

JUST VERTICAL

LEARNING GUIDE

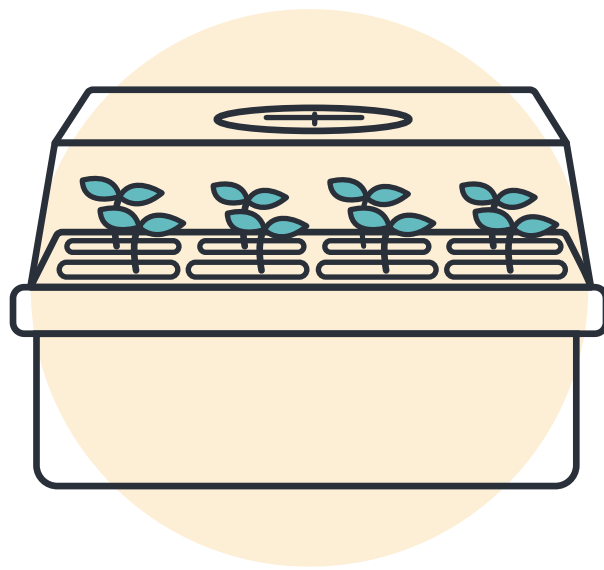


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LEARNING OUTCOMES, PURPOSE & EDUCATIONAL VALUE

Learning Outcomes

For this course, it is not as important to drive home the pure science facts and understandings ie. chemical formulas, taxonomic classifications, cellular respiration, plant physiology, botany, nomenclature, etc. It is more important that the students understand how these concepts relate directly to their specific climate and growing environments. It will also help explain how different systems and mechanisms affect certain outcomes throughout the entire plant life cycle.

Throughout this course, we strive to provide the students with avenues for them to champion their learning and to champion their food systems within the community. As the teacher, there are three core skills to making this a successful project:

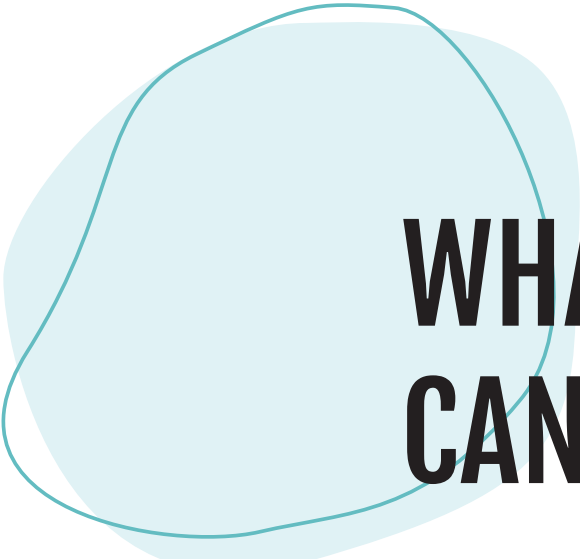
- How to cultivate people
- How to cultivate plants
- Where to go for help

Purpose

The purpose of this chapter is to get the students thinking about why they want to grow their own food, the basics of plant anatomy, and plant growth. Promoting an understanding of why this course exists and the impact it can have on local communities is just as important as the core understanding of the content.

Educational Value

- Explore attitudes with the students and their families. Try and recognize the importance of these
- Emphasize that the garden is a method of hands-on learning
- Encourage experimentation, observation, and record-keeping



WHAT STUDENTS CAN DEVELOP

What Students Can Develop

Table 1: Table of Practical Skills and Educational Aims for Curriculum

	Practical Aims	Educational Aims
Gardening	To create a successful garden	How to run a garden and enjoy doing it
Nutrition	To improve children's diet	How to grow food that is nutritious and learn about how it can contribute to healthy diets and better living
Environment	To add greenery to the home	Environmental awareness, understanding and respect for nature - learn about why plants and growing locally is good for the environment
Curriculum	Reinforce areas in the science curriculum such as chemistry, biology, physics, environmental science, etc.	Enhance understanding through hands-on education
Life Skills	Help students prosper	Planning, decision making, responsibility, etc.

Extra Resources

<http://www.fao.org/docrep/009/a0218e/a0218e00.htm>
www.gardeningknowhow.com/special/children/



LESSON 1 – TEACHER'S GUIDE

Learning Outcomes

Students will explore what plants need to be able to grow and what effect changing these inputs will cause in regards to water temperature, air temperature or humidity, soil components and soil health, sunlight and light in general, pH levels, nutrients (nitrogen, phosphorous, potassium etc.) and anything else that the students can think of that could contribute to plants' growing needs.

Students will learn the basics of what plants need to grow and how their decisions in what they feed the plants are going to affect the growth, aesthetics and taste of their produce.

Activities

Students brainstorm different nutritional and environmental requirements plants need to grow healthy. They can then try to guess what they think each parameter will do when there is a surplus or deficiency of that requirement in the plant and try to explain the reasoning behind it. This works best when students can draw or write down what happens when little to nothing is added, and excess is added.

Look for the following at the basic and advanced levels as well as what happens when little to none is added and excess is added.

Basic	Advanced	Little to None	Too Much
Sunlight	Photosynthesis	No new growth, seeds won't germinate, wilting, brown leaves	Tips of leaves go brown or yellow (top burn/bleaching). stems become too thin, long and weak (leggy)
Water	Saturation levels, humidity	Plants wilt and then die	Plant drowns, susceptible to mould growth, decaying of roots and plant cellular biomass, the plant eventually will die
Air	Oxygen, Carbon dioxide, Humidity	The plant can't breathe, deforming growth or stopping it all together	Plant wilting or dying and plant struggle to grow
Soil + Nutrients	Nitrogen, Phosphorous, Potassium, pH of soil or pH of liquid fertilizer	Nutrients: Yellowing and browning of leaves, roots stretch looking for more nutrients, frail cell structure pH: Black spotting (necrosis) and/or wilting	Nutrients: Red spots on leaves, yellow spots on leaves, wilting of leaves, parts of or whole plant dying pH: Yellowing of leaves, translucent whiting of the leaves, black spotting

Table 2: Nutritional and Environmental Plant Requirement Activity

Assignment

Have students draw and label a diagram of everything a plant brings in and everything it puts out as well as bringing in a plant from the natural environment outdoors to identify the different parts (roots, stems, leaves, possibly flowers or fruits).

Basic: Water and nutrients through roots, photosynthesis in and out through leaves

Advanced: Intake oxygen in roots, carbon dioxide in leaves, nitrogen, phosphorus, and potassium (and other crucial metals and non-metals plants need like Calcium, Magnesium etc.) through roots. Emits oxygen from leaves, water from leaves (transpiration).



Practice Questions & Answers

Knowledge Questions

1

Q: What are the main nutrients found in soil that are provided in liquid?

A: Nitrogen, phosphorus, potassium

2

Q: What is the process called that plants use to make food to grow?

A: Photosynthesis

3

Q: What gases are involved in the process of photosynthesis: when plants draw air in or exhale air out?

A: Draws in carbon dioxide and exhales out oxygen

4

Q: What is one method of soilless growing? Can you name any others?

A: Hydroponics, Aquaponics, Aeroponics, NFT, DWC

5

Q: What techniques can be used to grow plants, how can they be applied in a sustainable way?

A: Traditional soil-based agriculture, greenhouse growing, hydroponics, aeroponics, aquaponics. In sustainable applications, they will be suited to minimize environmental impacts such as nutrient runoff, food miles (shipping food long distances), and disruption of the local environment. Each application could be different depending on the area it is trying to serve (localized and very community-specific).

Thought Questions

1

Why would you want to grow your own food?

