Department of Agriculture
Special Area for Agricultural Development Program and **Agricultural Training Institute**
daan sa maunlad na kabuhayan

Why Conurbation Needs a Sustainable Urban and Peri-Urban Agriculture

Editors
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An urban farm in Alabama, United States of America. Image Source: Farm Flavor

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About this Book

The CoViD-19 pandemic brought realizations that urban and peri-urban agriculture (UPA) is critical in ensuring the security of households' food and nutrition in many cities in the Philippines. The conceptualization of this book titled **'Why Conurbation Needs a Sustainable Urban and Peri-Urban Agriculture'** was made possible to document activities of the Department of Agriculture´s Plant, Plant, Plant Program wherein UPA is a tool to provide food access to affected urban families.

Information contained in this material revolves on the local and global scenario of UPA production system, research and development (R&D) efforts, economic significance, and recommendation domains.

Readers of this book will get insights on the aspects mentioned. These are invaluable inputs to reveal the potentials and prospects of UPA that can guide all the actors (scientists, policy makers, extension workers, farmers, and fishers) involved in its production system.

The editors of the book hope to help urban families to start a low-cost UPA livelihood production in their homes or communities and its potential for focusing on food security and its commercialization becomes even more important.

This book highlights the purpose for popularizing UPA as a major production hub for food security. With the Special Area for Agricultural Development (SAAD) Program and Agricultural Training Institutes' studies and guides, it is the wish of the editors and authors to provide a useful reference material on the various aspects of UPA.

Image Source: Rappler


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Foreword

The Department of Agriculture has long recognized the importance of urban and peri-urban agriculture in dealing with the issues of food miles, high prices and low quality of products, and climate change.

Now, as CoViD-19 suddenly ravages the nation and world with unprecedented infections, deaths, and social paralysis, the need to produce our food in our backyards has never sounded so urgent and imperative. Globally, the threat of hunger is as real and as palpable as the threat of CoViD-19.

As part of our Plant, Plant, Plant initiative, we at DA are more vigorously promoting urban agriculture by distributing free vegetable seeds and planting materials in all urban barangays and increasing our budget for the Urban Agriculture and *Gulayan* Projects (*Gulayan sa Paaralan*, Barangay, and idle private lots). We are also linking up with various institutions, local governments, and the private so that we can make a difference "in a big way" in this time of pandemic.

We also showcase and disseminate agricultural technology innovations, such as solar-powered urban aquaponics that combines vegetables and tilapia, or poultry-raising.

This book, entitled "**Why Conurbation Needs a Sustainable Urban and Peri-Urban Agriculture**", was crafted to emphasize the importance and ways of attaining a good quality and nutritious food that is directly available and accessible to every household.

Through this publication, we hope to guide Local Government Units and other policymakers and stakeholders, and inspire all urban green thumbs to join our crusade to fully develop urban agriculture, not only as an emergency survival scheme but also as part of the new normal.

Mabuhay!

William D. Dar, Ph.D.
Secretary
Department of Agriculture

Message

Food is at the heart of every nation and the lifeblood of the world economy. It is the very foundation of all of civilization. As we evolve, we are reminded more of just how important it is to have all the necessary systems in place to ensure the availability, accessibility, and sustainability of food sources in all parts of the globe.

In the Philippines, food production activities are mainly undertaken in the rural areas. Hence, any disruption along the agriculture chain will lead to serious consequences on food security and nutrition among urban populations, especially the poor. Thankfully, we are seeing a huge shift in people's mindset about farming nowadays. Household food security through urban and peri-urban agriculture has become a national movement on its own, with more and more practitioners joining the country's now-growing "food security army."

While urban areas do not have the rich natural resources that rural communities have to sustain their farming ventures, we at the Department of Agriculture (DA) and the Agricultural Training Institute (ATI) take this as an opportunity to level up our services so that all needs are met at both ends of the demand-and-supply spectrum. Under the urban agriculture initiative of the DA's "Plant, Plant, Plant" Program, we get to empower city residents to become self-reliant in terms of growing vegetables and other fast crops as an accessible, and affordable source of healthy and nutritious food. This is through the provision of planting materials, information campaigns, and capacity-building activities conducted through various platforms available to the urban agriculture practitioners.

To strengthen the urban agriculture system, partnerships with local government units, academic institutions, non-government groups, and other public offices are also being forged. In this way, we can be assured that local and institutional mechanisms and policies will be in place to support the urban farming opportunities. This publication, additionally, forms a significant part of that support system needed by our urban agriculture practitioners as they learn and journey towards food security. While there is no one-size-fits-all solution to any agriculture venture, continuous learning is key to a productive urban agriculture experience. This book will allow any urban agriculture practitioner to actively seek knowledge, improve their skills, and foster a positive attitude towards agriculture despite any setback. May this document serve as a way to preserve urban agriculture as a viable industry rather than just a short-lived fad.

A number of reports point towards how much urban agriculture can feed the world's growing population especially in the cities. More than that, we see the opportunity for social and economic integration of different sectors of society, including women and the youth, as we expand our development strategies. It is our hope that publications such as this one will continue to open the eyes of Filipinos to the importance of urban agriculture in diversifying livelihood opportunities, supporting public health and nutrition, and increasing efforts to protect and preserve environmental and natural resources.

We recognize that this is only the start of our urban agriculture journey and we are truly excited to see how this venture will transform and adapt to the modern times. It is indeed an exciting time to be making our own contribution towards a food-secure nation. Together, let us continue to plant, plant, plant!

Rosana P. Mula, Ph.D.
Assistant Director
Agricultural Training Institute

Message

Humans in their quest to avoid hunger uncovered that cultivation of crops, domestication of animals, and raising fish and shellfish are ways of securing food for their families. Today, with the rapid urbanization rate that results in dwindling resources like space and affects the quality of environment, people are challenged to find alternative, simple, and practical ways of food production.

Under the new normal situation brought by the CoViD-19 pandemic, the Philippine government is increasingly prioritizing initiatives oriented towards empowering households economically and in matters of food and health security. Guided by the Plant, Plant, Plant paradigm launched in April 2020 by the Department of Agriculture is a significant milestone of Sec. William D. Dar's leadership. The Urban and Peri-Urban Agriculture (UPA) to name one guarantees the availability of safe and nutritious food in urban and peri-urban communities.

The Special Area for Agricultural Development (SAAD) adhered and implemented the UPA in 17 cities --- the home of the 30 poorest of the poor provinces. The restrictions in logistics especially the movement of food and the stoppage of work among the service sector led SAAD to do its share in abating the situation of increasing price and securing livelihoods of resource-poor households.

This print material on UPA contains strategies to improve food production and a forward looking perspective towards entrepreneurship such as processing and value adding. In this material are illustration of UPA models practiced and adopted by families and communities. These include growing crops; raise animals, fish, and shellfish that is integrated with agricultural technology innovations.

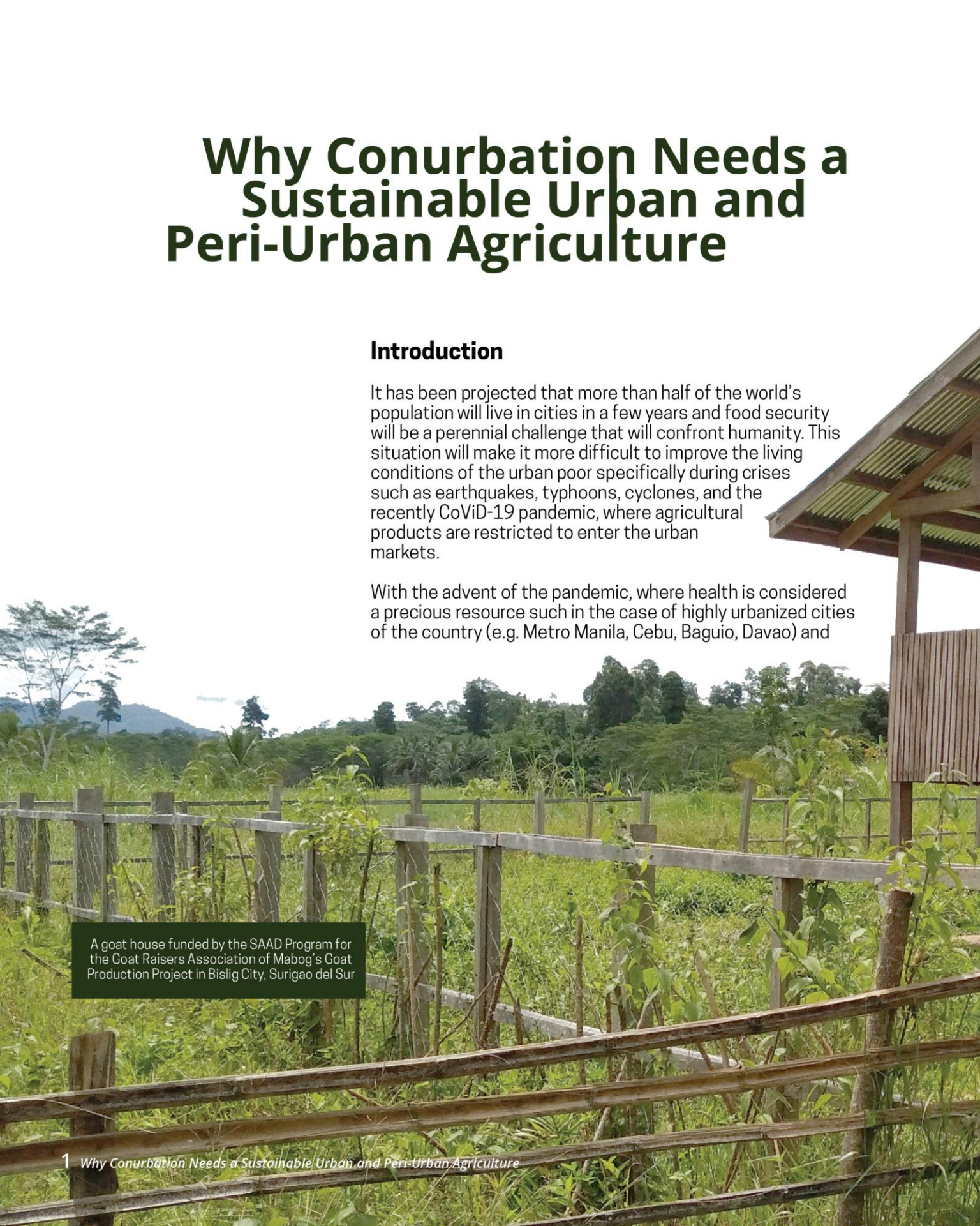
Myer G. Mula, Ph.D.
Program Director
Special Area for Agricultural Development

Why Conurbation Needs a Sustainable Urban and Peri-Urban Agriculture

Introduction

It has been projected that more than half of the world's population will live in cities in a few years and food security will be a perennial challenge that will confront humanity. This situation will make it more difficult to improve the living conditions of the urban poor specifically during crises such as earthquakes, typhoons, cyclones, and the recently CoViD-19 pandemic, where agricultural products are restricted to enter the urban markets.

With the advent of the pandemic, where health is considered a precious resource such in the case of highly urbanized cities of the country (e.g. Metro Manila, Cebu, Baguio, Davao) and



A goat house funded by the SAAD Program for the Goat Raisers Association of Mabog's Goat Production Project in Bislig City, Surigao del Sur

the 30 poorest of the poor provinces covered by the Special Area for Agricultural Development (SAAD) Program of the Department of Agriculture, the enormous potential of urban and peri-urban agriculture (UPA) as a sustainable food source is life-altering.

Urban and peri-urban agriculture has existed in various forms and occurs within and surrounding the boundaries of major cities. It was first documented during the Aztec and Mayan civilizations and in prehistoric Jericho in various forms and locations. An advantage of UPA is being in control of the type of crops, animals, and fish to raise considering the household needs and availability of resources.

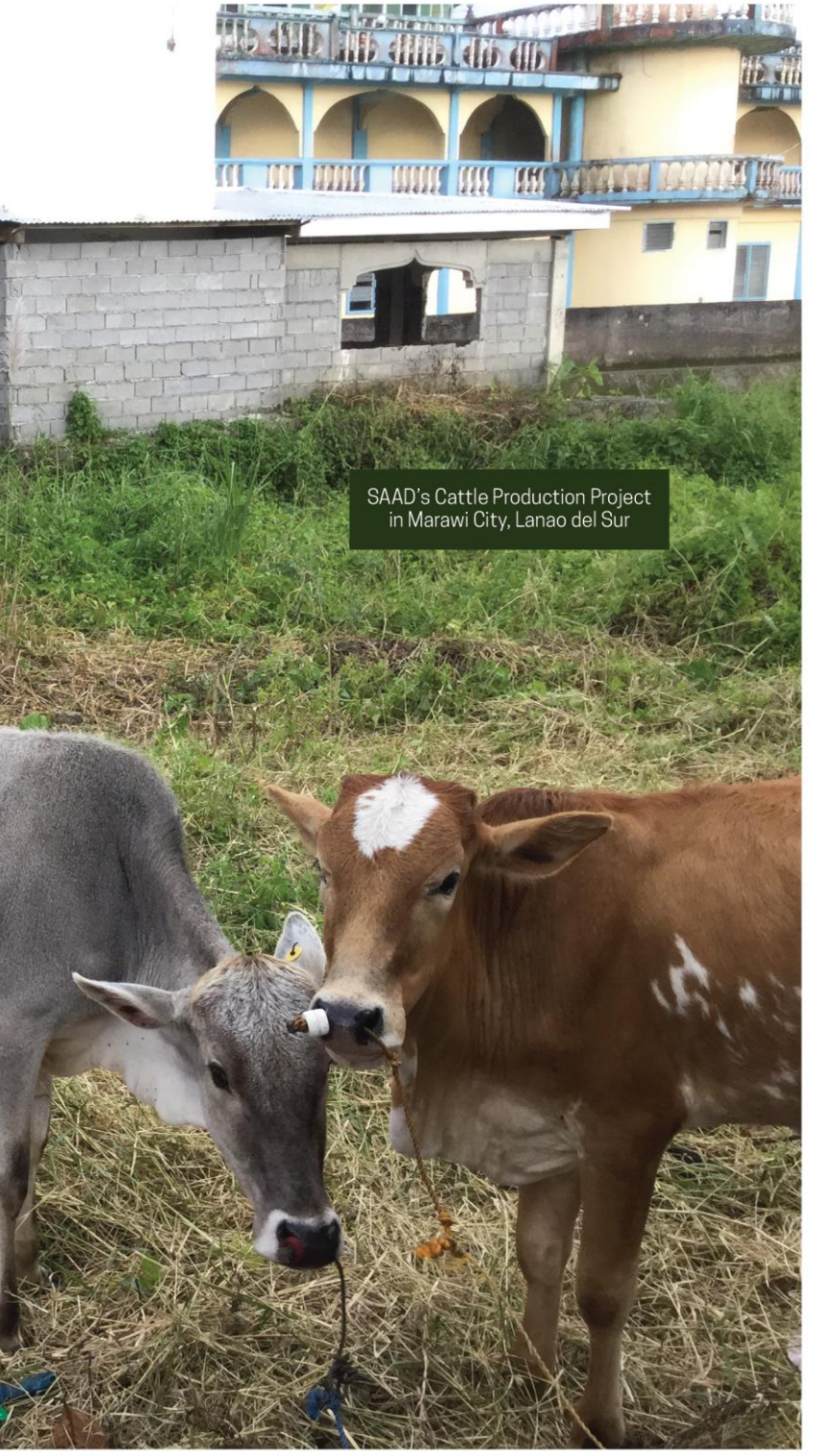
We all know that people in the countryside continue to flock to cities due to economic, social and creative opportunities. However, urbanization also presents major challenges. In the Philippines, urbanization is rapidly increasing with almost 49% of Filipinos now living in urban areas, and by 2030, that number is expected to jump to 77%. Metro Manila, for instance, has more than 12 million inhabitants, many living in dense communities with large building structures.

