand				699	Stewart D				1185
Sweden				961	Stewart K V				893
Utah				395	Stipp A C				345
Washington				639	Stjerndahl H				1454
Wisconsin				147	Stockton R S				418
U S S R				39	Stokes W L				282
Western States			38	159	Stolp D W				62
SEE ALSO kinds of soils					Stone E L				567
Sokolovskii D L				771	Stone drains				
Solomon Islands				1866	Australia				770
Somerset Moors (Gt Brit)				1813	California				476

	<u>Item</u>			<u>Item</u>	
Stone drains--Cont.				Subsurface drainage--Cont.	
Denmark	649	1693		peat and muck soils	519 521
Gt Brit	8	1084		538 539	
India	20	446		research	33 1545
New Zealand		769		Sweden	1016
Tasmania		785		Turkestan	1137
U S S R		706		types	695 779
Stony soils		33		U S S R	565
Storm drains	375 434	830		Yugoslavia	1732
897 1844 1852				SEE ALSO kinds of subsurface	
Story C G		894		drainage	
Straatmans W		1873		Subsurface drains	644
Strashnikov S N		777		construction	791 1129
Straub L G		759		depth	386 1013 1016 1137
Streams and brooks	643	1824		durability	788
Stringer N E		1195		installation	1673
Stripcropping	169	862 888		location	1013 1016
Structures	24 668	772 1323		maintenance	1016
1618				spacing	386 528 1016 1137
design		858 933		types	364 671
Gt Brit		1801		SEE ALSO kinds of subsurface	
handbooks	635 649	759		drains	
Indo-China		1304		Sudan	1
Mexico		1200		Sugar beets	409 503 1527
Oklahoma		862		Sugarcane	1554
Western States		38		Australia	894
SEE ALSO kinds of structures				Brazil	359
Stylianidis K		1773		California	756
Subkov A I		533		Colombia	458
Subsidies		1488		Cuba	1476 1477
Subsurface drainage	2	6		Louisiana	887 1179 1548
18 21 113				Natal	620
Australia	364 425 440	664		Puerto Rico	396 966 967
668 727 1196 1523		1540		1672	
British Columbia		184		Trinidad	898
Ceylon		1561		Turkey	1264
costs		788		Union of South Africa	1167
Cuba		799		Venezuela	774
design		7		Zululand	620
Egypt		1067		Sulzer Brothers	1291
Estonia		1125		Sump and bore drainage	1021
Finland	33 698	1545		Sumps	440 649 1229 1286
Florida		488		Supplemental drainage	678 1198
for mosquito control	597	605		Surface drainage	113 619
1668				632 664 668 727 740	
forests		565		819 885 893 1198 1523	
France	1712 1740	1741		Australia	425 440 678 809
Gt Brit	633 641	1084		bogs and swamps	611 852
India		20		1261	
irrigated soils	386	444		Ceylon	1561
Italy		788		costs	
Japan		1189		Louisiana	887
New Jersey		693		Cuba	799
New Zealand		783		Denmark	1261
Nicaragua	1668	1673		Egypt	1067
Norway		1496		for mosquito control	597 611
Ontario		1062		France	1740
Oregon		1129		Gt Brit	641 951



