INVESTIGATING MACHINE LEARNING ALGORITHMS TO FORECAST SOIL MATRIC POTENTIAL IN COTTON CROPS

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Research done within the

Smarter Irrigation for Profit 2

Objective: Support growers to monitor and control irrigation remotely based on Internet of Things and Remote Sensing

Challenge: How to automate the paddocks providing water efficiency, reducing labour and contributing with grower decisionmaking process?



Research done within the

Smarter Irrigation for Profit 2

New technologies integrated and automated smart sensing for cotton for

Forecast mechanism – save water in irrigation

Smart Irrigation Platform – IRRISENS

Wifield Logger / Automatic winches

Wi-Fi communication (range around 700m)



Project outcomes – IRRISENS platform

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Features

- Show monitoring bays, weather
- Forecast soil tension
- Automatic control system control all gates openings and closings without manual operation

RRISENS	
ather Station	START Automatic Irrigation Start Date: 29/09/2022 Start Time: 3 12:28
rol	START

Project outcomes – IRRISENS platform

Monitor bay & machinery (field)



Internet of Things (IoT) drives innovation in AgTech

Electronics and equipment cheaper and reliable

Communication spread through paddocks (robust Wi-Fi, LoRa, etc) V

Loggers / probes cover small areas



Labour to install and maintain the equipment in larger fields may be a challenge

Is it possible to create a mechanism to estimate soil matric potential in larger areas reducing labour and maintenance?

Inspiration: IrriSAT + Remote Sensing

IrriSAT provides Cummulative Evapotranspiration for growers in larger areas

Limitation: Remote Sensing does not provide soil tension deeper in soil – root zone (20cm)

Challenge: Elaborate a machine learning model to combine sensors + remote sensing data to estimate soil tension in areas without sensors installed, considering climate events



First Step Machine Learning – Data harvest and model training

80°0'0"

120°0'0"

2019/20

2020/22

160°0'0'

10

10

1'0'

100 200 300 400 km

IREC

Data haversted through Wifield Loggers – 3 seasons

IREC: 2019 – 2022 Cavaso: 2019/2020 Sundown Pastoral: 2020/2022



Dataset features – Algorithm Performance evaluation

Evaluation data

- Mixed data from all farms and all seasons
- Split data into training and testing
- window size 20 days (shuffled)
- $600 \le GDD \le 1700$

Testing

- Data from bays not trained
- window size 20 days (shuffled)
- $600 \le GDD \le 1700$

Weather data:

2019/20 – hotter and dryer – highest temp recorded (47.1C) 2020/21 – colder and wet – lowest temp recorded (19.7C)



First Tentative

Use data only from IREC

"Machine learning model LSTM could estimate soil tension from non monitored bays successfully with one and two season data"



Results with data from all 3 farms

Machine learning approach to estimate soil matric

potential in the plant root zone based on remote

https://doi.org/10.3389/fpls.2022.931491

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Editorial Board

This article is part of the Research Topic

Machine Learning and Artificial Intelligence for Smart Agr

About journal

Frontiers in Plant Science

ORIGINAL RESEARCH article

Sec. Sustainable and Intelligent Phytoprotection

olume 13 - 2022 | https://doi.org/10.3389/fpls.2022.931491

Front, Plant Sci., 15 August 2022

sensing data

Second Tentative

Use data from all farms and all seasons trying to forecast 14 days in advance

"Machine learning model CNN could estimate soil tension from non monitored bays successfully considering all farms"

In CNN approx 83% of estimated soil tension present similar sensor measurement error



dryer than sensor <= 10kPa = wetter than sensor <= 10kPa = 10kPa < dryer/sensor <= 20kpa = 10kPa < wetter/sensor <= 20kPa = forecast/sensor > 20kPa = Error

Concluding remarks

Machine learning models are able to estimate soil tension in no-monitored bays, since the model has as input data from one monitored bay

Convolutional Neural Network (CNN) hits 83% of satisfactory soil tension results in non monitored bays

Models need at least 20 days of monitored data to estimate soil tension properly

Attention needed for wrong estimation provided by both LSTM (5%) and CNN (4%)

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