FarmSense Leave Behind Packet

For: Colorado State University - San Luis Valley Research Center
Date: February 2026
Subject: Partnership Opportunity - Aquifer Recovery Pilot

EXECUTIVE SUMMARY

FarmSense is deploying a **deterministic farming operating system** designed to eliminate irrigation guesswork through forensic-grade data integrity. We're requesting a Letter of Support for our CRD grant application to validate a 9-field pilot before the June 29 Water Court Trial.

In exchange for your Letter of Support, CSU SLVRC receives:

- Open API access to 1-meter resolution soil moisture data
- 4 paid internships (2 Ag-Engineering + 2 Data Science)
- Co-authorship on resulting peer-reviewed papers
- Direct comparison to lysimeter measurements for validation

VISUAL SNAPSHOT

Deployment Phases

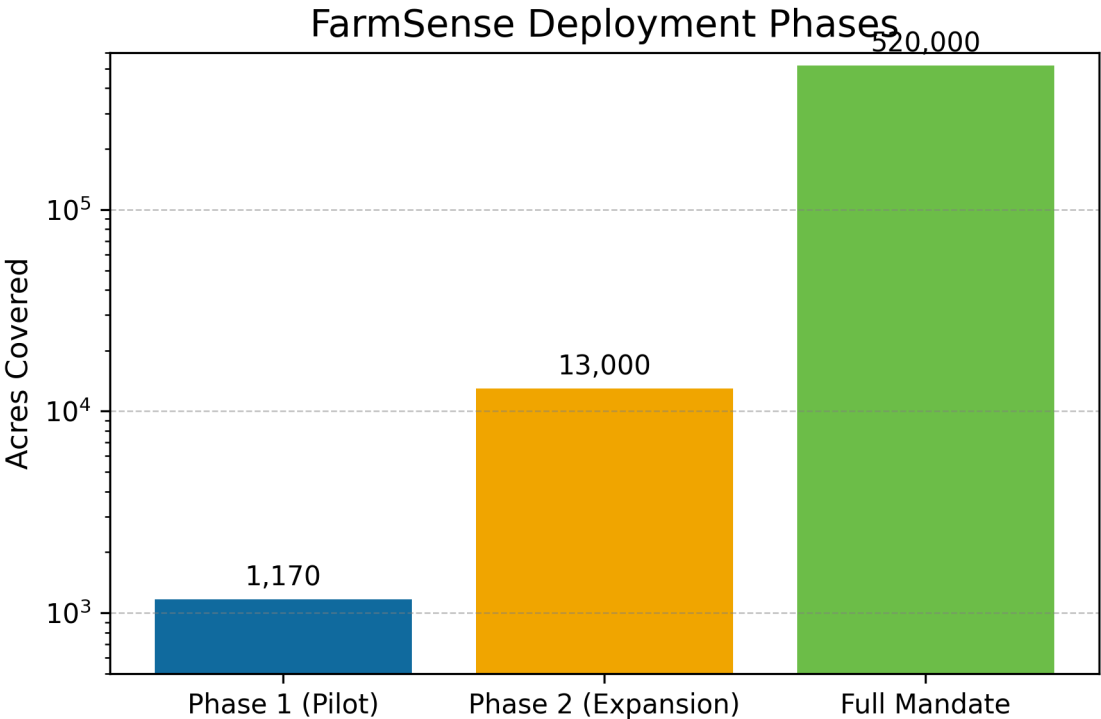A log-scale view of how the pilot grows into the full 520,000-acre mandate.

