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Hort 497A Aquaponics

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**Hydroponic Enterprise Budget**

**Crop Selection**

For this exercise I chose to grow spinach (*Spinacia oleracea)* hydroponically in a single bay setup. I picked the cultivar Olympia because it was shown to be one of the most productive per m2 out of 10 cultivars assessed in a 2007 trial. Also it is bolt resistant and resistant to several strains of downy mildew. Because it is considered semi-upright it is ideal for baby spinach harvesting. The crop is harvested every 23 days, 2 in some sort of germination chamber and 21 on the production floor. The Cornell Controlled Environment Agriculture Hydroponic Spinach Production Handbook (CCEAHSPH). This will be done in a high-density raft culture.

According to the CCEAHSPH, the biggest pest issue for baby spinach is *Pythium aphanadermatum.* It. is described as ubiquitous and extremely difficult to control. So rather than try to deal with losing an occasional crop to *P*. *aphanadermatum,* preventative care will be taken by regularly cleaning with a 2% Clorox® bleach solution.Now since my production cycle is 15.87 times per year, or 15 times with a 20-day remainder. That 20 days will be allocated either to December or January, when there will be a scheduled halt in production for cleaning. It will be done in the winter to maximize the savings on light supplementation and heating costs for the year. Twenty days of heating in January accounts for about 12.5% of total heating degree days needed annually, based on the degree days in the Greenhouse Energy Cost Estimator.

The CCEAHSPH suggests seeding at 1500 plants per m2. Using the Ohio State Extension Single Bay template which has 3072 sq. ft. which is 285.4 m2 Assuming similar 90% space utilization rate we get 0.9\*285.4\*1500= 385290 plants per cycle. According to the yield trial mentioned, Olympia produced 1594g/m2 on average over the 2 trial years. But their seeding rate was at 18 per 100cm2 or 1800 per m2. So since I am seeding at 1500 not 1800, 1500/1800=83.3% I will assume yields will be 0.833\* 1594=1328.33 g/m2.

So 1328.33 g/m2 \* 285.4m2 \*0.9 space used= 341.2 kg per cycle of marketable product will be produced. Seeds then will be needed at a rate of 1500 plants/m2 \* 285.4m2 \* 0.9 space utilization \* 15 cycles/yr. = 5,779,350 seeds per year. Seeds are 27800/# and come in 5lb. bags for $125 at ufseeds.com, so 42 5lb. bags of seed costing $5250 will suffice.

Non-organic spinach is about $0.50/oz. ($8/#) retail at Walmart, $0.33/oz. ($5.33/#) at Wegman’s, and the USDA ERS puts the price lower at $3.83/#in 2015. Prices from a farm in California selling bulk are about $4.92/#. Apparently it is very difficult to find wholesale prices for these types of products, so I am going to have to estimate, here it will be $2.50/# wholesale. So the 752 lbs. of product generate $1880 revenue per cycle, or $28200 per year.

To make this analysis work using the OHU Extension Lettuce Enterprise Budget a number of modifications and work-arounds were made to compensate for the difference in my production system and the lettuce/NFT system they are using. For instance, rather than try to change “lettuce heads” to some meaningful conversion, ‘Space’, ‘Pack-out’ and ‘No. Turns per Year’ are left unaltered and ‘Price’ is lowered to where ‘Total Return/Year’ comes to $28200. Seed prices are raised until seed costs equal $5250.

We will sell in 1lb. bags, the simplest packaging possible. Bags are available at $15/1000, so our 11280 lb. of produce will be packed in $180 worth of bags

