Operation of surface irrigation systems

B O G A R D, I. / Hydraulic problems in lay-flat irrigation.
In Hungarian.
Lay-flat irrigation method using soft plastic hoses with circular openings at certain intervals is described. The hydraulic problems - particularly pressure and discharge distribution - are discussed. The method facilitates operation of irrigation systems.

An automatically operated surface irrigation system requires:
1. properly prepared fields, 2. sensing and/or timing devices to turn on the inflow and to shut it off when irrigation is completed, 3. distribution system with automatically controlled mechanized gates. Existing possibilities for meeting these requirements are discussed. A description is given of proper field lay-outs and of an automatically operated (mechanized) check gate.

B O W M A N, C. C. / Semi-automation of irrigation.
VII Congress ICID, Mexico-City 1969, Question 24 : 271-275. 10 refs.
ICID, New Delhi.
The demand for water and the lack of good labor for irrigation has made it necessary to develop efficient automatic systems for the application of water. A description is given of a semi-automatic irrigation system, utilizing pressure-operated gates in conjunction with a series of portable water depth sensing transmitters and a portable receiver as controls. The system is designed for all surface irrigation methods where the water flows in a definite channel. The radio control system as described can also be used in conjunction
with sprinkler systems.

CURTIS, T. H. / Changing irrigation sets by the clock. 
Describes a clock system attached to a common canvas dam, which converts it into an automatically operated dam. Also describes an automatic border outlet dropgate and other types of automatic check gates which can be released by a timer. Automatic controls of this type are best suited where border irrigation is used.

FISCHBACK, P. and W. WITTMUSS / Automatic irrigation is here.
Description of an automatic furrow irrigation system with pumps, buried pipelines, and hydrants with air-inflated rubber valves. The system is controlled by tensiometers, placed at various locations in the field. The surface runoff is automatically pumped back into the system.
(See also Wittmuss)

GARTON, J. E. / Automation of cutback furrow irrigation.
The purpose of this study was to develop an automatic cutback irrigation system for furrow irrigation which would reduce labor requirements and improve irrigation efficiency. An extensive series of tests with short, level tubes of various diameters and lengths, having canopy inlets, was carried out to establish the flow under different heads. A relationship between the various items was established. Design procedures for practical cutback systems were developed with single and double cutbacks.

GARTON, J. E. / Designing an automatic cutback furrow irrigation system.
Shows how to design a supply ditch with a number of bays, separated by check dams, from which a large initial furrow stream is provided, and watering is continued with a cutback furrow stream for a certain time period. The labor saved is expected to pay for the system in less than its useful life.


A concrete-lined farm supply ditch is divided by check dams into a number of bays. The level furrow-outlet tubes in each bay are installed at a specific pre-determined height. By manually or automatically closing and opening the check dams, water is supplied to the furrows of one bay at a high initial inflow, which flow is cut back when the check to the next dam is opened up.


Two systems for automating surface irrigation are described. One uses pneumatic valves remotely controlled by tone telemetry to open and close turnouts at timed intervals. The other uses water-powered cylinders activated by float valves to operate center pivot gates. The automatic components can be adapted to various methods of surface irrigation and to supply by open ditches or buried pipelines.


Description, with drawings and photographs, of hydraulically operated check gates and turnout pipes for automatic irrigation of 4 ha citrus, reducing labor and conserving water. Pressure is obtained from a pump driven by a water wheel in the supply ditch. The water pressure is
conveyed by a P.V.C. pipeline to valves in the structures. The system is thought to be ready for commercial production.

Trans. ASAE 10 (1967) 5 : 639-642. 4 refs.

Inefficient use of water in surface irrigation is partly caused by high labor costs and inexpensive water. Requirements for automation are mentioned and a description is given of laboratory developments in the application of water to furrows, border strips or level basins by means of remotely controlled field gates. The gates can be operated by hydraulic or pneumatic valves, requiring a pressure line. The system is being tested in the field.

USDA Agr.Res.Serv. 41-104, July 1965, pp.21

Several models of a pneumatic nylon-reinforced valve for use in underground pipeline or ditch distribution systems are described. The system includes (1) a pneumatic closure (2) a three-way solenoid valve to regulate the inflow and outflow of air, (3) a source of air pressure to the valves and (4) a centrally located remote control system with timing by radio or carried by wire.