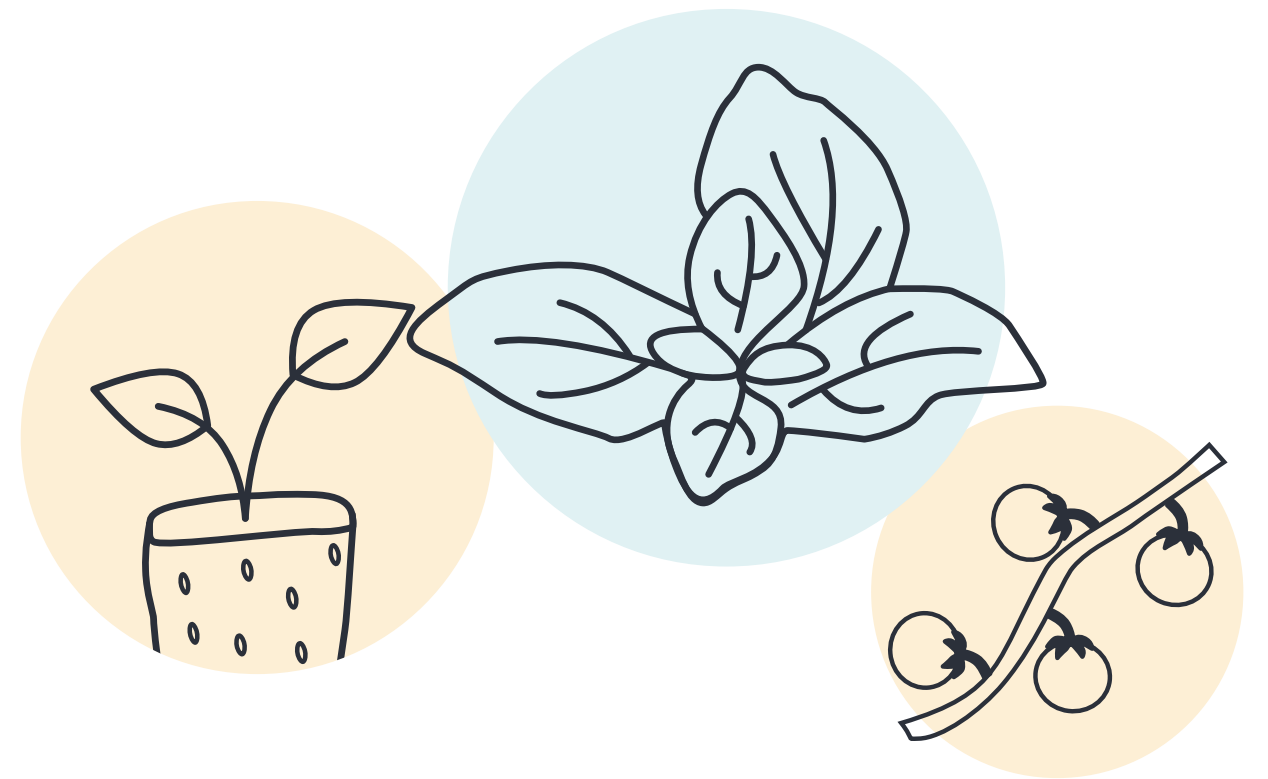
2

How can the community benefit from growing its own food?

3

Are there any specific plants that you would like to grow to use them in any specific recipes for cooking or baking etc.?

LESSON 1 – PLANTS AND HOW THEY GROW



How Long Have Plants Been Around?

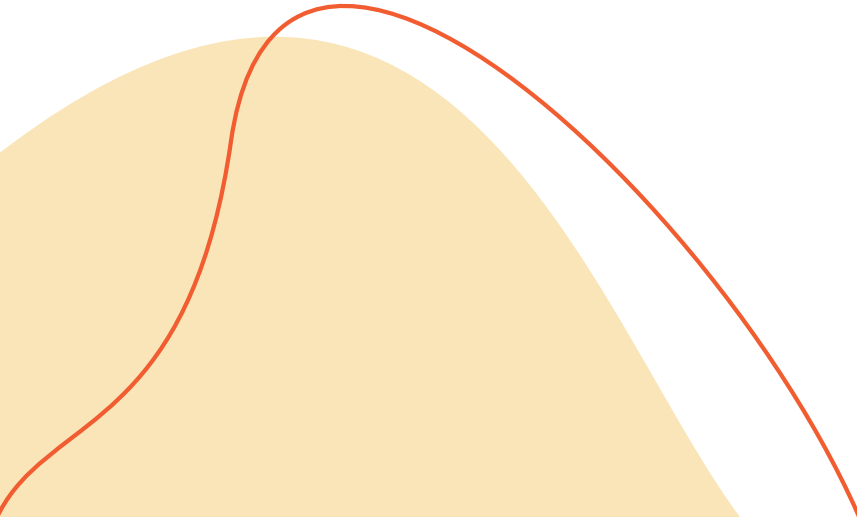
Plants have been around much longer than humans with the first plants appearing about 700 million years ago. The first plants were mostly mosses clinging to rocks. It wasn't for another 100 million years that leafy greens came into existence. (Hedges, 2001). Developing the history of plants has required the collaboration of many scientists and their results from around the world.



Why Have a Garden?

People all over the world grow their own food for different reasons: to eat, for fun, to feed the community, as a hobby, etc. The motivations vary for each individual and that is okay! What are some reasons why it would be beneficial to students, their family, and the community to have their own garden? Maybe the taste of fresh food or to try out a new recipe. For some this could be a small hobby to enjoy with family, for others it can be about bringing fresh, affordable food to the community.

Throughout this course reflect on why an individual would want to grow their own food. Working together by the end of this course, students will be able to grow their own food, and the choices are plentiful! Along the way, students will learn what affects the growth of plants in any growing area, what plants need to survive, how to grow with and without soil, how to use the community greenhouse, how to seed, transplant and harvest your plants.



PLANT GROWTH

Plants need certain things to grow. In this section, look at what those things are and why they matter.

Sunlight

The sun provides two important components for plants: warmth and energy. These help the plant to survive and grow. The energy that the sun provides is absorbed through the leaves of the plant and gets turned into food for the plant to grow. This process is called **photosynthesis**. Without sunlight, the plants would not be able to create their own sugars and carbohydrates for food and grow to healthy adult plants. Different plants like to have different amounts of sunlight. As we change the amount of sunlight the plant receives and absorbs, the plant may grow faster, slow down its growth, or even stop growing at all (depending on the type of plant and how old it is in its life cycle).

Figure 1; Simple Equation for Photosynthesis and Respiration

energy + **carbon dioxide** + **water** = **glucose** + **oxygen**

Air

Being able to breathe is as important to humans as it is to plants, especially for the roots and the leaves. The roots of the plant need to be able to breathe in oxygen. The leaves of the plant need to be able to breathe in the carbon dioxide from the air and breathe out oxygen. This breathing in of carbon dioxide and breathing out of oxygen is part of the process of photosynthesis.

Water

All living things need water to survive, including plants! Plants are 90% water, meaning that they take in far more water by weight than people do. Plants need to stay hydrated. Water has two main roles, first, it helps move nutrients through the plant and second, it is an important part of photosynthesis which creates food for the plant.

You must be careful as plants can have too much water. When plants have too much water the roots become unable to breathe as they are swamped/over-saturated. This could lead to the roots rotting and the plant dying. To avoid this, make sure water can always flow through the roots of the plant (McElrone et al. 2013, BBC 2017).





Soil

Plants naturally grow in soil which provides two important aspects for plants. First, it acts as a solid base for the roots to grow into and hold the plant up. Second, it provides nutrients that are key to plant growth. Here are some primary nutrients a plant needs for healthy growing: **nitrogen**, **phosphorus**, and **potassium**. It is important to remember, there are many other metals, non-metals and salts a plant needs for uniform, healthy growth.

Nutrients

Soil naturally provides the three main nutrients for plants: nitrogen, phosphorus, and potassium but when using a different growing method like hydroponics those nutrients are added manually by the user. For hydroponics, the nutrients are provided in a liquid form that goes directly into the water. It is important to remember that trace amounts of other metals, non-metals and salts are required for healthy roots, leaves and stems.