	<u>Item</u>					<u>Item</u>			
Surface drainage--Cont.					Sweden Kommitten for Maskinell				
Hungary				877	Tackdikning				1455
Illinois				118	Switzerland	1	544	549	
India				20		705	758	775	
Israel				879		972	996	1097	
Italy				886		1180	1281		
Kenya				852	Syme P S				783
Manitoba				1660	Syndicat Intercommunal des				
Midwestern States				817	Eaux du Val d'Azergues				
Mississippi				1608	(France)				1739
Netherlands				857	Syria				1848
New Zealand	711	712		814	Systems				668
Ontario				651	Australia		425	440	
orchards				1539	Balearic Islands			656	
peat and muck soils				538	Belgium			618	
research					Brazil			728	
Georgia				42	Colombia			684	
Puerto Rico				966	construction	440	471	699	
small farms and gardens				679		712	791	1619	
South Carolina				820	design	68	440	471	684
Texas				790		740	743	792	1409
types	695			779	Denmark				804
U S S R				706	Germany				1694
SEE ALSO kinds of surface					Gt Brit		786	1159	
drainage					irrigated soils		381	447	
Surface drains	730	760	814		Malaya			480	
SEE ALSO kinds of surface					Netherlands			765	
drains					New Zealand			712	
Surface inlets	1073	1114	1164		Northeastern States			778	
	1175	1197	1209		peat and muck soils			525	
Surinam	1677	1681	1714		Peru			807	
Surveys and surveying	689	800			small farms and gardens			109	
	907				Southeastern States			486	
Australia				364	Tasmania			785	
Iowa				1132	Union of South Africa			1041	
Minnesota				901	Utah			1619	
Mississippi				1608	Virginia		64	88	
New Zealand				9	Florida			1587	
Texas				790	Gt Brit			806	
Sutton J G	22	778—	782	999	India			463	
	1000	1197—1199	1292—1295		Iowa			1324	
	1553	1554	1633—1641		layout			440	
Svadovsky E G				534	maintenance and repair			688	
Swaan L de				1774		689	780		
Swamp and Overflow Land Grant					Gt Brit		669	798	
Act of 1850 (U S)				1649	India			834	
Swamp Land Act of 1850 (U S)					Mexico			1664	
				311	Nebraska			969	
Swamps SEE Bogs and swamps					Oregon			749	
Sweden	493	513	548	553	Peru			807	
	554	563	564	659	U S A			399	
	742	919	943	954	Utah			1619	
	961	1014	1016	1017	Missouri			631	
	1063	1074	1076	1077	New Zealand		699	712	
	1219	1326	1330	1378	types	738	801	1636	
	1424	1425	1432	1454	U S S R			616	
	1473	1485	1495	1686	Western States			38	
	1726	1727							

	Item					Item			
Tabasco project (Mexico)				1666	Texas--Cont.	240	243	244	
Tamayo J L				1200	247	267-	269	300	301
Tanaka T				784	303-	308	325	326	372
Tanganyika				636	373	431	459	790	867
Tanner C B	103			909	1233	1250	1514	1550	1559
Tascher W R				895	1606	1655			
Tasmania	785			856	Texas Agricultural Experiment				
Tatarinova N K				1201	Station		240	308	
Taylor G H				241	Texas Board of Water Engineers				
Taylor S A				170	190	217	304-	306	
Tedrow J C F	171			884	Theis C V				284
Temple F C				896	Theobald G H				1001
Tennessee 486	580	1572		1642	Thom W	609	1456	1457	
Tennessee State Planning Com-				1642	Thomas E E				468
mission				590	Thomas H E		259	285	
Tennessee Valley				7	Thomas J E				469
Terraces and terracing	2			142	Thomas P H				785
13	74	78	127	823	Thomas Sir R				470
145	158	727	760	908	Thompson C K				786
826	859	888	906		Thompson D G				316
1498					Thompson F B		535	536	
California				756	Thorne D W				471
Ceylon				1850	Thornton J F				42
claypan soils				169	Thorp J				472
construction	864	869		906	Thuet P				1780
1399	1450				Thurmann-Moe P		568-	572	
design		858	864	892	1775				
equipment			906	1399	Tibbetts F H				286
Finland				698	Tidal soils SEE Alluvial soils				
grading		187		892	Tide gates 574	579	626	1855	
grassed				880	Tile drainage	2	6	22	
Guinea				871	145	376	408	619	624
India				251	632	694	759	800	805
Iowa				185	808	846	1086	1154	1221
Italy				873	1286	1542	1555	1560	
Japan				872	Australia		377	678	770
Kenya				716	809	1021	1464	1551	
maintenance	824	850		911	benefits 1117	1198	1199	1218	
Mexico				876	bogs and swamps		697	753	
Missouri				816	1054	1123	1180	1214	
New Zealand				1399	California		1536	1652	
Nyasaland				897	Canada			652	
Ohio				869	Chile			1083	
Oklahoma				862	clay soils	1096	1190	1215	
orchards				1539	Colorado			1108	
Philippines				864	Corn Belt			175	
Puerto Rico				903	costs	399	695	740	754
Sahara Desert				1842	760	1117	1527		
Southeastern States	828			911	Australia		678	1213	
Southern States				906	Finland			1112	
spacing		880		892	Germany			1182	
Texas				867	Gt Brit			1024	
types		848		850	Ireland			1135	
Uruguay				870	Michigan			1501	
Wisconsin				909	Netherlands		768	1151	
Terzaghi K				1296	New Zealand		1098	1099	
Texas	142	190	201	202	1175				
208	210	216-	218	238	Pakistan			1853	

