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Prof. Brahma Singh Horticulture Foundation
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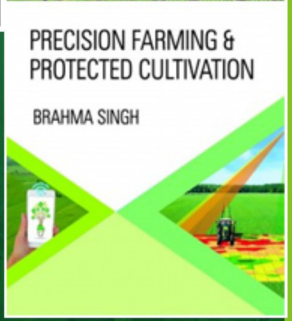
NEW AGE PROTECTED CULTIVATION



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New Age Protected Cultivation

(A magazine devoted for the advancement of protected cultivation technology)
January - June, 2020
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New Age Protected Cultivation

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Articles covering not more than eight pages including photographs, tables, diagrams etc. may be mailed to brahma88@gmail.com along with recent JPG photographs and five lines of brief about senior author. Hard copies are not required.

Enquiry : Email: brahma88@gmail.com, Ph.: +91-9818 313 660

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FROM EDITOR'S DESK

Chief Editor and Founder Chairman
BSHF, New Delhi

Dear Readers

It gives me immense pleasure to state that among the new age protected cultivation technologies vertical farming is not only progressing but is being debated too as a viable technology at every possible level. There are lot of opinions highlighting its necessity, enormous advantages, limitations and prohibitive cost for food, fodder, non-food and herbs production. Several opinions with facts and figures you would find under chapter, News. Bio-wall or vertical mini gardens have made their presence felt in metros, star hotels, Govt offices and important public places to improve the environmental chemistry and aesthetics in India.

There seems to be excitement and interest to practice soilless cultivation of certain crops, mainly vegetables, in open as well as protected/controlled environment with all available state-of-the art technologies for agriculture. Distinct and desired development is that these technologies are attracting youths to food production- a positive sign for future farming.

Soilless farming involving all modern technologies and gadgets is surfacing not a competitor/replacement to traditional or open field farming but as an unavoidable supplementary progressive and profitable modern system of farming loaded with several advantages mainly the farming amenable to aristocrat farmers with or without farms and lovers of automation. Saving on scarce water resource and fertilizers are major advantages in soilless farming.

The magazine also covers important topics such as protray seedlings production and organic protected cultivation. These technologies being in great demand in the country, hence are timely.

Wish you all happy, prosperous and rewarding 2020

Brahma Singh

30-12-2019

A. SOILLESS HORTICULTURE

Indian agriculture sector to go dutch in future?

The Indian agriculture sector may adapt Dutch technology for farming in the future because of its promising output. A consortium of Dutch companies is planning to launch two projects, one in Uttar Pradesh and the other one in Himachal Pradesh. The consortium aims to make Indian farmers aware of the high-yielding Dutch farm production technology. It wants Indian farmers to know that agriculture can be a lucrative business *(Grainmart News 14 Nov. 2019 (Anukriti Aray)*

China's largest high-tech vegetable greenhouse

The Chinese horticulture venture Kaisheng Haofeng has ambitious plans to become one of China's largest high-tech greenhouse growers. The joint venture between the Chinese CNBM group and Triumph Haofen Smart Agriculture Co., Ltd invests heavily in setting up new high tech greenhouse operations. The group recently planted the first tomato crops in a brand new 26-hectare glass greenhouse in Dezhou *(ridder.com)*

An underwater greenhouse

The air of the greenhouse stands at 79 degrees with humidity hovering around 83 percent. That's a pretty good environment for a typical plant. But this is no ordinary greenhouse: it's 20 feet under water, anchored to the floor of the sea just off the coast of Noli, Italy. Over here, experiments are underway with submerged agriculture. According to researchers, the project is interesting for countries with little or no farmland.

Various plants are grown inside of sea through containers on the sea floor. The containers are not too deep so that they can be reached by sufficient daylight to grow the cumin, strawberries and dill inside.

The balloon-like biospheres take advantage of the sea's natural properties to grow plants. The underwater temperatures are constant, and the shape of the greenhouses allows for water to constantly evaporate and replenish the plants. What's more, the high amounts of carbon dioxide act like steroids for the plants, making them grow at very rapid rates *(Hortitoday 03 Dec. 2019)*

Belgium: Indoor farming technology for mars biosphere

Will the first people to bake and eat bread on Mars do it due to a Belgian breakthrough? This is the challenge facing the Space Bakery project, a unique consortium composed of seven Belgian organisations using technology provided by Urban Crop Solutions. However, before they use their research to help feed the first people on the red planet later this century, the project aims to have a clear impact on Earth today. The project will focus on how we can produce food more sustainably and will help provide a nutritional staple food for many regions across the globe. The consortium has just been awarded a subsidy of 4.5 million euros by the Flemish Community (VLAIO, Flanders Innovation & Entrepreneurship), contributing to a total of over 6.3 million euros in funding *(urbancropsolutions.com)*

Moscow: A vertical greenhouse complex appeared in

A unique vertical farm opened in Moscow. Vertical farming is rather widely spread around the world and the technology is applied more and more often in projects with bigger amounts of investments and smaller acreages. Due to multiple layers there will be picked 10 times more greens here than in a traditional greenhouse. The innovative complex will grow lettuce, herbs and microgreens with the use of hydroponics and organic fertilizers only. Close water circuit allows for saving resources and minimizing the negative effect on the environment. The enterprise employs 280 local dwellers. With the coming expansion, up to 700 associates will be needed *(rosng.ru)*

Aeroponic cultivation technology

The use of aeroponic farming technology is not only to cultivate without the soil but more importantly, it can develop into building a three-dimensional spatial farming model. Other surfaces, such as walls and rooftops of urban buildings can be cultivated, which can create a real urban forest-like ecological space and is an important technical support for building a sustainable city *(sgcbh.com; lsmgny.com; sina.com.cn)*

Aquaponics -the future or fad?

The experts have conflict views. Some question its economic viability. Others support as a critical part of our food production system that we need. Others think aquaponics will always be a niche sector. It maybe it's a hundred years into the future, when we've destroyed the planet and we all have to live inside greenhouses *(Aquaculture North America (Matt Jones)*

Aquaponics

Turkey sends satellite into space to assist "smart agriculture"

Turkey will send a satellite to space next year to track agricultural fields and climate.

The project which was announced in late August by the Turkish Ministry of Agriculture and Forestry, aims to start a new era for Turkish agriculture.

The microsatellite called "Lagari" will observe pilot areas that will be selected based on product groups and climate. Mini satellite Lagari is scheduled to be sent to space next year. The satellite is named after Lagari Hasan Celebi, who, according to legend, was on the

first successful manned rocket flight. *(A Haber, tarimorman.gov.tr)*

Hydroponics revolutionizes agriculture in Japan

Despite the high energy cost of hydroponic agriculture, the number of such factories in Japan has tripled in a decade and there are almost 200 facilities nowadays. The hydroponic market is growing worldwide and it's currently worth about 1.5 billion dollars. According to the forecast of Allied Market Research, it is expected to multiply by four by 2023, reaching 6.4 billion dollars *(bbc.com)*

Hydroponics in Japan

German experiment on space tomatoes to sprout

It's hard enough to grow tomatoes from seeds out in a sunny garden patch. To do it in sun-synchronous orbit—that is to say, in outer space—would seem that much harder. But is it?

That's what plant biologists and aerospace engineers in Cologne and Bremen, Germany are set to find out. Researchers are preparing in the next couple of weeks to send a software upload to a satellite orbiting at 575 kilometers (357 miles) above the Earth. Onboard the satellite are two small greenhouses, each greenhouse bearing six tiny tomato seeds and a gardener's measure of hope. The upload is going to tell these seeds to go ahead and try to sprout.The experiment aims to not only grow tomatoes in space but to examine the workings of combined biological life support systems under specific gravitational conditions, namely, those on the moon and on Mars. Eu:CROPIS, which is the name of the satellite as well as the orbital tomato-growing program, is right now spinning at a rate which generates a force that is equal to gravity on the surface of the moon. Read the full article at IEEE Spectrum *(Michael Dumiak)*

How to cultivate on water

Floating farm

The stem of the plant will be rooted in land and a canopy will be created above water for the plant to grow and bear fruit. Harvesting the produce is also easy as one could sit on a thermocol raft and pluck the vegetables *((https://english.manoramaonline.com/districts/alappuzha/2019/09/13/vegetable-farming-in-water-alappuzha-farmer.html) 17 Sept 2019 Manorma*

Rekha reshmik from Kozhikode, Kerala has won award for backyard aquaponics farm

Rekha Reshmik from Kozhikode, Kerala has pioneered a unique method of farming which yields double the profits as well as the harvest. In her backyard, spanning no more than a few hundred square feet, she has implemented aquaponics.In just five years, Rekha's venture, Annapoorna Aquaponics, has grown by leaps and bounds and fetched her multiple awards. In fact, she is the recent district-level winner for modern fish farming. Besides the accolades, she also earns a sizable monthly income alongside fresh, organic ingredients for her self-sufficient kitchen.A graduate in Mathematics, Rekha previously worked as a software developer in Kozhikode. However, as her son was growing up, she found the corporate job inherently taxing and decided to quit. Soon, she started browsing options to earn from home *(The Better India -Sayantani Nath)*

Aquaponic farmer, Rekha Reshmik

Viennese start-up is dedicated to aquaponics

In Vienna, several young farmers founded the Blün company. Using aquaponics, they intend to save on water and fertilizers. "Aquaponics is a circulatory system that combines fish farming with vegetable production," Gregor Hoffmann told the *Kurier* in an interview.

View into the aquaponic facility / Source: Blün

At this time, the new entrepreneurs are only growing five rows of eggplants, tomatoes, peppers, chillies and cucumbers. "We have special varieties on offer, such as the ox-heart tomato or black eggplants. Once you have tasted one of these, you will want nothing else ever again. That's how intense and good their flavor is." And by the way: nothing gets thrown away. "If we end up with too many tomatoes, we will make ketchup out of it." *(www.bluen.at)*

UVI aquaponics featured in national geographic

The University of the Virgin Islands' Agriculture Experiment Station (AES) has been featured in the August 2019 issue of National Geographic, one of the leading magazines

on science, geography, history, and world culture, UVI has announced. UVI, a Land Grant institution, has been a leading public university researching aquaponics and has a great depth of knowledge and experience in the field. The program, which began in 1979, boasts a facility spanning 1.95 acres on the Albert A. Sheen Campus on St. Croix. *(The Virgin Islands Consortium)*

US (GA): Hydroponic school gardens fight hunger, offer fresh food options

Clark Creek Elementary in Acworth, Georgia, is about to get an upgrade to its food pantry. The school pantry feeds 92 kindergartens through 5th grade students each week, giving them a backpack full of food to keep them from going hungry over evenings and weekends when school meals aren't available. Many of the kids take food home to feed younger siblings too. To date, the school pantry hasn't been able to offer fresh fruit or vegetables; but that's about to change.

Clark Creek is one of 20 schools to receive a Gro More Good garden grant. The grant provides two hydroponic garden systems, plus the seeds and technical support to grow fresh vegetables throughout the school year. These hydroponic gardens enable schools to grow fresh produce inside the classroom, regardless of weather conditions or limited outdoor space. And since one hydroponically grown plant can produce more than 10x the yield of one grown traditionally in soil, the schools will have double the harvest, too. *(scottsmiraclegro.com)*

10 plants per square meter thanks to up- and down system for soilless strawberry production

The Up and Down system is not new in countries such as the Netherlands, but it is not as popular in Italy, especially when it comes to strawberries. The fruit is grown in soil-less conduits and the substrate is made of coir and perlite. Conduits are on two levels placed vertically, so operators can work standing straight. The system is equipped with mobile gutters allowing to work on two different cultivation lines in an alternative manner. The gutters are connected to axes and motorized tubes through which they are automatically lowered and raised, depending on the agronomic needs. During transplanting or crop collection operations, the gutters can then be lowered or raised at intervals so that to facilitate worker's activities, therefore, allowing them to have more space inside the structure. In addition to this edge, the raising and lowering system, which represents the main characteristic of the "Up & Down" tool, allows to adjust the height of the cultivation lines to the desired level.In this way operations tasks are further facilitated. During rest times, the entire cultivation is brought back to a single plan, so that to avoid the creation of shaded areasx *(scottsmiraclegro.com)*

Strawberry crop

Hydroponics bananas in Tajikistan- planned

Members of the "Dustobod 2" farm in the Spitamen district of the Republic of Tajikistan intend to build four innovative hectares of hydroponics on 4 hectares by 2021. There, they plan to grow tomatoes, cucumbers, bell peppers and bananas *(Source: a-ipp.ru)*

Greenhouse bananas-hydroponics

UK: A decade of coir substrate in commercial strawberry production

Agrovista has been working closely with three key partners over the past 10 years to develop a comprehensive agronomy offering to soft fruit growers.A decade ago, coir substrate was being introduced as a peat replacement for commercial strawberry production. During the intervening years, Botanicoir and Agrovista fine-tuned the 100% coir mix to develop the Precision Plus grade, which put Botanicoir on the global map, and more recently Precision Plus Ultra, now the product of choice for many large growers. Agrovista started to look at the options for improving the systems within which some of this substrate was used, and in 2009 struck up a trading relationship with Bato Plastics, a Dutch specialist in substrate troughs and pot systems.Bato pioneered square pots on legs for the cane fruit market, and trough systems to optimise substrate volume per plant.The move to substrate in a protected environment paved the way for biological control techniques. Koppert UK has worked closely with Agrovista's agronomy team to help more growers reap the benefits of this method of controlling pests, whilst keeping residues to the absolute minimum. *(www.agrovista.co.uk)*

New raft for hydroponic crops such as basil

Rosa Plast has introduced a new raft to grow basil hydroponically. Developed in collaboration with Cammelli, the companies claim that the productivity increases by 25%. They are designed to optimize processes, logistics, maintenance, cleaning operations and, most of all, to increase productivity per square meter *(Website: www.rosagroup.com)*

Hydroponic Basil Production

TAPKIT- Hydroponics

TAPKIT is a complete, relatively low-cost hydroponic production system. Teshuva Agricultural Products (TAP) develop and supply this system.

TAPKIT hydroponics

Good for growing chives, pak choi, basil, and several lettuce varieties. Tapkit could be used to can cultivate everything which has a three-four-week growing cycle from plantlets to harvest. This includes various leafy and baby leaf vegetables and fresh herbs. *(www.taprojects.com)*

Aquaponics with solar and photovoltaics

The aquaponics-solar greenhouse allows the simultaneous production of vegetables, fish and solar power. Low heating energy requirements and H-LED technology can guarantee production of high-quality food all year round.

There is a positive use of energy generated by the sun. This leads to a very low or even negative CO2 footprint (CO2 sink) for the food produced. *(www.ikratos.de)*

Aquaponic hydroponics

B. ROBOTIC AGRICULTURE

Australia's first fully robotic end-to-end vertical farm

After four years of research and development, the Stacked Farm's fully automated end-to-end vertical farm will soon be supplying leafy greens to national wholesalers including Sumo Salad, QSR, Dnata, Crown Resorts and Morco Fresh. Stacked Farm CEO Conrad Smith says the farm is commercially viable, scalable and competitive, from seedling through to packaging with leading-edge technology. *(Business News Australia (Matt Ogg)*

Modular micro farms, a new approach to urban food production?

One key tenet of the "urban resilience" idea is local food production. If fruits, veggies and herbs are grown in cities, they'll reduce the runoff, emissions, perishability and transport costs of produce. They'll also make cities more self-sustaining, rather than having to fully rely on food grown elsewhere *(Forbes (Scott Beyer)*

Babylon Microfarms

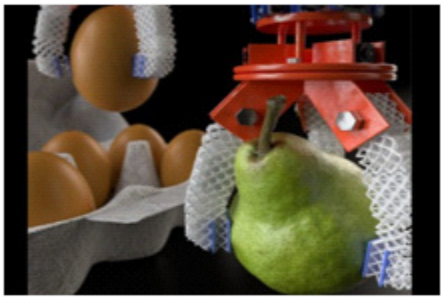
Weed removing robot

FarmWise Labs Inc. develops robots for the agricultural sector, and has developed a robot that kills weeds while leaving the crops untouched. The machine has already weeded over 10 million plants. The machine reduces labor and offers a chemical-free solution to weeds. The company has raised $14.5 million in a Series A round *(digitaltrends.com)*

Simon fraser university develops robotic hand with human touch

Over the last several years, researchers have sought to create robotic personal assistants and bionic limbs or prosthetics that combine the durability of common robots with the flexibility of soft robots. More recently, combinations of cellular structures have shown interesting progress toward the enhancement of non-trivial capabilities, such as grasping uniquely shaped objects.

In their latest study published in Advanced Intelligent Systems, Woo Soo Kim and colleagues from the School of Mechatronic Systems Engineering, Simon Fraser University used 3D printing to fabricate an architectured robotic body with deformable lightweight cellular structures.



Robotic gripper

Robot reaps ripe tomatoes

Root AI, a Massachusetts-based company, has developed a robot capable of picking tomatoes by ripeness and quality. Josh Lessing, Root AI's Co-Founder and CEO, says while the utilization of robotics isn't new, the industry is now fine-tuning the technology, providing exciting opportunities for the produce industry.

The harvesting robot is only the first step in a multi-pronged strategy to offer growers integrated ag-tech systems, with future products like disease detection and yield prediction. Lessing concluded. Ultimately, Root AI wants to be the global leader for intelligent agriculture solutions *(www.root-ai.com)*

C. DRONE IN AGRICULTURE

Unmanned aerial weed control

Scientists with the Weed Science Society of America (WSSA) say unmanned aerial vehicles (UAVs) may soon revolutionize weed management. *(Weed Science Society of America)*

Drone weed mapping

D. VERTICAL FARMING AND MICROGREENS

A number of vertical farms will disappear, but the sector as a whole will expand, *Michele Butturini, Wageningen University & Research*

Leafing through newspaper reports, you'd think that vertical farming is either the perfect solution to global hunger, or a completely failed agriculture system. As with many things, the truth isn't quite as extreme as that. Michele Butturini, researcher at WUR, who together with Leo Marcelis wrote the chapter "Vertical farming in Europe: present status and outlook" for the new Kozai book Plant Factory, can attest to this (*For more information on the Sky High project, see the NWO website. Leo and Michele also contributed a chapter to the second edition of the book Plant Factory)*

Vertical farms with optimal use of sunlight

The truly sustainable vertical farm of the future shouldn't be a compromise. The power of natural sunlight is essential," says François van der Merwe, CEO of CAN-Agri. François has some innovative ideas about today's vertical farms: "As I see it, most 'vertical farms' are not actually vertical. They are made up of horizontal layers that have been stacked vertically, and the top layer blocks out the sun for the layers below. It's a crying shame that we don't make optimal use of the power of natural sunlight." That realization prompted François and his business partner Gideo van der Merwe to develop a truly vertical crop production system that requires hardly any artificial light. They have rotated the traditionally horizontal layers through 90 degrees. François: "This allows each plant to get the necessary light from a naturally occurring source: the sun." *(www.priva.com)*

Vertical farm with sun light top to bottom and rotation

Vertical farming, micro-algae and bio-reactors — the new frontier of sustainable food.

It's attracting huge investment, particularly in the United States where venture capitalists see gains to be made in vertical farming. The major players, to date, have concentrated on producing perishable goods such as salad vegetables — crops that traditionally require large amounts of water. But vertical farming expert Paul Gauthier believes even staples like potato and wheat could eventually be grown indoors. "Everything is possible. I don't think there is anything in the vertical farm that we can't grow," he says. "I was growing coffee trees inside a vertical farm. "It's a question of which kind of design we have to make and what the economics are behind it."

Dr Gauthier, who now works for the New Jersey-based company Bowery Farming, admits both the capital and energy costs involved in vertical farming are "definitely huge". But that needs to be put in context, he argues, because significant government subsidies have long been provided to traditional farming operations *(ABC News (Antony Funnell)*

Tower gardens using LEDs

Sky High, a research programme led by Professor of Horticulture & Product Physiology Leo Marcelis, which aims to bring about a revolution in vertical farming, received a total grant of €5 million. By growing plants in layers on top of each other and illuminating them with special LED lights, you can produce fresh vegetables all year round, anywhere in the world, and under all weather and climate conditions *(Wageningen University & Research)*

Producing seedlings in an off-grid LED lit vertical farming facility

Plant Raisers Ltd, the largest propagator of glasshouse salad crops in the UK, has in addition to a recent expansion of its conventional glasshouse facility, partnered with sister company IGrowing Ltd to develop a system to produce seedlings using an off-grid LED lit vertical farming facility. The

resulting system is the culmination of over three years' research at Plant Raisers Ltd focussed on containerised growing seedlings with the minimum energy input. The project is now fully operational and will be further developed by iGrowing Ltd for customer specific applications. The system components can also be fitted into larger vertical farm developments looking to take advantage of the energy savings and design methodology *(nick@igrowing.co.uk)*

Vertical farming is a part of New Zealand's future"

Shoots Microgreens is New Zealand's first vertical farm in the heart of Wellington's CBD. Underground, in a former nightclub, multi coloured LED lights are stacked in vertical rows to boost microgreen growth. Shoots co-owner Matt Keltie opened the business in February 2018, after gaining funding support from the Energy Efficiency and Conservation Authority (EECA) to install the LED grow lights.

Underground Vertical farm

An indoor farm avoids many of the problems that come with growing microgreens in the great outdoors; no chemical pesticides or weed sprays are needed in this controlled environment. Plants can get optimal delivery of 'sunlight' through the LEDs, and these can be adjusted to mimic longer sunlight hours, which is why the plants grow around twice as fast. The temperature, air flow and water supply to microgreens is also carefully tailored to suit the plants, seeing the business use 95% less water than a traditional farm

Vertical farming is not a replacement for traditional New Zealand farming yet, but definitely part of our future. We are looking at helping to reduce food transport emissions further by expanding our operation to other cities like Auckland, and growing more varieties of edible plants *(www.eecabusiness.govt.nz)*

Vertical farming reaches new heights in Germany

The Association of vertical farming (AVF) was invited to visit its member Fraunhofer IME in Aachen, Germany, one of 72 institutes of the Fraunhofer-Gesellschaft, an organization for applied science in Europe with over 26,000 employees and various international branches around the world.

Fraunhofer IME building in Aachen, Germany. Credit: AVF

The Fraunhofer Institute for Molecular Biology and Applied Ecology IME has six different sites in Germany and conducts research in the field of applied life sciences from the molecular level to entire ecosystems. Its division "Molecular Biotechnology" is located in Aachen, Germany and conducts R&D in the field of biotechnology with a strong focus on plant-based applications.

Over the last 10 years, the IME has developed and established two different vertical farming systems at the Aachen site in cooperation with the Fraunhofer IPT and IIS (à VertiPharm) as well as the Fraunhofer IML (à OrbiPlant): VertiPharm, a fully automated vertical farm with a strong focus on different research applications (e.g. plant cultivation, plant phenotyping, biopharmaceutical production) and OrbiPlant, a novel and cost-efficient approach to vertical farming of food crops. These two vertical farming systems are complemented by LEDitGrow, an innovative multi-chamber system for the rapid development of plant growth protocols and the optimization of specific plant target values *(vertical-farming.net and www.ime.fraunhofer.de)*

US (NJ): Aero farms announces launch of microgreens

The indoor vertical concern, Aerofarms, has just introduced a new line of microgreens under their proprietary retail brand Dream Greens, to further expand their mission of nourishing communities with safe, fresh, nutrient-rich food.Two new varieties of microgreens are the Micro Super Mix and Micro Spicy Mix, *(www.AeroFarms.com www.DreamGreens.com)*

Indoor ag seen as key to feeding planet

Recent Controlled Environment Indoor and Vertical Food Production Coordinated Research Conference held at Southern Arizona's world-famous Biosphere2 research laboratory. "Open field agriculture in the U.S. is the largest in the world aimed at feeding the largest number of people, but there are limitations in land, labor, and resources," said co-coordinator Gene Giacomelli, estimating that the current greenhouse-grown vegetable effort represents slightly more than 1.3 million acres under glass.

