

BUILDING BUSINESS PRINCIPLES IN STEM CURRICULUM

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Aquaponics
Dr. Savage

Name: _____
Date: _____

Lab Activity: Determining the Cost of Nutrient Dosing – Production System

If controlled environment agriculture is going to be economically sustainable, we must be able to establish selling prices for our produce that allow us to purchase the materials we need to keep the farm going, as well as (hopefully) provide some measure of profit. As a starting point, we will consider the large production system as a **hydroponic** system (rather than aquaponics), and begin by calculating the costs associated with the nutrients added to fuel plant growth, with the objective of determining the total cost of nutrients used in the production over a typical six week grow-out cycle for a leafy green, such as our Salanova or romaine lettuce.

We will begin by determining a **unit cost** (cost/gram or cost/mL) for the common nutrients used in the greenhouse. Bulk cost is the total cost (material + shipping) for each nutrient. We divide the bulk cost by the number of units (grams or mL) in the bulk size.

Known Fixed Costs – Nutrients

Nutrient	Formula	Bulk Cost (\$/total amount)	Unit Cost (\$/g or \$/mL)
Potassium nitrate	KNO ₃		
Magnesium sulfate	MgSO ₄		
Ammonium nitrate	NH ₄ NO ₃		
Iron chelate	Fe-DPTA		
Phosphorus (liquid)	n/a		

Once we have determined the unit cost for each nutrient, we can calculate **dose cost** for each nutrient by multiplying the unit cost for each nutrient by the number of units (e.g., 100 g) in a single dose. When we have calculated the dose cost for each nutrient, we can calculate the **total single dose cost** by adding together all of the individual dose costs.

Dosing Cost – Single Dose – Production System

Nutrient	Dose Rate	Unit Cost	Dose Cost
KNO ₃	100 g		
MgSO ₄	100 g		
NH ₄ NO ₃	25 g		
Fe-DPTA	50 g		
Phosphorus	100 mL		
Total Single Dose Cost			

Weekly Dose Cost – Production System

We can now calculate the **weekly dose cost**. If we assume that the system is dosed twice per week with nutrients as shown in the table above, we simply take the *total single dose cost* calculated above, and multiply it by 2. If we were to dose the system three times per week, we would multiply the total single dose cost by 3.

$$\text{Weekly Dose Cost} = (\text{Total Single Dose Cost}) * (\# \text{ Doses per Week}) = (\$ \underline{\hspace{1cm}}) * (\underline{\hspace{1cm}}) = \$ \underline{\hspace{1cm}} / \text{wk}$$

Total Dose Cost – 6-Week Grow-out Cycle

Now that we have calculated the weekly dose cost, we can calculate our total nutrient dose cost, based on a six week grow-out cycle for the majority of our plants. We use the Weekly Dose Cost calculated above, and multiply it by 6 to calculate the total value of nutrients added.

$$\text{Total Dose Cost} = (\text{Weekly Dose Cost}) * \underline{6} = (\$ \underline{\hspace{1cm}} / \text{week}) * (6 \text{ weeks}) = \underline{\hspace{2cm}}$$

Nutrient Cost – Per Plant

Now that we have determined the total cost of nutrients used in a six week grow-out cycle, we can calculate the **nutrient cost per plant** over the six week time period by taking the total dose cost and dividing it by the total number of plants in the system. Our production system has 24 rafts for growing plants; each plant raft has 18 plant spaces. When fully populated, our system will hold 432 plants.

$$\text{Cost per Plant} = (\text{Total Dose Cost}) / (\text{Total Number of Plants}) = (\$ \underline{\hspace{1cm}}) / (432 \text{ plants}) = \$ \underline{\hspace{1cm}} / \text{plant}$$