	<u>Item</u>		
Tile drainage--Cont.			
Denmark	736	804	
Egypt		1839	
equipment	1154	1190	
Gt Brit	1024	1048	1356
1398			
Iowa		1209	
Netherlands		1151	
Ontario		1429	
Pakistan		1853	
Finland		1115	
France	722	1204	1739
Germany		1395	
grasslands		1098	
Gt Brit	17	108	729 732
733	1001	1048	1049 1064
1072	1158	1159	1162 1163
1529	1793	1799	1804
hilly regions			1036
history			1117
Iceland			697
Idaho			1215
Illinois			118
Indiana		1190	1218
Iowa			1209
irrigated soils	399	453	471
472	1197		
Australia		364	377
California	369	383	424
Utah			409
Washington			368
Kentucky			1534
Latvia			1015
Maryland			1592
Nebraska			1054
Netherlands	120	188	764
767	1030	1037	1092 1211
1751			
New Zealand	9	627	699
711	712	769	1029 1038
1098	1175	1214	
North Africa			675
Norway			1075
Ontario			651
orchards			1164
Australia	678	1069	1130
Sweden			1063
Washington			368
peat and muck soils			1117
Michigan			504
New Zealand			484
Northern States			525
Norway			501
Scotland			521
Pennsylvania	1073		1087
Quebec			1088
quicksand			1056
research	53	98	119

	<u>Item</u>		
Tile drainage--Cont.			
research--Cont.	131	134	
136	1035	1208	
Georgia			42
Indiana			1218
Iowa			185
Minnesota			1543
Netherlands			1217
New Zealand			1095
Sweden			1077
Utah			407
Rhodesia			753
saline-alkali soils	377	401	
417	429	1793	
Scotland			665
small farms and gardens			622
736	1072		
Sweden	659	1017	1074
Switzerland			1180
Tasmania			785
Union of South Africa			1041
U S S R	706		1123
Wales			1529
Washington			1215
SEE ALSO Pipe drainage			
Tile drains	2	672	744
capacity		1197	1198
cleaning			781
construction	713	754	1028
1053	1085		
Netherlands			1211
costs			1085
Denmark			1713
depth and spacing		97	740
760	1085	1114	1117 1165
1191	1197--1199	1205	1207
1221	1518	1555	1560
Australia	364	678	1130
Canada			652
Chile			1083
clay soils		1027	1216
Finland			1115
formulas	68	383	1096
1191			
Indiana			1218
Iowa			185
Netherlands	773	1059	1151
1211	1217		
New Zealand			1029
peat and muck soils	525		1027
research		1206	1208
sandy soils		1027	1216
Sweden			1077
design	407	664	713 1053
1105	1187	1197--1199	1293
Germany			1186
Netherlands			1211
durability			1084



				<u>Item</u>					<u>Item</u>
Tile drains--Cont.					Tisdall A L	172	425	473	
Gt Brit				8	474	475			
India		20	446		Titov N M				1321
inspection				1187	Tiulenev N A	537	1460	1461	
installation	408	738	1073		Tiuneev N A				787
1165	1207	1539			Tobacco	828	829	967	
California				801	Toe drains				70
Virginia				1056	Tolman C F	287	288	345	
joints				1198	Tomatoes				1502
location	53	407	664	1035	Tonelli A				788
1092	1117	1197	1198	1209	Tonga				1873
1560					Tonkin Gulf project (Indo-				
maintenance and repair	6		407		China)				1304
664	713	730	744	781	Topham P				897
1028	1105	1114	1165	1187	Tourneur M				1843
1560					Trach J				540
California				801	Tractors		371	1441	
Germany				1186	Trappel A				1777
Gt Brit	1064	1158	1163		Treadwell E F				345
1793					Trenchers	1085	1117	1335	
Netherlands				1211	1360	1421	1422	1452	
Virginia				1056	for bogs and swamps				1334
obstructions	754	781	1105		Gt Brit	786	1332	1343	1358
1164	1170				1458	1463			
size	97	131	678	740	Ireland				1135
760	1029	1117	1218		Japan				1411
slope	1114	1115	1211	1564	mechanical				
types			1070	1117	Finland				1379
SEE ALSO Pipe drains					France				561
Tile laying	664	744	800		Gt Brit	1371	1387	1388	
1086	1114	1187	1203	1560	1398	1451	1459	1462	
bogs and swamps				1334	Netherlands				1393
by hand	1057	1203	1432		Norway				1366
Canada				652	operating costs				1346
costs					Sweden				1454
Netherlands				1394	Netherlands		750	1212	
Sweden				1425	New Zealand	1098	1334	1341	
Denmark				804	1361				
equipment		1336	1360		Oregon				749
France				1377	specifications				1383
Germany				1395	Sweden		1326	1425	
Gt Brit	732	1049	1358		U S S R				1125
mechanical	750	1057	1366		Trenches		664	1013	
1369	1377	1404	1405	1432	Austria				1061
Netherlands				1394	Netherlands				1701
New Zealand				1361	New Zealand				1095
Norway				1366	Trenching		1198	1203	
U S S R				1427	Australia				678
Gt Brit		633	701		by hand	1040	1075	1165	1203
Netherlands				750	Canada				652
New Zealand	783	1057	1175		costs				
1334					Norway				1075
Oregon				749	Sweden				1425
Quebec				1210	Gt Brit				1040
Sweden				1432	mechanical				1165
Union of South Africa				1041	Norway				1075
Utah				1185	Netherlands				1151
Tinn G				1776	Norway				1075

