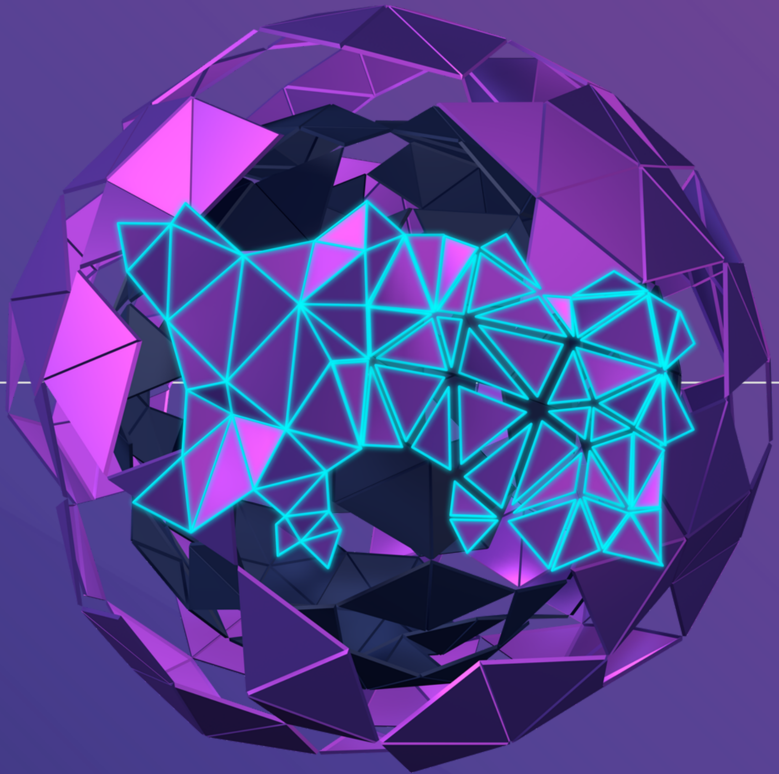
DIGITAL JERSEY

Smart Fields Pilot Report 2022



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INTRODUCTION

The Digital Jersey Smart Agriculture Working Group was established to analyse and improve the yield and quality of the Jersey Royal Potato.

The Smart Fields Pilot project was set up to review the "off-the-shelf" technology options available for Jersey farmers to capitalise on. The primary research and testing was completed with the help of the expertise in Digital Jersey and the technology industry. This project tested a combination of technologies, each providing a different set of data on the crop and/or the soil. The technologies included un-crewed aircraft (drones) to capture thermal, multispectral and RGB data as well as wireless sensors in the soil to communicate the soil conditions and environmental factors affecting the growth of the crops.

It became clear that technology can play a significant role in helping farmers when making decisions about inputs onto the potato fields. However participants acknowledged that there is a lack of skills and knowledge across the farming sector regarding the specific technologies available and how to test and implement them in Jersey's unique agricultural environment.

KEY OBJECTIVES

Improve performance

Identify patterns in crop performance using technology to understand the health of the plants

Collaboration

Work collaboratively with the Jersey Royal growers to implement technology in a small set of fields

Identify Opportunities

Identify patterns in crop performance using technology to understand the health of the plants

Test Technology

Test the technologies available to the farmers "off-the-shelf" which they can adopt in their regular growing practices

PROJECT PARTICIPANTS

Digital Jersey

Management of the project including data aggregation, analysis and visualisation. Provide technologies including LoRaWAN sensors, project mobile app and basic drone imagery with licensed pilots.

Jersey Laser Scanning (JLS)

Provided drone imagery, using the latest technology to provide insights to the growers.

Jersey Royal Company

Provided two fields, along with field management & supplies, for the project. Provided agronomic expertise & data analysis.

Albert Bartlett

Provided two fields, along with field management & supplies, for the project. Provided agronomic expertise & data analysis.

Anneville Farm

Provided one field, along with field management & supplies, for the project. Provided agronomic expertise & data analysis.

