An Overview of IoT Applications In Agriculture with Two Case Studies Done Locally In Iran

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Discussion Structure

Topics we will tackle

Introduction

- The Internet of Things (IoT) represents a significant technological advancement that interconnects everyday objects through the Internet, enabling them to send and receive data.
- Precision agriculture leverages IoT to optimize agricultural practices by using data from various sensors to monitor and manage environmental conditions, machinery, and irrigation systems.
- Two studies done in coordination to Iran’s agriculture are discussed.

Core Technologies and Architecture of IoT

- IoT refers to a network of interconnected objects with sensors enabling internet connectivity.

Three-Layer IoT Architecture based on IEEE P2413 standard:

- Application Layer: Interfaces with end users and applications.
- Networking and Communication Layer: Handles connectivity and data transmission.
- Sensing Layer: Collects data through various sensors.

Key IoT Technologies

- RFID: Uses radio waves to transmit data from mobile entities to readers.
- Identification Technologies: EPC and uCode for recognizing and addressing devices.
- Addressing Methods: IPv6 and 6IoWPAN-IPv4 for connectivity.
- Communication Technologies: WiFi, ZigBee, Bluetooth, LTE, and 5G.

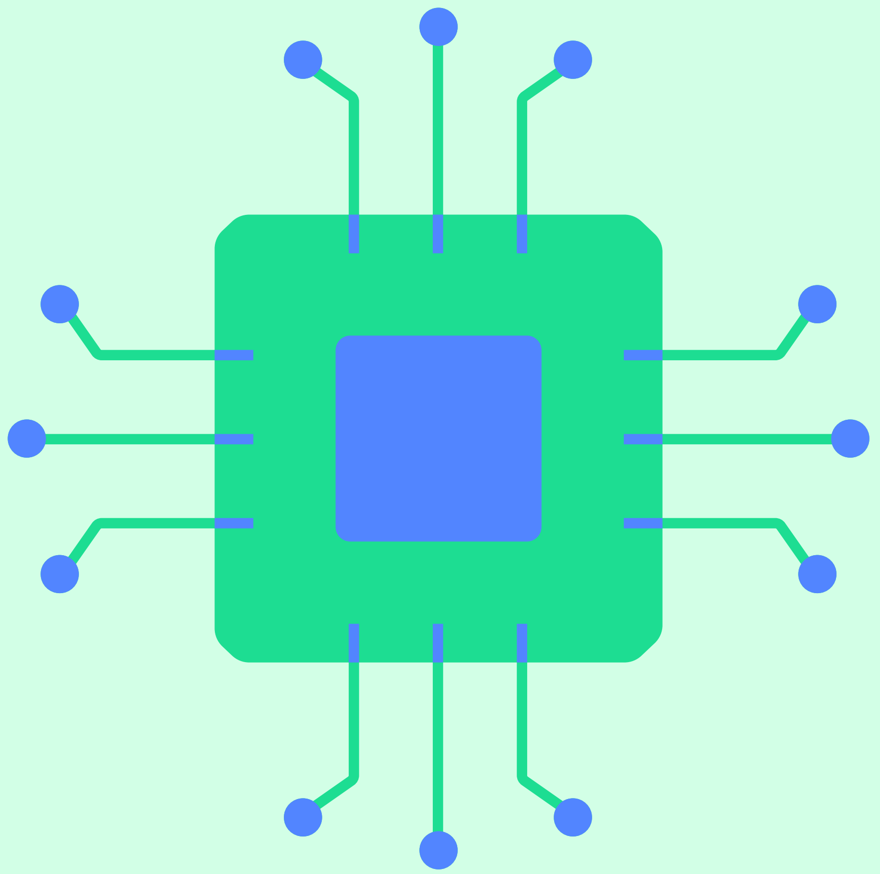
IoT and Enabling Technologies in Precision Agriculture

IoT Hardware Platforms

Growth Drivers: Small, inexpensive microcontrollers and computing hardware.

Components: Processors, wireless chips, memory, and more.

- Arduino Mega
- Arduino Uno
- Arduino Yun Beaglebone Black
- Raspberry Pi3 (B model)
- Intel Galileo



The IoT cloud platforms in the context of agriculture

- Major Providers: AWS IoT, Microsoft Azure IoT Hub, IBM Watson IoT, Google Cloud, Salesforce IoT.
- Benefits: Scalability, affordability, extensive reach.
- Usage: Monitoring, control systems, data analysis, and planning.

Machine To Machine (M2M) communications in agriculture and Agricultural Smartphone Apps

- Definition: Automated exchange of information between devices with minimal human intervention.
- Technologies: IP, WiFi, SMS, Zigbee.
- Applications: Connecting agricultural machinery and vehicles, remote monitoring.
- Popular Apps: Sirrus, Manure Monitor, Agrivi, TractorPal.

Internet of Things applications in agriculture

Precision Agriculture (PA) Overview

- A modern management approach using advanced technologies to enhance farming efficiency and productivity.

