Determination of Irrigation Depths Using a Process Model and Quantitative Weather Forecast

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Introduction

Automatic irrigation systems using sensors

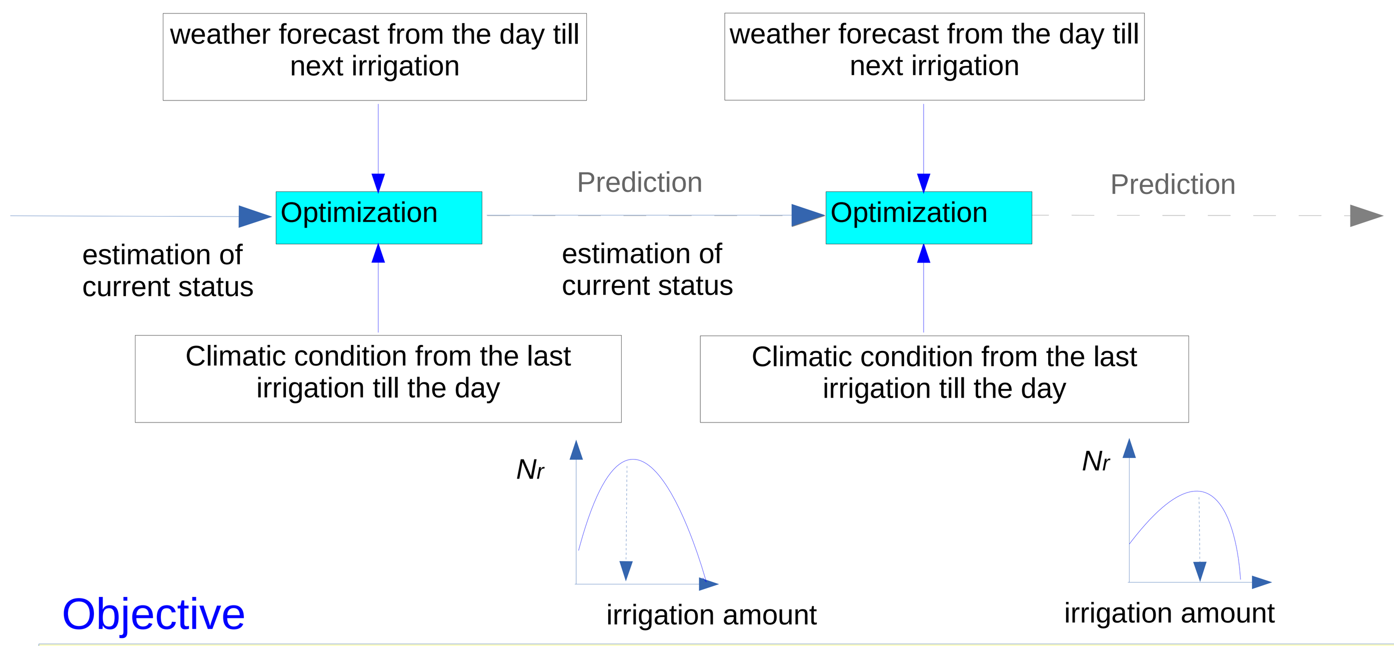
- Expensive(probes, dataloggers, EM valves...)
- Difficult or unable to adjust amount to weather forecast

- Computers getting affordable for farmers
- Numerical weather forecast: now available freely

Replacement of monitoring and optimization of irrigation scheduling using numerical simulation

New Procedure to Decide Irrigation Amount

Optimization of irrigation amount assuming as if the farmer obtained virtual income, which is nearly proportional to increment in DM attained during the interval



Objective

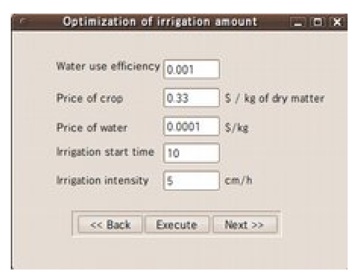
To evaluate effectiveness of proposed method as compared to automatic irrigation method in terms of net income under assumed prices of water and maize

