

NASA data

Core Game Mechanics & KPI Ranges

(This section would be presented to the player as a "Farmer's Field Guide" or tutorial pop-ups)

Your success in AgriSpace depends on understanding three key pieces of data from NASA's satellites. Keep this guide close, it will help you make the best decisions for your farm.

1. Primary NASA Data KPIs (Your Satellite Dashboard)

These are the live metrics from space that you must monitor and react to.

KPI	What It Measures	Critical Ranges & What They Mean
Soil Moisture (%)	Water content in the top layer of soil.	< 15%: CRITICAL (Wilting Point) - Plants are dying of thirst. 15% - 20%: STRESSED (Irrigation Trigger) - Time to water. 20% - 40%: OPTIMAL (Field Capacity) - Perfect conditions. > 40%: WATERLOGGED - Roots can't breathe; risk of rot.
NDVI (Index)	The health and density of your vegetation.	0.1 - 0.3: SPARSE/STRESSED - Crop is struggling or just sprouting. 0.3 - 0.6: MODERATE HEALTH - Growing, but monitor for stress. 0.6 - 0.8: HEALTHY & VIGOROUS - Ideal, productive crops. > 0.8: PEAK MATURITY - Ready for harvest.
Heat Index (°C)	How hot it really feels to your crops, considering temperature and humidity.	< 15°C: TOO COLD - Growth is slow. 15°C - 30°C: OPTIMAL RANGE - Normal growth. 30°C - 38°C: CAUTION/STRESS - Water demand increases significantly. > 38°C: EXTREME HEAT - Risk of severe damage and crop failure.

2. Resource Management (Your Farm's Vital Supplies)

You must manage these finite resources carefully across the entire season.

Resource	Optimal Level	Critical Low	Impact of Shortage
Water Reserve	500-800 mm	< 200 mm	Crop water stress, yield loss 30-70%
Financial Capital	\$2000-\$5000	< \$800	Limited options, forced to make poor decisions
Sustainability Score	80-100 Points	< 50 Points	Long-term soil health and farm resilience are failing

3. Feedback & Scoring (The Consequences of Your Choices)

After every major decision, you will see how your choice impacted your farm.

- **Yield Impact (%)**: The direct effect on your harvest. A positive number increases your final bounty; a negative number reduces it.
- **Sustainability Score (Points)**: Measures your environmental stewardship. Good practices (like drip irrigation, cover crops) add points. Wasteful practices (like flood irrigation, over-fertilizing) subtract points.
- **Resource Impact**: Shows the change in your Water Reserve and Financial Capital.

Your ultimate goal is to finish the season with a high Yield AND a high Sustainability Score, proving you can farm productively and responsibly.

Scenario 1: The First Sprout – Learning the Basics

Narrative Hook: "Welcome to your new farm! It's early in the season, and your newly planted corn is just sprouting. Let's learn how to read the land using NASA's eyes in the sky. Your first task is a simple irrigation decision."

Pre-Decision Dashboard:

- Soil Moisture: 18% (Approaching "Early Warning" drought stage)
- NDVI: 0.2 ("Early growth stage" - Sparse crops)
- Heat Index: 26°C ("Optimal Range")
- Water Reserve: 200 mm (Below "Optimal Level")
- NASA Data Insight: "SMAP data shows your topsoil is drying out. While the plants are small, consistent moisture is key for strong roots. The management threshold for irrigation is around 15-20% for your soil type."

Decision Point: *How will you water your young crop?*

1. Flood Irrigation (Use 150 mm of water)
2. Drip Irrigation (Use 50 mm of water)
3. Wait for Rain (Use 0 mm of water)

Consequences & Learning:

- Choice 1 (Flood): Yield +5%, Sustainability -20, Water Reserve now at 50 mm (Critical!). *Feedback: "You saved the crop but wasted a huge amount of water to evaporation and runoff. This is not sustainable, especially with low reserves."*
- Choice 2 (Drip): Yield +8%, Sustainability +15, Water Reserve now at 150 mm. *Feedback: "Excellent! You provided precise water to the roots efficiently. NASA's soil moisture data helped you make a water-smart choice."*
- Choice 3 (Wait): Yield -15%, Sustainability -5. *Feedback: "The stress was too much for the young plants. NASA's early warning data is there to be used—proactive decisions are better than reactive ones."*

Scenario Goal: Teach the fundamental connection between Soil Moisture data and irrigation efficiency.