Key Technologies in PA:

- Information Technology (IT)
- Geographic Information Systems (GIS)
- Global Positioning Systems (GPS)
- Wireless Sensor Networks (WSN)
- Data Collection Techniques

Objectives of PA:

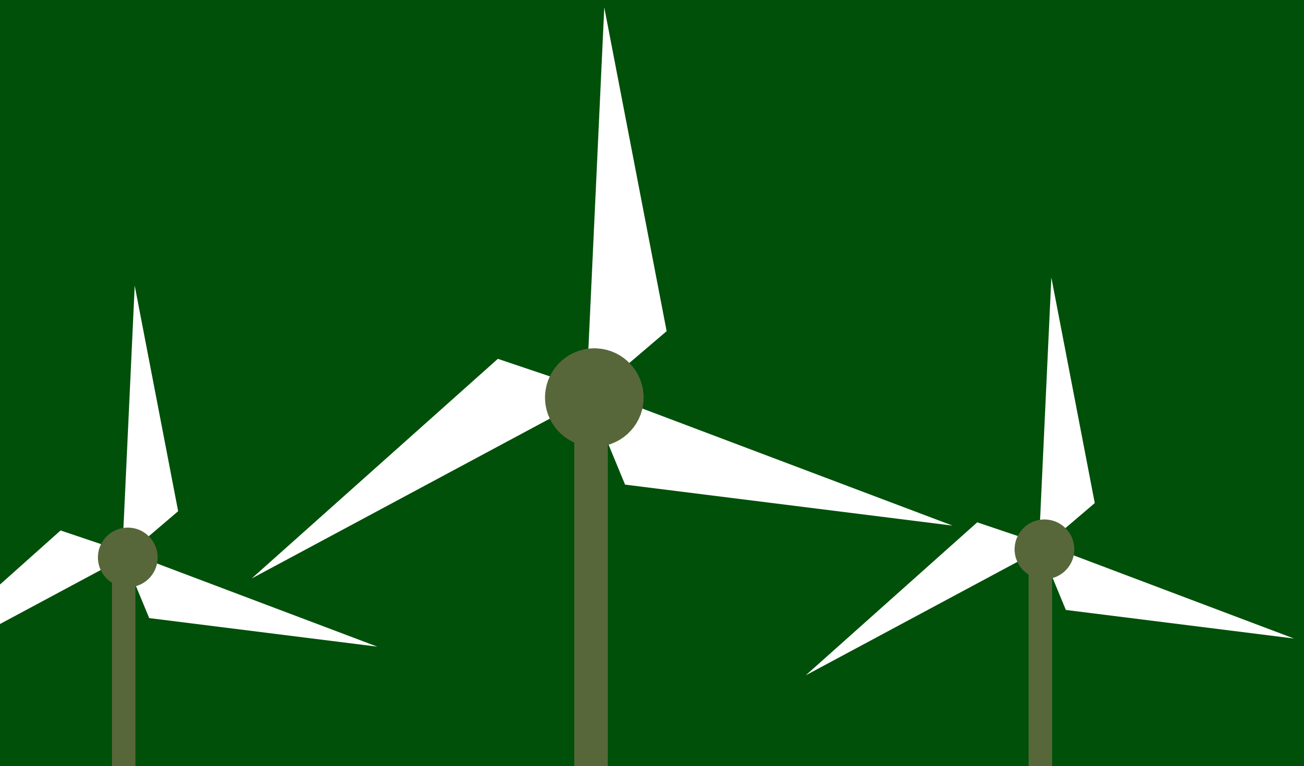
- Increase Crop Yields: Optimize inputs and farming practices.
- Minimize Environmental Impact: Reduce waste, conserve resources, and promote sustainability.

Environmental Monitoring and Control

- Wireless Sensor Networks (WSNs): Scalability, fault tolerance, energy efficiency, effective monitoring systems.
- Key Parameters: WSN’s sensor nodes can measure and process several environmental parameters e.g. soil moisture, temperature, humidity, water pH, wind speed
- Advancements: Greenhouse monitoring, automated controls, data analysis via cloud.

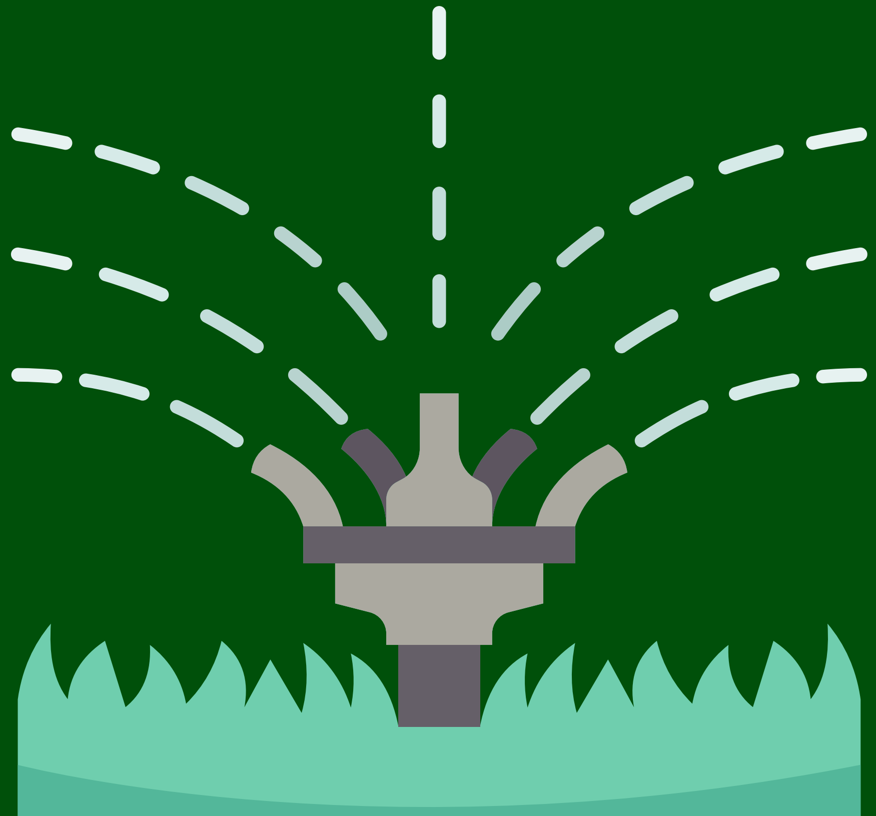
Ecological Monitoring

- Challenges: Environmental pollution, climate change, biological alterations.
- EIoT: Sensing, collecting, preprocessing, transmitting environmental data.
- Benefits: Continuous, real-time monitoring.