Indoor View

A prototype greenhouse for use on lunar or Mars missions is displayed at a recent conference on food production at Southern Arizona's famous Biosphere2 research laboratory.

Over the course of the conference, 33 speakers told of their research

successes and remaining problems in trying to grow things better, faster, and cheaper with discussions ranging from nutrition and post-harvest concerns to production systems and pest and disease management.

"We struggle with the same issues that greenhouse growers and indoor vertical farms do in looking at food security, keeping astronauts operating at peak performance on long-duration missions," said Ralph Fritsche, Senior Crop Project Manager in NASA's Life Sciences Office. "Right now, NASA is taking from current CEA knowledge and technology with a pay-if-forward mentality. Once we find solutions to similar problems in space, light bulbs will light up in the CEA industry on how these answers can be applied on earth." (Western FarmPess 25 Sept 2019

Growers use rockwool to produce specialty crops

While Grodan rockwool may be more often associated with greenhouse tomatoes and cucumbers, controlled environment growers are quickly learning that this substrate is an ideal choice for specialty crop production. Many growers producing-controlled environment food crops are familiar with Grodan rockwool. The clean, disease-free, inert substrate is used worldwide to produce greenhouse tomatoes and cucumbers. What growers may not be aware of is that Grodan rockwool can be used to produce specialty crops like strawberries, microgreens and hemp*(www.hortamericas.com)*

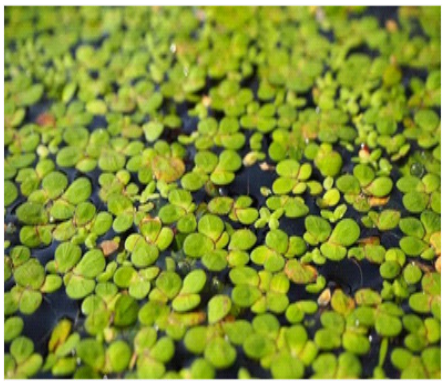
Microgreens on rockwool

US (PA): 60,000-square-foot vertical farm built in braddock

Fifth Season, an indoor farming company, announced plans for its first highly efficient, commercial-scale indoor vertical farm, which will open in early 2020 in Braddock, an historic steel town near Pittsburgh *(www.fifthseasonfresh.com)*

Could duckweed (lemna minor) be the next big vertical farm crop?

Duckweeds are a family of aquatic plants that can be found floating on still or slow-moving bodies of water worldwide. Also known as bayroot or watermeal, duckweed is a popular food in Southwest Asia. Duckweed is a major source of protein, which accounts for 40 percent of its dry weight. It's also the world's fastest-growing plant.



The world's largest collection of duckweeds can be found at Rutgers University. Professor Eric Lam in the Department of Plant Biology and his research team are developing a production platform using a hydroponic vertical farm production system. Growing in stacked trays, about 2½ acres of duckweed can produce 1.4 million pounds of dried plant matter annually. For the same production area, this is about 50 times the production output of corn *(www.hortamericas.com)*

Mini greenhouse for microgreens

The fully automated "Plantcube" greenhouse from Munich-based company Agrilution offers a closed ecosystem for plants and, according to the manufacturer, optimal growth conditions. Irrigation is done automatically.

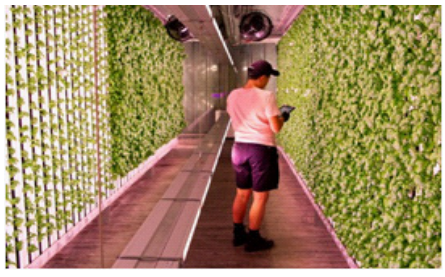
The fully automated greenhouse "Plantcube" / Image: Agrilution

The high nutrient density ensures an intense aroma and pronounced textures. Currently, 17 different lettuces, microgreens and herbs can be selected from the Agrilution range, among which there are unusual varieties such as red Pak Choi or Wasabina leaf mustard. The system is controlled by the Agrilution Cloud and a user-friendly app provides insight into the growth process and notes on maintenance and harvesting. The "Plantcube" is the size of a small refrigerator *(www.agrilution.com)*.

Urban farming start-up at michigan farm

On September 30th, Square Roots will cut the ribbon and officially open its newest indoor farm on the Gordon Food Service headquarters in Wyoming, Michigan. The company said this is the beginning of a strategic partnership that will see Square Roots' high-tech farms built on or near Gordon Food Service locations across the continent.

Square Roots' partnership with Gordon Food Service established urban farmiming training facility was announced at the end of March, with the first co-located farm opening six months later. Square Roots' says this speed is possible thanks to the modular, scalable farm-tech platform.



Urban farm training facility

Urban farm training facility

Each farm is described as "smart" - with digital technology allowing farmers to learn from each other. The company says that opening the Michigan farm brings it closer to the vision of a distributed network of indoor farms *(www.squarerootsgrow.com)*

High-tech indoor farming in Dubai

Desert terrain, extremely high temperatures and limited rainfall have historically made agriculture unworkable in the United Arab Emirates (UAE) — but thanks to new technology, companies in Dubai are finding ways to grow locally-sourced produce. With temperatures in the desert city regularly exceeding 40 degrees Celsius in summer months, a massive 80% of the Dubai's food supply is imported. But the government is keen to reduce dependency on imported foods. Badia Farms is one of several firms tapping into the demand for locally grown foods by developing an indoor farm in the city. Using hydroponics, a growing technique that doesn't require soil, the farm is successfully growing fruit and vegetables that are already being served in some of Dubai's top restaurants *(CNBC (Chloe Taylor)*.

Modern vertical farms

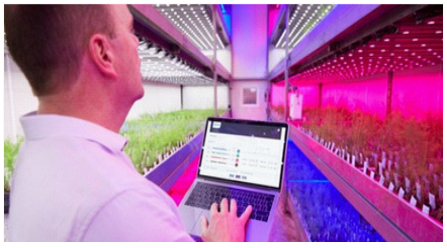
Plenty, Bowery, Aerofarms and 80 Acres Farms are among young companies that see a future in salad greens and other produce grown in what are called vertical farms that rely on robotics and artificial intelligence, along with LED lights. While the first versions of modern vertical farms sprouted about a decade ago, in recent years the introduction of automation and the tracking of data to regulate light and water has allowed them to get out of lab mode and into stores. Now they are trying to scale up. Plenty, Bowery, Aerofarms and 80 Acres Farms say they are prepared to make their crops 'grocery store competitive *(Indoor Vertical Farming, July, 10, 2019)*.

US: Aero farms raises $100m as investors rush to indoor farms

Another multi-million-dollar investment in vertical farming. AeroFarms confirms the publication by The Financial Times, reporting that they raised $100m in their Series E fundraiser to further expand their warehouses of stacked growing trays and branch out into different produce. This round again was led by the Ingka Group, the parent company of Ikea. Earlier AeroFarms announced its participation in a new high-tech consortium developing crops for indoor agriculture. Working together with Fluence, Priva, and BASF, they want to develop new crops specially intended for indoor agriculture.(Financial Times *(Lindsay Fortado)*

Bejo Zaden and signify team up to accelerate breeding of more seed varieties

Signify has partnered with Bejo Zaden to accelerate breeding of more seed varieties through a new vertical farm approach to cultivation. In the facility, a large climate-controlled room is equipped with Philips GrowWise Control System to automate control of Philips GreenPower LED dynamic modules. The company can now produce multiple crop cycles per year to meet the high demand from growers, faster *(www.philips.com/horti)*



Development of seed varieties for vertical farming

44-hectare greenhouse vegetable complex comes to Saudi Arabia

Dava corporation, owned by the Al Batal family, is forecast to grow in agricultural business since they have entered into a contract for a large-scale turn-key greenhouse project with the company Debets Schalke. Mr. Faisal Al Batal of Dava corporation and Wim van Weele of Debets Schalke confirmed the cooperation for the realization of three different greenhouse projects at three different locations with a total project size of 44 hectares. This is the largest horticultural investment in the Kingdom of Saudi Arabia ever*(www.debetsschalke.com)*

Proposed set-up

Microgreen quality

Dr. Roberto Lopez of Michigan State University recently presented on the keys to producing high quality microgreens using grow light technology.

Summary of Dr. Lopez's findings:

1) plants can be taller (easier to cut) under lower light
2) yield of microgreens only moderately increases under higher light
3) leaf area decrease under higher light
4) carotenoids and mineral nutrients decrease under higher light
5) anthocyanins (purple pigment) increase, intensifying color under higher light. All together Roberto recommends using relatively low light (6-8 mols per square meter per day) for growing microgreens and then finish up with higher light to intensify the color. These levels of light can be achieved at an intensity of 100-140 micromole per square meter per second over plants for 16 hours lighting per day (www.urbanvine.co)

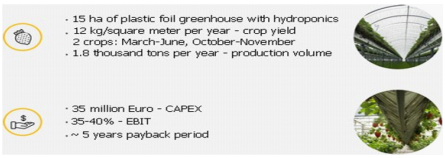
Microgreen with vertical farming trend

Amorette Farms is an indoor, vertical farm that grows non-GMO microgreens – the shoots of salad greens like arugula – using

controlled environment agriculture. Since launching this spring, the company is already serving about a dozen commercial clients, said its founder, Devyn Rothbrust*(The Business Journal (Jeremy Lydic)*

Russia: Indoor strawberry cultivation

One of the potential growth markets is indoor cultivation of strawberries in Russia. First, some general data regarding the Russian market for year-round strawberry cultivation:The economics of a strawberry greenhouse is as under in Russia. According to the report, the net operational margin of a plastic foil greenhouse project is 35-40%. The production margin for year-round projects involving lighting is higher.



Possible economics of strawberry cultivation in plastic foil greenhouses without lighting. Source: Company data, SPARK, open sources (www.neoconsult.ru)

U.S. vertical farms are racing against the sun

Several top U.S. indoor farms, stacked with plants from floor to ceiling, tell Reuters they are boosting production to a level where they can now supply hundreds of grocery stores.Plenty, Bowery, Aerofarms and 80 Acres Farms are among young companies that see a future in salad greens and other produce grown in what is called vertical farms that rely on robotics and artificial intelligence, along with LED lights. While the first versions of modern vertical farms sprouted about a decade ago, in recent years the introduction of automation and the tracking of data to regulate light and water has allowed them to get out of lab mode and into stores. Now they are trying to scale up.

Plenty and others say their customized, controlled lighting - some more blue light here, some more red light there - makes for tastier plants compared to sun-grown leaves and that they use 95% less water than conventional farms, require very little land, and use no pesticides, making them competitive with organic farms. And because vertical farms exist in windowless buildings that can be located in the heart of urban areas, produce does not have to travel far by fossil-fuel-guzzling trucks to reach stores*(Reuters (Jane Lanhee Lee)*

Vertical greenhouse production in Turkey

Turkey is looking to improve its position in the global agriculture market and has directed its focus to vertical greenhouses. Vertical greenhouses are expected to triple within the next 30 years and they will bring significant savings in transportation, environmental and energy costs. Vertical greenhouses are expected to be built specifically in major cities in order to save space and to prevent price increase in agricultural products. Additionally, it will create more jobs for the people living in the area*(Yeni Asir)*

Vertical vegetable production in Turkey

Microgreens in vertical farming- Munich, Germany

Urban and vertical farming-projects are becoming more and more present in the current, modern agriculture. For example, the South-German city of Munich has recently got their own regional cultivation project: under the name of Munich Micros, an ambitious team of innovative growers brings around 25 types of local cultivations to market. After the success in regional wholesale and food service industry, the cultivation company intends to steadily increase the production capacity as well as the product range *(www.agfprimeur.nl.)*

Microgreens

Vertical farm US (CA)

Plenty debuted its new farm, Tigris, designed for the flavor while producing with efficiency and cleanliness.

"Plenty is on a mission to change the way we eat by growing produce with crave able flavour while increasing availability to a world that long ago ran out of additional fruit and vegetable farmland," said Matt Barnard, CEO and co-founder of Plenty. "The globe can grow only one-third of the fruits and vegetables required to provide people with a healthy diet, and those fruits and vegetables are largely available only to the affluent or people who live near a Mediterranean climate. A farm like Tigris has the potential to improve human and planetary health, and that's exactly why Plenty is here."

Photo Credit: Spencer Lowell (Photographer)

"There are 70,000 edible fruit and vegetable varieties in the world, and because of the challenges of growing outdoors and putting food on trucks, we've been relegated to eat the few dozen that we find at the grocery store," said Nate Storey, chief science officer and co-founder of Plenty. "Plenty has unlocked a future where people across the globe, regardless of income or geography, can experience the joy of incredible, nourishing fruits and vegetables."

Photo Credit: Spencer Lowell (Photographer)

Tigris is currently being commissioned and will then undergo a facility-level food safety certification pursuant to internationally-recognized third-party standards (www.plenty.ag).

E. GENERAL

Daimler in Brazil opens urban farm

Mercedes-Benz do Brasil has opened an urban farm at its plant in São Bernardo do Campo: since November 2019 they have been growing organic vegetables at the truck and bus plant in keeping with ecological farming standards and serving them in the works canteen in accordance with the "farm-to-table" principle. As the vegetables are grown in a greenhouse directly next to the main restaurant, no further transportation is necessary *(www.daimler.combegreen.farm)*

A view of the farm

World food prize foundation honored with slovakian peace prize

The World Food Prize announced that Ambassador Kenneth M. Quinn was presented the Peace Prize From Slovakia on behalf of the Foundation and his work over the past 20 years. The ceremony was held December 12, 2019, at the Palffy Palace in Bratislava. *(World Food Prize Foundation)*

Papaya crop an alternative for intensive horticultural production of Almeria

The high-yield agricultural model in Almería is based on eight diferent crops grown under plastic greenhouses: tomato, sweet pepper, cucumber, courgette, aubergine, green bean, melon and watermelon. Having led fruit and vegetable exports in Spain for more than 50 years, a decrease in melon growing areas in Almería in the last years has caused a change in supply that is afecting the model's profit. Papaya cultivation could reactivate the profit of the agricultural model in Almería that is at a mature stage and also improve the available product range.

Papaya in greenhouse

(Mireille N. Honoré, Luis J. Belmonte-Ureña, Asensio Navarro-Velasco, Francisco Camacho-Ferre, 'Profit Analysis of Papaya Crops under Greenhouses as an Alternative to Traditional Intensive Horticulture in Southeast Spain', 2019, International Journal of Environmental Research and Public Health, 16, 2908.)

Holiday demand for edible flowers increasing

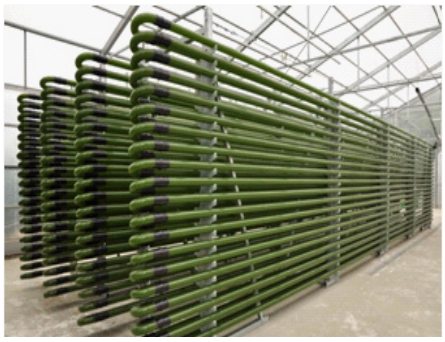
Supplies of edible flowers from California are steady, although slowing down slightly.

The flowers, including edible roses, marigolds, pansies and more which are sometimes sold as a 'confetti' mixed pack or by flower variety, are often greenhouse grown and come from Northern California. *(http://www.bayareaherbs.com/)*

Billion-year-old microbes could give us new food, fuel sources

Energy and food. These are the building blocks of any ecosystem. They are also the most important material components of any human society. The causes of wars, the motivation for inventions, the history of humankind itself is a struggle to find and secure these two resources. But a billion-year old group of microbes has the potential to provide us with food supplements, chemical feedstock and biofuels.

Kostas Vavitsas | December 9, 2019



Tubular glass photobioreactor. Image: IGV Biotech, CC-BY 3.0

Sensors are useful in indoor growing

Greenhouse sensors are critical components of your indoor grow monitoring systems. Sensors

continually measure specific conditions within a particular location and report that data to the system. As agricultural technology changes the way farmers grow, it's essential to stay informed on the latest advances in technology to increase crop yields and prevent disease.

Here are six reasons one should have smart sensors in greenhouse:

1. *Moisture Detection* - Knowing when to water and how much is a crucial component in the success of your grow operation. Smart sensors can calculate precisely how much and how often to water your crop to avoid root rot and other issues with over or under watering your plants.

2. *Control Access* - Smart sensors can be installed on key access points of your growing operation, giving you 24/7 monitoring of who is accessing key locations. Placing sensors on windows, doors, supply rooms, and other essential areas can alert you when different areas are being accessed and allow you to monitor unauthorized access.

3. *Monitoring Equipment* - The modern, smart farm requires many types of equipment to run optimally. Using sensors on irrigation, misting, and fertilizer systems will monitor the performance of pumps and pressure lines, allowing you to stay up to date on the system's efficiency. They can also be placed on vents, fans, and vented roofs to be alerted if they stop working or operate outside of predetermined parameters.

4. *CO2 levels* - Carbon dioxide is essential to the process of photosynthesis. Most indoor plants grown require a minimum CO2 concentration of 330 ppm to enable them to photosynthesize efficiently. Mounted sensors in your grow operation will monitor CO2 levels and alert you when levels dip below the predetermined amount so you can adjust accordingly.

5. *Monitor power supply* - Smart farms require plenty of power for critical equipment like fans, heaters, lighting, sprinklers, humidifiers, etc. Sensors can alert you to power outages that may impact your operation.

6. *Water pH levels* - Placing sensors into plumbing systems will monitor the pH levels in real-time. This can prevent nutrient deficiencies that can occur when water is over or under acidic, eliminating the need to test water samples using alternative methods.

Most systems provide real-time status of all monitored conditions through a cloud-based system. This offers immediate access to sensor data from any internet-connected device, such as a tablet or phone *(growlink.com)*

Water-cooled LED lighting

Greenhouse growers want more light, but not more heat in their cultivation. They want to decrease energy use in the greenhouse, and minimize the amount of maintenance the lights need to undergo. Oreon started from those ideas when it discovered the possibilities of LED lights. The water-cooled luminaires make it possible to significantly increase the intensity of the lighting without adding heat to the crop, something that was initially particularly popular with cultivations like hydroponic lettuce, herbs and cresses, where heat plays a major role. Now they're seeing more and more tomato growers making the switch as well, in order to be able to work with higher levels of lighting.

Oreon lights are all over the world now (www.oreon-led.com).

Wild relatives of chile peppers

Researchers aimed to fill critical knowledge gaps with regard to the distributions and conservation status of the wild relatives of chile peppers. The researchers were able to categorize 18 of the taxa as "high priority" for further conservation action as a consequence of a combination of their ex situ and in situ assessments, 17 as "medium priority," and two as "low priority." Priorities for resolving gaps in ex situ conservation were determined to be high for 94.6%, and medium or high with regard to increased habitat protection for 64.9% of the taxa.The preliminary threat assessment indicated that six taxa may be critically endangered, three endangered, ten vulnerable, six near threatened and 12 least concern.

The researchers concluded that taxonomic richness hot spots, especially along the Atlantic coast of Brazil, in Bolivia and Paraguay, and in the highlands of Colombia, Ecuador, Peru and Venezuela, represent particularly high priority regions for further collecting for ex situ conservation as well as for enhanced habitat conservation. (DIVERSITY AND DISTRIBUTIONS, harvest@worldveg.org)

Organic and fully self-sustaining greenhouse growing tomatoes in Iceland

Fridheimar Farm (situated in Reykholt, Iceland) produces one gallon of organic tomatoes per day through completely organic and self-sustaining horticulture. It uses only renewable energy resources. Geothermal power plants supply natural hot water to heat the greenhouse, as well as electricity for the artificial lighting, needed to grow tomatoes in all seasons. After shipping in a green fly from Denmark - which acts as a natural pesticide, eating insects that are harmful to the tomatoes – they have avoided using harmful chemical pesticides. Breeding their own bees, pollination is sure to occur within their greenhouse. Over 99% of electricity production and almost 80% of total energy production in Iceland comes from hydropower and geothermal power, reducing heating bills and carbon footprint. This fiercely battles

climate change (Local London (Megan Bantleman)

Screens protect organic baby leaf

Arrigoni, the group specializing in the production of protective screens for agriculture, calls itself "an excellent ally for organic farming", following a test in the field for the control of flea beetles. The test was performed on an organic rocket seeding, started in early September and harvested 17 days later. Both Scirocco MD White (windbreak and medium shading net, in flat weave HDPE monofilament) and Biomaglia (light polyamide net, anti-insects and anti-frost) were tested, positioned on the crop immediately after sowing and kept until the harvest*(www.arrigoni.it)*

Screens protect organic baby leaf

Precision medicine for plants

Researchers from the Utrecht University, in collaboration with colleagues at the University of York (UK) and the Nanjing Agricultural University (China) have developed a new technology to selectively destroy the pathogen that causes the devastating wilt disease without side effects on other beneficial microorganisms. "Here, we developed a novel approach using bacteriophages: special viruses that only eat up pathogenic bacteria. This precision medicine is fully natural and highly efficient", Jousset says. This new technology provides a long-lasting protection by destroying the pathogen while allowing soil life to recover. Even if pathogens survive the treatments, they are so weakened that they cannot compete anymore with natural microbes and go extinct. The researchers publish their new technology 2 December in Nature Biotechnology*(Utrech University)*

White and other poinsettia-the quest

www.suntoryflowers.com

Poinsettia Pure WhiteThink Pink

Princettia Queen Pink

Perfect for a Princess

Nitrogen into the regulation of flowering

The regulation of flowering in plants is a highly complex process that is dependent on many internal and external factors. Flowering at the wrong time point leads to a loss of seed production and endangers the plant's reproduction and survival of the species. To combat this problem, plants use a complex network of proteins to continuously monitor environmental factors, such as light and temperature, to determine the best time point for flowering. The work group of Dr. Vanessa Wahl from the Max Planck Institute of Molecular Plant Physiology, in cooperation with Dr. Anne Krapp from the National Institute for Agricultural Research (INRA) in Paris, have now revealed that nitrogen is involved in the regulation of the flowering time. In March, Dr. Wahl's group published their exciting results in the scientific journal New Phytologist.

In summary, plants are able to adapt their life cycles depending on the availability of nitrogen by delaying their flowering time, due to suboptimal growth conditions. Deeper knowledge about the interplay of nitrogen and sugar sensing in terms of flowering time will help to develop new strategies to increase the yield of crops when grown on nitrogen-limited soil. By understanding these biological processes, we stand to gain an important approach to optimizing the use and application of nitrogen fertilizer *(Max Planck Institute of Molecular Plant Physiology)* . In certain fruit trees like cherry flower appearance is prior to leaf production? The above does not explain it?

