

SmartFarm™ GROW LIGHT System

SmartFarm™ LED Grow Light System

SmartFarm™ LED Grow Light System is set up perfectly for school use. On wheels, it can demonstrate growing plants with LED lights from classroom to classroom. Each light blue, red, and white can be dialed up or down with a digital meter on the side of the device letting students test and learn which combinations work the best.

SmartFarm™ LED Grow Light System allows for countless experiments using the scientific method ranging from comparing plant growth under the Grow Light versus using sunlight to soil testing and experimenting to find just the right “light recipe” for your plant. Any classroom that deals with interdependent relationships in ecosystems would benefit from using Grow Light for hands-on science inquiry.

The most unique feature of the HamiltonBuhl® SmartFarm™ LED Grow Light System is the ability to select the wavelength regions presented to your plant during the stages of growth. Three knobs allow the user to select lighting settings in blue, full spectrum white, and red. Features of a plant can change depending on the light spectrum used at a given time during the growing stages. The SmartFarm™ LED Grow Light System allows you to experiment with many spectrums of light, or just use as a high bright LED grow light.

Standards Addressed with SmartFarm™ LED Grow Light System

Next Generation Science Standards

- ☐ Interdependent Relationships in Ecosystems K, 2, 3, MS, HS
- ☐ Weather and Climate. K, 3, MS, HS
- ☐ Waves 1, 4, MS
- ☐ Matter and Energy in Organisms and Ecosystems 5, MS, HS
- ☐ Human Impacts MS
- ☐ Human Sustainability HS
- ☐ Engineering Design K-2, 3-5, MS, HS

Common Core State Standards (CCSS) Math

- ☐ Common Core State Standards (CCSS) Math
- ☐ Measurement and Data K, 1, 2, 3, 4, 5
- ☐ Expressions and Equations 6, 7, 8
- ☐ Algebra HS
- ☐ Mathematical Modeling All Grades

ISTE

Knowledge Constructor
Innovative Designer
Computational Thinker

(CCSS) English Language Arts

- ☐ Writing: Research to Build and Present KnowledgeAll Grades
- ☐ Speaking and Listening: Comprehension and CollaborationAll Grades
- ☐ Speaking and Listening: Presentation of Knowledge and IdeasAll Grades



Growing Plants in the Classroom with LED GrowLight™ . . . Elementary [Page 3](#)

1. Planting Seeds
2. Controls versus Variables
3. Watch them Grow

The Scientific Method and LED GrowLight™ . . . Middle School [Page 7](#)

1. Steps of the Scientific Method
2. Create a Plant Growth Experiment
3. Communicate the Results

Scientific Inquiry with LED GrowLight™ . . . High School [Page 11](#)

1. What is scientific inquiry?
2. Designing an Experiment
3. Implementation and Communication

Growing for Social and Economic Sustainability . . . All Grades [Page 17](#)

1. "Rock and Wrap It Up"
2. Opportunities for increasing social impact
3. Decreasing carbon footprint

Additional Lesson Plans . . . Ages 9+ [Page 18](#)