Likewise, the average Filipino household also spends more than 40% of its income on food, while the poorest Filipinos have to allocate almost 60% of their available household budget to feed their families.

Traffic congestion, rising fuel prices, high cost of basic commodities, and poor road system have produced a problem in moving agricultural products from rural areas to urban markets where a lot of people reside and where the food is consumed more.

In these settings, the driving force appears to be increased migration from rural to urban areas, along with increased demand for crop-, animal-, and fish-based foods. At the same time, there is an urbanization of poverty, the challenges facing global agricultural production and food security, and malnutrition is a prevailing problem among the urban poor. The changing state of agriculture over time led to farming communities and policymakers to search for more remunerative and viable production portfolios during the time of crisis.

SAAD's Corn Production Project in Dapitan City, Zamboanga del Norte



SAAD's Cattle Production Project in Marawi City, Lanao del Sur

Urban and peri-urban agriculture has seen in recent years a clear shift mainly to produce vegetables for food and ornamentals for beautification to raising animals and fish. At present, growing crops and raising animals, and fish in urban and peri-urban areas is a common practice in many low-income countries and an important survival strategy for the urban poor while viewing economic return estimated to be comparable to the income of unskilled construction workers.

Crops, animals, fish, and shellfish will offer an opportunity to improve the quality of life through the accessibility of food, improve nutrition, and increase cash income from sales. Improved nutrition is attained as these households are likely to consume a diverse and nutritious diet to enhance their immune system. As diets change, as a consequence of urbanization and rising income, urban production may also, to some extent, meet the increased urban demand for food, and may complement rural and foreign sources of food supply to cities. It has been estimated that urban and peri-urban production only represents 20 - 30% of the country's total food production while 80% of food stock in urban areas is supplied by rural areas and imports.

The collective benefits from UPA include among others solving transportation problems, air pollution, and converting urban waste into organic fertilizer. To ensure the sustainability of production, UPA productivity needs an integrated production model through agricultural technology innovation (e.g. hydroponics and aquaponics) that will create a resilient food systems to accelerate the realization of food security. Given the potential benefits of UPA, government policies need to provide access to electricity, clean irrigation water, while also protecting and improving public health.

Bryan Tingas from Butuan City turned his backyard into vegetable garden during the CoViD-19 crisis. Image Source: PIA Caraga

In conclusion, the SAAD program has initiated the implementation of UPA including documenting and releasing six articles in advocating food availability and accessibility in support to DA's Plant, Plant, Plant Program namely: Container and Vertical Gardening for Vegetables and Herbs; Aquaculture for Tilapia and *Hito*; Livestock and poultry raising in urban and peri-urban areas; Hydroponics: an answer to food always in the home; Aquaponics: A perfect setting to feed urban and peri-urban families; and Vegetables you can harvest in less than two months to boost the immune system.

Aquaponics for crayfish. Image Source: aquaponictrend.blogspot.com

Goat Raisers Association of Mabog's Goat Production Project in Bislig City, Surigao del Sur

Agriculture Secretary William Dar and James Reid lead the launch of the Plant, Plant Plant Program on May 26, 2020, at the DA Central Office in Quezon City. Image Source: Business Mirror

Chapter 1

Container and Vertical Gardening for Vegetables, Herbs, and Fruits

by Myer G. Mula and Jemiema D.R. Arro

Image Source: Department of Agriculture - MIMAROPA Region

Introduction

Living situation in urban areas, such as Metro Manila, Baguio City, Davao, and Cebu, is becoming more and more difficult because of the influx of people in search of livelihood opportunities. This in turn results in the scramble for space either legally or illegally for household structure as well as for food production.

The continuous flow of people in the cities necessitates a form of intervention that will allow households to cope not just with shelter but most importantly for food. It has been proven that in times of food crisis, such as the CoViD-19 pandemic, urban dwellers will have to explore coping strategies to buffer the situation for food availability and accessibility. That is when urban or home gardening can be done. Intensive cultivation in a small space provides not only food on the table but also some cash because of the diverse production strategy in home gardens.

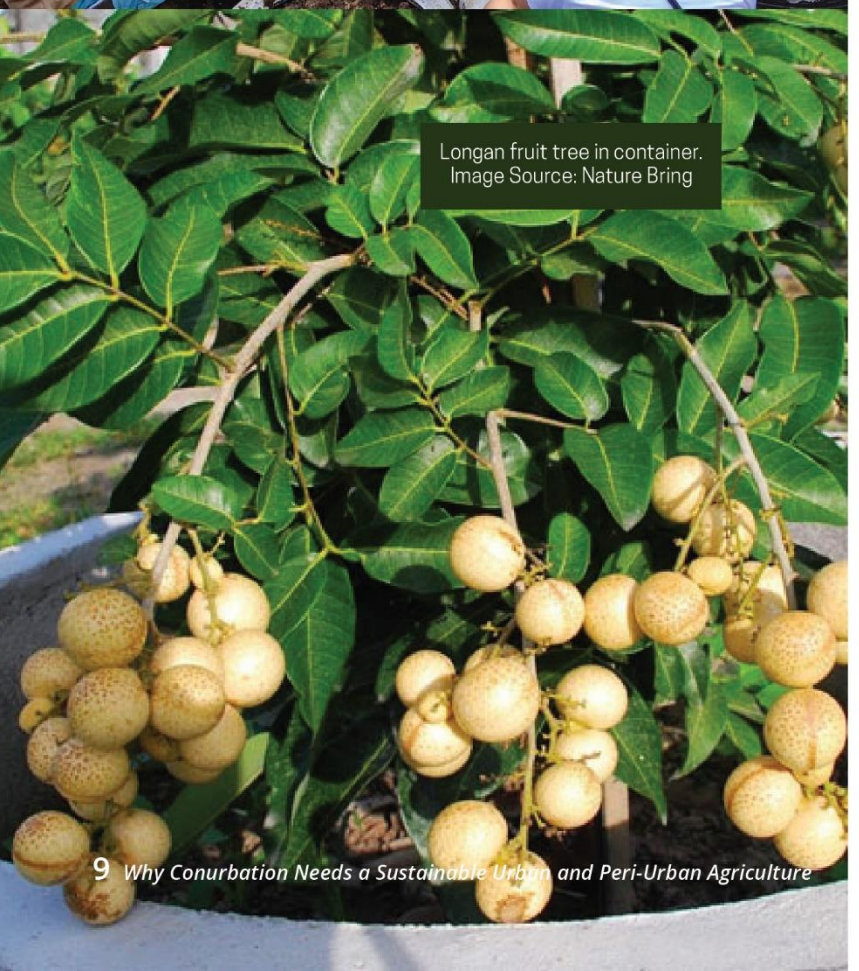
There are varied ways of producing food in urban areas. It is a form of farming using recycled containers. This could be done in any available space provided there is sunlight and air. Urban gardening often means growing food on rooftops, balconies, alleyways, sidewalks, or areas with spaces to put garden beds with. The problem is, not everyone has a backyard, roof, or balcony. We can overcome this by considering container gardening and vertical gardening. Container gardening involves growing plants in smaller containers, pots, or other vessels. You can be resourceful or creative by upcycling containers, such as crates, old toys, or paint cans. On the other hand, vertical gardening involves growing plants up a wall, or other vertical areas to maximize the use of space.

The government has recognized and supported urban gardening since 1998. The Department of Agriculture already implemented “Garden in the Sidewalk" and "Gulay sa Likod Bahay" programs. Through these, the Agricultural Training Institute (ATI) and the Bureau of Plant Industry (BPI) extended support to the informal settlers, including other urban families who would like to participate in the program.

In 2020, Agriculture Secretary William D. Dar once again emphasized the importance of urban agriculture through the Plant, Plant, Plant Program as a lot of Filipino families struggle for food accessibility because of the CoViD-19 pandemic.

Agriculture Secretary William Dar led the harvesting of fresh vegetables from the model Urban Agriculture project at ATI Quezon City.

Container gardening at Brgy. 6, Bañadero, Legazpi City. Image Source: Rotaract Club of Metro Legazpi



Longan fruit tree in container. Image Source: Nature Bring

Container Gardening

If you have limited outdoor space, be it a small yard, shared courtyard or balcony, a container garden with vegetables and fruits may be the ideal thing for you. One of the great things about container gardening is the ability to grow almost any vegetable and many varieties of fruit, given the right conditions and space enough for an appropriately-sized container.

With the right amount of sun exposure and watering system it's even feasible to successfully grow small fruit trees, such as star apple, chicos, guavas, longan, lemon, oranges, and calamansi. Mostly marcotted planting materials will bear fruit in a year.

Container gardens are also extremely space efficient as every part of soil will count for fruit and vegetable production - no growing space will be wasted as you care for and harvest your plants. Container garden also has the added benefit of being a great back-saver, or they can be configured for those with reduced mobility, making certain that growing fresh fruit and vegetables at home is accessible to all.

Yet another unique thing about container gardening is your ability as the gardener to chase the sun if necessary, as containers can be moved throughout the day. If you have no time to be moving containers whilst life carries on around you, no problem, plant for the amount of sun you have.

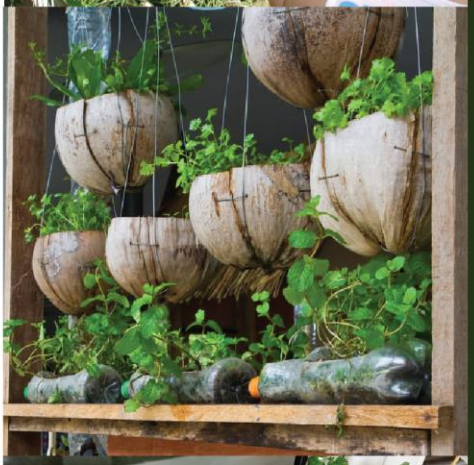
While it's true that many plants will demand a minimum of six hours of direct sun per day there are several 'shade vegetables' that will tolerate or thrive in partial shade and dappled sunlight.

A few things to consider in container gardening:

- 'Upcycling' can lead to some very interesting containers - steel pasta strainers are great for kitchen herbs, reclaimed vintage boxes will add flair to your vegetative stylings and even upcycled plastic totes can make great planters if you're more concerned with utility than style. You are limited only by your imagination and preferences. You'll want to remember to allow for drainage, so if necessary drill holes or otherwise puncture the bottom of your chosen containers.
- Almost any plant will grow in a container if the container is big enough.
- Straw bales themselves can be used as containers for gardening, even if they can be a little messy and break down relatively quickly they are one viable option. We've been enjoying pumpkins and zucchini straight off the top of straw bales this season - and it couldn't be easier.
- Be sure to provide enough water and food when gardening in containers, as the soil in containers will dry out faster and nutrients tend to flush through them with greater speed than their in-ground counterparts.
- Assess your sun exposure and plant accordingly.

Banana and pineapple growing in containers. Image Source: Garden DIY Ideas

Vegetables and fruits in a small yard container garden in the Philippines. Image Source: desertification. wordpress.com



Coconut shells and plastic bottles as upcycled container. Image Source: Shutterstock

Strawberry in containers. Image Source: The Upside

Eggplant and tomato in containers. Image Source: Grow it Organically

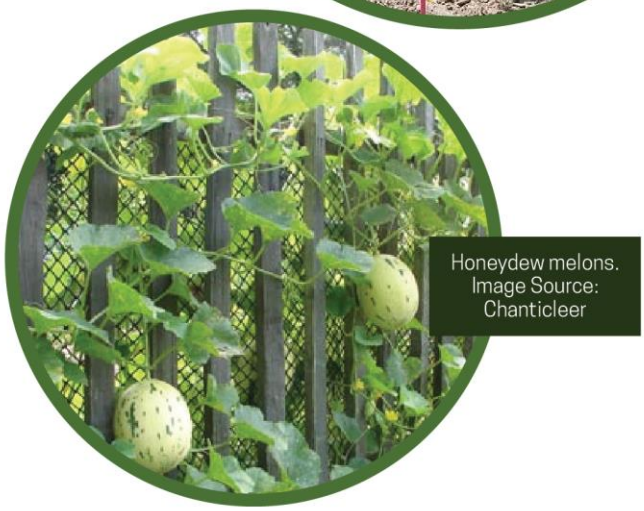
Vertical garden for tomatoes. Image Source: Seed to Pantry School

Vertical Gardening

There are so many ways to grow upwards - most vegetables and fruit-bearing plants grow upwards - when fitting food production into a smaller space, consider using a traditional trellis to a recycled pallet planter to a hanging hydroponic window garden. The options for vertical gardening are vast and require only some creativity - making productive space out of lost space is the key to maximum productivity in the small urban garden. Here are just a few to get you started:

Growing cucumbers on trellis. Image Source: Balcony Garden Web

- **Tomatoes** are very happy to grow in an upward or upside-down fashion when given the right amount of support. Old nylons cut into strips are fabulous for tying your plants to their upward structures as they are flexible and will result in the least amount of stress on the plant where they are attached. Maybe you don't wear nylons or your nylons are far too valuable to use in your urban garden, no worries, pick some up at the thrift store, they'll cost next to nothing. Alternatively, plant at the top of a wall down to a basement, and watch the branches fill up with sweet cherry tomatoes as the summer progresses.



Honeydew melons. Image Source: Chanticleer

- **Winter squash** and **melons** will happily grow towards the sky. Again, they will need adequate support, particularly as they begin to fruit, but they react well to being trained to where you have the room.
- **Peas** and **pole beans** will happily grow up anything strong enough to support them.
- **Cucumbers** are relatively simple to grow in the smallest of spaces.