Figure 1: Deployment phases chart

Concept Illustration

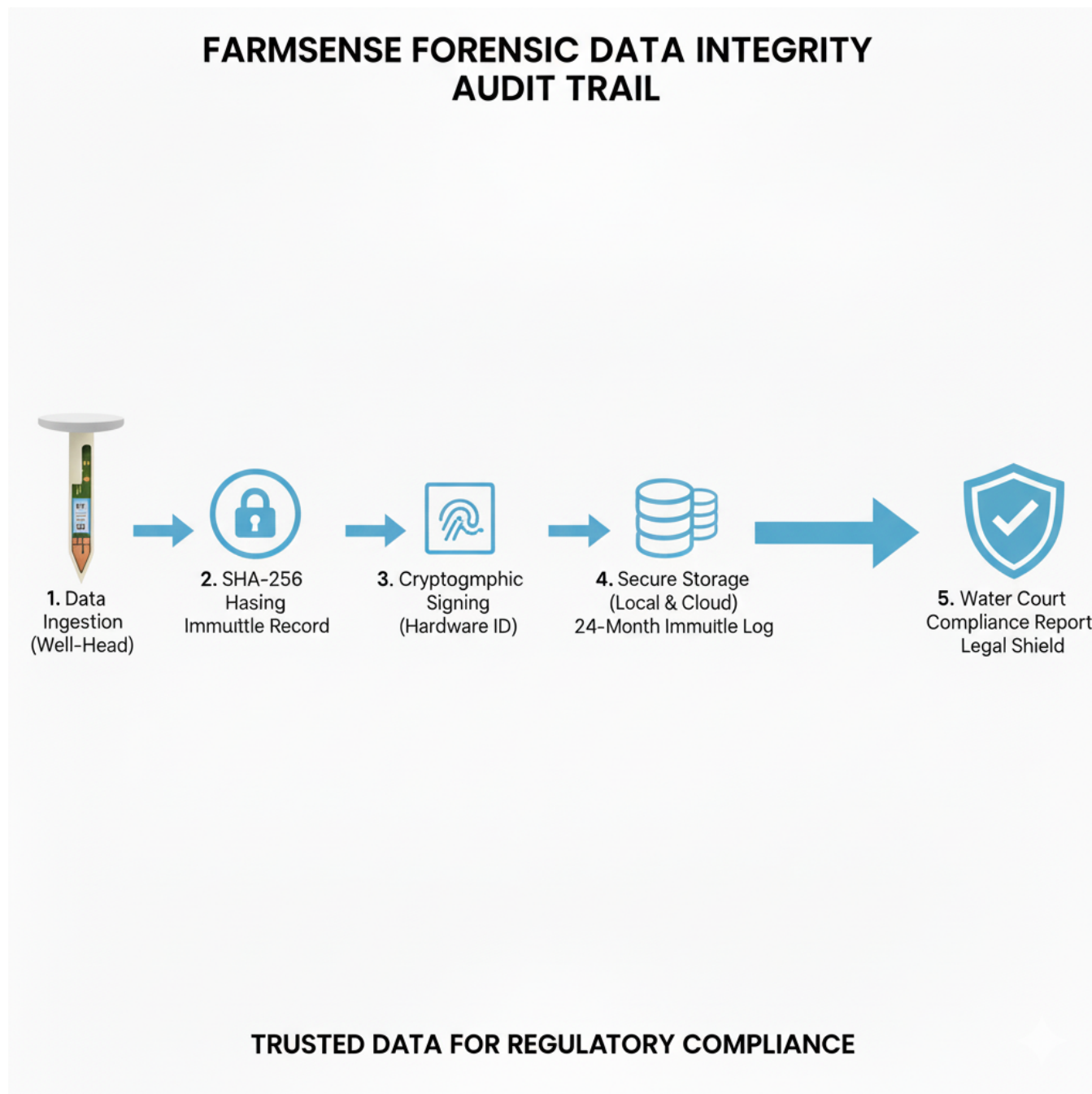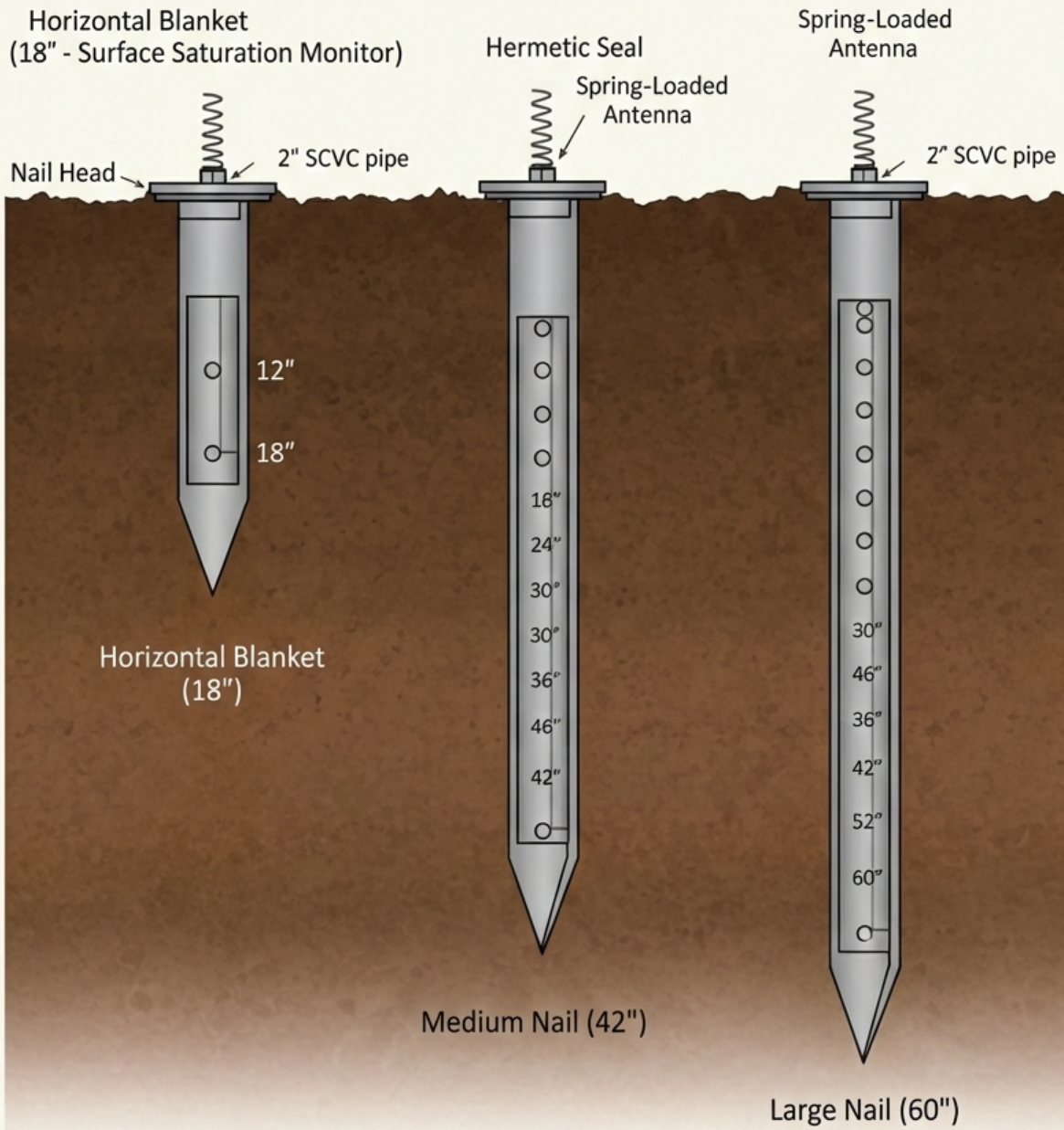The Heavy Edge sensor mesh that anchors the Court-ready proof.