Scenario 2: The Heatwave – Managing Compound Stress

Narrative Hook: "Your corn is now knee-high and looking good. But a sudden heatwave is forecasted. This changes everything. Heat dramatically increases water demand. Let's check the new data."

Pre-Decision Dashboard:

- Soil Moisture: 28% ("Optimal")
- NDVI: 0.55 ("Normal crop development")

- Heat Index: 39°C ("Very Hot / Severe Stress")
- Water Reserve: 150 mm (Carried over from last decision)
- NASA Data Insight: "MODIS Land Surface Temperature shows extreme heat. At 39°C, water demand doubles. Your good soil moisture will vanish quickly without action. NDVI is still healthy, meaning you can save the yield."

Decision Point: *How will you protect your crop from the heat?*

1. Run Overhead Sprinklers (Cost: 100 mm water; Effect: Cools air by 2°C)
2. Apply Mulch & Use Drip Irrigation (Cost: 60 mm water + \$50; Effect: Reduces soil evaporation)
3. Do Nothing (Hope the heat breaks)

Consequences & Learning:

- Choice 1 (Sprinklers): Yield +5%, Sustainability -25, Water Reserve now at 50 mm (Critical!). *Feedback: "The immediate cooling helped, but evaporative loss was extremely high. You've put your farm at severe risk if the drought continues."*
- Choice 2 (Mulch & Drip): Yield +10%, Sustainability +20, Water Reserve now at 90 mm. *Feedback: "Smart! The mulch conserved soil moisture, and drip irrigation delivered water efficiently. You managed both heat and water stress like a pro."*
- Choice 3 (Nothing): Yield -30%, Sustainability -15. *Feedback: "The heat caused severe wilting and flower drop. Combining NASA's heat index with soil moisture data is key to anticipating crises."*

Scenario Goal: Introduce Heat Index data and teach management of compound stresses (heat + water demand).

Scenario 3: The Crossroads – Strategic Crop Selection

Narrative Hook: "The season is halfway through, and your resources are low. The long-range forecast is for continued heat and dry spells. The corn you planted is struggling. It's time to make a strategic decision for your next planting."

Pre-Decision Dashboard:

- Soil Moisture: 14% ("Mild Drought")
- NDVI: 0.3 ("Mild stress possible" - Your current corn is struggling)
- Heat Index: 34°C ("Warm/Caution")
- Financial Capital: \$800 (At "Critical Low Threshold")
- NASA Data Insight: "Crop-CASMA's combined soil moisture and vegetation index confirms a developing drought. Your current water-intensive crop is not suited for these conditions. Consider switching to a drought-resistant variety."

Decision Point: *What will you plant for the next season?*

1. Stick with Corn (Hope for the best)
2. Switch to Sorghum (A drought-resistant crop)
3. Plant a quick-harvest vegetable (To generate quick cash)

Consequences & Learning:

- Choice 1 (Corn): Yield -40%, Sustainability -30, Financial Capital -\$200. *Feedback: "A poor match. The high water demand of corn led to failure in these drought conditions."*
- Choice 2 (Sorghum): Yield +0% (modest but secure), Sustainability +25, Financial Capital +\$100. *Feedback: "The perfect choice! Sorghum is thriving with less water. You've used NASA data to build climate resilience."*
- Choice 3 (Vegetable): Yield -10% (some loss from heat), Sustainability +5, Financial Capital +\$300. *Feedback: "A risky but financially savvy move. The quick cash helps, but it's not a long-term solution for soil health."*

Scenario Goal: Teach the strategic use of environmental data for long-term crop selection, introducing the Resource Management mechanic.

Scenario 4: The Deluge – Post-Flood Recovery

Narrative Hook: "A surprise thunderstorm dumped a month's worth of rain in one night. Your fields are waterlogged. The oxygen has been pushed out of the soil, and your plants are drowning. Recovery is now the priority."

Pre-Decision Dashboard:

- Soil Moisture: 48% ("Waterlogged" - far above field capacity)
- NDVI: 0.1 ("Very sparse vegetation" - Plants are dying)
- Heat Index: 22°C ("Optimal" - but too cool for drying)
- Financial Capital: \$900 (Carried over)
- NASA Data Insight: "GPM precipitation data confirms the extreme rainfall. SMAP shows saturated topsoil. The primary challenge now is drainage and soil aeration to prevent root rot."