Smart Irrigation Systems

- Water Demand: Agriculture accounts for 70% of global water consumption.
- Modern Systems: Networked sensors, microcontrollers, actuators.
- Implementation: Soil moisture sensors, data analysis, automated irrigation.



Predicting the Impact of Internet of Things on the Value Added for the Agriculture Sector in Iran Using Mathematical Methods

Case Study 1

Introduction

- **Context:** Iran faces significant water shortages, exacerbated by climate change, inefficient management, and excessive consumption.
- **Objective:** To investigate the economic impact of implementing IoT technology, specifically smart irrigation, in Iran's agriculture sector.

Background on Iran's Agriculture

- **Water Resources:** Iran has limited freshwater resources, with 92.2% used in agriculture.
- **Agricultural Efficiency:** Iran's agricultural productivity is low compared to similar climates.

Internet of Things (IoT) in Agriculture

- **IoT Definition:** IoT consists of interconnected devices that communicate and collect data to optimize operations.
- **Application:** In agriculture, IoT is used for smart irrigation, machinery control, and livestock tracking.

Smart Irrigation System

Technology: Utilizes Wireless Sensor Networks (WSNs) to monitor soil moisture, temperature, and weather conditions.

20-40%

Reduction of water consumption

20%

Increases agricultural yields

Economic Impact on GDP

Equation 2:

$$Y = c + f(x) + \varepsilon$$

Equation 3:

$$GDP_{predicted} = GDP + \sum_k \sum_g x_g^k {Y_1}_g^k {Y_2}_g^k \qquad (3)$$

- **Investment Coefficients**:
  - Water Savings: $Y1 = 0.007828 \times x$
  - Increased Production: $Y2 = 1726427 + (0.108973 \times x)$

- **Current GDP (2018)**: 18619 thousand billion Rials.
- **Predicted Increase**: Total value added from smart irrigation is 1254.45 thousand billion Rials.
- **New GDP Estimate**: 19873.45 thousand billion Rials, a 6.7% increase.

Economic Impact on GDP

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Investments	0.007828	0.000644	12.14954	0.0000
c	16368.61	24425.27	0.670151	0.5061

Source: FaghihKhorasani and FaghihKhorasani (2022)

Table 2a: The relationship between the impact of investment and value-added resulted from savings in water consumption.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Investments	0.108973	0.012958	8.409537	0.0000
c	1726427.0	491243.8	3.514399	0.0010

Source: FaghihKhorasani and FaghihKhorasani (2022)

Table 2b: The relationship between the impact of investment and value added resulted from increasing of agricultural .

Table 2a and 2b

Results and Discussion

- **Implementation Cost:** Approximately 1.05 billion Rials per hectare.
- **Annual Costs:** Calculated using investment data from pilot projects.
- **Economic Benefits:** Significant GDP growth due to improved agricultural efficiency and water savings.

conclusio n

1. **Potential for Economic Growth:** IoT implementation in agriculture can lead to substantial economic benefits.
2. **Sustainable Water Use:** Smart irrigation helps achieve sustainable water management.
3. **Recommendation:** Promoting IoT adoption in agriculture to enhance productivity and economic stability.

Evaluating the Possibility of Using the Power of the Received Signal to Estimate Soil Moisture

Case Study 2

Paper Name: “Evaluating the Possibility of Using the Power of the Received Signal to Estimate Soil Moisture in Outdoor and Indoor Environments” (Original Name Is In Persian)

Three researchers from the Persian Gulf University have proposed a scientific approach based on Internet of Things (IoT) technology for measuring soil moisture.

The results indicate that with proper processing of the received signal strength indicator (RSSI), it is possible to estimate soil moisture in agriculture with acceptable accuracy.