Environmental Conditions

In addition to sunlight, air, water, soil, and supplemental nutrients, plants also need protection from harsh elements like high winds, storms, and hail. Certain Plants enjoy specific temperature and humidity ranges and some plants even need to be pollinated. Flowering plants like strawberries and cucumbers need to be pollinated to produce the fruit. This is done naturally by insects such as bees or butterflies but can also be done by humans (hand-pollinating methods like using toothbrushes, make-up brushes and paint brushes) What is great about using a greenhouse is that these conditions can be controlled to help plants grow.



Photosynthesis

Photosynthesis is the process of how plants create their food. Plants take in light through small cells in the leaves called chloroplasts. These chloroplasts combine the sun's energy with water and carbon dioxide in the air to create the food that fuels the plants. As the sun's energy, water, and carbon dioxide are absorbed, the plant produces sugars to feed itself. This releases oxygen back into the outside environment. These sugars help the plant to grow while oxygen is important for keeping our air clean (RSC, 2017).

Did you know that plants' green colour comes from the pigments of chloroplasts! This green pigment is called Chlorophyll and is a part of the light-absorbing mechanisms of plants.



PLANT ANATOMY

Like people, all the parts of plants have a name and a purpose. In this section, students will learn what each part does and what it is called as well as some of the cool plants that can be found around the world.

Plant Parts and Their Purpose

There are three main parts of a plant: the roots, stem, and leaves. Each of these has its own job in making sure the plant stays productive. Some plants will also have other parts such as flowers or fruits.

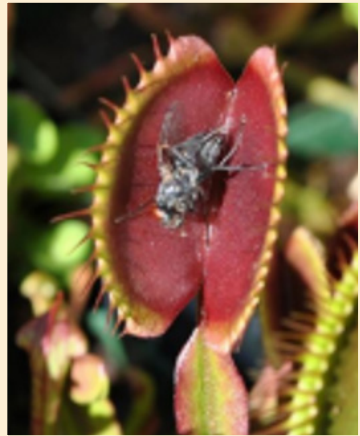
When a plant sprouts (or germinates from seed) the roots begin to spread underground where they have four main functions. The roots anchor a plant in place, absorb essential minerals and nutrients, move nutrients to the stem and store energy which is especially important in the winter.

The stem is the next most important part of the plant as it supports the plant and moves the nutrients and water between the roots and leaves. The stem allows for plants to support the growth of new leaves and plant matter.

At the end of the stems are the leaves which come in many different shapes and sizes. The most important function of the leaves is to collect energy from the sun and create food for the plant via a chemical process called photosynthesis (like solar panels!) (Mallory & Aiken, 2012).



The planet has many kinds of plants that have adapted to where they grow. There are some interesting examples of plant adaptations from around the world.



Venus Flytrap

The South-Eastern USA is the home of the Venus Flytrap which has sensitive hairs on the inside of the leaves that snap it shut on spiders and flies that walk in.

Baobab/Bottle Trees

The South-Eastern USA is the home of the Venus Flytrap which has sensitive hairs on the inside of the leaves that snap it shut on spiders and flies that walk in.



Rafflesia Arnoldii Flower

The South-Eastern USA is the home of the Venus Flytrap which has sensitive hairs on the inside of the leaves that snap it shut on spiders and flies that walk in.



GREENHOUSES AND HYDROPONICS

There are already plants growing outdoors so why grow indoors?
Why use hydroponics to grow along with soil practices?

Greenhouse

Greenhouses act to shelter plants against many of the conditions that slow down their growth such as temperature, strong winds, and pests. Greenhouses can allow people to grow food where otherwise it would be impossible, from deserts to the Arctic, greenhouses have become an important tool in feeding the world. A community greenhouse can also provide an important source of fresh food that you might otherwise not have access to. Greenhouses are used throughout Canada and the world to grow food. They can be small for a single family to use or big enough to feed entire countries.

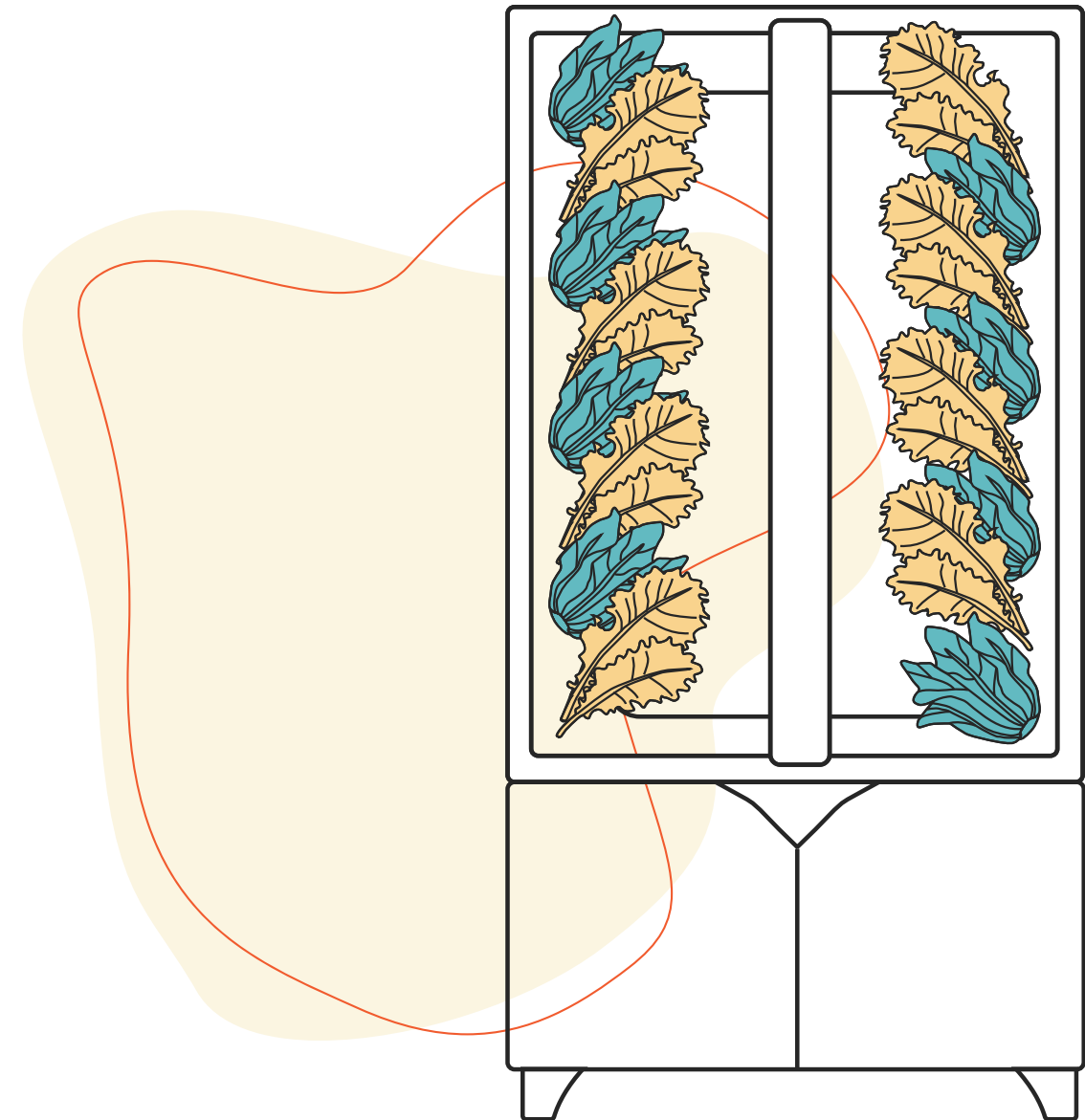


The Eden Greenhouse in Cornwall, United Kingdom

Hydroponics

Hydroponic growing means growing plants without soil and using a mineral-salt-based nutrient solution in water for plant food.

