



# Optimizing Rice Yields through Bio-Soil Amendments

A comparative study on the synergistic effects of coffee grounds and cow manure on soil fertility and crop quality in Kalasin Province.

**Institution:** Somdetpittayakom School, Thailand

**Project Level:** Junior High School Research Initiative

**Researchers:** Wattanachai Rachmontian, Chanapat Choopan, Jariya Nasathit, et al.

**Advisors:** Prakaikham Thesarin, Sasikarn Pannorat



Op

A comparative study on the effects of coffee on soil fertility in Pattani Province.



ADVISORS: P. TAKRINTHAI THESATHI, JASIRATH PANNORAT



igh

and  
initiative  
anapat Choopan,

# Project Snapshot: Bridging the Yield Gap

## The Challenge



Somdetpittayakom School's demonstration plots were underperforming due to soil degradation.

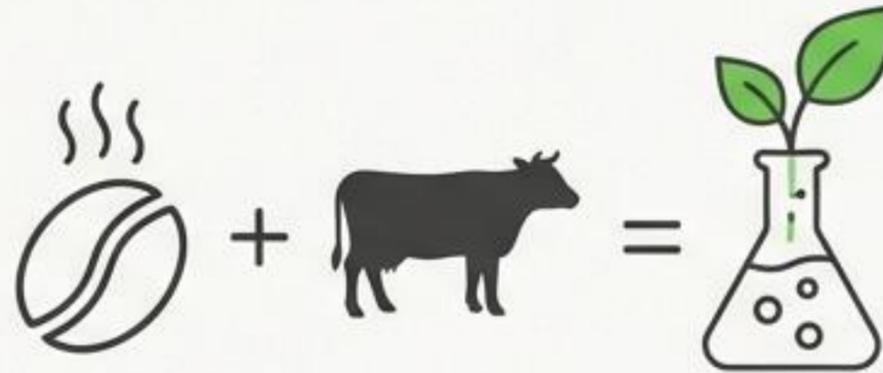
**144 kg** → **200 kg**

Previous Yield

Target

**Root Cause:** Hard texture, low nutrient profile.

## The Innovation



### Bio-Soil Synergy

**Method:** Combining organic waste (Coffee Grounds) with traditional fertilizer (Cow Manure) to create a hybrid amendment.