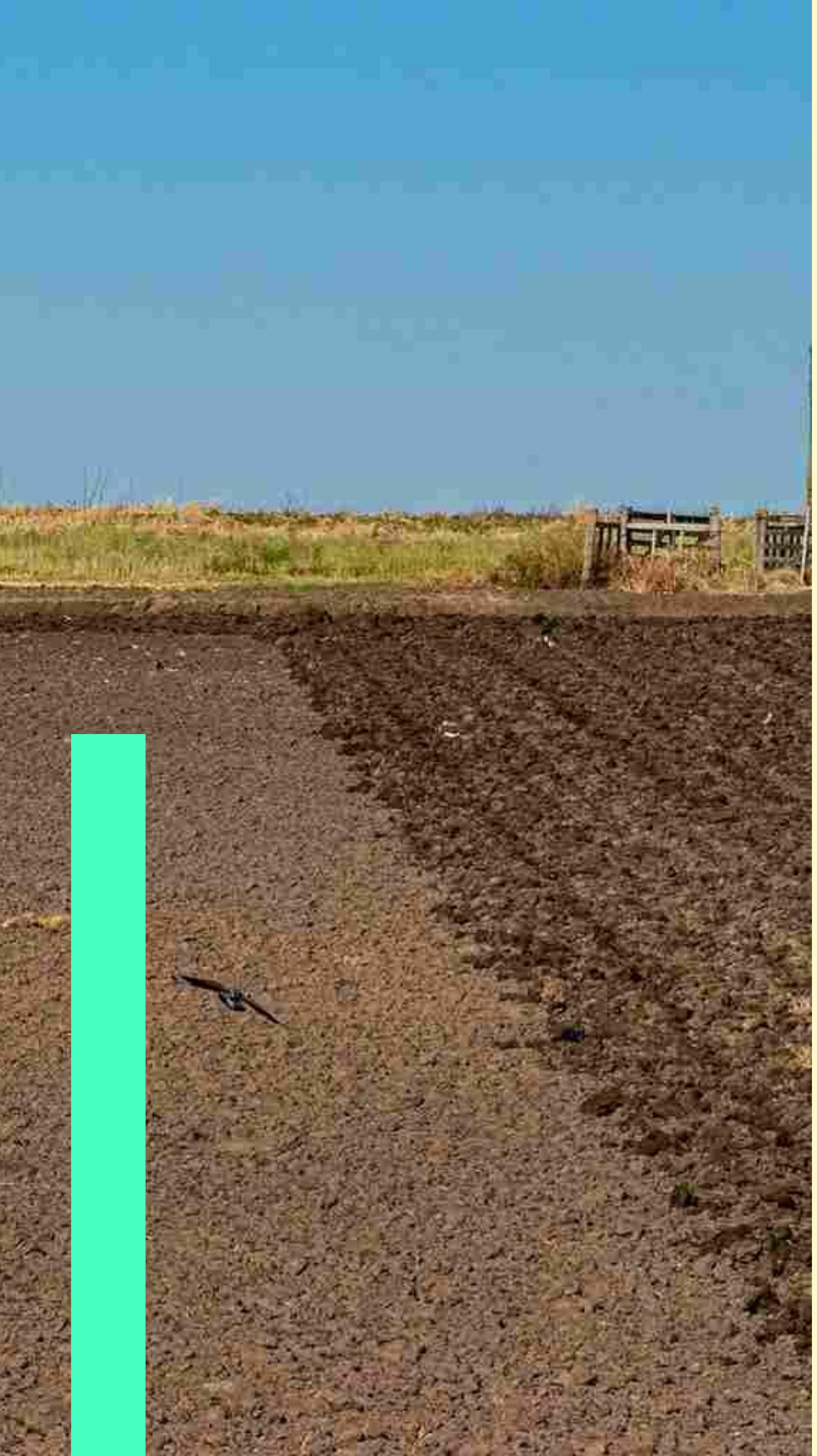
This and the method proposed could lead to a massive reduction in expenses of implementing a system to control soil moisture in order to achieve excellent irrigation.

Soil Moisture Measurement Challenges

Financial

Large Farms

Power Supply



Experiment Methodology

Materials:

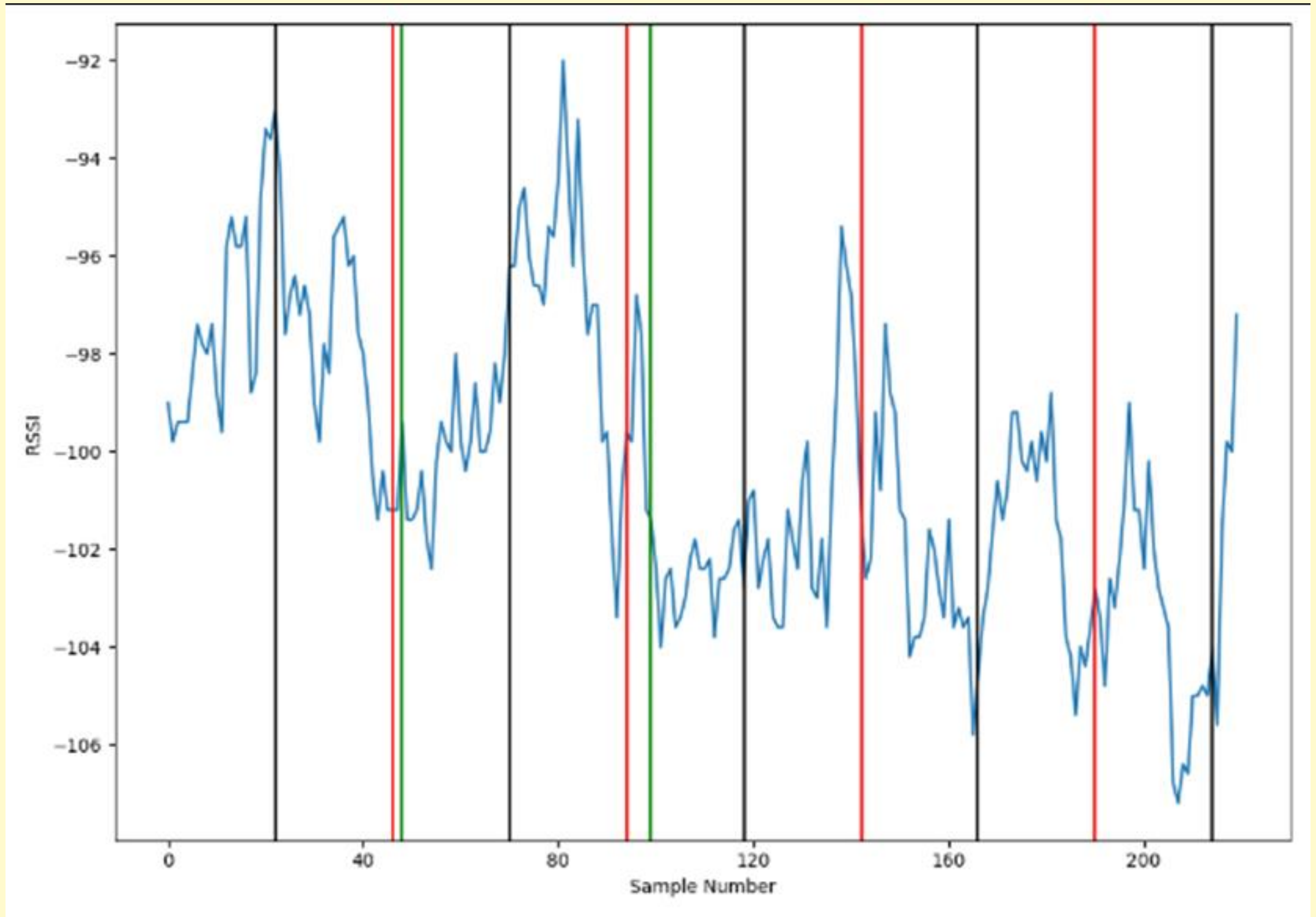
- a Lora module
- a soil moisture sensor