	<u>Item</u>			
Trenching--Cont.				
Utah	1185			
Trenka E	1276			
Trent River project (Gt Brit)	1816			
Trinidad	575	898	944	
Trist P J O	1830			
Trois Rivières project (Haiti)	1670			
Troxell H C	278	289-	292	
Trummer A	1778			
Truscott J H L	1244			
Truss P	1202			
Tsarevskii A	789			
Tuinstra U	1322			
Tule Lake (Calif)	1583			
Turkistan	1137			
Turkey	1264	1569		
Turnbull J	1333	1556		
Turner P E	898	899		
Turner W L		96		
Turner W L Jr		88		
Turnor C H		1779		
Twinn C R		586		
Udbyneder project (Denmark)		1693		
Uhland R E	173	1557		
Uhlen R		1780		
Ulich W L		790		
Ulrich R		1558		
Ulua River project (Honduras)		1675		
Union of South Africa	865	900		
1041 1166 1167				
U S S R	1	39	51	116
156 374 420 464 478				
499 500 506 509 511				
514 515 531 533 534				
537 542 560 565 587				
616 632 661 683 685				
687 706 707 710 719				
724 726 745 777 787				
789 889 912 913 1005				
1006 1022 1031 1034 1060				
1071 1102 1123 1125 1154				
1173 1176-1178 1201-1203				
1307 1313 1316 1321 1345				
1352 1353 1396 1402 1403				
1427 1439 1440 1442 1460				
1461 1465 1479 1531 1639				
1731 1756 1767 1787 1789				
U S Bur of Agricultural Economics	197	392	1603a	
U S Bur of Agricultural Engineering		63		
U S Bur of Reclamation		347		
1651				

	<u>Item</u>			
U S Bur of the Census	23			
24 1643				
U S Civilian Conservation Corps	1637			
U S Congress				
House				
Committee on Agriculture	346			
Committee on Irrigation and Reclamation	347			
Senate				
Committee on Agriculture and Forestry	348			
U S Corps of Engineers	1644			
U S Dept of Agriculture	336			
348 357 443 445 477				
1612 1639 1645				
Off of the Solicitor	349			
U S Dept of the Interior	208			
443				
U S Farm Credit Admin	314			
U S Forest Serv				
Upper Peninsula Experimental Forest (Dukes Mich)	552			
U S Geological Survey	208			
214 293- 295 388				
Water Resources Br	296			
297				
Water Resources Div	298			
U S Laws Statutes etc	350			
U S National Institutes of Health				
Malaria Investigations	599			
U S National Resources Committee	10 1646 1647 1571			
Water Resources Committee	338 351			
U S National Resources Planning Board	1559			
U S Navy	1626			
U S A SEE names of States and regions				
U S President's Water Resources Policy Commission	318 341			
U S Public Health Serv	614			
U S Regional Salinity Laboratory (Riverside Calif)	28 361			
403 410 442 449 453				
477 1257 1277				
U S Soil Conservation Serv	88			
92 174 488 489 525				
791 827 854 875 887				
1002 1203 1547 1599 1609				
1630 1634 1635 1644 1648				
reports	25			
Soil Conservation Experiment Station (Bethany Mo)	1318			
Southeastern Region	352			

