

# Could vertical farming be used as a more efficient method than conventional arable farming in Ireland?

## Aims

-To set up a miniature vertical farm and conventional arable farm

-To investigate how efficient vertical farming could be in Ireland by comparing the average dry mass, average stem length and average number of leaves produced, of lettuce and coriander plants under conventional arable farming conditions and hydroponic vertical farming conditions over a five week period.

-To compare the quality of the plants produced by both methods based on EU and Irish growing standards



## T-Test Results

We decided to do T-tests because there was a large sample size (a sample size of 96 plants in total). The t-test results state that the p-value of all of our sets of results were less than 0.05 (alpha level). Therefore there is a significant difference between the vertically and conventionally farmed lettuce and coriander. From looking at the results, we can also see that vertical farming has a higher average dry mass, number of leaves, and height than conventional arable farming. The Null hypothesis is when there is no significant difference between vertical and conventional arable farming. Null hypothesis is rejected because all of the sets of results  $p < 0.05$ .

## Introduction

Vertical farming involves growing crops in vertical stacks. Most vertical farms use hydroponic media instead of soil, and LED lights instead of sunlight. Vertical farming has the advantage that variables such as temperature, light intensity, humidity, and quantity of water and nutrients can all be controlled. [Kalandari, Fatemeh and Osman Mohd Tahir, 2018]

Vertical farms are being developed for use in areas where land is scarce and the soil is infertile. Vertical farming is well suited to urban areas, such as Dublin and Belfast, where space is at a greater premium. Growing food in these cities would also reduce food miles significantly. Vertical farms could be set up in places with infertile soil, for example Leitrim, where only 1% of soil tested having good overall fertility as of 2014 [Teagasc, 2014]. Vertical farming has significant environmental benefits as well, as it would allow Irish soil to replenish itself and encourage Irish biodiversity to recreate their habitats in soil [Coleman, David C, 2017]. Ireland could also focus on growing certain crops using vertical farms instead of importing them from other countries. This would be helpful in relation to Brexit, as we wouldn't have to depend on imports from other countries.

## Materials and Method

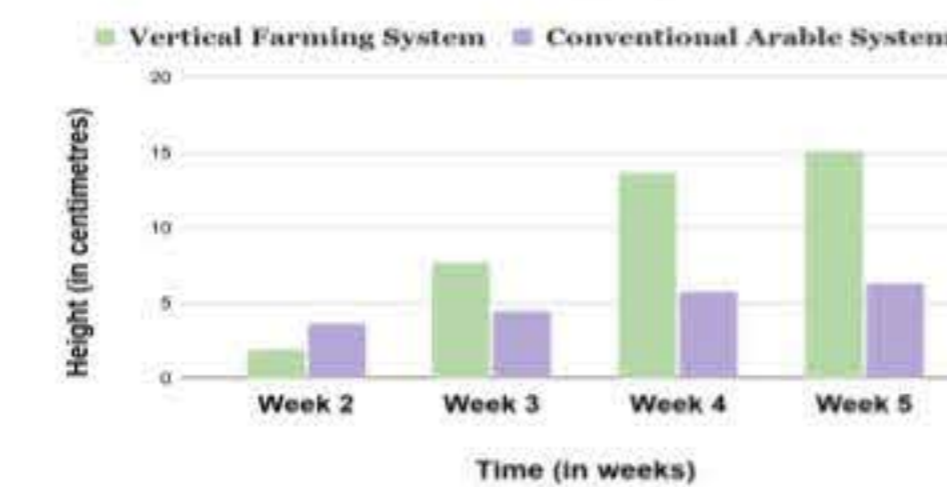
For our experiment, we grew lettuce and coriander using vertical farming and conventional arable farming methods respectively. We planted 24 lettuce seeds and 24 coriander seeds in each system. Each plant was given a label, and we recorded the height and the number of leaves for each plant every week. We compared the rate of growth of the plants by measuring their height, the number of leaves on each plant, the dry mass, and the length and width of the leaves. We statistically analysed our results by completing T-Tests. We also measured the quality of the plants by comparing the characteristics of our plants to EU and Irish standards.