Root zone temperature matters

To increase yield and shorten the growing cycle of their flowers, Cairo & Doutcher recently invested in Roots' RZTO system for their farm in Italy. Suitable stable temperature of roots has all positive effects on plants both in summer and winter. Above ground temperature does not harm much if root zone temperature is optimal. Mulch and watering with warm and cold water according to season are of help*(www.rootssat.com and www.cairodoutcher.com)*

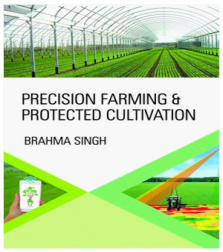
India: Tunnel farming gains popularity among farmers

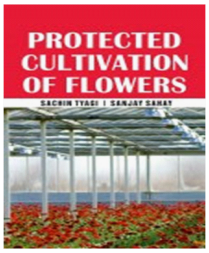
Tunnel farming technology for vegetable production has gained popularity among the small growers and farmers in Punjab. Sources in the Agriculture department said that tunnel farming was being carried out over 16,101 acres of land across the Province.Over 2,000 small farmers including female farmers have adopted tunnel farm technology on their own expanse in Sialkot, Daska, Pasrur and Sambrial tehsils of the district. cultivating off-season vegetables like cucumber, tomato, green chilli, paprika, pumpkin, bitter gourd, watermelon and melons etc. Business Recorder, 25 Nov. 2019

CEA to solve food shortages

A review of the literature led by researchers from the University of Florida attempts to provide clarification and analysis on various aspects of what a controlled environment system entails and the extent to which differing food production approaches can be applied to the many current and hopeful endeavours of Urban Agriculture.For urban farmers to benefit from controlled environment agriculture, analysis will need consideration of local demand and supply of food, location, population density, facility design, and crops produced. Preliminary research suggests that sustainability for these urban farms hinges on capital investment and operating costs, production volume, product quality and consistency, and local market trends.The researchers have offered a detailed examination of multiple facets of the controlled environment: carbon dioxide enrichment, humidity control, water and soil cycling and the environmental footprint, food safety, economic factors, electric lighting, and quite a bit more *(ashs.org)*

Recent books on protected cultivation





Indian army has weaponized ghost peppers

The Indian Army just weaponized one of the world's hottest peppers. The newest biological weapon on the market is a homegrown substance for India: Ghost Peppers, Chilli grenade; This chilli is also known as Bhoot Jhulakia or Naga Chilli. DRDO of DRL Tezpur did pioneering research on this chilli *(wearethemighty.com)*

Insect screens will become essential

Mesh screens will be an essential part in the Integrated Pest Management and for pollination. On the one hand, the mesh will keep in the biological controllers and on the other hand, pests are kept out. But the care for bees and bumblebees also requires extra attention *(www.ventiguard.com)*

Higher CO2 increases yield minimum by 2.8%

CO2 plays a major part in the production of glasshouse crops. Carbon (the C in CO2) is the second most abundant element that makes up a tomato plant. (Water makes up 80% of the plant, carbon makes up half of the remaining 20%). Most of that carbon is taken up by the plant via the absorption of gaseous CO2 through the photosynthetic process.It's amazing, according to Godfrey Dol, specialist in growing in semi-closed greenhouses, to think that a tiny concentration of 400 ppm atmospheric CO2 (0.04%) can help create enough trees, plants, fruits, and vegetables to feed all people, animals, and insects in the world.It makes sense then, that increased level of CO2 results in yield increases.In the worst-case scenario, during hot weather, a semi-closed glasshouse will still yield a 2.8% yield increase compared to a conventionalglasshouse*(www.glasshouse-consultancy.com)*

West Bengal: LED for chrysanthemum flowering

Smog has created havoc to chrysanthemum production in West Bengal. Led light in open fields and ploy houses helped flowering of chrysanthemum and promoted tourism to the area. *(Times of India, 17 Nov. 2019)*

Farmer putting up LED

A lit-up farm at night

Avoid the following for successful indoor farming

This list is not definitive but gives you a good idea of the most common mistakes to avoid.

1. Avoid a trial and error approach to design
2. Pick the right crop
3. Location, location, location
4. Simplify your business model
5. Be realistic about operational cost
6. Set prices based on what consumers will pay
7. The skills gap
8. Remember what you're selling (Read more at Hort Americas)

Plants may be better than technology at mitigating air pollution

Adding plants and trees to the landscapes near factories and other pollution sources could reduce air pollution by an average of 27 percent, new research suggests. The study shows that plants – not technologies – may also be cheaper options for cleaning the air near a number of industrial sites, roadways, power plants, commercial boilers and oil and gas drilling sites (Ohio State University *(Laura Arenschield)*

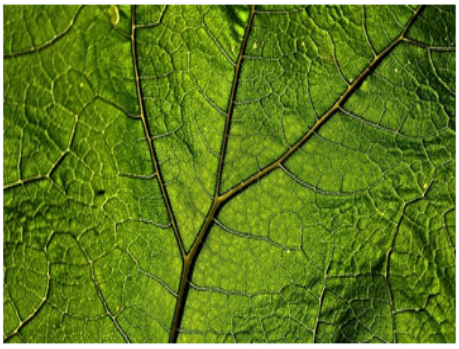
Growing grapes in high tunnels

High tunnels may help reduce pests and improve yields for grape growers in Arkansas, said Elena Garcia, horticulture professor and researcher for the University of Arkansas

System Division of Agriculture. High tunnels are plastic-covered structures, similar to greenhouses, but are passively heated and cooled," Garcia said. They provide intermediate environmental protection between greenhouse and field conditions. Results indicate that table grapes growing under tunnels have better yield and fruit quality. Pest pressures are also greatly decreased *(University of Arkansas)*

Grapes under high tunnel

An "Artificial Leaf" for fuel (university of waterloo)



Credit: Pixabay

Scientists have created an "artificial leaf" to fight climate change by inexpensively converting harmful carbon dioxide (CO2) into a useful alternative fuel. The new technology was inspired by the way plants use energy from sunlight to turn carbon dioxide into food. "We call it an artificial leaf because it mimics real leaves and the process of photosynthesis," said Yimin Wu, an engineering professor at the University of Waterloo who led the research. "A leaf produces glucose and oxygen. We produce methanol and oxygen."

Making methanol from carbon dioxide, the primary contributor to global warming, would both reduce greenhouse gas emissions and provide a substitute for the fossil fuels that create them.The key to the process is a cheap, optimized red powder called cuprous oxide. Engineered to have as many eight-sided particles as possible, the powder is created by a chemical reaction when four substances – glucose, copper acetate, sodium hydroxide and sodium dodecyl sulfate – are added to water that has been heated to a particular temperature.

The powder then serves as the catalyst, or trigger, for another chemical reaction when it is mixed with water into which carbon dioxide is blown and a beam of white light is directed with a solar simulator."This is the chemical reaction that we discovered," said Wu, who has worked on the project since 2015. "Nobody has done this before."

The reaction produces oxygen, as in photosynthesis, while also converting carbon dioxide in the water-powder solution into methanol. The methanol is collected as it evaporates when the solution is heated. An hour-long chemical reaction creates the engineered red powder that is the key to new technology to turn carbon dioxide into fuel. Next steps in the research include increasing the methanol yield and commercializing the patented process to convert carbon dioxide collected from major greenhouse gas sources such as power plants, vehicles and oil drilling."I'm extremely excited about the potential of this discovery to change the game," said Wu, a professor of mechanical and mechatronics engineering, and a member of the Waterloo Institute for Nanotechnology. "Climate change is an urgent problem and we can help reduce CO2 emissions while also creating an alternative fuel." *(Wu et al. (2019) Facet-dependent active sites of a single Cu2O particle photocatalyst for CO2 reduction to methanol. Nature Energy. DOI: https://doi.org/10.1038/s41560-019-0490-3)*

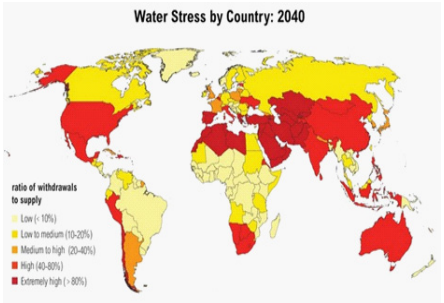
World's first true red spinach variety released

USDA Red, the world's first true red spinach variety has been developed and released by the Agricultural Research Service *(Hortdaily Wed 6 Nov 2019)*

USDA Red

Worldwide water scarcity by 2040

The World Resources Institute forecasts that the world's demand for water is likely to surge in the next few decades. Rapidly growing populations will drive increased consumption by people, farms and companies.It's not clear where all that water will come from. Climate change is expected to make some areas drier and others wetter. As precipitation extremes increase in some regions, affected communities face greater threats from droughts and floods *(World Resources Institute)*



Lorigene introduces new blue carnation

GMO flowers are widely accepted by the general public. Generally, people see this as a flower, which is not consumed such as food *(www.suntory.com and www.florigene.com)*

Blue carnation

New snack tomato for children

In addition to the existing Honey tomatoes and Joyn brands, Looye Growers are now

www.looye.com

Kalanchoe Tiger now available

New Kalanchoe Tiger series in pot size with a total of 9 colours such as red, orange, bronze, copper, yellow, pastel, white, pink, dark pink have been developed.

The Kalanchoe Tiger is grown exclusively by Decorum grower Slijkerman and is now (only to a limited extent) available in the Decorum webshop *(webshop.decorumplants.com)*

Edible flowers popular with floral designers

Edible flowers have become more popular among top class chefs and high-end restaurants over the years. However, nowadays more and more floral designers are starting to use them as well in their floral designs. At table arrangements and in glass vases, they are used more and more - all to make the dining experience more special. (www.afrextrading.com)

Bio-line app for bio-control

All the biological control in your pocket, anywhere, anytime and instantly: Bio-line Agrosciences has taken the challenge with theBioline App.The Bio-line App is a mobile application developed by Bio-line Agrosciences to help producers and distributors to implement their biocontrol programs in the best conditions.The goal of this application is simple: to make Integrated Pest Management and protection with Beneficial's accessible to all producers. Sébastien Rousselle, bio-solutions marketing manager, explains the concept: "The Bio-line App brings together many tools in a single place. It is no longer necessary to be cluttered with multiple sources of information, many sites or datasheets. Everything is gathered in the same place and updated regularly. We wanted an application accessible to all, easy to use and intuitiveto browse," says Sébastien Rousselle. "That's why it's totally free andavailable in many languages." Already three languages are available:French, English and Spanish. It can be downloaded immediately on iOS and Android application stores.*(www.biolineagrosciences.com)*

Internet of things "replaces" traditional labour model

Remote and automated agricultural production and management have greatly improved production efficiency and saved costs.After seeing the dashboard, you can quickly complete irrigation with one click. In the past, this often took a lot of effort to complete, and intelligent IoT applications are changing all walks of life. The role of IoT engineers is to make people's production and life more convenient and intelligent(scnews.newssc.org *(Wen Ji, Zhang Yu, Li Dan)*

Russian greenhouses produced almost 1 million tons of vegetables in Jan-Sep 2019

Russian farmers collected 966.7 thousand tons of protected ground vegetables from January – September 2019, of which 897.0 thousand tons in winter greenhouses, which is 13.5% higher than the level of 2018 (790.4 thousand tons).New greenhouses significantly exceed previously built ones in terms of production performance resulting in production volumes increase by 65% compared to 2014. By 2025, it is planned to increase production to 1.5 million tons per year *(Ministry of Agriculture of the Russian Federation)*

VR glasses slowly becoming known in horticulture

One can visit the greenhouse without visiting the greenhouse. VR glasses would be more than just a nice gadget in greenhouse industry. Eventually, these glasses are used to give virtual tours during training (www.ogvg.com).

OGVG Facebook

A new scouting tool – natutec scout

A new scouting tool – Koppert's Natutec Scout is being used by a number of tomato growers in the Netherlands. This tool does the work of scanning for pests using image recognition. The user then enters the count so that a dashboard can interpret the results into schematic overviews of the situation in the greenhouse. The tool allows growers to optimize the data collection of greenhouse pests so that hotspots can be treated as rapidly and effectively as possible*(www.koppert.com)*

World food prize 2019

The 2019 World Food Prize was awarded to Simon N. Groot of the Netherlands for his transformative role in empowering millions of smallholder farmers to earn greater incomes through enhanced vegetable production, benefitting hundreds of millions of consumers with greater access to nutritious vegetables for healthy diets. As founder and leader of East-West Seed, his initiative over the past four decades has developed a dynamic, smallholder-centric tropical vegetable seed industry, starting in Southeast Asia and spreading through Asia, Africa and Latin America. Congratulations to Simon N. Groot.

Turkey: Purple strawberries grown in aksaray from chinese seeds in high-demand

Havva Inanc, a woman grower in Eskil town of Aksaray, has been growing pharmaceutical plants in the last 6 years but now she has started growing purple strawberries with imported seeds from China.The grower now has production of purple strawberries in a 0.4-hectare area and the demand for the product has been increasing rapidly. Currently, the grower is sending her products to various Turkish cities such as Kahramanmaras, Konya, Sivas, Tokat, and Canakkale.The grower also noted that 2 academicians from Kayseri Erciyes University are testing the use of these strawberries in the treatment of diabetes. Currently, the sale price for these strawberries is around 5 USD per kg*(Haber 7)*

Purple strawberries

Vaccine to repel pathogen in tomato

Scientists knew that plants wage chemical war against bacterial, viral and fungal infections. Now they've learned how to "vaccinate" tomato plants with a natural chemical to boost their defenses against a pest that makes leaves shrivel up and die. In a report published Oct. 22 in *Science Signaling*, a team led by plant biologist Mary Beth Mudgett and chemical engineer Elizabeth Sattely describe how they saved tomato and pepper plants from bacterial speck, the common name for a bacterial infestation that can spread from leaf to leaf, turning leaves yellow and ultimately killing the plants.They accomplished this by treating uninfected leaves with a newly discovered and naturally occurring chemical called N-hydroxy-pipecolic acid, referred to as NHP. This chemical agent, in turn, triggered a series of chemical responses that made uninfected leaves less hospitable to pathogens seeking to invade. *(Stanford October 22, 2019)*

Santiana - Jointless tomato

The first jointless tomato variety has been announced in the Rijk Zwaan range.

It is a generative, open crop with horizontal leaves. The variety delivers nice trusses with evenly spaced fruit. The plant has sufficient strength and flower production to allow pruning to six fruits during some parts of the season. It also responds well to increasing light; whereas some varieties struggle *(www.rijkzwaan.com)*

N. Korean leader visits greenhouse farm under construction amid food shortages

North Korean leader Kim Jong-un visited a greenhouse farm under construction, calling for an improvement in agricultural techniques to increase vegetable output, state media reported Friday."(Kim) said ... to build such a modern greenhouse farm in each province to supply various species of fresh vegetables to the people all the year round is a thing he has long wanted to do certainly," it said.*(Yonhap News Agency)*

World food prize awarded to simongroot : Congratulations

The World Food Prize was awarded to Simon Groot on 17 October, 2019. The 2019 World Food Prize honors the unique achievements of Simon Groot and his company East-West Seed (EWS) over the past four decades. Groot has successfully developed a dynamic, smallholder-centric tropical vegetable seed industry, starting in Southeast Asia and spreading throughout Asia, Africa, and Latin America. His work has invigorated both rural and urban markets for vegetable crops, making nutritious vegetables more widely available and affordable for millions of families each year.*(European Seed)*

US (IN): Purdue scientist sending tomatoes into space to study plant defense

Any trip to Mars, likely to take a year or longer, will require astronauts to grow at least some of their own food along the way since it can cost $10,000 to send a pound of anything just as far as Earth's orbit. Astronauts will need the nutrients provided by fruits, leafy greens and other vegetables grown during their journey.

Before a journey to Mars happens, however, scientists need to answer fundamental questions about how life is affected by spaceflight and low- or no-gravity environments. Purdue University's Anjali Iyer-Pascuzzi aims to improve the odds of successful crops with a recently awarded NASA grant to understand the effects of spaceflight and simulated microgravity on plant defense responses.

Anjali Iyer-Pascuzzi

"We can't just assume that plant defense mechanisms work the same way in space flight as they do on Earth," said Iyer-Pascuzzi, an associate professor in the Department of Botany and Plant

Pathology. "There's evidence that microgravity may alter cell walls, and we know that the cell walls are barriers to plant pathogens."

Iyer-Pascuzzi has designed two experiments for astronauts to carry out on the International Space Station (ISS). The results will be compared with similar experiments conducted on Earth. The date for her experiments to be taken to the ISS is still being finalized.

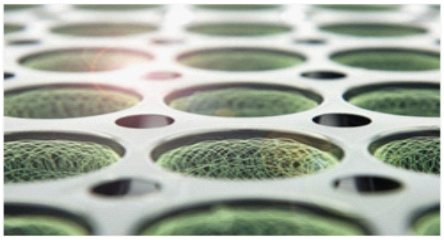
"NASA has been talking about going to Mars or long-term missions to the moon, and it's been working for years on the systems necessary to grow food there," Iyer Pascuzzi added. "Plant defenses are critical components of that. What we learn here will get us a little closer the goal of longer space missions." *(Purdue University)*

Russia: Greenery and potted flowers will be grown by robots in moscovsky greenhouse

Robots in the new universal greenhouse by Moskovsky Agricultural Holding with an acreage of 1.8 ha will allow for the yearround production of lettuce, tulips and potted flowers. With that, they are planning to grow 3.5 million pieces of flowers by the start of International Women's Day."Robotics is capable of transporting huge tables with lettuce, clever machinery is monitoring the microclimate and watering of 1.5 million plants at a time", shared the Production Director of the agricultural complex Moscovsky, Mr. Anatoliy Makaruk. *(tass.ru)*

A biodegradable plant propagation system

A new innovative plant propagation system that can be used for all propagation methods is proving to a big hit with Australian horticultural companies, according to its international distributors Klasmann-Deilmann.



The growcoon has a stable open net structure and is made from a 100 per cent biodegradable polymer which is approved for organic growing. It can be used with all propagation systems such as sowing, cuttings, grafting, tissue culture and hydroponic systems. The Growcoon is suitable for a wide range of standard trays and can be placed into the tray either manually or automatically using a dispenser that can be connected to the tray filling line.*(www.growcoon.com)*

IIHR Bangalore develops 2 processable tomato hybrids

The Indian Institute of Horticultural Research has developed two tomato hybrids, exclusively meant for the processing industry. These hybrids – Arka Vishesh and Arka Apeksha – are disease-resistant and are expected to not only boost farmers' incomes through higher yields but are also aimed at reducing processing costs because of higher total soluble solids (TSS) and lycopene content *(The Hindu BusinessLine (Vishwanath Kulkarni)*

Wood fibre and coir even better"

FibreDust have released a new premium blend of coir and wood fiber, creating a new level of growing media. "As an organic media, coir has significant advantages. From water retention, to aeration, to low EC and near neutral PH, coir is hard to beat. By adding wood fiber, we have made it even better", said CEO Sam Ahilan *(www.fibredust.com)*

Organic fertigation in greenhouses

After three successful years of testing, Van der Knaap Group are able to bring their biological fertilizer solution to the market. It will offer the USDA – National Organic Program growers in the US and Canada production numbers that are similar to those in traditional growing methods. The organic fertilizer is released in a reactor and administered through drippers. The organic fertilizer is created by converting residue proteins from other industries through a process inside of a reactor into liquid fertilizer that can be delivered through drip irrigation *(www.vanderknaap.info)*

Trials in coco substrates and organic fertigation

After separation, this is what the irrigation water looks like.

No more clogging up the drippers.

El Niño triggers 27.9% decline of vegetable production in Philippines

According to statements by the National Economic and Development Authority (Neda) of Northern Mindanao, there was a 27.9 percent decrease in the volume

of vegetables, root crops, fruits and industrial crops in the second quarter of 2019.

Neda-Northern Mindanao traced the overall decline to the occurrence of the weak El Niño, which started in the later part of 2018 until July of this year, which brought damage to crop areas in the region. Banana and pineapple, which contributed the largest share to total fruit production, showed negative harvests during the second quarter of 2019, registering 418,610 tons (a decrease of 0.19 percent) and 352,733 tons *(a decrease of 0.09 percent), respectively (sunstar.com.ph)*

Biological control in Almeria's greenhouses

In the 2019-2020 agricultural campaign, the area under plastic in Almeria cultivated with biological control mechanisms has increased by more than 2,000 hectares compared to the previous year. This represents an increase of 8.25 % compared to last season, bringing the total acreage to 24,740 hectares, according to data from the Territorial Delegation of Agriculture, Livestock, Fisheries and Sustainable Development. By crops, peppers are the flagship product, with 11,500 hectares; 1,020 hectares more than last season. This means that almost 100% of the pepper acreage features biological control techniques for pest control.

Tomatoes are second in the ranking with 5,300 hectares, compared to last season's 4,200 hectares. This crop has thus recorded a significant 20% increase. In the case of tomatoes, the acreage with biological control represents 60% of the total. The area under biological control has also increased in the case of cucumbers, from 3,350 hectares in the 2018-2019 campaign to 3,410 hectares this season. This represents an increase of almost 2%, with 70% of the crop's total area already featuring biological control. In the case of eggplant, the acreage has increased, but more slowly. The total acreage with biological control amounts to 1,620 hectares, which is only 10 hectares more than last season (almost 1% more). In this case, the area under biological control represents 73% of the total. In the case of zucchini, the area has also increased slightly, with 1,280 hectares expected, compared to 1,250 hectares last season; an increase of 2.3%. The productive acreage under biological control only represents 16% of the total in this case. Melons and watermelons fall by more than 9%. The melon and watermelon spring crops continue with the downward trend. 530 hectares of melons and 1,050 hectares of watermelons are expected, which is 9.4% and 9.5% less, respectively, than the 2018-2019 campaign*(diariodealmeria.es)*.

Year-round strawberry production

Kantyshevsky greenhouse in Ingushetia planned year-round greenhouse production of strawberry.Once the production capacity is achieved, we are aiming at getting on average 60-70 thousand kilos of crops that we will be mostly sending to Moscow as well as to neighboring regions and local market. Kantyshevsky greenhouse complex was created in 2018, the first crops were picked in the beginning of 2019 *(TASS)*.

New tomato greenhouse variety

In Axia Vegetable Seeds' test greenhouse enough can be found: yellow, orange, brown, white-yellow, all cherry tomatoes that can be cultivated for a vine or loose (Axia Vegetable Seeds, Burgemeester Elsenweg 53; 2671 DP Naaldwijk, Phone: 0174-255255 E-mail: info@axiaseeds.com

Vine cherry XavyHTL1709081

HTL1708146 HTL1505394

Grafting in vegetables

Grafting plants onto specially bred rootstocks is a practice that is common in tree crops. Grafting confers resistance to soil-borne diseases and pests, requiring less inputs and leading to sustainable crop productivity. It is now being used in some vegetable and fruit crops, such as tomatoes, eggplant, watermelon, cucumbers and cantaloupe.

A grafted tomato plant. (Photo: UC Davis Tomato Genetics Resource Center Image Library)

Grafting conveys a lot of merits in terms of disease resistance and yield maintenance. It enriches the production practices by introducing more variety. And by making impossible things become possible. (University of California (Jeannette E. Warnert)

India: Punjab to set up Centre of excellence for floriculture

Punjab in collaboration with the Dutch government is coming up with a Centre of Excellence (CoE) for floriculture at Doraha in Ludhiana. This CoE has already been approved and sanctioned under the National Horticulture Mission in the last fiscal year. The Centre would be established over an area of 7.5 acres with a total project cost of around Rs 8 crore. The project cost will be shared between the Centre and state in the 60:40 ratio. This will be the fourth CoE in the state. Currently, the state has CoE for vegetables (at Kartarpur), fruits (at Hoshiarpur) and Potato (at Jalandhar).The Tribune 27 Sept 2019 *(Vijay C Roy)*

New bio-stimulant improves chlorophyll production

Maxstim, which originates from the UK, has proven to be a very effective biostimulant in crops like berries (blueberries,

raspberries, strawberries, grapes), flowers (roses, alstroemeria, chrysanthemum), greenhouse crops (tomatoes, cucumbers, peppers), agricultural crops (melons, potatoes, pumpkins) and top fruit (apples, pears, peaches, oranges). Maxstim is a 100% natural biostimulant from vegetative origin, which uses a complex, precise blend of naturally occurring primary and secondary plant metabolites which stimulates growth and resistance. Maxstim is a plant primer, an elicitor and has biostimulant-like effects *(www.maxstim.com)*

Example of the effect of Maxstim in parsley, showing the effect in key processesU

Hydrophobic forces, Not h-bonds, bind DNA together

Scientists at Chalmers University of Technology in Sweden refuted the prevailing theory that hydrogen bonds (H-bonds) bind the two strands of the DNA together. They found out that water is the key. The results are published in the journal *Proceedings of the National Academy of Sciences of the United States of America (PNAS).*

New solution in the trend towards peat substitutes- Peligran

These days, more and more professionals and end customers are demanding peat-reduced substrates. The mineral substrate Perligran is an additive to ensure good results together with peat substitutes. Many substrate manufacturers – who often also extract their own peat – are currently facing a changing market. Not just environmental groups, but increasingly large chain stores such as REWE are also demanding ever greater quantities of peat-reduced substrates for the cultivation of decorative plants, fruit and vegetables.