The experiment was conducted in both indoor (inside a building) and outdoor (on the campus of Persian Gulf University) environments..

Results and Discussion

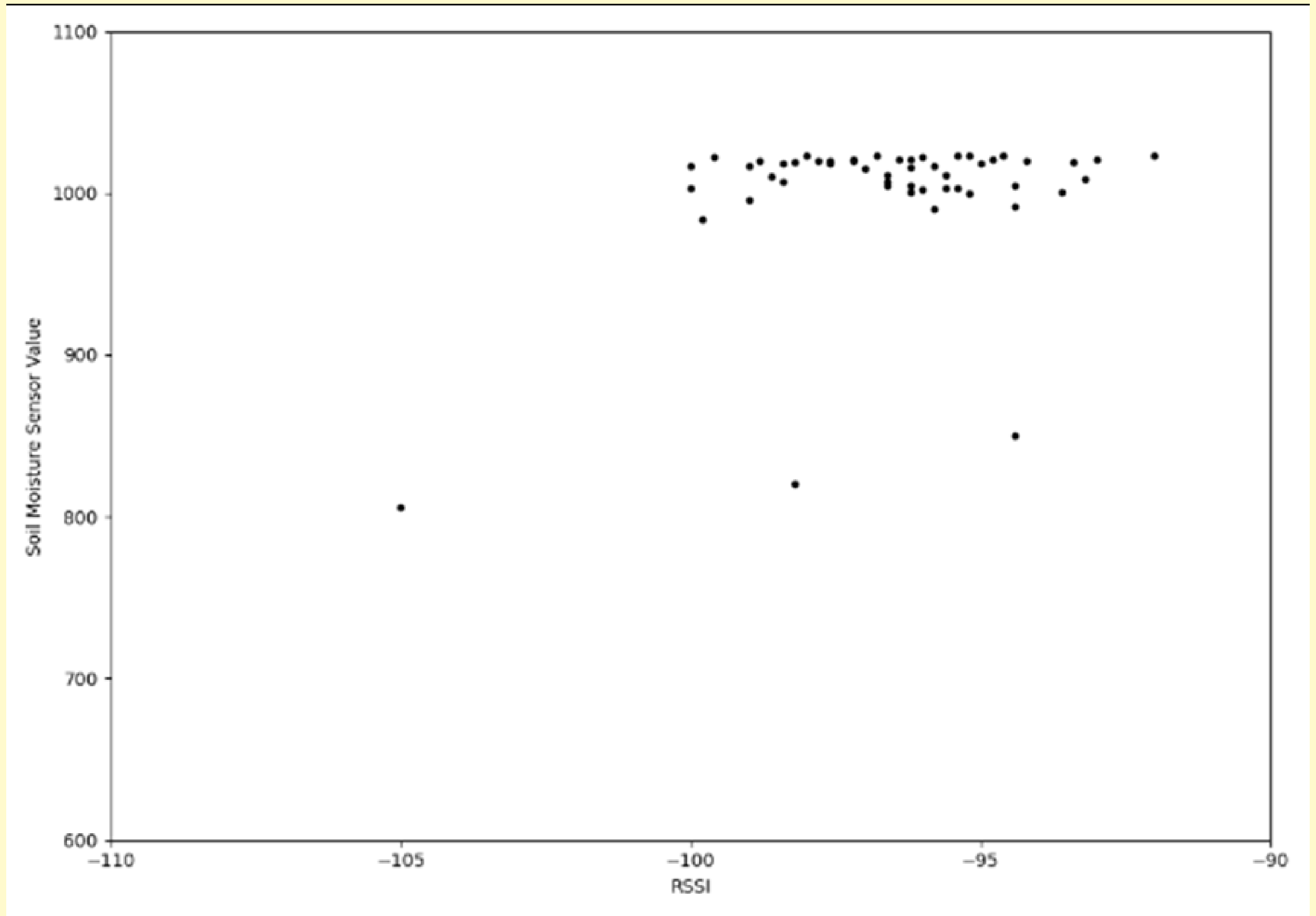