Hydroponics can come in different shapes and sizes whether that is vertical, horizontal, indoors, or outdoors. As discussed before, when growing without soil, there is still a need to provide the plants with the nutrients it needs in a solid or liquid form.





CONCLUSION, KEYWORDS & RESOURCES

Conclusion

We hope that throughout this chapter students thought about why they would want to grow plants in their community and have understood the basics of plant growth. The mechanisms of plant growth and how they can change the way they grow is fascinating. Students are encouraged to go through the practice questions to refine their understanding and to give some more thought to what was learned in this chapter.

Keywords

Acidic

Having a pH below 7.

Alkaline

Having a pH above 7.

Chloroplasts

Small parts found within cells in the leaves of plants that perform photosynthesis and are noticeable due to their high levels of a green pigment called chlorophyll.

Nitrogen

One of the key elements in plant growth found in soil or liquid nutrients. Nitrogen also exists in the form of a gas.

Phosphorous

One of the key elements in plant growth found in soil or liquid nutrients.

Photosynthesis

The process that plants use to turn light into food that fuels plant growth.

Potassium

One of the key elements in plant growth found in soil or liquid nutrients.

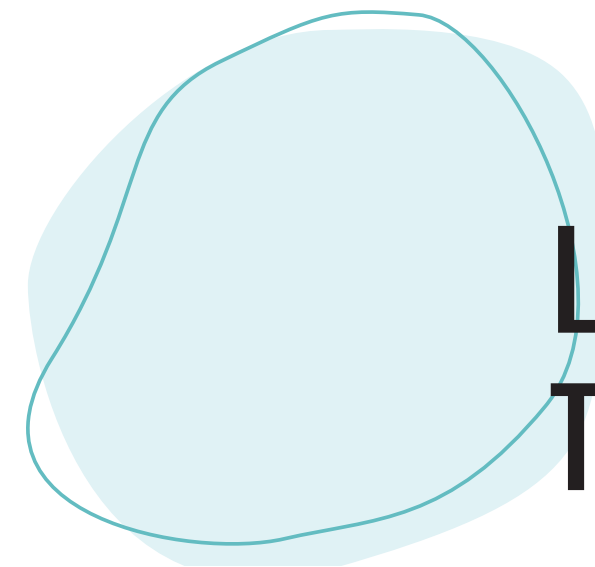
Additional Web Resources

http://fruitandnuteducation.ucdavis.edu/generaltopics/Tree_Growth_Structure/Photosynthesis_Respiration/

<http://www.rsc.org/Education/Teachers/Resources/cfb/Photosynthesis.htm>

http://www.bbc.co.uk/schools/gcsebitesize/science/add_gateway_pre_2011/greenworld/planttransportrev2.shtml

<https://www.nature.com/scitable/knowledge/library/water-uptake-and-transport-in-vascular-plants-103016037>



LESSON 2 – TEACHER'S GUIDE

FOOD INSECURITY: LOCAL & GLOBAL
SOLUTIONS

Learning Outcomes

This chapter and lesson should have students think about food security, food production, and healthy diets from a high-level perspective. The ideal outcome is that students understand the multi-faceted challenge to food security yet feel inspired to take on these challenges. This lesson will work to have students reflect on the solutions that they have read about and how they can apply them in a local community context.

Activities

- 1 Have students share what they thought about the global solutions provided in this chapter, particularly in the sections "Northern initiatives focused on growing" and "Global case studies"
 - a. Do students see areas where these solutions could be improved?
 - b. Do they have questions that require further investigation? Have them follow up and share with the class next time.
 - c. What did they like or dislike about these solutions?
- 2 Discuss how/where they think these solutions could be used in the community or their homes. Have the groups choose the solution that they think is the most viable and have them lay out a plan for how it would be implemented in the community.

Practice Questions & Answers

Knowledge Questions

- 1 **Q: What is food insecurity?**
A: Food insecurity at the household level is defined as not having access to food, or not having reliable access to affordable, quality, nutritious food
- 2 **Q: What can be done to combat food insecurity?**
A: There are lots of possible solutions, but the most effective solution is to increase the incomes of people facing food insecurity

Thought Questions

- 1 **How are some communities in the north trying to fight food insecurity, how do you think these solutions are helping communities, are there any drawbacks?**
- 2 **How does having food production in your local community impact your quality of life?**



LESSON 2 – FOOD INSECURITY

Introduction

This chapter will help students understand food insecurity, what causes food insecurity, its effects on the population, and some solutions.

Key Concepts

- Food insecurity
- Climate change
- Logistics and transportation
- Solutions for food insecurity

Key Questions

- What is food insecurity?
- What are the local solutions?

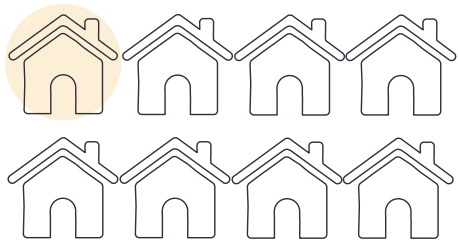
What is Food Insecurity?

Food insecurity is a term that is often talked about as a problem in modern society, but what does it mean? Food insecurity at the household level is defined as not having access to food, or not having reliable access to affordable, quality, nutritious food. Food insecurity happens most often due to financial constraints, or a mismatch in income and prices of food. This is a significant problem throughout Canada and has been linked to problems in physical, mental, and social health. This is a significant challenge for the healthcare system and the communities dealing with food insecurity firsthand.

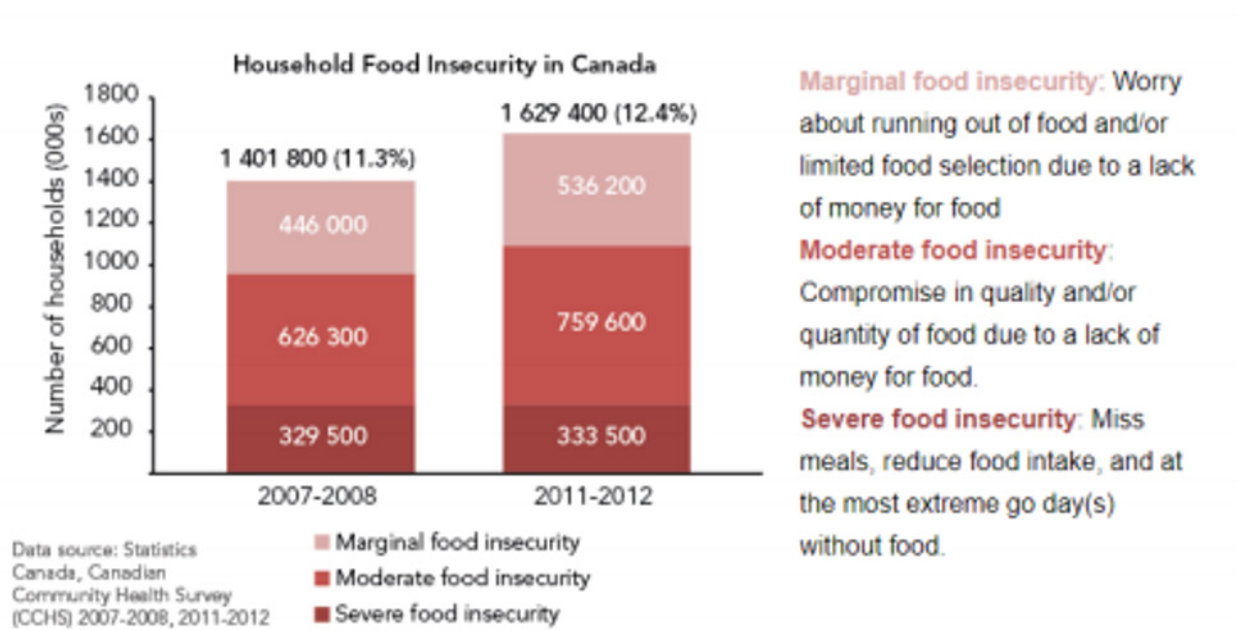


Where is Food Insecurity?