Perligran

Perligran provides an ideal basis for the successful cultivation of flowers, fruit and vegetables – with guaranteed quality and certified according to stringent Dutch quality standards (RHP). It is also included on the Swiss and German FiBL lists as a soil additive for organic agriculture *(www.knauf-aquapanel.com)*

Woven polyethylene®

An international greenhouse and woven polyethylene (PE) cover company is looking to strengthen its market in Australia with the development of new and stronger products.

PIC Plast Ltd from Israel has been operating in Australia periodically for several years with customers mainly from the vegetable growing industry, but more recently blueberry, raspberry and blackberry growers have begun to use PIC Plast's Solarig® tunnel covers.

"We are also excited about the potential of our new, strengthened the edges of SOLARIG® for covering crops like grapes, kiwifruit, cherries and apples," Sales and Marketing manager Mark Bunyard said. "I'd like to start promoting these in Australia and New Zealand. We have had good success in South America and in the grape growing regions of Europe. Furthermore, our factory has a capability to produce metal structures which allows us to manufacture greenhouse tunnels kits, net houses, A-Frames structures and crop protection."

SOLARIG®

SOLARIG® is also easily fabricated (stitched, welded). So in the case of greenhouses, it's often advantageous to stitch insect nets onto the sides or add a venting net into the apex of a tunnel cover. Repairs to cuts or damaged covers on greenhouses or tunnels can also be easily done by stitching these closed. In terms of lighting properties, Mr Bunyard commented on the good light transmission (88%) and light diffusion (up to 60%) of SOLARIG®. Different grades (thicknesses), widths and roll lengths are available *(www.pic-plast.com).*

Scented blooms lasting months without care

An innovation in floral design and all-natural home fragrance. Natural Fragrance Rose offers something entirely new in floral that is both natural and long-lasting, they announce in a press release. "It is an intuitive, eco-friendly home fragrance collection made of luxurious, organic roses." At the PMA Fresh Summit

Conference and Expo that will be held in Anaheim (CA) next month, one can discover this complete line of beautiful, botanically-infused blooms *(www.NaturalFragranceRose.com)*

Turkish tomatoes for Italian delicacies

Izmir, a city located in western Turkey, is one of the major exporters of dried tomatoes in the country. The city exports dried tomatoes to 85 countries, mainly to Europe *(AA (Metin Aydemir)*

Solar dehydration of tomatoes

Turkey tops Europe with its greenhouses and generates 2 billion USD revenue from greenhouse products

Turkey tops the European countries in terms of greenhouses with 77.200 hectares and generates a revenue of 2 billion USD from these greenhouses annually. The average organization size doubled in the last decade from 0.2 hectares to 0.4 hectares and Turkey shares the 3rd place with Spain in the world in terms of greenhouse area. China tops the world rankings with 2.7 million hectares of greenhouses followed by South Korea. 46 % of the greenhouses in Turkey are from plastic. 24 % of the greenhouses are low tunnel greenhouses whereas 17 % are high tunnel greenhouses. Only 13 % of the greenhouses are made from glass (A Haber)

Organic soap for a clean greenhouse roof

In the summer there is sometimes too much, in the winter often just too little. Yes, the sun cannot be controlled. To catch every ray of light in the coming dark days, it is time for growers to remove chalk and coatings from the greenhouse roof. This is now possible with an organic cleaning product based on plant extracts.

AG Clean+ has a 100 percent biological composition of natural plant extracts combined with water, alcohol, citrate and vinegar *(www.agronagroup.com)*

Functional quality of little-studied tomato varieties

Scientists at Universidad de Sevilla (Spain) have investigated the commercial and functional quality parameters in little-studied tomato varieties to find possible noticeable differences. For the study, five cherry tomato varieties and six common (i.e., non-cherry) tomatoes were evaluated. Overall the commercial quality parameter values were lower in cherry varieties - the scientists report - Cherry cereja showed the highest values of total sugars, Green Zebra showed the highest levels of phenolics, Tigerella and Byelsa showed the highest levels of lycopene, Orange showed the highest levels of phytoene *(Food Chemistry, Vol. 277: 480-489.:2018).*

In fruit trees, plastic has much better yield return than glass or horticultural nets

There is a worldwide rising demand for tree protection", says Juan Antonio García of Armando Alvarez. "In fruit trees, plastic has much better yield return than glass or horticultural nets, due to the versatility in helping the crop development and the relatively small investment" Just like traditional horticultural plastics, the advantages of fruit tree protection are better fruit quality, increasing productivity, extension of the crop cycle, physical protection against rain, hail, wind and frost with reduction of crop losses. "The protection of fruit trees under plastic covers has established itself as an essential tool in the search for the early return on investment in some fruit species like grape, cherry, banana and as a valuable alternative for the viability of other species like kiwi, mango, peach, papaya, and Japanese medlar *(www.armandoalvarez.com)*

Horticulture is the future

In the United States, there is no end in sight for developments in the horticultural sector, thinks Peter. "Also not worldwide. Climate change, water scarcity, labor shortages, urbanization - concentrated agriculture is the answer to all these problems. And this is only possible in the modern greenhouse. You can place these structures in the craziest places."

"You can use raw materials very efficiently. Not to mention the mechanization and automation possibilities. It makes me proud that we, as the horticultural sector, can offer solutions for the issues the world is facing. I sometimes wonder if we acknowledge that enough. Of course, there is money to be made in this sector. But as a Dutch-American, I like to combine idealism with capitalism," Peter concludes(www.totalenergygroup.com)

CO2 GRO begins first commercial floriculture demonstration in Canada

Toronto based CO2 GRO has begun its first commercial demonstration project of its CO2 Delivery Solutions with a Canadian floriculture operation in the Niagara region. The demonstration is being conducted at the customer's commercial greenhouse with the goal of demonstrating more developed root systems in young plants, more flowering, accelerated growth time and the positive effects on common pathogens on a number of flower varieties*(www.co2delivery.ca)*.

How can China provide vegetables for 1.4 billion people?

Over the past decade, China's vegetable production has increased and has always been the world's largest. Thanks to the six

large key vegetable production areas and technologies such as greenhouse and vegetable breeding, China now can provide its 1.4 billion people with fresh vegetables all year round, despite the country's diverse land and weather conditions.

In Mohe, China's northernmost city winter temperatures can reach below minus 40 degrees Celsius. In western China's Tuokexun, there are only nine days of rainfall on average each year. The Qinghai-Tibet Plateau in southwest China has an average elevation of more than 4,000 meters. Despite its diverse land conditions, 1.4 billion Chinese people are still able to eat vegetables all year round. So how does China provide vegetables to its population all year round?

In northern China, temperatures drop rapidly in autumn and soil gradually freezes in winter and outdoor plants cannot be grown for five to six months. But science and technology have solved this problem. *(Read the full article at XinHuaNet)*

Tomato jumping genes could help speed-breed drought resistant crops

Researchers from the University of Cambridge's Sainsbury Laboratory (SLCU) and Department of Plant Sciences have discovered that drought stress can trigger the activity of a family of jumping genes (Rider *retrotransposons*) previously known to contribute to fruit shape and color in tomatoes. Their research revealed that the Rider family is also present and active in other plants such as rapeseed, beetroot, and quinoa.

Transposons, or jumping genes, are mobile snippets of DNA code that copy themselves into new positions within the genome. Discovered by Nobel prize-winning scientist Barbara McClintock in the 1940s, only now are scientists realizing that transposons are not junk at all but actually play an important role in the evolutionary process, and in altering gene expression and the physical characteristics of plants.

For more details, read the news article in the University of Cambridge websiteSeptember 18, 2019.

Empowering taxonomic research on important pollinators

The family Syrphidae, commonly called hover flies or flower flies, include some 6,000 living species. As "one of the most abundant groups of flower-visiting insects", with adults of most species feeding almost exclusively on pollen and nectar or honeydew, these flies are among the most important pollinators, both for wild plants and numerous crops (Biodiversity Heritage Library *(Grace Costantino)*

UK: New greenhouse ready for date palm tissue culture

When thinking of a greenhouse in the United Kingdom, the production of date palms probably doesn't come to mind. However, this is what a new greenhouse in Glastonbury, built by Bridge Greenhouse, will be used for. Date Palm Developments produces high quality, virus-free date palms by tissue culture, which they then ship to farms all over the world, mainly the Middle East. In 2002 Bridge Greenhouses build their first greenhouse, which they have now outgrown. 20 metres next to the old greenhouse, a brand-new complex has arisen*(www.bridgegreenhouses.co.uk)*

Working towards a fossil fuel-free future

Growers should start preparing their greenhouses now for a fossil fuel-free future, researchers from Wageningen University & Research (WUR) advise.

Speaking this June to an audience at the GreenTech exhibition in Amsterdam, Feije de Zwart – WUR's researcher in greenhouse technology – revealed that researchers examined several options, including:

- lowering the glasshouses' set points (such as for temperature, light, and humidity)
- using CO2-free energy sources like green electricity, geothermal waste/ heat, and surplus heat extracted from the greenhouse
- better energy conversion (LED lighting, smart dehumidification)
- better insulation through the deployment of screens, coated glass, double glass, etc.

The following are explained

1. How can growers help reach worldwide carbon neutral goals?
2. Energy-conserving techniques could help mitigate rising fuel bills.
3. Alternative heating methods.
4. Growers advised to harvest excess heat from glasshouses. The report also recommends that growers harvest excess heat from their own glasshouses.During the summer, there is so much solar light and heat excess from that [light] that it easily compensates for the heat demands in winter. Be prepared for the future. If you build a new greenhouse now then build it in such a way that you can already add a second screen, for example, so that it will not be too difficult to go towards a low-temperature heating system*(www.greentech.nl)*.

Fine-mesh multifunctional anti-hail nets. -good for pest control

Professional agriculture is increasingly focusing on pest control , as pests have damaged and continue to severely damage crops. Protecting crops is now a must in agriculture and defense tools to prevent attacks and reduce the use of pesticides and treatments must be implemented.

In horticulture, attention mainly focuses on controlling viruses.

The **20/10 anti-aphid net** features holes measuring <0.24 mm2. This way, even the smallest insects cannot get through, which is essential especially when plants start producing.

The **Monotex 50** net with holes measuring 1 mm2 is suitable against *Tuta absoluta*. It achieves control of the insects while guaranteeing ventilation. When it comes to fruit cultivation, Monotex 50 is useful against *Drosophila suzukii*, which is harmful mainly to cherries and soft fruit, but it can also be used in citrus groves, where it is also used as a shading net. Finally, to control *Halymorpha Halys*, R&D projects conducted by prestigious Italian and international bodies such as project Life Su.Sa. Fruit have reached excellent results when using fine-mesh multifunctional anti-hail nets. In particular, peach and apple test fields in Piedmont showed how photoselective anti-hail net Iridium® (2.4 x 4.8 mesh) considerably reduced attacks while guaranteeing an excellent use of the light. Mulching films are also practical to prevent weeds, which are often vectors of this virus *(www.agrintech.it)*

Preparing a greenhouse for storm in 6 minutes

One of the biggest benefits for growers who live in areas prone to storms is that they can retract hectares of roofs in less than 6 minutes allowing them to react only when the storm will hit their location. The company showed in a video how their retractable greenhouse underwent a tropical storm.

Top photos: Cravo greenhouse two months after Hurricane Irma came through with gusts reaching 180 kph (110 mph) The roofs and walls were retracted before the hurricane. Conventional poly houses (lower two photos) were destroyed.

Hectares can be retracted in less than 6 minutes

Growers have a choice to leave the roof closed during the storm to protect the crop or retract the structure and walls to protect the house in the event that the winds are forecast to exceed the design load of the structure," explained Richard Vollebregt with Cravo.

"One of the biggest benefits for those growers who live in areas prone to these storms is that they can retract hectares of roofs in less than 6 minutes allowing them to react only when the storm will hit their location." This means that growers do not have to decide days ahead of a hurricane arrival whether to cut the poly off their roofs when a major storm is forecast.

Retracting automatically

If the winds are forecast to be greater than the design load, hectares of roof and walls can be automatically retracted in minutes to protect the structure and coverings. In the event of a power failure after the storm, the motors can be manually powered using an Allen key turned by hand or a drill that is powered by a battery or a generator *(www.cravo.com)*.

Coco-pallet

Annually, the world harvests an estimated 74 billion coconuts, where around 85% of the unwanted hairy husk is either being burned, thrown in the ocean, or piled up to create a giant biohazard.Jan van Dam, a researcher at the Wageningen University who helped develop the product for CocoPallet, says that they can find means to turn the often-thrown resource into something useful.

Coconut pallet

Berry cultivation under plastic photoconverters

The French companies Agripolyane and Cascade during the 2017/2018 campaign, research was carried out on strawberry, raspberry and blueberry crops. With strawberries, it was shown that the use of luminescent plastics led to a yield increase of 15%, with precocity and equal sugar content and shelf life. A raspberry yield increase of 15% was also observed in the early stages, while an approximately 60% higher yield was recorded in the case of blueberries *(agrodiariohuelva.es)*

Berry Cultivation in France

Vaccinating for tomato viruses is the future

Abbreviations such as CMV, TYLCV, ToMV, ToMMV, TSWV terrorise tomato growers nowadays, as they represent the acronyms of some of the viruses that damage both greenhouse and open-field crops. Growers spend most of their money trying to control the spreading of viruses. Hygiene measures, crop protection, insects - whatever is available. Italian growers believe things might change in the near future. A scientist gave the details of a new method that enables a quick identification and production of "RNA" vaccines effective against infectious agents. The research group showed that it is possible to strengthen the plants' natural defenses against viruses using RNA vaccines. *(Source: Gago-Zachert S. et al. Highly efficacious antiviral protection of plants by small interfering RNAs identified in vitro. Nucleic Acids Research (2019). doi: 10.1093 / nar / gkz678.)*

Little leaf farms - England

This is what six acres of lettuce looks like from way up high. Thanks to @ahorowitz1 for snapping this incredible picture

Lettuce farm

Cauliflower and broccoli pills

Australian farmers could soon be producing broccoli and cauliflower pills, giving consumers one serves of vegetables in a tiny capsule. The horticulture industry hopes a demand for nutrient-rich powders and supplements will create a new market for vegetables, indirectly solving the problem of farm waste in the process. It's an idea John Said is helping to develop. He grows vegetables on 2,000 hectares across the country: "I mean it's a pretty big ask to say to someone, 'Here, just take this pill and it's a broccoli pill', but in the future, who knows? I mean, if it's got other vitamins and minerals and perhaps other oils as well and it serves a really good purpose for the body, then, by all means, let's develop that."

It's also a chance to make something of the cauliflowers and broccolis that aren't picked at harvest time, with about 15 per cent of his crop left on the ground, often just with slight and/or cosmetic defects. "We've always thought about food waste, we've always thought about yield, but we've never been able to truly get a market or a particular process that addresses that issue," Said said. "So I think we're the closest we've ever been to being able to address an issue like that." *(abc.net.au)*

Plant plastic possible

Plastic is a problem for the environment and the planet's health. As a result, universities and businesses are increasingly developing food packaging materials that break down faster, with no harmful residues, and that do not use petroleum. The first products are ready for practical use, like bio-degradable foil made of polylactic acid or grass paper.

Polylactic acid is produced with the help of lactic acid bacteria, for example, from corn starch and is biodegradable. It can be used to make foils, cups and bowls. Such plastics from renewable raw materials have a significantly better climatic impact than petroleum-based plastic, as corn, wheat or sugar cane will extract carbon dioxide from the air for their growth. Even though "plant plastic" is still in its infancy and comparatively expensive, experts see great prospects. Packaging specialists are also experimenting with algae, coconut fibers, tomato plants, banana stems, sawdust and cotton waste to develop novel boxes and trays for food. Grass paper has been in use successfully for some time and consists of up to 60 percent grass instead of wood *(BZfE, hortdaily 9/3/2019)*.

Fusarium-resistant cucumber varieties introduced byRijk Zwaan

For years, there has been an urgent need from growers for cucumber varieties with Fusarium oxysporum resistance. Rijk Zwaan has introduced not one but two such varieties onto the commercial market. The newcomers Forami RZ and 24-272 RZ are both resistant to the fungal infection which is notably difficult to combat. The varieties are particularly suitable sfor growers in Spain, Greece and South Africa *(www.rijkzwaan.com)*

Resistant and susceptible cucumber

New Jersey (US)-mobile greenhouse gives residents education in healthy eating

RWJBarnabas Health's Wellness on Wheels van is traveling around New Jersey, equipping everyone from kids to seniors with knowledge about nutrition, gardening and how healthy foods like fruits and vegetables affect their health. In a country where millions of people don't eat enough fruits and vegetables, it's an important service. NJTV News *(Lauren Wanko)*

Protected growing of raspberries

Raspberry off season production is possible in pol-tunnels. *(www.aurorafruit.it)*

Archive picture

China is trying to boost its crops by using electric fields

Chinese scientists are exposing crops to powerful electric fields in an attempt to make them grow faster without using chemical pesticides or fertilizers (New Scientist, West Herald, 27 August, 2019; newscientist.com)

Rain resistant wheat: Gene editing

Researchers from the National Agriculture and Food Research Organization (NARO) and Okayama University said that genome editing helped them develop the new wheat variety in just about a year. Such development used to take about 10 years using conventional breeding techniques.

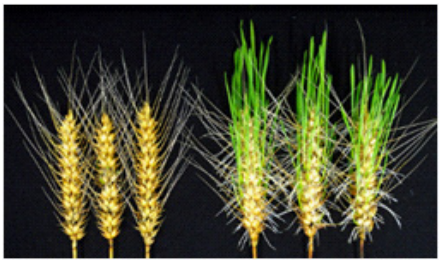


Photo Source: Okayama University and the National Agriculture and Food Research Organization

US (NH): Extending strawberry season with low tunnels

Researchers with the New Hampshire Agricultural Experiment Station at the University of New Hampshire have succeeded in quadrupling the length of the Granite State's strawberry growing season as part of a multi-year, multi-state research project that aims to benefit both growers and consumers. Learn more about this research project in the video produced in collaboration with USDA Northeast Climate Hub.

Growing more with less

A Nuffield research report reveals numerous currently available methods for Australian horticulture producers to boost the efficiency and productivity of low-tech greenhouse systems and unlock new market opportunities. Travelling across Brazil, Singapore, Japan, Israel, Europe, Canada, the United Kingdom, the United States and the Netherlands, Mr Nguyen's research defines factors that impact low-technology greenhouse management and makes recommendations to growers operating in these systems.

1. Temperature control and ventilation is key to productivity, and in low tech greenhouses, temperature control with roof vents is effective, if somewhat limited.

2. In places with hot, dry climates like the Arava Valley in Israel, saw-tooth multi-span or flat arch structures are used. A strip is cut out of the structure and replaced with insect netting that is permanently open. With an average rainfall of only 20mm, humidity is not an issue.

3. Other low-tech climate control practices observed in Brazil included evaporative cooling with misters and suction fans, and the laying of black plastic along crop rows to pool water which would then evaporate.

4. By covering the ground with a clay loam, overlain with a layer of manure and capping it with river sand, growers have created an ideal environment for preserving precious water.The clay loam has high water retention properties, and the manure boosts microbial activity while the river sand acts as a mulch and holds the water within the soil, reducing evaporation and unwanted humidity *(nuffield.com.au)*

Organic greenhouse cucumber

Fertility management of seedlings and transplants is considered a key challenge in organic greenhouse production. This study was conducted to determine response of greenhouse-grown cucumber *(Cucumis sativus)* and nutrient release profile to two organic fertilizers and their combinations applied at three different concentrations in organic substrate. The organic fertilizers used were a turkey litter–based compost (TC) and a dairy manure vermicompost (VC). In addition, two control treatments [no fertilization (CK), conventional liquid fertilizer (CF)] were included. For TC, substrate leachate pH decreased for the first 17 days after addition and then increased, whereas electrical conductivity (EC), and calcium (Ca) and nitrate-nitrogen (NO3−-N) concentrations increased and then declined. For VC, EC decreased continuously over time from days 0 to 52, whereas pH increased. The Ca and NO3−-N concentrations decreased over time to 24 days and then did not change further. For TC/VC combinations, EC was stable for the first 17 days and then declined. For all organic fertilizer applications, potassium concentration was stable for the first 17 days and then decreased, whereas most of the sodium, ammonium-nitrogen, and chloride were no longer leached by 24 days. The VC and TC/VC combinations did not affect cucumber seed germination rate, seedling survival rate, seedling height, and leaf greenness (SPAD) as compared with CF. The stem length, leaf number, dry weight (DW), root index, and SPAD readings of cucumber transplants increased with increasing TC and VC fertilizer applications. The TC/VC combinations increased the biomass of cucumber transplants compared with CK, and did not differ from CF. The results of this study indicated that the 28.32 lb/yard3 of VC (high rate) or the 9.44 lb/yard3 of VC combined with 4 lb/yard3 of TC (medium rate) can be substituted for CF for the cultivation of cucumber seedlings. Based on DW, the 12 lb/yard3 of TC (high rate) or the 4 lb/yard3 of TC combined with 9.44 lb/yard3 of VC (medium rate) fertilizers were suitable replacements for CF for the cultivation of cucumber transplants.

Yuqi Li and Neil S. Mattson 2019 Effect of Organic Fertilizer Source and Rate on Growth and Nutrient Leachate Profile of Greenhouse-grown Cucumber. American Society for Horticulture Science in HortTechnology:Volume 29: Issue 4: 450–456.

Protected apple cultivation under convertible cover

Retractible / convertible foil cover is the most important aspect of the innovative protected apple cultivationsystem that Wageningen University & Research has been working on since 2018. The cultivation system combines biological crop protection, physical crop protection and targeted capturing of pests such as the apple sawfly. Within the 'Green crop protection and pollinators' project, new cultivation systems are being researched that would ensure crops of strawberries, lilies, apples or arable crops are not as dependant on crop protection agents while making sure that growers can maintain their market positions.*(Wageningen University & Research)*

The convertible cover closes within 2.5 minutes when it starts to rain.