Growing Plants with SmartFarm™ LED Grow Light System

Topic: Planting Seeds to Watch them Grow	Grade Level: K-4	Estimated Unit Time: One Semester	HB Tools Integrated: <ul style="list-style-type: none"> SmartFarm™ LED Grow Light System
Unit Objectives <ul style="list-style-type: none"> ... to understand the relationship between light, soil, seeds, and water ... to compare plant seeds grown in different conditions ... to chart the growth of plants in a table ... to log the growth of plants in a journal 			Subjects Integrated: <ul style="list-style-type: none"> Science Technology Engineering Art Mathematics
Materials <ul style="list-style-type: none"> SmartFarm™ LED Grow Light System Plant seeds, soil, water Ruler Camera or markers/colored pencils 			ISTE Standards met: <ul style="list-style-type: none"> Knowledge Constructor Innovative Designer Computational Thinker
Vocabulary <p>Organism: Any living thing. (ex. person, cat, strawberry plant)</p> <p>Plant: Living thing that uses energy from the sun to make its own food. (ex. oak tree, seaweed, rose, grass)</p> <p>Mineral: A non-living material found on earth. It is not an animal or a plant. It has properties such as hardness, color and texture. (ex. chalk, clay, diamonds, rocks, gold)</p> <p>Compost: Decomposed (broken down, rotted) organisms (plant and animal) that are used to make soil better for plants.</p> <p>Decompose: Decay, rot or break down into small pieces. (ex. Worms help decompose organisms into compost)</p> <p>Organic Matter: Material that comes from something that was once alive. (ex. Decayed leaves, dead animals and rotting plants). Compost is made up of organic matter.</p> <p>Soil: Mixture of minerals, organic matter, air and water. We also call it dirt.</p> <p>Control: A subject that has not been changed by an independent variable used as comparison for checking the results of an experiment.</p> <p>Variable: What the scientist changes in each trial. Also called an "independent variable."</p>			Next Gen Science Standards met: <ul style="list-style-type: none"> K-2 Engineering Design 3-5 Engineering Design Interdependent Relationships in Ecosystems [K, 2, 3, MS, HS] Weather and Climate [K, 3, MS, HS] Common Core State Standards (CCSS) Math: <ul style="list-style-type: none"> Measurement and Data [K, 1, 2, 3, 4, 5] English Language Arts (CCSS): <ul style="list-style-type: none"> Writing: Research to Build and Present Knowledge [All Grades] Speaking and Listening: Comprehension and Collaboration [All Grades] Speaking and Listening: Presentation of Knowledge and Ideas [All Grades]
Activities and Assessments <ul style="list-style-type: none"> Plant Journal Data Charts Lab Report Summary of the Learnings 		Opportunities to Differentiate Instruction <ul style="list-style-type: none"> Allow students to work individually or in groups Add additional variables Have students take photos instead of drawing 	

Growing Plants with SmartFarm™ LED Grow Light System

Lesson 1: Planting Seeds

Students will spend the day putting together components of the Grow Light, and getting acquainted with the materials used for growing plants: Grow Light, seeds, and soil, and learning the vocabulary except control and variable which will be discussed in the second lesson.

Lesson 2: Controls versus Variables

Students will learn about controls and variables. They will choose a variable to test against the control. They can change the LED light combination, water, soil-type, temperature, number of seeds. Set up the experiment.

Lesson 3: Watch them Grow

Using the data charts, record the changes you see as your seeds grow. This will take place over a number of weeks. Introduce the lab report and have students complete it as the experiments take place.

Plant Journal		Every day you make observations about your plant, draw a picture in your plant journal.
Draw what you observe in each plant:		
Control	Test Plant	

Growing Plants with SmartFarm™ LED Grow Light System

Data Charts

Control Plant

Observation	Soil	Height (cm)	Color	Description	Anything Else?
1. Date					
2. Date					
3. Date					

Variable Plant

What variable (e.g. light, water, soil) are you testing?

Observation	Soil	Height (cm)	Color	Description	Anything Else?
1. Date					
2. Date					
3. Date					

Lab Report

Growing Plants Lab

Name:

Date:

Question: What are you wondering about the plants?

Hypothesis: What do you think is going to happen? Make a prediction.

Methods: What are the steps you will take to complete the experiment? There may be more than 3 steps.

- 1.
- 2.
- 3.

Materials: What will you use to complete the experiment?

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Growing Plants with SmartFarm™ LED Grow Light System

Procedure: Write your plan in sentences.

Results: Draw a picture to show your results.

Conclusion: What happened? Was your hypothesis correct?

Summary of the Learnings

After the experiment, answer the following questions:

- What were you testing?
- Which treatment (the control or the variable) had the tallest plants?
- What was the height of the tallest plant?
- What was the height of the shortest plant?
- Which treatment had the most leaves?
- Which treatment had the most flowers or fruit?
- What was the strangest thing you observed?
- Why do you think this happened?