Figure 2: Heavy Edge concept

Sensor Detail

A visualization of the Heavy Edge sensing tiers, focusing on the sensor-to-cloud journey.

FARMSENSE SOIL MOISTURE HARDWARE - VERTICAL STAKES

Horizontal Blanket
(18" - Surface Saturation Monitor)

Hermetic Seal

Spring-Loaded
Antenna

Spring-Loaded
Antenna

Nail Head

2" SCVC pipe

2" SCVC pipe

12"

18"

Horizontal Blanket
(18")

16"
24"
30"
30"
36"
46"
42"

Medium Nail (42")

30"
46"
36"
42"
52"
60"

Large Nail (60")

Material: 3/16" Stainless Steel
Casing: 2-inch SCH40 PVC
Lifespan: 20+ Years

Figure 3: Heavy Edge sensor detail

THE PROBLEM: WATER COURT REALITY

The Subdistrict 1 Water Plan mandates **15% pumping reduction across 520,000 acres**. Current solutions rely on:

- Water balance estimates that cannot survive legal cross-examination
- Monthly soil sampling that misses real-time variability
- Satellite-only monitoring without ground truth validation

Result: Defensive "insurance pumping" that wastes water, energy, and money while failing to demonstrate compliance.

THE SOLUTION: DETERMINISTIC FARMING OS

FarmSense replaces estimates with physical residuals using a "Heavy Edge" sensor network. Each Jetson Nano is paired with one gateway hub (LoRa + 5GHz mesh) to keep the field-level compute connected, so that per-field hardware budget includes both the Nano and its dedicated gateway.