Master Farms

Provided one field, along with field management & supplies, for the project. Provided agronomic expertise & data analysis.

Airtel Vodafone

Provided network for NB-IoT sensors, provided support for IoT devices, provided NB-IoT devices.

IoTCI

Provided network for LoRaWAN sensors, provided support for IoT devices, provided database for LoRaWAN data.

Jersey Telecom

Provided network for LoRaWAN sensors.

DELIVERABLES

Milestone	Description	Delivery Date	Deliverable Achieved
Technology Architecture	Technology architecture for the project developed to capture the required data/information for the objectives	10th January 2022	Yes
Initial Technology Deployment	The technology to capture data in the selected fields was deployed to start capturing information from the fields.	From 20th January 2022	Yes
Crops Planted	The potato seeds were successfully planted across all fields, using both hand planting and machine planting techniques in fields with and without plastic covering.	From 20th January 2022	Yes
Data Dashboard	An app was developed for the farmers to gain insights in one single location. This app enabled the farmers to interact with the project with ease.	15th April 2022	Yes

DELIVERABLES

Milestone	Description	Delivery Date	Deliverable Achieved
Actionable Insights to Growers	Actionable insights into crop performance and field conditions were provided to the growers responsible for each field.	NA	Not to the level desired
Crops Harvested	The crops were harvested in all fields, having successfully grown and monitored crops with every farmer. Crops were harvested using both hand and machine harvesting techniques.	30th August 2022	Yes
Technology & Objectives Analysis Completed	Technology implementation analysis and project objectives analysis was undertaken to evaluate the effectiveness of the project. This was used as the basis for the development of the plan for 2023 and beyond.	30th September 2022	Yes

TECHNOLOGY

Technology Proposed	Purpose
Drone - Multispectral imagery	Multispectral imagery from a drone can provide a wide variety of insights, primarily plant health and emergence as well as disease and irrigation management.
Drone - Thermal imagery	The temperature & humidity sensor used in LSN50v2-S31 is SHT31, which is a fully calibrated, linearised, and temperature compensated digital output from Sensirion, provides a strong reliability and long-term stability. The SHT31 is fixed in a waterproof anti-condensation casing for long term use.
IoT sensor - temperature & humidity	Soil pH value affects the amount of nutrients and chemicals that are soluble in soil water. Some nutrients are more available in acid conditions and some more available in alkaline conditions. LSPH01 probe is made by Solid AgCl reference electrode and Pure metal pH sensitive electrode. It can detect soil's pH with high accuracy and stable value. The LSPH01 probe can be buried into soil for long time use. The probe is IP68 waterproof.
IoT sensor - pH value	Soil moisture can be a determining factor in the yield of the crop, it also aids the temperature regulation of the soil. Soil conductivity measures the amount of salt in the soil, providing an indication of soil health. Soil salinity effects crop yield, nutrient availability, pH value. It is designed to measure the soil moisture of saline-alkali soil and loamy soil. The soil sensor uses FDR method to calculate the soil moisture with the compensation from soil temperature and conductivity. It also has been calibrated in factory for mineral soil type.