Shoe-holder garden.
Image Source: Garden Web

- **Asian greens, salad greens,** and **kitchen herbs** will all happily grow in nothing more than a recycled pallet on its side.

- **Greens** or **kitchen herbs** will also happily grow in sections of rain gutter which can either hang or be fixed to the side of almost any southward facing structure or in a network of hanging bottles in a south-facing window.

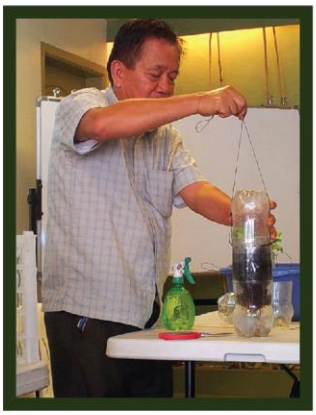
- **Potatoes** will grow vertically if provided with the right container. Imagine you're using a clean garbage can with all kinds of holes drilled in the bottom. Throw down a few inches of soil and compost, add your cut and cured pieces of seed potatoes and cover them with 6 more inches of dirt then water. When the aerial parts of the plant have reached about 6 - 8 inches, add more soil leaving only a few inches of green exposed. This cycle can be repeated several times throughout the season. When the plants turn brown and die, it's time to harvest.

Potato tower.
Image Source:
Starting From
Scratch

- **Strawberries** will thrive in hanging baskets. Our ground covering strawberries do little more than make for fat, happy chipmunks, hanging them means you might get to eat some too.

After deciding to grow your own vegetables, choosing the right plants for your space may be the most important decision you'll make. Many plants will require a minimum of 6 hours of direct sun per day and other vegetables will prefer partial shade during the hottest days of the summer. Assess your space, choose wisely.

Strawberries on wall.
Image Source: Imgur



Let's start growing our food. Just remember these five rules based from the Enriched Potting Preparation technology of Dr. Eduardo P. Paningbatan, retired Professor ng Agricultural Systems Institute ng University of the Philippines Los Baños.

1. **Plant Selection**. Aside from the vegetables and fruits identified earlier, there are vegetable and herb varieties that are easy to grow in urban spaces, such as lettuce, *pechay*, spring onion, basil, mint leaves, etc. They can easily be bought from hardware, grocery stores, or your nearest Agrivet stores.

2. **Plant Right**. Potting your plants takes a few simple steps.

   - Put some gravel in the bottom of your container or put small holes in your upcycled container to help with drainage. Without proper drainage, soil can become waterlogged and plants may die.

   - Fill the container with soil mix, which is composed of ⅓ compost, ⅓ carbonized rice hull, and ⅓ garden soil.

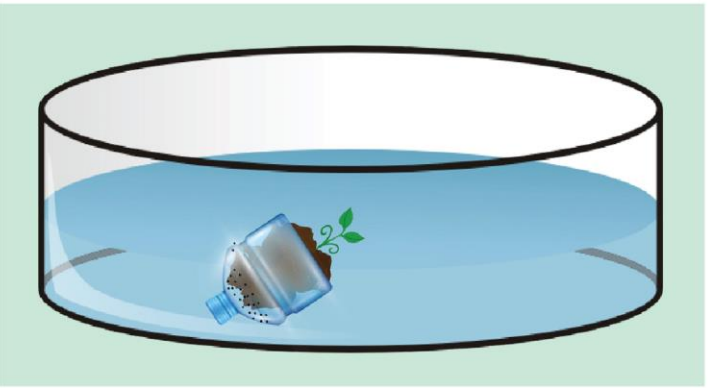
   - Tamp the soil after the seeds or seedlings are in place.

   - Water gently and expose the plants under the sun strictly for only two hours.

Image Source:
DOST-PCAARRD

3. **Water Wisely**. Hand water every morning. During the summer season, watering in the evening is advisable. A little afternoon shade can keep them from drying out too quickly.

4. **Prevent Pests**. If pests were observed, you can submerge the plant in a bucket full of water for 10 to 20 minutes. Don't use pesticides.



5. **Plants need food too**. Like humans, plants also need nutrition to grow. Water and sunlight may not just be enough for them. Feed your vegetation with Compost oil Extract (CSE). Shake the CSE well to dilute it. Mix five tablespoons of CSE in a liter of water. Use the mixture to water the plants. This should be done once a week.

Chapter 2

Container Aquaculture for Tilapia and *Hito*

by Myer G. Mula and Jemiema D.R. Arro

Image Source: aquaponicmanual.blogspot.com

Urban and peri-urban agriculture occurs within and surrounding the boundaries of major cities and includes products from crops, livestock, fisheries, and forestry, which ensues through a multiple farming and gardening systems. Collective benefits from this system include among others food accessibility; increase the availability of fresh, perishable food; can enrich urban environment; solving transportation problems, converting urban waste into fertilizers; and recreational activities.

This type of agricultural mechanism is abetting people leaving within the community and adjacent communities to cope with food scarcity and hunger during the time of crisis such as the CoViD-19 pandemic where the movement of people is restricted to work for income to support their family daily needs.

The SAAD Program launched on April 27, 2020 the first series which is Container and Vertical Gardening for Vegetables and Herbs to advocate food availability and accessibility in support of DA's Plant, Plant, Plant Program.

This section will focus on raising fish in backyards, in containers, on balconies, on rooftops, in school gardens, on river banks, and communal lands to improve sources of food and will likewise offer many urban poor a viable income, job, and protein source.

Many studies suggest that one can now simply raise tilapia (*Oreochromis niloticus*) and *hito* (catfish) in their homes with plastic drums or tanks. The technology has become the mainstay of small-scale aquaculture projects in many developing countries, including the Pacific region. It is manageable, environment-friendly, adaptable to urban and peri-urban conditions. Other freshwater fish, such as carp, and shellfish can also be raised.

Filipinos exposing themselves from the CoViD-19 as they wait in line outside a supermarket in Manila. Image Source: The Telegraph online

Aquaculture farming using a shipping container in South Africa. Image Source: Innovatedevelopment.org

Tilapia and *hito* are some of the consumable freshwater fishes in the Philippines. They manifest both firm and delicious flesh. They can be processed into dried, salted dried, smoked or pickled products.

In 2009, the Bureau of Fisheries and Aquatic Resources (BFAR) in Region 10 demonstrated the low-cost technology in three barangays in Cagayan de Oro City. The method uses plastic drum containers to grow food fish and does not require aeration and other expensive accessories. In the demo, 30 to 50 pieces of 3-4 inches *hito* can be grown in one plastic drum with a survival rate of 90%.

Tilaipia-raising in a drum. Image Source: Herbie Emmanuel Medalla

Image Source: FishFarm Tank

Image Source: Survival Kit

Three-barrel aquaculture system. Image Source: R&D Aquafarms Inc.

There are also some barangays in the National Capital Region that practice container aquaculture for tilapia. According to David V. Balillia, who is in charge of Gulayan at Bulaklakan in Barangay Holy Spirit in Quezon City, urban residents can become producers of fish if they convert plastic containers into fish ponds in their backyard. A 45-gallon plastic drum can grow about 50 tilapia up to its consumable size in four months. In 2014, the said barangay created a demo farm, which won the major distinction as the Outstanding Farmers of the Philippines.

This guide briefly describes how to raise tilapia and *hito* in your own backyard using 200-liter plastic drums. Other containers found in the house such as old refrigerators, fiberglass tanks or even large washing dishes can also be used.

Let's start setting up the container aquaculture at home!

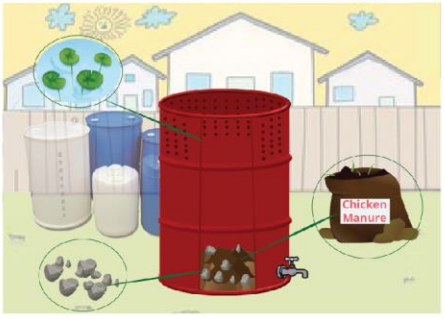
1. **Site selection**. Select a site here water and sunlight are accessible throughout the year. Containers should get enough sunlight to allow the growth of small aquatic plants (algae), which will serve as food for the fishes. Place the containers in a site where it can collect some rainwater but still be protected from heavy downpour, which may cause overflowing.

2. **Preparation of drums**. Choose a large barrel or drum that is not less than a meter deep and with a large surface area. A drum about 100 cm high and 54 cm wide (200-liter) can grow 20 fishes.

   Drill small holes at the top edge of the drum or barrel above the desired waterline to reduce the chance of overflowing during heavy rain.

   Add rocks and gravel as well as floating and submerged plants. Add a small shovel-full of natural manure to the drum. Chicken manure works well. Apply chicken manure at the bottom of the drum with a depth of about 6 cm.

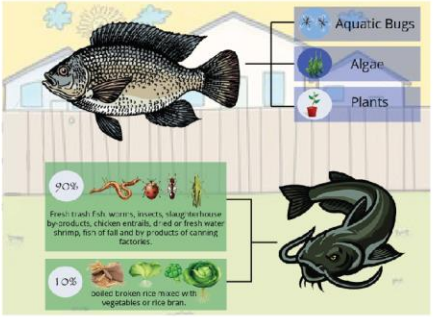
   Fill the drum with fresh water. Rainwater or underground water can be used to raise tilapia or *hito*. Let the water-filled drum stand for one week to dechlorinate and settle.

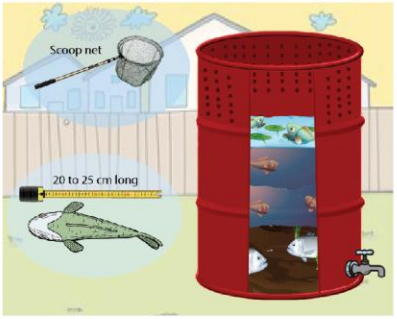


3. **Stocking**. Make sure the drums are clean from dirt, unwanted weeds, and fishes. Maintain one fish per 10 liters of water. Stock the drums either early in the morning or late in the afternoon when the water temperature is low so as not to stress and weaken the fish.

4. **Feeding**. The tilapia thrives well on aquatic bugs, algae, and plants while the hito feeds on 90% meat or other protein sources and the remaining 10% is composed of boiled broken rice mixed with vegetables or rice bran. Fertilize the drums once a month to ensure good production of algae. To maintain it, use a bag filled with leaves, manure, and scraps.

5. **Harvesting**. For tilapia, harvesting can be done five months after stocking. Select a net that will fit the opening of the drum. Dip or lift nets are suitable. For *hito*, the rearing period depends upon the size of fingerlings stocked. Harvesting can be done when the fish are about 20 to 25 cm long. Draining the drum or any container should be done before capturing them by seines (net hung vertically, one side with floats, the other side with sinkers) or scoop nets.





Backyard fish farm. Image Source: Pinterest

Chapter 3

Livestock and Poultry-raising In Urban and Peri-Urban Areas

by Myer G. Mula and Natalianne O. Delos Reyes

SAAD's Layer Chicken Egg Production Project of Bayobay Livestock and Vegetable Production Association in Borongan City, Eastern Samar

Urban and peri-urban agriculture has existed in various forms and places for a long time. It was practiced in the Aztec and Mayan civilizations and prehistoric Jericho. More recently, it has been banned in some modern cities, but continues to emerge in others. Lately, it even seems to be growing in importance and scope especially during times of crisis as in the case of the CoViD-19 pandemic. A city is resilient only if most of its residents can withstand and recover from the effects of a disaster.

Urban consumers use more animal products than rural consumers, and consumption as a whole seems to be increasing. Neglect of the livestock sector can only lead to negative developments, while positive attention can help to uncover the opportunities inherent to this form of livestock production.

Urban goat farmer in Oakland, California. Image Source: Sierra Club

Animal (livestock and poultry) raising has often been part and parcel of urban and peri-urban agriculture, presenting its own specific problems and opportunities. As with all branches of urban and peri-urban agriculture, animal keeping now seems to be recognized for the positive role that it can play on living conditions across the world. Animals may offer an opportunity to improve the quality of life through increased cash income from sales and improved nutrition. Improved nutrition is attained as these households are likely to consume a diverse and nutritious diet, including animal-based foods. As diets change, as a consequence of urbanization and rising income, urban animal production may also, to some extent, meet the increased urban demand for animal-based foods.

Maintaining animals in cities is common in many developing countries. Goats, pigs, ducks, quail, chickens, pigeons, rabbits and many other types of animals can be found in cities around the world. Each of these animals has its specific advantages and disadvantages. Particularly small animals are adaptable to backyard conditions, they require little capital to start with, it is easy to sell them and they reproduce fast.

Chicken. A major purpose of having chicken is also to supplement the household revenues in terms of food and cash. With low daily wages, the sale of only a few eggs can be a very substantial contribution to the family income. However, urban households with relatively high incomes keep chickens, especially laying hens, because they think that eggs produced at home are of higher quality than those found at the market. The special liking that people take for village raised chickens (more taste, tougher meat) is expressed at a higher price for these animals. A startup for low maintenance areas in urban areas would be five hens and a rooster.

Pigeon. Pigeon keeping is very popular in the Mediterranean region; for instance, in the Nile delta, dovecotes are common in both rural and urban areas. Pigeons can contribute substantially to household diets and income. They do not compete with other animals for space and feed; if fed by their owners, the birds tend to remain in the neighborhood, but they can find food within a radius of 15 km, thereby making use of the different vegetation cycles of local plants. In low-input systems, feeding is necessary only during the short period when the animals are getting accustomed to their new home.

Pigeons adapt easily to urban conditions and are a common sight as they scavenge in town squares and markets. Dovecotes are normally located on rooftops, which makes pigeon keeping possible even for people who live in high rise buildings. Pigeons brood about five times a year and reach maturity at about six months of age; incubation lasts 18 to 20 days and both sexes are involved in the hatching. Surprisingly, despite being easy to raise and cheap to produce, this species is very rarely considered in urban food security programs.

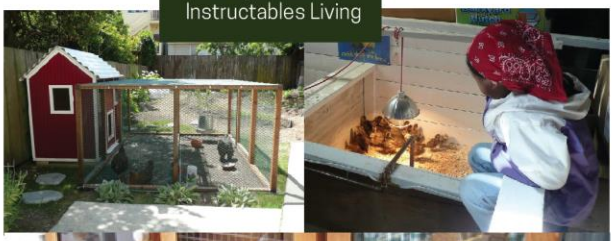


Image Source: Instructables Living


Image Source: Inhabitat


Image Source: Chase Guttman


Image Source: The Wall Street Journal


Image Source: The Urban Farmer

Quail. Locally named pugo are small fowl that exist in the wild but can also be raised in a backyard cage occupying small space and is not expensive. Unlike chickens, most city ordinances don't restrict or outlaw raising quail. They are quiet, small, even-tempered birds that can produce about five to six eggs per week. The capital needed is also very modest and the gestation period is short. In 35 days after hatching, the birds will start to lay eggs.