Decision Point: *How will you manage the flood recovery?*

1. Install Drainage Pipes (Cost: \$400; Effect: Fast soil drying)
2. Plant a Cover Crop (Cost: \$100; Effect: Slow soil improvement, long-term benefit)
3. Apply Nitrogen Fertilizer (Cost: \$150; Try to boost recovery)

Consequences & Learning:

- Choice 1 (Drainage): Yield +15% (for the next crop), Sustainability +10, Financial Capital now \$500. *Feedback: "A costly but effective engineering solution. You've quickly restored field conditions."*

- Choice 2 (Cover Crop): Yield +0% (this season), Sustainability +25, Financial Capital now \$800. *Feedback: "A brilliant long-term choice! The cover crop's roots will aerate the soil and improve its structure for years to come."*
- Choice 3 (Fertilizer): Yield -10%, Sustainability -30, Financial Capital now \$750. *Feedback: "Oh no! On waterlogged soil, the fertilizer washed away (leaching), polluting groundwater and wasting your money."*

Scenario Goal: Introduce post-disaster recovery and the concept that sometimes the best action has long-term benefits rather than short-term yield.

Scenario 5: The Final Harvest – Balancing Act

Narrative Hook: "This is it. The final stretch before harvest. You're facing a combination of challenges: lingering dry soil, fluctuating temperatures, and your resources are stretched thin. Your ability to balance everything you've learned will determine your final success."

Pre-Decision Dashboard:

- Soil Moisture: 16% ("Early Warning")
- NDVI: 0.45 ("Normal/Slight stress")
- Heat Index: 36°C ("Hot/Stress Begins")
- Water Reserve: 120 mm (Critical Low)
- Financial Capital: \$800
- Sustainability Score: [Carried over from previous scenarios]
- NASA Data Insight: "All indicators are flashing yellow. The crop is slightly stressed but salvageable. This is a classic end-of-season balancing act between using your last resources for a final yield push or conserving them for the future."

Decision Point: *How will you manage your final pre-harvest week?*

1. Final Irrigation Push (Use all 120 mm water; go for max yield)
2. Minimal Intervention (Use 40 mm water; conserve resources)
3. Sell Water Rights (Sell 80 mm water for \$400; sacrifice some yield for cash)

Consequences & Learning:

- Choice 1 (Push): Yield +20%, Sustainability -20, Water Reserve now 0 mm. *Feedback: "You maximized yield but left your farm with no water security for the future. A risky, short-sighted victory."*
- Choice 2 (Conserve): Yield +5%, Sustainability +15, Water Reserve now 80 mm. *Feedback: "A sustainable choice. You secured a decent harvest while preserving your farm's ability to bounce back next season."*
- Choice 3 (Sell): Yield -5%, Sustainability +0, Financial Capital +\$1200. *Feedback: "A strategic financial decision. The cash injection provides flexibility for next year's investments, though you sacrificed a bit of yield."*

Finale: The game concludes with a "Farmers Report Card", summarizing the player's total Yield, final Sustainability Score, and Resource Health. It breaks down how their decisions in each interconnected scenario led to this final outcome, explicitly linking their choices to the use of NASA EO data.

Professional Description

Core Game Mechanics & KPI Ranges

(Farmer's Field Guide – Satellite Dashboard & Tutorial)

Your success in **Farm Navigation** depends on understanding key Earth observation data provided by NASA satellites. Keep this guide handy – it will help you make informed, sustainable decisions for your farm.

