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Contributions by Jans Wesseling, Jan van Schilfgaarde, and Herman Bouwer to effective and responsible water management in agriculture

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ABSTRACT

The first three, successive Editors-in-Chief of *Agricultural Water Management*, Jans Wesseling, Jan van Schilfgaarde, and Herman Bouwer, were of Dutch origin, received their early training immediately after World War II, and started their careers in the early 1950s: Jans in The Netherlands and Jan and Herman in the USA. In this paper we review the circumstances and the highlights of their contributions to responsible management of water in agriculture. Following a sketch of the state of agricultural water management research around 1950, both in The Netherlands and in the USA, we describe their training, document their early scientific contributions, especially in the realm of agricultural drainage, and highlight their later service as research managers. The three careers reflect the great progress in the second half of the 20th century: the scope of water management research widened, computational capabilities became more powerful, experimental methods became more sophisticated. With increasing attention for environmental implications of water management, the focus of research changed from mainly water quantity to both water quantity and quality. The review of the careers of the first three Editors-in-Chief shows that the journal *Agricultural Water Management* from its inception and throughout its first quarter century was in very good hands.

1. Introduction

Jans Wesseling, Jan van Schilfgaarde, and Herman Bouwer were the first three, successive Editors-in-Chief (EICs) of *Agricultural Water Management* (Oster et al., 2006). All three are of Dutch origin, received their early training immediately after World War II, and started their careers in the early 1950s by studying various aspects of agricultural drainage. Later their interests diverged. Jans Wesseling became Head of the Department of Water Management of the Institute for Land and Water Management Research at Wageningen, The Netherlands, where with his team he focussed on regional water management. Jan van Schilfgaarde held a wide variety of leadership positions in the United States Department of Agriculture-Agricultural Research Service (USDA-ARS), eventually paying much attention to irrigation agriculture in arid and semi-arid regions. Herman Bouwer focussed on artificial recharge of groundwater and also served as Director of the U.S. Water Conservation Laboratory of the USDA-ARS at Phoenix, Arizona. Serving as successive Editors-in Chief in the later parts of their

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careers, they brought to the journal *Agricultural Water Management* a wide variety of experience. In this paper we review the circumstances and the highlights of their contributions to responsible management of water in agriculture.

The outline of this paper is as follows. In Section 2, we describe the state of agricultural water management research around 1950, both in The Netherlands and in the USA. In Sections 3–5, we describe the careers of, respectively, Jans Wesseling, Jan van Schilfgaarde, and Herman Bouwer. We describe their training, document their early scientific contributions, especially in the realm of agricultural drainage, and briefly highlight their later service as research managers. In Section 6, we present some concluding remarks.

2. State of agricultural water management research around 1950

2.1. *The Netherlands*

In 1952 the journal *Soil Science* published a special issue on *Soil Science in the Netherlands*, providing an overview of the state of soil science and water management (Anon., 1952). The special issue opens with a description of Dutch agriculture by W.C. Visser of the Government Service for Land Improvement, Drainage, and Reallocation at Utrecht. Dutch soils and water control are described, respectively, by C.H. Edelman and F. Hellinga of the State Agricultural University at Wageningen, while tile drainage and subirrigation are treated by S.B. Hooghoudt of the Agricultural Experiment Station and Institute for Soil Research, Organization for Applied Natural Sciences, at Groningen. Reclamation of heathland and its cultivation, reclaimed peat soils and their agricultural importance, and reclamation of dune-sand soils are discussed, respectively, by J.A. Eshuis, K.J.M. Mohrman, and K. van der Meer, all of the Dutch Heath Reclamation Company at Arnhem. A.J. Zuur and B. Verhoeven of the Research Department of the Noordoostpolder Authority treat, respectively, the drainage and reclamation of lakes and of the Zuiderzee, and the embankment and cultivation of marine foreland. The special issue closes with a description of physical planning in reclaimed and newly colonized areas by S. Groenman of the State University of Utrecht.

In the 1952 special issue of *Soil Science*, the emphasis is on the wide variety of historical and then current activities aimed at increasing the area of land available for food production, with much attention for water management. Now, half a century later, the emphasis is on limiting production or exploring alternative land use, in some cases even returning the land to its former or closely related state. Nevertheless, modifications of water management are still playing a key role.

In the remainder of this subsection, attention is focused on drainage research. In The Netherlands, drainage research was initiated and flourished at the Soil Science Institute at Groningen in the 1930s and 1940s, but in the 1950s Wageningen became the center of activity.

2.1.1. *Drainage research at Groningen*

Drainage theory and practice was vigorously pursued from the late 1920s onward by Symen Barend Hooghoudt (1901–1953) (Hooghoudt, 1952; Raats and van der Ploeg, 2005). His chief inspiration came from the steady state, hydraulic approach going back to L.A. Colding. A visit in 1931 to E. Desirens at Zürich brought Hooghoudt in contact with an analysis of drainage problems based on what he called the law of Dupuit-Darcy, and the associated laboratory and field methods for determining the required soil physical/hydrological properties. E. Desirens and J. Donat pioneered the auger hole method for determining hydraulic conductivity in the field. Hooghoudt (1936) greatly improved the underlying theory, verified the theory in the laboratory, and developed the equipment needed for measurements in the field.

Hooghoudt (1937) developed a theory for steady flow, resulting from uniform input at the groundwater table, to parallel ditches reaching to an impermeable base, and with a groundwater table everywhere below the soil surface. Building upon the hydraulic approach of Colding and his followers, he assumed that the vertical distribution of the pressure head is hydrostatic at any point in the field, and that as a consequence the slope of the groundwater table can be regarded as the driving force for the flow in the horizontal direction. Later he removed the restriction of the impermeable base being relatively close to the drain or the bottom of the ditch (Hooghoudt, 1940). To this end he introduced the device of partitioning the flow region in two parts, one part away from the drain or ditch in which the flow is approximately horizontal and another part close to the drain or the ditch in which the flow is radial. The radial resistance is then accounted for by introducing an equivalent thickness of the water conducting layer below the drain, with this thickness being a known function of drain spacing, real thickness of the water conducting layer below the drain, and diameter of the drain. The resulting equation is usually referred to as the Hooghoudt drainage equation.

After World War II, Hooghoudt and his associates put much effort in the application of drainage theory, not only for agricultural soils, but also in the planning of airports, sports fields and parks (Raats and van der Ploeg, 2005). The further development and experimental verification of drainage theory became the responsibility of, respectively, J.J. Van Deemter and L.F. Ernst. Van Deemter (1949, 1950) adapted the hodograph method to give exact solutions of the problems of drainage and infiltration for systems of parallel, equidistant drains or ditches in soils with homogeneous hydraulic conductivity to infinite depth, including the effects of rainfall, evaporation, and upward or downward flow. The hodograph method was introduced in 1934 by the mathematician Hamel to describe seepage under a dam, and was used to solve drainage problems by Vedernikov in 1939, Davidson and Rosenhead in 1940, and Gustafsson in 1946. Van Deemter also used the so-called relaxation method of Southwell, which is suitable for all two-dimensional steady problems, including for soils with heterogeneous hydraulic conductivity. In view of its wide applicability, Hooghoudt was impressed more by the relaxation method than the hodograph method, this despite the mathematically sophisticated nature of the latter.

After Van Deemter left in 1947 for the Royal/Dutch Shell Laboratory, he was succeeded by the physicist Ernst, who used Van Deemter's numerical relaxation method to obtain a new formula to calculate the hydraulic conductivity from auger