Growing Plants with SmartFarm™ LED Grow Light System

Topic: Scientific Method and GrowLight™	Grade Level: 5-8	Estimated Unit Time: Varies	HB Tools Integrated: <ul style="list-style-type: none"> SmartFarm™ LED Grow Light System
Unit Objectives ... to understand the relationship between light, soil, seeds, and water ... to think like a scientist ... to tract data and chart results ... to implement the scientific process			Subjects Integrated: <ul style="list-style-type: none"> Science Technology Engineering Art Mathematics
Materials <ul style="list-style-type: none"> SmartFarm™ LED Grow Light System Plant seeds, soil, water Ruler Camera 			ISTE Standards met: <ul style="list-style-type: none"> Knowledge Constructor Innovative Designer Computational Thinker
Vocabulary Organism: Any living thing. (ex. person, cat, strawberry plant) Organic Matter: Material that comes from something that was once alive. (ex. decayed leaves, dead animals and rotting plants). Compost is made up of organic matter. Control: A subject that has not been changed by an independent variable used as comparison for checking the results of an experiment. Variable: What the scientist changes in each trial. Also called an "independent variable." Scientific Method: Process by which scientists evaluate a theory including questioning, hypothesizing, experimenting, evaluating, and sometimes adapting a trial to ensure the validity of a conclusion. Inquiry: Asking questions and performing experiments to reach the truest possible result			Next Gen Science Standards met: <ul style="list-style-type: none"> MS Engineering Design Interdependent Relationships in Ecosystems [K, 2, 3, MS, HS] Weather and Climate [K, 3, MS, HS] Waves [1, 4] Matter and Energy in Organisms and Ecosystems [5, MS, HS] Human Impacts [MS] English Language Arts (CCSS): <ul style="list-style-type: none"> Writing: Research to Build and Present Knowledge [All Grades] Speaking and Listening: Comprehension and Collaboration [All Grades] Speaking and Listening: Presentation of Knowledge and Ideas [All Grades]
Resources: BrainPop: Scientific Method AMNH-- How to Plan an Experiment		Common Core State Standards (CCSS) Math: <ul style="list-style-type: none"> Expressions and Equations [6, 7, 8] 	
Activities: Data Charts		Opportunities to Differentiate Instruction <ul style="list-style-type: none"> Allow students to work individually or in groups Add additional variables Have students take photos instead of drawing 	

Growing Plants with SmartFarm™ LED Grow Light System

Lesson 1: Steps of the Scientific Method

Students can learn the steps of the scientific method and be introduced to the SmartFarm™ LED Grow Light Systems. Promote inquiry by having students ask questions about using the light and how it can most effectively help them grow plants. They will plan an experiment using the SmartFarm™ LED Grow Light in the next lesson.

Suggested Resource: [BrainPop: Scientific Method](#)

Lesson 2: Create a Plant Growth Experiment

Students will create an experiment using the Grow Light. They will choose a variable to test against a control plant. They can change the LED light combination, water, soil-type, temperature, number of seeds. Set up the experiment.

Suggested Resource: [AMNH - How to Plan an Experiment](#)

Lesson 3: Communicate the Results

Using the data charts, record the changes you see as your seeds grow. Compare the results to your hypothesis. Reflect on the changes each time you make an observation. Encourage students to take pictures of the plants and place them in an album to see the changes over time. This will take place over a number of weeks. Introduce the lab report and have students complete it as the experiments take place.

Suggested: Data Charts, Lab Report, Summary of the Learnings

Data Charts

Control Plant

Observation	Soil	Height (cm)	Color	Description	Anything Else?
1. Date					
How does this align with your hypothesis?					
1. Date					
How does this align with your hypothesis?					
1. Date					
How does this align with your hypothesis?					

Growing Plants with SmartFarm™ LED Grow Light System

Variable Plant

What variable (e.g. light, water, soil) are you testing?