For the vertical farm, we used the hydroponic deep water culture method. We grew these plants in the growing medium perlite, and fed them a water solution with added nutrients (4ml of fertiliser per 1 litre of water, as recommended on the instruction manual of the VAXER fertiliser). Once their roots grew, they regulated their own water usage using the water solution in the basin of the hydroponic system. We also used an LED Light and an air pump to control the environment.

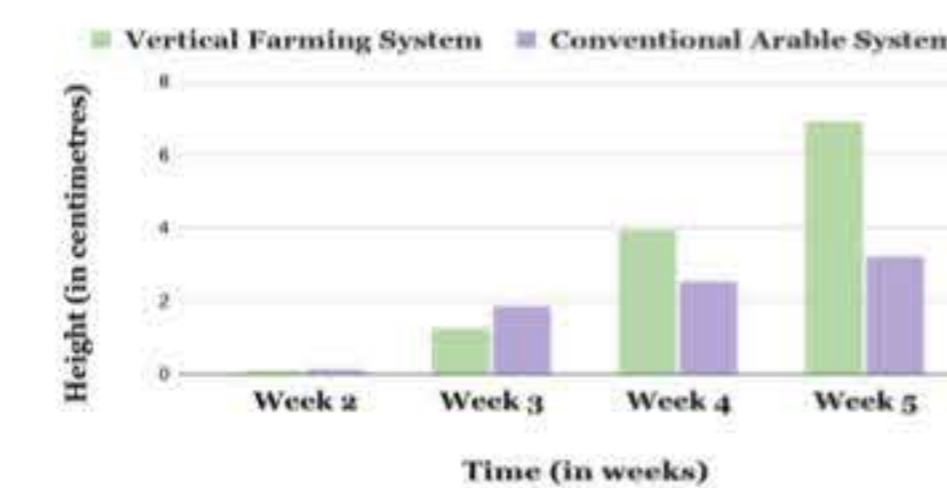
In the conventional arable farm, we used soil-based farming. We fed the plants 10 ml of water every second day. This was set up using soil and natural sunlight.

## Results

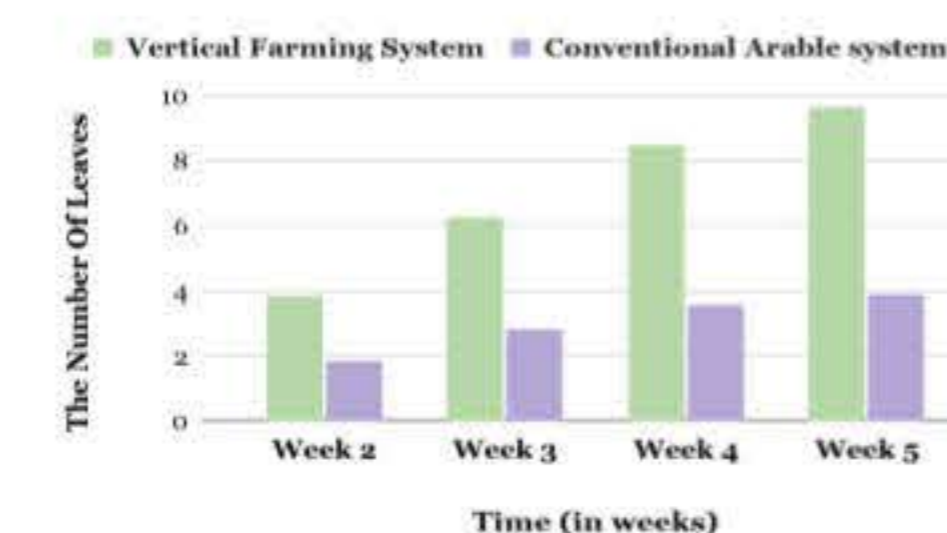
### A Bar Chart of The Mean Height of Lettuce Plants in Each Farming System