In urban quail raising, the monetary profit may not be the paramount consideration. It is having a supply of fresh eggs that is probably more important and very healthy low-fat white meat, and supplies the fertilizer you need for your home garden. If more urbanites will produce food, especially healthy food, then food security is enhanced. Even if there are areas that are struck by disasters and they cannot deliver the usual commodities to the metro areas, there will be food available from the urban farmers.

Rabbit. Raising rabbits in urban areas is common in many countries (i.e. Indonesia, Mexico, Ghana and Egypt) where rabbit meat is fast becoming a regular dish (and in others, it already is) and can be found in many restaurants, farmer's markets, and meat shops. In the Philippines, Filipinos have forgotten that rabbits were introduced after World War II by US Peace Corps and some religious missionaries to help alleviate the problem of food scarcity brought about by the devastation of war. Instead, rabbits have come to be cared for as pets instead of being produced as meat sources.

Image Source: Zac Sarian

Image Source: Oakland North

Image Source: Money Crashers

Image Source: FAO

Image Source: Monthly Agriculture

Because of its tremendous nutritional benefits, the United States Department of Agriculture (USDA) has proclaimed it as "the most nutritious meat known to man." It is a good source of protein and is recommended for a variety of health-specific specialty diets. It is low in cholesterol, saturated fats, calories, and sodium, and can provide 100% of the recommended daily allowance (RDA) for vitamin B12.

Growing rabbits requires little space and can be done on the farm, backyard, or even a small space at home. Start your rabbit farm on a small scale while learning the basics. A good way to start small is by getting two bucks and 10 does.

In the Philippines, there is a group called Association of Rabbit Meat Producers (ARaMP Inc.) which was organized to establish and develop the rabbit industry in the country and to advocate the use of rabbit meat in Filipino households. The national organization was formed in August 2015 and presently has 176 rabbit raisers, with the majority members from Central Luzon, (Bulacan), which is eyed to be the "Rabbit Capital of the Philippines".

Image Source: Rural Living Today

According to Ms. Angelica Veneracion of ARaMP, their organization is growing despite the pandemic, as they are continuing to develop bigger production capacities; the majority of their production goes to the rabbit raisers who are breeding or expanding their capacity. They have a niche market of healthy meat consumers. The excess bucks are slaughtered and used as the protein source by the families of the raisers and are also being sold at the market in the form of frozen rabbit meat.

SAAD's Swine Production Project of Bayobay Livestock and Vegetable Production Association in Borongan City, Eastern Samar

Image Source
My Farm Blog

Pig. Swine or pig farming allows households to generate supplementary income in peri-urban squatter settlements (slums). Pig keeping adapts well to being a mostly family-type activity, where the role of women is very important, both in collecting household waste and in looking after the animals. Pig production implies a significant reuse of household waste as a feed, and also the waste of commercial enterprises (bakery, market vegetable and fruit leftovers) and industrial (brewery, abattoir) activities is also welcome.

However, urban and peri-urban animal production raises different concerns such as transmission of tetanus from livestock waste, improper disposal of animal corpses, and chemical contamination from the overuse of antibiotics and pesticides. To address these issues, policies must specify the permissible numbers of animals in specific locations based on human population density and animal type.

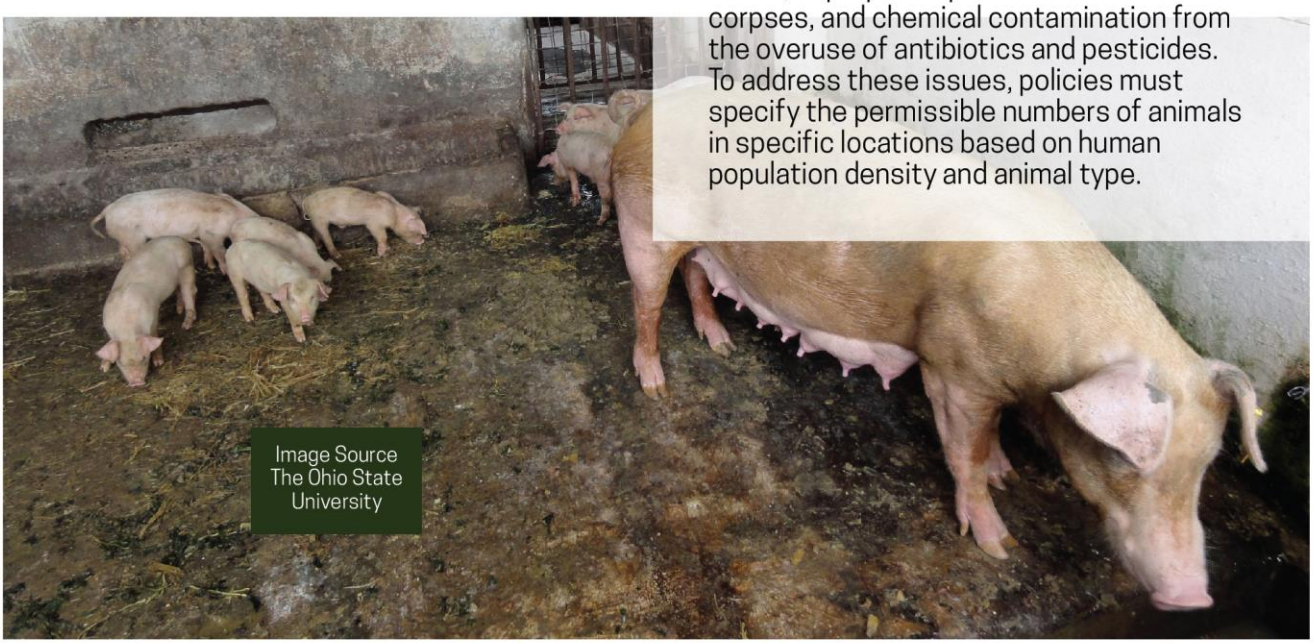


Image Source
The Ohio State University

Chapter 4

Hydroponics: an answer to food always in the home (FAITH)

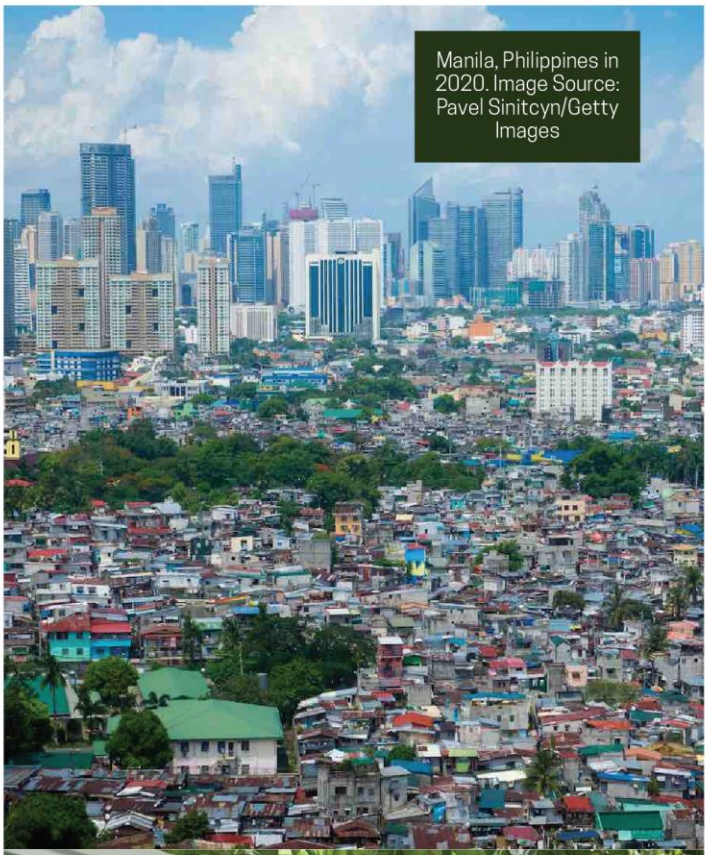
by Myer G. Mula and Jemiema D.R. Arro

A model hydroponics displayed at the Agricultural Training Institute's 2020 National Farmers' and Fisherfolk's Month celebration on May 29, 2020.

Placing the puzzle of Hydroponics among the big players of this agenda is surprisingly not very difficult because it fits so well to major headlines, e.g. climate change and energy conservation, mega cities and urbanization, increase of the world's population, food security, health and welfare, water scarcity, agricultural resources and so on. This article will provide an overview only, not claiming to be that entire comprehensive.

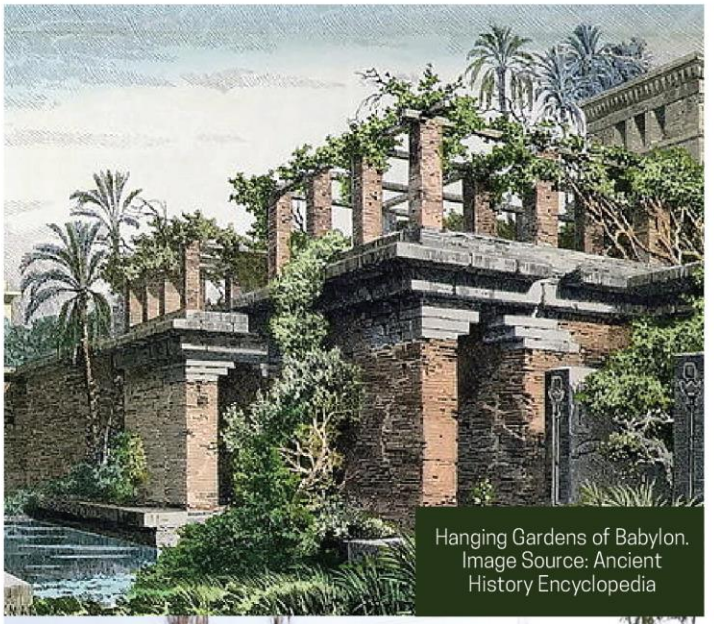
We all know that people continue to flock to cities due to economic, social and creative opportunities they acquire. However, urbanization also presents major challenges. In the Philippines, urbanization is rapidly increasing with almost 49% of Filipinos now living in urban areas, and by 2030, that number is expected to jump to 77%. Much of this urbanization has occurred in its largest cities like Baguio, Cebu, Davao, and Metro Manila. Metro Manila, for instance, have more than 12 million inhabitants, many living in dense communities with large building structures. Traffic congestion, rising fuel prices, and poor road infrastructure have produced a problem in transporting agricultural products from rural areas to urban markets where more people reside and where the food is consumed more. The same scenario that we can see in urban areas of the poorest of the poor provinces covered by the SAAD Program.

Urban agriculture is one of the key solutions to global food insecurity, however due to land scarcity inside urban areas, implementation of this solution is challenging. To address this, urban and peri-urban hydroponic farming is introduced since hydroponics is an effective way of conserving both water and space.



Manila, Philippines in 2020. Image Source: Pavel Sinitcyn/Getty Images

Image Source: Pure Greens Arizona LLC



Hanging Gardens of Babylon. Image Source: Ancient History Encyclopedia

Mexico City brings back chinampas or floating gardens from the Aztec Era. Image Source: Mother Jones

Vertical Aeroponic Garden at O'Hare International Airport. Image Source: GreenRoofs.org.

Urban Agriculture has seen in recent years a clear shift mainly to produce vegetables for food and ornamentals for beautification. As a matter of proof, the identified risks have diminished by implementation of hydroponics such in the case of Taiwan and England. This technology has met the demands of modern cities for physical and psychological in- and out-door relaxation; for improving city environment; and for food and income security to provide year round a wide variety of fresh fruits and vegetables. Moreover, hydroponics reduces water needs and cultivation space for plant growth, minimizes food health risks of harvested produce and helps to check environmental contamination.

Hydroponics is not an invention of our time. The Hanging Gardens of Babylon and the Floating Gardens of the Aztecs were beautifying the civic centers; in addition, fruit trees and vegetables were cultivated in such places. It is part of the ecological system to manage the urban environment. In arid climate it can increase humidity and lowering temperatures. It captures dust and polluted air by the foliage of the plants. It can contribute to the reduction of the net discharge of CO_2, one of the gases speculated to contribute to global warming, because plants and trees need CO_2 for photosynthesis. The captive action, of course, is at its highest during the vegetation growth phase. In cities, however, much of the carbon stored in vegetation is likely to be quickly released through decomposition to organic matter, so lasting effect is little.

All this shows that hydroponics has positive impact upon the greening and cleaning of the cities, offering green zones for micro-climate changes (shade, temperature, sequestration of CO_2). Most importantly, city dwellers will enjoy such green areas, enhancing community self-esteem and stimulating community livelihood.

Image Source: EU Political Report

iFarm Chairman Tsai Wen-chin. Image Source: Taiwan News

Image Source: Bangkok Post

Taiwan has the largest Asia's vertical farming, the Yes Health iFarm, which uses a hydroponics system, has a technology-driven 14-story vertical farm covering 2,645 square meters, and grows over 30 varieties of vegetables, including arugula, ice plant, and mustard leaf. At least 80% of Taipei's department stores are supplied by the iFarm.

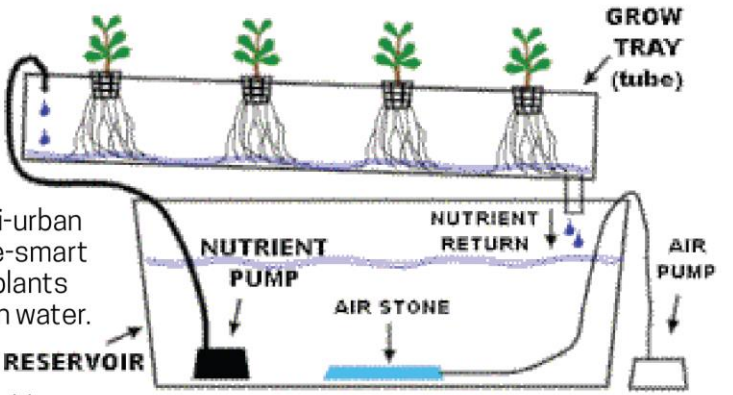
In January 2020, the Department of Agriculture sent SAAD Program Director Myer G. Mula and staff of the Bureau of Plant Industry (BPI) to explore the farm's precision agriculture technology.