The difference between semi-closed and pad and fan glasshouses

Pad and fan glasshouses have been in use for a long time. Most fruiting plants are prone to reduced quality and yield at maximum temperatures of more than 30 degrees Celsius. The cause is a reduced viability of pollen and as a result, the fruit will be soft, dull,

misshapen and smaller in size.As fruit and vegetable production in greenhouses gained popularity, growers in hot climates resorted to pad and fan greenhouses. The evaporation of water can reduce the air temperature significantly. Everyone experiences the evaporative cooling power of water, after a swim, when you leave the water and a mild breeze starts evaporating the water droplets on your body. It feels warmer to be under the water where no evaporation takes place. *(www.glasshouse-consultancy.com)*

UAE: Growing sustainably in the heat of the Abu Dhabi desert

The Pure Harvest Smart Farms greenhouse in Abu Dhabi is producing greenhouse vegetables in temperatures that reach 53 degrees Celsius. The greenhouse features a state of the art climate control system that adjust the lighting and air intake through sensors, so the greenhouse stays around a Mediterranean climate. The greenhouse can grow year-round, and because of the high amount of solar hours, the produce is of very high quality *(www.pureharvest.ae)*

AI- for tomato production

This artificial intelligence is part of a Bosch technology solution called Plantect. Developed specifically for agriculture, Plantect is a data-based early-warning system that alerts farmers to the potential risk of crop infection. The system's hardware consists of wireless sensors that measure temperature, humidity, and other conditions in the greenhouse.These parameters affect crop development and provide the intelligence needed to detect the risk of infection, not only in tomatoes, but also in other greenhouse crops. The sensors' readings are uploaded to the Bosch IoT cloud in a data package *(www.bosch.com)*

Europe has the untapped onshore capacity to meet global energy demand

Europe has the capacity to produce more than 100 times the amount of energy it currently produces through onshore windfarms, new analysis from the University of Sussex and Aarhus University has revealed. In an analysis of all suitable sites for onshore wind farms, the new study reveals that Europe has the potential to supply enough energy for the whole world until 2050.The study reveals that if all of Europe's capacity for onshore wind farms was realised, the installed nameplate capacity would be 52.5 TW - equivalent to 1 MW for every 16 European citizens (University of Sussex *(Neil Vowles)*

Russia: Major eggplant greenhouse to be opened in leningrad region- Russia

The biggest eggplant greenhouse in the Northwest Federal District of Russia is scheduled to be opened in September 2020. Production capacity is going to reach 10 thousand tons from 14 ha. The overall amount of investments will comprise 81.7 million Euro *(online47.ru)*

Sygenta purple tomato

The new purple-skinned YOOM cocktail tomato was developed through a natural selection breeding program by Syngenta Vegetable Seeds' tomato specialists. YOOM tomatoes have a distinctive purple-skinned color. It is packed with flavor and has a nice sweet-sour balance, which gives a lasting Umami/savory taste sensation for consumers.*(www.syngenta.com)*

YOOM cocktail tomato

Spain: Cooling greenhouse surface trend in Almeria

This is an update of the research on albedo or reflectance, which, 12 years ago, meant the characterization of a buffer effect of global warming by urban settlements, specifically in the horticultural area of Almería.Greenhouse horticulture has experienced in recent decades a dramatic spatial expansion in the semiarid province of Almería, in southeastern Spain, reaching a continuous area of about 30,000 ha, the widest greenhouse area in the world. Almería greenhouse covers have two complementary positive effects on climate change: one local, neutralizing global warming in the area, and another on a planetary scale, partially offsetting of the total carbon footprint. *(Ministerie van Landbouw, Natuur en Voedselkwaliteit)*

Paper mulch

A few days ago, the experimental farm that the INTIA (Navarre Institute of Agrifood Technologies and Infrastructures) has in the Navarre town of Sartaguda hosted an open day, which served to showcase the tests that the entity is carrying out to replace plastic mulch in horticultural greenhouses for more sustainable ones*(navarracapital.es)*.

Pollinator collapse

There's a saying among lawyers that goes, "If the facts aren't on your side, argue the law. If the law isn't on your side, argue the facts. If neither the facts nor the law are on your side, pound the table."

Substitute the word "science" for "law" and the same would apply to many environmental advocacy groups and even some politicians campaigning to ban various pesticides on the grounds that they're contributing to a dangerous collapse in our pollinator population. *(Jon Entine | July 30, 2019https://geneticliteracyproject.org/2019/07/30/the-world-faces-pollinator-collapse-how-and-why-the-media-get-the-science-wrong-time-and-again/?mc_cid=6e277be9b1&mc_eid=9b4cfb9f18)*

Pollnators

Turkey: Entrepreneur started dragonfruit production in his greenhouse and earn significant profits

Grower Bilal Bayram in Kumluca district of Antalya switched to dragonfruit production 2 years ago in his greenhouses and he is delighted with the results so far. The harvest period starts after July and continues until the end of December. Since there is no need to use chemicals or fertilizers for production, the production costs are relatively low compared to other products. Bilal Bayram: I have a 1.5-hectare greenhouse for dragonfruit production which I had started in 2017. Last year I have received 4.000 products and sold it for 2.5 USD per piece. This year I'm expecting around 12.500 products and I expect the prices to remain around the same level. Dragonfruit is much more profitable compared to other fruits. Production costs are much lower and the prices at the market are high and stable.*(Gunes)*

Nanotechnologies and semi-closed greenhouses for protected cultivation

Nanotechnologies too can be applied to regulate the protected environment in a greenhouse, especially in places with difficult weather conditions. Idromeccanica Lucchini, a specialist in the design and manufacture of greenhouses, can do just that.

Semi-closed Greenhouse

Nanotechnologies can work as a shield against infrared rays while maintaining transmittance unaltered. This means that the quantity of light that reaches plants is not modified, but the temperature is lowered. In addition, films last longer as rays are reflected. In some cases, they can last double the time of normal films. *(www.lucchiniidromeccanica.it)*

By virtue of the architectured cellular technology, the robotic gripper was capable of handling soft objects such as bell peppers, tomatoes, and even eggs without breaking or damaging them, mimicking the strength and tenderness of a human hand *(advancedsciencenews.com)*

Growing fruits and vegetables at an average summer temperature of 45°C- Saudi Arabia

Saudi Arabia is hot and dry. Difficult conditions for growing fruits or vegetables, but not impossible. Farmers and growers in the country would, therefore, be greatly helped with knowledge about watering, fertilization and crop protection. That is why the Greenhouse Horticulture Business Unit at Wageningen University & Research is contributing to the setup of demonstration plots spread around the kingdom.

There will be around 100 demonstration plots. The farmers and growers are being approached by King Faisal University with support from WUR Greenhouse Horticulture and the cooperation of the Ministry of Environment, Water & Agriculture of Saudi Arabia, which is also financing the project.*(Wageningen University & Research)*

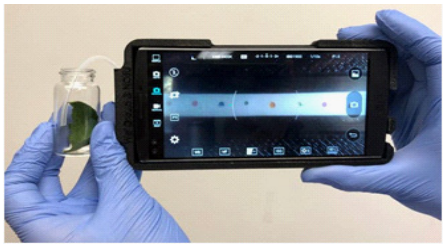
France: Greenhouses fitted with photovoltaic films

Three French horticultural partners have installed ASCA photovoltaic films at a commercial greenhouse nearby France. Partners in the project are horticultural Eiffage Energie Systèmes, the French growers with Les Maraichers Nantais and Groupe Olivier. Covering 43m² and incorporated in three different ways, the project aims to demonstrate the merits of the ASCA organic photovoltaic film and its ability to meet the specific needs of producers.

The 79 ASCA photovoltaic modules installed as part of this demonstration cover a total surface area of 43m². The green electricity produced will be monitored over a period of one year and fed back into the grid, covering a proportion of the greenhouses' energy costs: lighting, dehumidification, automatic irrigation system, etc.The objective of the pilot project is therefore to demonstrate the merits of OPV technology and especially of the ASCA photovoltaic film for this type of application. If the test proves to be a success it will be deployed on a larger scale *(en.asca.com)*

A new way to fight crop diseases, with a smartphone

A hand-held device could help farmers identify blighted plants, and perhaps reduce agricultural losses. It's like a strep test for tomatoes and tubers. With a smartphone-based sensor, a tomato leaf is tested for late blight *(By Knvul Sheikh, The New York Times, July, 30, 2019)*



Smartphone

Hybrid lighting system in greenhouse tomatoes-UK

Evesham Vale Growers and R & L Holt, premium tomato growers in the UK, have once again chosen Philips LED and HPS lighting for a new greenhouse, based on the 25% increase in crop production that was achieved with its Philips hybrid lighting set-up which was installed by Philips Horti LED partner Certhon in 2015*(www.philips.com/horti)*

Hybrid lighting system

Generate energy above the crop in greenhouse

A solar concentrator should can offer a solution. The grower can hang the concentrators just under the roof. The incoming light is 'split': active light can be converted into electrical and thermal energy via a small solar panel, while diffuse light would feed the crop. The grower can use the energy that is generated or deliver it back to the grid. *(Lucas de Groot lucasdgroot@gmail.com, HortiDaily -19-7-2019*

'Non-susceptible' sweet pepper plants discovered

Working in a partnership with vegetable breeding companies, scientists from Dutch research company KeyGene have discovered sweet pepper plants which show a new type of insensitivity to a group of harmful pathogens: Gemini viruses. The new find is also described as a 'loss of susceptibility'.

This type of insensitivity to virus infections is expected to last longer than the commonly used 'resistance' approach. The scientists presented their findings at an international scientific conference in Glasgow on 14 July. KeyGene aims to use this breakthrough to contribute to the sustainable cultivation of crops such as sweet and hot pepper, cotton and cassava, which currently require regular spraying against whitefly, the main disseminator of geminiviruses.

In addition to causing a loss of yield in various crops worldwide, geminiviruses are a key factor in the so-called 'zero tolerance' chemical approach to the whitefly. This insect can disseminate the virus so efficiently that only a small number can engender massive virus damage.

To breed crops that are sensitive to geminiviruses (such as sweet and hot pepper, cotton and cassava) in a more sustainable way and achieve good yield stability, crops with a resistance to the virus offer a smart and effective solution. However, very few varieties with resistance against geminiviruses have been available to date and no resistance against the virus is available for breeding in crops such as sweet pepper.

A characteristic of resistant plants is their ability to defend themselves against viruses by recognising them. The genetic material of viruses can change easily, however, which may mean that the plant can no longer recognise the virus, and the resistance stops working. While the traditional approach to tackling this problem involves introducing a new resistance by breeding with for instance wild relatives of a crop plant, such breeding programmes take many years.

In cooperation with four leading vegetable breeding companies, Rijk Zwaan, Enza, Limagrain Vegetable Seeds and Takii, KeyGene scientists chose a strategy that is very similar to resistance yet still completely different: breeding crops that have lost their susceptibility and, in doing so, become insensitive to the virus.

These non-susceptible plants do not need to defend themselves at all: the viruses cannot get to them as the plant no longer produces a particular protein required for infection by the virus. It is expected that this 'loss of susceptibility' approach will last longer than 'resistance' as it is much harder for viruses to adapt to something that is not there than to something that is *(www.keygene.com)*

Indigenous techniques to grow orchids in Telangana

Inside one of the poly houses at the Centre of Excellence (CoE), Jeedimetla, an experiment has been on for the last two years. The poly house has rows of raised platforms on which are 10,000 plants each of Sonia White and Sonia Red varieties of Dendrobium orchids. Beneath these platforms are micro sprinklers, which when in operation, create a mist-like atmosphere within the poly house. These, coupled with rooftop sprinklers, help reduce the temperature and increase the humidity levels that are required to grow orchids.

Telangana's arid weather conditions are not conducive to grow orchids. However, there's a growing demand for orchids in the commercial market in Hyderabad and other urban pockets of the State. In recent years, a few farmers in Sangareddy and Medak districts have begun growing orchids, knowing that each flower stalk can fetch a price of □10 to □20 [0.13-0.26 EUR] in the market.

The CoE began experimenting in 2017. The horticulture department narrowed down on genus Dendrobium, one of the widely cultivated orchids for commercial use in India and abroad. *(The Hindu (Sangeetha Devi Dundoo- floral Daily 7/12/2019)*

Light4food

In order to be able to follow the crop reactions under extreme conditions, very high light levels between 1000 and 1500 µmol PAR have been chosen. A part of the cells is fitted with dynamically adjustable LED lighting to investigate both the effects of the light level and the light spectrum in Vertical Farming in greenhouse horticulture.

Facility to come up

Through an extensive measuring and control system, photosynthesis, water and nutrient uptake of the entire crop can be made measurable, whereby different nutrient solutions can be offered independently of each other. The complete energy balance of the cells can also be followed by intensive energy and climate monitoring *(Wageningen University and Research)*.

All climate research greenhouse

A greenhouse within a greenhouse to research all climates in a greenhouse.to research the behaviour of a greenhouse in a certain climate, you need to simulate the climate outside the greenhouse. And what better way to do that than... a greenhouse? A greenhouse in a greenhouse - that's the All Climate Greenhouse in a nutshell. Actually, it concerns two greenhouses: a large greenhouse as an outer shell and within a somewhat smaller greenhouse with two sections. Every outside climate in the world can be simulated in the outer greenhouse, after which the inner greenhouse can be used to see how the cultivation of various crops can be

optimized in that climate.Parties, that helped make the special greenhouse possible, are Demokwekerij Westland, Bom Groep, Ridder, Priva, Hoogendoorn Growth Management, Hortilux Schréder, AAB NL and Stolze. *(© HortiDaily.com7/11/2019)*

Electric tractor to transport and tow fruit bins

Helpy, an electric tractor for the transport and towing of fruit bins by Ecogreen Italia is suitable to harvest apples, pears, peaches, oranges, kiwifruits, etc.

"It can tow between 10 and 12 bins and makes fruit harvesting extremely efficient. We are selling a lot of them, precisely because it is an electric and eco-friendly machine," explains owner Leonardo Zanarini *(in the photo below)*.

Helpy tractors have the following characteristics depending on the model:

- 2 motors 750 W / 1000 W each
- 4 batteries 240 A / 260 A each
- charger included
- max speed 3.00 km/h
- wheel track 100 / 105 cm
- electrical steering
- unladen weight 300 kg
- size 140x120x55 / 150x130x63

info@leozann.it

High tunnels for specialty crops- US (Indiana)

A study out of Indiana and Purdue Universities sought to gain a better understanding, from the perspective of farmers, of the challenges and advantageous opportunities associated with using high tunnels for specialty crops in Indiana.High tunnels are essentially unheated greenhouses that can help farmers extend the growing season so that they can improve profitability and productivity of their farms. They provide protection from extreme weather such as high winds, heavy rain, hail, snow and drought.Unlike greenhouses, high tunnels are simple structures over bare ground and its natural soil. They function without elaborate heating or cooling systems and are generally basic frames set into the ground and covered with one or two layers of greenhouse-grade plastic.High tunnels are an increasingly popular part of the infrastructure among small and diversified farms that market their products directly to consumers. In addition to extending the growing season, research has strongly indicated that high tunnels can increase yield, enhance shelf life, and improve the quality of crops grown.*(The complete article is available on the ASHS HortTechnology electronic journal web site: https://journals.ashs.org/horttech/view/journals/horttech/29/3/article-p290.xml. DOI: https://doi.org/10.21273/HORTTECH04258-18 . Or you may contact Analena Bruce of Indiana University at anabruce@indiana.edu or call her at (412) 716-5040*

New technology manipulates light naturally for different crops

A particular plastic for a particular crop. That's the idea behind the 5 layers' technology of Egyptian film manufacturer Al Quds. For several years, they've been cooperating with the Lancaster University to manipulate the light naturally through the plastic for different crops. "Each and every crop is different and that is vital to bear in mind when choosing your crop cover. Together with the growers, we'll try to create a crop cover that is unique to their crop", says Ibrahim Shabaan, Executive Manager at the company. According to Ibrahim, it's time to write a new chapter in the way a grower is growing their vegetable crops. "We have tested hundreds of crop cover designs until we had just the right combination of properties to deliver the perfect light environment for this remarkable fruit." Egyptian film manufacturer Al Quds introduces 5 layers' technology. Effects on three vegetables are as under *(www.alqudsplastic.com)*.

Tomato:

- Increase yields up to 15%.
- Early fruit maturity.
- Reduced internode length.
- Early fruit colouration (7-10 days)
- Improved root development.
- Wonderful tasting fruit.
- Better shelf life due to firmer fruit.

Cucumber:

- Increase yield across the full season up to 23%.
- Increase average fruit weight.
- Increase fruit numbers per plant.
- Improve fruit uniformity.
- Regulate fruit shape index.

Peppers:

- Higher number of fresh fruit (15%).
- Higher average fruit weight (40-50g/fruit).
- Higher fresh yield (19%, 1.9kg/m2).
- More uniformal fruit shape index.
- Thicker fruit wall.
- Optimum shelf-life.

Generate energy above the crop

Using sunlight to generate energy without filling the greenhouse with solar panels. With this idea, Lucas de Groot recently won first prize in the Cleantech Challenge. In the energy agreement, the Dutch government also requires glasshouse horticulture to reduce energy demand. This can be achieved by using less energy or by generating energy. The known solutions for generating energy, such as wind turbines and solar panels, are not ideal for this sector. Windmills provide drop shadow and you cannot lay solar panels on top of the greenhouse. The grower hangs the concentrators just under the roof. The incoming light is 'split': active light is converted into electrical and thermal energy via a small solar panel, while diffuse light feeds the crop. The grower can use the energy that is generated or deliver it back to the grid *(lucasdgroot@gmail.com)*

USA (NH): strawberry with low tunnels

Researchers with the New Hampshire Agricultural Experiment Station at the University of New Hampshire have

succeeded in quadrupling the length of the Granite State's strawberry growing season as part of a multi-year, multi-state research project that aims to benefit both growers and consumers. Learn more about this research project in the video produced in collaboration with USDA Northeast Climate Hub*(: University of New Hampshire (Lori Wright)*

Transparent solar panels on the greenhouse roof

Light is important for greenhouse horticulture. The more light, the higher the production. For that reason alone, it is not profitable for entrepreneurs to place regular solar panels on the roof of their greenhouse in order to generate electricity. But what if those solar panels are partially transparent? Would the loss of light outweigh the production of electricity? To answer that question, the Greenhouse Horticulture Business Unit of Wageningen University & Research is examining existing semi-transparent solar panels.*(Wageningen University)*

Root zone temperature optimisation (RZTO) and Irrigation by condensation (IBC) technologies

The delegation organised by the Australia-Israel Chamber of Commerce learned about Roots' agri-tech solutions – including its patented Root Zone Temperature Optimisation (RZTO) and Irrigation by Condensation (IBC) technologies - and how they might be applied in Australia to help ameliorate the impact of drought on agriculture *(rootssat.com)*.

Disinfecting the soil using steam- Biovap

A machine that uses steam to disinfect the soil with excellent results is finally available. It is semi-moving, suitable for both protected crops and open-fields and works in all cases where soil fatigue must be eliminated or prevented. The steam deactivates nematodes, fungi and weed seeds with an entirely organic principle.

Biovap

There are two models available: the larger has a 1000 kg/hour vapor generator, while the smaller has a 650 kg/hour generator. The steam is injected into the soil at a depth of 20-25 cm. A film is immediately placed to cover the sterilized surface so as to make the treatment more effective. *(www.ingaunavapore.it)*

Self-watering system- Orchids

Westerlay Orchids introduces SmartWick: an innovative self-watering system featured for their Bloom Haus collection of premium orchids for Kroger stores. Rooted in the rich horticultural history of Santa Barbara, Westerlay Orchids is a second generation family-owned business. With a simple mission of growing orchids that "inspire your home" Westerlay's debut of the innovative SmartWick system carries that mission one step further.

The SmartWick easy watering system is designed to keep each plant perfectly hydrated from farm to store and on to customer homes. After purchase, owners simply fill the water reservoir every week with 3oz. – 5oz. of water, making sure that the SmartWick (but not the plant itself) is partly submerged, then sit back and enjoy fresh blooms. SmartWick does all the work to provide easy, effective watering, helping maintain the longevity and optimum health of each orchid plant. *(www.westerlayorchids.com)*

Hurricane resistant greenhouse system rated up to 175 mph wind loads

Alquimi and its technology group Island AgTech, together with its strategic engineering partner Sprung Structures Ltd, based in Calgary, Alberta, have finalized development of the first fully certified hurricane resistant greenhouse system that can withstand wind loads up to 175 mph to meet IBC – 2015 building codes.

10.5K IAT-Sprung greenhouse project in the Caribbean region

Greenhouse damage across Puerto Rico after hurricane Maria, 2017

Alquimi has projects underway across the Caribbean and soon hopes to expand into the Pacific region. The company intends to "disrupt the current food supply chain and grow local" through its climate smart greenhouse technologies.(www.alquimirenewables.com)

Greenhouse cultivation will never replace open fields

In addition, outdoor herb grows more robust and the aroma is incomparable to greenhouse products.*(www.gemuesehof-reinheimer.de)*

Year-Round Intensive Organic Vegetable Production under Protected Cultivation

Ashish Yadav*, R.K. Avasthe, Adarsh Kumar and Rajeni Pradhan
ICAR Research Complex for NEH Region, Sikkim Centre, Tadong, Gangtok, Sikkim
*Email: 2005ash@gmail.com


Ashish Yadav

Introduction

India is the second largest producer of vegetables in the world next to China. Horticulture production is gaining importance in the country and there has been a record production of horticulture crops with production reaching 311.7 Million Tonnes during year 2017-18 which is 3.7% higher than the previous year and10% higher than the past 5 years' average production.The contribution of vegetables remains highest (59–61%) in horticulture crop productions over the last five years. During 2017-18, the area under vegetables is estimated at 10.3 million ha with a production of ~180.0 million tones in India. According to FIBL & IFOAM Year Book 2018, **India rank 9th in terms of World's Organic Agricultural land and 1st in terms of tota l number of producers**. India produced around 1.70 million MT (2017-18) of certified organic products. The total organic produce exported during 2017-18 was **4.58 lakh MT of worth Rs. 3453.48 crore(515.44 million USD)** *(http://apeda.gov.in)*. The total area in India under organic certification is ~5.71 million hectare and total certified organic cultivable land in Sikkim is ~78,000 hectare with an average size holding of 1.17 hectare.*(www.apeda.gov.in)*. The market for organic vegetables is on the increase and there are a variety of markets possibilities for producers who want to grow certified organic vegetable crops. Vegetables are an important source of food and nutrition and provide regular cash income. Vegetables, especially as practiced by smallholder farmers in developing countries are particularly vulnerable to climate change. Adapting vegetable productionto climate change is essential for promoting food security and poverty alleviation, as well as for the sustainable management and conservation of natural resources. Many countries already are experiencing climate change impacts such as irregular, unpredictable rainfall patterns, increased incidence of storms and prolonged droughts. Changing weather patterns also allow for the emergence of pests and diseases that affect crops and animals. Adoption of protected cultivation techniques with organic management not only increases productivity and income but also reduces risks from extreme weather events and climate changes, and also contributes to reduced emission efforts. Protected cultivation or plasticulture in the forms of greenhouses, net houses, low tunnels, mulches etc. offers several advantages to grow crops of high quality and yields, thus using the land and other resources more efficiently. According to World Greenhouse Vegetable Statistics 2019, an estimated world greenhouse vegetable area is 4,96,800 ha *(www.cuestaroble.com)*.

Advantages of protected cultivation

Earlier production

Protected cultivation raises the temperature, which helps plants grow more quickly and mature earlier. Vegetables grown under low cost plastic tunnels, plastic rain shelters or on black plastic mulch can be harvested 7 to 21 days earlier. Harvesting one to two weeks earlier often significantly increases market advantage and the prices growers receive.

Reduced loss of nutrients

Many bio-fertilizers nutrients are not held tightly in the soil and heavy rainfall may leach them below the roots of plants grown on bare ground. Protected cultivation prevents rainfall from percolating through the soil and leaching nutrients beyond reach of plant roots especially in light sandy soils. Preventing leaching improves the efficiency of production and quality of produce.

Weed controls

Black plastic mulch prevents the growth of most weeds thus reducing the labour requirement. Clear plastic, however, does not prevent weed growth because light can penetrate it.

Increased plant growth

Plants grow more under protected conditions because of greenhouse effects and increase in air & soil temperatures. When plants are grown under protected conditions, the CO2 released from plants during night accumulates in the greenhouse and eventually increases the photosynthetic efficiency during day time.

Less water requirement

Mulching helps in reducing evaporation from the soils and maintained soil moisture more uniformly than the open field conditions. Since plant growth rate on mulch may be twice that on unmulched soil, plants may require more water even though evaporation is reduced. Mulching cannot substitute for a sound irrigation program. However, less water evaporates from soil under plastic mulch and therefore less water required for per unit of production.

Improved quality

Vegetables grown under protected conditions are cleaner, disease free and less subject to rots especially during rainy season.

Reduced soil compaction

Soil under plastic low tunnels and mulch remains loose, friable, and well aerated. Roots have access to adequate oxygen, and microbial activity is enhanced.