**Environmental Parameters**

The CCEAHSPH states that the Air temperature should be 24°C during the day and 19°C at night. The relative humidity should be kept between 50-70%. The water temperature should be 25°C, and it should be 10-11 inches deep to prevent the roots from reaching the bottom. The dissolved oxygen (DO) levels should be about 7 mg/L (ppm), and they say crops can fail at less than 3 ppm. This systems has monitors and sensors for all of those values except DO.The total DLI for the spinach in production area should be 17-22 mol/m2. We will aim for 21-22. Using the Korczynsji DLI estimates this will be my light supplement needs, for each of my 256.9 m2 in production.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Average Interior DLI | Moles needed | Moles need with Production Pause |
| Jan | 8.1 | 13.9 | 4.633333 |
| Feb | 11.4 | 10.6 | 10.6 |
| Mar | 17.9 | 4.1 | 4.1 |
| Apr | 21.1 | 0.9 | 0 |
| May | 24.4 | -2.4 | 0 |
| Jun | 27.6 | -5.6 | 0 |
| Jul | 27.6 | -5.6 | 0 |
| Aug | 24.4 | -2.4 | 0 |
| Sep | 17.9 | 4.1 | 4.1 |
| Oct | 14.6 | 7.4 | 7.4 |
| Nov | 8.1 | 13.9 | 13.9 |
| Dec | 8.1 | 13.9 | 13.9 |

(Source Korczynski et al. 2002. HortTech 12(1) 12-16)

When the moles needed are multiplied by the production area and summed we get 13872.6. We will be using 1000-watt metal halides, the price of which I dropped significantly from the lettuce budget due to online price checks. If the HID efficiency is 3 then we will use 4624.2 kwh/yr. If we are paying $0.08/kwh, then our light supplementing costs for the year are only $369.94

**Other Spreadsheet Modifications**

Labor was reduced to 2 hrs./wk. for deliveries, next to no time on marketing since I am selling wholesale, Transplant/Harvest/Package was reduced to 10 hr./wk. because cleaning cutting across spinach seems like it would be less labor intensive than handling and individually packing out heads of lettuce. Rates were left the same. Advertising campaigns and costs were reduced to 0 again because we are selling wholesale. The business does not need both a cell number and a landline so the landline was removed. An in-ground raft system was assumed to be less costly to build than an NFT system by 50%.

**Conclusion**

In the end a price of $2.82 per pound or total return of $31,767 per year was my break-even point where my return on investment was $0 / yr. At $3/# My return on investment is $2075, and at $4 it is still only a measly $13355. This is not a big money maker, and admittedly this was cutting cost corners left and right, so there would be a number of improvements on this scenario I would recommend. This operation would do better if it were larger by benefitting from economies of scale in a number of areas by bringing down the fixed costs per production unit. It could also be attempted somewhere warmer. And obviously to whatever extent the product could be moved at retail premiums instead of whole prices that would probably help as well.

**Appendix**

Spreadsheet attached separately

**Citations**

Brandenberger, L. Cavins, T., Payton, M., Wells, L., Johnson, T. Yield and Quality of Spinach Cultivars for Greenhouse Production in Oklahoma. HortTechnology *2(2007) vol. 17 no. 2 269-272* <http://horttech.ashspublications.org/content/17/2/269.full.pdf+html>

Brechner, M., de Villiers, D. Cornell Controlled Environment Agriculture Hydroponic Spinach Production Handbook.<http://www.cornellcea.com/attachments/Cornell%20CEA%20baby%20spinach%20handbook.pdf>

<http://www.ufseeds.com/Olympia-Hybrid-Spinach-Seeds.item>

<https://www.walmart.com/ip/Marketside-Baby-Spinach-6-oz/34017490>

<http://www.vmo.org/en/index/page_vegeprice/>

<https://www.amazon.com/dp/B019JATS6S?psc=1>

<https://www.amazon.com/dp/B01I2BJRSO?psc=1>

<http://www.fourstarplastics.com/plastic-bags/Food-Bags/Gusseted-Poly-Bags.html#YToxMzp7czoyOiJpZCI7YjowO3M6NjoibGFuZ2lkIjtiOjA7czo1OiJjYXRpZCI7czoyOiIzNSI7czo1OiJtYW5pZCI7aTowO3M6NjoicGFyZW50IjtiOjA7czo0OiJzb3J0IjtpOjA7czo0OiJwYWdlIjtpOjE7czo1OiJvcmRlciI7czozOiJhc2MiO3M6NzoidmFybGlzdCI7TjtzOjEyOiJzZXR2YXJpYWJsZXMiO2E6MTp7aToxNDtzOjE6IjUiO31zOjQ6ImdyaWQiO2k6MTtzOjEwOiJyZXNwb25zaXZlIjtpOjA7czo1OiJyZXNldCI7aTowO30>=