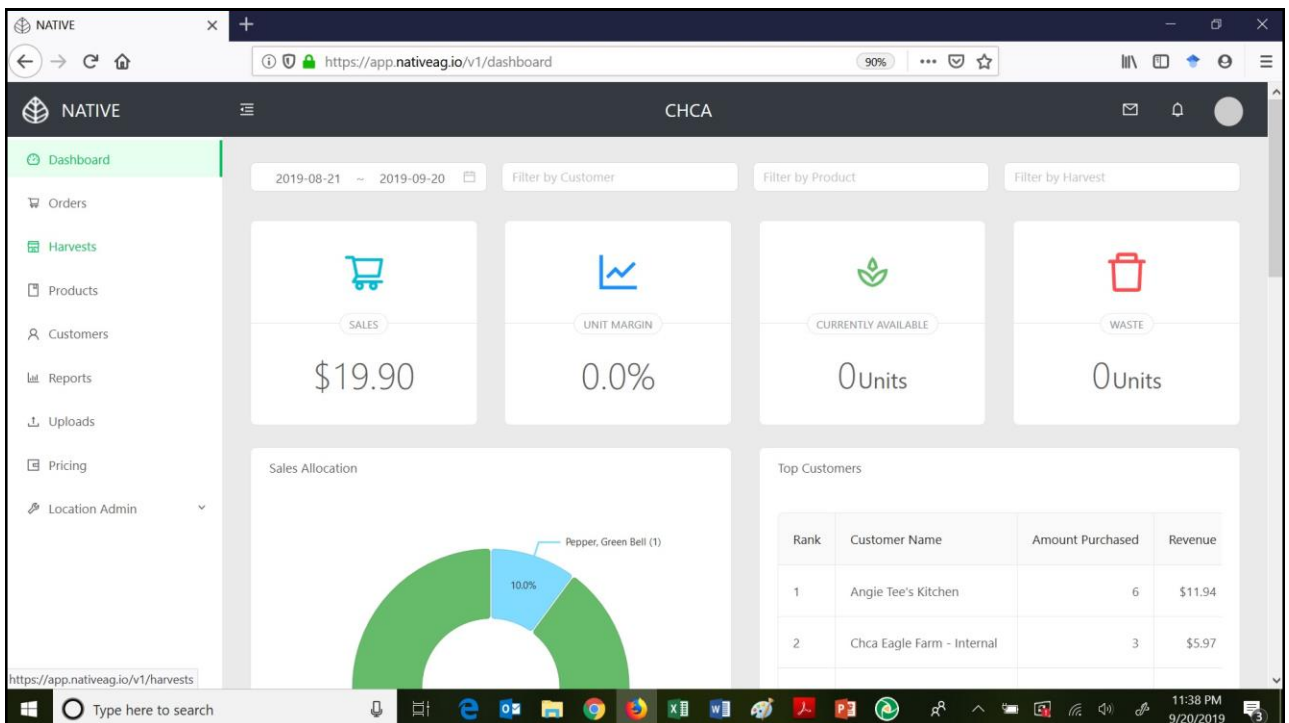
OTHER VARIABLE COST PARAMETERS

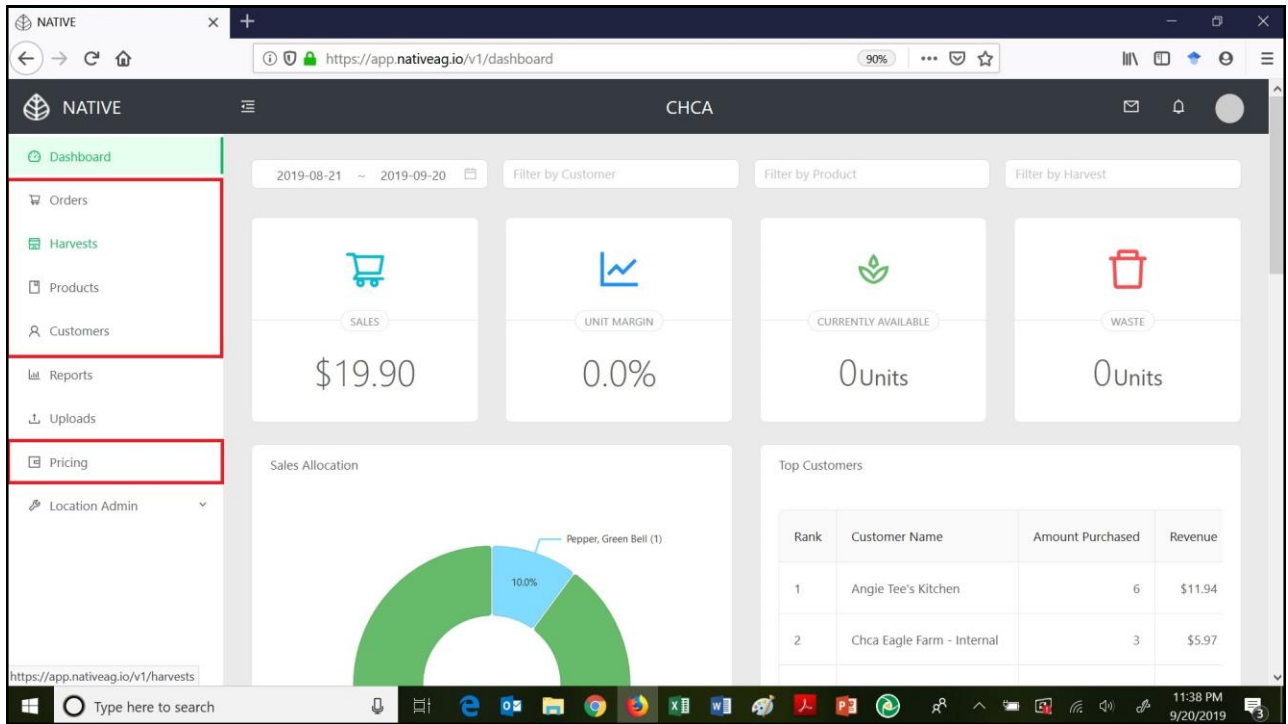
- **Seed and grow media**
- **Nutrients**
- **Electricity**
 - Kill-a-Watt units
- **Water**
 - Metered addition of system make-up water
 - Does not include water used for cleaning, etc.
- **Natural Gas**
 - Natural gas forced air greenhouse heaters (November – March)
 - Dedicated meter for greenhouse
- **Time / Labor**
 - Cumulative minutes to plant, transplant for germination, transplant for grow out, harvest, package