With the knowledge and experiences acquired during the state visit, the SAAD Program and the BPI plan to incorporate Taiwan's farming practices and technology to their farmer-beneficiaries through their existing provision of technical training activities, agricultural production and livelihood interventions, as well as marketing and enterprise development assistance.

Another is an underground advanced indoor vertical farm in Liverpool, North England called Farm Urban, which is the creation of Jens Thomas and Paul Myers in 2014. *Bok choy*, parsley, tarragon and basil alongside dozens of varieties of lettuce grow together in harmony under the pink glow of a LED light set-up. Their aim is to change people's relationship with food: the traditional methods of agriculture, they say, and using acres of land is no longer sustainable. The world's population is growing – the World Health Organization estimates it will increase to 9.7 billion people by 2050, with 70% of people living in urban areas. "To preserve natural habitats and improve worldwide food security there should be a complete overhaul of food production methods", said Thomas and Myers.

Farm Urban's operations director, Jayne Goss, carries a strip of hydroponically grown lettuce. Image Source: Joel Goodman/ The Guardian

Hydroponics: A Precision Agriculture



Hydroponic systems are presently being experimented on and diligently employed in the available lands, building spaces or roof tops within the confines of the urban and peri-urban areas of the country. Hydroponics is a climate-smart agriculture technology and an art of growing plants without soil using mineral nutrient solutions in water. With hydroponics, plants are grown in an inert medium, and a balanced, pH adjusted nutrient solution delivered to the roots in a highly soluble form. This allows plant to uptake its food with very little effort. There are several types of hydroponics systems — some of which are the wick system, the deep-water culture system, the ebb and flow (or flood and drain) system, drip systems, the nutrient film technique (NFT) system, the aeroponic system, and the simple nutrient addition program (SNAP) system.

A model hydroponics displayed at the Agricultural Training Institute's 2020 National Farmers' and Fisherfolk's Month celebration on May 29, 2020.

The NFT is one of the most popular types of hydroponics systems. It is versatile and modular due to the nature of its components. It works by delivering nutrient solution to the plants by means of using a water pump. Gravity then guides the water back to the main reservoir. A key element of a good NFT is how the nutrient solution flows over the roots. The word "film" is ideally a small amount of water flowing through the channels to allow plants get sufficient amount of oxygen. Most commonly used plants in this setup are lettuce, basil, and salad greens (e.g. watercress).

Based on precision agriculture, hydroponics crop growing systems can increase yields by at least 30%, and can harvest in a short period of time (e.g. 30 days for leafy vegetables such as lettuce, watercress, *kangkong*, *pechay*, *bok choy*, etc.) while converting inputs like seeds, nutrients, and time invested into bigger and healthier profits. The systems optimize irrigation, using only the quantity of water that crops need. Several studies suggest that hydroponics gardening empowers households to have direct access to clean food and is a source of family income; encourages recycling; answers government's efforts to implement smart farming agriculture; and realizes conservation of limited resources, such as water, electricity, space, and time.

Building the Hydroponics Garden

There are various ways of growing things hydroponically. In one popular method, people stand their plants in a plastic trough and let a nutrient solution trickle past their roots (with the help of gravity and a pump). That's called the nutrient-film technique: the nutrient is like a kind of liquid conveyor belt — it's constantly sliding past the roots delivering to them the goodness they need. Alternatively, people can grow plants with their roots supported by a nutrient-enriched medium such as rockwool, sand, or vermiculite, which acts as a sterile substitute for soil.

Image Source: AeroGarden

Another method is called aeroponics and it's typified by a popular product called the AeroGarden. Although the name suggests growing plants in air, the roots are actually suspended inside a container full of extremely humid air. Effectively, the roots grow in a nutrient-rich aerosol a bit like a cloud packed full of minerals.

Various crops, such as tomatoes, zucchini, cucumbers, bell peppers, lettuce, celery, watercress, strawberries, honeydew melons, Mediterranean and Asian herbs, and Asian greens are among plants that do particularly well in hydroponics.

Here are the DIY Network's steps in building a hydroponics garden using the nutrient-film technique:

1 Locate the hydroponics system in an enclosed structure, either indoors or outdoors.

If outdoors, protection is needed, such as a wind barrier. Checking the water levels is more often done due to water loss from evaporation. If indoors, add grow lights to provide supplemental lighting to the plants. An important reminder is that the floor should be level to ensure even coverage of water and nutrients for the plants.

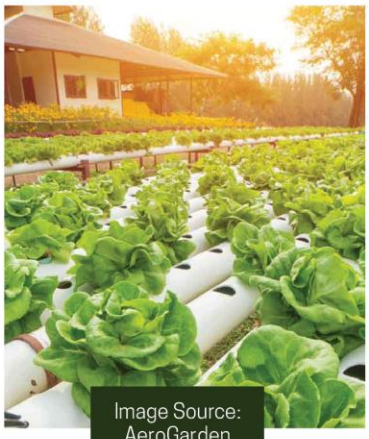


Image Source: AeroGarden

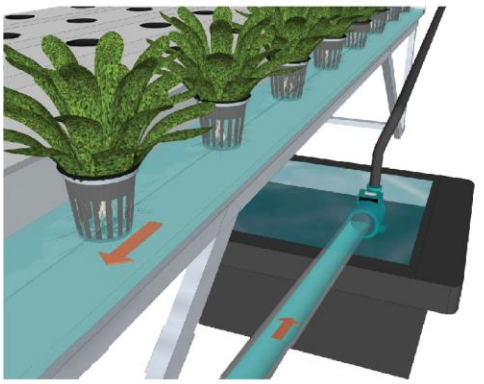
Image Source: Blogging Hub

2 Assemble the hydroponics system.

The system consists of six growing tubes made of 6" PVC pipe, a stand and trellis made of PVC, a 50-gallon nutrient tank, a pump, and a manifold. The tank sits under the table of 6" PVC growing tubes, and the pump sits inside the tank to push nutrients up to the plants via a manifold of smaller PVC pipes and plastic tubes. Each growing tube has a drainpipe that leads back to the tank. The manifold sits on top of the pipes and sends pressurized water to the tubes.

To get the nutrients to the plants in this system, water is pushed through a square of PVC, the manifold, and then gets shot out to small plastic tubes that run inside each of the larger growing tubes. The nutrient tubes have very small holes in them, one hole between each plant site. The nutrients shoot out the hole and spray the plant roots. At the same time, the jet of water makes air bubbles so the plants get enough oxygen.

3 Mix the nutrients and water in the tanks.



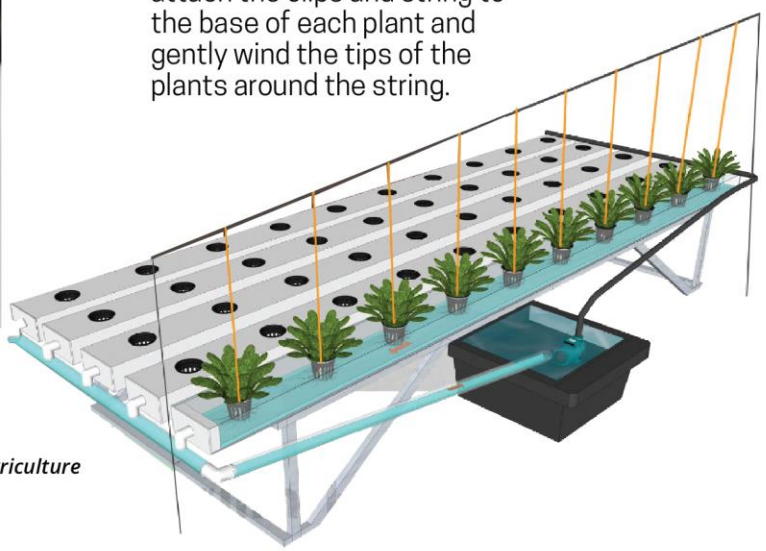
Fill the 50-gallon tank with water. Then add two cups of nutrients to the tank, turn on the pump and let the system run for about 30 minutes to get all of the nutrients thoroughly mixed.

4 Add plants to the growing tubes.

The key is to choose the healthiest plants and then remove all of the soil off their roots. To wash the dirt off the roots, submerge the root ball in a bucket of lukewarm to cool water. Water that's too warm or too cold can send the plant into shock. Gently separate the roots to get the soil out. Any soil left on the roots could clog up the tiny spray holes in the nutrient tubes. After the roots are clean, pull as many roots through the bottom of the planting cup and then add expanded clay pebbles to hold the plant in place and upright. The expanded clay pebbles are hard, but they're also very light so that they don't damage the plant roots.

5 Tie the plants to the trellis.

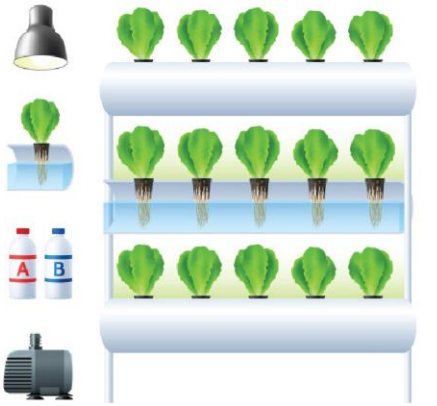
Use the plant clips and string to tie the plants to the trellis. The string will give them support to climb straight up, which helps to maximize the space in this confined area. Tie the string loosely to the top of the trellis, attach the clips and string to the base of each plant and gently wind the tips of the plants around the string.

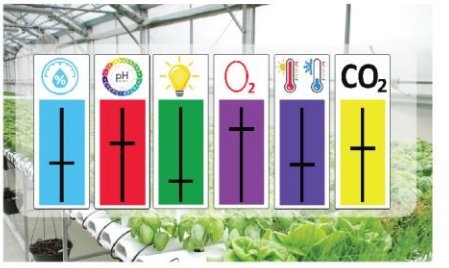


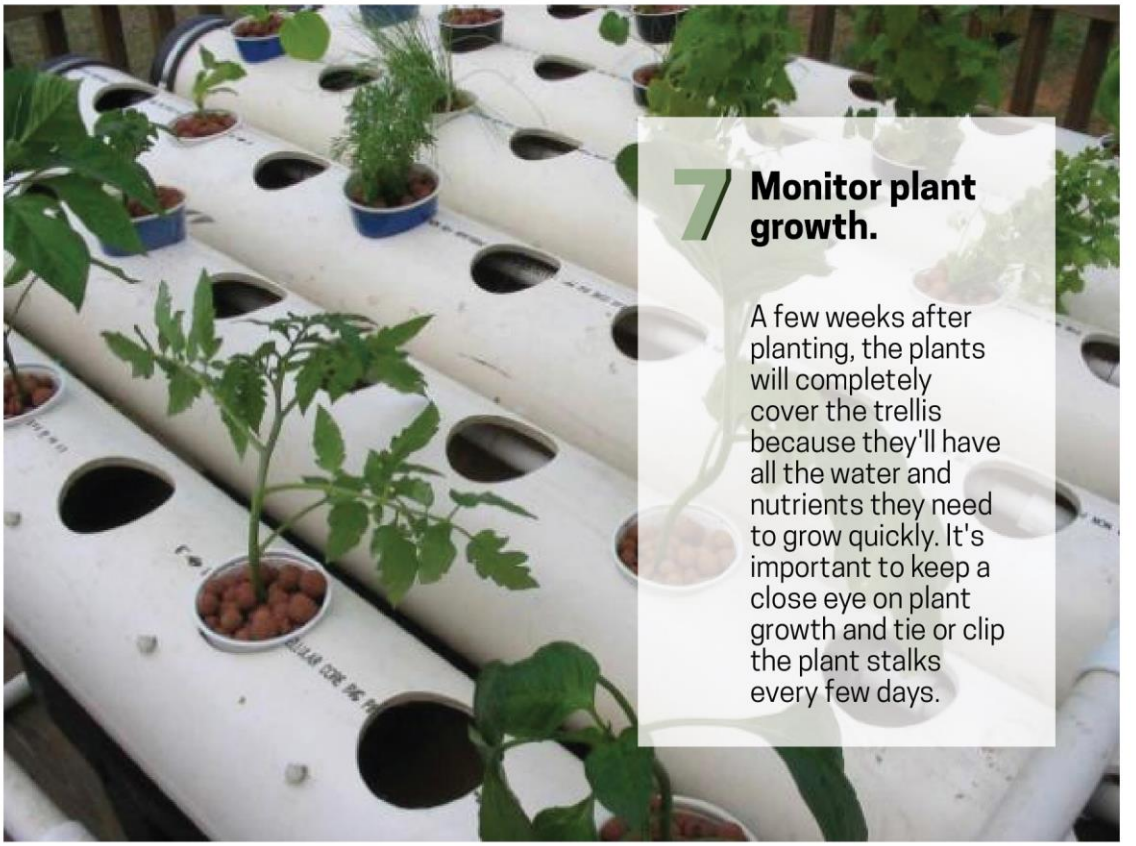
6 Turn on the pump and monitor the system daily.

Check the water levels daily; in some areas, it may be necessary to check it twice a day, depending on water loss due to excessive heat and evaporation. Check the pH and nutrient levels every few days.

To maintain the quality of the nutrient solution, three important parameters are needed, such as the pH level of the water (pH is a major determinant of nutrient uptake by the plant; pH range—5.8 to 6.8 [6.3 optima]), the electric conductivity (the strength of ionic fertilizer solutions; EC—0.5 to 2.0 mS/cm), and the temperature (20-25 °C [24 °C optimal]). Because the pump runs full time, a timer is not needed, but make sure the tank doesn't dry out or the pump will burn up.







7 Monitor plant growth.

A few weeks after planting, the plants will completely cover the trellis because they'll have all the water and nutrients they need to grow quickly. It's important to keep a close eye on plant growth and tie or clip the plant stalks every few days.

8 Inspect for pests and diseases.

Look for signs of pests and diseases, such as the presence of insect pests, chewed leaves, and foliar diseases. One diseased plant can swiftly infect all the other ones since they are so close to each other. Remove any sick plants immediately.

Because plants grown hydroponically don't have to spend their energy trying to find food, they can spend more time growing. This helps them to be healthier and stronger because they can use some of that energy to fight off diseases. Since the leaves of the plants never get wet unless it rains, they're much less likely to get leaf fungus, mildew, and mold. Even though hydroponic plants are good at fighting off diseases, they still have to fight pests.