Food insecurity is a problem globally as well as across Canada. Food insecurity affects over 815 million people globally, most prominently in regions of sub-Saharan Africa, South Eastern and Western Asia. Often food insecurity can trigger conflicts or wars in regions which then make the food insecurity problems worse. Natural disasters also make problems of food insecurities worse as regular farming, and supply chains are destroyed or interrupted.



In Canada 1 in 8 households are food insecure. That means more than 4 million individuals in 1.15 million children in Canada are food insecure (Tarasuk et al. 2012). Within the context of food insecurity, there are also different levels, from the limited selection to missing meals. These different levels of food insecurity are defined in 3 categories: marginal, moderate, and



What Does This Mean?

Food insecurity can have a serious impact on the well-being of individuals and families. Physical health problems, especially re-occurring conditions can be worsened. It has also been observed that those living in food insecure households are more likely to have re-occurring conditions that are detrimental to overall well-being (Vozoris & Tarasuk, 2003, Tarasuk et al., 2013). Food insecurity also presents a special challenge for children living in food insecure households as they face increased risk in problems of mental wellbeing such as depression, hyperactivity, inattention, and suicidal ideas through early adolescence and adulthood.

Food insecurity can also seep into other aspects of an individual or family's lives. When there is not enough income to properly feed a family, other expenses can be cut such as important medications as well which can amplify other effects of food insecurity.

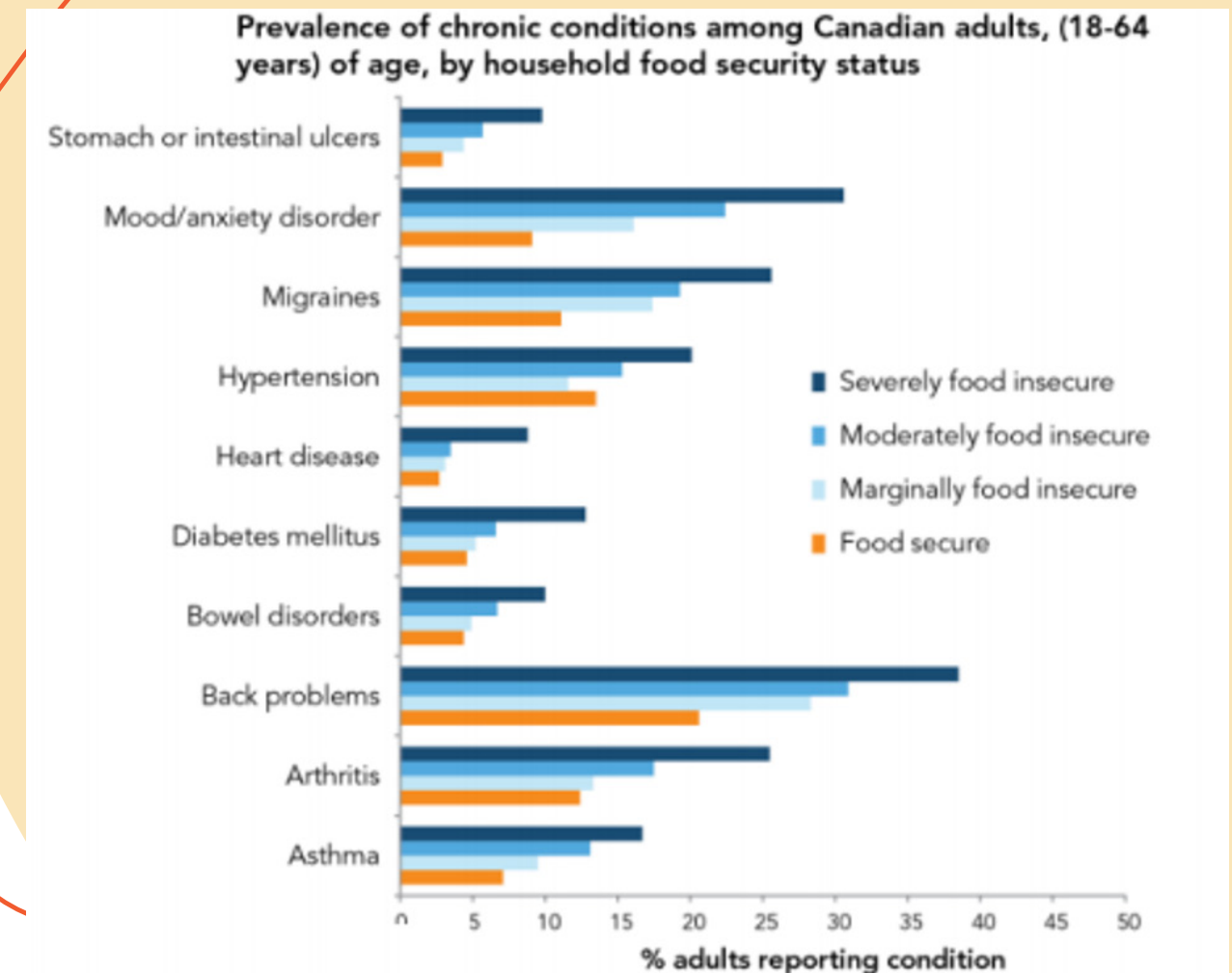
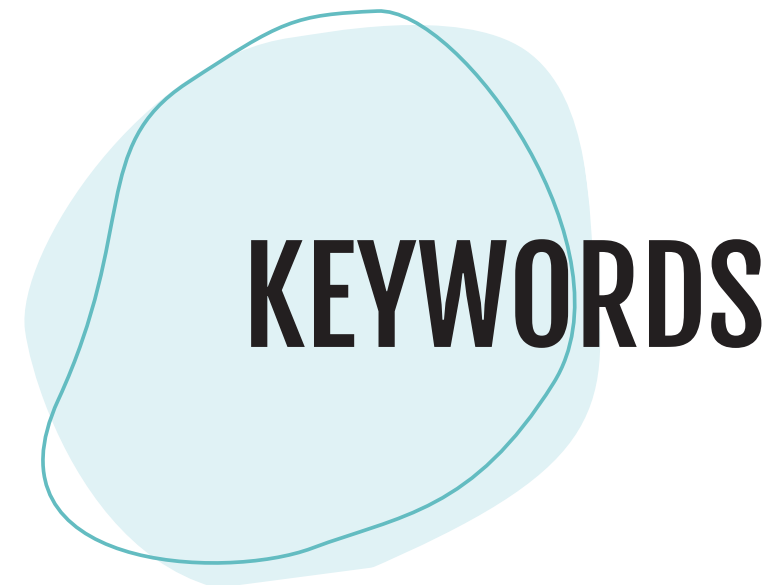


Figure 1: Tarasuk et al., 2013

Solutions for Food Insecurity

The best solution for food insecurity is to increase the incomes of families and individuals through social assistance programs. Examples of this working well are senior's old age assistance payments, Canadian Pension Plan, and other senior entitlements. Food insecurity is reduced by up to half when seniors turn 65 and begin receiving entitlements (McIntyre et al., 2016). Making additional income sources available to all individuals who are food insecure is a necessary and important step in reducing food insecurity.