Disadvantages of protected cultivation

Greater initial costs

Establishment of protected structures requires an intitial investment making production costs significantly higher than for traditional practices. Yearly maintenance costs further increase production expenses. These costs, however, should be offset by increased returns from earlier harvests, better quality and higher yields.

Increased management

Although plasticulture technology offers several important advantages over conventional production practices, it requires skilled and trained persons to harness the full potential of protected cultivation. Timely management of all the operations is necessary to get higher and quality produce.

Preliminary considerations prior to going into protected cultivation

Before deciding to go for the protected cultivation or plasticulture system for high value crops, one should carefully consider the following factors:

- Vegetables intended to grow suits to production under protected cultivation.
- Vegetables should be intensively managed under various cropping systems.
- Sufficient financial resources available or obtainable.
- Good market availability.
- One should establish first a successful track record growing high value crops under open conditions then plasticulture system may be profitable.

General cultivation practices for organic vegetables

Site

Site should be free from gravels, well drained and near to market. Site preparation is an important component of a successful protected cultivation system. The field should be ploughed early and allowed sufficient time todecompose the applied FYM or organic manure before planting crops.

Orientation

A north-to-south orientation is recommended for more uniform plant stands and ripening. However, facilitating soil drainage is the most important factor to be considered for planting.

Soil

Healthy soil is the basis of organic farming. Regular additions of organic matter in the form of cover crops, compost, or manure create a biologically active soil, with good structure and capacity to hold nutrients and water. The practice of crop rotation to promote a healthy soil should be initiated in the one or two years prior to planting establishment. This is best for both reducing soil pests and maintaining soil organic matter.

Land preparation

Land preparation or bed shaping, is an important practice in the protected cultivation system. The soil must be loose and friable and free of stones, clods, sticks, and undecomposed plant residue. About 4-5 inch raised bed should be prepared. The land should be prepared to a fine tilth for low cost plastic tunnels, low cost plastic shelters, low cost plastic greenhouses and open conditions. Well decomposed FYM to be applied @ 1.5-2.0 kg/m2 or vermicompost @ 0.5-1.0 kg/m2 along with neem cake @ 200 g/m² at the time of final land preparation. If soil is acidic in nature, it is advisable to apply dolomite/lime @ 200 g/m2. Lime should be applied at least 20-30 days before planting.

The soil should be prepared well and brought to a fine tilth before transplanting. Green manure crops like dhaincha, sunhemp and cowpea should be cut after 45 days of planting and after chopping in to small pieces can be applied in soil to further improve the nutrient status in soil.

Plastic Tunnel

Green manure crops are capable of accumulating 4-5 t/ha of dry biomass and 100 kg N2/ha in 50-60 days.

Pollination

Pollination should be a major problem under low cost plastic tunnels and low-cost plastic greenhouses so it is advised to grow self pollinated vegetables or leafy vegetables.

Nursery management and sowing methods

Nursery should be raised under protected condition in low cost polyhouse or under low cost plastic tunnels. Seeds of cole crops, pakchoi, rayo sag etc., can be sown in nursery about 30-40 days before transplanting. The selected area should be free from soil-borne diseases, well leveled, fertile and provided with better irrigation and drainage facilities. The raised bed of 15 cm height and 5 m x 1 m size should be prepared. The seeds should be sown in rows made 10-15 cm apart and 1.5 cm deep. Watering should be done regularly to maintain the required moisture for proper germination. The bed should be covered with thin layer of dry grass to check evaporation and to maintain temperature. As soon as the seeds germinate the upper grass layer should be removed carefully and later on cultural operations should be followed as per requirement. Normally four to six weeks after seed sowing the seedlings are ready for transplanting. Irrigation should be stopped one week before transplanting. Cole crop, okra, dalley chilli and tomato seedlings should be treated with Azospirillum + Phosphate Solubilizing Bacteria (PSB) (20 %) for 15 minutes at the time of transplanting to get better yield and quality produce. Transplanting of cole crops seedling is done in rows at a distance of 30 cm x 30 cm. Direct seeding should be done for

leafy, root and other vegetables after seed treatment with Trichoderma viride @ 1g/kg seed to reduce damping off (seedling rot) disease.

Interculture and irrigation

Most of the vegetables like cole crops and leafy vegetables are shallow rooted crop and roots are restricted within 15-20 cm of soil so light earthing up should be done after 30 days and 45 days of planting and deep cultivation should be avoided.Regular shallow cultivation should be given to the soil to remove young weeds and to provide soil mulch. Once the foliage has covered the soil, it is better to stop hoeing since it may damage the roots. Normally three to four hoeing and weddings are required to keep the crop weed free.Vegetables require sufficient moisture in the soil for uniform and continuous growth. Hence, frequent irrigation at 10-15 days interval is given depending on weather conditions for the crops under protected cultivation. The dry conditions adversely affect the quality and yield of shoots by being more fibrous.

Organic vegetable production under low cost protected structures

The Indian scenario has changed tremendously during the last decade because of change in the life style and food habits. The people are becoming more aware to eat healthy foods. High value crops like vegetables are an important component of health food and provide nutritional and health security. Though, the greenhouse technology has registered substantial growth in the recent years on productivity and quality improvement around the globe but still the low cost protected structures are preferred over high cost structures considering the cost involved and poor financial status of Indian farming community. The most common low cost protected structures are:

a. Low cost plastic tunnels

Low cost plastic tunnels or open tunnels are greenhouse-like structures, covering the plants along the row. These tunnels are about 1.0 m high and 1.5 m wide at the base and are erected with bamboo sticks or wooden poles of about 1 inch diameter. A transparent UV stabilized plastic sheet of 35 or 45 GSM is placed on the bamboo structure to allow sunlight during the day passes through the plastic sheet, and is absorbed by the soil.

Walk-in-Tunnel

This raises the temperature to desired levels. The plastic sheet serves two purposes: first it traps heat and reduces water loss and second it protects plants from adverse climatic conditions. Transparent plastic films are stretched over low (about 0.5 m or so) as a flexible wall on both sides of tunnels. The plastic films are properly tied up on bamboo structures with wire. Good cross ventilation and potential stresses caused by heavy wind, hail or heavy rains must be considered while constructing the structure.

Advantages of low-cost plastic tunnels

- Vegetables can be produced year-round regardless of the season to get better return.
- Provides crop diversification opportunities and supports production of high quality and clean products.
- Makes cultivation of vegetables possible in areas where it can't grow in open conditions viz. high altitudes.
- Used for raising healthy and early nursery.
- Maintains optimum temperature for plant growth.
- Enhances nutrients uptake by the plants.
- Increases photosynthetic activities of the plants.
- Used for cultivation during winter.
- Protection against wind, rain, frost and snow.

Vegetable cropping sequences for low cost plastic tunnels

#	Cropping Sequences
1.	Broccoli - Spinach - Coriander - Broccoli - Coriander
2.	Broccoli - Coriander - Cabbage - Radish - Coriander
3.	Coriander - Radish - Fenugreek – Spinach - Coriander
4.	Cabbage - Local Rayo Sag - Broccoli – Coriander
5.	Cabbage - Spinach - Broccoli - Coriander
6.	Coriander – Radish –Fenugreek – Cauliflower - Pakchoi

b. Low cost plastic rain shelters

Plastic rain shelters are very simple structures, covering the plants along the row. These are about 7 ft. high at one end and 6 ft. high at other end to give slanting roof. Crossed bamboo sticks are placed at the roof for supporting the plastic sheets. The width of these shelters can be 6-8 ft. The plastic rain shelters are erected with bamboo or wooden poles of about 1-2 inch diameter.

Bambo Polyhouse

A transparent UV stabilized plastic sheet of 45 GSM is placed on the bamboo structure to cover the roof. The plastic films are properly tied up on bamboo structures with wire. The plastic sheet simply protects the plants from adverse climatic conditions for eg. high rainfall, hail storms and frost during winter.

Advantages of low-cost rain shelters

- Vegetables can be produced in rainy season to get better return per unit area.
- Provides crop diversification opportunities and supports production of high quality and clean produce viz.

tomato, cucumber, gourds, capsicum, pea etc.

- Maintains optimum temperature for plant growth.
- During winter season it protects crop from frost.
- Protection against wind, rain and hail storm during rainy season.

Vegetable cropping sequences for low cost plastic rain shelters

#	Cropping Sequences
1.	Tomato –Tomato - Pea
2.	Bitter gourd/Sponge Gourd/Bottle Gourd –Tomato - Pea
3.	Bitter gourd/Sponge Gourd/Bottle Gourd – Capsicum - Pea

c. Greenhouse

Greenhouses are generally madeup of various clading material viz., polycarbonate sheet, FRP sheet or plastic sheet (low cost polyhouse). The high priced vegetables viz., broccoli, tomato, cucumber and capsicum are most important crops for production during winter season or off-season in greenhouse. Generally indeterminate tomato varieties are grown in the protected structures to utilize vertical space judiciously. Optimum spacing found suitable for tomato is 60 x 60 cm, capsicum is 40 x 40 cm and cucumber 100 x 100 cm. It has been found suitable that tomato should be maintained as single stem plant by regular pinching of auxiliary side branches and train them along the string. Capsicum and cucumber can also be pruned and trained in such fashion. At the stage of first branching, two or more shoots along with crown flower buds develop naturally. This crown bud should be pinched off with side branches to allow one or two branches to develop as main branch and trained along the string. Plant do keep producing the terminal flower buds on the side shoots pruned as main stem, which should be pinched to allow plant to grow continuously. Pruning is done frequently at an interval of 15 days to avoid crowding of branches. In tomato, fruits are harvested at turning to red ripe stage according to the market distance capsicum are harvested at full mature green stage or full ripe (red or yellow) but firm stage as per market demand generally capsicum requires 45 days from anthesis to full grown mature green stage and further about three weeks to reach firm ripe stage.

Tomato in Polyhouse

Advantages of greenhouse

- Vegetables can be produced year-round regardless of the season to get better return.
- Provides crop diversification opportunities and supports production of high quality and clean products.
- Makes cultivation of vegetables possible in areas where it can't grow in open conditions viz. high altitudes.
- Maintains optimum temperature for plant growth.
- Used for cultivation during winter.
- Protection against wind, rain, frost and snow.

Vegetable cropping sequences for low cost polyhouse

#	Cropping Sequences
1.	Cucumber –Tomato – Cabbage (Cole Crops)
2.	Capsicum –Tomato – Broccoli (Cole Crops)
3.	Tomato – Capsicum – Cauliflower (Cole Crops)

Major challenges in organic vegetable production

- Sustain production under the changing climatic conditions and increased competition for land, labour, water and energy for other economic uses.
- Breed/identify crop varieties for organic production system.
- Develop efficient and cost-effective seed and planting material supply chain to augment productivity.
- Develop cost effective production technologies.
- Ignorance of right stage of harvesting and value addition which results in low price of produce.
- Inadequate attention towards value chain management to prevent losses and to ensure supply during off seasons.
- Creation of value chain infrastructure and establish market information system for intelligent marketing of truthfully labeled produce to fetch better price.

Strategies for sustainable development

- Horticulture advisory service needs to be strengthened.
- Awareness should be created for off-season vegetable production on scientific lines.
- Protected crop and nursery production technology should be popularized to make it profitable/viable on commercial scale.
- Infrastructure for post-harvest management viz., cool transport chain, pre-cooling units, packing houses, short- and long-term cold stores etc. should be developed.
- Human Resource Development programmes should be strengthened with higher emphasis on training of farmers for scientific cultivation of vegetable crops.
- Extension network for dissemination of knowledge/technologies and monitoring of their adoption should be strengthened.
- Agri Export Zone should be identified by the Government for export of organic vegetables and contract cultivation / cooperative farming should be encouraged.

Protray Seedlings: A Boon for Hi-tech Vegetable Cultivation

G.L. Sharma, T.Tirkey, H.K. Panigrahi and Rajesh Agrawal
Centre of Excellence on Protected Cultivation & Precision Farming
Indira Gandhi Krishi Vishwavidyalaya, Krishak Nagar, Raipur-492 012 (Chhattisgarh)

Dr. G. L. Sharma

Introduction

Availability of healthy true to type seedlings is pre-requisite for remunerative vegetable cultivation. Generally, vegetable seedlings are grown in outdoor ground beds using flats or raised beds in India. But in the recent past with the advancement of technology, vegetable seedlings can also be grown inside a protected structure either in ground beds or using various types of containers, primarily protrays or plug trays. In this advanced system, each seedling grows in an individual cell so there is less competition among the newly emerging seedling and greater uniformity can be achieved. Less labor is required for preparation of soil, formation of beds and uprooting seedling. This technique could also be subjected to mechanical automation. Protrays seedlings establish better in the field because roots are not damaged in pulling while uprooting. The portrays or plug tray nursery raising technology facilitate for production of disease free, vigorous and season independent seedlings using protected environment. Depending on the objective, different types of protected structures, like greenhouse, net house and poly tunnels are used to take care of biotic and abiotic stresses during seedling growing period. In order to raise high density seedlings without root borne diseases, plastic portrays along with sterilized growing media are used. The type and ingredients of media used for nursery raising have been standardized as also the size and volume of the cells of pro trays for different vegetable crops. Irrigation and fertigation schedules have also been standardized for raising of seedlings of different vegetables in different seasons. The root development under this system of nursery raising is so vigorous that mortality rarely occurs due to transplanting. This technology has a very high potential of adopting as an agro-enterprise supporting production of seedlings of different vegetables crops. A suitable protected structure, depending on the local climate requirement and volume of seedling aimed to be produced can be constructed. The plug tray nursery raising technology is also suitable for cucurbits for their off season cultivation in Northern India during early spring.

Positive aspects of the technology

The protray seedlings raising technology has provided several comparative advantages as compared to the nursery bed technique used for production of the vegetable seedlings. These benefits are described briefly here under:

a. This technology ensures production of healthy, uniform, disease free vigorous vegetable seedlings for the vegetable growers. Whereas, it is very difficult to produce uniform and disease free seedlings from outside grown nursery beds.

b. Since the cost of hybrid seed of vegetables is very high, germination and formation of healthy seedling from every seed is important from economic point of view. Therefore protray seedling technology ensures good germination percent and production of healthy seedlings.

c. Seedling production under protected structures may provide opportunity for self employment and help to generate more jobs in the field of horticulture in the rural areas.

d. Through this technology it is possible to produce disease free nursery irrespective of dependence on optimum climatic conditions to come. This facility will enable the growers to produce off- season vegetables. Hence more profit to the vegetable growers.

e. The protray raised seedlings can be very conveniently handled. They are easy transfer from one place to another in form of the trays. Moreover, they can be kept for few days with proper care, where as the nursery bed raised seedlings are to be transplanted immediately after uprooting.

f. It is possible to grow seedlings of cucurbit crops which are difficult to grow in traditional nursery bed technique

g. When transplanted the protray raised seedlings are free from transplanting shock. They also not show sign of wilting after transplanting which is common in case of nursery bed grown seedlings as they sre pulled for uprooting. The roots are damaged in this uprooting and plant takes few days to recover this damage. Since this damage does not occur in protray raised seedlings, they give 7-8 days early fruiting.

h. This protray seedlings raising technology is amenable for fully automation at various stages of seedling production. The filling of growing media, placement of the seeds, both time and frequency of irrigation, nutrient and chemical applications, transfer etc. all can be accomplished by mechanical automation, which will save valuable human labour.

Limitations of nursery bed methods of seedling raising

a. It is nearly impossible to raise virus free nursery during rainy and post-rainy season because of prevalence of favourable ambient atmospheric conditions.

b. Development of soil borne fungus and nematodes mainly during high humidity and temperature period, which adversely affect plant growth. Moreover, duration of nursery raising is long also during winter season.

c. Germination in less during winter month due to low temperature.

d. Nursery of vegetables like cucurbits is not at all possible under traditional system of nursery beds.

e. Off-season nursery cannot be raised due to abiotic factors like temperature, humidity and untimely rainfall.

The working of the technology

The tray or pro trays are filled with the growing medium. A small depression (0.6 cm) is made with fingertip in the center of the cell of the portray for sowing. One seed per cell is sown and covered with medium. Coco peat with 300 to 400 per cent moisture is used and hence no immediate irrigation is required until germination. After sowing 10 trays are kept one over other for 3 to 6 days, depending on the crops. The entire stack will be covered using polyethylene sheet to ensure conservation of moisture until germination. The stacked trays are spread in single layer once the germination commences to avoid etiolation. The trays are shifted to net house on germination of seedlings and spread over the beds or raised platform benches. The trays are irrigated lightly every day depending upon the prevailing weather conditions by using a fine sprinkling rose can or with hose pipe fitted with rose spray. Drenching the trays with fungicides as a precautionary measure against seedling mortality is also being done. Spraying of 0.3 per cent (3 g / litre) water soluble fertilizer using poly feed (19 all with trace elements) twice (12 and 20 days after sowing) is practiced to enhanced the growth of the seedlings. The trays are provided with protective cover from rain by covering with polyethylene sheets in the form of low tunnel whenever there is untimely rainfall. The seedlings at right stage of planting are hardened by withholding irrigation and reducing the shade before transplanting or dispatching to the growers. Systemic insecticides are sprayed 7-10 days after germination and before transplanting for managing the sucking insect vectors. The seedlings would be ready in about 21-42 days for transplanting to the main field depending on the crop species and ambient environment conditions.

Protray (seedling tray) selection

The cell size influences the field performance of the seedling, especially earliness. When larger cells are used the plant has more space to grow, so it is possible to produce an older, more mature seedling without it becoming spindly, lanky or root bound. In general, larger protrays result in earlier-maturing crops. Larger cells, however, take up greener house space, more growing medium and are more expensive to grow.

Table-1: Size of commonly used vegetable portrays.

Tray (no. of cells)	Plant Density (Cells / 0.3 Sq.M.)	Cell Volume (CC)	Recommended Crops
24	14	171	Early tomato, Onion, Brinjal
38	23	106	Early tomato, Onion, Brinjal, Cole crops
50	31	66	Early tomato, Cucurbits, Cole crops, Brinjal
72	47	43	Early peppers, early cole crops, early Cucurbits
128	78	23	Main-season tomato, peppers, Cole crops
200	122	11	Late-season peppers, Cole crops
288	175	7	Processing tomato, onion

Tray effect on plant growth

Besides other factors, the shape, size, colour and depth of the protray also influence the quality of seedlings produced. Compared to plastic trays, Styrofoam seedling trays are more expensive, insulate the root media, delay seedling growth, promote algae and harbor disease. Plastic trays are more commonly used and are preferred. However, darker-colored trays absorb more heat and tend to produce faster growth than light-colored trays (e.g., black versus white plastic trays). Styler and Koranski (1997) reported that the plug tray was the base of the transplant production and the design of its cell commanded more and more attention. The roots of seedlings in cells proliferate mostly on the periphery of root ball at the growing medium and protray cell interface.

Tomato transplants grown in square cells were larger than those in round cells. (Larson, 1987). Latimer (1991) reported that square cells improved soot growth of marigold seedlings compared with round cells. Lettuce and leek seedlings produced higher shoot weights when they were grown in inverse pyramid containers compared to cylinder ones. (Cox,1984) However, these reporters indicated that the influence of cell shape was caused by the change in the growing medium volume or plant density in the plug tray. Chen et al. (2002) found even if the growing medium volume and plant density in the plug tray was the same, cell shape also affected plant growth.

Seedling age and transplant scheduling

The optimum age for vegetable seedlings depends on both the crop and the cell size to be used. In general, larger cells will enable production of larger, more mature seedlings. Seedlings growth in larger cells has been reported to give higher and early yields compared to smaller cells however; the overall yield is largely the same. Hence, growing practices and schedules for different crop species and cell sizes has to be standardized based on prevailing local requirements.

Growing media

The growing media or soil less mixture is generally composed of a combination of Coco peat, vermiculite and horticultural perlite in the ratio of 3:1:1. Media

containing coarser-textured (long-fibred) coco peat provide better drainage and aeration, therefore promoting better root development. Some soil less mixes nutrients and fungicides which can also be used to raise vegetable nursery. Besides this equal ratio mixture of virgin sand, well rotten FYM, and soil can also be used as growing medium.

Rooting and growing media are one of the most important factors in raising vegetable nursery because the growth and development of nursery plants and roots proliferation depends on it. Growing media are divided into soil, soil-less group or mixture of both. Growing media are soil, sand, coco peat, FYM/compost, vermicompost, peat moss, perlite, pumice, sawdust, ashes etc. Mostly under open field condition, farmers are using soil, sand and well rotten FYM as they are cheap, easily available, retain sufficient water, air and allows sufficient drainage. However, for protrays any of the following medium solely or in combinations as per local availability and economy of production can be used after standardization.

Soil

Soil is the basic crust of the earth and composed of material in solid, liquid and gaseous states. Its texture depends on the relative proportion of sand, silt and clay. The soil of the medium should be of optimum pH (6.5-7.5). It should have good drainage quality and good organic matter content as well.

Sand

Sand is the small rock containing particle size (00.05 to 2.00 mm) formed by the weathering with low 1.6 g cm-2 bulk density. Sand alone or in combination with other growing media are used in nursery. Sand is the heaviest of all rooting media. Sand contains virtually no mineral nutrients and has no buffering capacity. It is used mostly in combination with organic matter, soil. coco peat or any other locally available material.

FYM / Compost

Farm Yard Manure (FYM) or compost is used as moisture-holding humus material either alone or in combination with soil and sand. Compost supplies the macro and micronutrients also. FYM or compost is also used for mixing in the medium to improve its water holding capacity. Well rotten and powdered forms are used for better performance in seedling raising. Undecomposed FYM leads to the termites and suppress the seed germination. The nutrient content of the compost and its air and water relationship can vary widely based on the nature of organic raw materials.

Vermicompost

Vermicompost is a very useful growing medium in nursery raising and it can be prepared easily by rearing of worms. It provides all the required parameters to the nursery like firmness, water, air and better nutrition and support to the seedlings. This can be produced by the farmers themselves to reduce the cost of production. It is a better alternative to any other costly medium.

Soil less medium

The suitable soil less media should be capable to retain enough water, air and available nutrient for the seedlings. It must also have good drainage and allows easy leaching for excessive salt that accumulate in the substrate and damage the crops. Further research efforts are required to make soil less media as cost effective for protray seedling production on commercial scale.

Saw dust

Saw dust may be used for nursery raising medium. This is a by-product of wood and timber industry, free from harmful substances. It has very good moisture retention capacity, free from microorganism inoculums and neutral in reaction.

Peat

Peat consists of the remains of aquatic, marsh, or swamp vegetation, formed as a result of partial decomposition under anaerobic or semi-anaerobic conditions. It is dark brown to black in colour, low pH with a low moisture-holding capacity but with 2.0 to 3.5 percent nitrogen. It can be used as per availability alone in combinations with other medium after standardization.

Sphagnum moss

Sphagnum moss is used for propagation is the dehydrated young residue of plants in the genus Sphagnum, like S. papillosum, S. capillaceum, and S. palustre. It is relatively light in weight and has a very high-water holding capacity, which is able to absorb water 10 to 20 times of its weight. The stem and leaf tissues of sphagnum moss consist largely of groups of water holding cells. This material is generally shredded, either by hand or mechanically, before it is used in a propagation or growing medium. It has a pH of about 3.5 to 4.0 and small quantity of minerals. The economic aspect should be taken into account for use of sphagnum moss as medium for portray raising of vegetable seedlings.

Perlite

Perlite is a grey white aluminium silicate mineral, mined from lava flows. It is light in weight, highly expandable 94-20 times to its original volume) when heated approximately at 982°C. The surface holds moisture and nutrients to make them available to the seedlings. Since it is sterile in nature, perlite is free from the diseases and insect pests. It has low cation exchange capacity and does not influence the pH of the media. The high porosity of perlite helps to control water holding capacity and aeration of substrates. A course perlite is 1.2 – 2.0 mm in diameter with pH of 7.5.