H O W E, O. W. and D. F. H E E R M A N N / Efficient border irrigation design and operation.
Trans. ASAE 13 (1970) (1) : 126-130. 6 refs.

Three border irrigation systems on different soil types were studied to determine design and operation criteria for the most efficient application. In practice, the uniformity coefficient appeared to be independent of stream size (within the range 0.03-0.12 cfs) and of slope, though best results were obtained on low gradients. The critical variable for an efficient water application was the cut-off time.
Operation, not design, proved to be the key to efficient irrigation.

HUMPHREYS, A. S. / Control structures for automatic surface irrigation systems.
Description, photographs and sketches of automatically operated checks (flexible canvas dams and rigid metal gates with float-actuated timers) in lined and unlined irrigation supply ditches.

HUMPHREYS, A. S. / Automatic mechanical irrigation gates.
VII Congress ICID Mexico City 1969, Question 24. 2 refs.
Two general classes of gates are described: fully automatic, operating on the energy of flowing water, and semi-automatic, requiring resetting or moving at each irrigation. Types of gates tested were: center-of-pressure check gate, sinking float border turnout gate used in combination with a check gate, float-operated check gate, drop gate. Schematic drawings and descriptions of automatic and semi-automatic border irrigation systems are given.

HUMPHREYS, A. S. / Mechanical structures for farm irrigation.
Mechanical, automatic irrigation structures like check gates, drop gates, metal apron gates and water level control checks, in lined and unlined farm supply ditches are being developed to improve surface irrigation methods and systems.

Lay-flat tubing, made of butyl rubber or plastic, can be used to replace farm supply ditches, thus simplifying the water distribution. In this paper the hydraulic design of such a system is presented. The cross-sectional area of tubing, 4 to 16 inches in diameter, for
different degrees of tubing roundness was determined and is given in
table form; the discharge for irrigation tubing of different
diameters and degrees of roundness as related to head loss is presented
in diagrams.

L A L, R. / Increasing efficiency of furrow irrigation with a variable
discharge.
Journ. Institution Engineers (India) 48 (1967) 3 (Part Cl 2, Sp) : 771-
783. 5 refs.
Analyses water losses due to deep percolation and runoff in furrow
irrigation and presents a method of reducing these losses by varying
the stream size. A dimensionless graph is included to estimate the
percentage variation in inflow with time.

New Zealand J.Agric. 106 (1964) 4 : 318-319.
Description of an automatically (time) operated canvas check and
ditch outlet.

Defines requirements for automation in irrigation.

R A M, M. / Surface irrigation.
Israel Nat.Com. ICID Tel-Aviv 1962, pp.28. 7 refs.
See also: V Congress ICID, Question 16, Tokyo, 1963 : 465-483.
A discussion on surface irrigation: methods, hydraulics and the
uniform distribution of water. How a high degree of efficiency can be
attained in furrow irrigation by means of stream regulation is
analyzed and a mathematical solution to the problem, based on logical
approach, is presented.
Irrigating with cutback furrow streams.


Cutback of inflow is generally recommended in furrow irrigation to provide an equal intake-opportunity time and uniform water distribution along the run. Tests were conducted in which irrigation was started in a variable number of furrows at the beginning of successive time intervals. A mathematical analysis of the variation is presented, as well as tables showing the number of furrows started at the beginning of each time interval and being irrigated during such an interval. In this way the available quantity of water can be distributed correctly and the required number of siphons (if used) can be estimated.

(See continuation of tables and discussions: J. 95 (1969) IR4 : 591-594.)

*VYREV, I.* / Mechanisierung und Automatisierung der Berieselung. (Mechanized and automatic irrigation.)


The labor productivity in irrigation can be increased from 0.6-0.8 ha to 10.15 ha/shift by mechanization and automation of the supply system, especially for longer furrows (300-400 m). By means of a simple pneumatic valve, 20 to 30 siphons can be put to work at one time. Flexible pipe is used, which can be laid out and rolled up mechanically. Border irrigation can be automated by using buried pipes with remotely controlled taps. Electric devices are used in furrow irrigation to indicate when the water has reached the end of the furrows.