1. Primary NASA Data KPIs (Satellite Dashboard)

KPI	What It Measures	Critical Ranges & Interpretation
Surface Soil Moisture (%)	Water content in the topsoil (0–5 cm).	< 15%: CRITICAL – Plants near wilting point. 15–20%: STRESSED – Irrigation needed. 20–35%: OPTIMAL – Good field capacity. > 35%: WATERLOGGED – Oxygen deprivation, root rot risk.
Root-Zone Soil Moisture (%)	Moisture availability within the crop's root depth (0–30 cm).	< 12%: CRITICAL deficit. 12–20%: Moderately stressed. 20–30%: Healthy. > 30%: Oversaturated.
NDVI (Normalized Difference Vegetation Index)	Vegetation health & density (photosynthetic activity).	< 0.1: Bare or non-vegetated. 0.1–0.3: Sparse/weak growth. 0.3–0.6: Moderate vegetation. 0.6–0.8: Healthy crops. > 0.8: Peak maturity / dense canopy.
Vegetation Optical Depth (VOD)	Plant biomass & water content (from microwave data e.g. SMAP).	Low: Sparse/dry vegetation. Medium: Normal crop conditions. High: Dense, well-hydrated vegetation.
Land Surface Temperature / Heat Index (°C)	How hot it feels to crops (temperature + humidity).	< 15°C: TOO COLD – Growth slowed. 15–30°C: OPTIMAL. 30–38°C: HIGH DEMAND – Heat stress likely. > 38°C: EXTREME STRESS – Severe crop damage risk.
Evapotranspiration (ET)	Combined soil evaporation + plant transpiration.	ET > rainfall/irrigation: Water deficit. ET ≤ inputs: Sustainable balance.

Precipitation (mm)	Actual rainfall input from satellite precipitation products (e.g. GPM).	Low: Drought risk. Excess: Flooding, waterlogging.
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2. Resource Management (Farm Vital Resources)

Resource	Optimal Range	Critical Threshold	Shortage Impact
Water Reserve	300–700 mm	< 100 mm	Severe crop water stress, yield loss 30–70%.
Financial Capital	\$2,000–\$5,000	< \$500	Limited options, forced risky decisions.
Sustainability Score	80–100 points	< 50 points	Soil degradation, poor long-term resilience.
Soil Health Index	0.7–1.0	< 0.4	Reduced fertility, erosion, declining productivity.
Nutrient Reserve	Balanced seasonal NPK	Major deficit or excess	Deficit: stunted crops. Excess: runoff & pollution.
Equipment Durability	≥ 80%	< 40%	Failures, costly repairs, farming delays.

3. Feedback & Scoring

Every decision provides immediate feedback:

- **Yield Impact (%)** – Effect on harvest output.
- **Sustainability Score (points)** – Rewards environmentally responsible actions.
- **Resource Impact** – Updates to water reserve, financial capital, and soil health.
- **Risk Level Indicator** – Alerts when satellite data signals upcoming stress.

Your ultimate goal: **finish the season with both high Yield and a strong Sustainability Score.**

Scenario Design Examples

Scenario 1: The First Sprout – Irrigation Basics

Narrative: “Your corn seedlings just emerged. NASA satellite data shows your topsoil is drying out. A first irrigation decision awaits.”

- **Dashboard:**
 - Surface Soil Moisture: 16% (Near stress threshold)
 - Root-Zone Moisture: 12%
 - NDVI: 0.18 (Sparse growth)
 - Heat Index: 24°C (Optimal)
 - Water Reserve: 200 mm
- **Choices:**
 - Flood Irrigation (120 mm)
 - Drip Irrigation (50 mm)
 - Wait for Rain (0 mm)
- **Consequences:**
 - Flood: Yield +4%, Sustainability –15, Water Reserve 80 mm.
 - Drip: Yield +6%, Sustainability +10, Water Reserve 150 mm.
 - Wait: Yield –12%, Sustainability –5.

Learning Goal: Link soil moisture data to smart irrigation.

Scenario 2: The Heatwave – Compound Stress

Narrative: “A sudden heatwave strikes. Water demand skyrockets. Can you protect your crops wisely?”

- **Dashboard:**

- Soil Moisture: 30%
- NDVI: 0.55
- Heat Index: 37°C (High stress)
- Water Reserve: 150 mm

- **Choices:**

- Overhead Sprinklers (90 mm water)
- Mulching + Drip (60 mm water + \$60)
- Do Nothing

- **Consequences:**

- Sprinklers: Yield +5%, Sustainability –20, Reserve 60 mm.
- Mulch + Drip: Yield +8%, Sustainability +15, Reserve 90 mm.
- Nothing: Yield –25%, Sustainability –10.

Learning Goal: Show how heat + water stress interact.

Scenario 3: Strategic Crop Choice

Narrative: “Mid-season drought is worsening. Your resources are low. Time to choose your next crop.”