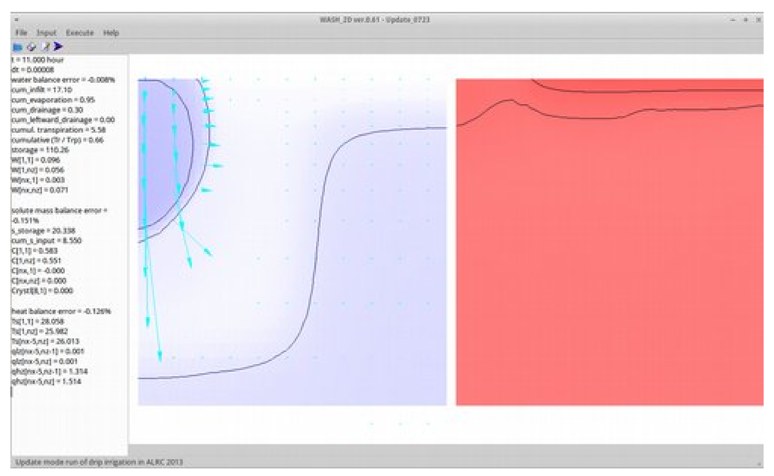
Used Process Model

WASH_2D for solving 2-d movement of water, solute and heat in soils with the finite difference method was used.

Features of WASH_2D:

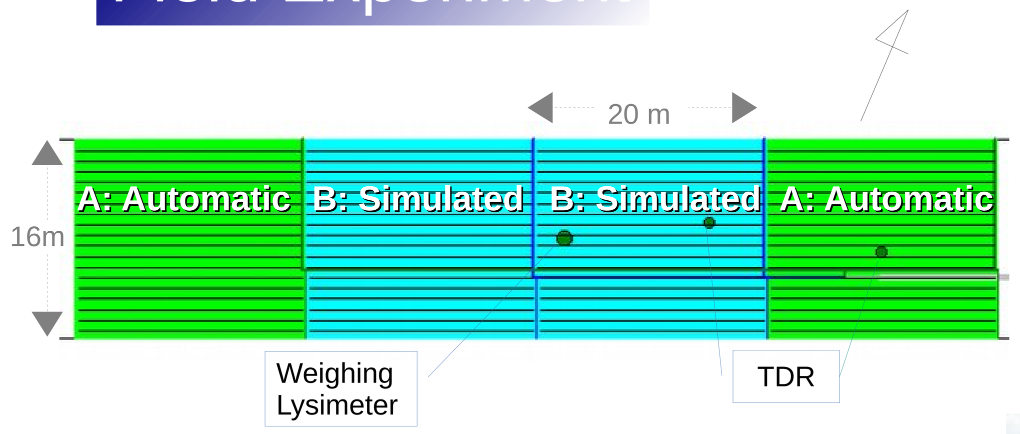
- Root water uptake with a macroscopic root water uptake model
- Plant growth
- Automatic search of optimum irrigation depth
- Hysteresis in retention curve
- Thermal vapor movement