Observation	Soil	Height (cm)	Color	Description	Anything Else?
1. Date					
How does this align with your hypothesis?					
1. Date					
How does this align with your hypothesis?					
1. Date					
How does this align with your hypothesis?					

Lab Report

Growing Plants Lab

Name:

Date:

Question: What are you wondering about the plants?
Hypothesis: What do you think is going to happen? Make a prediction.
Methods: What are the steps you will take to complete the experiment? There may be more than 3 steps. 1. 2. 3.
Materials: What will you use to complete the experiment? • • •

Growing Plants with SmartFarm™ LED Grow Light System

Procedure: Write your plan in sentences.

Results: Show your results in a graph or chart.

Conclusion: What happened? Was your hypothesis correct?

Summary of the Learnings

After the experiment, answer the following questions:

What were you testing?

What did you notice about the growth of your plant?

Did this align with your hypothesis?

What was the strangest thing you observed?

Why do you think this happened?

How would you perform the experiment differently in the future?

Growing Plants with SmartFarm™ LED Grow Light System

Topic: Scientific Inquiry Investigations with SmartFarm™ LED Grow Light System	Grade Level: 9-12	Estimated Unit Time: Varies
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HB Tools Integrated:

- SmartFarm™ LED Grow Light System

Unit Objectives

- ...to use inquiry-based learning to draw conclusions to a scientific question
- ...to understand the difference between the scientific method and scientific inquiry.
- ...to understand the relationship between light, soil, seeds, and water
- ...to think like a scientist, to track data and chart results, to implement the scientific process

Subjects Integrated:

- Science
- Technology
- Engineering
- Art
- Mathematics

Materials

- SmartFarm™ LED Grow Light System
- Plant seeds, soil, water
- Camera or markers/colored pencils

ISTE Standards met:

- Knowledge Constructor
- Innovative Designer
- Computational Thinker

Vocabulary

Scientific Method: Process by which scientists evaluate a theory including questioning, hypothesizing, experimenting, evaluating, and sometimes adapting a trial to ensure the validity of a conclusion.

Inquiry: Asking questions and performing continued investigations to reach the truest possible result.

Next Gen Science Standards met:

- HS Engineering Design
- Interdependent Relationships in Ecosystems [K, 2, 3, MS, HS]
- Weather and Climate [K, 3, MS, HS]
- Matter and Energy in Organisms and Ecosystems [5, MS, HS]

English Language Arts (CCSS):

- Writing: Research to Build and Present Knowledge [All Grades]
- Speaking and Listening: Comprehension and Collaboration [All Grades]
- Speaking and Listening: Presentation of Knowledge and Ideas [All Grades]

Common Core State Standards (CCSS) Math:

- Algebra [HS]

Scientific Method	Scientific Inquiry
Linear/defined order	Non-linear/fluid
Answers a single posed question	May end up generating more questions
Results may be communicated at the conclusion of the experiment	Communication is a key component throughout
Source: http://www.curriki.org/oer/What-is-inquiry-vs-the-scientific-method/	

Resources

[Growing with LED lights - Al Jazeera](#) (Clip: Begin at 17:17)

[AMNH - How to Plan an Experiment](#)

Growing Plants with SmartFarm™ LED Grow Light System

Activities and Assessments

Data Charts
Lab Report

Opportunities to Differentiate Instruction

- Allow students to work individually or in groups
- Add additional variables
- Use guided inquiry instead of the current open inquiry model

Lesson 1: What is Scientific Inquiry?

Students will be introduced to the SmartFarm™ LED Grow Light System. After watching the video on growing with LED lights, have students list out their questions about growing plants with the LED Grow Light. Encourage discussions on “light recipes” and promote inquiry by having students challenge each other to research possibilities for growing plants under LED lights. They will be planning scientific inquiry investigations using the LED Grow Light in the next lesson.