Green Iglu is a charitable organization based out of Toronto that pairs local greenhouse infrastructure with educational programming to enable remote communities to grow affordable, nutritious food. Their vision is to build, grow, and empower a food secure Canada. Green Iglu's operations are integrated into the communities through stakeholder participation, horticulture education, and hiring local community members to ensure that each greenhouse can operate sustainably while supplying affordable food year-round. Their methods and technology have allowed remote communities to take ownership over their food supply chain and to grow produce in places never thought possible. Curious to learn more? Check out their website www.greeniglu.com



Keywords

Nutritional deficiency

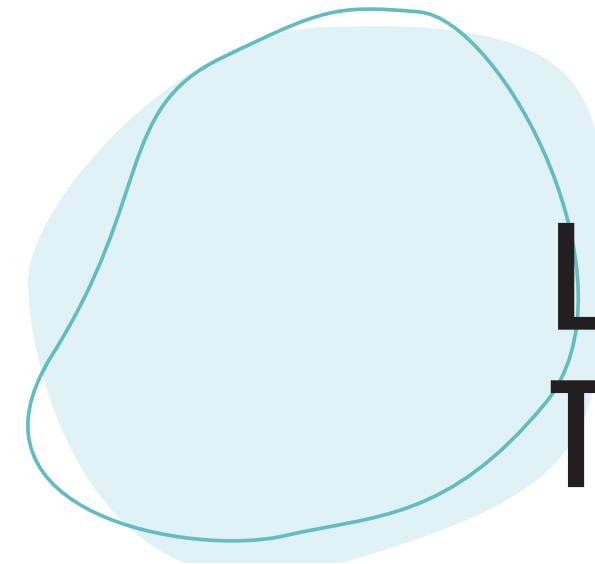
An inadequate supply of nutrients via vitamins and minerals that can lead to malnutrition or disease.

Calorically dense

The number of calories (or energy) per gram of food. Calorically dense foods that provide very little nutrients are often termed 'empty calories.'

Biological diversity

The variability or different amounts of living organisms.



LESSON 3 – TEACHER'S GUIDE

ALTERNATIVE GROWING METHODS



Learning Outcomes

This chapter will explore what types of alternative growing methods have been developed for plant growth. The specifics of what they are capable of growing, what role food production can play in helping communities, and how these solutions have been implemented will be explored.

Practice Questions & Answers

Knowledge Questions

1

Q: What are the three main macronutrients?

A: Carbohydrates, Proteins, Fats (or lipids)

2

Q: What do you need to consume to have a healthy diet?

A: Healthy mix of micronutrients and macronutrients from vegetables, fruits, grains, and meats and alternatives

3

Q: What advantages are there to growing in the community?

A: Community empowerment, healthy diets, affordable food, fresh food, education, boost to the local economy, being able to choose what to grow. There are other acceptable answers, use your discretion.

Thought Questions

1

How are some communities in the north trying to fight food insecurity, how do you think these solutions are helping communities, are there any drawbacks?

2

How does having food production in your local community impact your quality of life?



LESSON 3 – ALTERNATIVE GROWING METHODS

The Role of Food Production in Alleviating Food Insecurity

There are different approaches to alleviating food insecurity around the globe and across Canada. As discussed, one of the most successful and common approaches to reducing food insecurity has been working to increase the incomes of the most food insecure. This is a great approach and works well as evidenced by the results of those programs. However, it is not the only way to alleviate food insecurity. Remember food insecurity at the household level is defined as not having access to food, or not having reliable access to affordable, quality, nutritious food. To complement efforts to increase the buying power of families and individuals there should also be efforts to increase the supply of fresh, nutritious, affordable food.

By increasing the supply of food in the local market the price of the food should decrease. By decreasing the price of the food an individual's ability to purchase food increases. For example, if John has \$100 to buy vegetables and a basket of vegetables costs \$25 John can only afford to buy 4 baskets. However, if the supply of vegetables increases and the price decreases to \$20 then John with \$100 can now afford to buy 5 baskets of vegetables. So, in this example, John does not have any more money, but he can now buy and consume more food.

From a purely economic view, this is an example of how bringing in more produce for the local market either via production or importing food can be beneficial to residents. However, when looking at the local production of food many other benefits come with it. Some of these benefits are community empowerment, education, and boosts to the local economy.

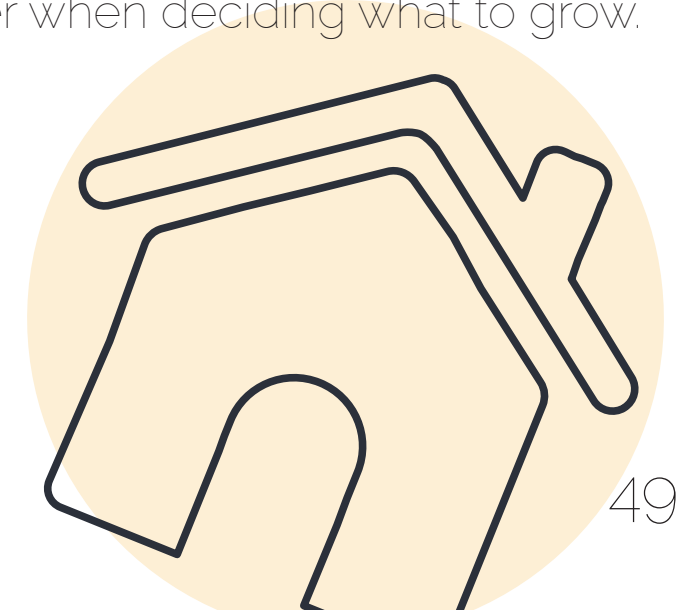
Community empowerment from local food production comes from having control over what is grown and brought to the local market. This means that the community can decide on what they want to grow and what they want to consume. By giving residents the option to choose may get them more involved in the community, spurring a greater sense of community belonging which in turn helps promote mental well-being.

Education comes through formal teaching and informal methods. Formal teaching happens at schools where hands-on skills and knowledge is imparted to students and provides a way to enrich the lives of the students in a way that benefits the community. Informal education may arise through students and teachers sharing their knowledge and learnings informally with other members of the community. Informal education may also occur through community events at the greenhouse.



Local production also benefits the local economy by keeping economic production within the community. This means that the dollars spent on food go back to supporting local jobs and local companies instead of outside companies. Some of the jobs that may come with local production are construction of the greenhouse, managing production of the facility, packaging of the produce, and distribution.

With local production, there is also the question of what to produce. Depending on what is available already you may choose to grow different crops. Ultimately the choice is up to the grower, local needs, and the community. However, there are some important points to consider when deciding what to grow.



What Can be Produced in Greenhouses

Some of the most common produce items that are consumed are leafy greens, fruits, and grains. Each one of these crops' nutritional values and growth potential will be explored in more detail.

Leafy Greens

Leafy greens are often grown and consumed locally as they are a crop where freshness is important. Many leafy greens are quick to wilt or break down if it takes too long to get them to market. From the leafy greens, the Brassica family of plants is one the most well-known. The brassica family includes kale, cabbage, cauliflower, brussel sprouts, and bok choy. Another popular group is the Lactuca family of plants which includes lettuces. Both brassicas and lettuces are the easier plants to cultivate, especially when growing without soil. Brassicas especially tend to be nutritionally dense providing many of the micronutrients that are needed in a healthy diet. Though leafy greens are full of many important vitamins, minerals, and nutrients they often don't have many calories or dense macronutrients (fats, carbohydrates, or proteins). That is why a healthy balanced diet also includes fruits, grains, meat and alternatives, as well as other sources of macronutrients.