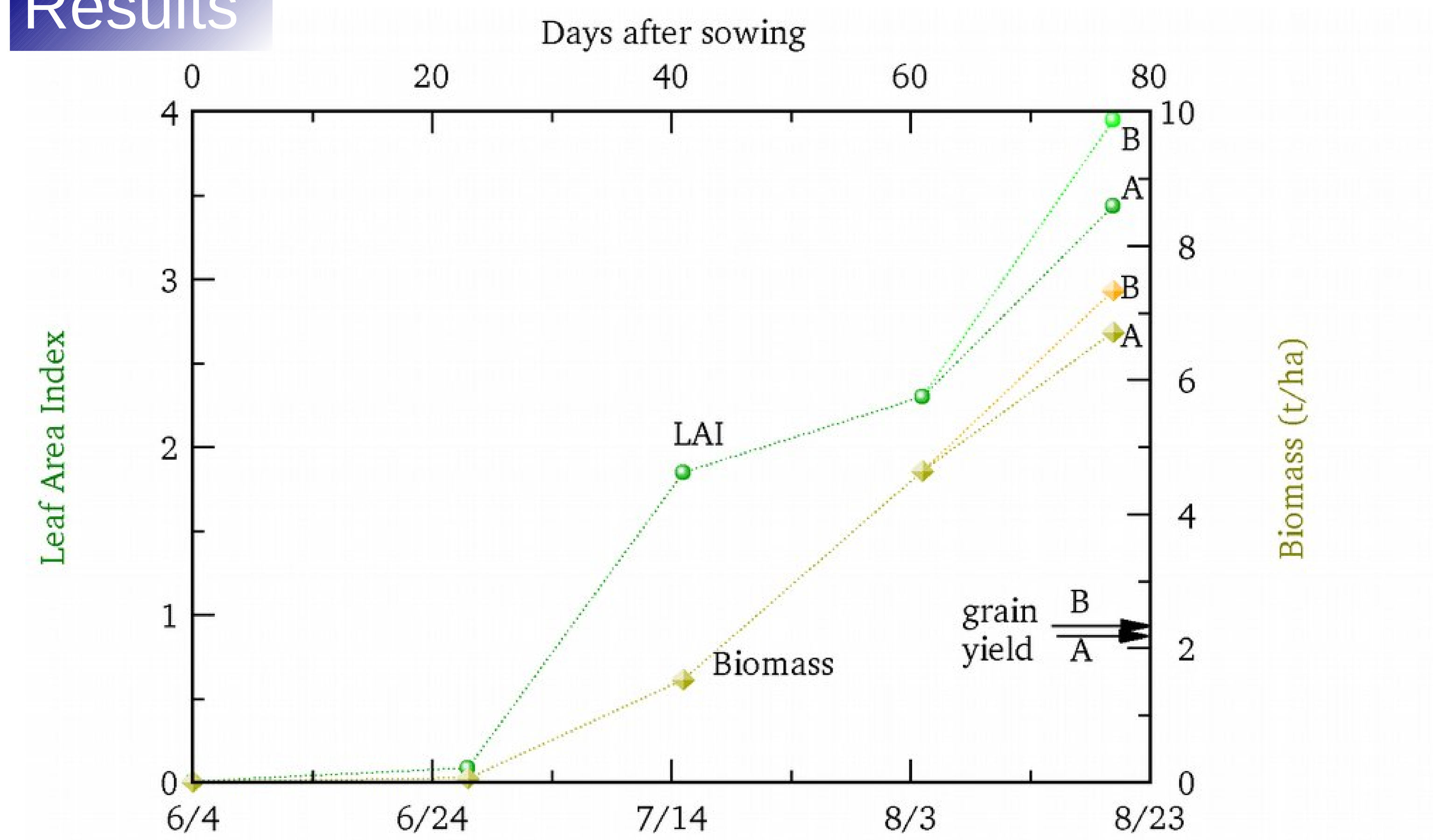
Freely distributed from: http://www.alrc.tottori-u.ac.jp/fujimaki/download/WASH_2D

Field Experiment



- Crop: Sweet Corn (Amaenbou86), 90 x 20 cm, sown on June 4th.
- Soil: sand
- Irrigation method: drip (90 cm x 20 cm)
- Interval for simulated irrigation: Two days
- Automatic irrigation: Apply 1 hour when θ at the depth of 15cm < 0.09