	<u>Item</u>					<u>Item</u>			
U S Soil Conservation Serv--					Vernier Swamp (France)				1715
(Cont.)					Vertical drainage	695			754
Southeastern Tidewater Soil					800				
Conservation Experiment					bogs and swamps				1055
Station			42		irrigated soils				473
Southwest Region			353		New Jersey				693
Spartanburg Outdoor Hydraulics Laboratory	827	881			Solomon Islands				1866
Stillwater Outdoor Hydraulics Laboratory			1003		U S S R	1173			1307
Upper Mississippi region	792				Vertical drains	487			1283
793					1296				
Upper Mississippi Valley					blasted				1107
Soil Conservation Experiment					bored	473	1021	1107	1287
Station (La Crosse Wis)	227				California				1169
U S Tennessee Valley Authority					construction				693
590					Texas				790
U S Waterways Experiment Station (Vicksburg Miss)	1047				Vicente-Chandler J				903
Upson J E	299				Vidme T				150
Uruguay			870	1680	Vietnam				1860
Utah	46	233	241	282	Vik K				1562
329	344	392	395	407	Villeneuve G O				1210
409	410	411	413	435	Vincent A E				1464
442	444	448	449	451	Vineyards	66	361	425	692
477	481	596	686	811	1720				
1082	1185	1226	1257	1277	Virgin Islands				1570
1619					Virginia	64	88	141	180
Utah Agricultural Experiment Station					486	543	582	1056	1558
Station	392	407	1082		1589	1626			
Utz E J			1657		Virginia Agricultural Experiment Station				88
					Visser W C	177	178		189
Valentin J			1204		797	1211			
Valenzuela A V M			794		Viswanath B				168
Van Bavel C H M			1205		Vladimirov A G				478
Vanderwerken R J			1298		Vlasov N P				1006
Van Doren C A	175		176		Vlei soils SEE Bogs and swamps				
Van Hovenberg H W			1674		Vogelzang H				1212
Van Kevich A B			1005		Vohra H R				1299
Vannote R L	611		1437		Volda A N				1465
Van Schilfgaarde J	95		1206		Voigt O				1466
1207	1208				Volpi C A				1683
Van Straaten N J			900						
Van Vlack C H	795	1209	1560		Wadleigh C H				402
Vasilakes G S			901		Wageningen project (Brit (Guiana)				1678
Veen J van			1781		Walcheren project (Netherlands)				
Veenebos J S		538	796		1305	1718	1750	1785	
Vegetables	677	809	1518		Wales	11	333	647	734
Venezuela	149	774	1570		1033	1314	1503	1529	1530
Venø Bay project (Denmark)					1826				
			1749		Walker A W				479
Venstrom C			398		Walker C				1214
Vereeniging "Nederland in de Vreemde"			1783		Walker E D				904
Verhoeven B	72		902		Walker G P				1218
Verink J B			797		Walker J P	64	1056		1594
Vermaat J G			1561		Walker P				180
Vermuyden C	1798	1807			Wallace J C				1831
					Wallihan E F		65		181
					Wallis W T		1649		1650