Suggested Resource: [Growing with LED Lights-- Al Jazeera](#)

Lesson 2: Design an Investigation using Scientific Inquiry

Students will continue to engage with the LED Grow Light and choose a particular question to explore. Students should know that as the investigation plays out, their findings may shift their focus and bring them closer to the evidence-based answer they are seeking. If students are struggling, have them consider changing the LED light combination, water, soil-type, temperature, number of seeds. Set up the initial investigation.

Suggested Resource: [AMNH - How to Plan an Experiment](#)

Lesson 3: Implementation and Communication

As the investigation unfolds, encourage constant exploration and research into concepts at play in the investigation. Possible areas to explore include light waves, light emissions, growing seasons, growing patterns, geographic locations, geotechnical studies in the area, alternate ideas about answering the same scientific question, to name a few.

Using the data charts, record the changes as they occur. Compare the results to your hypothesis. Reflect on the changes each time you make an observation and discuss where the knowledge gaps are in the experiment. What does the team need to learn more about? This will take place over a number of weeks. Introduce the lab report and have students complete it as the experiments unfold.

Suggested: [Data Charts](#), [Lab Report](#)

Growing Plants with SmartFarm™ LED Grow Light System

Data Charts

Control Plant

Observations	Category A	Category B	Category C	Category D
1. Date				
How does this align with your hypothesis?				
What new information do you need after this observation? Where are the knowledge gaps?				
1. Date				
How does this align with your hypothesis?				
What new information do you need after this observation? Where are the knowledge gaps?				
1. Date				
How does this align with your hypothesis?				
What new information do you need after this observation? Where are the knowledge gaps?				

Growing Plants with SmartFarm™ LED Grow Light System

Variable Plant

What variable (eg light, water, soil) are you testing?

Observations	Sample Category A	Sample Category B	Sample Category C	Sample Category D
1. Date				
How does this align with your hypothesis?				
What new information do you need after this observation? Where are the knowledge gaps?				
1. Date				
How does this align with your hypothesis?				
What new information do you need after this observation? Where are the knowledge gaps?				
1. Date				
How does this align with your hypothesis?				
What new information do you need after this observation? Where are the knowledge gaps?				

Growing Plants with SmartFarm™ LED Grow Light System

Lab Report

Scientific Inquiry Investigation

Name:

Date:

Question: *What are you investigating?*

Abstract:

Introduction:

Hypothesis: *What do you think is going to happen?*

Methods: *What are the steps you will take to approach this investigation? Continue to add on as your work unfolds.*

- 1.
- 2.
- 3.

Materials: *What will you need to complete the investigation?*

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-
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Growing Plants with SmartFarm™ LED Grow Light System

Procedure: Explain your process. Why are you using the methods you chose?

Results: Show your results using a graph or chart.

Conclusion: What happened? Was your hypothesis correct?

Continued Study: Explain how this investigation informs future research and testing that you could do.

Social Sustainability with “Rock and Wrap it Up” and the LED Grow Light System

Topic: Sustainability and You	Grade Level: All ages	Estimated Unit Time: One Week
Unit Objectives ... to use SmartFarm™ LED Grow Light System to fight climate change ... to encourage donation of food grown with GrowLight ... to understand how food waste is converted to CO2e		
Materials <ul style="list-style-type: none"> • Rock and Wrap it Up Curriculum • SmartFarm™ LED Grow Light System • Whole Earth Calculator 		
<p>This material is meant to supplement the 3-Day Curriculum from “Rock and Wrap it Up” (rockandwrapitup.org).</p> <p>Day 1 Additions: Introducing Rock and Wrap it Up</p> <ul style="list-style-type: none"> • Discuss the carbon footprint of an outdoor farm versus an indoor farm. What foods are better produced indoors instead of outside? Where might this growing system be useful geographically? • Consider: How could growing food help to decrease poverty? <p>Day 2 Additions: Opportunities for Increasing Social Impact</p> <ul style="list-style-type: none"> • Determine how much food can be produced in the classroom with the LED Grow Light. What is the potential to donate or compost this food? • Use the Whole Earth Calculator to determine how many meals you could donate with the food grown at your school. • What else can you do to reduce your carbon footprint? <p>Day 3 Additions: Decreasing Your Carbon Footprint</p> <ul style="list-style-type: none"> • Experiment with the Whole Earth Calculator. What if every class had an SmartFarm™ LED Grow Light System? How much CO2e could be saved if the food is composted? How many meals could be donated? • Consider CO2e savings from using LED lights instead of other lights to grow indoors. 		