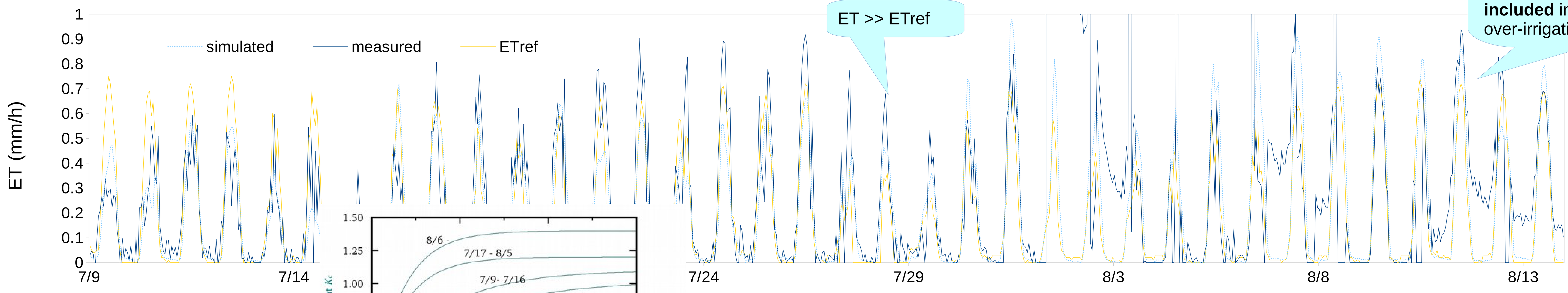
Results



Growth of the sweet corn

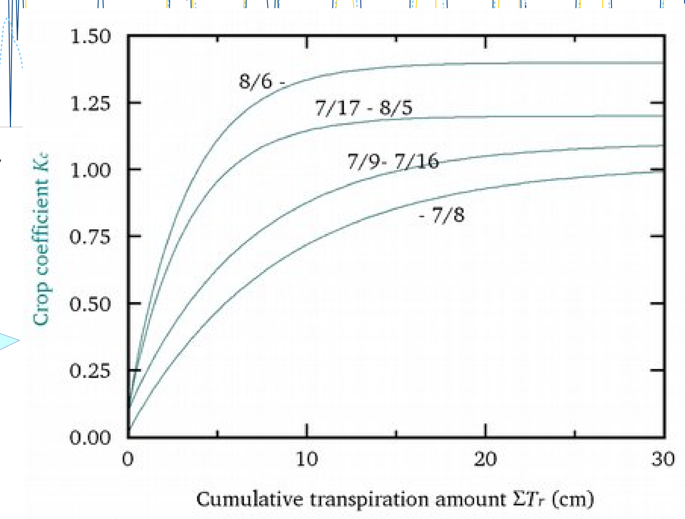
ET < ETref due to damage by corn borer. Since this effect was **not included** in the model, over-irrigation occurred.

ET >> ETref

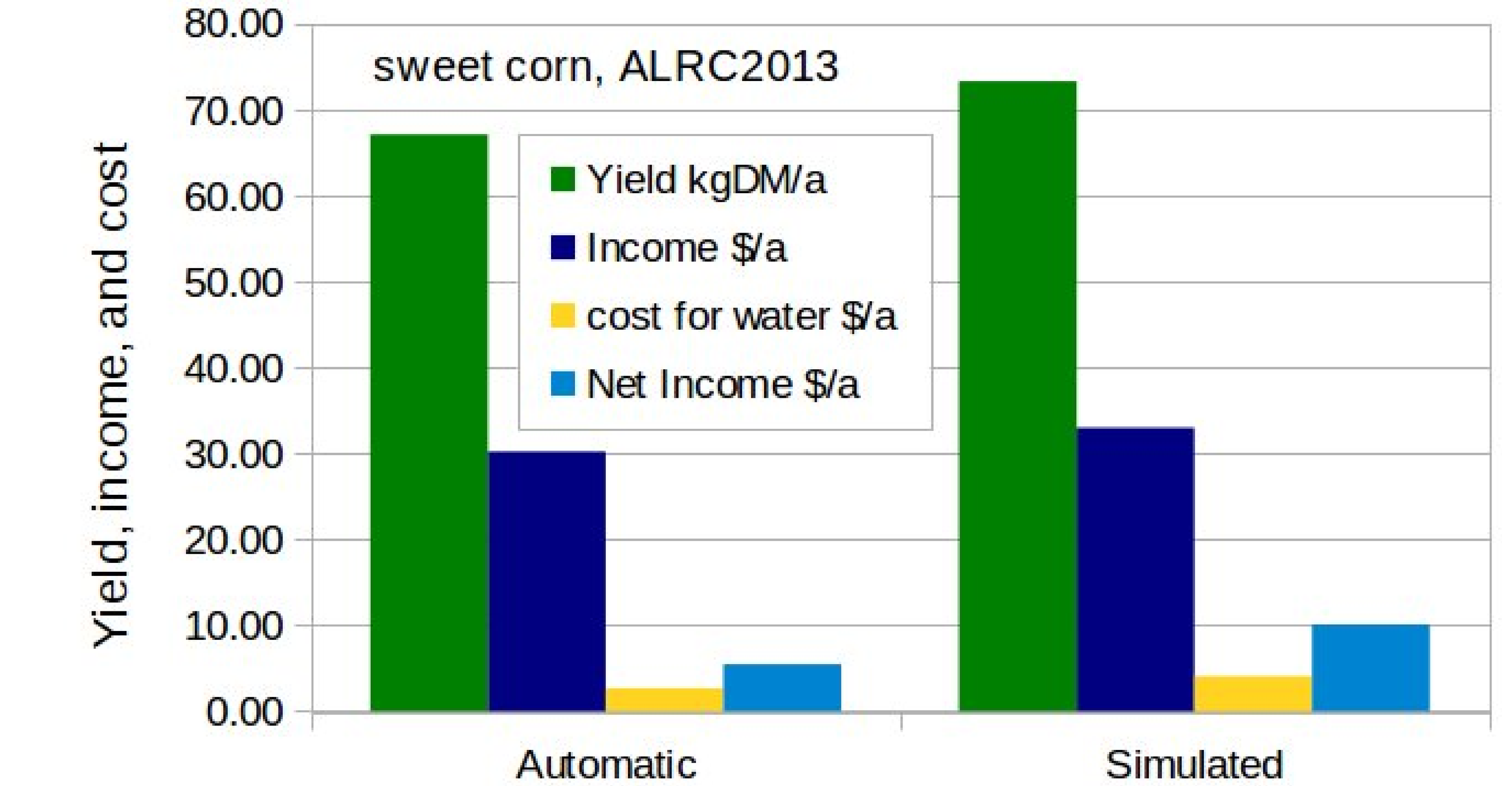


Comparison of measured and simulated ET

Crop coefficient function used in the model was sometimes updated to match with actual growth stage and ET.