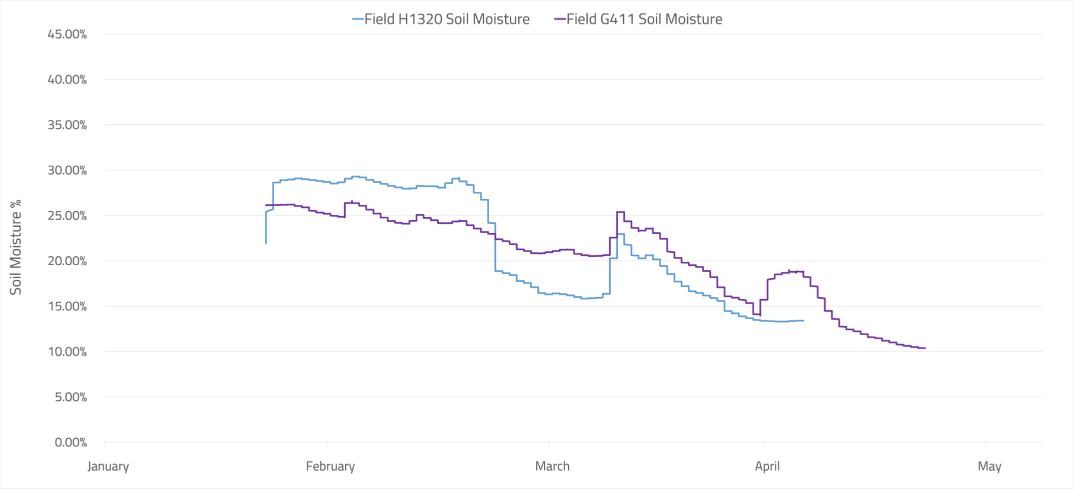
TECHNOLOGY

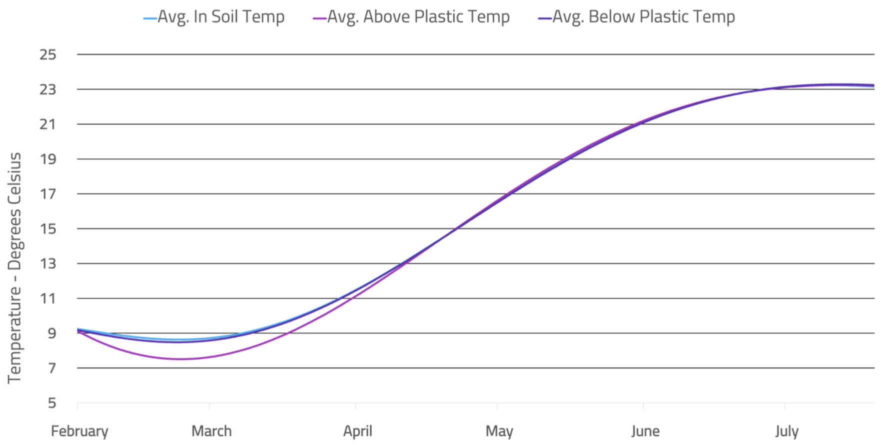
Technology Proposed	Purpose
IoT sensor – soil moisture & conductivity	Soil moisture can be a determining factor in the yield of the crop, it also aids the temperature regulation of the soil. Soil conductivity measures the amount of salt in the soil, providing an indication of soil health. Soil salinity effects crop yield, nutrient availability, pH value. It is designed to measure the soil moisture of saline-alkali soil and loamy soil. The soil sensor uses FDR method to calculate the soil moisture with the compensation from soil temperature and conductivity. It also has been calibrated in factory for Mineral soil type.
IoT sensor – soil temperature	Soil temperature is the determining factor that drives the root growth for the seeds when planted. The temperature sensor used in LSN50v2-D22 is DS18B20, which can measure -55°C ~ 125°C with accuracy ±0.5°C (max ±2.0 °C). There are two sensor cable which are waterproof, moisture-proof and anti-rust for long term usage.
IoT sensor – soil npk value	Nitrogen (N), Phosphorus (P) and Potassium (K) are the nutrients most required by crops to grow successfully. N & P are constituents of proteins and nucleic acids for the plant tissue, while K is important for the regulation of processes in the plant such as osmosis and enzyme activity. LSNPK01 detects soil's Nitrogen, Phosphorus, and Potassium use TDR method, and uploads these values via wireless to the LoRaWAN IoT Server. The probe is IP68 waterproof and can be buried into soil for long term use.
IoT weather station	Monitoring the climate locally will be vitally important to determine the effect on a variety of factors such as disease spread and irrigation requirements. It will also provide a baseline for the effect of the experiment by comparing the data to the other weather stations around the island.

DATA CAPTURE

The IOT sensors provided detailed insight into the health of the crops and soil. The power behind this data increases as you begin to layer multiple years of data on top of each other.