- **Dashboard:**

- Soil Moisture: 14%
- NDVI: 0.32
- Heat Index: 33°C
- Capital: \$800

- **Choices:**

- Continue with Corn
- Switch to Sorghum (drought-resistant)
- Plant Fast-Harvest Vegetables
- **Consequences:**
 - Corn: Yield –35%, Sustainability –25, Capital –\$100.
 - Sorghum: Stable Yield, Sustainability +20, Capital +\$50.
 - Vegetables: Yield –10%, Sustainability +5, Capital +200.

Learning Goal: Teach adaptive crop selection with NASA drought insights.

Scenario 4: The Flood – Post-Rain Recovery

Narrative: “An extreme storm waterlogged your fields. Recovery strategy is key.”

- **Dashboard:**
 - Soil Moisture: 45% (Oversaturated)
 - NDVI: 0.15 (Severe stress)
 - Heat Index: 22°C
 - Capital: \$900
- **Choices:**
 - Install Drainage (\$400)
 - Plant Cover Crop (\$100)
 - Apply Nitrogen Fertilizer (\$150)
- **Consequences:**
 - Drainage: Yield +12% (next crop), Sustainability +8, Capital \$500.
 - Cover Crop: Yield 0%, Sustainability +20, Capital \$800.

- Fertilizer: Yield –15%, Sustainability –20, Capital \$750.

Learning Goal: Long-term vs short-term recovery trade-offs.

Scenario 5: The Final Harvest – The Balancing Act

Narrative: “It’s the end of the season. Soil is dry, temperatures unstable, and resources scarce. Every move counts.”

- **Dashboard:**

- Soil Moisture: 17% (Warning)
- NDVI: 0.48
- Heat Index: 36°C
- Water Reserve: 120 mm
- Capital: \$800

- **Choices:**

- Final Irrigation Push (use all 120 mm)
- Minimal Intervention (40 mm)
- Sell Water Rights (80 mm → +\$400)

- **Consequences:**

- Push: Yield +18%, Sustainability –20, Reserve 0.
- Conserve: Yield +6%, Sustainability +12, Reserve 80.
- Sell: Yield –5%, Capital +1200, Sustainability stable.

Learning Goal: Teach balance between maximizing yield vs ensuring future resilience.

Search results

AgriSpace – Game Design Document (GDD)

1. Game Overview

Title: AgriSpace – Farming with NASA's Eyes in the Sky

Genre: Serious Game / Simulation

Platform: Web & Mobile (cross-platform)

Audience: Students, young professionals, and farmers interested in climate-smart agriculture.

Core Vision: Teach sustainable farming by leveraging **real NASA satellite data** on soil, vegetation, and weather to make informed agricultural decisions.

2. Core Game Mechanics

The gameplay is built around **data-driven decision-making**, where the player uses live-like KPIs from NASA EO datasets to manage their farm.

- Satellite Dashboard** – Player monitors key indicators updated each turn.
 - Decision Points** – Player chooses farming actions (e.g., irrigation, planting, fertilization).
 - Resource Management** – Limited water, money, and soil health must be balanced.
 - Feedback System** – Every action updates yield, sustainability, and future resilience.
 - Scenario Progression** – The game unfolds across sequential challenges (seasonal events).
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3. NASA Data KPIs (Key Performance Indicators)

(Powered by real EO data ranges from NASA missions such as SMAP, MODIS, Landsat, and GPM)

KPI	Source	What It Measures	Key Ranges & Meaning
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Soil Moisture (% Volumetric Water Content)	SMAP (Soil Moisture Active Passive)	Water content in the top 5 cm of soil	< 10%: Drought risk; 10–20%: Stressed; 20–35%: Optimal; > 35%: Waterlogged
NDVI (Normalized Difference Vegetation Index)	MODIS / Landsat	Crop health & biomass	0.1–0.3: Sparse; 0.3–0.6: Moderate growth; 0.6–0.8: Healthy; > 0.8: Peak productivity
LST / Heat Index (°C)	MODIS LST	Land surface temperature (crop stress)	< 15°C: Too cold; 15–30°C: Optimal; 30–37°C: Heat stress; > 37°C: Critical
Precipitation (mm/day)	GPM (Global Precipitation Measurement)	Rainfall over fields	< 2 mm: Dry; 2–5 mm: Moderate; > 5 mm: Flood risk

4. Resource Management System

Resource	Optimal Level	Critical Low	Gameplay Impact
Water Reserve	400–600 mm/season	< 150 mm	Reduced irrigation capacity → yield loss up to 60%
Financial Capital	\$2000–\$5000	< \$800	Limits ability to buy tech & recovery tools
Soil Health (Sustainability Score)	80–100 pts	< 50 pts	Impacts long-term productivity & resilience

5. Feedback & Scoring

Every decision affects **three scores**:

- **Yield Impact (%)**: Determines harvest success.
- **Sustainability Score (0–100)**: Rewards eco-friendly practices.
- **Resource Balance**: Tracks remaining water, finances, and soil condition.