Vermiculite

Vermiculite is a micaceous mineral that expands markedly when heated. Chemically it is hydrated magnesium aluminium / iron silicate. When expanded, vermiculite is very light in weight, 90 to 150 kg per cubic meter, neutral in reaction with good buffering properties, and insoluble in water. It is able to absorb large quantities of water (80 percent porosity). It has a relatively high cation exchange capacity (CEC 100-150 meq/100 g) and thus can hold nutrients in reserve and later on release them. It contains 9-12% magnesium and 5-8% potassium to supply the plants.

Pumice

Chemically pumice is mostly silicon dioxide and aluminium oxide, with small

amounts of iron, calcium, magnesium and sodium in the oxide form. Pumice is screened to different size grades but is not heat treated. It increases aeration and drainage in rooting mixture and can be used alone or mixed with peat moss.

Rock wool

Rock wool is a manmade mineral fibre. It has a high percentage of pore space, which holds both the nutrient solution and air to supply to the root system. The rock wool contains 40-50% easily available water and 40-45% air capacity by volume. It acts as a support medium for the root system and as a means for holding nutrient solution and air in close proximity to the roots. It is sterile, easily managed and transported and completely consistent in performance. It has a pH of about 7.0 – 7.5.

Coco peat

Coco peat is biodegradable and an eco friendly growing medium made of natural coir fiber. It is extracted from coconut husk-the mesocarp of coconut fruit. It is a complete organic and soil free potting medium and if can replace soil and peat moss. Coco peat is environment friendly, a mixture of corky cellular material and short fiber and does not create any disposal problem. It is free from any admixture and heavy metals and like peat moss. It has a high water holding capacity, almost five times its volume.

Table-2: Spacing, plant population and seed requirement of vegetable crops

(Chaurasiaet al.2003)

Vege-tables	Types of Variety	Spa-cing	No. of plants per ha	1000-seed weight (g)	Actual seed requirement (g)
Tomato	(OP)	60 x 45	33,333	4.0	200
Tomato	(Hyb.)	60 x 50	30,000	3.3	150
Brinjal	(OPL)	60 x 45	33,333	4.0	200
Brinjal	(OPR)	60 x 45	33,333	4.0	200
Brinjal	(Hyb. L)	90 x 60	20,000	4.0	120
Brinjal	(Hyb. R)	90 x 60	20,000	4.0	120
Chillies	(OP)	60 x 30	50,000	4.0	250
Chillies	(Hyb)	60 x 45	33,333	3.3	165
Capsicum	(OP)	60 x 30	50,000	3.3	415
Capsicum	(Hyb)	60 x 50	30,000	5.5	250
Cabbage	Early (OP)	45 x 30	66,666	3.0	300
Cabbage	Early (Hyb.)	45 x 30	66,666	3.0	300
Cabbage	Mid (OP)	45 x 45	44,444	3.0	200
Cabbage	Mid (Hyb.)	60 x 45	33,333	3.0	165
Cabbage	Late (OP)	60 x 45	33,333	3.0	165
Cabbage	Late (Hyb.)	60 x 60	25,000	3.0	115

It provides better aeration and enhances strong and healthy root growth. It is resistant to bacterial and fungal growth. It retains and releases nutrients over a long period. It has uniform texture and consistency, free from pathogen, weed seeds and toxins. This is one of the ideal medium for protray seedling raising and available commercially in the form of compressed coco peat cubes.

Seeding equipment

The sowing of the seeds can be done either manually or through seeding equipment (or seed pen). Manual indenting and sowing of small vegetable seeds in plug trays is a slow and labour-intensive operation, which limits the production capacities of vegetable nurseries and also enhances cost of production per seedling. High-capacity imported seeders have not been adopted by nursery growers due to their high costs. The selection of the seeding equipment depends on

(a) Ease of sowing on different protray sizes;

(b) Whether required for handling raw seed as well as pelleted seeds;

(c) Number of portrays need to be seeded per day.

Generally, Plate type Vacuum seeders and Needle or Nozzle type mechanical seeders are available. Gaikwad and Sirohi (2007) at IARI has developed a prototype pneumatic seeder which was fabricated and tested for its performance for sowing capsicum and tomato seeds in plug trays. The seeder could make indents in one row of cells in a plug tray and simultaneously place single seeds in the indented cells. The seeder worked satisfactorily at suction pressures of 4.91 and 3.92 kPa and nozzle diameters of 0.46 and 0.49 mm to achieve more than 90% single seed sowing in the case of capsicum and tomato, respectively. The capacity of seeder, depending on the tray size used, ranged between 38,000 and 60,000 cells per hour. The total cost of sowing 1000 cells using a prototype precision plug seeder was found to be Rs. 1.56 which was only 15.27% of the estimated cost of manual sowing.

Further, at IIHR, Bengluru a tray type dibbler with capacity of 100 portrays per hour and a vacuum seeder with capacity of 50 portrays per hour were designed and developed by Rathinakumariet al (2005). The tray type dibbler is made out of wooden board with 98 nylon pegs to dibble in the media. The tray type vacuum seeder is made of acrylic sheet and it consists of a vacuum chamber, seed plate with 98 holes to pick the seeds, vacuum pump and necessary control valves. It was observed that the seeder picked and dropped the round shaped seeds like cabbage, cauliflower and knolkhol perfectly, i.e., 100% singles. For other vegetable seeds, the metering performance of the seeder was good with singles in the range of 93-97%, doubles between 3-7% and no missing was recorded. It is suggested that these handy and low-cost tray type dibbler and tray type vacuum seeder are very much useful for small vegetable nursery growers.

Seedling trays and covering seed

The trays are filled with pre-moistened growing media and then the media is compressed or “dibbled” to make a

uniform surface for the seed. The media should be compressed between properly. The seeded trays are then covered with medium-grade vermiculite. Seed of all vegetable species must be covered after seeding. Vermiculite is preferred as covering material because it is easy to apply evenly, allows good aeration, does not support algae growth and does not allow root growth between cells. The trays are now ready for watering before being placed in the shed net or poly house. The medium comprising of FYM, soil, sawdust, peat etc. should be filled dry in condition in protrays and watering is done after seed sowing.

Pretected structures for germination

Most vegetable crops will benefit from the use of the protected structures like shed net, poly house, low tunnel poly house etc. This is usually an insulates structure in which temperature and relative humidity can be maintained as per requirement. The goal is to facilitate the germination process in a confined area to minimize the cost of seedling production. Air circulation is important to ensure uniform temperature and humidity throughout the chamber which can be done either as natural ventilation or installation of exhaust fans in combination of cooling pads. There should be a thermostat to maintain the temperature regime. The humidity can be regulated through use of automatic intermittent mist sprays.The protected structure by ameliorating micro-climate enables off season production of seedlings. Reduce incidence of disease and pests and also help for uniform growth.

Racks and benches for protray placement

Vegetable seedling raising rack system can be more suitable for placing the portrays on benches inside the greenhouses and for transportation of the portrays to the field for transplanting. Plug trays are usually handled on racks made of either angle-iron or wood with wire-mesh tops. Proper placement of racks in the greenhouse is important. Trays must be elevated off the ground to prevent root growth in the soil underneath and to ensure proper aeration. The benches or beds for placing of portrays should be level having slight gradient to prevent water from running into low spots and to facilitate proper drainage.

Environmental requirements

The 'growing-on stage' of the seedlings may be defined as the period of time from their emergence to the plants to the hardening before transplanting in the field. During this growing stage, environmental conditions like temperature, humidity, and light, watering and nutrition, all affect the growth and quality of the seedlings. Nursery raising of various vegetable crops within the same greenhouse can be a difficult process. The environmental requirements for one crop may not suit for another. For example, cabbage transplants require relatively cool temperatures and low fertility levels, while tomato, brinjal, chilies seedlings require higher temperatures and more fertility. Wherever possible, crops with dissimilar requirements should be grown in separate greenhouse where they can be managed in staggered batches as per their requirements.

Table-3: Optimum temperature for germination of different vegetable crops.

Crop	Germination	Approx. no of days to Emergence	Growing Temperature (Day)	Growing Temperature (Night)
Tomato	21-24	3-4	18-21	10-18
Peppers	26-28	4-6	18-21	12-18
Cole crops	18-24	2-3	12-18	8-15
Cucurbits	24-30	2-3	21-24	12-18
Onions	18-24	3-4	16-18	8-15

Temperature

Different vegetable crops vary in their response to temperature. The optimum day and night growing temperatures for several crops are listed in the Table No.-3

Irrigation of protrays

Before starting commercial vegetable nursery raising enterprise it is advisable to have a detailed water analysis to verify quality of irrigation water for the seedling raising. The pH of the water used for watering plug transplants should be between 5.5 to 6.5. In this pH range, nutrients are more available. The amount and frequency of watering depends on cell size of protrays, growing media, greenhouse ventilation and weather conditions. It is important to water thoroughly, and moisten the entire plug of the protrays, which will promote root growth up to the bottom of the plug. If the plug is not watered thoroughly, root growth will be confined to the top of the plug. Allow the plug to dry down before watering, but the plant should not wilt severely, as this will damage roots and seedling health.

Feeding the seedlings in protrays

The application of the nutrients in raising vegetable seedlings affects the quality of the seedlings and its ability to establish in the field. Well-grown seedlings will have adequate nutrient reserves to ensure rapid establishment under a wide variety of field conditions. Vegetable seedlings are usually fertilized with a soluble fertilizer which is applied in the irrigation water. Avoid application fertilizers with a high concentration of nutrients at the seedling stage. The fertigation programme used in raising vegetable seedling depends on nutrient requirement of vegetable seedling which is affected by species, season and growing medium. After one week of germination, seedlings of vegetable crops required to be feed with various essential nutrients. As per availability in the market we choose different fertilizers which vary in percent of nitrogen (N), phosphate (P2O5), and potash (K2O) like 19:19:19 or 15:15:15 and traces of micronutrients. After selection of suitable fertilizers, stock solution is prepared along with micronutrient and applied 70-80 ppm (parts per million) in the month of summer and 140 ppm during winter season along with irrigation water once a day. If feeding once every seven days, concentration of 250 to 350 ppm nitrogen can be applied. Cole crops require less

Table-4: Concentrations of N, P, K and ECs for 100 ppm solution of various water soluble fertilizer materials for use in vegetable transplant production.

(Hasan *et al.*, 2010)

Fertilizer analysis	Rate for 100 ppm N (g/100 litres of water)	Parts per million (ppm)			Electrical conductivity (EC) mm-hos/cm*
		N	P	K	
20-20-20	50	100	43	83	0.40
20-10-20	50	100	21	83	0.60
20-08-20	50	100	17	83	0.75
17-05-19	59	100	12	92	1.00
15-05-19	67	100	14	83	0.70
14-00-14	71	100	0	83	0.85

fertilizer as other crops. This solution of nutrients can be applied either through spray or more conveniently as dissolved in irrigation water. Through this technique seedlings are ready to transplant after about 25-30 days.Growers should use fertilizers that have most of the nitrogen in nitrate form. Fertilizers having high concentration of urea should be avoided. Fertilizer analyses recommended for transplant production mentioned below:

A high concentration of phosphate (P2O5) may promote excessive seedling elongation under certain conditions. Use of the fertilizer with a low to medium phosphate concentration is recommended. An alternative is to use a fertilizer with no phosphate (such as 14-0-14) for most feedings, and apply a high-phosphate fertilizer periodically (once every four or five feedings) to promote growth. Do not withhold phosphate completely, as this will delay field establishment.

Seedlings should be watered as required and the nutrient solution concentration and application frequency should be modified to promote the desired amount of growth. Fertilizer requirements vary depending on cell size (larger cells require less fertilizer), and the nutrient content of the growing media (less fertilizer should be used if the media contains high nutrient concentration).

Fertigation requirements of transplants

Different vegetable crops vary in their response to fertilizer, so the feeding programme must be modified for different crops as per requirement. Tomato is very responsive to fertilizers but excess of fertility will reduce transplant quality. While feeding at every watering, fertilizer concentration of 50 to 100 ppm N should be used depending on the stage of plant development. It is advantageous to do feeding less often at a higher concentration. For weekly feeding, use a concentration of 250 to 350 ppm N. Peppers require more fertilizers than tomatoes therefore if feeding is done at every watering, then approximately 100 ppm N may be used but if feeding is done less often then higher concentration may be used. Cole crops do not require as much fertilizer as other crops and 100 to 150 ppm N application weekly should be sufficient under most conditions. Since cucurbits have a relatively short growing cycle compared to other crops therefore two to four applications of 100 to 150 ppm N at weekly interval should be sufficient to produce good quality vine crop transplants. Generally, the nutrient uptake by the roots is low at low temperature during winter season therefore concentration need to be increased accordingly and vice versa during summers when the nutrient uptake automatically increases. The Nitrogen dose should be 140-150 ppm N during winter and it should not be more than 90-100 ppm N during summers.

Calculation of fertilizer solution of PPM concentration

Formula: Weight of fertilizer (grams) = solution concentration (PPM) x solution volume (litres) divided by 10 x (% N of fertilizer material).

Example: For making a 100 PPM solution of 20-10-20 fertilizer in a 500-litre water, the amount of fertilizer required is = (100 x 500) / (10 x 20) = 250 grams. Amount of fertilizer required = 250 grams.

Nursery raising technology for cucurbits

At Centre for Protected Cultivation Technology of the I ARI, New Delhi Singh et al (2010) conducted experiments on the plug-tray nursery raising technology for major cucurbits and standardized the technology. Under this technique seedlings of these cucurbits are raised in multi-celled plastic plug-trays consisting the individual cell volume of 18-20 cc. These cells may be of any shape like inverted pyramid, round or hexagonal etc. but inverted pyramidal shape is most effective for producing vigorous seedlings Standardized soil-less media consisting of coco peat, vermiculite and perlite is used in 3:1:1 ratio as on volume basis. First the media is mixed thoroughly and after adding required quantity of water. Then it is filled in the plug-trays and a slight impression is made in each cell by gentle push with first finger of hand and then one seed in each cavity is sown.

After sowing of the seeds a thick layer of vermiculite is spread over the seeds in each plug-tray followed by a light irrigation through fine sprinklers. If the ambient temperature is low (< 12°C during night) specially during winters, the plug-trays are kept in the germination room by keeping the trays in vertical stacks over each other and the temperature of the germination room is kept at around 20-25°C with the help of hot air blowers etc. The plug-trays are taken out from the germination room immediately after germination of the seeds and are spread on the floor of the nursery greenhouse or seedling benches. Irrigation in the plug-trays was done as per requirement. Fertigation is done thrice a week in summer season but daily in winter season and in each fertigation N:P:K (20:20:20 grade) solution is applied at 100-140 ppm. Seedlings of these cucurbits are mostly ready for transplanting within 18-22

days of seed sowing during peak winter months (i.e. December and January). The optimum time taken by different cucurbit vegetable for plug-trays nursery raising is little bit different from crop to crop. Summer squash nursery is ready for transplanting within 20-25 days of seed sowing, cucumber seedlings takes 22-25 days, musk melon and water melon 25-28 days, bottle gourd 20-22 days and pumpkin 18-20 days and bitter gourd takes 25-28 days. (Singh *et al.*,2010)

Further, studies on watermelon transplants grown in plug trays and effect of mycorrhizae fungus was also done by Ban et al. (2007) at Croatia .They concluded that plug trays containing 40 cells, each of which were 100 ml cell volume, produced plants that were the tallest, has greatest number of leaves and the thickest stems as compared to the transplants grown in smaller cells of 60 ml and 80 ml volume. There were no differences between transplants in 60 ml and 80 ml cells. However,The mycorrhizae fungus G. *mosseae* resulted in extra growth only in transplants that were grown for 40 days or more. Shorter growth periods apparently did not result in sufficient overall root development. Inoculation with arbuscular mycorrhizal fungi may improve transplant development if they are grown for a longer period.Their study has demonstrated that better quality transplants can be obtained by growing watermelon seedlings in plug cells of 100 ml volume rather than in smaller cell sizes. In addition, mycorrhizae fungi may have an added benefit if the plants are grown for at least 50 days. However, profitable production of quality watermelon transplants can be achieved in 80 and 60 ml cells of at least 40 days growth along with inoculation with the *Glomus mosseae* arbuscular mycorrhizal fungus.

Pest and disease management

The primary means of controlling disease and pests on growing vegetable seedlings is by sanitation and by managing the greenhouse environment to avoid pest and disease development through prophylactic measures. Control of weeds inside and surroundings of the greenhouse is most important which may harbor many diseases and pests. If the portrays are reused for growing of seedlings, they must be washed to remove any soil or growing media which may remain adhered to the plastic trays. If signs of damping-off diseases are noticed in the greenhouse, seedlings can be treated with Mancojeb (0.25%) or Carbendazim(0.1%) fungicides solution prepared in water either through spraying or preferably drenching. Foliar fungicides spray should be avoided under high-temperature conditions, which may injure tender foliage of newly growing seedlings. Besides damping-off damage of *Pythium* and *Rhyzoctonia* disease have been also seen within the greenhouse. These diseases often flourish in damp parts of the greenhouse and where algae and moss are allowed to grow, and will spend part of their lifecycle in the soil beneath the benches. Therefore, observance of proper sanitation and prophylactic measures are the pre-requisite for avoidance of pest and disease incidence.

Table-5: Expected economics of plug-tray nursery raising in cucurbits and expected employment generation.

Singh *et al* (2010)

S. No.	Size of nursery greenhouse	No. of possible seedling batches	Estimated total number of seedlings (lakhs)	Expected net profit (lakhs)	Expected employment generation
1.	500 m2 naturally ventilated with foggers only	4 three winter (Dec. to Feb.) one rainy season	12.0 (in four batches)	1.5	150 days x 4 persons = 600 man days

A field experiment was conducted in Andhra Pradesh, during the summer and kharif seasons of 1997-98 and 2000-01, by Rahman et al. (2003). They reported that soil solarization with white polythene sheet for 30 days during the peak of summer resulted in the lowest incidence of damping-off in tomato (3.9%), aubergine (1.5%) and chilli (1.3%) caused by *Pythium, Fusarium* and *Phytophthora*, followed by seed treatment with captan. Among the fungal antagonists, *Trichoderma viride* recorded the lowest incidence of damping-off (5.7% in tomato, 4.7% in aubergine and 4.7% in chilli) followed by seed treatment with *Pseudomonas fluorescens, T. harzianum* and *Azotobacterchroococcum* which were at par with each other. They concluded that the occurrence of damping-off disease in nurseries, can be effectively controlled by soil solarization of nursery beds during the peak of summer or seed treatment followed by soil application with *Trichoderma viride*.

Sometimes, algae become a serious problem on the surface of coco peat mixture or growing medium because it tends to form a crust which makes difficult to wet the portray mixtures during routine irrigation. The use of vermiculite for covering the surface of newly seeded trays will help prevent algae problem to interfere with the seedling growth.

Hardening techniques

Hardening-off seedlings is very important, especially if they are to be planted under stressful, early-season conditions. Withholding of the irrigation of the seedling two days before transplanting makes them ready to face the situation in the field and ensures better establishment and less mortality. Seedlings should not be harden-off by withholding fertilizer as this can result nutrient deficiencies and can delay field establishment. Besides this keeping of plants outside green house under ambient conditions for 5-7 days can also be practiced. This allows plants to become acclimatized to the field conditions while they are still in the protrays. Plants should be held in an area that is exposed to full sunlight, but is protected from desiccating winds. The plants should be observed regularly and watered as required. If a risk of frost the plants should not be moved inside the polyhouse.

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Commercial Orchids Production under Protected cultivation by Amateurs….

Anand Zambre
National Committee for Plasticulture Applications in Horticulture (NCPAH),
MoA & FW, GoI, New Delhi, India, ed@ncpahindia.com


Anand Zambre

Introduction

Orchids cultivation under protected cultivation in India is still a new concept and very few farmers are successfully growing orchids in India. We got an opportunity to visit one of such successful projects near Bhubaneshwar in Odisha where a retired army officer after his retirement decided to grow orchids under polyhouses. Orchids cultivation is considered as a difficult crop to grow as the plants need low light intensity, high humidity and moderate temperatures. Thus, controlling climate is a key issue in growing orchids along with other issues like high investment, skills and knowledge in IPM, INM, cultural practices. Mr. Mohanti along with his wife decided to take a challenge of cultivating Orchids and within a span of 18 months, he managed to be a successful grower of Orchids and set a good example for other farmers in Odisha and pan India.

After serving in the Indian Army for 22 years and working for 5 years in the corporate, he decided to come back to his Hometown Bhubaneswar. He joined his very dear friend in his Engineering Consultancy Firm and his wife, Monalisa was weighing various options of how to contribute positively and be part of a growth story. There was always an urge to do something, and get associated with such a Sector, where one could add value and contribute in the economic growth, no matter how big or small it may be.So, theystarted exploring various options during August 2017 like starting a NGO with a social cause, disposal of solid waste, setting up an Engineering Testing Lab or farming. Finally, they homed on to do something in the field of horticulture. Due diligence and homework started by meeting the experts in the field, visiting institutions, farm houses in Odisha, Goa, North East, and Pune. They zeroed on to "Orchids Cultivation" to start with and then expand to other fields after establishing a firm foothold. Now the question arises; why orchids? Well, Orchid is considered amongst top ten beautiful and highest selling flowers in the world, it is a hardy plant, the cut flower has a long shelf life and to top it up, we have a high potential to grow orchids in a conducive coastal climate and last but not the least; there is an wow factor associated with this beautiful flower.


Orchids in polyhouse

Now, the idea is ready, concept chalked out but where is the land? Like a divine blessing; they got the permission from one of his very close childhood friend's mother to use their land for farming. There was no looking back after that. They applied for subsidy to the Horticulture Department, Odisha and it was amazing to see the support and help extended by the Government officials to keep the ball rolling for them and expedite the sanction process.

Important check points before starting the project:

They received the subsidy sanctioned in February, 2018. The Project of orchids cultivation started on 01st Mar 2018.

Before proceeding any further in the Project, the conflict started in decision making process, whether to go in for a poly house or grow the orchids in shade net house which was the general practice at that point of time in Odisha state. The school of thoughts in favor of shade net house highlighted better ventilation and free air movement, rain water which is good for orchids, less temperature built up and low cost. However, just one point intrigued them is the likelihood of excessive retention of water in the media (Coconut husk) during monsoon which is like cyanide poison for the plants and subsequent decomposition due to continuous wetting of media. They finally decided to go in for the Polyhouse and today are happy for taking that decision. And probably orchids started growing in the Polyhouse for the first time in Odisha.

Second important aspect was to check the quality of water before starting the Project. Though they had a bore well, it was lying defunct for last few years without a pump. He activated the bore well, took the water sample, got it tested and it failed, pH value being highly alkaline. They realized, because of lack of use of bore well, the water might have become more alkaline. They continued doing pumping of water from the bore well for couple of days, and again got the water tested. Fortunately, the water parameters matched the requirements in terms of pH, TDS (Total dissolved solids) and EC (Electric conductivity).

Third important aspect which was needed attention was the siting of the Polyhouse. Being part of the cyclonic zone, the 6.5 mtr high Polyhouse (at the ridge) needed to be sited in such a way that it takes inherent advantage of the naturally available wind barrier in terms of trees all around, at the same time, care has to be taken so that the structure is not very close to the nearest tree line. After due diligence, the lateral distance between the polyhouse edge and the nearest tree line was kept 1.5 times the height of the trees.