The insights from the data will help improve future crop development by showing the impact of soil & plant health on crop yield. In 2022 we collected 220,080 lines of data from the IoT sensors, providing a good baseline for future analysis.





The graph above shows the level of moisture in the soil and provides a clear indication of the impact of rainfall. On average this shows the rainfall is absorbed by the plants in 3-5 days giving insight into the required frequency of irrigation of some fields.

The graph to the left shows the average temperature across the fields across the three temperature probes (above plastic, beneath plastic and in the soil). This correlates well with the weather data gathered & shows the impact of the plastic (3-5-degree increase in soil temperature).

DRONE DATA

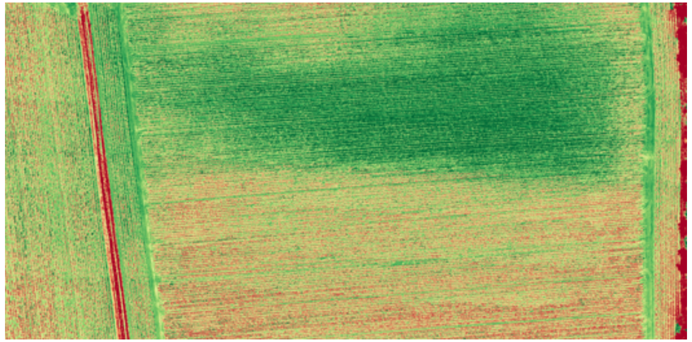
"We used drone imagery to pinpoint crop performance in different areas of the field as well as disease control and crop stress."

Dr Ben Cruickshank - Technical & Agronomy Manager, Albert Bartlett (Jersey)

The drone imagery gave insights into crop health as well as potential irrigation & disease issues in the fields. Throughout the 2022 season 432 minutes of drone flying were completed, providing 45 orthomosaic maps for analysis.

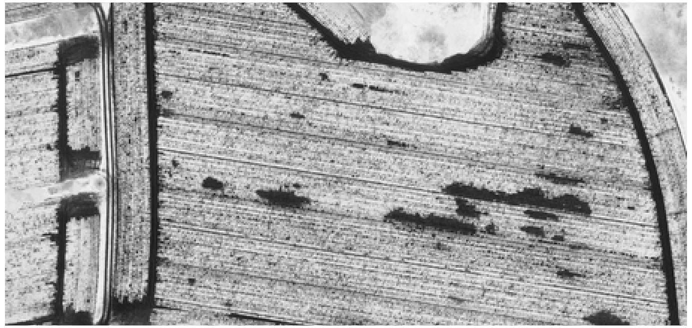
DRONE DATA

NDVI Analysis (Normalized Difference Vegetation Index)



The NDVI analysis overlaid on this image of the field shows the lack of hydration/irrigation in the southern part of the field. This means the crops were strained throughout the growing season by the lack of water, leading to lower yields.

NIR Analysis (Near-infrared spectroscopy)



Example of blight spotted across one of the fields using NIR analysis. The sensor is able to identify where the crop has low chlorophyl levels and indicate where needs to be treated. The dark spots indicate blight in the field.

PILOT OUTCOMES

Key lessons learned

- **IoT Sensors** – The farmers found the soil moisture sensor data useful however using the IoT sensors was challenging. To establish island-wide adoption, it's necessary to work collaboratively on the key IoT sensor capability for all farmers. This would involve a select few locations around the island having embedded soil moisture sensors throughout the growing season, with an open island-wide soil monitoring dashboard available to all farmers.

- **Drone imagery** – The drone imagery was the most valuable data captured, providing farmers with direct information on the health of the plants, and giving them insights they were not able to spot in the field. The process & technology tested throughout the project became well refined and understood improving the quantity and quality of data collected throughout the growing season.

- **Education of tech** – Farmers indicated that the data insights and analysis were valuable, however, a greater understanding of the data would be beneficial. To improve the value provided the farmers are interested in education sessions on each of the data types and how to implement changes to the crops based on the information.