Indoor Environment

RSSI over time for indoor environment

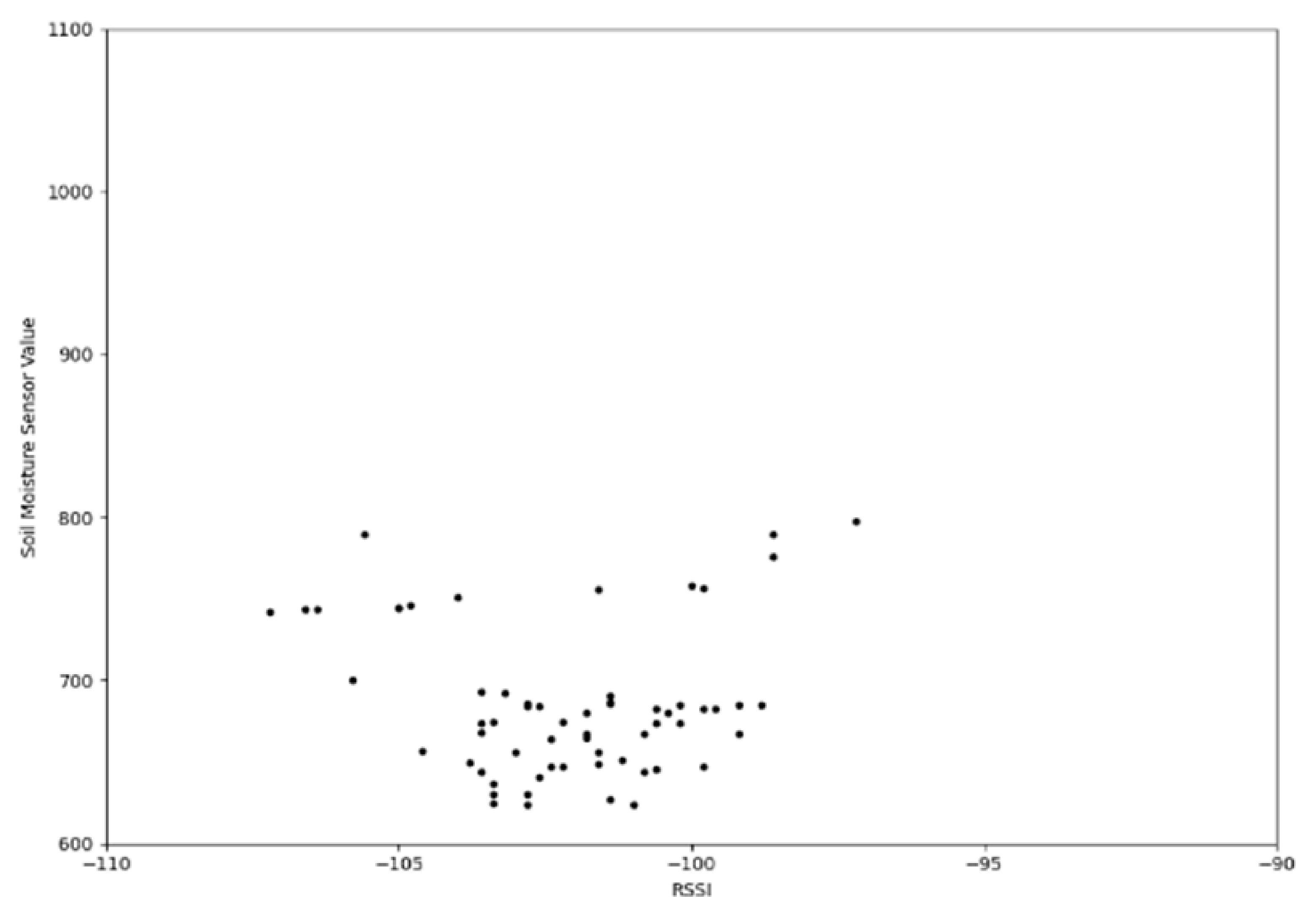


Results and Discussion

Indoor Environment