## The Result



**Significant Agricultural Optimization**

**30 seeds/gram**

Heavier Seeds vs 35/g Control

**Plant Height:** Increased to 189 cm average.

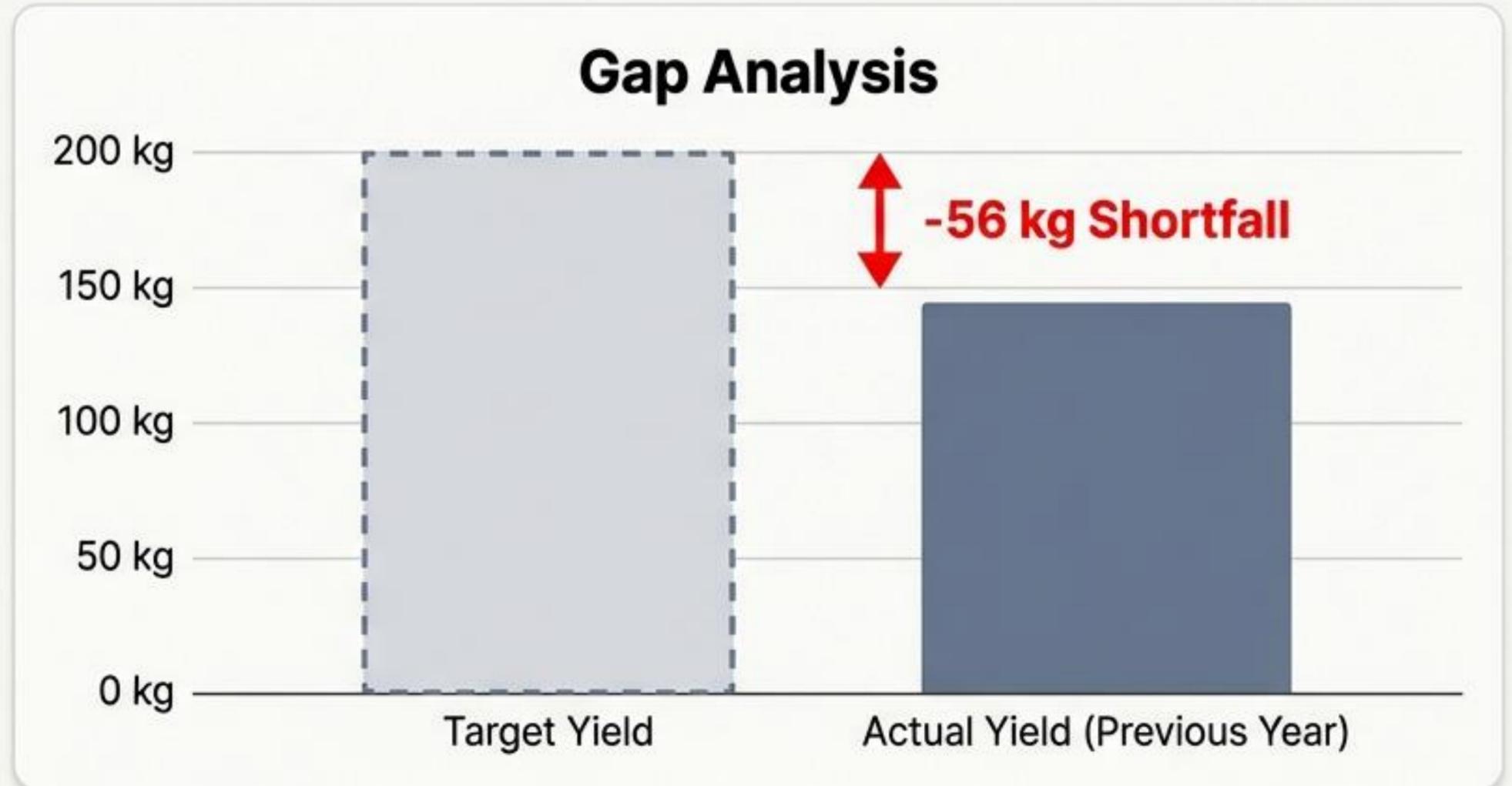
**Key Insight:** The combination of coffee grounds and cow manure outperformed both individual components, proving that physical soil restructuring is just as vital as chemical nutrient addition.

# The Baseline: Identifying Soil Degradation

Agriculture in Thailand faces a shift from subsistence to commercial farming, leading to soil degradation.

At Somdetpittayakom School, the demonstration fields (dredged from Wari Reservoir) were physically and chemically suboptimal.

Previous experiments using coffee grounds alone improved N-P-K levels but failed to close the yield gap.



## Soil Profile

- Texture: Hard, Reddish-Yellow Clay
- Chemistry: Low Nitrogen (N), Low Phosphorus (P)

# The Contenders: Coffee Grounds vs. Cow Manure

## Coffee Grounds

### The Structurer

- **Properties:** High organic matter, naturally dark color.
- **Role:** Improves soil porosity, water retention, and provides Potassium (K).



## Cow Manure

### The Accelerator

- **Properties:** Nutrient-dense organic fertilizer.
- **Role:** High Nitrogen content stimulates rapid vegetative growth (height, leaf length).

## The Hypothesis

We hypothesize that blending these two inputs will create a 'Bio-Soil' that solves both the physical hardness of the soil and the chemical nutrient deficiency, resulting in higher yields than either input used alone.