*VYREV, I.* und *PETROV* / Wasserentnahme aus offenen Gräben bei der Furchenbewässerung. (Water application from open ditches for furrow irrigation.)


The advantages of the use of siphons above spiles or closed-type
take-out boxes and pipes are discussed. Proper water application with siphons is possible when the water level in the ditch is 30 cm above land surface. Siphons are time-saving compared with fixed outlets.


Based on experience gained in Russia, the smallest supply ditches in newly developed irrigated areas in Bulgaria were given a capacity of 100-200 l/sec. Water is supplied to the furrows through T-shaped or -shaped of 6-10 m (total weight 5-10 kg). The last section has outlets every 60-75 cm, each with a piece of plastic pipe 50-80 cm long, leading to a furrow. One man can handle 8 to 12 such distributory sets in one shift, irrigating about 5 ha.


Description of an automatic surface irrigation system with (1) adequate water, (2) supply through pipes to the fields, (3) pneumatic valves in the pipeline system, (4) control of the need for and the advance of water application by means of tensiometers, (5) an electronic device to operate pumps and valves according to signals received from the tensiometers, (6) collectors and a pumping system for re-use of surface runoff. The system is being tested in the field.


A system developed by the Inst. Hydrotechnik und Melioration in Sofia to irrigate sloping lands, consists of (1) a reservoir at a higher elevation, (2) buried pipelines or open supply ditches, (3) canvas
hoses with openings in one or two directions. Possibilities for automation are considered.
Economics of surface irrigation

HUGHES, Wm.F. / Some considerations in the evaluation of irrigation systems.
Discusses some of the more salient considerations and the nature and type of costs associated with or induced by irrigation.
Irrigation is a longtime undertaking; for supplementary purposes installation costs might be too high to be profitable. Practices are not the same in arid, humid or sub-humid conditions and various conditions require specific considerations. Items mentioned are: economics of scale regarding size of development, crops in view of water need and yield, use of irrigation facilities, labor, various costs involved.

Costs involved in sprinkler and surface irrigation in the Columbia Basin Project for 1956 and 1957 are compared. Sprinkler-irrigated farms used less water per unit of area; the yields were higher in 1957 but lower in 1956 than those in surface irrigated areas. Total costs per acre on sprinkler-irrigated farms were US $ 21.68 in 1956 and US $ 17.4- in 1957; on surface irrigated farms the respective costs were US $ 10.20 and US $ 7.53.

MORHAUS, G. H. / Sprinkling or irrigation.
Discussion of criteria which have to be considered when the economics of overhead and surface irrigation are compared. Examples of calculations are given to show whether sprinkling is profitable or not.
Sprinkler and surface irrigation were compared as to their physical characteristics, investment costs, operating costs, labor requirements, and water requirements. The farm survey method was applied in conducting the study, which took place in 1957. Time-and-motion studies were used when determining labor requirements.

In this study the relative feasibility was determined of surface versus sprinkler irrigation under different physical and economic conditions. Facilities evaluated included field water supply systems (lined and unlined ditches, gated pipe, portable versus permanent main lines), alternative sources of power, etc. For each of these facilities, irrigation design specifications were determined in different groups of uniform slopes, of soil texture and of farm sizes.

Field studies were made of labor costs under various methods of irrigation and with a stream size varying between 10 and 50 l/sec. Labor costs in surface irrigation increase roughly in proportion to decreasing stream size, while in overhead irrigation these costs remain nearly constant for flows above 16-18 l/sec.
A survey was made of costs involved in surface and overhead irrigation on 25 farms in Italy between 1955 and 1960, representative also for Spain, Greece, Turkey. Installation costs amounted to about US $ 820/net ha for surface irrigation (fixed annual costs 8-10%) and to about US $ 550/net ha for sprinkling (fixed annual costs 10-12%). Total annual costs range from US $ 90 - US $ 150. Expenditure is heavily subsidized by the Government.
Glossaries, terminology


Description of various terms used in irrigation; compiled in England.