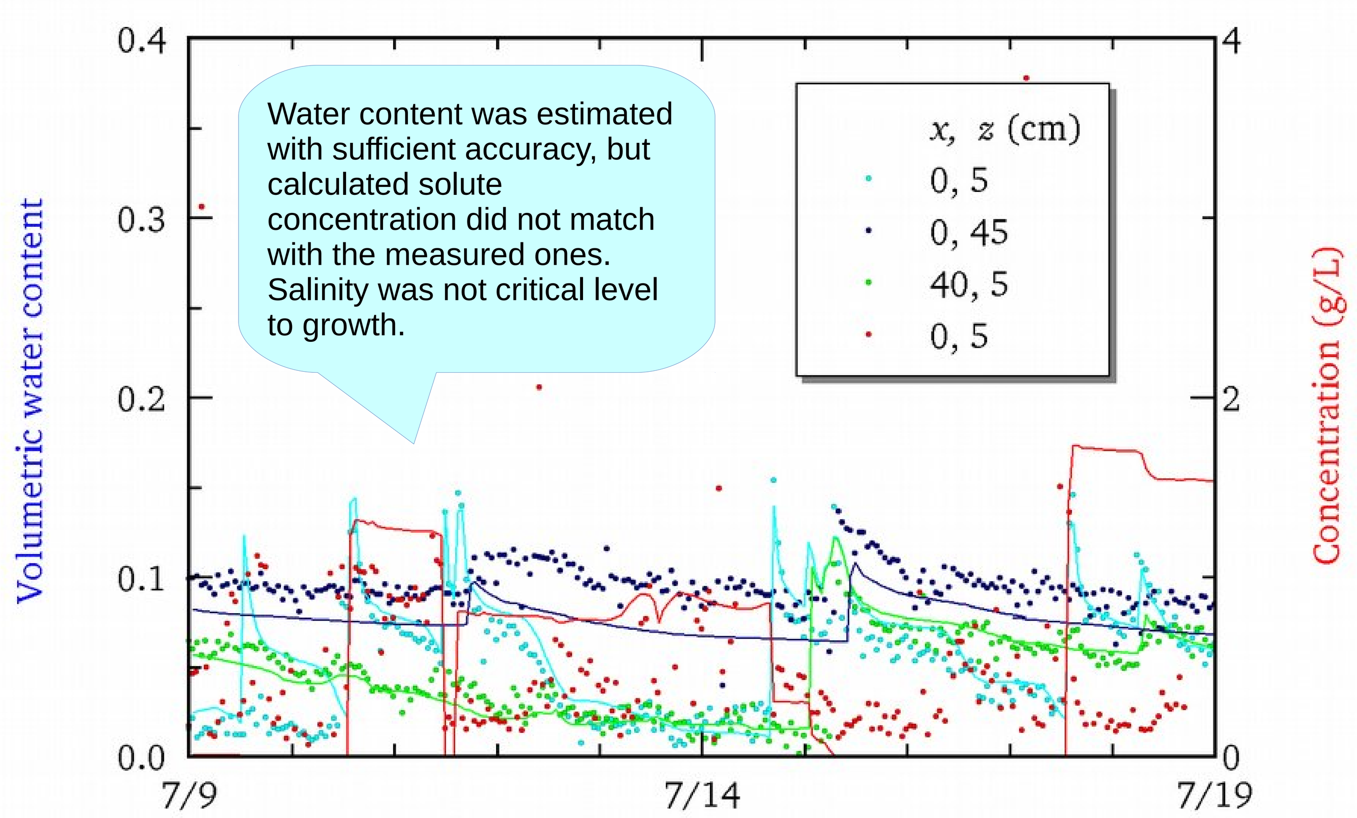


Crop coefficient (only for transpiration) as a function of cumulative transpiration amount



Comparison of net income

Water content was estimated with sufficient accuracy, but calculated solute concentration did not match with the measured ones. Salinity was not critical level to growth.



Measured and simulated water content for plot B

Conclusions

Proposed strategy can at least alter automatic irrigation systems and save costs for equipments such as soil moisture probes, dataloggers and solenoid valves.