# Experimental Design: Four Isolated Micro-Climates

- **Preparation:** June 1–8, 2025 (Plowing and resting)
- **Planting:** August 4, 2025 (Transplanting RD6 sticky rice)
- **Harvest:** November 16, 2025

**Plot 1:**  
Control  
(Unmixed Soil)

**Plot 2:**  
Soil + 24kg  
Coffee Grounds

**Plot 3:**  
Soil + 24kg Cow  
Manure

**Plot 4: The Mix** ★  
(Bio-Soil: Coffee +  
Manure)

# Methodology: Rigorous Data Collection via GLOBE Protocol

To ensure accuracy, the study followed international GLOBE protocols for **soil analysis** pre- and post-cultivation.

## Physical Analysis



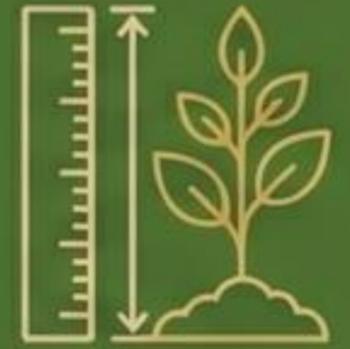
- Soil Color (Munsell Chart)
- Texture (Hand Molding)
- Temperature (Digital Thermometer at 5cm depth)

## Chemical Analysis



- pH Balance (1:1 Distilled Water Mix)
- Fertility (N-P-K Test Kits)

## Biological Analysis



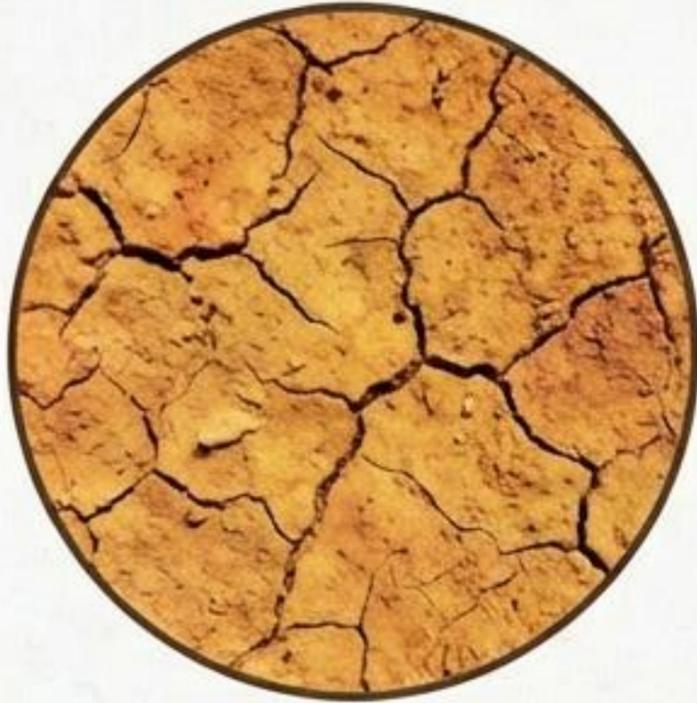
- Plant Height & Leaf Count
- Panicle Density & Seed Weight

### Key Insight:

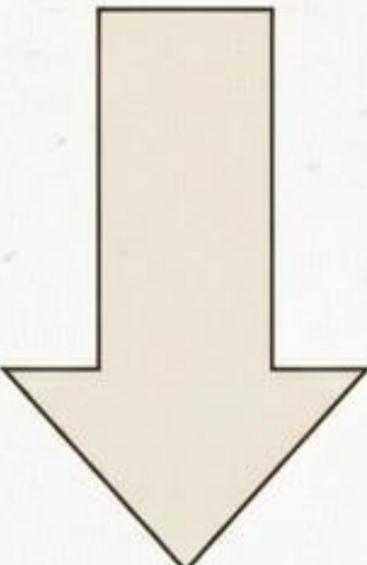
Data was recorded every 15 days throughout the cultivation period to track growth trajectories across all four plots.