PILOT OUTCOMES

Key lessons learned

- **Scale/farmer time** – One of the biggest issues for the farmers was the lack of scale of the project, meaning they were not able to engage in the project as much as they would like to throughout the growing season. The solution is to provide the technology at scale across all of their fields to make the adoption of technology part of their process.

- **Frequency of engagement** – As an early-stage pilot we were initially testing how to best use the technology. This lead to process and technology improvements throughout the season but meant that in 2022 we did not get a consistent record to work from. Moving forward the insights from the data/imagery collected can be improved, providing a consistent dataset for the farmers to work from.

- **NB-IoT** – Sensor deployment was more complicated and expensive than expected leading it to be dropped halfway through the project. Whilst NB-IoT is useful and is an option for IoT sensors, currently there are better solutions for farmers to adopt easily.

FUTURE OUTLOOK

The pilot project shows that technology has the potential to improve crop yields and reduce carbon emissions, giving the farmers tangible value whilst contributing to the island's carbon-neutral goals.

However, the lack of familiarity with the technology and the small data sets mean the value was not fully harnessed. Moving forward, it is vital to address these areas as we develop the project to ensure the key issues faced in the pilot are mitigated. Longer term there is clearly scope to provide a technology solution for the sector which improves productivity, whilst reducing carbon emissions.

FUTURE OUTLOOK

Scale

Providing an island-wide data visualisation tool to enable the agricultural sector to gain insights across their portfolio, focussing on historic input data, plant health and soil conditions.

This stream of work will have to solve the following challenges:

Gathering, storing and visualising the data for farmers.

Capturing data (IoT & Imagery) on a frequent basis.

Methodically capturing soil condition data using IOT sensors, in a manner that seamlessly interacts with the farming operations.

Regulatory challenges to get the scale of aerial imagery required on a frequent basis.

Skills

Providing in-person sessions and an online education toolkit for the farmers to access, focusing on the technology available (IoT & aerial imagery).

This stream of work will have to solve the following challenges:

Providing an online toolkit for the farmers to access on an ongoing basis.

Providing access to the toolkit in a variety of languages (where relevant) for the farming industry to access.

Providing access to on & off-island expertise to ensure a robust education programme is in place.

Statistics

Increasing the amount of information and data collected will increase the value provided from the ongoing monitoring. To enable this an intensive programme must be put in place to capture quality datasets on the fields.

This stream of work will have to solve the following challenges:

Ensuring a quality dataset is established for what good and bad data looks like for soil conditions, plant health and environmental factors.

Capturing a consistent dataset of drone imagery for the island-wide model to work from. This will give insight into what a Jersey Royal looks like under the algorithm, instead of the wider crop varieties which have been tested in other countries.

2023 NEXT STEPS

Scale

- Engage with Government, farmers & other key stakeholders in the industry
- Map out the requirements of a platform to with the required stakeholders
- Establish the funding mechanism to build the platform required, based on the requirements gathered
- Establish a partner to build the platform based on the requirements gathered
- Engage with the Director of Civil Aviation to establish the required approvals to complete frequent island-wide drone analysis

Skills

- Engage with local education experts, technology experts as well as Government & other key stakeholders in the industry
- Map the process & education requirements to ensure the courses provided cover the required content
- Establish the funding mechanism for the courses
- Engage with experts in the IoT & Drone analsysis space to understand the potential and required education to maximise the benefits of the technology

Statistics

- Engage with Government, farmers & other key stakeholders in the industry to understand what data (both volume and quality) is available
- Scope the requirements and design for an island-wide soil quality & moisture map
- Establish the funding mechanism for the soil moisture map programe
- Work with a local data expert to establish a baseline analysis from the data captured & gathered to understand what good looks like
- Begin to capture a consistent dataset for soil moisture throughout the year across at least 5 locations on the island.

Thanks for reading

For more information
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