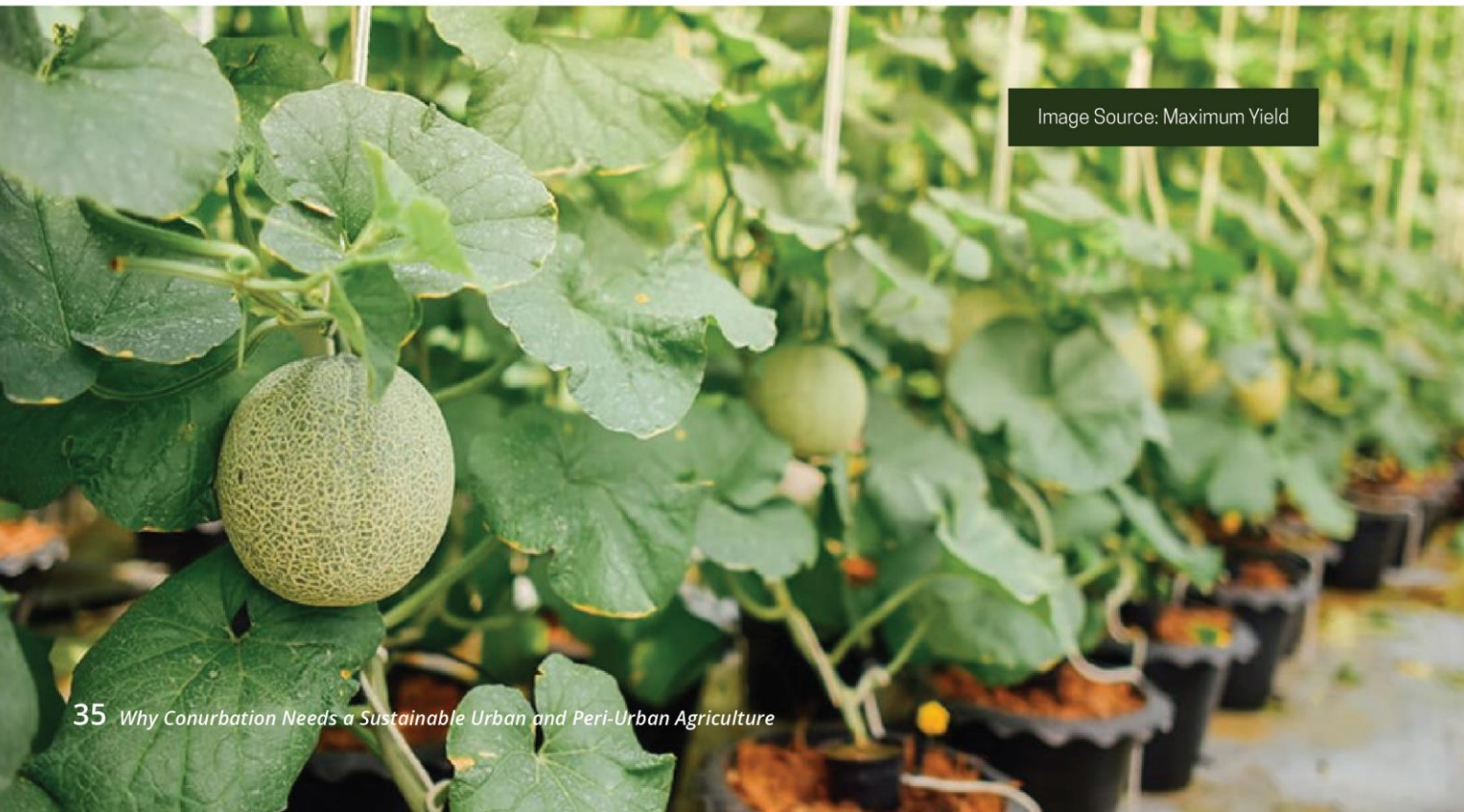


Image Source: Maximum Yield

Image Source: Gardening Heavn

Image Source: Seed to Pantry School

Image Source: Maximum Yield

Chapter 5

Aquaponics: a perfect setting to feed urban and peri-urban families

by Myer G. Mula and Jemiema D.R. Arro

Agriculture Secretary William Dar inspects the urban aquaponics model established at the Philippine Coconut Authority Compound, Quezon City on May 27, 2020.

Image Source: University of Minnesota

An answer to food security

Global hunger and food insecurity are perennial issues that confront human societies. In the World 2017 Report of the Food and Agriculture Organization (FAO) revealed that starvation affects around 815 million people (11% of the world's population). It has been projected that more than half of the world's population will live in cities in a few years, making it more imperative to improve the conditions of life of the urban poor specifically during crisis such as earthquakes, typhoons, and the recently CoViD-19 pandemic, where agricultural products (e.g. crops livestock, poultry, fish, and shellfish) are restricted to enter the urban markets.

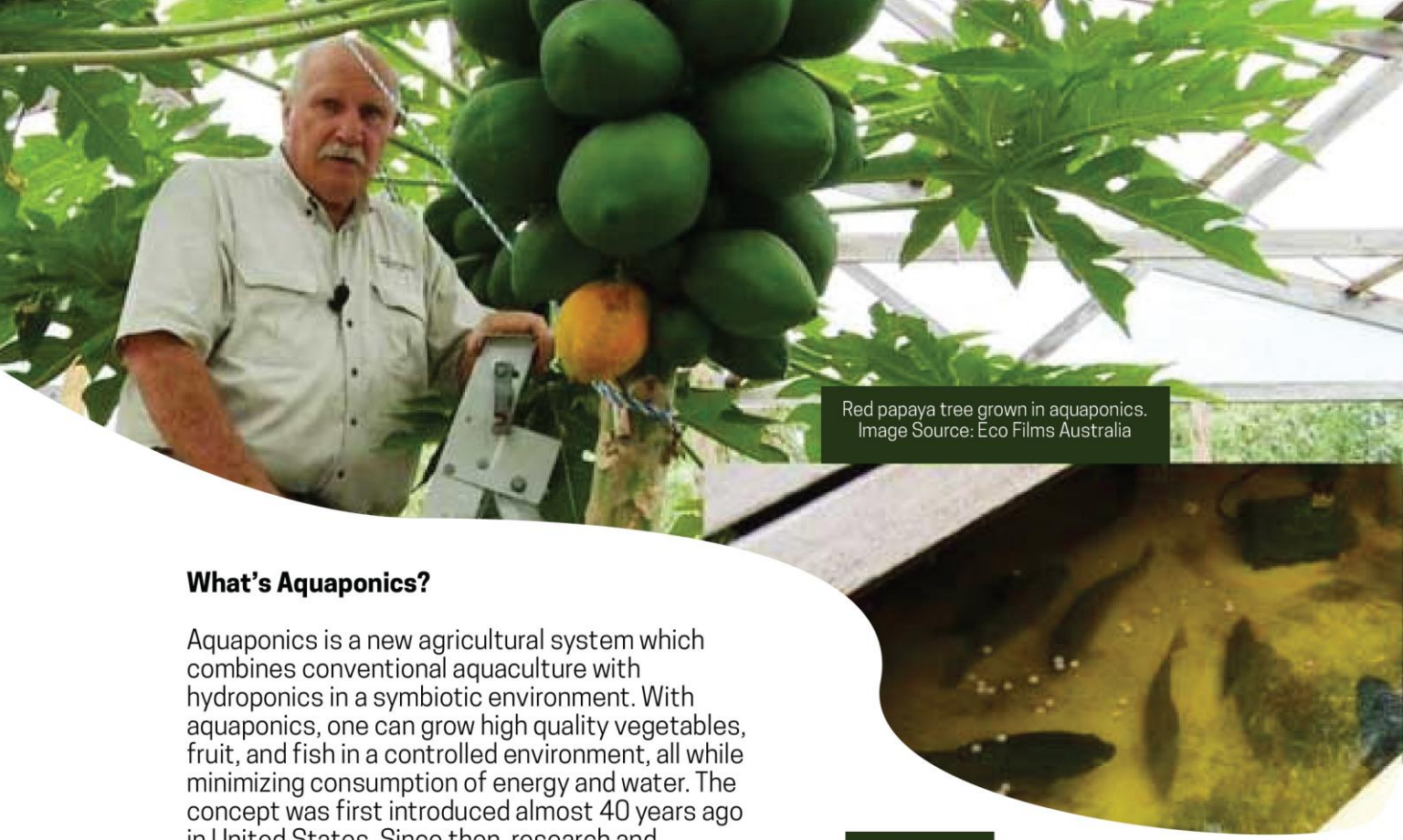
With aquaponics, one can grow veggies and fish all year round. With adequate support from both the public and private sectors, aquaponics can help fix the food system not only in cities but also in peri-urban communities. Thus, aquaponics has a huge potential as a commercial venture and as a way to provide food. It has been claimed that 25 square feet of plant bed can sustain one person for life.

Food security is a global concern

When scaled up commercially, aquaponics venture can potentially be a food basket in urban as well as in peri-urban areas. Aquaponics' operation is undeniably earth-friendly. Since water is recycled in circular manner, it only leaves negligible footprint from the environment.

In most developing countries where water is considered a precious resource such in the case of highly urbanized cities of the country (e.g. Metro Manila, Cebu, Baguio, Davao) and the 30 poorest of the poor provinces covered by the SAAD Program of the Department of Agriculture, the enormous potential of aquaponics as a sustainable food source can be life-changing.

The FarmHouse by EDL in Capas, Tarlac. Image Source: Aquponics Philippines



Red papaya tree grown in aquaponics.
Image Source: Eco Films Australia

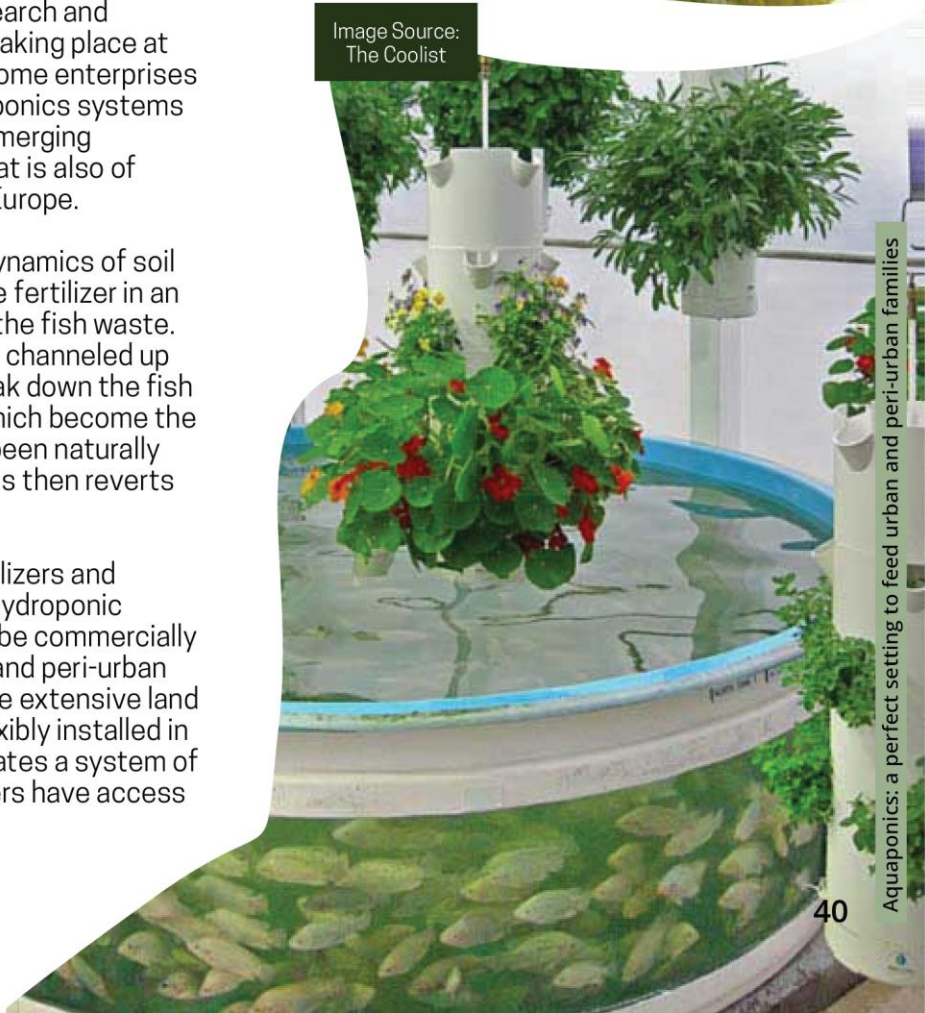
What's Aquaponics?

Aquaponics is a new agricultural system which combines conventional aquaculture with hydroponics in a symbiotic environment. With aquaponics, one can grow high quality vegetables, fruit, and fish in a controlled environment, all while minimizing consumption of energy and water. The concept was first introduced almost 40 years ago in United States. Since then, research and development efforts have been taking place at many research institutions and some enterprises have successfully adapted aquaponics systems at the commercial level. It is an emerging sustainable agricultural model that is also of interest to Australia, Africa, and Europe.

Aquaponics mimics the natural dynamics of soil and water in the environment. The fertilizer in an aquaponics system comes from the fish waste. Fish excrete in the water which is channeled up into the plants' bed. Bacteria break down the fish pooh into nitrates and nitrites, which become the plant's food. The water that has been naturally cleaned up by this circular process then reverts back to the fish tank.

Without the use of chemical fertilizers and pesticides, it is the only organic hydroponic method that has proven itself to be commercially viable. Aquaponics can be urban and peri-urban agriculture since it doesn't require extensive land or soil, and the system can be flexibly installed in limited space in the city. This creates a system of 'Farm-To-Table', where city-dwellers have access to fresh, local vegetables.

Image Source:
The Coolist



Sustainability and income turned into one

Sustainable and eco-friendly, aquaponics programs support the international community's goals in three domains: food, water and energy.

Aquaponics is a smart and integrated system that combines aquaculture and hydroponics. In this technique, farming is blended with fish culture in organic, natural and sustainable way. Aquaponics works based on the principle of symbiosis among plants, nitrogen-fixing bacteria and fish. If you were to think of the classic triple-helix of cooperation that could be found in a natural ecosystem, then this could be one of the best examples. This makes the system very efficient – less water is used but more food is produced. It has been claimed that aquaponics beats traditional farming in terms of efficiency, growing crops in half the time.

The aquaponics technology empowers households to have direct access to clean food, generate additional income, encourage recycling, and conserve limited resources, such as water, electricity, space, and time. Some aquaponics are run by renewable energy sources such as the sun and the wind; others even tap the law of gravity to make their aquaponics systems work. This enables aquaponics to operate in energy-efficient, sustainable and eco-friendly way.

Aquaponics can be done anywhere (home, school, community, and commercial places), providing fresh local food that is free of pesticides, herbicides, and chemical fertilizers:

- At home, aquaponics can grow hundreds of kilograms of fish and fresh vegetables that a family needs.

- At school, it can be applied as an excellent model of nature's biological cycle.

- In a community, it can be done to provide food banks and charities to feed people in need.

