Adoption of irrigation scheduling methods in South Africa

by

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DECLARATION

I declare that the thesis, which I hereby submit for the degree Philosophy Doctor at the University of Pretoria is my own work and has not previously been submitted by me for a degree at this or any other tertiary institution.

SIGNATURE DATE

ABSTRACT

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Irrigation scheduling is accepted as the process to decide when to irrigate crops and how much to apply and is assumed to play an important role in the general improvement of water efficiency on the farm. However, the idea that there is a single key to the adoption of irrigation scheduling on the farm is simplistic. It implies that science has all the answers, and "we need just to convince the farmers".

The objectives of this study were to investigate the adoption process in South Africa with the further purpose to identify the possible human and socio-economic factors that may influence it. In order to appreciate the spectrum of soil-plant-atmosphere irrigation scheduling models and techniques that are available to potential users, it was necessary to quantitatively describe and classify the scheduling methods. The adoption of irrigation scheduling methods among commercial and small-scale farmers was investigated on a scheme (macro) level as well as on-farm (micro) level through a quantitative assessment of scheduling methods on a national basis, semi-structured interviews with irrigation professionals, survey among a stratified sample of commercial farmers and case studies of small scale irrigation farmers.

It was hypothesized that the adoption behaviour of irrigation farmers is determine by socio-economic (independent) and intervening factors. It was also hypothesized that ground level support and effective dialogue between scientist and farmers are conducive for the implementation of irrigation scheduling.

The study indicates that only 18% of irrigation farmers in South Africa make use of objective irrigation scheduling method, while the rest make use of subjective scheduling methods based on intuition, observation, local knowledge and experience. Differential perceptions occur between farmers as well as between farmers and scientists with regard to the concept of "irrigation scheduling" commonly being used. These differences contributed to the communication gap between science and the practice of irrigation scheduling resulting in the unsuccessful communication between farmers and scientists and the ultimate low adoption rate.

The implementation of irrigation scheduling models are predominantly advisor-driven and not farmer-driven, as they are perceived by farmers to be complex and not easy to implement on the farm. Younger farmers are more willing to use irrigation models because of their higher computer literacy levels and positive attitude towards the use of computers in general. The technology level of a farm, size of farming operation and the value of the crop being produced determine the selection of irrigation scheduling methods. The general problems experienced by some farmers with regard to bulk water delivery hampers the implementation of more precise irrigation scheduling.

Farmers' awareness, flexibility and willingness to change, innovate and step outside of accustomed ways of implementing irrigation, are strongly influenced by their social, economic, cultural and institutional settings, and not merely by irrigation scheduling technology. Perceived indicators of efficient use of irrigation on the farm include increased production levels, decreasing electricity costs, improvement of crop quality and efficiency of fertiliser use. Farmers identified accuracy, reliability, ease of implementing and affordability as important technological characteristics of scheduling methods and devices.

The case studies of small-scale irrigation farming revealed that weak institutional arrangements and handling of farmers' affairs on the level of several small-scale irrigation schemes hampers sustainable agricultural development. Small-scale irrigators have reported that the lack of competent extension support prevents them from implementing irrigation scheduling. Also, the scientific framework used by scientists and advisors to convey information to irrigators often follows the linear transfer of technology approach instead of following the "learning based approach".

A significant relationship exists between the number of information sources used and the implementation of the type of scheduling methods The majority of irrigation farmers are more interested in the use of irrigation scheduling to identify "troubles or problems" experienced with irrigation, and inevitably farmers will differ in their selection of the most appropriate scheduling method and technique.

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LIST OF ACRONYMS

AC	Alternating Current
AE	Application Efficiency
AED	Atmospheric Evaporative Demand
Agri SA	Agriculture South Africa
ARC	Agricultural Research Council
ARC-ILI	Agricultural Research Council - Instituut vir Landbou Ingenieurswese
ARDRI	Agricultural and Rural Development Research Institute of the University of Fort Hare
BBP 3	Beste Besproeiings Praktyke No 3
BBP 17	Beste Besproeiings Praktyke No 17
BEWAB	Besproeiingswater Bestuursprogram
BMP	Best Management Practices
CANEGRO	Cane growth model
CANESIM	Cane simulation model
CASP	Comprehensive Agricultural Support Programme
CMA	Catchment Management Agency
CROPWAT	Crop Water Requirements Program
CU	Christiansen uniformity coefficient
DBSA	Development Bank of South Africa
DoA	Department of Agriculture
DOA Northwest	Northwest Provincial Department of Agriculture
DSSA	Decision Support System for Agro Technology Transfer
Du_{lg}	Distribution uniformity
DWAF	Department of Water Affairs and Forestry
E	Soil water evaporation
Em	Maximum total evaporation from specific crop surface in given growth stage
Eo	Pan Evaporation
ECDA	Eastern Cape Department of Agriculture
ECATU	Eastern Cape Appropriate Technology Unit
ET	Evapotranspiration

ETref	Reference evaporation (Penman-Monteith Method)
ET_0	Evapotranspiration as calculated from evaporation pan
FAM	Freely available moisture
FAO	Food and Agriculture Organisation of the United Nations
FDR	Frequency Domain Reflectometry
FSDA	Free State Provincial Department of Agriculture
FFS	Farmer Field School
FSU	Farmer Support Unit
GIS	Geographical Information System
GWK	Griekwalandwes Cooperative
IT	Information Technology
KDA	KwaZulu Provincial Department of Agriculture
KSA	Key Strategic Areas
LAI	Leaf Area Index
LANOK	Landbou Ontwikkelings Korporasie
LL	Lower limit of water storage
LPDA	Limpopo Provincial Department of Agriculture
LWP	Leaf Water Potential
ML	Mega Litre
MPDA	Mpumalanga Provincial Department of Agriculture
MSSA	Marketing Surveys and Statistical Analysis
NAFU	National African Farmers Union
NCDA	Northern Cape Provincial Department of Agriculture
NDA	National Department of Agriculture
NEPAD	New Partnership for Africa's Development
NEWSB	New Soil Water Balance
NIEP	Nkomazi Irrigation Expansion Programme
NWA	National Water Act (Act No. 36 of 1998)
NWRS	National Water Resource Strategy
O&M	Operation and maintenance
OHS	Open Hydroponics System
ORWUA	Orange Riet Water User Association
PCA	Plant Canopy Analyser
PAWC	Plant Availability Water Capacity

PRWIN	Probe for Windows
PUTU	PUTU crop growth model
RAW	Readily Available Water
RDP	Rural Development Program
RESIS	Revitalising Program of Small-scale Irrigation Schemes
RF	Refill point
SAM	South African Malsters
SAPWAT	South African Procedure for estimating Irrigation Water Requirements
SASA	South African Sugar Association
SASRI	South African Sugar Research Institute
SIS	Scientific Irrigation Systems
SMS	Short Message Service
SPSS	Statistical Package for Social Science
SSI	Small-scale Irrigation
SST	Small-scale Irrigation Technology
SWB	Soil Water Balance
T	Transpiration
TAM	Total Available Moisture
TDR	Time Domain Reflectometry
TRA	Theory of Reasoned Action
TOT	Transfer of Technology
TSB	Transvaal Suiker Beperk
UDL	Upper Drained Limit
USAID	United States of America Department of International Aid
VINET	Vineyard Evaporation for Irrigation System Design and Scheduling
WC/DM	Water conservation/Demand Management
WFD	Wetting Front Detector
WMP	Water Management Plan
WRC	Water Research Commission
WUA	Water User Association
WUE	Water Use Efficiency
WUI	Water Use Index