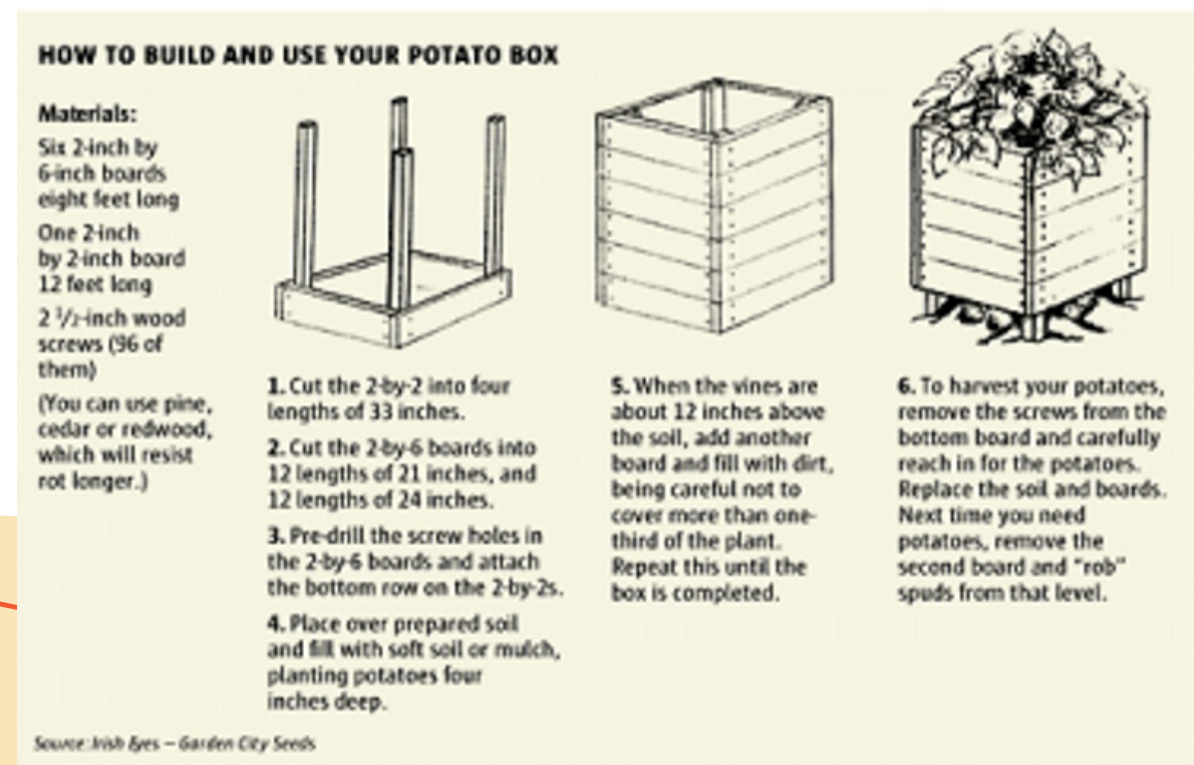
Fruits

Fruits such as strawberries or tomatoes are also a popular choice for local production as they take on different flavours and textures when they are produced locally and don't spend as long in transit as typical grocery store varieties. Many strawberries, tomatoes, and other fruits are picked well before they are ripe to survive the transit and storage process and ripen throughout the transportation process. If you have never tried fresh tomatoes or strawberries one difference you may notice is how soft the skin of the fruit is when it is fresh. Fruiting crops present an extra level of complexity in growing because they need to be pollinated. Pollination happens when the pollen from the male part of the plant gets transferred to the female part of the plant. This can happen via insects moving the pollen such as honeybees, it can also be done by hand using brushes. Pollen is sometimes transferred outdoors by wind or indoors using fans. Fruits like leafy greens help provide a balanced diet through important vitamins and minerals. They also offer more calories and macronutrients than many leafy greens but not enough to sustain daily caloric intake.



Grains

Grains such as barley, rice, and oatmeal as well as starchy vegetables such as potatoes are a good way to help satisfy the daily caloric intake needed. They offer a solid basis of both micro and macronutrients, specifically, they pack a ton of carbohydrates which can provide energy to people. These crops are more difficult to grow in systems without soil due to their size and how they grow. However, that does not mean there aren't novel solutions for growing. Potatoes for example can grow very well in a stacked vertical system as seen below. This system can grow up to 100lbs of potatoes in as little as 4 square feet! Adding to the mix of fruits, leafy greens, and grains it is also important that individuals consume meats and alternatives to keep a healthy balanced diet.



Meat & Alternatives

Meat products provide many macronutrients, particularly proteins and fats, as well as essential micronutrients for a balanced diet. Meat can be obtained from traditional sources such as hunting or by purchasing from the store. Additionally, there are options for consumers who choose not to consume meat to meet their macro and micronutrient needs through alternative products such as soy, tofu, tempeh, legumes, and others.

In addition to what we think of as 'normal' meat sources companies are increasingly focusing on creating realistic meat substitutes. Companies such as 'Beyond Meat' (www.beyondmeat.com) and 'Impossible Foods' (www.impossiblefoods.com) are creating meat alternatives that look, taste and behave like real meat in almost every way. They are doing this all while greatly minimizing the environmental impacts of their products.

Northern Initiatives Focused on Growing

Food security in the north is an issue that has captured the attention of individuals and communities across Canada and the world. Several initiatives are working on growing food in the north. Two of these projects are Green Iglu and the Growcer. Though they both have different approaches to feeding the North they both have the same mission, providing affordable, nutritious food to local communities.



Figure 2: Source www.ruralite.org/arctic/

The Growcer

The Growcer is a container farming set-up that is designed to be a turnkey solution that allows individuals to start their own self-contained farms in any climate. They have designed their system to require very little set-up in terms of power requirements or time. This system can be run on a single propane tank for energy and only 10-12 hours per week of work. More about the Growcer can be found on their website at: www.thegrowcer.ca.

Green Iglu

Green Iglu is a charitable organization based out of Toronto that pairs local greenhouse infrastructure with educational



Figure 3: Source growfarnorth.ca

programming to enable remote communities to grow affordable, nutritious food. Their vision is to build, grow, and empower a food secure Canada. Green Iglu's operations are integrated into the communities through stakeholder participation, horticulture education, and hiring local community members to ensure that each greenhouse can operate sustainably while supplying affordable food year-round. Their methods and technology have allowed remote communities to take ownership over their food supply chain and to grow produce in places never thought possible. Curious to learn more? Check out their website www.greeniglu.com

Fresh Food and Food Security

These initiatives are working to provide food security, having a reliable source of fresh, affordable nutritious food. These efforts provide benefits to the people consuming the produce in some subtle ways beyond providing enough supply to reduce the price.

By growing the produce fresh in the community, it allows people to eat the produce within hours of it being picked. This adds better flavours and textures but also has better nutrient content. Micronutrients have been observed to start to break down beginning when produce is picked. So, the longer it takes from harvest to your plate the lower the micronutrient content becomes (Barrett 2007). This does not mean that produce that is not ultra-fresh isn't worth consuming, as it certainly is, but just that there may be lower micronutrient content within this produce.



Growing fresh food in the community is also a means to reduce emissions from transportation. Transportation emissions can add significantly to the carbon footprint of produce. There has been interesting work done on what is called 'food miles' (the distance food travels before arriving on your plate) to evaluate which part of the transportation process has the most significant impact. These works state correctly that local food is not always the most important aspect in food security globally, that diversification of food sources through trade and shipping plays an important role in providing affordable food to a global population (Desroschers & Hiroko 2012).

Global Case Studies in Food Production

Around the globe, efforts are being made to make produce affordable, abundant, and to lessen its environmental impact. These can be at the molecular level like smart nitrogen which has a delayed-release formula that reduces the nitrous oxide (a chemical used in fertilizer) released into the local watershed by having the fertilizer release itself slowly over time (Li et al., 2012). There have also been recent advances in large-scale indoor farming with the success of companies such as Plenty Inc and Aerofarms.

Indoor farming on a large scale has been in existence for a long time in the form of greenhouses, however recent advances in LED technology have made true indoor farming a profitable venture. This allows indoor farms to grow far more produce and design their systems to grow vertically in an ultra-contained space for maximum production as seen below.