ULTIMATE GOAL

- **“What does it cost us to grow, harvest, and package a plant from our system?”**
 - If we are going to sell produce from our greenhouse, we need to know our costs to establish our price points.
 - In a bigger sense, we see the impact of **labor** in the final cost analysis
- Through this financial analysis, students see (1) why sustainable, locally grown agricultural products are generally more expensive, (2) that profit margins on these agricultural products may be very thin, and (3) without efficient growing methods and a steady customer base, many sustainable farmers don't make it financially.

SO HAVING ESTABLISHED AN ESTIMATE OF “COST TO GROW” PER PLANT, WHAT’S NEXT?





The screenshot shows the NATIVE Customers page for CHCA. The left sidebar is the same as the dashboard. The main area is titled "Customers" and includes a search bar labeled "Search By Customer Name..". Below the search bar is a table listing customer records.

	Customer	Primary Contact	email	Phone Number	Approved	Address
✉	Angie Tee's Kitchen	Angie Tee	angiesatay@gmail.co	513-520-	✓	10497 Ln, Cin
✉	Grate Thymes Food Servi...	Jenny Tippitt	jenny.tippitt@chca-oh.org	513-247-9944 ex. 338	✓	11525 Snider Road, Cinc
✉	Leaning Eagle Coffee Bar	Stephen Carter	stephen.carter@chca-oh....	(513) 247-0900	✓	Cincinnati Hills Christian
✉	Chca Eagle Farm - Internal	Kevin Savage	kevin.savage@chca-oh.org	(513) 520-0987	✓	11525 Snider Road, Cinc

At the bottom of the table, there are navigation controls: a left arrow, a page number "1" in a green box, and a right arrow. The footer of the page includes "© 2019 NATIVE" and "Built with Love". The system clock indicates 11:45 PM on 9/20/2019.

NATIVE <https://app.nativeag.io/v1/products>

Dashboard Orders Harvests **Products** Customers Reports Uploads Pricing Location Admin

*** Name**
Product Name

Description

*** Shelf Life (Days)** 1 *** Base Variant Name** *** Base Variant Price** \$

*** Product Category** **Product Family** Upload a photo

Cancel Submit

Pepper, Colored Bell

Type here to search





11:54 PM 9/20/2019

NATIVE CHCA

Products Product Packaging Product Families

Products

Search Product Name...

Name	Description	Pricing	Shelf Life (Days)	Photo
Basil, Genovese Current Harvests: 0		Pounds: \$18.99	5	
Basil, Italian (Purple) Current Harvests: 0		Pounds: \$18.99	5	
Miz-America (Red Asian Green) Current Harvests: 0	Dark red, toothed mizuna ...	Pounds: \$5.99	7	
Mizuna, Green (Asian Green) Current Harvests: 0	Essential salad mix ingredie...	Pounds: \$5.99	7	

<https://app.nativeag.io/v1/products>

Type here to search

11:52 PM 9/20/2019


NATIVE x +

https://app.nativeag.io/v1/products 90%

Products Product Packaging Product Families

Products

Search Product Name...