	<u>Item</u>					<u>Item</u>			
Walton L				1563	Waterways--Cont.				
Warburton J H				905	sodding	813	840	846	849
Ward O C				308		869	875	904	
Wardlaw H H				480	types			847	851
Wardrop G				1467	SEE ALSO	Grassed waterways			
Wäre M				539	Watson J D				182
Warne W E				1651	Webb C T				1215
Warnick F M				481	Webb H W T				1844
Wash project (Gt Brit)				1829	Webb R				798
1831					Webb W P				300
Washington	231	252	256		Weber J L				708
261	263	368	393	421	Weber Basin Reclamation proj-				
639	997	1215	1319	1368	ect (Utah)				392
1558	1580				Wedgwood F				1007
Washington Dept of Conserva-					Weed control	SEE UNDER			
tion and Development				252	Canals and ditches				
Water policies		213	1647		Weir W				799
Water rights	312	313	328		Weir W W	26	418	482	800
Water spreading	237	821	867			801	1564	1652	
Water table	28	75	95	115	Wel R A van				802
119	120	179	229	231	Welch D S				567
235	271	408			Weld W A				906
California		211	1172		Well batteries		100	1247	
clay soils			1096		Well Drainage District (Miss)				1497
Florida	488	489	1537		Wellington M S				803
measurement			33		Wells H M				301
peat and muck soils			527		Wells	115	399	402	404
research	77	442	449	1206		417	429	453	472
Texas			431			1224	1229	1277	1273
Western States			38			1524			1296
SEE ALSO	Ground water				Arizona				1258
Waterlogging	181	379			California	482	1172		1258
Gt Brit		1382			design				1246
Pakistan		470			Egypt				1839
Quebec		634			Florida				457
Rhodesia		1484			France		1712		1739
Southwestern States		444			Georgia				1225
Watershed Protection and Flood					Idaho		279		281
Prevention Act of 1954 (U S)					installation				1259
315	317	349	357	358	Oregon				231
Watersheds	106	126	840		Sweden				1063
905	985	1523	1617		U S S R				706
Arkansas			308		Utah		409	1226	1257
Iowa			1324		Washington				231
Louisiana			308		SEE ALSO	Observation wells			44
management	805	1492	1618		Welsh H D				183
Missouri			309		Welton K				1008
Tennessee			1642		Wentholt L R				250
Texas			308		Wenzel L K				1784
Waterways	727	1253			Werff H J van der				1785
Australia	840	905			Werff W A van der				266
Brazil		833			Werner D A				302
construction	833	908			Werner P W				354
design		946			Wernimont K				1216
location		908			Wesseling J		1216	1217	
maintenance	833	851	869		West Virginia		523	925	
seeding	813	854	895	908					

				<u>Item</u>					<u>Item</u>
Westerhof J J				72	Wood I D	810			1566
Westermann T				804	Wood J K				1082
Western States	38	159		197	Wood N N				483
206	255	287	313	338	Woodburn R				200
345	382	430	432	490	Wooden drains				
1270	1517				British Columbia				1136
Weston A D				1565	Denmark				1104
Wheat	1498			1557	Finland				1104
Whisler B A				1684	Germany				1089
Whitaker J R				16	Netherlands				767
White D G				1480	New Zealand				712
White L R				852	Norway				1075
White W N	303-	306			U S S R				706
Whitley F H				805	Woodruff C M				186
Whitlock R	806	1832			Woods M G M				910
Whitt D M				169	Woodward G O				1220
Wiancko A T				1218	Woodward L				811
Wiegeling G				807	Woodward S M				1011
Wiel S C				345	Wooley J C				1325
Wieringermeer project (Nether-					Wooten H H	1567	1655-	1657	
lands)				1698	Workman L J				1010
Wijk W R van				1216	Worley L D				911
Wiklander L				1219	Wouda D F				1786
Wilcox E V				808	Wright S J				1468
Wilcox J C				184	Wyoming	266	387	388	436
Wilcox L V				450	Wyoming Agricultural Experi-				
Wilde S A				540	ment Station				388
Wildlife SEE Effects on wildlife					Wyoming State Engineer				266
Williams G R				1323					
Williams L L				612	Xinias Lake (Greece)				1759
Williams M B				355					
Williams P C				27	Yarnell D L				1011
Willis G W				307	Yoder R E				888
Wilm H G				1009	Young G E	357			358
Wilmot R S				613	Young S P				1012
Wilson C M				1675	Young T W				1568
Wilson E				573	Yugoslavia	1569			1732
Wilson H				907					
Wilson H A				185	Zagumennyi A				912
Wilson H M				908	Zakarchenko V				1787
Wilson I S				809	Zeeuw J W de				120
Wilson R J				614	Zhilin A P				514
Wilton W T				1323	Ziegel W				1788
Windmills					Zingg A W	187			309
Denmark				649	Zlatkin M A	913			1789
Gt Brit				1239	Zock R T				310
Netherlands	1227	1253		1697	Zubets V M				1005
1701					Zuiderzee project (Netherlands)				
Winterberg S H				138	143	188	750	1695	1696
Winton G H				356	1729	1754	1755	1765	1783
Wisconsin	103	147	157	485	1790				
540	909	1630	1633		Zululand				620
Wojta A J				909	Zuur A				812
Wolfe E				1324	Zuur A J	72	188		1790
Wolfe J W				1301	Zuurveen H				189
Wolman A	1653			1654	Zwerman P J		33		1221
Wolnitzky A				1685					
Wood C W				1302					