Salient Features of the Polyhouse and Plantation:

- Polyhouse with gutter height at 4.5 mtr and ridge height at 6.5 mtr.
- 200micron UV stabilized Infrared (IR) cooled 5layer white colored poly film.
- 115 GSM, UV stabilized, mono filament, black colored 50 % shade net with sliding mechanism was used. This is required for controlling the lux level.
- Multi-level irrigation system (micro sprinklers, fogging and misting system) to address each layer of strata within the Poly house.
- Application of pesticide and fertigation through pumping system.
- Timer based air circulation fans, which create a gentle breeze and keep the orchids happy during the hot and humid tropical summer.
- Solar fencing system has been erected all around the Polyhouse to save the valuable orchids and the structures from wild animals. This fencing is friendly as far as life of animal is concerned and not so friendly if they want to trespass.
- 45,000 ltrs semi underground water sump with CGI sheet cover.
- Rain water harvesting done for the surface run off water.
- Dendrobium orchids comprising of 80% Earsakul Sonia and 20% Singapore / Sanan white were planted in the Polyhouse.
- North-South alignment of the benches on which the orchids were planted keeping in mind the movement of sun.

The site clearance, construction of associated infrastructure and plantation work was completed in a record time of four and half months on 18th Jul 2018.

Challenges faced:

- Torrential rain: After the plantation work on 18th July, they went out for a short vacation. There was very heavy rainfall in Bhubaneswar on 21st July. Though the Polyhouse could withstand the rainfall from the top, the ground slope created the havoc. There was gush of water towards the Polyhouse because of the sloping ground, the side curtains could not sustain water pressure and it got sheared off from the top. The entire Poly house was flooded with water. It was a herculean task to drain off the water in next couple of days. One can well understand the agony of doing repair work, just three days after the successful completion of the Project. They remain ever grateful to the Erector, who immediately mobilized his team from Pune and we got it back to shape. A lesson was driven home and we created a two feet deep water channel parallel to one side of the Polyhouse to protect it from flooding in future.
- Snake enjoying the warmth of coconut husk: One fine morning, when applying the fertigation, some movement was observed on the bed where the orchids are freshly planted and there it was, a two feet long snake all coiled up. Not to blame the poor creature as we are invading into their territory! After a bit of deliberation, they placed the carbolic acid in bottles with the caps pierced at different locations so as to prevent entry of snakes.
- Elephant's visit: Slowly the winter set in and paddy harvesting started. This is the party time for the pachyderms. In fact, a lone elephant visited the farm house one night but was effectively stopped from entering the Polyhouse because of the solar fencing.
- Devastation by cyclone 'Fani': Then came the months of summer and the blooming of flowers had already started. As if the nature God was trying to test the perseverance of the orchids, they heard the announcement of a very severe cyclone going to hit the coastal belt of Odisha. They had two days' time in their hand. They took four important steps. Rolled down the side curtains and tucked it firmly to the framed structure, tied up the retractable side nets into bunches like thick cylindrical ropes at the roof level to prevent it from getting torn by the cyclonic gush of wind, filled up the water sump apprehending power break down for at least ten days, charged the emergency high beam torch lights. Then came the cyclone 'Fani' with all its fury on 03rd May 2019. The wind speed touched 185 Kms per hour and it was a total devastation with thousands of trees and electric poles uprooted, roof top blown away, hoardings gone and dish antennas flying in the sky. Anyway, with lots of difficulty by avoiding the fallen trees on each and every road, he and his friend could reach the farm house riding a bike. It was a heart wrenching scenario out there. Hundreds of mango trees gone with almost 8 to 10 thousand Kgs of mangoes strewn on the ground. Finally, they could reach the Poly house location and noticed the following damages:
  - 40% of the poles tilted to one side.
  - One odd pole sheared off from the foundation bedding.
  - The entire poly film torn into shreds and lying scattered on the ground.
  - Solar fencing damaged at couple of places because of trees falling on it.
  - CGI roof top of the water sump gone and along with it half of water was just sucked out of the sump and gone by the cyclonic wind.
  - Electric pole inside the farm house uprooted.
  - Flooding due to accumulation of rain water but not as intense as it was on 21st July 2018.
  - Couple of benches the net portion had caved in.

Overcoming the disaster of 'fani':

04th May 2019, the day after 'Fani' was a clear sky and piercing bright sunlight and all orchids were braving out the scorching summer heat in the coastal area. The boys working in the Farm House had all tears in their eyes and said, "Saab everything is finished".

A quick assessment at site made them realize that they had to provide the shade to all the plants ASAP if they have to give a second life to the orchids. Couple of more days of direct exposure to the piercing sun, and that would be the end of orchids and their dream. By God's grace not a square inch of the retractable shade net was torn as they had rolled it and tied it up before 'Fani'. They called the boys together and said, "If we decide to save the Project, we are ready to spend but you should also be ready to give your 24x7 for next few days". They said they were ready and one of the boys said he would first get the farm house in order then go and repair his house in the village. That was the end of discussion and the herculean task of revival started. Climbing up the poles and opening up the net started. It was a difficult task; the knots were tightened because of high wind pressure. But there was no going back, the work continued in the night and the charged high beam torch light was handy. It took almost two days' time to spread the shade net and fix it to the Poly house frame.

Second task was to give a kind of protection to the plants to save them from probable fungus attack and they sprayed fungicide manually as the electrically operated system was out of service.

Next criticality was the irrigation, which was of paramount importance to beat the summer heat and drying up of the media (Coconut husk). There was a respite because of the rainfall post cyclone, the media was fairy wet. They had approximately 25,000 Ltrs of water still left in the sump. Manual irrigation started by boys and by hiring labour. Slowly the water was getting depleted from the sump and getting the electricity restored was next to impossible. And they never had a generator.

Next task was to get a generator, which could run bore well and sprinkle irrigation system. The requirement was 7.5 KV DG set but getting it from a branded company was costing something like two lacs rupees including the transport from Kolkata. All generators in Odisha were sold out and not available. Then started the process of exploring the market and finally, homed on to a locally assembled DG set which was producing a lot of noise at one fourth price. They got the normal electric supply back after almost a month. The DG set is still working fine in their farm house.

Unfortunately, the project was not covered under insurance. It was not that we did not try for it but none of the insurance companies was forthcoming in getting the Polyhouse insured, might be because of the high-risk factor.

Mr. Mohanty giving information on his Orchids Project

Back to normal:

It took more than a month to get the situation under control and the orchids fought like brave hearts to withstand the vagaries of nature. For the last three months they are getting exquisite blooms and achieving operational break even. They have been harvesting approximately 10,000 sticks every month on an average out of 25,000 orchids planted in the Polyhouse. Challenges are plenty as they are dealing with life of plants. But it is 100% doable because amateurs like them without any knowledge on orchids couple of years back can say it and show it with confidence that there is immense potential in this field provided, we adopt a scientific approach, follow the discipline, process, protocol and proactive. Most important being the human factor; nothing succeeds if one does not have the right Team on ground.

They believe in sharing of knowledge and welcome the budding entrepreneurs and enthusiasts to visit their Farm House. They take pride on their abilities to assist and educate visitors about setting up the infrastructure for growing orchids, and hope visitors would gain better insight of the entire process and would adopt a holistic approach to set up their own enterprise. If required, they can provide the consultancy and assist in setting up of the project.

It was really a dream came true for Mrs and Mr. Mohanty as we saw rich flowers in his polyhouse. In his words, dream big, do bigger, work harder and fight till you achieve dream…

We learnt a lot from this couple during our visit to his farm. I am sure the surrounding farmers and young students who visited and will visit his farm and speak to him, will surely get motivated to start their own projects. My salute to Mrs and Mr Mohanty for their grand success, successful efforts and positive thinking that made them successful farmers.

Col Sujan Mohanty (Retd) and Ms. Monalisa Mohanty

Orchids n More
www.orchidsnmore.com
Mob: 85990 82300

Note: Above story narrate the hidden happening in a venture for which one should be careful to meet the challenges.

Hydroponics: A Future Technology for Urban Horticulture

S. R. Singh and S. Rajan
ICAR-Central Institute for Subtropical Horticulture, Rehmankhera, Kakori-226101 Lucknow U.P.

S. R. Singh

Green revolution efforts are being neutralized by faster growing population. One fourth population of the nation is malnourished due to imbalance diet in spite of sufficient food availability (FAO, 2012). The fruit and vegetable can mitigate these problems as they are rich in minerals and vitamins. Faster urbanization and diversion of agricultural lands in developmental works and expansion of cities has put much pressure for higher production from a small piece of land. Rural-to-urban migration, have profoundly enhance the proportion urban population. Though government has secured the people for food but these are not sufficient to solve the malnutrition problem. Balanced food is needed for 32 % urban people of the nation which presently being catered from rural areas by using intensive cultivation and faster transportation involving a huge amount of non renewalenergy. Due to further increasing of urban periphery, more and more rural areas are becoming part of peri-urban and urban.Immense population pressure, increasing food prices, socio-economic and environmental stresses, especially in the urban areas, making the food, nutrition, health and environmental security a serious challenge (Devakumar and Chhonkar, 2013). The main purpose of urban horticulture is to meet part of food demand of urban population by judicious utilization of land and other available resources, although small land holding and uncertain climatic conditions, insect pest infestations restricts regular and higher production. **Hence hydroponics may play an important role in order to produce maximum food with efficient input use, and low climatic and insect pest risks.** The hydroponic farming has efficiency to increase the many fold production by using the roof and defective land with multiple cropping under adverse climatic situation with minimum external inputs and energy. This technology is highly productive, amenable to automation, suitable in areas with water scarcity, degraded and sick lands, roof top and indoor of buildings.

Hydroponic is a method of growing the plant without soil by using the inert medium and adding the nutrient solution all elements needed by plants for its optimum growth and development.

The hydroponic system has many advantages over the conventional growing system.

- It needs 70-80 percent less water.
- More production per unit area with additional possibility vertical farming
- Optimization of nutrient is possible for different crop.
- Less infestation of disease and pest due to control conditions, balance nutrients and devoid of soil.
- It can address the problem of residue free, natural antioxidant rich fresh horticultural produce.
- Space available at roof top, indoor can be productively utilized and aesthetic value may be increased instead of fresh farm produce for consumer of vicinity (reducing the transport cost and environmental concerns)

Limitations

- High initial investment cost
- High degree of management skill
- Less number of high value crops for Indian consumers preference

Designs of hydroponics:

The three main types of hydroponics are prevalent.

1. Liquid hydroponics: In Liquid hydroponicsonly, the nutrient solution used.

It may be classified as

I. Circulating type:
- Nutrient Film Method
- Deep Flow Method

II. Non circulating type (open system)
- Root dipping method
- Floating method
- Capillary method

2. Solid hydroponics: The method has a solid medium for the roots It may classified as
- Hanging bag method
- Grow bag method
- Trench method
- Pot method

3. Aeroponics System
- Root mist system
- Fog feed system

Component of Hydroponic system: A hydroponic system needs following component which varied according to structure size and resources.

Water Pump: The parts of water pump should be non reactive with nutrient salt solution. Pump with very high head does not require in hydroponics systems for solution circulation. As the nutrient solution more effectively conducts electricity compared to water hence a safety device is necessary with the water pump for safe operation. A trip switch should be used to disconnect electricity supply whenever it needed.

Nutrient and oxygen regulation sensors: Small plant needs less oxygen than Therefore; the nutrient solution circulation span can be reduced during

initial growth period of the plant which can reduce the electricity consumption. Automation by using timer could reduce energy consumption and can enhance the nutrient use efficiency. Inclusion of oxygen concentration detection sensor is necessary for optimum circulation of oxygen for maximum plant growth. The sensor automatically activates the pump,whenever the oxygen concentration is low nutrient solution.

Channels or growing structure: Growing structure is made of according type hydroponic systems. Aeropoics require a frame box with fogger or mister. A nutrient film technique requires foodgrade PVC pipes for circulating nutrient solution as the channels. UV stabilized channels pipes are more durable and sustainable. Painting of these pipes white paint will prevent the increase intemperature of nutrient solution during the summer as higher temperature reduce the root activity and nutrient up take of plant which effect growth. The flow rate required in hydroponics is kept 2 litres per minute. To adjust the flow rate an over-flow pipe will have to be fitted in the system. Ebb and flow system require a shallow water tank of stainless steel or plastic with growing trays whereas drip system of hydroponic needs grow bags or grow channel with drip nutrient supply system

pH and EC Meters: EC and pH meters are essential component of hydroponic system. In commercial production system automatic EC, pH and temperature recorders are placed to check the EC, pH and temperature nutrient solution. In small home garden units to monitor and regulation of the EC and pH of nutrient solution one can use ordinary portable EC and pH meter.

Blowers: It maintainsthe air circulation through the plants so that to avoid fungal disease and distribution of pollens to facilitate pollination inside protected structures. Some pollination devices may alsobe used in place of blower for efficient pollination in cross pollinated crops. This device shakes the individual plants to facilitate the pollination under the protected structures.

Nutrimeter: To measure the nutrient content of the solution nutrimeter would be essential if EC and TDSare not monitored properly.

Nutrient solutions

Plant nutrients of hydroponics systems are in inorganic and ionic form. The nutrient dissolved in water in cat ionsforms are

- Calcium (Ca2+)
- Magnesium (Mg2+)
- Potassium (K+)

The major nutrient anions in nutrient solutions are:

- Nitrate (NO3)
- Sulfate (SO4)
- Phosphate (H2PO4)

Hydroponic solutions:

Use different combinations of salts to prepare final composition of nutrient solutions for hydroponically grown plants.

Most commonly used salts for the macro-nutrients are;

- Potassium nitrate -KNO3.
- Calcium nitrate - Ca(NO□)□
- Potassium phosphate- KH2PO4
- Magnesium sulphate - MgSO4

Essential elements to supply the micro-nutrients of the plantsto be added to hydroponic solutions are

- Fe (Iron)
- Mn (Manganese)
- Cu (Copper)
- Zn (Zinc)
- B (Boron)
- Cl (Chlorine)
- Ni (Nickel)
- Chelating agents are used to keep Fe soluble.
- Many variations of the nutrient solutions used by Arnon and Hoagland in 'Modified Hoagland solutions' and are widely used.

Nutrient elements and their acceptable concentration in a hydroponic solution:

Element	ppm in solution	
	Range limit	Average
Nitrogen	150-1000	300
Calcium	300-500	400
Magnesium	50-100	75
Phosphorus	50-100	80
Potassium	100-400	250
Sulphur	200-1000	400
Copper	0.1-0.5	0.5
Boron	0.5-5.0	1.0
Iron	2.0-10	5.0
Manganese	0.5-5.0	2.0
Molybdenum	0.001-0.002	0.001
Zinc	0.5-1.0	0.5

ppm - Parts per million (1 mg in 1000 ml water)

Environmental requirements of hydroponic: Specific environment is required for quality yield production crops. Environmental conditions, water quality, physiochemical status of substrate, frequency and doses of irrigation, crop management and quality of light effect the crop yield and quality under hydroponics.

Light: The requirement for light is just as essential for plants grown hydroponically as for those in soil. When plants are grown hydroponically outdoor one may rely mostly on solar radiation, while growing plants indoor it is necessary to provide artificial illumination. In the past, balance has been achieved by using a combination of fluorescent tubes and ordinary sodium lamps, so that both the blue and red ends of the spectrum were present respectively. Now days, LED light emitters may be preferred. Photosynthetically active radiation (400-700 nm) is essential is artificial lighting is required. Generally, areas with good sunlight do not require artificial lighting.

Temperature: A favourable temperature is as important for plants in artificial culture as for those in soil. The night temperature profoundly affects stem growth and fruit setting. Leafy vegetables are preferred option for hydroponics system to avoid

high nitrate and pesticide residue levels as they consumed fresh. For leafy & exotic vegetables temperature range of 15-18°C is optimum although they can tolerate as low as 7°C temperature. Temperature range of 15-32°C for cucumber and 18-27°C for tomato and capsicum are optimum for crop production.

Water: Water quality is an important component of hydroponics as it directly affects the nutrient availability. Hydroponically grown plant prefers slightly acidic growing conditions than a geoponic plant. Between pH range 5.5 to 6.5 most of nutrients becomes available hydroponic plant. Hence neutral water is preferred for the system.

Aeration for the roots: In order to absorb water and nutrients, the roots require a certain amount of oxygen. Plants do not grow well in water logged soil devoid of air space and most plants do not grow well in water culture unless provision is made to aerate the solution by circulating it or by bubbling air into it. The solubility of oxygen in water is low (0.004%) and further decreases with increase in temperature.

Anchorage: For plants growing in soil, sand or gravel culture anchorage is not a problem. However, when plants are grown in water culture, it is necessary to provide some mean of support for the seedlings (like clay balls filled in the plastic mesh cups) and later the plants above the nutrient solution (stacking threads or wires) to allow plats to grown vertically.

Standardisation package of practices hydroponics in subtropical region

The successful attempts of standardization of hydroponics technology **package of practices** for subtropics, Indian Council of Agriculture Research - Central Institute for Subtropical Horticulture, Lucknow started to standardize the cultivation of vegetables, herbs and strawberry as well as hydroponic propagation of plants under subtropical climatic conditions. The Institute has demonstrated four hydroponic system, i.e., aero-ponic system, ebb and flow system, NFT system and drip hydroponic system with help of Rastriya Krishi Vikash Yojana U.P. Government. Suitability of crop varieties, hydroponics system suitability, ideal microclimate, light intensity, nutrient, water temperature, Electric conductivity, and pH concentration has been standardized for optimum production of high value horticultural crops.

Strength of nutrient solution is measured through electric conductivity but it measures as whole strength of solution and does not indicate one or more nutrient are out of balance. Low conductivity implies low nutrient concentration which results low growth rate of plant. Higher conductivity leads to more yield but one be careful as higher conductivity may damage the plant, hence optimum conductivity for each crop should kept for maximum productivity.

pH concentration regulates the nutrients uptake of the crops. A high pH can reduce the availability of iron, manganese, boron, copper, zinc and phosphorus where as low pH reduces the availability potassium calcium sulphur, calcium and magnesium. Optimum range of pH, EC, and TDS has been standardized for subtropical regions

Crop	pH	EC (mS/cm)	TDS (ppm)
Capsicum	6-6.5	1.8-2.2	1250-1540
Tomato	5.5-6.5	2-5	1000-2500
Lettuce	5.5-6.5	0.8-1.2	400- 850
Pak Choi	6.5-7.0	1.5-2	1050-1400
Cucumber	6.0-6.5	1.7-2.4	1150-1750

The nutrients for nutri-rich high value vegetables and strawberry plants have been standardized.

Drip system hydroponic

Smart nutrient solution for all crops

Propagation of guava

Tomato under NFT

Lettuce in Aeroponics

Keeping in view the importance of soil less culture in urban and peri-urban areas CISH, Lucknow has started designing the low-cost vertical hydroponics systems for vegetable growers. Four to five layered vertical structures developed to increase the productivity manifold on roof top or indoor gardening of vegetables and ornamentals. The Nutrient Film Technique Modals and media-based model has been designed according to need of growers. The nutrient kit with management of nutrient concentration, electric conductivity and pH of the system has also being provided to the growers for easy growing of the crops.

Vertigo Hydroponics

SinglerowDouble-row

Triangle

Conclusion:

Hydroponics is potential technology to transform urban horticulture scenario. Health consciousness of people, high incidence of fatal diseases due excess of residual pesticides in horticultural crops, inclination towards green living have forced people to adopt the reliable system of crop growing which could offer ample opportunities to supplement the fresh safe and healthy, pesticide free, natural antioxidant rich produce. The hydroponics technology can offer the livelihood opportunity in vertical farming system for roof and indoor gardening. The round the year production possibility makes it more promising for supply the horticulture produce at lucrative prices.

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GLIMPSE OF RESEARCH ON VERTICAL VEGETABLE PRODUCTION AT ICAR—CISH, LUCKNOW, UP

Mr. Ganesh Mhaske

Company Name	:	GM Greenhouse
Location	:	Talegaon Dabhade, Pune
Proprietor	:	Mr. Ganesh Mhaske
Phone	:	9604111010
Email	:	gmgreenhouses@gmail.com

The fully automated greenhouse area 2000 sqmtr constructed by GM GREENHOUSES for M/s. Kevin Infrastructure company, Banglore, has the latest and most advanced technology to create an ideal growing environment for the respective crops by controlling the optimal temperature, humidity, EC/pH, timing for irrigation and many more parameters. This is essential for practicing precision hydroponics NFT Gully system, where each crop gets the ideal climatic conditions and nutrition for healthiest crop.

Vertical Strawberry Gardens –Tourist Attraction

T. Janakiram
Assistant Director General (HS), ICAR, New Delhi-110012

T. Janakiram

Mahabaleshwar is synonymous with strawberries and is also known as the Land of Strawberries.Strawberries are known for its delicacy and value-added products like strawberry jellies, fudge and even a strawberry pizza. Strawberries were brought to the region from Australia by the British during the British rule. As of late 2015, it is grown in an estimated area of 3,000 acres with about 30,000 metric tonnes of the fruit being produced annually. It contributes to about 85 percent of the total strawberry production in the country.

The region between Mahabaleshwar and Panchgani is known for large-scale strawberrycultivation due to its climate being cool, stable, and dry. Strawberry plants mainly thrive in regions where the temperatures range between 18 °C and 25 °C.

Farmersmostly cultivate the plants growing in rows. However, these are sometimes grown in vertical stacks as well using thermocol and card board structures supported by iron frames and provided with fertigation facility. Bhilara farm cultivates strawberries in 3-4 acres of which one acre is dedicated for verticalfarming. The farmer is cultivating two varieties namely Nabila and Winter Dawn. The crop is taken in 6 months from October to March. Thepotting media included cocopeat and soil. Four plants are accommodated per pot and the pots are arranged in such a way to allow sun light in equalproportion. Nearly 50 fruits are harvested per pot per month which yields 300 fruits in 6 months. Vegetables like broccoli and cauliflower are planted at the base of the vertical poles for additional income utilizing the ground space. The fruits are sold at Rs 400 per Kg. The strawberries are first plucked and then segregated depending on their size and quality

The vertical farming attracts many tourists during the harvesting season, pickers are given boxes to enjoy harvesting of tasty strawberries. This is an awesome activity to indulge in with the kids. It teaches them about the ecology and cultivation; while at the same time they get to taste delicacy of farm fresh strawberries.

Every year Strawberry Festival attracts many tourists and they are allowed to pick but also to eat as many strawberries as they like. The farms are open for this purpose.

The Mahabaleshwar strawberry is a seasonal fruit with the usual season lasting between October–November and April–May. Mother saplings, some of which are imported from Californiain the month of June, are planted in nurseries in places like Wai. The runners produced by each of these saplings are replanted in the month of September. The land is prepared after the monsoon season in September by fumigation and covering the fields with plastic sheets. The saplings are planted in holes punched through these sheets and all cultivation practices are followed like application of fertilizersetc.

Mahabaleshwar strawberry is used in making various food products in the region such as preserves, jams, fruit crushes, ice-creams, milkshakes, strawberry with fresh cream, strawberry fudge, strawberry wine and jelly toffees.

Photographs from Facebook

Prof. Brahma Singh Horticulture Foundation, BSHF

Registration No.1590; 03 October 2019

E-713, Mayur Vihar, Phase-2, Delhi-110021

brahma88@gmail.com

Activities of the foundation

a. To organize national and international horticulture and associated sciences congress, conclave, seminar, conference, workshop and meetings.

b. To organize exhibitions/ trade fairs on horticulture and associated subjects.

c. To promote horticulture education, research and development.

d. To recognize contributions in horticulture and associated subjects by way of awards.

e. To undertaking, support, outsource innovations and productive research.

f. To promote secondary horticulture/protective horticulture/hi-tech horticulture/vertical farming/high value crops/products and alike subjects.

g. Search for innovative horticulture crops and farmers and consumer's friendly horticulture marketing and other post- harvest activities.

h. Promotion of linkages and cooperation among national and international horticultural bodies and institutions both in public and private sector.

i. To work in national and international collaborative mode for promotion of horticulture.

From this issue onwards the BSHF would publish New Age Protected Cultivation e-Magazine

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