# Soil Physical Analysis: Creating a Hospitable Root Environment

## Plot 1 (Control)



- Texture: Hard / Compact
- Temp: 36°C (Hot)

  
**-3°C**  
**Temperature Drop**

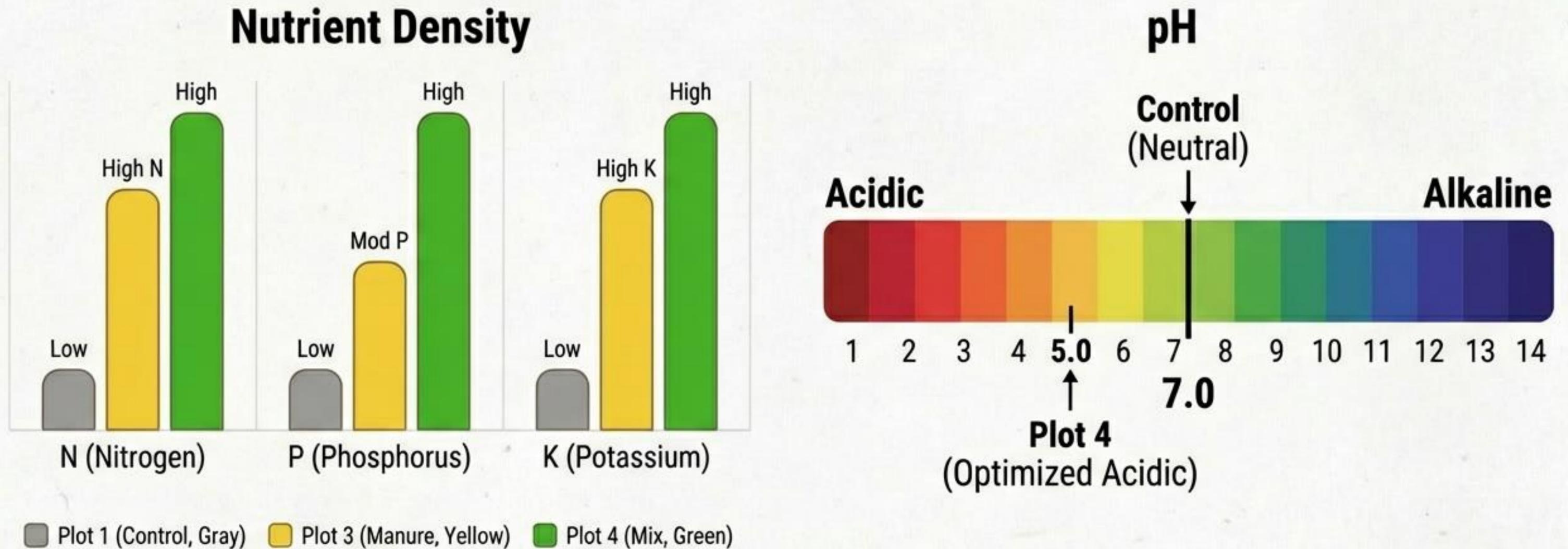
## Plot 4 (The Mix)



- Texture: Clumpy / Soft
- Temp: 33°C (Cooler)

**Analysis:** The addition of coffee grounds transformed the soil structure, allowing for better root penetration. The darker color and moisture retention created a cooler micro-climate (33°C) ideal for root uptake.

# Soil Chemical Analysis: Optimizing the Nutrient Profile



**Key Insight:** While Manure (Plot 3) provided Nitrogen, the Mix (Plot 4) achieved the highest overall nutrient density. The shift to pH 5.0 indicates an active chemical alteration by the bio-fertilizers.