Architecture

- Tier 1: Physical Sensors (Ground Truth)
  - Horizontal blankets: 18" sensors at 12"/18" depths
  - Master vertical nails: 42" (5-depth) or 60" (7-depth)
- Tier 2: Dynamic Soil Mapping
  - Recursive Bayesian filter learns soil texture from moisture movement
- Tier 3: Satellite Multi-Spectral
  - Sentinel-1/2 for NDVI, NDWI, and SAR radar

Pilot Specifications

Component	Value
Fields	9 (hub-and-spoke topology)
Acreage	~1,170 acres
Sensors	~108 total
- ~99 horizontal blankets (18", 2-depth)	
- 9 master vertical nails (42" OR 60")	
Measurement points	~270
Primary compute	1× NVIDIA Jetson Nano
Backup	Hosted cloud + cold spare on-site
Gateway hubs	Each Jetson Nano pairs with its own gateway hub (LoRa + 5GHz mesh), adding to per-field hardware costs
Update interval	15 minutes
Spatial resolution	1-meter virtual grid

FORENSIC-GRADE DATA INTEGRITY

Designed specifically to survive **Water Court cross-examination**:

Feature	Implementation
Hashing	SHA-256 at well-head
Signing	Cryptographic keys in hardware module
Audit trail	Immutable, timestamped logs
Storage	24 months local + hosted cloud backup
Compliance	Automated State Engineer reports

THE JUNE 29 TRIAL

Critical Timeline:

- February 14: CSU Letter of Support needed
- February 28: Grant award notification
- April 15 - May 15: Field installation
- June 1: Full operations begin
- **June 29: Water Court Trial**

The pilot must demonstrate:

1. Physical ground truth from sensor residuals
2. Automated compliance reporting without manual manipulation
3. Immutable audit trails with cryptographic verification
4. Third-party validation from CSU SLVRC

PARTNERSHIP BENEFITS

What CSU SLVRC Receives

Benefit	Detail
Data access	Open API to 1m-resolution soil moisture
Internships	2 Ag-Eng + 2 Data Science (paid)
Co-authorship	Credit on peer-reviewed papers
Verification	Direct comparison to lysimeter measurements
Research access	Real-time validation infrastructure

CSU's Commitment

Requirement	Timeline
Letter of Support	February 14, 2026
Co-location	Sensor placement near lysimeters
Validation	Comparative analysis methodology

SCALING TO REGIONAL MANDATE

Phase 2 (Fall 2026)

- 100 fields (~13,000 acres)
- ~12 Jetson Nanos, distributed architecture
- Validated cost model for full deployment

Full Mandate (2027+)

- 520,000 acres across ~4,000 fields
- ~48,000 sensors, ~110,000 measurement points
- ~445 Jetson Nanos, 30-50 gateway hubs
- **Economic impact: $25M-$50M annually**

COMPETITIVE DIFFERENTIATION

Feature	FarmSense	Traditional Solutions
Physical residuals	2-depth + 5/7-depth sensors	Satellite-only estimates
Update frequency	15 minutes	Weekly or monthly
Spatial resolution	1-meter grid	30-meter satellite pixels
Processing	Heavy Edge (on-field)	Cloud-dependent
Compliance	Automated forensic reports	Manual compilation
Failover	Triple redundancy	Single point of failure

CONTACT INFORMATION

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DEVELOPMENT SCHEDULE

- **February 2026:** Finalize pilot design and documentation
- **March 2026:** Secure CRD grant and CSU Letter of Support
- **April 2026:** Field installation and initial calibration
- **May 2026:** Full operations and data collection
- **June 2026:** Water Court Trial preparation and validation

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APPENDIX: TECHNICAL DEEP DIVE

The Bayesian Engine

FarmSense OS runs a **Recursive Bayesian Filter** on the Edge GPU:

1. **Predict:** Generate moisture state from soil map and ET data
2. **Observe:** Ingest latest sensor residuals and satellite clips
3. **Update:** Adjust local soil coefficients if error exceeds threshold

Regression Kriging

- **GPU acceleration:** CuPy for matrix operations
- **Trend variable:** Satellite data defines spatial shape
- **Hard constraints:** Physical sensor residuals anchor values
- **Output:** 1-meter virtual grid in <5 seconds

Sensor Specifications

Horizontal Blanket Sensors:

- Length: 18"
- Depths: 12" and 18"
- Coverage: 1 per 10-14 acres
- Lifespan: 20+ years
- Material: 3/16" stainless steel

Master Vertical Nails:

- **Medium (42"):** 5 depths (18", 24", 30", 36", 42") for potatoes/barley
- **Large (60"):** 7 depths (18", 24", 30", 36", 42", 52", 60") for alfalfa
- Lifespan: 20+ years
- Material: 3/16" stainless steel

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