End of game: Player receives a **Farmer's Report Card** with:

- **Final Yield**
 - **Sustainability Score**
 - **Resilience Rating** (long-term farm health).
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6. Gameplay Scenarios (Step-by-Step)

Scenario 1: Early Growth – Water Decisions

- **Dashboard:** Soil Moisture = 14% (stressed), NDVI = 0.2 (sprouting), Heat Index = 25°C, Water Reserve = 300 mm.
 - **NASA Insight:** “SMAP indicates soil moisture is approaching stress threshold. Early irrigation is critical.”
 - **Choices:**
 1. Flood Irrigation (uses 120 mm water) → Yield +5%, Sustainability -15
 2. Drip Irrigation (uses 40 mm water) → Yield +10%, Sustainability +20
 3. Wait for Rain → Yield -15%, Sustainability -5
 - **Goal:** Teach soil moisture–irrigation link.
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Scenario 2: Heatwave Shock

- **Dashboard:** Soil Moisture = 28%, NDVI = 0.55, Heat Index = 39°C, Water Reserve = 160 mm.
- **NASA Insight:** “MODIS LST shows extreme heat. Water demand is doubled.”
- **Choices:**
 1. Overhead Sprinklers (100 mm water) → Yield +7%, Sustainability -20
 2. Mulching + Drip (60 mm water + \$80) → Yield +12%, Sustainability +15
 3. Do Nothing → Yield -25%, Sustainability -10
- **Goal:** Combine Heat Index + Soil Moisture for compound stress management.

Scenario 3: Crop Choice under Drought

- **Dashboard:** Soil Moisture = 12%, NDVI = 0.3, Heat Index = 34°C, Capital = \$700.
- **NASA Insight:** “Crop-CASMA drought monitor shows prolonged stress. Choose wisely.”
- **Choices:**
 1. Replant Corn (high risk, high water demand) → Yield -30%
 2. Plant Sorghum (drought-resistant) → Yield +5%, Sustainability +20
 3. Plant Short-cycle Vegetables (cash crop) → Yield 0%, Capital +\$200
- **Goal:** Teach adaptation through crop selection.

Scenario 4: Flood Event

- **Dashboard:** Soil Moisture = 45%, NDVI = 0.15, Precipitation = 60 mm in 24h.
- **NASA Insight:** “GPM confirms heavy rainfall. SMAP indicates waterlogged soil.”
- **Choices:**
 1. Install Drainage (\$400) → Yield +10%, Sustainability +15
 2. Cover Crops (\$120) → Yield +0%, Sustainability +25
 3. Fertilizer Boost (\$150) → Yield -10%, Sustainability -20
- **Goal:** Show post-disaster recovery trade-offs.

Scenario 5: Final Harvest Balance

- **Dashboard:** Soil Moisture = 16%, NDVI = 0.45, Heat Index = 36°C, Water Reserve = 100 mm, Capital = \$900.
- **NASA Insight:** “All indicators at caution levels. Balance yield vs sustainability.”

- **Choices:**

1. Full Irrigation Push (use 100 mm) → Yield +20%, Sustainability -20
2. Minimal Irrigation (use 40 mm) → Yield +8%, Sustainability +10
3. Sell Water Rights (sell 60 mm for \$300) → Yield -5%, Capital +\$300

- **Goal:** Teach final resource balancing & long-term thinking.
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7. Finale & Player Learning

At the end of the season, the game summarizes:

- **Total Yield (% of maximum potential)**
- **Final Sustainability Score (0–100)**
- **Farm Resilience Rating** (based on soil & resource health)

Players clearly see how **NASA EO data + their decisions** shaped both immediate yield and long-term farm sustainability.