# Plant Architecture: Growth Response to Bio-Soil

## Control (Plot 1) averages

Height: Lower avg

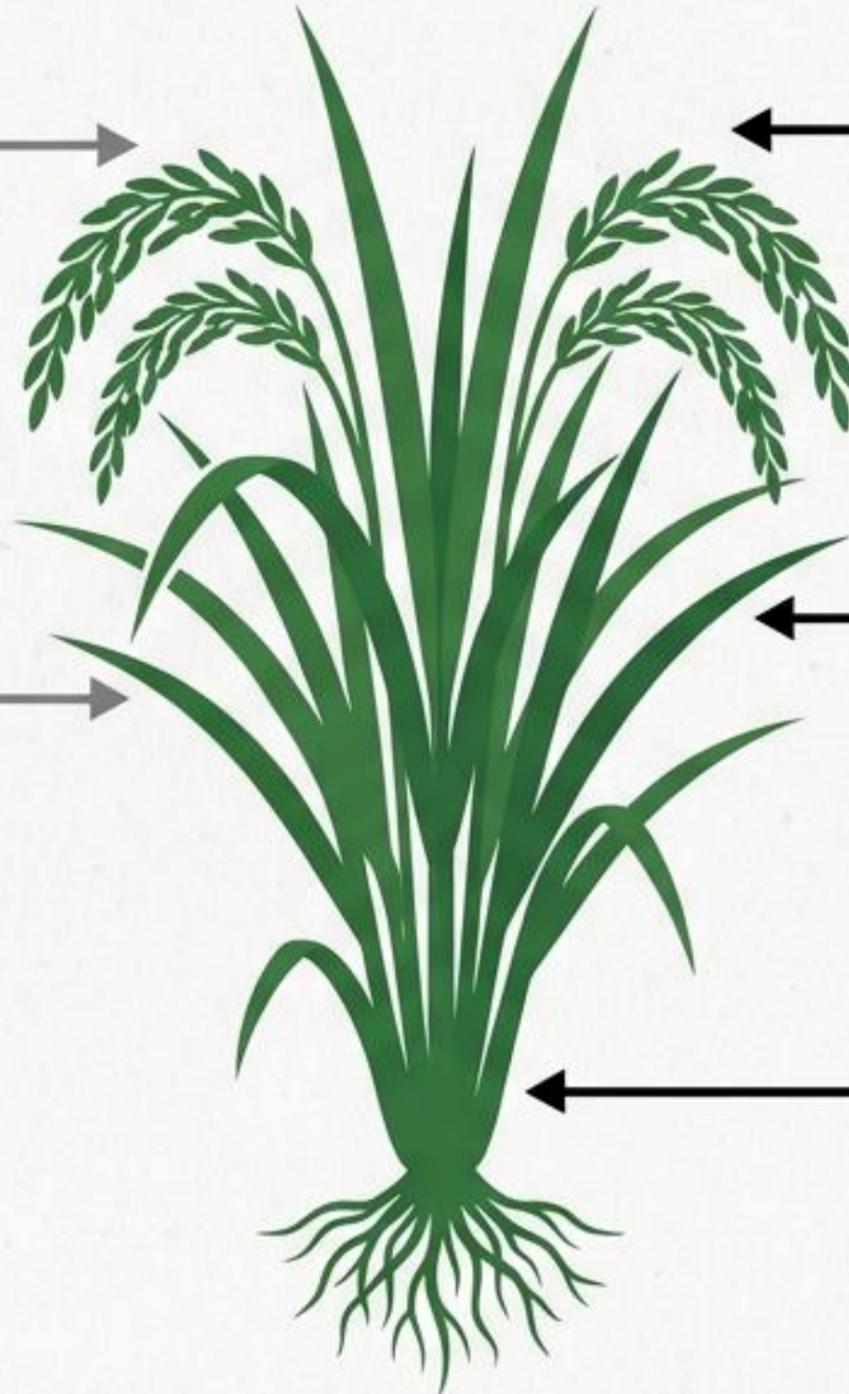
Leaf Length: Moderate

## Plot 4 (The Mix) stats

**Max Height: 189 cm**

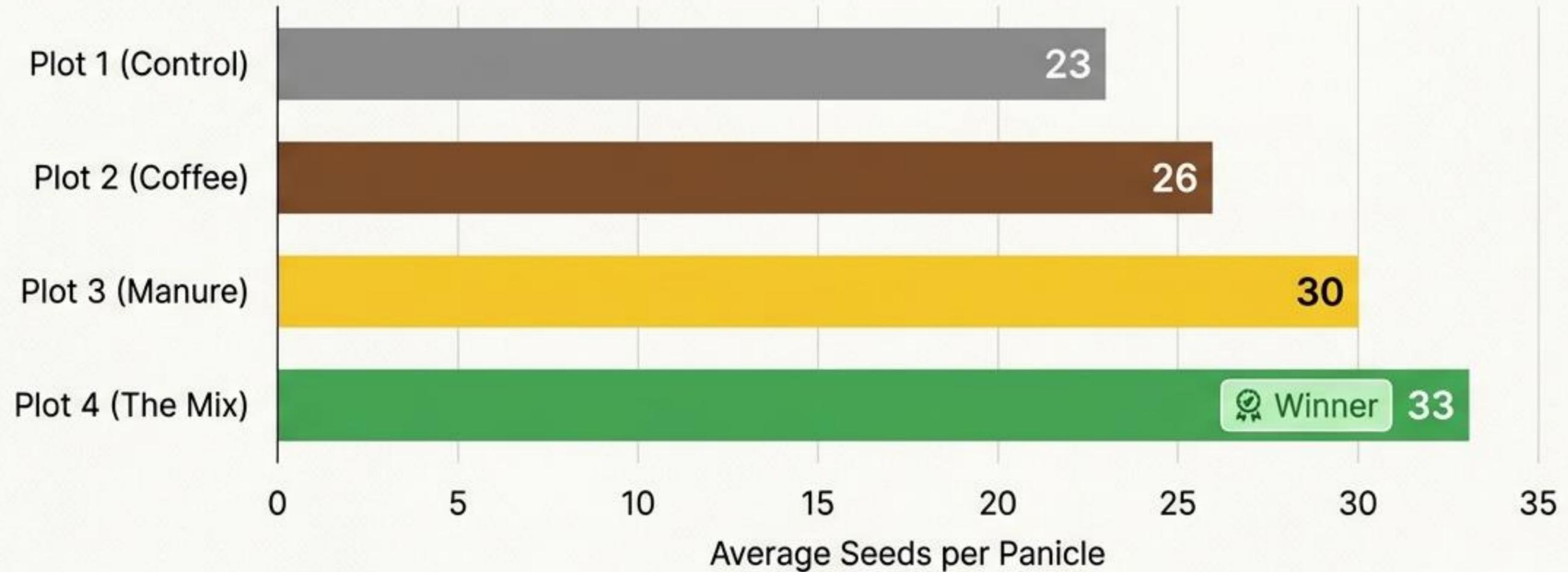
**Avg Leaf Length: 96 cm**

**Stem Circumference: 8 cm**



The high Nitrogen content from the cow manure specifically rapid vertical growth, while the coffee grounds ensured the soil structure could support this larger architecture.