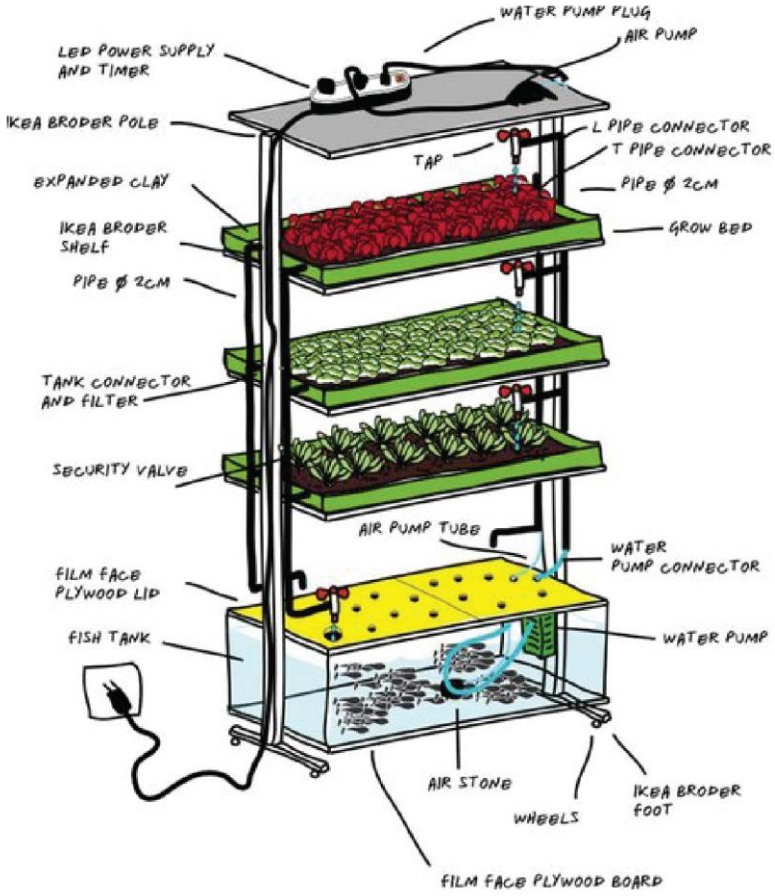
- In commercial spaces, it is also a rapidly growing commercial industry as entrepreneurs realize that aquaponics and controlled environment agriculture can provide high-quality locally-grown fresh food yearly. Large commercial aquaponic farms in developed countries (e.g. US, Australia, Europe) are providing fresh food to grocery store chains, hospitals, and institutions.

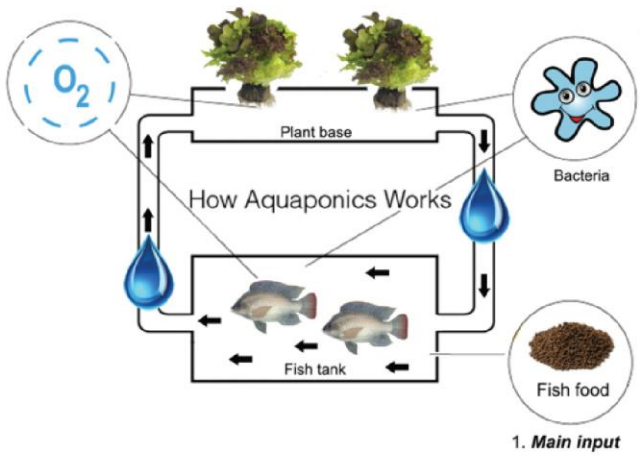
Image Source: Robert Hoskins/ Twitter

Image Source: Aquaponic Trend

Benefits of Aquaponics

1. **Water conservation:** Aquaponics consumes less than 10% of the water used in traditional agriculture
2. Year-round access to fresh produce and fish which could not be achieved in urban areas during winter
3. Higher yields and more efficient production than soil gardens
4. Removal of the need to add nutrients to the soil as well as the need to replace dirty waste water
5. Reduction of the intense pressure placed upon our soils and the need for fertilizers and pesticides
6. Less need for land
7. Protection from the elements, such as flooding and drought, because of the indoor controlled environment
8. Less disease potential than traditional farming
9. The versatility of the system allows for a wide variety of crops to be grown
10. Specialty markets are a great use of aquaponics, meeting the local demand for exotic products





1. ***Main input***

What are the startup costs for an Aquaponic system?

Aquaponic systems can vary depending on the design and components chosen, but a good estimate for a fully equipped commercial-sized aquaponic greenhouse can be Php 500,000.00 to Php 1,500,000.00. At home or hobby systems, can start at as little as Php 15,000.00.

How aquaponics works

Aquaponics can be done either indoor or outdoor that simulates every natural waterway on earth. it is a technology that helps in adapting to and mitigating the impacts of climate change.

As aquaponics technology continues to develop, there are three methods and two of which are primary that have evolved. First, is the media-filled bed system, which many backyard enthusiasts use, and the second is raft system, which most commercial growers use. The third, is the Nutrient Film Technique (NFT), which is less popular.

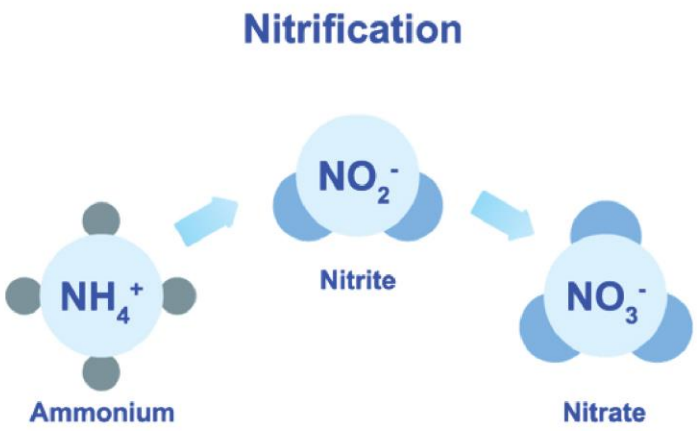
The three basic components are fish tank, filter, and hydroponic (raceway). The raceway is interconnected with pipes to become a production system for fish and vegetables in one infrastructure and one body of water.

This illustrates the symbiotic relationships in an aquaponics system. Aquaponics works because it's an ecosystem approach to agriculture. Once the fish are fed, they excrete ammonia, which becomes dissolved in the water.

Nitrifying bacteria, which are purposely cultivated in the aquaponics system, then metabolize this ammonia. These nitrifying bacteria convert the ammonia to nitrite and then nitrate, which essentially is plant food. This nitrate-laden water is then moved to the hydroponic component of the aquaponics system, where the plants uptake and remove the nitrate from the water, thus cleaning the water for the fish. The cleaned water then goes back to the fish tank.

The route from fish to plants is populated by a filter of beneficial bacteria (*Nitosomonas* and *Nitrobacter sp.*) that converts the fish waste — mostly harmful ammonia (NH3) and nitrites — into nitrates and other nutritional elements that plants thrive on. The plants take up this natural fertilizer and return waste-free water back to the fish.

The cycle repeats, reusing the self-contained system's water over and over again, until balance is achieved. Once the system gains equilibrium, it rolls on without much help.



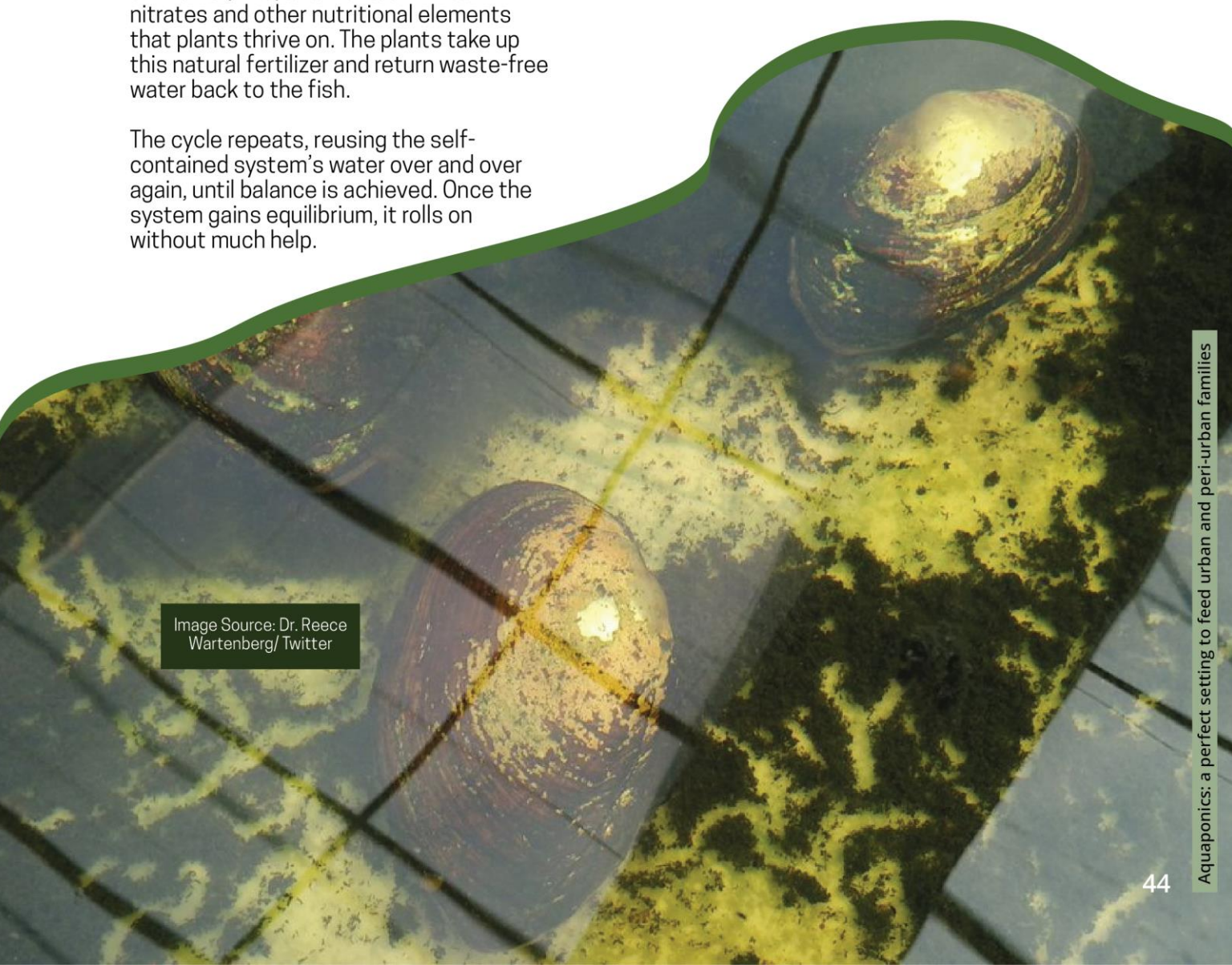


Image Source: Dr. Reece Wartenberg/ Twitter

Five steps in building aquaponics at home using the media-filled bed system method:

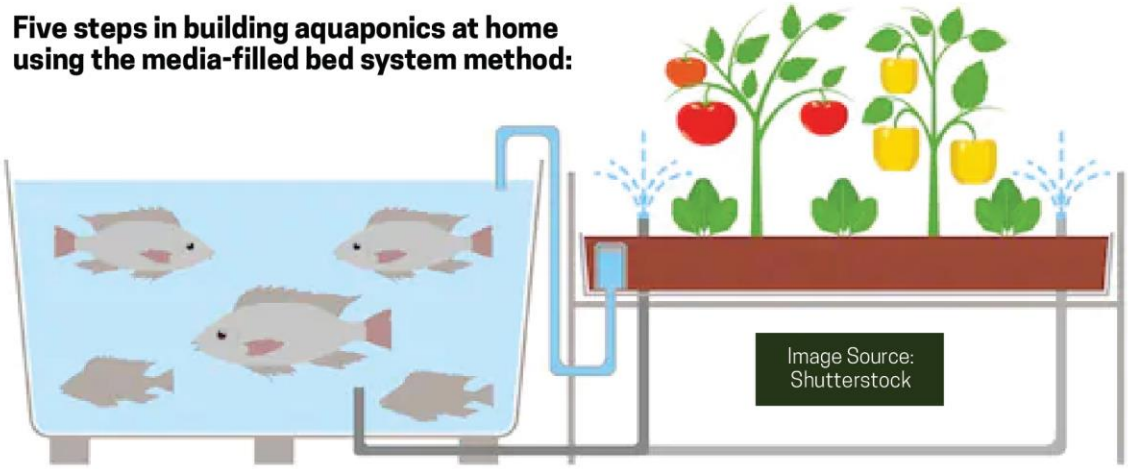


Image Source: Shutterstock

Image Source: Hannah Smith/ Weebly

1. **Building the Fish Tank.** Choosing the fish needs to be taken into account as it will determine the size of the tank. Using or repurposing a standard acrylic aquarium can be done. However, most people choose to use large barrels or food-grade containers with opaque sides.

To set the tank, dechlorinate the water and allow it to cycle for between four to six weeks before adding the fish. This gives the bacteria time to build up, ensuring there is enough present to break down the ammonia and nitrites into the nitrates needed to feed the plants.

Include a pump, which allows the water to be drawn from the tank, to the grow bed, and back again.

2. **Build the Media Bed.** The media bed, also known as the flood table, can either be built above the fish tank or to the side of the tank. It will act as the container for the growing plants.

Large heavy duty plastic trays or wooden pallet crates can be used. They need to be built on top of a stand that is able to withstand its weight.

Once the media bed has been placed, fill it with the chosen media, such as clay pebbles (which are pH neutral and won't affect the water). The pebbles also hold moisture. Stick to a ratio of 1:1 between the size of the fish tank and the size of the grow bed, so that the volumes are the same.

3. **Add the Fish.** Once the tank has cycled properly, add the fish. There are a number of different fish and aquatic animals that work well in an aquaponics setup.

Tilapia is currently the most popular and easily raised food fish. It reaches harvest size quickly and will tolerate a wider range of pH and water temperature levels (15-24 °C) than most fish. Tilapia is omnivorous and usually won't harass or feed on their smaller brothers.

Catfish is the leading, commercially raised freshwater fish. It is hardy, suitable to warm-water conditions up to 27 °C and resistant to many diseases and parasites that can appear in self-contained tanks. Because catfish crowd the bottom of tanks, they are usually raised at lesser density levels.

Trout is a favorite food fish but is more difficult to raise. It requires relatively cold water temperatures (13 °C or less). Water this cold will affect the growth of vegetables. Lettuce and other cool-weather crops will grow slowly with water at this temperature. Tomatoes, cucumbers, squash, and other warm-season crops aren't suited for systems raising trout or other cold-water species.