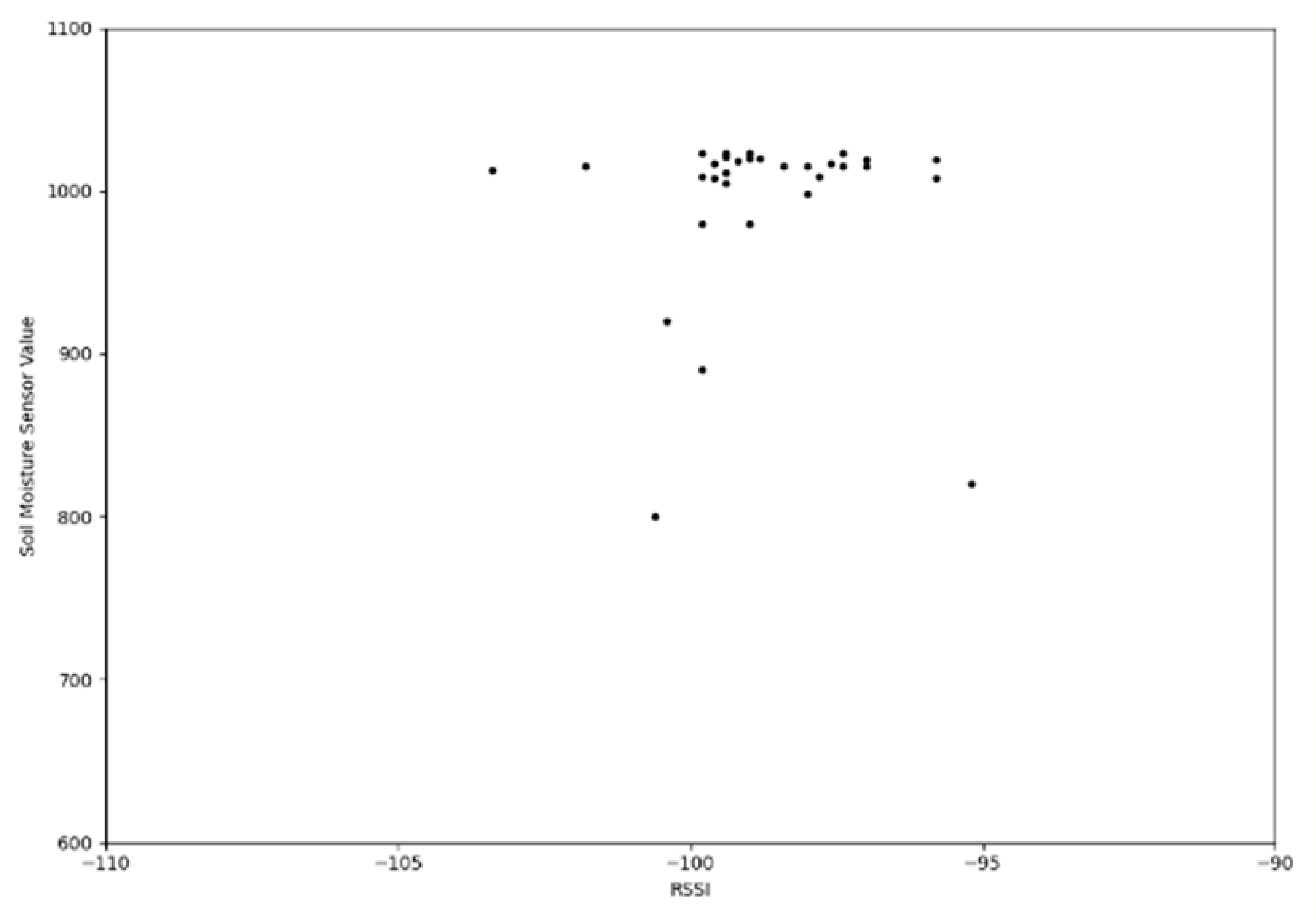
Soil moisture versus RSSI scattering for dry soil at night



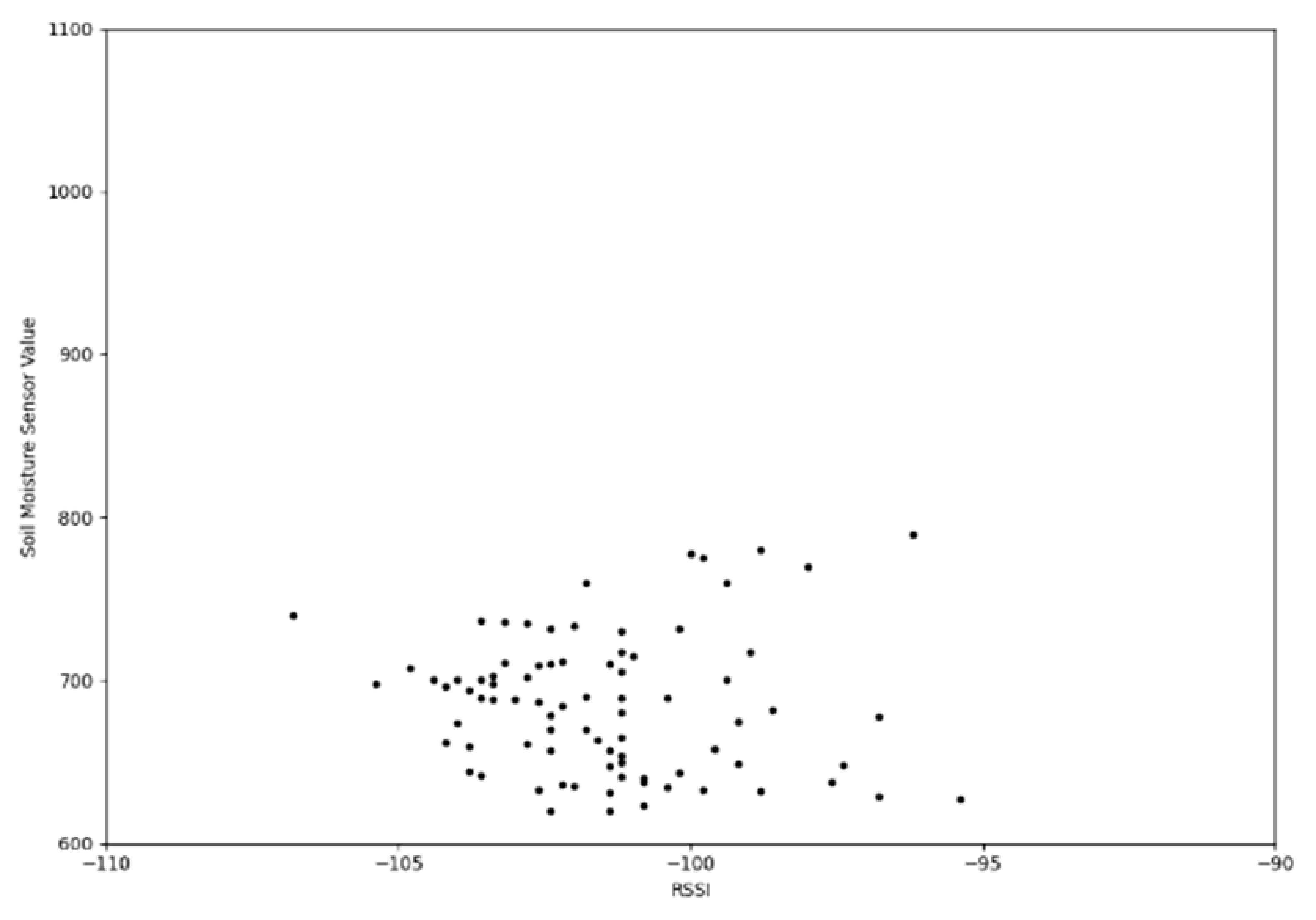
Soil moisture versus RSSI scattering for wet soil at night