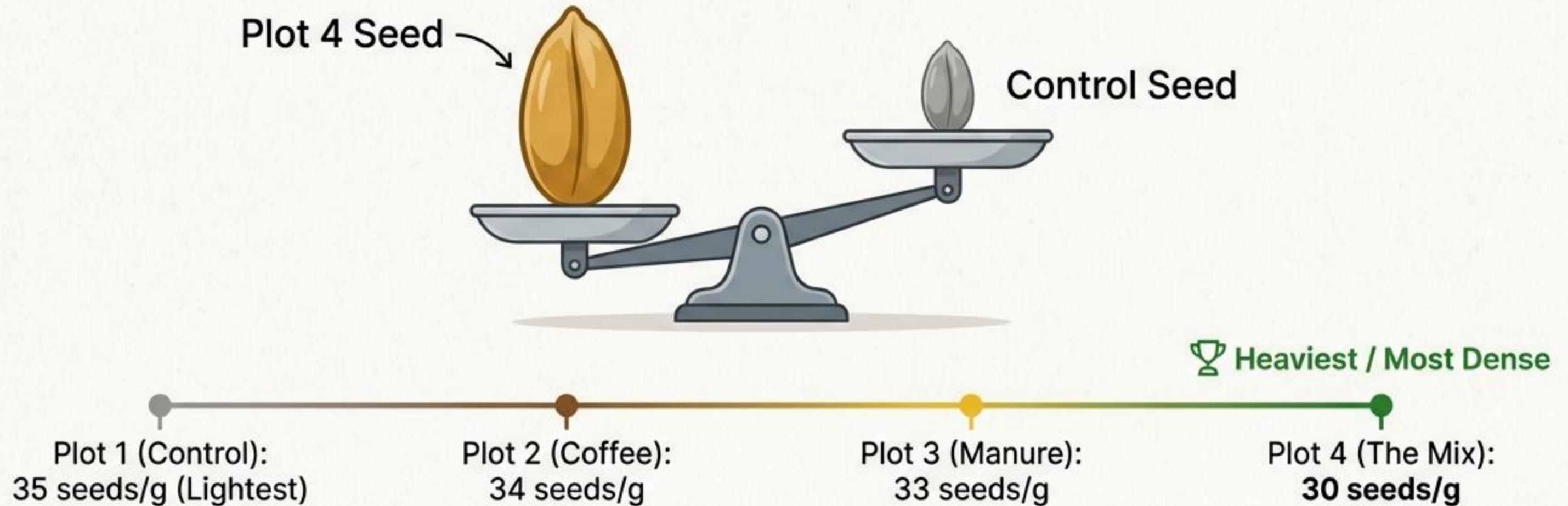
# Production Output: Increasing Seeds per Panicle



The mixture outperformed the manure-only plot by roughly **10%**, demonstrating that coffee grounds add value beyond simple fertilization.

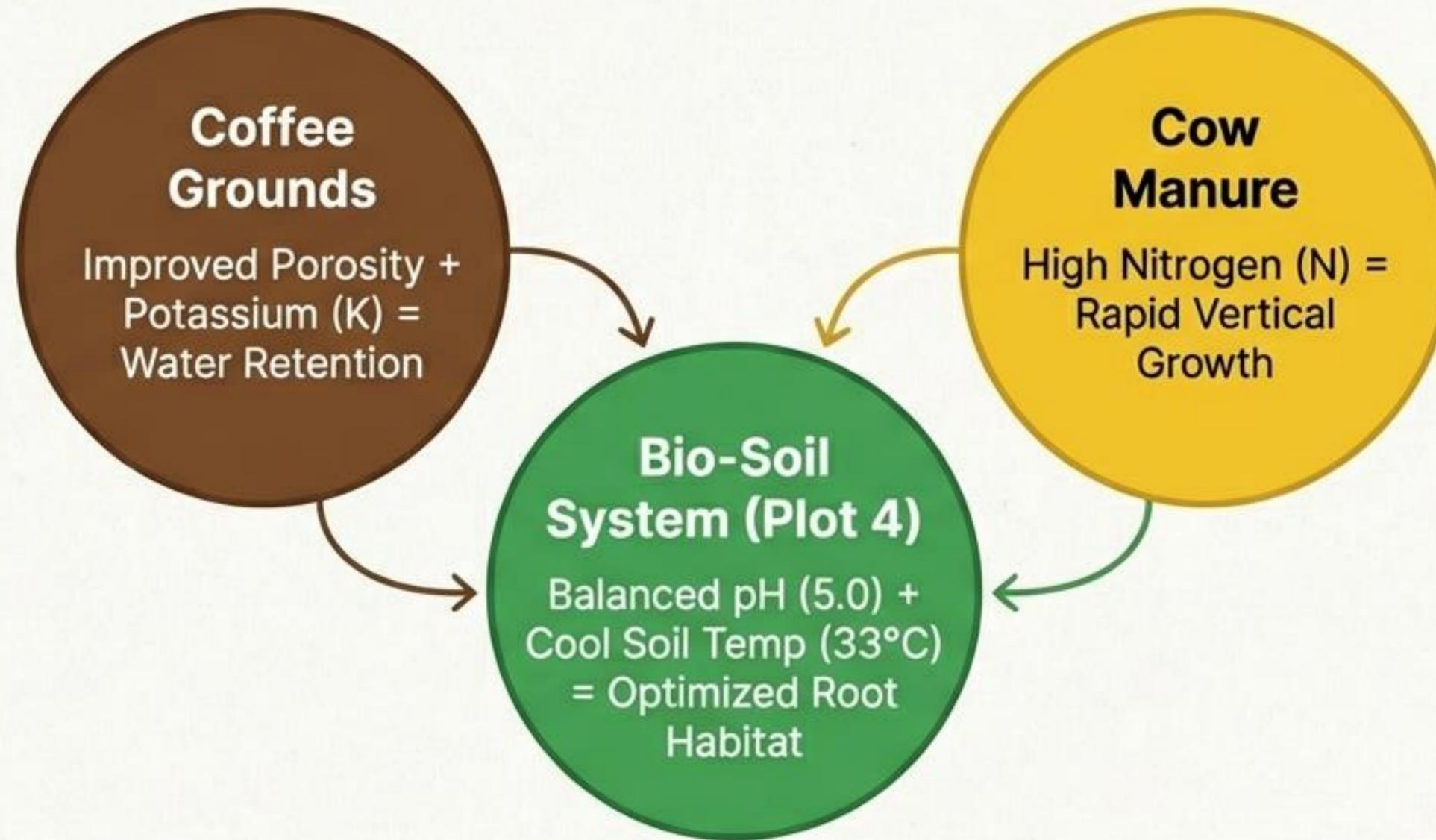
# Grain Quality: Heavier, More Nutrient-Dense Seeds