HB Tools Integrated:

- SmartFarm™ LED Grow Light System

Subjects Integrated:

- Science
- Technology
- Art
- Mathematics

ISTE Standards met:

- Knowledge Constructor
- Innovative Designer
- Computational Thinker

Next Gen Science Standards met:

- Interdependent Relationships in Ecosystems [K, 2, 3, MS, HS]
- Weather and Climate [K, 3, MS, HS]
- Human Impacts [MS]
- Human Sustainability [HS]

Common Core State Standards (CCSS) Math:

- Measurement and Data [K, 1, 2, 3, 4, 5]

English Language Arts (CCSS):

- Writing: Research to Build and Present Knowledge [All Grades]
- Speaking and Listening: Comprehension and Collaboration [All Grades]
- Speaking and Listening: Presentation of Knowledge and Ideas [All Grades]

Opportunities to Differentiate Instruction

- Work in groups
- Take excess cafeteria food to a shelter

SmartFarm™ LED Grow Light System

Objectives

- Develop a smart device that maintains a suitable growth environment for plants using sensors.
- Understand the background and application areas of smart farming technology.
- Verify the input/output process of the materials through physical operations to enhance understanding and interest in software.

Summary

This project aims to explore the environmental factors required for plant growth and create a smart farm device that utilizes Arduino and various sensor modules to provide an optimal growth environment.

Activity

1. Understanding various smart farming technologies applied in agriculture.
2. Arduino coding using C language and electronic circuit wiring.
3. Writing algorithms that produce different execution values based on various sensor conditions by linking multiple sensors.

Requirements

PC, Arduino SmartFarm™ Grow Light System

1st Session

- Understanding the background and application fields of smart farming
- Learning about various environmental factors necessary for plant growth and designing a personal smart farm.

2nd Session

- Installing the Arduino Integrated Development Environment (IDE).
- Understanding Arduino interface and hardware.

3rd Session

- Assemble the smart farm main body using a wooden frame.
- Connect input/output devices such as soil moisture sensors and temperature/humidity sensors to the circuit.

4th Session

- Research suitable light wavelengths and soil moisture for plant growth to create reference for coding.

5th Session

- Creating an icon library that displays different icons according to the humidity value.
- Displaying the sensor input value on the LCD.

6th Session

- Create a conditional statement to adjust the output of the growth LED according to the condition value.
- Debugging the source code of the SmartFarm™.
- Discuss additional features that can be added to the SmartFarm™.

SmartFarm™ **GROW LIGHT** System

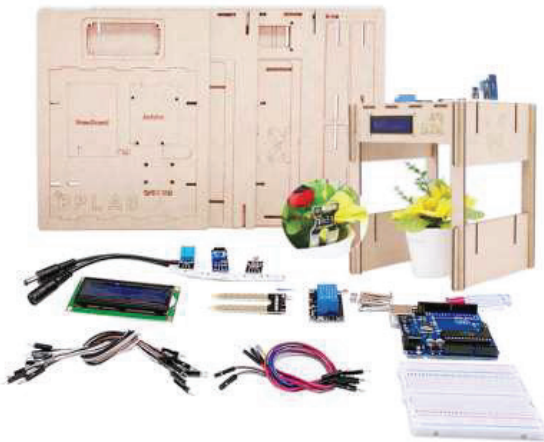
SmartFarm™ LED Grow Light System

Lesson Plan

Recommended for ages
9 years old and above

Kit Components:

(flower pot not included)



Completed System:



The plant growth LED is turned on (perceives darkness around the device):