Romaine, Coastal Star Lettuce (...)

Shelf Life: 7 day(s)

Description: A longtime favorite. The large,...

[Edit →](#)




Pac Choi (Bok Choy), Asian Gre...

Shelf Life: 7 day(s)

Description: Flared jungle green leafy blad...

[Edit →](#)



Basil, Genovese

Shelf Life: 5 day(s)

Description: None

[Edit →](#)

Type here to search

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NATIVE x +

https://app.nativeag.io/v1/pricing 90%

Customer Specific Pricing

chca eagle farm - internal

Chca Eagle Farm - Internal

Basil, Genovese - Pounds:	\$	Basil, Italian (Purple) - Pounds:	\$
Miz-America (Red Asian Green) - Pounds:	\$	Mizuna, Green (Asian Green) - Pounds:	\$
Pac Choi (Bok Choy), Asian Green - Pounds:	\$	Pepper, Colored Bell - Bell Pepper, Colored:	\$
Pepper, Green Bell - Bell Pepper, Green:	\$	Pepper, Jalapeño - Pepper, Jalapeño:	\$
Romaine, Dragoon Lettuce (Green Mini-Romaine) - Head:	\$1.99	Romaine, Coastal Star Lettuce (Green Mini-Romaine) - Head:	\$1.99
		Romaine, Truchas Lettuce (Red Mini-Romaine) - Head:	\$1.99

https://app.nativeag.io/v1/pricing

Type here to search

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NATIVE CHCA

Harvest Info Waste Info

Harvests

2019-08-21 ~ 2019-09-20 Search Harvest ID or Product Name..

Product	Harvest ID	Amount Harvested	Amount Remaining	Amount Wasted	Date of Harvest
Winterbor Jagged Edge Kale	09-16-10	6	0	0	2019-09-16
Pepper, Green Bell	09-03-2019	1	0	0	2019-09-03
Winterbor Jagged Edge Kale	08-28-19	2	0	0	2019-08-28
Winterbor Jagged Edge Kale	08-23-19	1	0	0	2019-08-23

1

NATIVE CHCA

Ref ID Product Grade

Date of Harvest Quantity Cost of Goods Sold/Item

Add Harvest Cancel Submit

Orders

2019-08-21 ~ 2019-09-20 Search Order ID or Customer Name.. ☒ Approved ☒ Pending ☒ Disapproved

	Order ID	Customer	Delivery Date	Status	Price
+	1659e414n	Angie Tee's Kitchen	2019-09-16	approved	\$11.94
+	9b0519a4n	Grate Thymes Food Service	2019-09-03	approved	\$1.99
+	fc5d6165n	Chca Eagle Farm - Internal	2019-08-28	approved	\$3.98
+	2f0c855bn	Chca Eagle Farm - Internal	2019-08-23	approved	\$1.99

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WHERE ARE WE?

- Beginning October 21, harvesting 72 heads of lettuce (Romaine, buttercrunch), 3-5 kg kale, 1-2 kg bell peppers per week
- In late November, harvests will add 5-8 kg tomatoes, and 1-2 kg jalapeno peppers
- Selling produce to the school's cafeteria
- Selling produce outside of the school to a local catering business, and adding additional crops requested by the caterer
- Having discussions to sell lettuce and kale to two additional restaurants outside of the school
- CHCA Eagle Farm has a student business manager, and is a student-run business enterprise at CHCA; all proceeds support operation of the farm and greenhouse



CONTACT

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CHALLENGES TO INTEGRATING AQUAPONICS

Capital / Funding

- start-up (equipment)
- consumables (fish, feed, seeds, growing supplies)
- operation & maintenance costs (WQ monitoring, utilities)
- indoor vs. outdoor facilities (laboratory vs. greenhouse)

Educational

- Multiple teachers teaching same subjects
- Multiple teachers teaching to their experiences and passions
- Teaching “depth over breath” or coverage of all concepts

Personal

- Time – system O&M – weekends, breaks, summer
- Personal monetary investment – out-of-pocket

NO PERSONAL PASSION = NO AQUAPONICS!