**Seed Weight Metric:** Seeds required to reach 1 gram (Fewer seeds = Heavier individual grains).



Key Insight: Plot 4 didn't just produce *more* seeds; it produced **larger** seeds. This represents a significant increase in biomass and market value.

# The Science of Synergy: Why the Mix Won



Conclusion: The 'Bio-Soil' functioned as a complete system. The coffee grounds provided the physical 'house' for the roots, while the manure provided the chemical 'food' for the plant.

# Performance Ranking & Recommendations

## 1. Plot 4 (The Mix)

Superior in every metric: Height, Yield, Weight, Soil Texture.

## 2. Plot 3 (Manure)

Good growth, but lower seed weight than the mix.

## 3. Plot 2 (Coffee)

Improved texture, but insufficient nutrients for high yield.

## 4. Plot 1 (Control)

Failed to meet yield potential.

**Recommendation:** To reach the 200–250 kg target, Somdetpittayakom School should adopt the Coffee + Manure mix for all future cultivation.

# Broader Impact: From Waste to Resource

## Environmental Impact



Repurposing coffee grounds reduces landfill usage while enhancing soil.

## Economic Impact



Reducing reliance on expensive chemical fertilizers by utilizing local waste.

## Educational Impact



Demonstrating that dredged reservoir soil can be rehabilitated via science.

# Research Team & Acknowledgments

## The Researchers

- Wattanachai Rachmontian, Chanapat Choopan, Jariya Nasathit, Warisara Lmpool
- Kritiwit Ritchai, Natthaphong Kaewmuang, Nathaporn Wutti, Ployrung Kanna
- Prakasit Jaboon, Kanyanut Sapa, Chananya Kinaseeta, Siwaporn Kaewsangsee
- Advisors: Prakaikham Thesarin, Sasikarn Pannorat

## Support & Standards



Institute for the Promotion of Teaching Science and Technology (IPST)  
GLOBE Thailand (Global Learning and Observations to Benefit the Environment)  
Somdetpittayakom School Administration