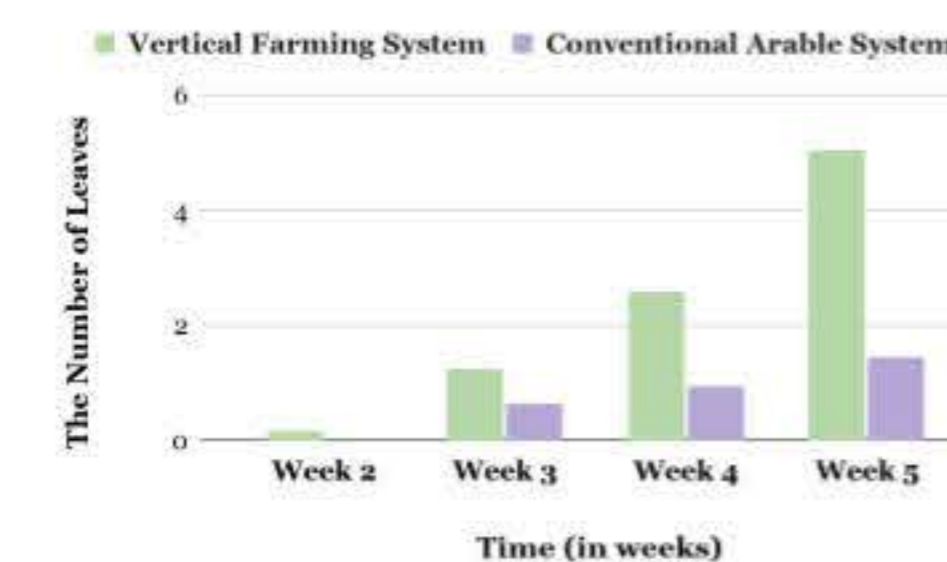
### A Bar Chart of The Mean Height of Coriander Plants in Each Farming System



### A Bar Chart of The Mean Number Of Lettuce Leaves in Each Farming System



### A Bar Chart of The Mean Number of Coriander Leaves in Each Farming System



## Conclusion and Recommendations

Our results showed that, on average, the vertically farmed plants were taller (15.15 cm vs 6.28 cm for lettuce, 6.93 cm vs 3.21 cm for coriander), had a larger dry mass (7.10 grams vs 0.07 grams for lettuce, 0.29 grams vs 0.02 grams for coriander), had a larger number of leaves (9.63 vs 3.88 for lettuce, 5.04 vs 1.46 for coriander), and had bigger leaves. All of these difference were statistically significant according to the two-tailed t-test, where  $p < 0.05$ . We found that the biggest plants in the vertical farming system were sellable by EU and Irish standards (According to UNECE standards and The Official Journal of The European Union), whereas the biggest plants in the conventional arable farm were unsellable. Our data indicates that vertical farming has a much faster rate of growth and produces better quality plants than conventional arable farming. By looking at these results, we have come to the conclusion that vertical farming is a more efficient method of farming than conventional arable farming in Ireland.

Vertical Farms would be of great benefit to restaurants and hotels in Ireland, because they could set up small vertical farms and grow fresh vegetables and herbs to use when cooking. They could set up this in any available place (even if it doesn't have access to sunlight), for example car parks, underground areas, kitchens and attics. Larger vertical farms could also be set up to transport fresh produce to food shops around Ireland. To add more depth to our project, we would like to find ways to spread the light source further to ensure plants obtain the same amount of light

## Summary Of Results

### The Mean Results for the Lettuce Plants

	Vertical Farm	Conventional Arable Farm	T-test Results (p-value)
Dry Mass	7.10 grams	0.07 grams	0.002
Height (as of week 5)	15.15 cm	6.28 cm	0.00000004
No. of Leaves (as of week 5)	9.63	3.88	0.00007

### The Mean Results for the Coriander Plants

	Vertical Farm	Conventional Arable Farm	T-test Results (p-value)
Dry Mass	0.29 grams	0.02 grams	0.02
Height (as of week 5)	6.93 cm	3.21 cm	0.01
No. of Leaves (as of week 5)	5.04	1.46	0.04