Carp is hardy and adaptable to a wide range of conditions. This makes them a good choice for beginners. Not always a favorite food fish, the carp that grows in clean, aquaponic water don't have the muddy taste of the one taken from rivers and lakes.

Goldfish, cousin to the carp, is a popular, non-harvestable choice for home systems. Hardy and easy to obtain, goldfish and their larger relative Koi fish add decorative touches to the system. Both are a good choice for beginners.

Bivalves (e.g. mussels) is a type of saltwater or freshwater mollusk. This small shellfish is now very popular, relatively abundant, and fairly cheap. They have a lot of benefits. Surely, there are a lot of potentials to experiment with aquaponics by integrating them into the cycle. It will enable the farmer to reap even more benefits.

Prawn and shrimps (crustaceans) may not be the first choice when establishing an aquaponics system, but they are an excellent choice as they provide nutrition for your plants and food. They can tolerate a pH range of 6.5-8 but are not good at coping with temperature changes. Keeping sure that pH level was sorted before the shrimp and prawns arrive in the tank can help raisers to start harvesting within 3-6 months.

Lobster (crustacean), a type of crayfish, are another popular choice. They are more aggressive but can withstand temperature fluctuations better, tolerating temperatures between 12 °C and 20 °C. Temperature levels also need to be monitored as they'll need to stay within the range of 7.5 to 9 pH. They will be ready to harvest within 6 to 12 months.

Gastropods (e.g. snails) can help maintain the balance in aquaponic system, consuming extra food in the system. Most fish can consume snails ensuring food alternative to the fishes. Snails also tell the balance of calcium salts in the water, which can be bad for the plants. The best snails to get are Malaysian Trumpet Snails and Ramshorn Snails.

4. **Add the Plants.** Leafy plants tend to grow best in aquaponics setups. However, if fish is enough, fruiting plants, such as peppers and tomatoes, can also be grown. Some of the easy-to-grow plants are basil, kale, lettuce, mint, and watercress.

A heavily stocked tank and well-established setup will help grow beans, cabbage, kangkong, cauliflower, cucumbers, squash, tomatoes, peas, peppers, and strawberries.

It's best to plant seedlings to give plants a head start. Place the roots gently into the pebbles, ensuring they reach far enough down to draw nutrients from the water that will pass through.

Tend the plants as one would in normal gardening techniques. However, it is much lesser as not many weeds grow in the system.

5. **Maintain the System.** Feeding the fish a quality diet, such as flake food, is a must. Be careful not to introduce diseases onto the tank. Adding any live food is not recommended. Feed the fish as much as they can eat in around five minutes, two to three times per day.

Testing the water tank every week is also advisable to check the pH, ammonia, nitrites, and nitrate levels. Ammonia and nitrite levels should always be undetectable, and the nitrites should be low if the plants are doing their job properly. The pH should be neutral, between 6.8 – 7.0, which is ideal for the fish, shellfish, the plants, and the bacteria.

Aquaponics systems typically need to be buffered up (raised) because they'll drop below 7.0 once the initial cycle has finished. To raise the pH, add powdered calcium hydroxide and potassium carbonate alternately to the tank.

In conclusion, aquaponics can be an effective driver to reduce global hunger and malnutrition, giving flesh and teeth to the overarching goal that "no one will be left behind."

Chapter 6

Vegetables you can harvest in less than two months to boost immune system

by Myer G. Mula and Jessa Mae D. Gabon

Image Source: David Roms Backyard Garden/ Facebook

Urban Agriculture potentials to improve health in metropolis set-up

Urban agriculture manifests relevance to socio-economic perspective and ecology. It provides integrative development by creating income opportunities, promoting social inclusion by reducing gender inequalities, and aids management of city wastes and biodiversity.

Health as a commodity. Commodification in all of its possible forms is omnipotent in the process of urbanization. Most of the time, the gears of industrialization are concentrated in the urban areas, making the metropolitan areas as centers of activities with regards to the circulation of commodities. This means that urbanization can be seen in the lens of development of the society, but can also manifest disturbing burgeoning issues in the aspects concerning the human capital (determining human economic value). One of the forefront issues of urbanization is health and food security.

In broader view, urban settlements expose people to an array of embedded risks, they might not even notice. However, while problems stated above make urban living seem dreadful, Impacts of Urban Agriculture report states that, "[…] agriculture can become an integral part of good environmental management of urban space".

Vegetables you can harvest in less than two months to boost immune system

SAAD beneficiary, Dampalan Farmers Association, from Dapitan City, Zamboanga del Norte harvested cassava.

This means urban agriculture is an approach to extract potentials to address certain problems by transforming small idle areas into a productive, valuable space. Aside from having a green space, urban farming is an opportunity to manage waste, land, and ecology while only requiring usage of resources that are innately available in the area.

Literally confined, due to the community quarantine in hopes to manage the spread of novel coronavirus or CoViD 19 – health, food supply and nutritional balance of the people are at risk for urban, peri-urban, and rural areas. Basically, urban farming is an opportunity to improve food security and address nutrition inadequacy and improve immune system to combat the pandemic.

However, malnutrition is not a brand-new matter of concern, as the Food and Nutrition Research Institute (FNRI) reported the prevalence of obesity among adolescents and adults continues to grow in the previous years, and even escalated three times for children in the past 15 years. Factors include reduced physical activities, imbalanced nutrition caused by the limited access of healthy varieties of food, and heightened intake of processed and salty foods commonly consumed in the poor urban areas.

Additionally, according to the World Health Organization (WHO), Filipinos are reported to be at risk of non-communicable diseases (NCDs); cardiovascular diseases, diabetes, chronic respiratory diseases and cancer, which account to 68% of mortality rate. This calls for multi-sectoral collaboration in order to effectively create compelling and impactful progress in the health sector.

Crop planning

An advantage of urban agriculture is being in control of the type of crops to cultivate considering the household needs and availability of resources. This is called crop planning. The Agricultural Training Institute – Regional Training Center Northern Mindanao (ATI-RTC X) specifically defined crop planning as:

Crop planning considers what, when, where and which plants grow in relation to their requirements for space, sunshine, water, maturation, season of planting and tolerance for each other. It involves a cropping pattern in which different categories of vegetables are raised, followed by a system of crop rotation to keep the cycle going and to provide a suitable, healthy environment for plants to grow. For a family food garden, crop planning means raising vegetables that will provide for the nutritional needs of the household members all year round.

The Agricultural Knowledge Management Section of ATI-RTC X suggests specifically for family or household nutrition to cultivate easy to grow, productive, insect or disease-tolerant, indigenous varieties of crops that can be harvested over a long range of time. Short and long maturing crops are suggested to be mixed to balance nutrition supply of both food and soil or cultivation area. It is also practical to prioritize crops with more than one edible part that are protein, carbohydrates, minerals and vitamin-rich (Table 1).

Table 1. Nutrient-rich crops from Crop Planning BIG Series - Agricultural Knowledge Management Section of ATI-RTC X.

Nutrient Sources	Carbohydrates / Energy	Vitamin A	High Protein	High Vitamin C	Iron-Rich
Crops	Cassava, sweet potato, taro (*gabi*), rice bean (*tapilan*), dried hyacinth beans (*batao, harabilla*), dried lima beans (*patani*), dried pigeon pea (*kadyos*), dried stalk beans (*habas*), mung bean	Amaranth (*kulitis*), hot pepper leaves, horse radish leaves (*malunggay*), bitter gourd (*ampalaya*) leaves, spinach, kangkong, sweet potato leaves, squash	Winged bean, lima bean, rice bean, hyacinth bean, pigeon peas, string beans (*sitao*), jack beans	Horseradish, bitter gourd leaves, amaranth leaves, mustard, pechay, bitter gourd fruit, kangkong, spinach	Amaranth leaves, pigeon peas, lima beans, sweet potato leaves, winder bean, monggo, pechay, spinach, kangkong, pepper leaves

This last part of the Special Area for Agricultural Development (SAAD) Program's Urban Agriculture Series is an introduction to several crops for a household's nutrient resources, such as legumes, root crops, young corn, and other easy to grow crops that can be harvestable in less than two months.

Growing and harvesting vegetables in less than two months

There are times when you need a crop to run its course in a short time frame in order to keep the garden productive and provide food always on the table. Here are the following crops to consider when you are planting against the clock.

Snap Beans. They are useful in warm summer weather. In addition to cropping rather quickly, beans are soil builders that benefit ensuing crops by fixing atmospheric nitrogen in their roots then releasing it when the plants die off. The fastest to produce are the bush types, ready to harvest in 50+ days.

Farmers tend a vegetable garden on a roof of a textile plant in Shaoxing, East China's Zhejiang province. The roof garden which functions as a layer of heat insulation in summer provides the workers with plenty of fresh vegetables and fruits. Image Source: China Daily

Okra. Start harvesting in 50 to 60 days. The plants can produce for ten to 12 weeks. It grows and bears seed pods, which quickly turns them black and kills them. Start harvesting a few days after the okra blooms fade.

Eggplant. Generally, first harvest of eggplants begins 60 days from transplanting. Eggplants should be harvested when the fruit surface is glossy and tender and before seeds within the fruit become brown.

Chili Peppers. Grow hot peppers any time of the year. Hot peppers are ready for harvest in 60 days after sowing.

Bitter Gourd ***(ampalaya).*** 45 days after transplant it will start to flower and in 60 days you can start your harvest. Harvest frequently with an interval of 2-4 days since ampalaya ripens easily. It is best to harvest fruit early in the morning.

Pole Sitao. Begin harvest at 50 days from planting, depending on the pod diameter and toughness. It is harvested by hand every 3–4 days for up to 30 times during the growing season. Harvest early in the morning (6–8 am) to avoid weight loss.

Summer Squash. It gives another option for warm weather. Numerous varieties can be harvested in less than two months. The earliest varieties come in just over 40 days. Look for 'Yellow Crookneck', 'Early Prolific Straightneck' or 'Raven'.

Cucumber. They are another option for the middle of summer. The best varieties for quick production are the early pickling types and also require less space than the normal season types.

Mumbai-based Priyanka Amar Shah started iKheti, an urban farming enterprise that facilitates farming among city dwellers through workshops, consultancy and gardening resources. Image Source: The Better India

Vegetables you can harvest in less than two months to boost immune system

La Chambeaudie Farm is located on the 500 square meter roof of a medical center owned by Paris Metro (RATP). Image Source: CNN

Beets. They don't mind some heat. While roots mature to a harvestable size in 50+ days, baby greens can be used in salad mixes as early as 30 days. 'Early wonder' is a good variety for earliness, tasty greens, and well-formed roots.

Green Onions (leeks). Normally, most leeks mature 100 to 120 days after sowing the seeds, but a few varieties mature in as few as 60 days. However, transplant leeks are easily propagated and will produce green onions very quickly in less than 2 months.

Kale. Greens, including collards, kale, mustard and turnip, all qualify for the rapid harvest category. While they are fairly flexible for growing temperatures, best flavor comes with cool weather. They can be harvested as baby greens to use in salads, or many varieties will produce full sized leaves in under 60 days.

Bok Choy. Asian greens are also fast producers of cool season vegetables. These small sized brassicas can produce mature crops in about a month.

Pechay. Harvest as early as three weeks after planting or between 30-40 days after sowing. Harvest preferably in the afternoon to minimize postharvest losses. Upon harvesting, wash the plants, trim old leaves and remove roots.

Water Spinach *(Kangkong)*. With enough sunlight, the leaves can be harvested in as early as 60 days from sowing. To harvest, cut the top leaves leaving up to 2 leaf nodes from the roots. New stems will grow from these leaf nodes in just a few days. In about 2-3 weeks, the new stems will be ready for another round harvest.

Spinach. It is another great option. As with other greens, spinach can be harvested leaf-by-leaf for baby greens, or whole when mature. A few early performers include 'Space', 'America' and 'Bloomsdale'.

Lettuce. In all its colors and forms, is a good consideration because this can be harvested leaf-by-leaf for baby greens, or whole when mature in 45 days. Heading types may take a bit too long, but the leafy types that would work are too numerous to list.

Baby corn. It can take from 60 to 100 days to reach harvest depending upon variety and the amount of heat during the growing season. To meet these criteria, harvest ears 1 to 3 days after silks become visible. Harvest baby corn every 2–3 days. At this early stage of ear development, the ear can grow very quickly, becoming too large in just 4–5 days. Some field corn varieties may need to be harvested before the silks emerge.

Ken Sparks grows an array of fruits and vegetables at his home in East Los Angeles, California. Image Source: Mariah Tauger/ Los Angeles Times

Chapter 7

The Way Forward

by Rosana P. Mula and Myer G. Mula

Urban agriculture in Metro Manila. Image Source: Department of Agriculture

Sustaining a food-secure conurbation requires two important processes: synthesis and enhancement of existing knowledge, and packaging this for easy access by various interest groups. Together, these constitute the entire research, development, and extension (RDE) continuum. This explains the reason for this initiative where relevant knowledge, especially technological innovations on urban and peri-urban agriculture (UPA), including fishery, are assembled for households, families and policy-makers to rely upon for more remunerative and viable production, even entrepreneurial portfolios.

Moreover, in pushing for the improvement of the delivery and implementation of the UPA, stakeholders of all sectors must act together to sustain a secure food system. Food security means that safe and nutritious food is consistently available, accessible, and reasonably priced.

Households that practice UPA are likely to have access to a wider variety of nutritious foods such as crops, livestock, poultry, fish, and shellfish products that strengthens the immune system. In addition, UPA has been linked with improved nutritional status in children. Furthermore, when fully maximized it can also provide people with a primary or supplemental income.

In this context, in order to maintain the continuous supply of inputs like seeds, seedlings, organic fertilizers, fingerlings, and others, local government units (LGUs) and their households and communities have to be trained in an array of technologies such as seed production, organic composting, cultural management, and value-adding activities like food processing.

Given the potential benefits of UPA, government policies for urban planning need to address access to clean irrigation water, organic fertilizer, and electricity, while also protecting public health. Likewise, policies must specify the permissible number of animals in specific locations based on human population density and animal type. Ensuring the utilization of locally available farm inputs will also reduce the need for purchasing more expensive commercial supplements (e.g. organic fertilizer, fingerlings).

While these mechanisms are in place, a monitoring and evaluation system also contributes to sound planning efforts and future policy directions for UPA´s support, promotion, and enhancement. In this way, knowledge gaps can be, likewise, continually addressed and the RDE continuum can be improved for UPA.

For a stronger and more stable UPA program, the realization and implementation of strategies as mentioned is vital.

Image Source: Department of Agriculture Communications Group

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