Figure 4: Source aerofarms.com

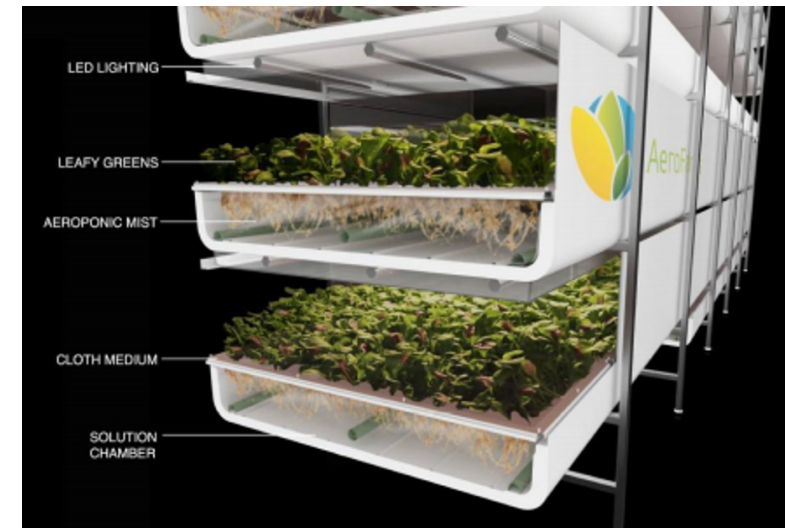


Figure 5: Source aerofarms.com

allows people to build truly innovative cutting-edge farms anywhere in the world.

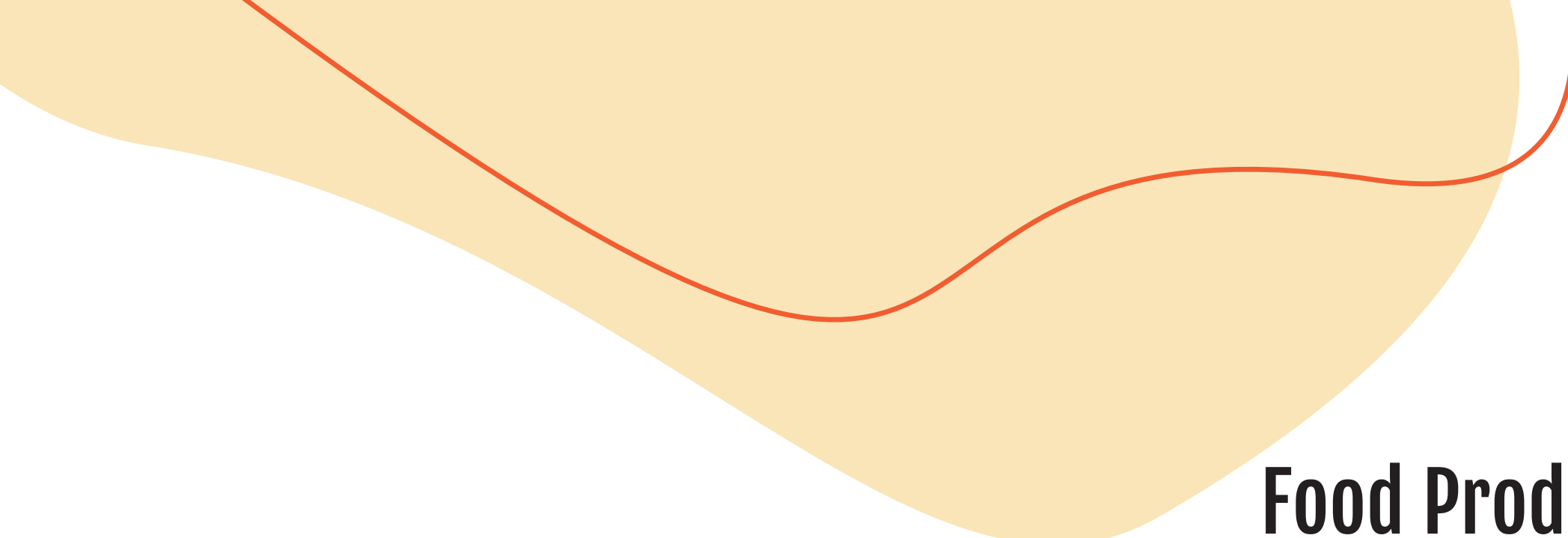
In addition to large-scale central farms, there has also been a movement in recent years towards empowering individuals to grow some of their own produce. These individual systems for homes work to leverage some of the same aeroponic and hydroponic technologies that have been utilized in large-scale farms.

Just Vertical is an example of one of these companies. As

they are part of an individual's home they also must fit into the home and lifestyle of the user. This can be included in design



Figure 6: Source justvertical.com



by fitting into a room (as seen above) or via user interaction by leveraging app technology to work with a user's smartphone. In the end, the solution to feeding a growing global population will not come from a single source but will be a combination of all these solutions: centralized, community-based, and individual.

Solutions also arise from communities working with each other and not purely technical advances or changes. Communities that grow their own food either centrally or individually can also benefit from sharing within their community and with other surrounding communities. This sharing can take the form of selling produce, bartering, or giving. This sharing can promote resiliency within the community, if a neighbour's crop fails and an agreement is in place to share what is grown, one person's failure does not mean they will go hungry, the community acts to support each other. This acts as a form of insurance for the community's food resiliency.

Food Production in Your Community

Community-level food production takes many different forms, from your backyard veggie garden to the lettuce pot in the window. One of the new and innovative ways people are championing this is through indoor gardening. Indoor gardening has now progressed in science and design to the point where companies like Just Vertical have fused design and science into one functional piece.

Check out Just Verticals products and how they take on indoor gardening at: justvertical.com

Practical Challenges to Maintaining Plant Life

Maintaining plants indoors or outdoors requires various inputs in the form of time, energy, water, nutrients, and others. In either case, it takes some learning to make sure that the plants thrive.

In a traditional outdoor agriculture setting on a large farm mechanical equipment such as tractors and combines are often used to help reduce the amount of labour required. Outdoor agriculture often relies on the sun and rain to help the plants grow with little human interaction. Farmers may add fertilizers such as nitrogen, potassium, or phosphorus to the soil to help improve yields. Often pesticides or herbicides are applied to fields to protect the crops from insects or weeds.

Indoor agriculture presents its own set of challenges often requiring more human labour. Indoor agriculture usually requires human intervention to get the water to the plants either manually or via a pump system. Indoor agriculture also requires that soil, nutrients or both are brought indoors to the system to provide something for the seeds to grow in. Indoor agriculture may also require supplemental lighting which is another source of energy use. Setting up an indoor growing system is more expensive in the short term as the actual structure and insides need to be built. However, as discussed earlier these indoor systems can be built in places that outdoor agriculture is not feasible leading to long-term gains. Indoor agriculture also provides a method to de-risk growing by protecting the crops from the elements.





CONCLUSION & KEYWORDS

Conclusion

Indoor agriculture provides a great outlet for community empowerment, a way to provide food, and a source of income. However, it will not solve food insecurity for communities by itself. There are still technical challenges growing in such remote and harsh conditions that hamper the ability to grow enough for everyone or all year long. Setting up greenhouses for communities is still quite expensive and may not be feasible for every community. There are also barriers to having successful greenhouses such as the knowledge required to operate one and to care for it.

Keywords

Micronutrients

A chemical element or substance required in trace amounts for the normal growth and development of living organisms.

Macronutrients

A substance required in relatively large amounts by living organisms, in particular: a type of food (e.g., fat, protein, carbohydrate) required in large amounts in the human diet, a chemical element (e.g., potassium, magnesium, calcium) required in large amounts for plant growth and development.

Geodesic Greenhouse

A dome constructed of short struts following geodesic lines and forming an open framework of triangles or polygons. Widely used in growing as it maximizes growing conditions.

THANK YOU!



JUST VERTICAL