Results and Discussion

Indoor Environment



Soil moisture versus RSSI scattering for dry soil at daylight

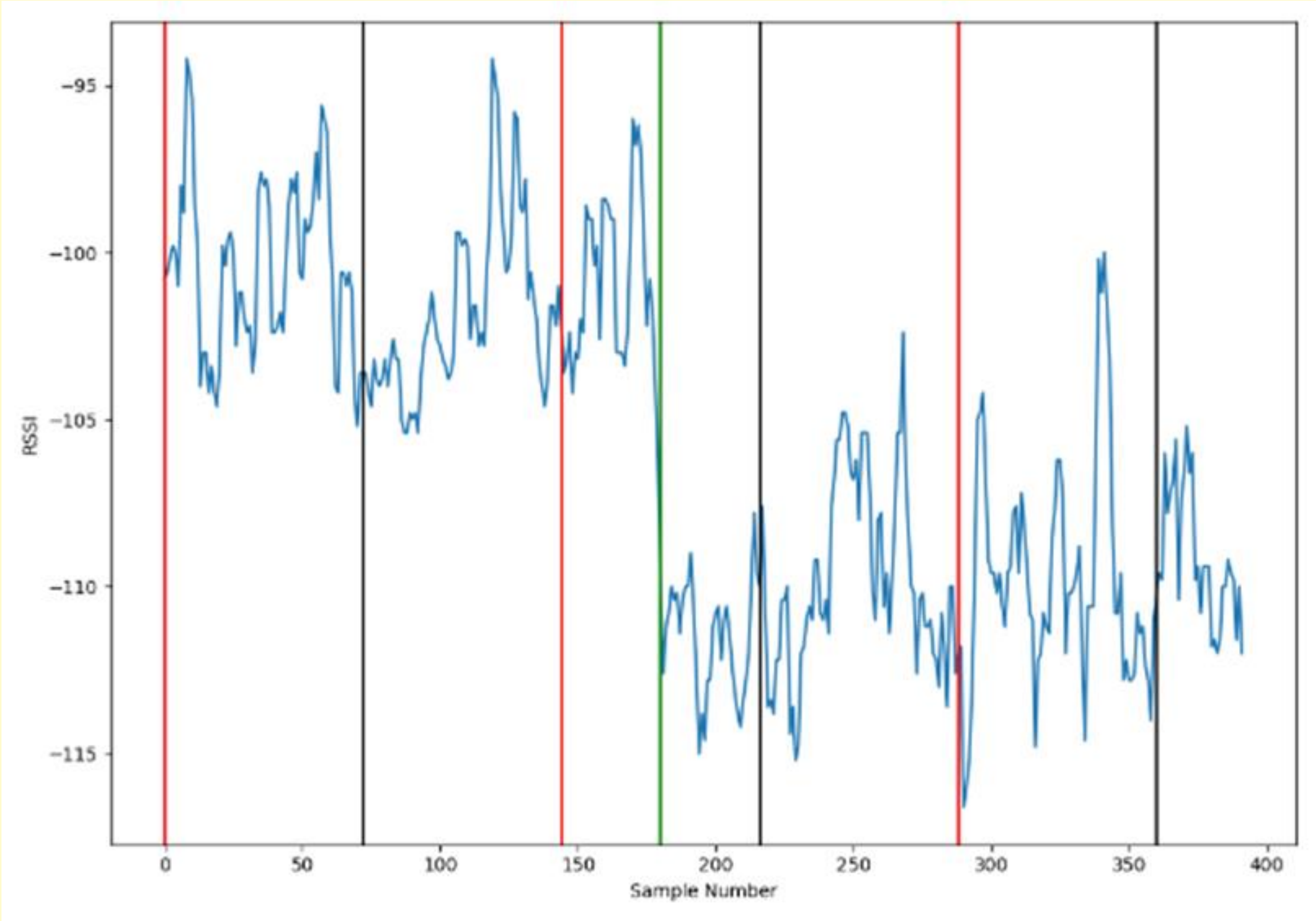


Soil moisture versus RSSI scattering for wet soil at daylight

Results and Discussion

Outdoor Environment

RSSI over time for outdoor environment



Conclusion

Ultimately, this research concludes that the relationship between RSSI and soil moisture is significant enough to consider it as an acceptable criterion for measuring and estimating soil moisture in smart agriculture at a much lower cost than similar methods.

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Resources

- Abbasi M. & Yaghmaee M. (2019). “Internet of Things In Agriculture: A Survey” University of Isfahan IoT Conference (2019)

- FaghihKhorasani H. & FaghihKhorasani A (2022). “Predicting the Impact of the Internet of Things on the Value Added for the Agriculture Sector In Iran Using Mathematical Methods” AGRIS on-line Papers in Economics and Informatics

- Dokard A., Keshavarz A. & Mansorinejad M. (2023). "Evaluating the Possibility of Using the Power of the Received Signal to Estimate Soil Moisture in Outdoor and Indoor Environments" University of Isfahan IoT Conference (Fall of 2023)

Thank You!